PILOT PLANT AND LABORATORY TESTWORK

on Cirque Bulk Pilot Plant Samples
submitted by

CURRAGH RESOURCES LTD.

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Project No. L.R. 4086, 4123

NOTE:

This report refers to the samples as received.

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LAKEFIELD RESEARCH
A DIVISION OF FALCONBRIDGE LIMITED
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Discussion - Continued

ABSTRACT

Pilot plant testwork was conducted on bulk ore samples from the Cirque deposit. The purpose was to evaluate the flowsheet and reagent scheme developed In the laboratory in a continuous pilot plant operation. Additional laboratory testwork was also carried out on pilot plant samples mainly to aid pilot plant operations.

Initial pilot plant testwork was conducted on Ore Type 5 and a mixture of Ore Type 5 and Ore Type 4. In these Initial tests, poor metallurgical results were obtained. The main reason for this was the fact that because of the complexity of the flowsheet, rapid identification of the operating problems was not possible. After Test PP-9 the pilot plant was stopped and additional laboratory testwork was carried out.

After completion of laboratory testwork, the pilot plant operation was resumed with adjusted circuit and operating parameters. The results obtained in this second part of the pilot plant operation were considered satisfactory. Table No. 1 compares the metallurgical results obtained In a laboratory continuous locked cycle test and In the pilot plant.

TABLE NO. 1 :
Comparison of Laboratory and Pilot Plant Results - Pilot Plant Composite

Test No.	Test Type	Product	Weight %	Assays %, g/t			% Distribution		
				Pb	Zn	Ag	Pb	Zn	Ag
F-17	Laboratory Continuous	Pb Concentrate	4.3	60.2	1.81	-	81.0	0.6	-
		Zn Concentrate	16.7	0.72	54.4	-	3.8	94.3	-
		Combined Tail	79.0	0.61	0.59	-	15.2	4.9	-
		Feed	100.0	3.18	9.6	-	100.0	100.0	-
PP16	Pilot Plant Continuous	Pb Concentrate	3.57	70.8	3.61	180	78.3	1.3	13.2
		Zn Concentrate	17.40	1.26	55.0	168	6.8	94.7	60.1
		Combined Tail	79.03	0.61	0.51	16.4	14.9	4.0	26.7
		Feed	100.00	3.20	10.1	62.2	100.0	100.0	100.0

The results from the pilot plant testwork have Indicated the following:

- The semi-bulk flotation flowsheet and reagent scheme developed In the laboratory performed well in a continuous pilot plant operation, except that the reagent distribution within the circuit and the pH values were slightly different than in the laboratory.
- Lead concentrate recovery from most of the ore types Is closely related to (a) fineness of concentrate regrind, and (b) lead concentrate grade (Figure No. 1).

Abstract - Continued

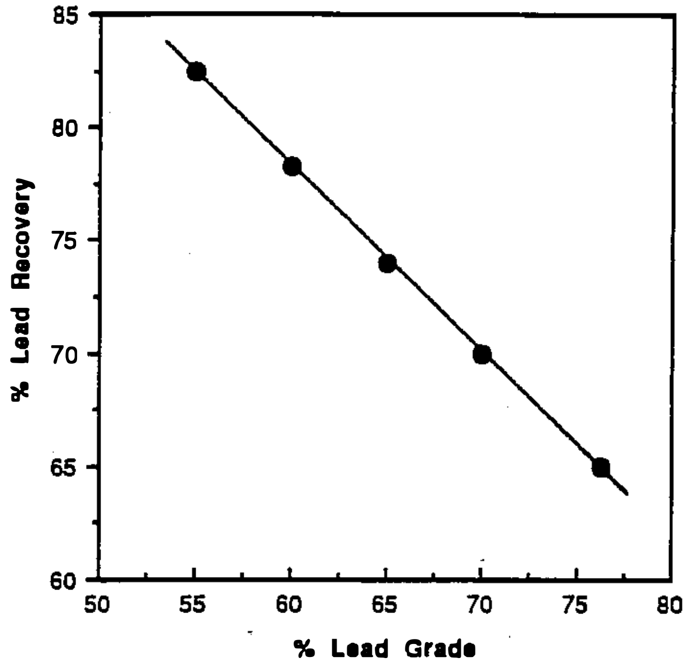

FIGURE NO. 1 : Lead concentrate grade vs recovery relationship

- The flowsheet developed for treatment of the Cirque ore was proven to be flexible enough to accommodate variations in the ore.

This report describes the results obtained in the pilot plant and the laboratory on the pilot plant ore samples.

INTRODUCTION

At a meeting held at Lakefield on December 18, 1990 with Mr. G. McDonald of Curragh Resources and Mr. W. Rosser of Kilborn Engineering (Toronto), the details of the pilot plant testwork were discussed. The major objectives of the pilot plant would be as follows:

- To confirm the metallurgical results obtained In the laboratory In a continuous pilot plant operation.
- To generate data for a feasibility study and plant design.
- To generate sufficient final products (i.e. lead and zinc concentrate) for marketing.

The additional laboratory testwork was carried out between December 20 and January 10 on bench scale ore samples. The Phase 1 pilot plant commenced on January 15 and was run until January 29. Phase 2 of the pilot plant was started on February 22 and was run until February 27, 1991.

During the pilot plant testwork, Mr. McDonald and Mr. Rosser were present to supervise the operation.

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SUMMARY AND CONCLUSIONS

1. Description of Samples Used in the Pilot Plant Testwork

Six different bulk samples were received at Lakefield between January 2 and February 22, 1991 for pilot plant testwork. These samples were identified as follows:

Ore Type 5: was a bulk 100 tonne sample representing ore similar to 70% of the Cirque orebody. This sample was used in pilot plant Tests PP-1 to PP-8.

Ore Type 4 : was a 25 tonne sample of baritic ore and was used for preparation of PP Composites 1 and 2.

Upper Medium Ore: consisted of a 10 tonne lot and was used for preparation of PP Composite 1.

Raise 1 and Raise 2 : were additional 20 tonne (Raise 1) and 10 tonne (Raise 2) samples, Raise 1 ore was used for preparation of PP Composite No. 2, and Raise 2 ore was processed in Test PP-17.

Hanging Wall : material was a 10 tonne lot which was not used during the pilot plant operation.

The second phase of the pilot plant testwork was carried out on PP Composite No. 2 consisting of Ore Type 5, Ore Type 4, Upper Medium, and Raise 1 ores.

Approximate composition of the composite ore samples, according to ore types was: Ore Type 5:Ore Type 4:Upper Medium = 70:20:10.

The head assays of the pilot plant bulk samples and composites are shown in Table No. 2.

TABLE NO. 2 :
Head Analyses of Pilot Plant Samples and Composites

Element	Assays %, g/t					
	Ore Type 5	Ore Type 4	Upper Medium	PP Comp No. 1*	PP Comp No. 2**	Raise 2
Lead (Pb), Total	3.56	2.74	2.61	3.21	2.99	2.79
Zinc (Zn), Total	9.62	0.47	8.59	9.08	9.90	6.65
Lead (Pb), Oxide	0.68	7.79	0.41	0.55	0.50	0.53
Zinc (Zn), Oxide	0.06	0.08	0.09	0.10	0.08	0.066
Iron (Fe)	13.60	9.12	12.10	12.70	12.6	9.72
Sulphur (S)	25.20	25.2	25.60	23.50	25.2	21.3
Barite (Ba)	22.10	32.1	29.2	24.10	26.0	28.5
Carbon (C), Total	0.71	0.49	0.13	0.56	0.48	0.48
Carbon (C), graphitic	0.49	-	-	0.40	-	-
Gold (Au)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Silver (Ag)	67.20	52.2	62.8	61.3	60.0	46.6

* blend of 4, 5 and upper medium (70:20:10) used in Test PP-9 only.
**blend of 4, 5, and upper medium (70:20:10); blended from PP Comp No. 1 and Raise 1 ore; used in Tests PP-10 to 16.

Summary - Continued

2. Processing Characteristics of the Pilot Plant Ores

The flotation behaviour of the pilot plant bulk ore was different than the laboratory composite ore on which laboratory development was performed. These differences were as follows:

- Zinc rejection during lead cleaning was more difficult on the pilot plant bulk ore than on the laboratory composite.
- Carbon content of the bulk samples was much higher than that of laboratory sample. This influences the rate of lead flotation as well as the zinc recovery in the Zn prefloat circuit.

Because of these differences, adjustments In the operating conditions and reagent distribution were required to obtain optimum metallurgical results.

In general, as for the laboratory ore, the pilot plant ore was a finely disseminated massive sulphide ore where the liberation between galena, pyrite and sphalerite minerals occurred at about 10-20 µm size. Therefore, very fine lead regrinding was required to obtain high grade lead concentrates. The relationship between lead concentrate grade and particle size Is illustrated in Figure No. 2.

Other important parameters for improvement in the metallurgical results were flowsheet configuration and application of high intensity conditioning.

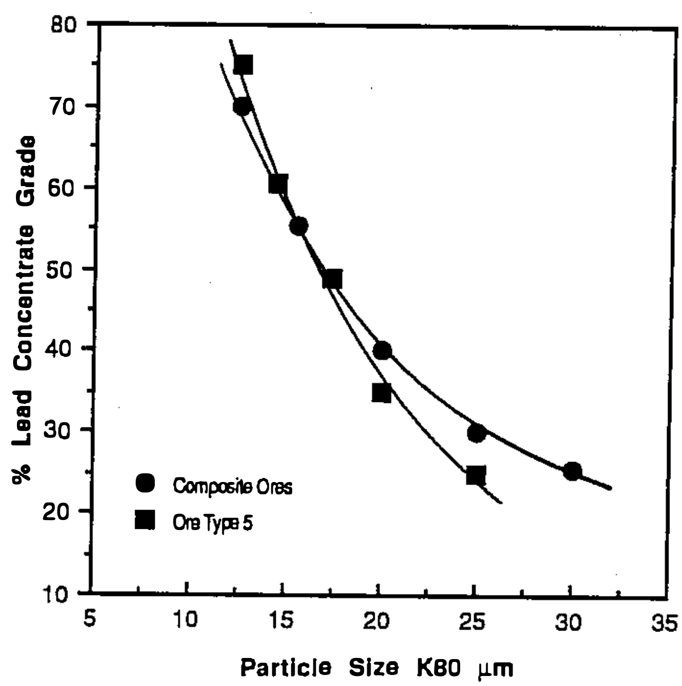


FIGURE NO. 2 : Lead concentrate grade vs K_{80} particle size - calculated values

Summary - Continued

3. Pilot Plant Operation

The pilot plant operation was divided into two phases. Phase 1, the initial pilot plant operation, consisted of 9 single shift tests conducted on Ore Type 5 (8 tests) and PP Composite 1 (1 test). Phase 2 was a 60 hour continuous run conducted 24 days after termination of the initial single shift tests. The continuous test was divided into 7 test periods with PP Composite 2 ore, and one test period on the Raise 2 bulk sample.

The test periods averaged 7-8 hours each. During the pilot plant operation, the following variables were examined:

- basic flowsheet configuration
- high intensity conditioning
- fineness of lead concentrate regrind
- reagent additions, points of addition, and reagent types
- effect of recycle water.

4. Pilot Plant Results - Initial Pilot Plant Operation

The initial pilot plant was started with the flowsheet and reagent scheme developed in the laboratory testwork (Volume 2). However, in this initial pilot plant operation, problems were experienced in achieving selectivity between lead and zinc minerals, as well as in flotation of zinc in the zinc prefloat stage.

During this testwork, extensive changes in the reagents and flowsheet configuration were made. From the results obtained (Table No. 3) the following observations were made:

- Addition of the carbon prefloat in Tests PP-3 and 4 was not effective, and in fact created more difficulties in the lead cleaners because too much frother was used in the carbon prefloat. This produced voluminous froths in the lead cleaners.
- Combined treatment of the semi-bulk tailing and lead rougher tailing for zinc recovery, instead of flotation in two separate circuits, resulted in reduced zinc recovery (Test PP-6).
- Reduction in the lead regrinding capacities and changes in the flowsheet (Test PP-7) resulted in dramatic losses in lead recovery.
- The single test on PP Composite 1 (Test PP-9) gave very poor results.

Because of the poor performance of the initial pilot plant, the pilot plant was stopped and detailed laboratory testwork was performed on pilot plant ore.

Summary - Continued

TABLE NO. 3 :
Pilot Plant Metallurgical Results - Initial Operation

Test No.	Product	Weight %	Assays, %, g/t Pb	Zn	Ag	% Distribution Pb	Zn	Ag
PP-2	Pb 4th Cleaner Concentrate	5.60	50.2	12.8	175	82.9	7.2	18.3
	Zn 3rd Cleaner Concentrate	17.47	0.98	50.4	182	5.0	88.7	59.4
	Zn Combined Tails	76.93	0.53	0.52	15.5	12.0	4.0	22.3
	Cyclone Overflow	100.00	3.39	9.92	62.2	100.0	100.0	100.0
3	C Prefloat Concentrate	7.80	5.65	6.14	95.9	12.3	4.7	11.5
	Pb 4th Cleaner Concentrate	4.07	57.1	13.2	152	64.6	5.2	9.5
	Zn 3rd Cleaner Concentrate	16.03	1.37	52.5	192	6.1	82.0	47.5
	Zn Combined Tails	72.10	0.85	1.16	28.2	17.1	8.1	31.4
	Cyclone Overflow	100.00	3.59	10.3	64.8	100.0	100.0	100.0
4	C Prefloat Concentrate	12.70	5.64	6.16	127	18.9	7.5	21.0
	Pb 4th Cleaner Concentrate	3.80	53.9	19.4	150	54.0	7.1	7.4
	Zn 3rd Cleaner Concentrate	15.18	1.89	50.2	179	7.6	73.1	35.4
	Zn Combined Tails	68.32	1.09	1.88	40.5	19.6	12.3	36.1
	Cyclone Overflow	100.00	3.80	10.4	76.6	100.0	100.0	100.0
5	Pb 4th Cleaner Concentrate	3.90	51.5	19	164	60.9	7.5	10.8
	Zn 3rd Cleaner Concentrate	14.35	1.31	54.2	166	5.7	78.2	40.2
	Zn Combined Tails	81.75	1.35	1.74	35.5	33.4	14.3	49.0
	Cyclone Overflow	100.00	3.30	9.94	68.7	100.0	100.0	100.0
6	Pb 4th Cleaner Concentrate	4.05	57.7	10.3	171	68.7	4.2	10.8
	Zn 3rd Cleaner Concentrate	13.66	1.52	52.3	179	6.1	71.8	38.0
	Zn Combined Tails	82.29	1.04	2.9	40.0	25.2	24.0	51.2
	Cyclone Overflow	100.00	3.40	9.95	66.8	100.0	100.0	100.0
7	Pb 4th Cleaner Concentrate	2.23	55.5	10.7	189	37.1	2.4	6.3
	Zn 3rd Cleaner Concentrate	20.04	5.94	44.2	164	35.6	88.6	49.1
	Zn Combined Tails	77.72	1.17	1.16	38.4	27.2	9.0	44.6
	Cyclone Overflow	100.00	3.34	10.0	73.3	100.0	100.0	100.0
8	Pb 4th Cleaner Concentrate	10.84	23.6	31.5	145	73.1	34.7	27.0
	Zn 3rd Cleaner Concentrate	14.98	2.38	38.8	162	10.2	59.1	41.7
	Zn Combined Tails	74.19	0.79	0.83	24.6	16.7	6.3	31.3
	Cyclone Overflow	100.00	3.50	9.84	62.8	100.0	100.0	100.0
9	Pb 4th Cleaner Concentrate	8.43	25.2	42.1	188	64.4	37.7	23.8
	Zn 3rd Cleaner Concentrate	9.85	3.30	47.3	173	9.9	49.5	25.5
	Zn Combined Tails	81.71	1.04	1.48	41.4	25.8	12.8	50.7
	Cyclone Overflow	100.00	3.30	9.42	64.3	100.0	100.0	100.0

5. Laboratory Testwork on Pilot Plant Ore

The laboratory testwork on the pilot plant ore was concentrated on determining the effect of critical parameters that affected the pilot plant metallurgical results. The parameters included in this evaluation were:

- primary grinding fineness
- lead regrinding fineness
- type of secondary collector
- flowsheet configuration.

Summary - Continued

The results obtained In this testwork showed the following:

- Finer primary grinding reduced lead concentrate grade dramatically (Table No. 4).

TABLE NO. 4 :
Effect of Fineness of Primary Grinding on Lead Metallurgical Results - Locked Cycle Test

Grind K_{80}, µm	Lead Concentrate				
	Weight %	Assays %		% Distribution	
		Pb	Zn	Pb	Zn
81	4.3	60.2	1.81	81.0	0.8
59	6.3	41.6	3.19	81.9	2.1

These results confirmed that in order to produce high grade lead concentrates, coarser primary grinding has to be used. This Is the basic concept on which the flowsheet was originally developed.

- The fineness of the regrind of the semi-bulk concentrate influenced lead concentrate grade significantly (Table No. 5). At reduced regrinding, the lead concentrate grade was reduced.

TABLE NO. 5 :
Effect of Semi-Bulk Regrinding Time on Lead Concentrate Grade

Test No.	Regrind Time, min	Lead Concentrate				
		Weight %	Assays %		% Distribution	
			Pb	Zn	Pb	Zn
F9*	35	4.28	57.1	2.79	76.6	1.3
F19	15	4.10	54.4	3.15	71.5	1.3
F21	60	2.85	62.1	1.54	56.5	0.5

*standard regrind

Very fine regrinding, however, reduced lead recovery significantly.

- Secondary collector addition (Table 6) was beneficial in the following ways:
  - increased concentrate grade from 57% Pb to 70% Pb.
  - reduced zinc distribution into the lead concentrate from 21.1% Zn to 7.0% Zn.

TABLE NO. 6 :
Effect of Secondary Collector Additions

Test No.	Collector Used	Lead Cleaner Concentrate					Lead Rougher Concentrate				
		Wgt %	Assays %		% Dist'n		Wgt	Assays %		% Dist'n	
			Pb	Zn	Pb	Zn		Pb	Zn	Pb	Zn
9	A317	4.28	57.1	2.79	76.6	1.3	18.20	15.0	10.7	85.5	21.1
10	A317 CA830/TH	3.00	70.5	1.13	69.2	0.4	10.41	23.2	6.47	79.1	7.0

Summary - Continued

- The zinc flowsheet configuration was examined in two continuous locked cycle tests (Table 7) where the point of recirculation of the zinc cleaner concentrate was varied.

The recirculation of the zinc first cleaner scavenger concentrate to the prefloat feed instead of to the first cleaner feed improved overall zinc concentrate grade and recovery. The continuous pilot plant was operated with the latter flowsheet, however, because operation of the Zn prefloat in the initial pilot plant was generally very difficult.

TABLE NO. 7 :
Effect of Flowsheet Configuration

Test No.	Purpose	Product	Weight %	Assays %		% Distribution	
				Pb	Zn	Pb	Zn
F-15	Zn Cl Scav Conc recycle to 1st Cl Cond (A317 only)	Pb Cl Conc	4.2	59.0	1.76	79.3	0.8
		Zn Cl Conc	14.1	0.71	47.7	3.2	70.9
		Zn Comb Tail	81.8	0.66	3.28	17.4	28.3
		Head (Calc)	100.0	3.09	9.47	100.0	100.0
F-17	Zn Cl Scav Conc recycle to Pre-float Cond (A317 only)	Pb Cl Conc	4.3	60.2	1.81	81.0	0.8
		Zn Cl Conc	16.7	0.72	54.4	3.8	94.3
		Zn Comb Tail	79.0	0.61	0.59	15.2	4.9
		Head (Calc)	100.0	3.18	9.62	100.0	100.0

In general, the major parameters developed during laboratory testwork and described in Volume 2, were essential in obtaining good metallurgical results. However, readjustment in the point and levels of reagent additions in the pilot plant was necessary in order to obtain froth characteristics and froth loadings similar to those obtained in the laboratory tests. Taking into account these factors, operation of the pilot plant resumed with the second phase 24 hour continuous operation.

6. Phase 2 Pilot Plant Testwork

Phase 2 was a 24 hour per day continuous pilot plant operation divided approximately into 8 hour shifts or test periods, where only basic reagent adjustments in the circuit were made.

The flowsheet and reagent scheme developed in the laboratory were used in these tests.

6.1. Grinding Circuit

In all pilot plant testwork (including Phase 1) a conventional rod mill-ball mill circuit was used. The basic primary grinding flowsheet configuration is shown in Figure No. 3.

Summary - Continued

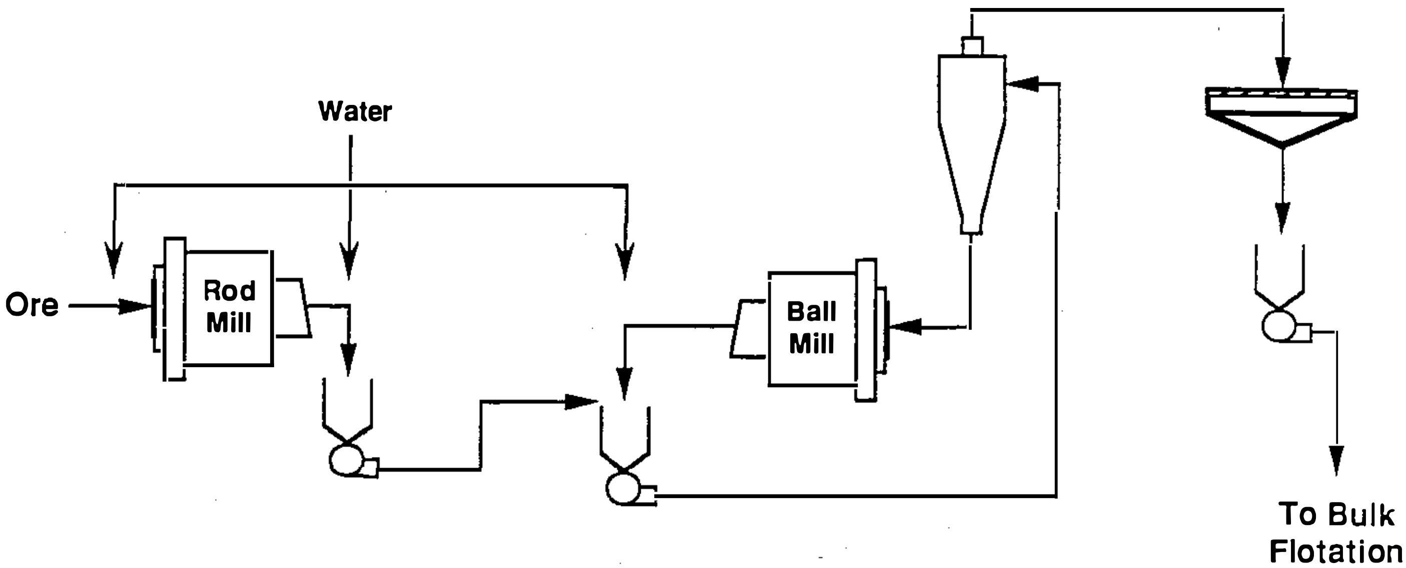


FIGURE NO. 3 : Pilot plant grinding circuit flowsheet

During the testwork, an attempt was made to maintain the fineness of primary grinding at a K_{80} of about 80 µm (±10). The adjustment in the grinding circuit to achieve the required fineness of grind was made by adjustment in steel load and pulp densities.

Because the ore was relatively soft and a low feed rate was used (due to limited amount of ore available), the grinding fineness varied from test to test. This affected semi-bulk flotation recovery and selectivity.

6.2. Regrinding Circuits

6.2.1. Semi-Bulk Concentrate Regrind

The semi-bulk regrinding circuit consisted of a ball mill operating in closed circuit with two 25 mm cyclones (Figure 4).

The semi-bulk concentrate was reground to about K_{80} = 18 µm (±3) which was determined to be manageable in the commercial operation but not necessarily the optimum. Attempts to coarsen the semi-bulk concentrate regrind to about 25 µm resulted in poor lead metallurgical results.

Summary - Continued

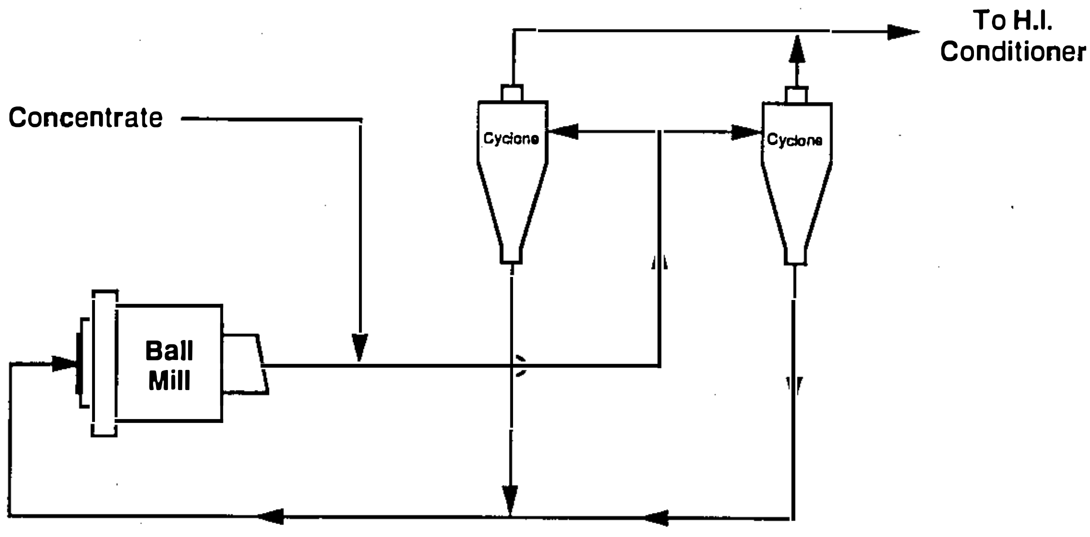


FIGURE NO. 4 : Semi-bulk regrind circuit configuration

6.2.2. Lead Concentrate Regrind

The lead rougher concentrate regrind circuit configuration was essentially the same as that in semi-bulk regrinding (Figure 4), except that a small regrind mill was used.

In this circuit the lead rougher concentrate was reground to about K_{80} = 11 µm.

During both the initial and continuous pilot plant operations, the fineness of regrind was maintained at a relatively constant level. Changes in the mill size only were made.

6.2.3. Zinc Scalp Concentrate Regrind

The zinc scalp regrind circuit consisted of a ball mill operating in closed circuit with a single 50 mm Mozley cyclone (Figure 5) in Test PP-10 and in closed circuit with two 25 mm cyclones in all other tests.

The scalp concentrate regrind fineness varied between K_{80} = 24 µm and K_{80} = 37 µm. This was due to the variation in the mill regrind feed rate and recirculating load of the cyclone underflow.

It should be noted that the zinc scalp regrind produced a coarser regrind than that used in the laboratory testwork, which in turn resulted in lower zinc concentrate grade and recovery. The optimum zinc regrind fineness is K_{80} = 20 µm.

Summary - Continued

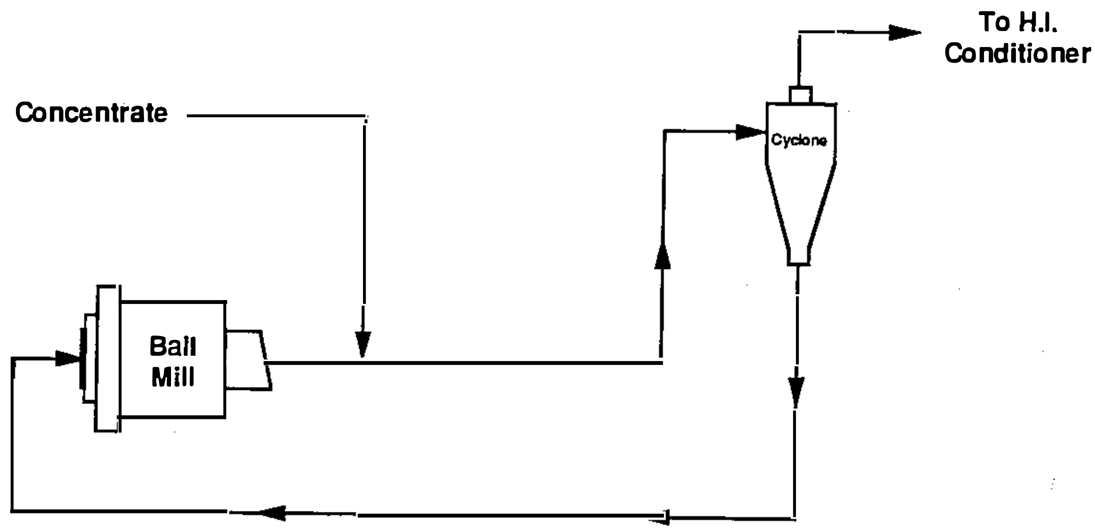


FIGURE NO. 5 : Zinc scalp concentrate regrind (with a single cyclone, Test PP10)

6.3. Lead and Zinc Flotation Circuit

Because of the metallurgical problems in the initial tests, the continuous pilot plant tests were carried out under strict conditions used in the laboratory testwork.

Adjustments were made during the testwork in reagent additions throughout the circuit. Effort was also placed on improvement in the zinc prefloat circuit.

The effect of recycle water was examined in Test PP-16. A single shift test was also performed on the Raise 2 sample (Test PP-17).

The results of these tests are shown in Table No. 8.

The results obtained in the pilot plant and laboratory locked cycle tests are compared in Figure No. 6.

Summary - Continued

TABLE NO. 8 :
Pilot Plant Continuous Metallurgical Results

Test No.	Product	Weight %	Assays, %, g/t Pb	Zn	Ag	% Distribution Pb	Zn	Ag
10	Pb 4th Cleaner Concentrate	3.40	76.9	2.57	169	77.9	1.0	10.4
	Zn 3rd Cleaner Concentrate	18.60	1.27	45.6	166	7.0	92.8	55.6
	Zn Combined Tails	77.99	0.65	0.73	24.2	15.1	6.2	34.0
	Derrick Screen U'Size	100.00	3.36	9.14	62.2	100.0	100.0	100.0
11	Pb 4th Cleaner Concentrate	2.83	76.7	5.06	224	69.2	1.5	10.2
	Zn 3rd Cleaner Concentrate	17.42	1.76	49.4	178	9.8	90.7	49.9
	Zn Combined Tails	79.75	0.83	0.93	31.1	21.1	7.8	39.9
	Derrick Screen U'Size	100.00	3.14	9.49	60.9	100.0	100.0	100.0
12	Pb 4th Cleaner Concentrate	2.88	74.0	6.08	321	64.1	1.9	14.4
	Zn 3rd Cleaner Concentrate	15.56	2.45	50.4	177	11.4	82.9	43.0
	Zn Combined Tails	81.56	1.00	1.77	33.5	24.5	15.3	42.6
	Derrick Screen U'Size	100.00	3.33	9.46	60.5	100.0	100.0	100.0
13	Pb 4th Cleaner Concentrate	2.84	76.4	3.44	180	69.2	1.0	9.9
	Zn 3rd Cleaner Concentrate	16.20	1.77	53.4	164	9.1	89.3	51.6
	Zn Combined Tails	80.95	0.84	1.16	24.5	21.7	9.7	38.5
	Cyclone Overflow	100.00	3.14	9.69	59.6	100.0	100.0	100.0
14	Pb 4th Cleaner Concentrate	3.32	63.9	6.35	168	68.8	2.2	8.8
	Zn 3rd Cleaner Concentrate	16.55	1.69	52.0	197	9.1	89.9	51.7
	Zn Combined Tails	80.13	0.85	0.95	31.1	22.1	7.9	39.5
	Cyclone Overflow	100.00	3.08	9.58	58.9	100.0	100.0	100.0
15	Pb 4th Cleaner Concentrate	2.89	75.3	2.6	196	67.4	0.8	9.5
	Zn 3rd Cleaner Concentrate	16.45	1.75	52.3	175	8.9	89.6	48.1
	Zn Combined Tails	80.66	0.95	1.14	31.5	23.7	9.6	42.4
	Cyclone Overflow	100.00	3.23	9.60	58.7	100.0	100.0	100.0
16	Pb 4th Cleaner Concentrate	3.57	70.8	3.61	180	78.3	1.3	13.2
	Zn 4th Cleaner Concentrate	17.40	1.26	55.0	168	6.8	94.7	60.1
	Zn Combined Tails	79.03	0.61	0.51	16.4	14.9	4.0	26.7
	Cyclone Overflow	100.00	3.23	10.1	62.2	100.0	100.0	100.0
17	Pb 4th Cleaner Concentrate	2.60	74.4	5.31	263	69.0	2.2	16.4
	Zn 4th Cleaner Concentrate	10.72	2.85	53.3	156	10.9	89.3	40.3
	Zn Combined Tails	86.68	0.65	0.63	20.7	20.1	8.5	43.2
	Cyclone Overflow	100.00	2.80	6.40	44.2	100.0	100.0	100.0

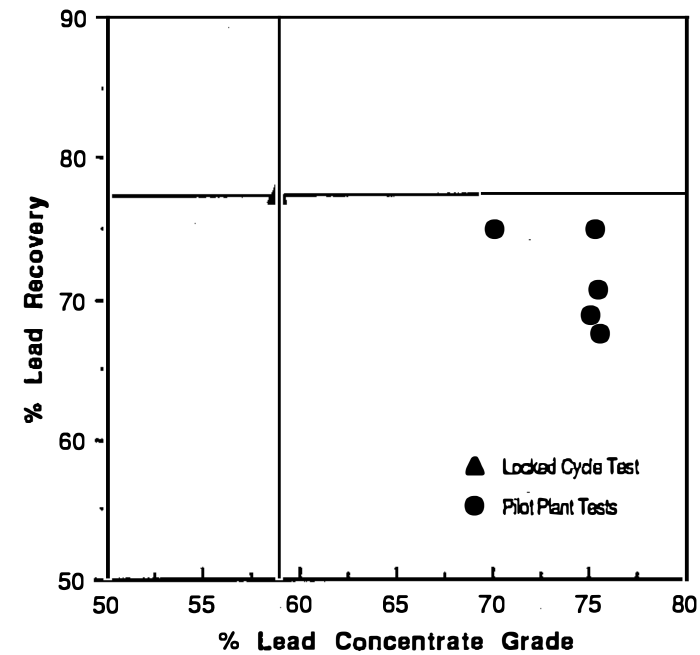
The results obtained in the pilot plant continuous operation showed the following:

- The flowsheet and reagent scheme, developed in the laboratory, worked well in the pilot plant after adjustment to the levels of reagent additions, and some further improvements may be expected with more detailed optimization of the circuit. The lead concentrate grade in the pilot plant (Figure 6) was much higher than that obtained in the laboratory testwork. This resulted in reduced lead recovery.
- In the zinc prefloat circuit, the pH was the most critical parameter in achieving good zinc flotation. With reduced lime additions from 600 g/t to 250 g/t, zinc flotation improved significantly.
- The introduction of depressant SD200 to the zinc cleaners resulted in improved zinc metallurgical results and reduction in the lime consumption.
- The use of recycle water in the circuit (i.e. up to 70%) had no effect on metallurgical results.

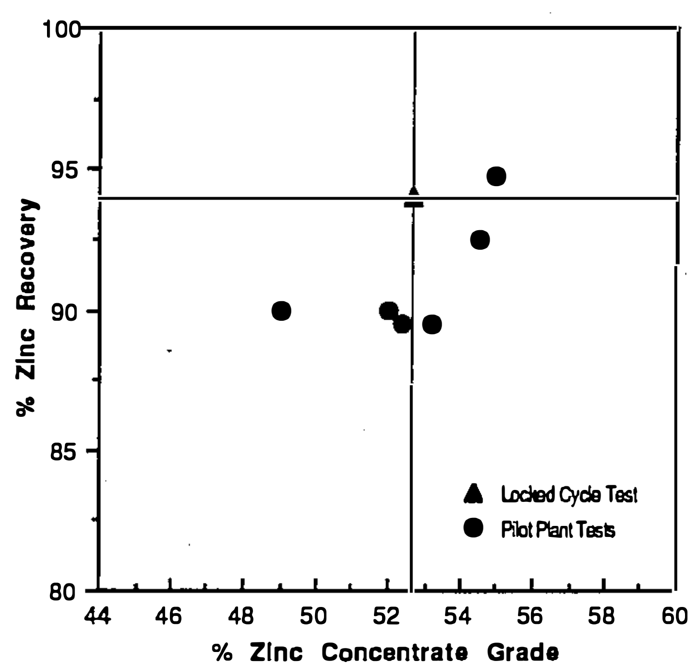
Summary - Continued

FIGURE NO. 6 : Concentrate grade versus recovery - Comparison of results

A. LEAD



B. ZINC



Summary - Continued

7. Final Treatment Procedure

7.1. Flowsheet

The flowsheet shown in Figure No. 11 of this volume of the report was used in the pilot plant. No changes or modifications in the flowsheet were required (other than recycle of the Zn 1st cleaner scavenger concentrate to the Zn 1st cleaner after Test PP-4).

7.2. Reagent Scheme

The reagent scheme used in the pilot plant is shown in Table No. 9.

TABLE NO. 9 :
Pilot Plant Reagent Scheme

Reagent	Additions, g/tonne					
	Semi-bulk	Pb Rougher	Pb Cleaners	Zn Scalp	Zn Prefloat	Zn Cleaners
Modifiers & Depressants						
Na_2CO_3	1900	300	100	-	-	-
$Ca(OH)_2$	-	-	-	1000	200	300
$CuSO_4 \times 5 H_2O$	-	-	-	500	500	-
SD200/NaCN (1:1)	-	300	300	-	-	-
SD200	-	-	-	-	-	120
Collectors & Frothers						
A317 (xanthate Cyanamid brand)	60	40	10	60	20	10
CA830/thiourea (80:20)	30	20	20	-	-	-
MIBC	20	10	-	-	-	-
DF1012	-	-	-	50	-	10
M2030	-	-	-	15	10	10

This reagent scheme was similar to that developed in the laboratory, except that depressant SD200 was introduced to the zinc cleaners, and the actual reagent distribution within the circuit was slightly different.

7.3. Overall Metallurgical Results

The overall metallurgical results obtained in the pilot plant are shown in Table No. 10.

Summary - Continued

TABLE NO. 10 :
Pilot Plant Metallurgical Results Obtained on Various Composites

Ore Type	Product	Weight %	Assays %, g/t			% Distribution		
			Pb	Zn	Ag	Pb	Zn	Ag
PP Composite 1 ore : Massive Sulphide : Baritic:Upper Med = 70 : 20 : 10	Lead Cleaner Conc	3.57	70.8	3.61	180	78.3	1.3	13.2
	Zinc Cleaner Conc	17.40	1.26	55.0	168	6.8	94.7	60.1
	Combined Tailing	79.03	0.61	0.51	16.4	14.9	4.0	26.7
	Feed	100.00	3.23	10.1	62.2	100.0	100.0	100.0
Raise 2	Lead Cleaner Conc	2.60	74.4	5.31	263	69.0	2.2	16.4
	Zinc Cleaner Conc	10.72	2.85	53.3	156	10.9	89.3	40.3
	Combined Tailing	86.68	0.65	0.63	20.7	20.1	8.5	43.2
	Feed	100.00	2.80	6.40	44.2	100.0	100.0	100.0

The results obtained in the pilot plant continuous operation were considered satisfactory.

8. Summary of Pilot Plant Operating Data

The conditions, observations and results of the pilot plant tests are summarized in the following sections.

8.1. Initial Pilot Plant Operation

The initial pilot plant operation included Tests PP-1 to PP-9. Following are shift test conditions and results.

TABLE NO. 11 :
Variables and Observations

Test No.	Conditions, Observations and Variables
PP-1	**Primary Grinding:** Preliminary test on Ore Type 5. The bench scale grind was essentially duplicated (i.e. 80% -87 µm). **Regrinding:** The regrinding circuits performed satisfactorily although the semi-bulk regrind feed chute leaked somewhat. **Flotation:** Preliminary test on Ore Type 5. Mechanical difficulties were experienced with some of the cells (i.e. Zn 2nd cleaner cell 2 worked intermittently, Pb 1st cleaner circuit was removed from the circuit half-way through the run, Zn cleaner scavenger cells were not operational), and the Zn cleaner conditioner was not run. Semi-bulk flotation was satisfactory, Pb flotation was disrupted by the reduced cleaner capacity, and Zn flotation was disrupted by the cell problems.

TABLE NO. 11 : Continued

Test No.	Conditions, Observations and Variables
PP-2	**Primary Grinding:** Circuit operation was stable. The grind was finer than in Test PP-2. **Regrinding:** Circuit operation was stable. Grind products were roughly similar to those achieved in the bench scale testwork (i.e. 80 % -14 µm, 9 µm, and 18 µm for semi-bulk, Pb and Zn regrind products respectively). **Flotation:** Reagent levels were adjusted, with Pb circuit collector and depressant levels generally increased. Zn reagent levels were generally left unchanged. All conditioners and flotation cells were operational, although Zn 2nd cleaner cell 2 continued to work intermittently. Lead product grades were generally <50% grade (i.e. grab samples).
PP-3	**Primary Grinding:** Collector was not added to the ball mill as carbon preflotation was performed. Grind fineness was similar to that in Test PP-2. **Regrinding:** Circuit operation was satisfactory. Semi-bulk, Pb and Zn regrind finenesses were similar to, finer, and coarser respectively than those in Test PP-2. **Flotation:** Flotation of carbon prior to semi-bulk flotation. Relatively minor reagent adjustments were made, although lime was increased in the Zn circuit. Carbon flotation led to high Pb and Zn losses and more unselective semi-bulk and Pb flotation due to the high frother addition. Zinc circuit flotation resulted in a slightly higher grade product (i.e. >52 % Zn).
PP-4	**Primary Grinding:** Grind fineness was fairly similar to that in Test PP-3. Circuit operation was satisfactory. **Regrinding:** Ball loads in the semi-bulk and Pb regrind mills were reduced to reduce overgrinding. The Pb regrind mill balls were replaced half way through the run. The Pb regrind product was noticeably coarser (i.e. 80 % -13 µm in PP-4, 80 % -9 µm in PP-3). **Flotation:** Carbon preflotation was continued, with reduction of frother. Alternative Zn depressants were used in the Pb circuit, with NaCN and $ZnSO_4$ substituted for SD200/cyanide in the semi-bulk and Pb regrind mills respectively. These changes and the reduced regrinding did not improve selectivity.
PP-5	**Primary Grinding:** Collector addition to the ball mill was resumed as the carbon prefloat was eliminated. The grind product was a bit coarser than in Tests PP-2 to PP-4. **Regrinding:** Circuit operation was disrupted by overflowing of the Pb regrind discharge pump due to the high Pb rougher concentrate weight. Semi-bulk and Pb regrind products were a bit finer than in Test PP-4. **Flotation:** The zinc cleaner scavenger concentrate was recycled to the Zn cleaner conditioner rather than to the Zn prefloat conditioner. Reagent adjustments included introduction of Na_2CO_3 to the Pb regrind, reduction of the secondary Pb collector (CA830/Thiourea), and reduction of $CuSO_4$ in the Zn prefloat. Selectivity in the Pb circuit improved slightly, with Pb grades of over 60% being achieved in two grab samples late in the run. However, the Pb grade deteriorated during the sample period to 51-52% Pb. Zinc product grade was 54 %.

TABLE NO. 11 : Continued

Test No.	Conditions, Observations and Variables
PP-6	**Primary Grinding:** Some variation in feed rate occurred. Grind fineness was relatively fine, 80 % -53 µm. **Regrinding:** Circuit operation was stable with a larger cyclone in the Pb grinding circuit. Zinc regrind product was coarser due to the greater feed (i.e. Zn rougher concentrate). **Flotation:** The zinc flowsheet was altered, with one stage Zn rougher flotation replacing the scalp-prefloat circuits. Zn losses were quite high (i.e. 24 %). Major reagent adjustments in the semi-bulk/lead circuits included: SD200/cyanide addition to the semi-bulk and Pb regrind mill discharges instead of to the mill feeds, use of R242 collector in the Pb regrind (7 g/t), slightly increased depressant levels and A317 collector, and elimination of secondary collector CA830/Thiourea. Pb product grade improved to 55-60% late in the sample period, but was considerably lower through the earlier hours.
PP-7	**Primary Grinding:** Circuit operation was stable. The primary grind was coarser than in most of the previous tests, 80% - 82 µm. **Regrinding:** Smaller mills were substituted for the Sala semi-bulk and Hardinge Pb regrind mills to reduce overgrinding. Regrind finenesses were noticeably coarser (i.e. 80 % -15 and 13 µm respectively). **Flotation:** Several changes were made to the flowsheet (extended Pb rougher, elimination of Pb 1st cleaner tail recycle early in the run) and Pb collector (A317/3418A substituted for A317). A high Pb circuit circulating load developed. High lead grades were achieved in most grab samples until late in the run. Pb content in the Zn concentrate was extremely high, >5 %.
PP-8	**Primary Grinding:** Circuit operation was stable. **Regrinding:** Circuit operation was stable. The zinc regrind was similar to that in Test PP-7, and the semi-bulk and Pb regrind products were coarser than in Test PP-7. **Flotation:** The Pb 1st cleaner was scavenged, with the concentrate recycled to the semi-bulk regrind. The tail was pumped to the Zn prefloat circuit. Very poor and unselective Pb flotation occurred, poorer than in any previous run. Extensive reagent changes were made late in the run, including increases in the carbonate and depressant additions. However, flotation was not improved. Zn product grade and recovery were also poor.
PP-9	**Primary Grinding:** Preliminary test on PP Composite 1 ore (Type 5:4: Upper Medium grade ore in the ratio of 70:20:10). Grind fineness was similar to that in Test PP-8 with Type 5 ore. Circuit operation was stable. **Regrinding:** Circuit operation was stable. Regrind product sizes were generally similar to those achieved with Ore Type 5, although the Pb regrind was a bit finer. **Flotation:** The cleaner scavenger was not used. The Pb circuit was as in Test PP-6. The Zn circuit was as in Test PP-5. Lead and zinc flotation results were similar to those in Test PP-8, although Zn product grade, while low, was higher than in Test PP-8, mainly due to lower Pb content.

Summary - Continued

TABLE NO. 12 :
Rod Mill Grinding Data

Test No.	Feed					Mill Disch g/L	Product			Power	
	Rate kg/h	Cons kg	Cum % Passing -48 mesh	Cum % Passing -200 mesh	K_{80} µm		Cum -200 mesh	% Pass -400 mesh	K_{80} µm	Input kWh/t	Work Index (metric)
PP-1	544	2992	27.0	18.0	4699	2098	40.3	26.6	295	5.1	11.7
PP-2	525	3150	28.0	18.8	4299	2099	47.3	33.2	260	5.4	11.5
PP-3	529	3968	27.4	18.2	4355	2098	46.4	33.0	275	5.2	11.4
PP-4	521	3647	25.1	17.3	5328	2096	46.0	32.7	285	5.2	11.5
PP-5	525	3938	25.5	16.9	4732	2094	45.5	31.9	286	5.0	11.3
PP-6	524	3675	27.9	18.3	4795	2099	46.8	32.7	264	5.0	10.6
PP-7	525	3675	24.4	16.4	5202	2099	46.0	33.0	287	5.2	11.5
PP-8	528	3611	30.1	19.8	3787	2103	45.1	31.3	275	5.4	12.2
PP-9	523	4707	28.6	19.1	4271	2097	48.2	34.1	251	5.3	11.1
Total	-	33363	-	-	-	-	-	-	-	-	-

TABLE NO. 13 :
Ball Mill Grinding Data

Test	Pulp Densities, g/L			Circ Load %	Product			Power			
	Mill Disch	Cycl U/Flow	Cycl O/Flow		Cum -200 mesh	% Pass -400 mesh	K80 µm	Ball Mill Input kWh/t	Ball Mill Work Index	Overall Input kWh/t	Overall Work Index*
PP-1	2103	2760	1335	-	73.9	43.3	87	9.1	18.5	14.2	15.3
PP-2	2100	2770	1345	-	87.6	65.7	58	9.1	13.1	14.4	12.4
PP-3	2103	2764	1349	-	85.3	64.1	62	8.9	13.3	14.0	12.5
PP-4	1924	2756	1314	-	82.8	62.4	68	8.9	14.3	14.1	13.1
PP-5	1941	2271	1305	-	79.1	56.1	77	8.9	16.1	13.9	14.0
PP-6	1938	2758	1305	692	89.0	69.2	53	9.1	12.0	14.1	11.5
PP-7	1903	2755	1286	417	76.8	54.7	82	9.3	18.1	14.5	15.0
PP-8	1915	2760	1304	1119	86.5	64.3	60	9.0	13.1	14.4	12.8
PP-9	1910	2770	1300	567	84.9	61.9	64	9.1	14.7	14.4	13.1

*metric

TABLE NO. 14 :
Primary Grinding Circuit Densities

Test	Density, g/L			
	Rod Mill Disch	Ball Mill Disch	Cyclone U/Flow	Cyclone O/Flow
PP-1	2098	2103	2760	1335
PP-2	2099	2100	2770	1345
PP-3	2098	2103	2764	1349
PP-4	2096	1924	2756	1314
PP-5	2094	1941	2271	1305
PP-6	2099	1938	2758	1305
PP-7	2099	1903	2755	1286
PP-8	2103	1915	2760	1304
PP-9	2097	1910	2770	1300

Summary - Continued

TABLE NO. 15 :
Semi-Bulk Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum% Pass 16-18 µm	9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	9-10 µm	K_{80} µm
PP-1	1293	-	1175	-	-	-	-	-	-
PP-2	1558	1840	1145	67.8	47.6	26	87.2	63.5	14
PP-3	1500	1530	1140	57.5	34.0	32	85.1	58.0	17
PP-4	1490	1460	1280	51.4	28.5	35	78.2	49.9	18
PP-5	1175	1220	1150	67.3	48.5	25	86.2	63.0	14
PP-6	2140	2200	1135	59.2	38.6	31	94.4	67.8	12
PP-7*	1210	1220	1110	74.7	54.3	20	85.4	62.3	15
PP-8*	1690	1770	1280	58.4	36.9	30	72.9	46.4	20
PP-9*	1458	1453	1230	64.8	42.7	25	77.6	52.3	18

*Sala mill used in Tests PP-1 to 6; smaller Hazen Quinn mill in Tests PP-7 to 9.

TABLE NO. 16 :
Pb Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	9-10 µm	K_{80} µm
PP-1	1400	-	1110	79.2	57.4	19	-	-	-
PP-2	1910	2050	1138	88.8	65.8	13	99.0	81.9	9
PP-3	2125	2065	1160	91.9	73.4	11	99.0	92.3	<9
PP-4	2050	2060	1170	81.8	57.5	16	94.6	58.3	13
PP-5	1690	1610	1040	89.4	73.0	12	98.3	92.2	<9
PP-6	1920	1935	1160	92.0	62.9	17	97.1	75.8	10
PP-7*	1220	1210	1070	86.3	63.2	15	90.2	67.0	13
PP-8*	1870	1780	1270	74.6	46.3	20	87.1	66.3	13
PP-9*	2105	2385	1205	86.0	60.4	14	96.9	70.0	11

*Hardinge mill used in Tests PP-1 to 6; smaller Denver mill in Tests PP-7 to 9.
Steel load decreased after Test PP-3.

TABLE NO. 17 :
Zn Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	9-10 µm	K_{80} µm
PP-1	1555	-	1210	-	-	-	-	-	-
PP-2	2293	2338	1273	36.5	24.8	56	79.2	57.4	18
PP-3	2290	2360	1315	38.5	27.2	57	49.7	32.0	31
PP-4	2475	2460	1180	34.9	25.4	70	57.9	39.2	28
PP-5	2350	2370	1260	38.7	27.5	57	62.6	39.8	25
PP-6	1450	1580	1260	42.0	31.1	68	55.6	38.5	36
PP-7	2235	2215	1365	38.6	25.6	57	58.3	36.9	26
PP-8	2190	2160	1330	26.8	19.4	82	55.5	36.7	28
PP-9	2325	2365	1250	29.4	19.8	79	56.1	35.9	28

Summary - Continued

TABLE NO. 18 :
Semi-Bulk and Pb Circuit Densities and Temperatures

Tes No.	Density, g/L											Temp. °C	
	Bulk Feed	Bulk Tail	Bulk Regr Mill Disch	Bulk Regr Cycl U/F	Bulk Regr Cycl O/F	Pb Ro Feed	Pb Ro Tail	Pb Regr Mill Dich	Pb Regr Cycl U/F	Pb Regr Cycl O/F	Pb 1st Cl Tail	Bulk Feed	Pb Ro Feed
PP1	1335	1285	1293	-	1175	1103	1040	1400	-	1110	1030	15	21
PP2	1345	1380	1558	1840	1145	1078	1035	1910	2050	1138	1048	-	20
PP3	1349	1315	1500	1530	1140	1055	1030	2125	2065	1160	1055	15	23
PP4	1314	1250	1490	1460	1280	1065	1015	2050	2060	1170	1050	14	17
PP5	1305	1260	1175	1220	1150	1035	1010	1690	1610	1040	1030	14	20
PP6	1305	1260	2140	2200	1135	1075	1030	1920	1935	1160	1060	13	19
PP7	1286	1250	1210	1220	1110	1060	1010	1220	1210	1070	1015	13	19
PP8	1304	1210	1690	1770	1280	1160	1050	1870	1780	1270	1055	12	19
PP9	1300	1240	1458	1453	1230	1090	1058	2105	2385	1205	1068	13	10

TABLE NO. 19 :
Zinc Circuit Densities and Temperatures

Test No.	Density, g/L										Temp. °C	
	Zn Scalp Tail	Zn Ro 1 Feed	Zn Ro 2 Tail	Zn Regr Mill Disch	Zn Regr Cycl U/Flow	Zn Regr Cycl O/Flow	Zn Prefloat Tail	Zn 1st Cl Feed	Zn Cl Scav Tail	Thick U/Flow	Zn Scalp Feed	Zn Ro 1 Feed
PP1	1275	-	-	1555	-	1210	1030	1060	-	1430	18	-
PP2	1308	-	-	2293	2338	1273	1023	1115	1038	1505	-	-
PP3	1225	-	-	2290	2360	1315	1020	1075	1095	1690	18	-
PP4	1230	-	-	2475	2460	1180	1015	1115	1075	1460	17	-
PP5	1185	-	-	2350	2370	1260	1010	1075	1050	1540	16	-
PP6	-	1155	1060	1450	1580	1260	-	1145	1145	1260	-	13
PP7	1170	-	-	2235	2215	1365	1015	1150	1060	1330	15	-
PP8	1155	-	-	2190	2160	1330	1010	1090	1030	2160	14	-
PP9	1155	-	-	2325	2365	1250	1025	1113	1065	1150	15	-

TABLE NO. 20 :
pH Levels

Tes	pH															
	Rod Mill Disch	Bulk Feed	Bulk Tail	Pb Ro Feed	Pb 1st Cl	Pb 2nd Cl	Pb 3rd Cl	Pb 4th Cl	Zn Ro 1 Feed	Zn Ro 2 Feed	Zn Scalp Feed	Zn Prefloat Conc	Zn 1st Cl	Zn Cl Scav	Zn 2nd Cl	Zn 3rd Cl
PP1	10.5	10.2	9.9	10.6	10.3	9.9	9.8	-	-	-	8.7	10.5	10.8	-	11.7	11.9
PP2	10.6	10.3	10.0	9.9	9.8	9.9	9.9	10.0	-	-	10.6	10.7	11.5	11.5	12.0	12.2
PP3	10.5	10.2	9.8	9.6	9.6	9.8	9.8	9.7	-	-	9.9	11.7	11.9	11.9	12.2	12.2
PP4	10.5	10.0	9.7	9.4	9.5	9.6	9.4	9.7	-	-	10.0	11.9	11.7	11.7	12.0	12.1
PP5	10.3	9.9	9.7	9.6	9.6	9.5	9.5	9.4	-	-	10.3	11.2	11.7	11.6	11.9	11.9
PP6	10.2	9.6	9.4	9.6	9.7	9.9	9.7	9.6	10.6	10.6	-	-	11.7	11.6	11.9	11.9
PP7	10.3	9.8	9.5	9.9	9.9	9.8	9.8	9.7	-	-	10.2	10.9	11.6	11.5	11.8	11.8
PP8	10.3	9.7	9.5	10.1	10.0	9.8	9.8	9.8	-	-	10.2	10.8	11.7	11.5	11.9	11.6
PP9	10.6	10.0	9.8	10.1	10.2	10.0	10.0	9.9	-	-	10.4	11.4	11.8	11.6	12.3	12.0

Summary - Continued

TABLE NO. 21 :
Zinc Flotation Reagent Additions

Test	Reagent Additions, g/t													
	Ca(OH)$_2$					$CuSO_4 \cdot 5H_2O$			M2030					
	Zn Scalp Cond 1	Zn Regr	Zn Prefloat Cond 1	Zn 2nd Cl	Zn 3rd Cl	Zn Scalp Cond2	Zn Regr	Zn Prefloat Cond 2	Zn Scalp Feed	Zn Scalp Cell 3	Zn Prefloat Feed	Zn Prefloat Cell 3	Zn H.I. Cond	Zn Cl Scav Feed
PP1	1103	452	662	452	254	921	154	474	7	3	7	3	6	-
PP2	749	186	653	515	211	949	183	469	7	3	7	-	5	-
PP3	516	599	1452	970	525	953	179	737	7	3	7	1	5	-
PP4	545	622	3248	777	609	956	184	1662	7	3	7	-	6	-
PP5	686	571	457	697	457	914	171	343	7	3	7	-	6	-
PP6	1143[1]	914	-	823	423	105[1]	171	-	6[2]	1[4]	3[4]	-	6	-
PP7	686	571	457	998	438	914	171	457	7	3	7	-	6	-
PP8	682	560	469	1265	469	909	151	477	6	4	7	-	6	-
PP9	901	579	688	1241	564	1147	161	459	8	4	9	3	6	-

Test	Reagent Additions, g/t								
	A317						DF250		
	Zn Scalp Feed	Zn Scalp Cell3	Zn Prefloat Feed	Zn Prefloat Cell 3&4	Zn H.I. Cond	Zn Cl Scav Feed	Zn Scalp Feed	Zn Prefloat Feed	Zn 1st Cl Cond
PP1	39	5	23	23	69	-	-	26	-
PP2	57	11	46	-	74	56	69	5	6
PP3	57	11	71	52	71	-	68	-	-
PP4	58	12	46	22	75	-	69	-	-
PP5	69	11	34	-	73	11	40	-	-
PP6	86[2]	69[3]	0.1[4]	-	74	11	-	-	-
PP7	86	34	34	-	86	33	57	-	-
PP8	87	32	34	-	85	34	52	-	-
PP9	126	46	67	34	86	34	49	-	-

1) Zn Rougher Conditioners; 2) Zn Rougher 1 Feed; 3) Zn Rougher 2 Feed; 4) Zn Rougher 2 Cell 4

TABLE NO. 22 :
Semi-bulk and Pb Flotation Reagent Additions

Test	Reagent Additions, g/t																			
	Na_2CO_3				SD200/NaCN					R242			A317/3418A or A317[1]						
	RM Feed	Bulk Regr	Pb Regr	Pb 2nd Cl	Bulk Regr	Pb Regr	Pb 2nd Cl	Pb 3rd Cl	Pb 4th Cl	BM Feed	Bulk Regr	Pb Regr	BM Feed	Bulk Ro 1 Feed	Bulk Ro 2 Feed	Pb Ro H.I. Cond	Pb Ro Cell 4-5	Pb 1st Cl H.I. Cond	Pb 3rd Cl
PP1	2250	3309	-	-	282	278	88	82	-	-	-	-	55	-	10	19	-	9	-
PP2	2371	343	-	-	320	368	137	137	137	-	-	-	91	-	23	69	11	45	-
PP3	2268	113	-	-	408	384	91	95	91	-	-	-	-	79	28	91	16	23	-
PP4	2879	-	-	-	726[5]	225[6]	92	91	92	-	-	-	-	69	31	31	12	-	-
PP5	2377	280	117	-	254	288	91	69	89	-	-	-	49	-	48	48	39	11	-
PP6	2377	114	111	-	343[7]	326[7]	137	114	91	-	-	7	93	-	57	46	34	-	-
PP7	2377	114	-	-	343	347	145	94	70	-	7	10	86	57	88	88	11[2]	114[3]	-
PP8	2364	341	110	-	443	605	154	159	120	9	-	-	102	63	63	85	17	73	34[4]
PP9	2277	218	283	220	479	344	138	115	92	-	-	-	33	11	34	39	17	-	2

1) A317/3418A = 70:30 in PP-7 & 8; A317 in all other tests;
2) Cell 7 of Pb Rougher;
3) 17 g/t in Pb 1st Cl Cell 3;
4) in Cl Scav Feed
5) $ZnSO_4$ substituted for SD200/NaCN;
6) NaCN substituted for SD200/NaCN;
7) Mill Discharge

Summary - Continued

TABLE NO. 22 : Continued

Test	Reagent Additions, g/t													
	CA830/Thiourea						MIBC							DF250
	Bulk Ro 1 Feed	Bulk Ro 2 Feed	Pb Ro H.I. Cond	Pb 1st Cl H.I. Cond	Pb 1st Cl Cell3	Pb2nd Cl Cell3	Carbon Prefloat	Bulk 1 Feed	Bulk 2 Feed	PbRo Ro H.I. Cond	PbRo Cell 4-5	Pb 1st Cl H.I. Cond	Pb3rd Cl	Carbon Prefloat
PP1	22	11	7	19	5	9	-	33	11	5	-	4	-	-
PP2	48	23	34	19	5	5	-	23	11	6	3	2	-	-
PP3	45	23	40	19	7	5	-	11	10	6	3	-	-	36
PP4	46	22	39	20	-	5	18	12	12	13	3	-	-	-
PP5	20	14	41	9	-	-	-	20	9	8	8	2	-	-
PP6	-	-	-	-	-	-	-	29	8	8	6	2	-	-
PP7	-	-	-	-	-	-	-	29	9	8	3[8]	3	-	-
PP8	-	-	-	-	-	-	-	28	9	6	3	9	15[9]	-
PP9	-	-	-	-	-	-	-	25	6	2	4	2	1	-

8) in Cell 7
9) In Cleaner Scavenger Feed

TABLE NO. 23 :
Metallurgical Results

Test No.	Product	Weight %	Assays, %, g/t Pb	Zn	Ag	% Distribution Pb	Zn	Ag
PP-2	Pb 4th Cleaner Concentrate	5.60	50.2	12.8	175	82.9	7.2	18.3
	Zn 3rd Cleaner Concentrate	17.47	0.98	50.4	182	5.0	88.7	59.4
	Zn Combined Tails	76.93	0.53	0.52	15.5	12.0	4.0	22.3
	Cyclone Overflow	100.00	3.39	9.92	62.2	100.0	100.0	100.0
3	C Prefloat Concentrate	7.80	5.65	6.14	95.9	12.3	4.7	11.5
	Pb 4th Cleaner Concentrate	4.07	57.1	13.2	152	64.6	5.2	9.5
	Zn 3rd Cleaner Concentrate	16.03	1.37	52.5	192	6.1	82.0	47.5
	Zn Combined Tails	72.10	0.85	1.16	28.2	17.1	8.1	31.4
	Cyclone Overflow	100.00	3.59	10.3	64.8	100.0	100.0	100.0
4	C Prefloat Concentrate	12.70	5.64	6.16	127	18.9	7.5	21.0
	Pb 4th Cleaner Concentrate	3.80	53.9	19.4	150	54.0	7.1	7.4
	Zn 3rd Cleaner Concentrate	15.18	1.89	50.2	179	7.6	73.1	35.4
	Zn Combined Tails	68.32	1.09	1.88	40.5	19.6	12.3	36.1
	Cyclone Overflow	100.00	3.80	10.4	76.6	100.0	100.0	100.0
5	Pb 4th Cleaner Concentrate	3.90	51.5	19	164	60.9	7.5	10.8
	Zn 3rd Cleaner Concentrate	14.35	1.31	54.2	166	5.7	78.2	40.2
	Zn Combined Tails	81.75	1.35	1.74	35.5	33.4	14.3	49.0
	Cyclone Overflow	100.00	3.30	9.94	68.7	100.0	100.0	100.0
6	Pb 4th Cleaner Concentrate	4.05	57.7	10.3	171	68.7	4.2	10.8
	Zn 3rd Cleaner Concentrate	13.66	1.52	52.3	179	6.1	71.8	38.0
	Zn Combined Tails	82.29	1.04	2.9	40.0	25.2	24.0	51.2
	Cyclone Overflow	100.00	3.40	9.95	66.8	100.0	100.0	100.0
7	Pb 4th Cleaner Concentrate	2.23	55.5	10.7	189	37.1	2.4	6.3
	Zn 3rd Cleaner Concentrate	20.04	5.94	44.2	164	35.6	88.6	49.1
	Zn Combined Tails	77.72	1.17	1.16	38.4	27.2	9.0	44.6
	Cyclone Overflow	100.00	3.34	10.0	73.3	100.0	100.0	100.0
8	Pb 4th Cleaner Concentrate	10.84	23.6	31.5	145	73.1	34.7	27.0
	Zn 3rd Cleaner Concentrate	14.98	2.38	38.8	162	10.2	59.1	41.7
	Zn Combined Tails	74.19	0.79	0.83	24.6	16.7	6.3	31.3
	Cyclone Overflow	100.00	3.50	9.84	62.8	100.0	100.0	100.0
9	Pb 4th Cleaner Concentrate	8.43	25.2	42.1	188	64.4	37.7	23.8
	Zn 3rd Cleaner Concentrate	9.85	3.30	47.3	173	9.9	49.5	25.5
	Zn Combined Tails	81.71	1.04	1.48	41.4	25.8	12.8	50.7
	Cyclone Overflow	100.00	3.30	9.42	64.3	100.0	100.0	100.0

Summary - Continued

8.2. Continuous Pilot Plant Operation

TABLE NO. 24 :
Variables and Observations

Test No.	Conditions, Observations and Variables
PP-10	**Primary Grinding:** Preliminary test with PP Composite 2 ore. The ore was fed at about 600 kg/h. The ball mill circuit was classified with a 109 µm Derrick vibrating screen. A very high circulating load resulted due to insufficient screening capacity. The ball charge to the ball mill was increased from 300 to 400 kg part way through the run. The grind product was 80% -59 µm. **Regrinding:** A 50 mm cyclone was used in the Zn regrinding, and two 25 mm cyclones were used in the semi-bulk regrind. The Sala mill was used for semi-bulk regrinding, and the two smaller mills were used for Pb and Zn regrinding (as in Tests PP-7 to 9). Problems were encountered with cyclone plug-ups. Pb rougher concentrate regrinding resulted in minimum size reduction from 80% passing 12 µm to 10 µm. **Flotation:** Excellent Pb product grades were achieved. Zinc product grades were generally less than 50%. The frequent cyclone plugups disrupted flotation circuit stability.
PP-11	**Primary Grinding:** As for Test PP-10. **Regrinding:** Cyclone plugging continued to be a problem. The Zn scalp concentrate was relatively coarse and additional balls were added to the Zn regrind mill. **Flotation:** Stability continued to be disrupted somewhat by cyclone plugups, especially in the Zn circuit. High lead grades were again achieved. Zn product grade was 49 %. Recoveries were a bit lower than in Test PP-10.
PP-12	**Primary Grinding:** As for Tests PP-10 and 11. A circulating load of over 1400% was calculated. **Regrinding:** Semi-bulk regrind pulp densities were higher than in Tests PP-10 and 11. Cyclone plugging was mainly experienced in Zn regrinding. Additional balls were added to the Zn regrind mill. **Flotation:** Relatively non-selective Pb flotation occurred in the first half of the run (i.e. Zn in Pb concentrate 6 -10 % Zn). Reduction in frother to the Pb rougher and 1st cleaner circuits restored selectivity. Zn recovery during the sampling period was low, 83 %.

TABLE NO. 24 : Continued

Test No.	Conditions, Observations and Variables
PP-13	**Primary Grinding:** The screen was replaced by a 50 mm cyclone. Circulating load was 428 %. The grind product was 80% -84 μm, coarser than in the previous three runs. **Regrinding:** Cyclone plugging, especially the Zn regrind cyclone continued to be a problem. The Zn scalp concentrate was quite coarse and the regrind product was also fairly coarse (80% -37 μm).; **Flotation:** Some reagents were adjusted. The Pb 4th cleaner depressant was reduced, and MIBC additions were generally kept low. In the Zn circuit, lime and $CuSO_4$ were jointly added to the 1st prefloat conditioner and collectors to the 2nd conditioner. Also, the 2nd and 3rd cleaners were reduced to 2 and 1 cells respectively. Pb product grades continued to be excellent. Modification of the Zn circuit did result in improvement in Zn product grade to 53 %. Cyclone classification of the ground ore did not therefore impair the metallurgical results. Subsequent tests therefore involved cyclone classification rather than screening, and plans to include unit cell flotation in the grinding circuit were cancelled.
PP-14	**Primary Grinding:** As in Test PP-13. The grind product was finer, 80 % -67 μm, which was similar to that achieved in Tests PP-10 to 12 with the screen. **Regrinding:** Plugging of the cyclones was greatly reduced and flotation circuit stability therefore increased. The scalp concentrate continued to be coarse, but the regrind product was suitable, 80% -28 μm. **Flotation:** Circuit operation was fairly steady, with reasonably low Zn prefloat and Zn cleaner scavenger tail grades (by x-met). High combined tails assays as indicated by X-met were misleading. Results were similar to those in Test PP-13, although the Pb concentrate grade was under 65 %.
PP-15	**Primary Grinding:** The cyclone overflow product was relatively coarse, 80 % -88 μm. **Regrinding:** Circuit operation was steady. **Flotation:** Attempts to achieve a Zn concentrate grade of about 55 % were not successful, as product grade was similar to that obtained in the previous two tests. Pb flotation was similar to that achieved in Test PP-13. Samples were taken for environmental, liquid - solid separation, and mineralogical testwork.
PP-16	**Primary Grinding:** The ore was ground in a mixture of scalp tailings water and fresh water (62 % : 38 %). Problems were encountered with pumps plugging so that the rod mill discharge was pumped directly to the ball mill feed instead of to the cyclone. Grind product was relatively fine, 80 % -49 μm. **Regrinding:** Circuit operation was stable. The zinc scalp concentrate and regrind product were coarse, 80 % - 121 μm and 46 μm respectively. **Flotation:** Flotation with a mixture of pond water and fresh water (ratio not determined). Low pressure from the recycle system necessitated use of fresh water makeup. Zn circuit frother was DF1012 instead of DF250. No other major reagent changes were made. Metallurgical results were excellent with high grades and recoveries achieved.

TABLE NO. 24 : Continued

Test No.	Conditions, Observations and Variables
PP-17	**Primary Grinding:** Grinding of Raise 2 ore (i.e. low grade Pb and Zn) with cyclone classification. The rod mill product was fed directly to the ball mill feed, as in Test PP-16. Additional balls were added to the ball mill. The grind was fine, 80 % -52 µm. **Regrinding:** Circuit operation was stable. In general, products were a bit finer than in Tests PP-10 to 16. **Flotation:** Flotation of Raise 2 ore. Collector additions to the semi-bulk rougher, Pb rougher and 1st cleaner were increased as the froths appeared to be very selective. Zn circuit reagents were not significantly altered. Metallurgical results were generally quite good although Zn in the Pb product and Pb in the Zn product were higher than in most of previous seven tests.

TABLE NO. 25 :
Rod Mill Grinding Data

Test No.	Feed					Mill Disch g/L	Product			Power	
	Rate kg/h	Cons kg	Cum % Passing -48 mesh	Cum % Passing -200 mesh	K_{80} µm		Cum% Pass -200 mesh	Cum% Pass -400 mesh	K_{80} µm	Input kWh/t	Work Index (metric)
PP-10	590	5605	29.7	19.5	4087	2098	42.9	28.7	326	3.4	8.6
PP-11	604	4832	31.2	20.8	3967	2101	42.8	29.7	334	3.3	8.6
PP-12	590	4720	32.6	21.5	3711	2109	47.1	33.6	299	2.6	6.4
PP-13	598	4784	29.6	19.6	4002	2098	43.4	29.2	314	3.3	8.2
PP-14	601	4808	28.4	18.6	4141	2109	44.9	31.0	305	3.3	7.9
PP-15	600	4800	31.1	20.5	4252	2103	44.4	31.0	328	3.3	8.2
PP-16	603	6030	29.4	19.2	4447	2100	43.3	30.0	341	3.1	7.8
PP-17	596	5960	27.4	17.5	4577	2108	39.8	27.8	404	3.4	9.8
Total	-	41539	-	-	-	-	-	-	-	-	-

Rod Charge = 305 kg for Tests PP-10 to 17.

TABLE NO. 26 :
Ball Mill Grinding Data

Test	Ball Chg kg	Pulp Densities, g/L			Circ Load %	Product			Power			
		Mill Disch	Cycl* U/Flow	Cycl* O/Flow		Cum % Pass -200 mesh	Cum % Pass -400 mesh	K_{80} µm	Ball Mill Input kWh/t	Ball Mill Work Index	Overall Input kWh/t	Overall Work Index*
PP10	400	2167	-	1322	950	87.1	64.4	59	7.8	10.5	11.3	9.8
PP11	400	2122	2337	1304	-	84.3	60.3	64	7.2	10.2	10.5	9.6
PP12	400	2128	2372	1309	1464	85.3	59.2	63	7.2	10.6	9.9	9.0
PP13	400	1968	2804	1297	428	76.1	55.2	84	7.7	14.6	11.0	11.8
PP14	400	2052	2798	1282	-	83.3	61.4	67	7.7	11.9	11.0	10.3
PP15	400	1986	2817	1300	304	75.3	53.4	88	7.7	14.9	10.9	12.0
PP16	400	2248	2843	1272	903	90.5	72.3	49	7.5	8.4	10.5	8.2
PP17	500	2574	2764	1254	414	89.2	70.4	52	9.2	10.3	12.6	10.1

*screen oversize and undersize respectively in Tests PP-10 to 12.

Summary - Continued

TABLE NO. 27 :
Primary Grinding Circuit Densities

Test	Density, g/L			
	Rod Mill Disch	Ball Mill Disch	Cyclone* U/Flow	Cyclone* O/Flow
PP10	2167	2173	-	1322
PP11	2101	2122	2337	1304
PP12	2109	2128	2372	1309
PP13	2098	1968	2804	1297
PP14	2109	2052	2798	1282
PP15	2103	1986	2817	1300
PP16	2100	2248	2843	1272
PP17	2108	2574	2764	1254

*screen oversize and undersize respectively in Tests PP-10 to 12.

TABLE NO. 28 :
Semi-Bulk Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm
PP10	1730	1646	1170	65.2	44.9	27	91.7	66.2	13
PP11	1673	1443	1210	57.3	36.1	31	79.6	52.1	17
PP12	1846	1916	1226	57.7	36.2	31	81.8	56.8	16
PP13	1750	1822	1212	61.2	40.3	29	88.5	60.5	14
PP14	1748	1720	1230	59.0	37.2	29	83.4	54.7	16
PP15	1722	1734	1212	60.2	38.1	28	83.9	57.6	15
PP16	1741	1687	1129	59.9	39.7	29	80.5	54.1	17
PP17	1816	1776	1130	61.7	40.5	27	94.0	68.2	12

Circulating load in Test PP-17 = 351 %
Ball charge 400 kg for Tests PP-10 to 17.

TABLE NO. 29 :
Pb Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm
PP10	1996	1940	1148	92.6	66.9	12	97.1	71.2	11
PP11	2173	2323	1245	90.3	58.9	14	96.0	68.1	12
PP12	2050	2056	1240	94.1	57.2	13	95.6	59.5	13
PP13	2018	2000	1190	93.7	58.4	13	94.8	55.4	13
PP14	1996	1984	1204	90.6	57.4	14	97.0	81.1	11
PP15	1994	1964	1194	91.6	58.3	14	97.9	68.4	11
PP16	2054	2086	1202	93.3	66.0	12	96.8	72.8	11
PP17	1951	1961	1183	98.2	76.6	9	99.3	80.2	9

Ball charge 200 kg for Tests PP-10 to 17.

Summary - Continued

TABLE NO. 30 :
Zn Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm
PP10	2258	2254	1184	40.7	33.4	56	61.5	42.2	26
PP11	1973	2046	1295	28.5	20.7	85	56.6	38.7	31
PP12	2088	2064	1188	36.0	26.8	65	65.6	44.3	24
PP13	1610	1698	1130	28.5	21.8	115	56.4	41.1	37
PP14	2190	2200	1226	29.8	22.8	109	59.7	41.4	28
PP15	2328	2334	1240	33.5	25.9	101	56.2	38.3	32
PP16	1820	1823	1348	29.0	22.9	121	38.2	25.1	46
PP17	2253	2279	1259	35.5	24.9	73	63.8	41.5	24

Circulating load in Test PP-17 = 211 %
Ball charge = 225 kg PP-10, 275 kg PP-11, 305 kg PP-12 to 17

TABLE NO. 31 :
Semi-Bulk and Pb Circuit Densities and Temperatures

Test No.	Density, g/L											Temp. °C	
	Bulk Feed	Bulk Tail	Bulk Regr Mill Disch	Bulk Regr Cycl U/F	Bulk Regr Cycl O/F	Pb Ro 1 Feed	Pb Ro Tail	Pb Regr Mill Dich	Pb Regr Cycl U/F	Pb Regr Cycl O/F	Pb 1st Cl Tail	Bulk Feed	Pb Ro Feed
PP10	1322	1272	1730	1646	1170	1082	1040	1996	1940	1148	1084	14	20
PP11	1304	1261	1673	1443	1210	1131	1043	2173	2323	1245	1166	14	19
PP12	1309	1262	1846	1916	1226	1130	1056	2050	2056	1240	1166	15	18
PP13	1297	1270	1750	1822	1212	1116	1010	2018	2000	1190	1090	14	20
PP14	1282	1270	1748	1720	1230	1104	1044	1996	1984	1204	1106	15	20
PP15	1300	1268	1722	1734	1212	1106	1048	1994	1964	1194	1104	16	20
PP16	1272	1276	1741	1687	1129	1083	1053	2054	2086	1202	1094	19	22
PP17	1254	1226	1816	1776	1130	1089	1038	1951	1961	1183	1085	15	20

TABLE NO. 32 :
Zinc Circuit Densities and Temperatures

Test No.	Density, g/L								Temp. °C
	Zn Scalp Tail	Zn Regr Mill Disch	Zn Regr Cycl U/Flow	Zn Regr Cycl O/Flow	Zn Prefloat Tail	Zn 1st Cl Feed	Zn Cl Scav Tail	Thick U/Flow	Zn Scalp Feed
PP10	1240	2258	2254	1184	1024	1122	1082	1040	16
PP11	1219	1973	2046	1295	1015	1125	1060	1234	19
PP12	1226	2088	2064	1188	1012	1116	1050	-	19
PP13	1230	1610	1698	1130	1010	1118	1138	-	17
PP14	1186	2190	2200	1226	1012	1142	1052	-	17
PP15	1210	2328	2334	1240	1018	1213	1064	2670	17
PP16	1220	1820	2107	1348	1013	1215	1070	1823	20
PP17	1189	2253	2279	1259	1020	1115	1053	-	15

Summary - Continued

TABLE NO. 33 :
pH Levels

Test	pH													
	Rod Mill Disch	Bulk 1 Feed	Bulk Tail 2	Pb Ro 1 Feed	Pb 1st Cl	Pb 2nd Cl	Pb 3rd Cl	Pb 4th Cl	Zn Scalp 1 Feed	Zn Prefloat Conc	Zn 1st Cl	Zn Cl Scav	Zn 2nd Cl	Zn 3rd Cl
PP10	11.2	10.7	10.5	10.5	10.6	10.6	10.6	10.6	11.0	11.7	12.5	12.7	12.7	12.7
PP11	10.8	10.4	10.1	10.2	10.2	10.2	10.2	10.2	10.7	11.3	11.6	11.8	11.4	11.8
PP12	10.8	10.3	10.3	10.2	10.2	10.2	10.1	10.3	10.7	11.3	11.7	11.8	12.0	11.8
PP13	10.8	10.4	10.2	10.1	10.2	10.2	10.0	10.0	10.8	10.3	11.9	12.0	12.1	11.8
PP14	10.8	10.2	10.0	10.1	10.1	10.1	10.0	10.0	10.8	10.1	11.6	11.8	11.9	11.8
PP15	10.8	10.3	10.1	10.1	10.2	10.1	10.0	10.0	10.8	10.1	11.6	11.8	11.9	11.8
PP16	10.8	10.3	10.0	10.2	10.3	10.2	10.0	10.0	11.0	10.2	11.4	11.4	11.8	12.0
PP17	10.2	9.5	9.4	10.0	10.0	10.0	9.9	9.8	10.5	9.8	11.7	11.8	12.0	11.9

TABLE NO. 34 :
Reagent Additions (Semi-bulk and Pb Circuits)

Test No.	Reagent Additions, g/t												
	Na_2CO_3			SD200/NaCN					A317				
	RM Feed	Bulk Regr	Pb Regr	Bulk Regr	Pb Regr	Pb 2nd Cl	Pb 3rd Cl	Pb 4th Cl	BM Feed	Bulk Ro 1 Feed	Bulk Ro 2 Feed	Pb Ro H.I. Cond	Pb 1st Cl H.I. Cond
PP10	2542	296	102	298	427	83	81	164	10	51	10	70	10
PP11	2503	342	100	342	362	79	79	159	12	50	10	63	10
PP12	2514	312	103	365	366	81	83	158	11	48	10	41	11
PP13	2508	301	100	334	336	81	80	80	10	52	10	42	10
PP14	2503	315	101	333	330	79	81	80	10	49	10	40	10
PP15	2500	301	100	338	335	80	81	81	10	46	11	42	10
PP16	1791	294	100	334	336	80	80	80	10	50	40	42	10
PP17	1812	321	115	340	329	81	75	70	10	50	40	48	11

TABLE NO. 35 :
Reagent Additions (Semi-bulk and Pb Circuits - Continued)

Test	Reagent Additions, g/t										
	CA830/Thiourea						MIBC				
	BM Feed	Bulk Ro 1 Feed	Bulk Ro 2 Feed	Pb Ro H.I. Cond	Pb Ro 2 Feed	Pb 1st Cl H.I. Cond	Bulk Ro 1 Feed	Bulk Ro 2 Feed	Pb Ro H.I. Cond	Pb Ro 2 Feed	Pb 1st Cl H.I. Cond
PP10	18	10	7	14	10	32	22	3	12	9	7
PP11	10	21	10	19	10	38	21	3	12	11	8
PP12	10	18	9	17	7	40	23	2	6	8	8
PP13	10	20	8	11	18	39	22	1	-	39	-
PP14	9	20	10	17	29	41	20	2	-	-	-
PP15	10	19	9	14	26	40	20	2	-	1	-
PP16	10	20	17	15	25	40	10	2	-	2	-
PP17	22	22	20	18	48	40	31	3	-	9	-

Summary -Continued

TABLE NO. 36 :
Reagent Additions (Zn Circuit)

Test	Reagent Additions, g/t													
	Ca(OH)2						CuSO4			M2030				
	Zn Scalp 1	Zn Scalp Regrind	Zn Prefloat Cond	Zn 2nd Cl	Zn 3rd Cl	Zn 4th Cl	Zn Scalp Cond 1	Zn Scalp Regrind	Zn Prefloat Cond	Zn Scalp 1 Feed	Zn Scalp 2 Feed	Zn Prefloat Feed	Zn Cl H.I. Cond	Zn Cl Scav Feed
PP10	692	623	921	1607	1342	-	935	167	405	8	3	7	7	1
PP11	656	978	883	574	139	77	915	165	458	8	5	7	8	1
PP12	681	821	698	748	95	143	928	171	479	7	3	7	8	1
PP13	661	961	300	609	68	189	905	166	464	10	3	8	10	1
PP14	717	848	280	359	138	101	889	173	559	10	3	9	10	1
PP15	673	807	258	357	127	133	908	169	686	13	3	7	9	1
PP16	794	570	266	169	64	136	789	162	537	10	3	6	10	1
PP17	808	713	285	237	192	104	804	177	564	12	3	9	10	1

TABLE NO. 37 :
Reagent Additions (Zn Circuit - Continued)

Test	Reagent Additions, g/t										
	A317					DF250		DF1012		SD200	
	Zn Scalp 1 Feed	Zn Scalp 2 Feed	Zn Prefloat Feed	Zn Cl H.I. Cond	Zn Cl Scav Feed	Zn Scalp 1 Feed	Zn Prefloat Feed	Zn Scalp 1 Feed	Zn Prefloat Feed	Zn Cl H.I. Cond	Zn 2nd Cl
PP10	74	5	51	81	12	38	-	-	-	-	-
PP11	69	-	88	92	11	36	-	-	-	-	-
PP12	72	-	121	113	11	32	-	-	-	-	-
PP13	97	-	72	52	20	45	-	-	-	-	-
PP14	103	-	35	56	25	45	1	-	-	-	-
PP15	93	-	24	54	25	43	3	-	-	-	-
PP16	99	-	24	50	25	-	-	50	-	54	25
PP17	104	-	23	55	26	-	-	51	1	36	33

Summary - Continued

TABLE NO. 38 :
Pilot Plant Continuous Metallurgical Results

Test No.	Product	Weight %	Assays, %, g/t			% Distribution		
			Pb	Zn	Ag	Pb	Zn	Ag
10	Pb 4th Cleaner Concentrate	3.40	76.9	2.57	169	77.9	1.0	10.4
	Zn 3rd Cleaner Concentrate	18.60	1.27	45.6	166	7.0	92.8	55.6
	Zn Combined Tails	77.99	0.65	0.73	24.2	15.1	6.2	34.0
	Derrick Screen U'Size	100.00	3.36	9.14	62.2	100.0	100.0	100.0
11	Pb 4th Cleaner Concentrate	2.83	76.7	5.06	224	69.2	1.5	10.2
	Zn 3rd Cleaner Concentrate	17.42	1.76	49.4	178	9.8	90.7	49.9
	Zn Combined Tails	79.75	0.83	0.93	31.1	21.1	7.8	39.9
	Derrick Screen U'Size	100.00	3.14	9.49	60.9	100.0	100.0	100.0
12	Pb 4th Cleaner Concentrate	2.88	74.0	6.08	321	64.1	1.9	14.4
	Zn 3rd Cleaner Concentrate	15.56	2.45	50.4	177	11.4	82.9	43.0
	Zn Combined Tails	81.56	1.00	1.77	33.5	24.5	15.3	42.6
	Derrick Screen U'Size	100.00	3.33	9.46	60.5	100.0	100.0	100.0
13	Pb 4th Cleaner Concentrate	2.84	76.4	3.44	180	69.2	1.0	9.9
	Zn 3rd Cleaner Concentrate	16.20	1.77	53.4	164	9.1	89.3	51.6
	Zn Combined Tails	80.95	0.84	1.16	24.5	21.7	9.7	38.5
	Cyclone Overflow	100.00	3.14	9.69	59.6	100.0	100.0	100.0
14	Pb 4th Cleaner Concentrate	3.32	63.9	6.35	168	68.8	2.2	8.8
	Zn 3rd Cleaner Concentrate	16.55	1.69	52.0	197	9.1	89.9	51.7
	Zn Combined Tails	80.13	0.85	0.95	31.1	22.1	7.9	39.5
	Cyclone Overflow	100.00	3.08	9.58	58.9	100.0	100.0	100.0
15	Pb 4th Cleaner Concentrate	2.89	75.3	2.6	196	67.4	0.8	9.5
	Zn 3rd Cleaner Concentrate	16.45	1.75	52.3	175	8.9	89.6	48.1
	Zn Combined Tails	80.66	0.95	1.14	31.5	23.7	9.6	42.4
	Cyclone Overflow	100.00	3.23	9.60	58.7	100.0	100.0	100.0
16	Pb 4th Cleaner Concentrate	3.57	70.8	3.61	180	78.3	1.3	13.2
	Zn 4th Cleaner Concentrate	17.40	1.26	55.0	168	6.8	94.7	60.1
	Zn Combined Tails	79.03	0.61	0.51	16.4	14.9	4.0	26.7
	Cyclone Overflow	100.00	3.23	10.1	62.2	100.0	100.0	100.0
17	Pb 4th Cleaner Concentrate	2.60	74.4	5.31	263	69.0	2.2	16.4
	Zn 4th Cleaner Concentrate	10.72	2.85	53.3	156	10.9	89.3	40.3
	Zn Combined Tails	86.68	0.65	0.63	20.7	20.1	8.5	43.2
	Cyclone Overflow	100.00	2.80	6.40	44.2	100.0	100.0	100.0

9. Smelter Impurity Analyses

The lead and zinc concentrates from pilot plant Tests PP-16 (Composite 2 ore) and Test PP-17 (Raise 2) were submitted for impurity analyses. The assays of the individual concentrates are summarized in Table No. 39.

Summary - Continued

TABLE NO. 39
Concentrate Analyses

Element		Assays % PP-16 Pb Conc	PP-16 Zn Conc	PP-17 Pb Conc	PP-17 Zn Conc
Lead	Pb	70.2	1.24	74.7	2.84
Zinc	Zn	3.48	54.8	5.10	53.3
Copper	Cu	0.016	0.079	0.007	0.065
Iron	Fe	4.55	5.87	2.20	6.00
Nickel	Ni	<0.002	<0.002	<0.002	0.002
Bismuth	Bi	<0.002	<0.002	<0.002	<0.002
Cadmium	Cd	0.025	0.33	0.047	0.34
Cobalt	Co	<0.002	<0.002	<0.002	<0.002
Chromium	Cr	<0.002	<0.002	<0.002	<0.002
Arsenic	As	<0.001	<0.001	<0.001	<0.001
Antimony	Sb	0.008	<0.002	0.011	<0.002
Tin	Sn	<0.001	<0.001	<0.001	<0.001
Gallium	Ga	0.0001	0.0003	<0.0001	0.0003
Germanium	Ge	<0.0010	0.0043	<0.0010	0.0107
Indium	In	<0.002	<0.002	<0.002	<0.002
Manganese	Mn	0.003	0.024	0.003	0.035
Mercury	Hg	0.0010	0.013	0.0013	0.0058
Molybdenum	Mo	<0.002	<0.002	<0.002	<0.002
Thallium	Tl	0.005	0.010	0.004	0.007
Thorium	Th	<0.001	<0.001	<0.001	<0.001
Selenium	Se	<0.0003	<0.0003	0.0004	<0.0003
Tellurium	Te	<0.0003	0.0014	<0.0003	0.0006
Uranium	U	<0.001	<0.001	<0.001	<0.001
Gold	Au g/t	0.13	<0.02	0.05	0.03
Silver	Ag g/t	171	166	263	157
Titanium	TiO_2	<0.10	<0.10	<0.10	<0.10
Silicon	SiO_2	0.49	0.64	<0.20	0.94
Aluminum	Al_2O_3	<0.10	<0.10	<0.10	0.13
Calcium	CaO	0.03	0.08	0.07	0.10
Magnesium	MgO	<0.01	<0.01	<0.01	<0.01
Sodium	Na_2O	0.002	0.005	<0.002	0.003
Potassium	K_2O	0.013	0.012	<0.002	0.009
Fluorine	F	<0.01	0.02	0.04	0.03
Chlorine	Cl	0.0081	0.013	0.0038	0.014
Sulphur	S	18.2	35.6	16.9	34.2
Phosphorus	P	0.0064	0.0029	0.0015	0.0048
Carbon	C	1.29	0.28	0.20	0.44
Insoluble		0.70	2.36	0.13	2.47
L.O.I. (1000°C)		10.3	18.4	8.64	18.5
	Total	98.3	99.0	99.3	98.4

DISCUSSION

1. Description of Samples Used in the Testwork

Details of samples received for pilot plant testing are shown in Table No. 40.

TABLE NO. 40 :
Pilot Plant Samples

Ore	Tonnes Received*	Date Received	Lakefield Research No.
Rock Type 5	100	Jan 2-7, 1991	9135894
Rock Type 4	25	Jan 2-7, 1991	9135894
Upper Medium	10	Jan 2-7, 1991	9135894
Hanging Wall	10	Jan 2-7, 1991	9135894
Raise 1	20	Feb 22, 1991	9136189
Raise 2	10	Feb 22, 1991	9136189

* approximate; mainly based on estimate of ore to be shipped from minesite.

Crushing of Individual Samples

SAG mill testing was intended for Rock Type 5 and 4 ores. These ores were first thoroughly blended by front end loader, and about half of each sample was stage crushed to -9.5 mm in the pilot plant crusher circuit. A sample was cut by the automatic sampler to provide samples for head assay and for laboratory testwork.

Each crushed sample was blended by front end loader.

The Upper Medium ore, and Raise 1 and 2 ores were similarly treated, but the entire samples were crushed. The Hanging Wall material was not crushed.

Composite Preparation

PP Composite 1 - PP Composite 1 was prepared by combining crushed Rock Type 5, Rock Type 4 and Upper Medium ore samples in the ratio of 70:20:10. The composite was blended by front end loader. A total of about 15 tonnes was made.

PP Composite 2 - the following samples were used in the composite:

- about 12 t of Rock Type 5 ore, reserved for SAG grinding, was crushed.
- about 3.4 t of Rock Type 4 and 1.7 t of Upper Medium ore, each already crushed.
- about 11 t of PP Composite 1, already crushed.
- about 20 t of Raise 1 ore, already crushed.

Discussion - Continued

The composited ore, in total about 48 t, was blended by front end loader in preparation for pilot plant testwork.

Feed for the pilot plant tests was as follows:

Rock Type 5 :	Tests PP-1 to 8
PP Composite 1 :	Test PP-9
PP Composite 2 :	Tests PP-10 to 16
Raise 2 :	Test PP-17.

Note that PP Composite 2 was regarded to be essentially the same as PP Composite 1 except that the Raise 1 component may have contributed a little less of Rock Type 5 and a little more of Rock Type 4 and Upper Medium ore (i.e. In a ratio of 60:40 rather than 70:30).

Rock Type 4, Upper Medium ore, and Hanging Wall ore were not directly fed to the pilot plant.

2. Head Assays

The head assays for the various pilot plant ores are shown In Table No. 41.

TABLE NO. 41 :
Head Analyses of Pilot Plant Sample and Composite

Element	Assays %, g/t					
	Ore Type 5	Ore Type 4	Upper Medium	PP Comp No. 1*	PP Comp No. 2**	Raise 2
Lead (Pb), Total	3.56	2.74	2.61	3.21	2.99	2.79
Zinc (Zn), Total	9.62	0.47	8.59	9.08	9.90	6.65
Lead (Pb), Oxide	0.68	7.79	0.41	0.55	0.50	0.53
Zinc (Zn), Oxide	0.06	0.08	0.09	0.10	0.08	0.066
Iron (Fe)	13.60	9.12	12.10	12.70	12.6	9.72
Sulphur (S)	25.20	25.2	25.60	23.50	25.2	21.3
Barium (Ba)	22.10	32.1	29.2	24.10	26.0	28.5
Carbon (C), Total	0.71	0.49	0.13	0.56	0.48	0.48
Carbon (C), graphitic	0.49	-	-	0.40	-	-
Gold (Au)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Silver (Ag)	67.20	52.2	62.8	61.3	60.0	46.6

* blend of 4, 5 and upper medium (70:20:10) used in Test PP-9 only.
**blend of 4, 5, and upper medium (70:20:10); blended from PP Comp No. 1 and Raise 1 ore; used in Tests PP-10 to 16.

The following should be noted:

- While Ore Type 5 and Ore Type 4 were designated as "sulphidic" and "baritic" respectively In fact barite and sulphur levels were similar for all of the ores tested, with the main differences being the lead/zinc grades and carbon level. All ores treated in the pilot plant could therefore be described as "baritic" rather than "sulphidic".
- The carbon levels were generally over 0.5 %, as compared with <0.2 % in the bench scale ores. This had a appreciable effect on the metallurgy In the pilot plant.
- The zinc level of PP Type 5 ore was lower than that in the bench scale sample.

Discussion - Continued

3. Pilot Plant Operation

Phase 1 pilot plant operation was from January 15-18, 21-22, and 24, 25 and 28, 1991. The testwork consisted of nine single shift tests, which averaged 7-8 hours per test. PP Rock 5 ore was used in Tests PP-1 to 8 and PP Composite 1 ore was tested in Test PP-9. Feed rates were from 523 to 544 kg/hour.

Phase 2 operation was continuous for 69.5 hours from 6:30 pm February 24 to 4:00 pm February 27, 1991. In the Initial 59.5 hours, PP Composite 2 ore was processed, with operation divided Into 7 tests, most of which were 8 hours in duration. Raise 2 ore was treated in the final 10 hours. Feed rates were from 590-604 kg/hour.

During the pilot plant operation, the following variables were examined:

- basic flowsheet configuration
- high Intensity conditionIng
- fineness of lead concentrate regrind
- reagent additions, points of addition, and reagent types
- effect of recycle water.

3.1. Primary Grinding

The milling flowsheet used in most of the pilot plant tests Is shown in Figure No. 7.

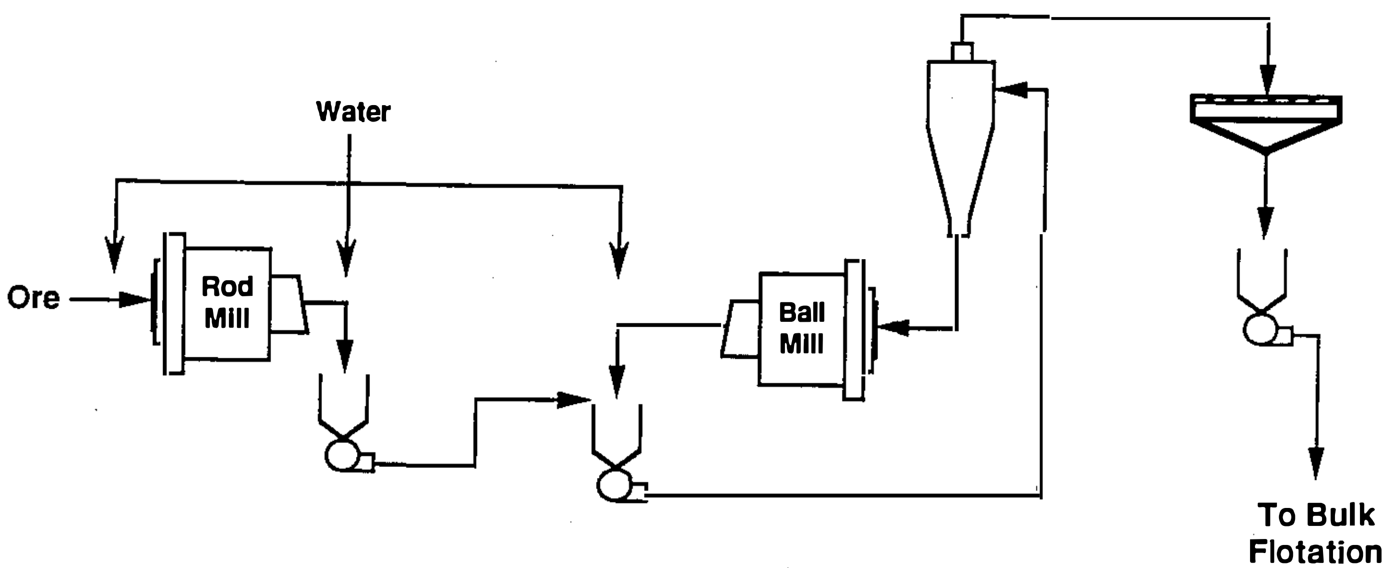


FIGURE NO. 7 : Primary grinding circuit

Discussion - Continued

The ore, which had been crushed to -9.5 mm, was ground in open circuit In the rod mill. The rod mill discharge was pumped to the ball mill discharge pump, and the combined mill discharges were pumped to a 50 mm cyclone. The cyclone underflow was returned to the ball mill, and the overflow was passed through a 30 mesh vibrating screen. The screen was Intended to keep very coarse material out of the flotation circuit in case of cyclone plugging.

Reagent additions In the milling circuit included soda ash to the rod mill and collector addition to the ball mill feed. In two tests, which involved a carbon prefloat stage, collectors were not added to the mill.

Variations in this "standard" milling flowsheet were examined In several tests. These included the following:

- Pumping of the rod mill discharge directly to the ball mill feed instead of to the cyclone (termed "Revised" milling flowsheet) in Tests PP-16 to 17. This was performed as problems were experienced In Test PP-16 with pump plugging on commencement of recycle water testing.

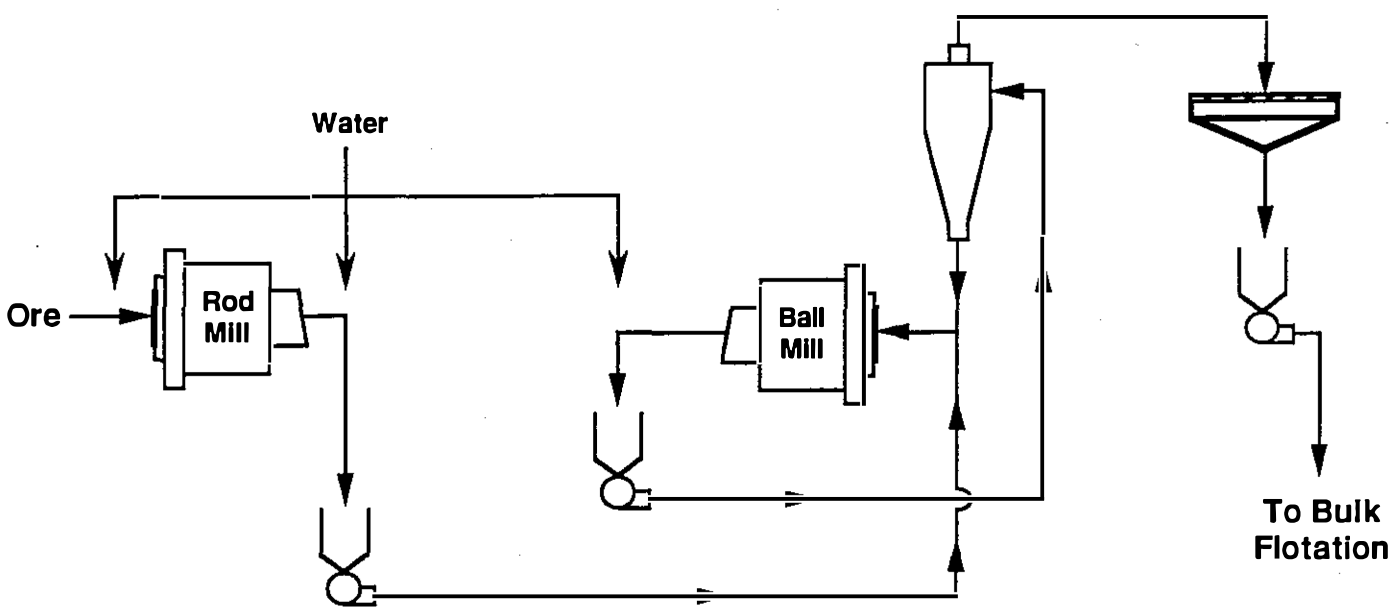


FIGURE NO. 8 : Alternative milling circuit with rod mill discharge to ball mill feed

- Substitution of the cyclone for a vibrating Derrick screen (aperature 109 μm, area 0.84 m^2) in Tests PP-10 to 12 (Figure No. 9). Examination of this circuit was completed to determine whether overgrinding of barite and galena as a resuit of cyclone classification led to poor metallurgy.

Discussion - Continued

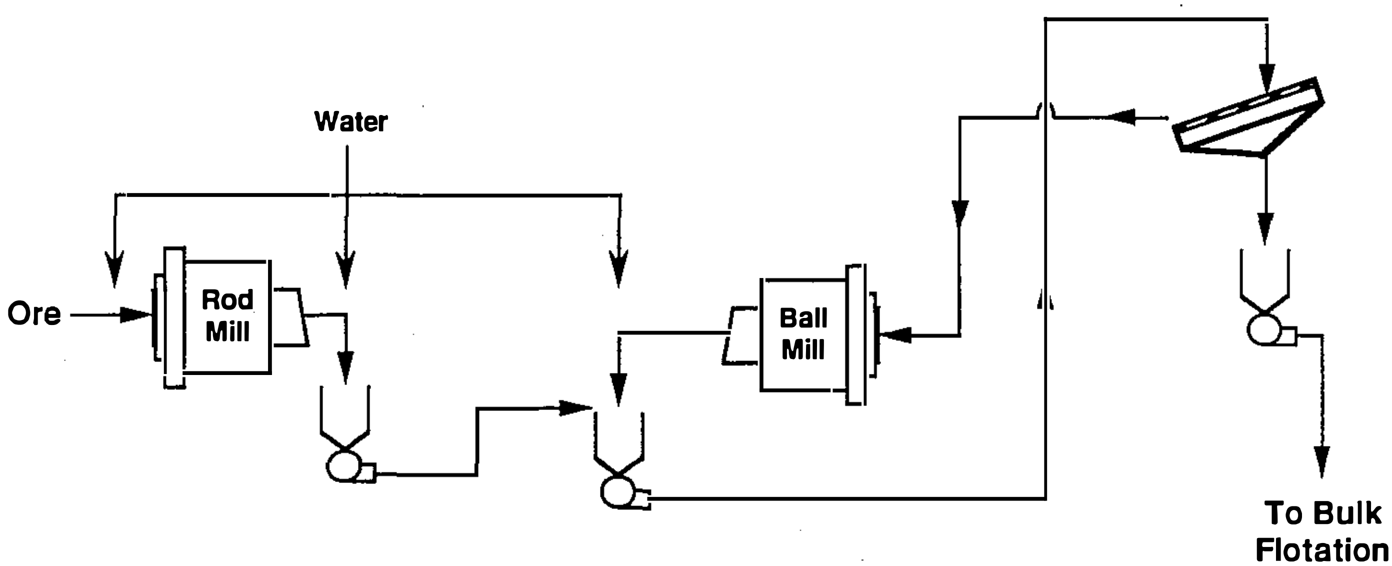


FIGURE NO. 9 : Alternative milling circuit with classification by screening

During the testwork, the fineness of the primary grinding product was intended to be about 80 % - 80 to 85 µm. Attempts to control the grind fineness involved adjusting the following parameters:

- rod mill steel charge
- bali mill steel charge
- bali mill pulp density
- ore feed rate.

3.2. Regrinding

Three regrinding circuits were included in the fiowsheet. Products reground included the following:

- Semi-bulk concentrate (in one test - PP-8, the Pb 1st cleaner scavenger concentrate was combined with the semi-bulk concentrate and ground).
- Pb rougher concentrate.
- Zn scalp concentrate.

The flowsheet for each of the circuits is shown in Figure No. 10.

Discussion - Continued

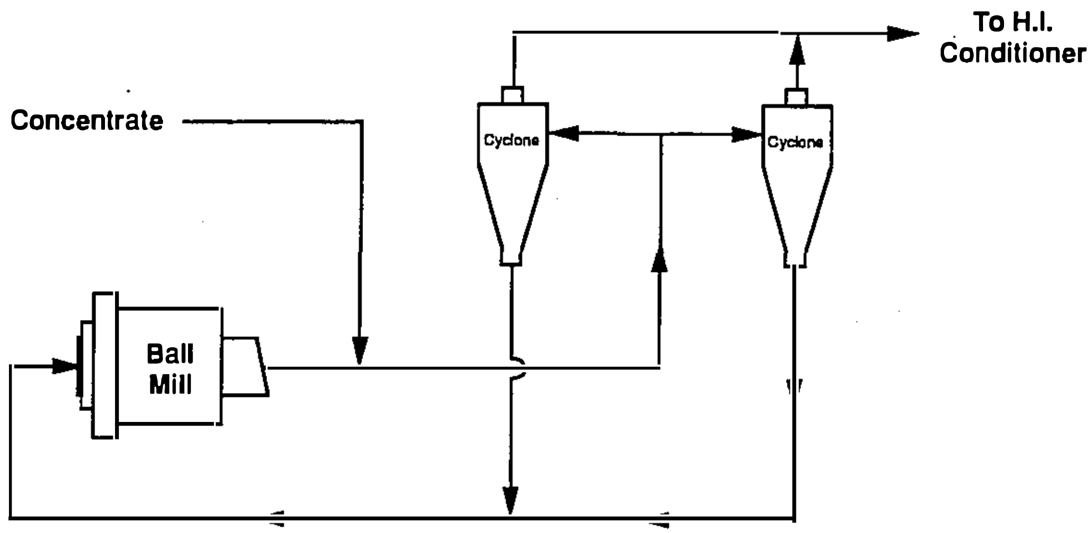


FIGURE NO. 10 : Regrinding circuits flowsheet

The circuits were operated as follows. Concentrate was fed to the mill discharge pump, and the combined concentrate and discharge was split and pumped to two cyclones (note that the feed to double cyclones was split with a Y connection in the line). The cyclone underflows were combined and fed to the mill, and the overflows were combined and fed to a high intensity conditioner.

3.2.1. Semi-Bulk Regrind

The semi-bulk concentrate was reground in a Sala (1067 mm x 610 mm diameter) ball mill with 400 kg of 25 mm balls. The target grind was about K_{80} = 11-12 µm which was achieved in bench scale testwork. The regrind fineness was controlled by varying mill size, ball charge, and number and size of cyclones.

In the initial tests, different mills and ball charges were tested with a single 50 mm cyclone. These variations included:

- PP-1 to 6 : Sala mill with 550 kg of 25-38 mm balls
- PP-7 to 9 : Hazen Quinn (812 mm x 406 mm diameter) mill with 200 kg of 25 mm balls

The changes made in PP-7 were intended to reduce the grind fineness, and specifically to reduce Pb overgrinding.

Discussion - Continued

3.2.2. Lead Concentrate Regrind

The lead rougher concentrate was reground in a Hazen Quinn (812 mm x 406 mm diameter) ball mill with 200 kg of 25 mm balls. The target grind was K_{80} = <9 µm to 9 µm which was achieved in the bench scale testwork. The regrind fineness was controlled by varying mill size, ball charge, and cyclone size and number.

In the initial pilot plant, different cyclones, mills and ball charges were tried. These included:

- PP-1 to 5 : a larger Hardinge conical (205 mm long cylindrical section, 914 mm diameter) mill was used with a larger ball load of 580 kg of 25-38 mm balls.
- PP-6 : As for PP-1 to 5 but with a single 50 mm cyclone.
- PP-7 to 9 : As for Tests PP-10-17 (i.e. small mill, low ball charge, double cyclone).

3.2.3. Zinc Scalp Concentrate Regrind

The zinc scalp concentrate was reground in a Denver (812 mm x 406 mm diameter) ball mill with 225-305 kg of 25 mm balls. The target grind was about K_{80} = 18-21 µm, which was achieved in bench scale testwork.

The regrind was controlled by ball charge and number and size of cyclones. These parameters were kept constant in all tests except that a single 50 mm cyclone was used in one test (PP-10) and ball charge was increased in the continuous operation.

3.3. Flotation

The flotation circuit flowsheet finalized in the continuous operation is shown in Figure 11. Numerous flowsheet options had been studied in the initial pilot plant (single shift tests) testwork (as discussed in the initial Pilot Plant Result section). The flowsheet philosophy remained constant throughout both the initial and continuous pilot plants. However many variations in equipment, points of recirculation, reagent schemes and additions, the the control philosophy were tested in the initial pilot plant work (single shift tests) in attempts to find acceptable, stable metallurgy and later in the continuous pilot plant work to optimize metallurgy.

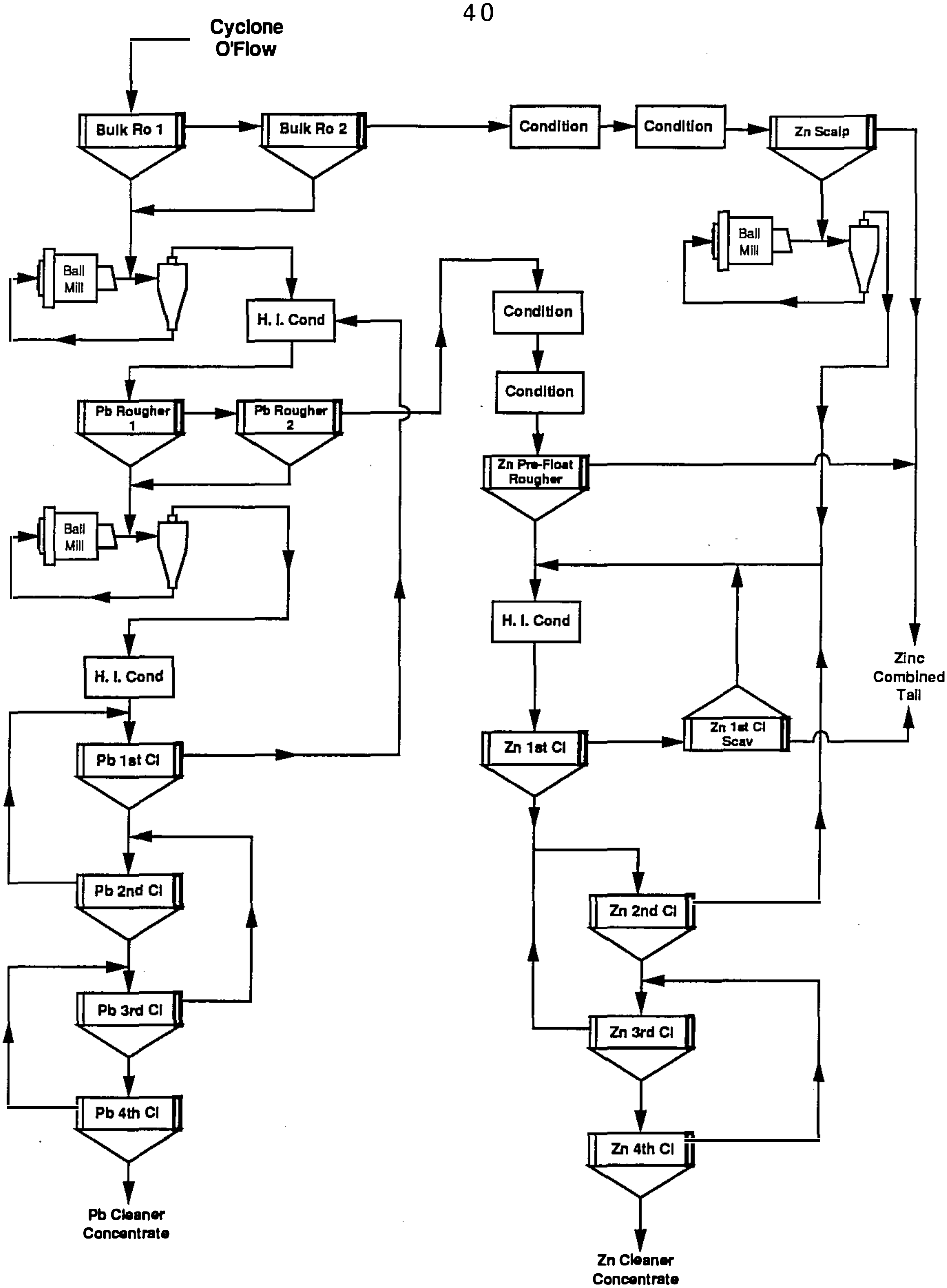


FIGURE NO. 11 : Continuous pilot plant flotation flowsheet

Discussion - Continued

Circuit operation was as follows:

Semi-Bulk Flotation

Frother (MIBC) and additional collectors (A317 and CA830/Thlourea) were added to the primary grinding circuit product, and a semi-bulk concentrate was floated in two banks of cells. Most of the lead and a portion of the zinc (as middlings) reported to the concentrate. A portion of the pyrite, most of the barite, and most of the carbonaceous material were rejected in the tails.

The semi-bulk tails were fed to the zinc scalp conditioners.

Lead Flotation

The semi-bulk concentrate, after grinding with soda ash and depressant was conditioned with collectors, along with the Pb 1st cleaner tail, in a high intensity conditioner. The conditloned pulp was then floated in two banks of lead rougher cells. A considerable portion of the sphalerite was rejected in this stage. The tails were pumped to the Zn prefloat conditioners.

The lead rougher concentrate was reground with soda ash and depressant SD200/cyanide and conditioned in a high intensity conditioner with collectors and frother, and pumped to the Pb 1st cleaner cells. Four cleaner stages In closed circuit were included in the flowsheet. Additions of SD200/cyanide depressant were made to each of the 2nd, 3rd and 4th cleaners. (Note that SD200/cyanide is the same reagent as was used in the bench scale testwork. (In the bench scale test report Volume 2, the reagent was generally referred to as PKD-C).

Zinc Flotation

The semi-bulk tail was conditioned with lime and cupric sulphate, and a concentrate was floated in two banks of cells with A317 and M2030 collectors and DF250 (or DF1012) frother. The scalp tails were generally thickened In a thickener and discharged. The semi-bulk concentrate was reground with lime and cuprite sulphate.

The Pb rougher tail was also conditioned with lime and cupric sulphate and a concentrate floated in one bank of cells with the collectors and frother. The tail was pumped to tailings and the concentrate was combined with the scalp concentrate. Separate Zn scalp and prefloat circuits were used as the fine zinc in the Pb rougher tail floated more readily with less $CuSO_4$ and at a lower pH than did the coarser zinc in the semi-bulk tail.

The combined zinc scalp and prefloat concentrates were conditioned with collectors In a high intensity conditioner, and pumped to zinc cleaning.

The cleaner circuit consisted of a 1st cleaner in open circuit, followed by 2nd, 3rd and 4th cleaners In closed circuit. The Zn 1st cleaner scavenger tail was pumped to tailings. The concentrate was recycled to the Zn 1st cleaner H.I. conditioner.

Discussion - Continued

During the continuous operation, the following major circuit and operating modifications were made:

- Lime and $CuSO_4$ additions to the zinc prefloat were altered. Both reagents were added to the 1st conditioner, and collectors were added to the 2nd conditioner (instead of lime to conditioner 1 and $CuSO_4$ to conditioner 2). This allowed reduction of both reagent addition levels.
- The number of zinc cleaners was increased from three to four, and the number of zinc 2nd and 3rd cleaner cells were reduced from 3 to 2 and from 2 to 1 respectively.
- Several reagent addition levels were modified.
- Depressant SD200 was added to zinc cleaning and frother DF250 was replaced by DF1012. Both changes were made in PP-16.
- Recycle water was used in one test (PP-16).

In PP-16, the zinc scalp tail water, from the thickener overflow, was used in the grinding circuit. In addition, pond water was recycled to the flotation circuit. Pond water consisted of total tails water (from Zn scalp, Zn prefloat, and Zn 1st cleaner scavenger tails) from the initial and continuous pilot plants.

4. Initial Pilot Plant Results

4.1. Primary Grinding

4.1.1. Rod Mill

The rod mill grinding results are summarized In Table No. 41.

TABLE NO. 41 :
Rod Mill Grinding Data

Test No.	Feed					Mill Disch g/L	Product			Power	
	Rate kg/h	Cons kg	Cum % Passing -48 mesh	Cum % Passing -200 mesh	K_{80} µm		Cum % Pass -200 mesh	Cum % Pass -400 mesh	K_{80} µm	Input kWh/t	Work Index (metric)
PP-1	544	2992	27.0	18.0	4699	2098	40.3	26.6	295	5.1	11.7
PP-2	525	3150	28.0	18.8	4299	2099	47.3	33.2	260	5.4	11.5
PP-3	529	3968	27.4	18.2	4355	2098	46.4	33.0	275	5.2	11.4
PP-4	521	3647	25.1	17.3	5328	2096	46.0	32.7	285	5.2	11.5
PP-5	525	3938	25.5	16.9	4732	2094	45.5	31.9	286	5.0	11.3
PP-6	524	3675	27.9	18.3	4795	2099	46.8	32.7	264	5.0	10.6
PP-7	525	3675	24.4	16.4	5202	2099	46.0	33.0	287	5.2	11.5
PP-8	528	3611	30.1	19.8	3787	2103	45.1	31.3	275	5.4	12.2
PP-9	523	4707	28.6	19.1	4271	2097	48.2	34.1	251	5.3	11.1
Total	-	33363	-	-	-	-	-	-	-	-	-

Discussion - Continued

A total of 28.6 tonnes of Rock Type 5 (Tests PP-1 to 8) and 4.7 tonnes of PP Composite 1 (PP-9) were processed. Power input levels were 5 kWh/t. Work index values of 10.6 - 12.2 (metric) were obtained, and grind products were K_{80} = 250 to 300 μm.

4.1.2. Ball Mill and Overall

The results of ball mill grinding are shown In Table No. 42.

TABLE NO. 42 :
Ball Mill Grinding Data

Test	Pulp Densities, g/L			Circ Load	Product			Power			
	Mill Disch	Cycl U/Flow	Cycl O/Flow	%	Cum% Pass -200 mesh	Cum% Pass -400 mesh	K8o μm	Ball Mill Input kWh/t	Ball Mill Work Index	Overall Input kWh/t	Overall Work Index*
PP-1	2103	2760	1335	-	73.9	43.3	87	9.1	18.5	14.2	15.3
PP-2	2100	2770	1345	-	87.6	65.7	58	9.1	13.1	14.4	12.4
PP-3	2103	2764	1349	-	85.3	64.1	62	8.9	13.3	14.0	12.5
PP-4	1924	2756	1314	-	82.8	62.4	68	8.9	14.3	14.1	13.1
PP-5	1941	2271	1305	-	79.1	56.1	77	8.9	16.1	13.9	14.0
PP-6	1938	2758	1305	692	89.0	69.2	53	9.1	12.0	14.1	11.5
PP-7	1903	2755	1286	417	76.8	54.7	82	9.3	18.1	14.5	15.0
PP-8	1915	2760	1304	1119	86.5	64.3	60	9.0	13.1	14.4	12.8
PP-9	1910	2770	1300	567	84.9	61.9	64	9.1	14.7	14.4	13.1

*metric

Ball mill power inputs were 8.9-9.3 kWh/t and ball mill work indices were variable, from 12.0 to 18.1 (metric). Overall power inputs were about 14.4 kWh/tonne and work indices were 12-15 (metric).

Grind products were quite variable in fineness, ranging from K_{80} = 53 to 87 μm. Variability in grind results was largely due to the level of circulating load, which varied from 417 to over 1000 in Tests PP-5 to 9. Variations in feed rate during each test also contributed somewhat to the variability in grind results.

In general, the testwork indicated that there was little difference between the grinding characteristics of Rock Type 5 (PP-1 to 8) and PP Composite 1 ore (PP-9). It also yielded considerably higher work indices than did the SAG mill testing.

4.2. Regrinding

4.2.1. Semi-Bulk Concentrate Regrind

The results of the regrinding of the semi-bulk concentrate are shown In Table No. 43.

The fineness of the semi-bulk concentrates were K_{80} = 25-35 μm. Regrind products were K_{80} = 12 to 20 μm. The target regrind of K_{80} = 11-12 μm was therefore not quite achieved In most tests.

Discussion - Continued

TABLE NO. 43 :
Semi-Bulk Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm
PP-1	1293	-	1175	-	-	-	-	-	-
PP-2	1558	1840	1145	67.8	47.6	26	87.2	63.5	14
PP-3	1500	1530	1140	57.5	34.0	32	85.1	58.0	17
PP-4	1490	1460	1280	51.4	28.5	35	78.2	49.9	18
PP-5	1175	1220	1150	67.3	48.5	25	86.2	63.0	14
PP-6	2140	2200	1135	59.2	38.6	31	94.4	67.8	12
PP-7*	1210	1220	1110	74.7	54.3	20	85.4	62.3	15
PP-8*	1690	1770	1280	58.4	36.9	30	72.9	46.4	20
PP-9*	1458	1453	1230	64.8	42.7	25	77.6	52.3	18

*Sala mill used in Tests PP-1 to 6; smaller Hazen Quinn mill in Tests PP-7 to 9.

Attempts to coarsen the grind in Tests PP-7 to 9 resulted in marginal reduction in grind fineness. Recycle of the Pb 1st cleaner scavenger concentrate to the regrind circuit in Test PP-8 resulted in a definite coarsening of the product to K_{80} = 20 µm.

Based upon the data, grinding characteristics of Rock Type 5 and PP Composite 1 ore concentrates were similar.

In general, circuit operation was reasonably stable without much disruption due to cyclone plugging.

4.2.2. Lead Concentrate Regrind

The results of the regrinding of the lead rougher concentrate are shown in Table No. 44.

TABLE NO. 44 :
Pb Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm
PP-1	1400	-	1110	79.2	57.4	19	-	-	-
PP-2	1910	2050	1138	88.8	65.8	13	99.0	81.9	9
PP-3	2125	2065	1160	91.9	73.4	11	99.0	92.3	<9
PP-4	2050	2060	1170	81.8	57.5	16	94.6	58.3	13
PP-5	1690	1610	1040	89.4	73.0	12	98.3	92.2	<9
PP-6	1920	1935	1160	92.0	62.9	17	97.1	75.8	10
PP-7*	1220	1210	1070	86.3	63.2	15	90.2	67.0	13
PP-8*	1870	1780	1270	74.6	46.3	20	87.1	66.3	13
PP-9*	2105	2385	1205	86.0	60.4	14	96.9	70.0	11

*Hardinge mill used in Tests PP-1 to 6; smaller Denver mill in Tests PP-7 to 9.
Steel load decreased after Test PP-3.

Discussion - Continued

Grind products were K_{80} = <9 µm to 9 µm in PP-1 to 6. These values were similar to those achieved in the bench scale testwork. Coarsening of the grind in Tests PP-7 and 8 resulted in K_{80} values of 13 µm, and size reduction in these tests was therefore extremely limited.

In general, circuit operation was reasonably steady, and cyclone plugging was not a common occurrence. In some of the early tests, efforts to pull the Pb rougher concentrate heavily resulted in overflowing of the Pb regrind mill discharge pump. Changing the cyclones to a single 50 mm cyclone in Test PP-6 did not improve circuit operation, and its use was discontinued.

4.2.3. Zn Scalp Concentrate Regrind

The results of the zinc regrind circuit are presented in Table No. 45.

TABLE NO. 45 :
Zn Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm
PP-1	1555	-	1210	-	-	-	-	-	-
PP-2	2293	2338	1273	36.5	24.8	56	79.2	57.4	18
PP-3	2290	2360	1315	38.5	27.2	57	49.7	32.0	31
PP-4	2475	2460	1180	34.9	25.4	70	57.9	39.2	28
PP-5	2350	2370	1260	38.7	27.5	57	62.6	39.8	25
PP-6	1450	1580	1260	42.0	31.1	68	55.6	38.5	36
PP-7	2235	2215	1365	38.6	25.6	57	58.3	36.9	26
PP-8	2190	2160	1330	26.8	19.4	82	55.5	36.7	28
PP-9	2325	2365	1250	29.4	19.8	79	56.1	35.9	28

The zinc scalp concentrate was K_{80} = 56-68 µm in Tests PP-1 to 7. The concentrate was somewhat coarser in Tests PP-8 and 9 with two banks of Zn scalp cells, with the 2nd bank presumably pulling coarser material.

Grind fineness, K_{80} = 18-36 µm, was dependent on the amount of concentrate fed to the circuit and on the circulating load conditions from test to test.

4.3. Flotation

The overall metallurgical results are shown in Table No. 46.

Discussion - Continued

TABLE NO. 46 :
Initial Pilot Plant Metallurgical Results

Test No.	Product	Weight %	Assays, %, g/t			% Distribution		
			Pb	Zn	Ag	Pb	Zn	Ag
PP-2	Pb 4th Cleaner Concentrate	5.60	50.2	12.8	175	82.9	7.2	18.3
	Zn 3rd Cleaner Concentrate	17.47	0.98	50.4	182	5.0	88.7	59.4
	Zn Combined Tails	76.93	0.53	0.52	15.5	12.0	4.0	22.3
	Cyclone Overflow	100.00	3.39	9.92	62.2	100.0	100.0	100.0
3	C Prefloat Concentrate	7.80	5.65	6.14	95.9	12.3	4.7	11.5
	Pb 4th Cleaner Concentrate	4.07	57.1	13.2	152	64.6	5.2	9.5
	Zn 3rd Cleaner Concentrate	16.03	1.37	52.5	192	6.1	82.0	47.5
	Zn Combined Tails	72.10	0.85	1.16	28.2	17.1	8.1	31.4
	Cyclone Overflow	100.00	3.59	10.3	64.8	100.0	100.0	100.0
4	C Prefloat Concentrate	12.70	5.64	6.16	127	18.9	7.5	21.0
	Pb 4th Cleaner Concentrate	3.80	53.9	19.4	150	54.0	7.1	7.4
	Zn 3rd Cleaner Concentrate	15.18	1.89	50.2	179	7.6	73.1	35.4
	Zn Combined Tails	68.32	1.09	1.88	40.5	19.6	12.3	36.1
	Cyclone Overflow	100.00	3.80	10.4	76.6	100.0	100.0	100.0
5	Pb 4th Cleaner Concentrate	3.90	51.5	19	164	60.9	7.5	10.8
	Zn 3rd Cleaner Concentrate	14.35	1.31	54.2	166	5.7	78.2	40.2
	Zn Combined Tails	81.75	1.35	1.74	35.5	33.4	14.3	49.0
	Cyclone Overflow	100.00	3.30	9.94	68.7	100.0	100.0	100.0
6	Pb 4th Cleaner Concentrate	4.05	57.7	10.3	171	68.7	4.2	10.8
	Zn 3rd Cleaner Concentrate	13.66	1.52	52.3	179	6.1	71.8	38.0
	Zn Combined Tails	82.29	1.04	2.9	40.0	25.2	24.0	51.2
	Cyclone Overflow	100.00	3.40	9.95	66.8	100.0	100.0	100.0
7	Pb 4th Cleaner Concentrate	2.23	55.5	10.7	189	37.1	2.4	6.3
	Zn 3rd Cleaner Concentrate	20.04	5.94	44.2	164	35.6	88.6	49.1
	Zn Combined Tails	77.72	1.17	1.16	38.4	27.2	9.0	44.6
	Cyclone Overflow	100.00	3.34	10.0	73.3	100.0	100.0	100.0
8	Pb 4th Cleaner Concentrate	10.84	23.6	31.5	145	73.1	34.7	27.0
	Zn 3rd Cleaner Concentrate	14.98	2.38	38.8	162	10.2	59.1	41.7
	Zn Combined Tails	74.19	0.79	0.83	24.6	16.7	6.3	31.3
	Cyclone Overflow	100.00	3.50	9.84	62.8	100.0	100.0	100.0
9	Pb 4th Cleaner Concentrate	8.43	25.2	42.1	188	64.4	37.7	23.8
	Zn 3rd Cleaner Concentrate	9.85	3.30	47.3	173	9.9	49.5	25.5
	Zn Combined Tails	81.71	1.04	1.48	41.4	25.8	12.8	50.7
	Cyclone Overflow	100.00	3.30	9.42	64.3	100.0	100.0	100.0

4.3.1. Carbon Prefloat Flotation

A carbon prefloat was conducted in Tests PP-3 and 4 (Figure No. 12) in order to remove fine carbon prior to flotation of galena.

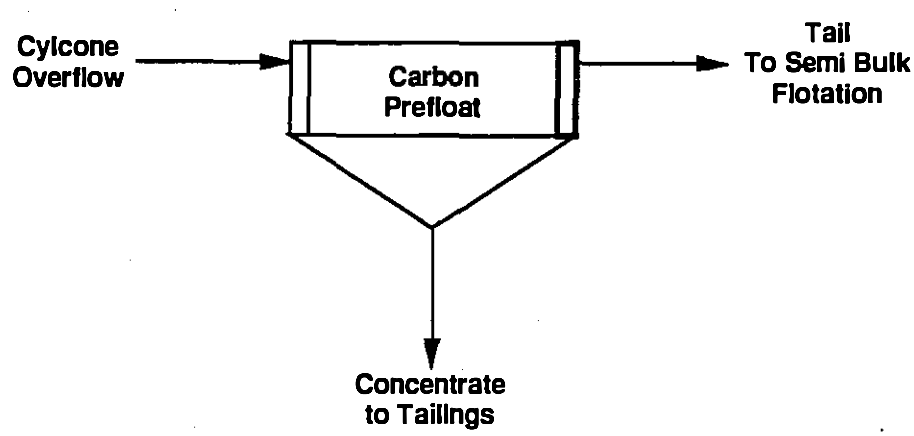


FIGURE NO. 12 : Carbon prefloat circuit flowsheet

Discussion - Continued

In these tests, collector was not added to milling. MIBC or DF250 was added to the float feed, and all collectors, along with additional frother were added to the semi-bulk feed.

The prefloat impaired lead circuit metallurgy in the following ways:

- Lead losses in the concentrate were quite high, from 12-19%, zinc losses were 5-8%.
- High frother additions resulted in voluminous froths in the lead circuit, making control very difficult, and reducing selectivity.

Further testwork with carbon preflotation was not pursued.

4.3.2. Semi-Bulk Flotation

Semi-bulk flotation recoveries in Tests PP-2 and 5-9 (without carbon preflotation prior to semi-bulk flotation) were generally a little lower than those achieved in the bench scale testwork. Lead tailings grades were 0.67-0.87 % Pb in four of the tests and over 1.2 % in two tests. Tailings grades in the bench scale tests were 0.6 % Pb.

Concentrate grades were variable, ranging from 11-23 % Pb and 9-12 % Zn. Lead grade did not seem dependent on levels of reagent addition or grind fineness. Concentrate grades in bench scale testwork were typically 8-10 % Pb and 10-11 % Zn.

Semi-bulk flotation following carbon preflotation in Tests PP-3 and 4 resulted in the following:

- Somewhat increased lead losses in the semi-bulk tails (0.96 % Pb)
- Decreased selectivity towards zinc, as concentrate zinc grades were over 18 %.
- Voluminous froths throughout the lead rougher and cleaner circuits due to the high frother addition in the carbon prefloat.
- Use of MIBC instead of DF250 in the carbon prefloat results in a further decrease in selectivity against zinc.

4.3.3. Lead Flotation

In general, lead circuit flotation was unselective, as maximum concentrate grades obtained were less than 58 % Pb. Selectivity towards zinc was poor, with final concentrate zinc grades of 6-20 %. The testwork did not duplicate bench scale results. This was due to the following factors:

- The pilot plant ore samples were different than the bench scale samples, particularly in the amount of carbon present.
- Limited regrinding capacities contributed to low lead product grades.
- Due to flowsheet complexity, rapid identification of operating problems was not possible. As testwork proceeded, and metallurgical problems continued, depressant and collector levels were increased and optimum levels were not identified.

Discussion - Continued

Poor selectivity towards zinc began in the lead rougher where well over 90 % of the zinc in the rougher feed was floated. Rougher concentrate grades were quite variable, ranging from 9 to 31 % Zn as compared with 6-7 % typically obtained in the lab testwork.

The following variables were examined to improve lead metallurgy:

- regrind fineness
- flowsheet configuration
- zinc depressant and secondary collector type.

More than one variable was changed in each test, so that analysis of the effects is somewhat subjective.

4.3.3.1. Regrind Fineness

The semi-bulk concentrate regrind and the Pb rougher concentrate regrind circuits were modified during the testwork in order to improve lead circuit metallurgy. Primarily, efforts were directed towards decreasing grind fineness in the belief that overgrinding was resulting in smearing of galena onto sphalerite surfaces.

The regrinding circuits were operated as follows In Tests PP-4 through 9:

PP-4 :
Full ball charges; over 500 kg in each of the bulk and Pb regrind mills (in addition, alternative zinc depressants NaCN and $ZnSO_4$ were added).

PP-5 :
Reduced ball load in the semi-bulk regrind mill (200 kg, reduced from 550 kg). (Ball charge In the Pb regrind mill was temporarily reduced, but restored after about 3 hours).

PP-6 :
A single 50 mm cyclone was used in the Pb regrind circuit. (In addition, the CA830/Thiourea collector was eliminated and R242 was substituted).

PP-7 to 9 :
Smaller semi-bulk and Pb regrind mills were substituted, with a reduced Pb regrind ball charge. (Flotation flowsheets were modifled In these tests).

The results of the regrinding modifications can be summarized as follows:

- No major improvement was achieved in Pb circuit metallurgy by modification of the regrinding equipment or procedure.
- Product grades in Tests PP-6 and 7 were slightly improved to 55-58 % Pb, but improvement may have been a result of technique or reagent levels and types.
- Attempts to coarsen regrind products may have contributed to the very poor metallurgy in Tests PP-8 and 9.

Discussion - Continued

4.3.3.2. Flowsheet Configuration

The lead circuit equipment and flowsheet were modified as follows in Tests PP-6 to 9 :

PP-6 & 7 :
As in Tests PP-4 to 6.

PP-7 :
A 2nd bank of Pb rougher cells was introduced. The Pb 1st cleaner tail was not recycled but sent to the Zn prefloat circuit early in the run, but was fed to 2nd Pb rougher at the beginning of the sample period (Figure No. 13).

PP-8 :
The Pb 1st cleaner tail was scavenged. The cleaner scavenger tail was pumped to the Zn circuit, and the concentrate was recycled to the semi-bulk regrind circuit (Figure No. 14).

Variation of flowsheet resulted in the following:

- Recycling of the Pb 1st cleaner scavenger concentrate to the bulk regrind (PP-8) resulted in a coarser product and very poor metallurgical results.
- Feeding of the Pb 1st cleaner scavenger tail or Pb 1st cleaner tail to the Zn prefloat circuit (PP-8 and 7 respectively) resulted in problems in the zinc circuit.
- Extension of the Pb rougher was considered to be advantageous for Pb recovery.

In summary, flowsheet modifications were not successful in improving the metallurgy.

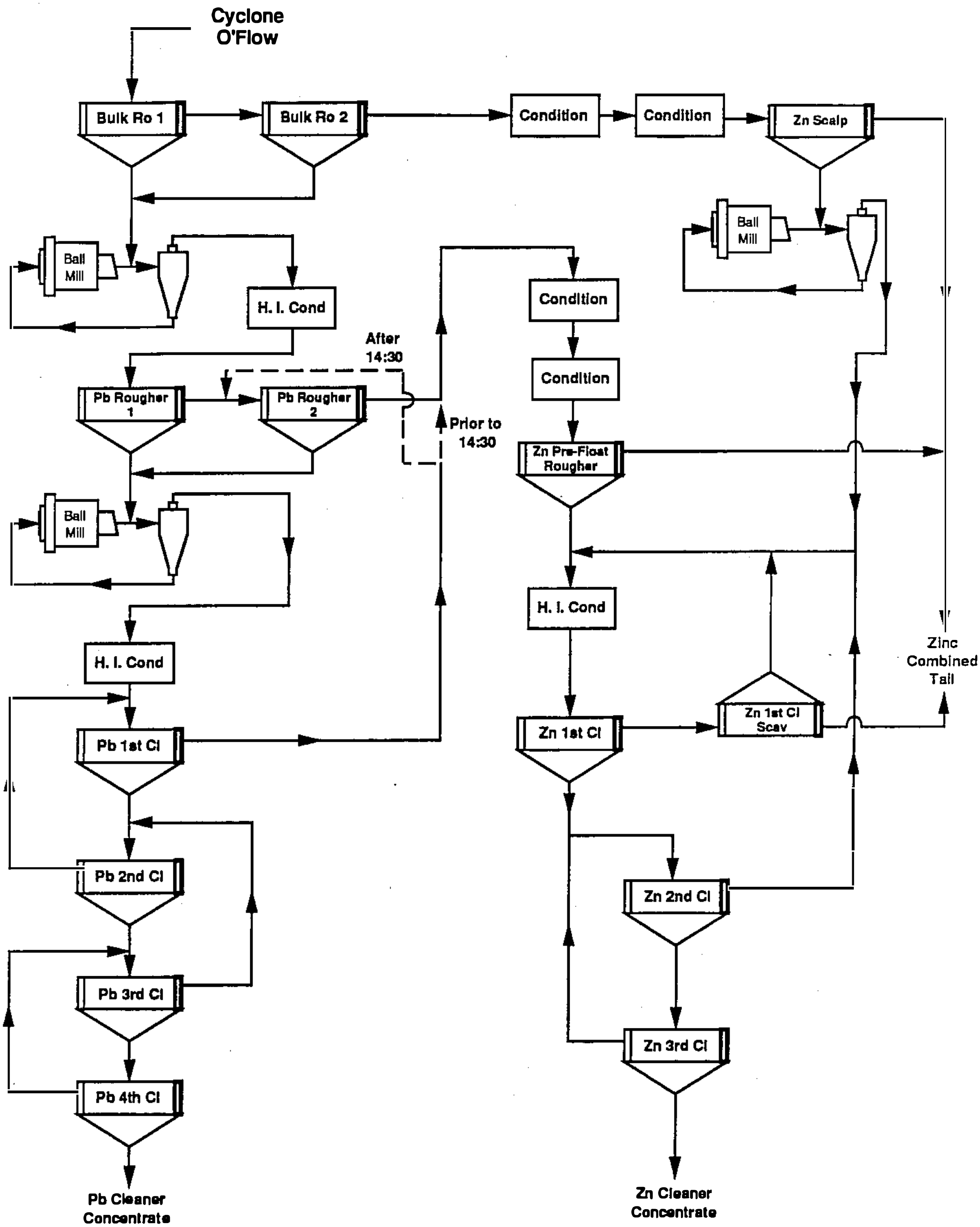


FIGURE NO. 13 : Test PP-7 flowsheet

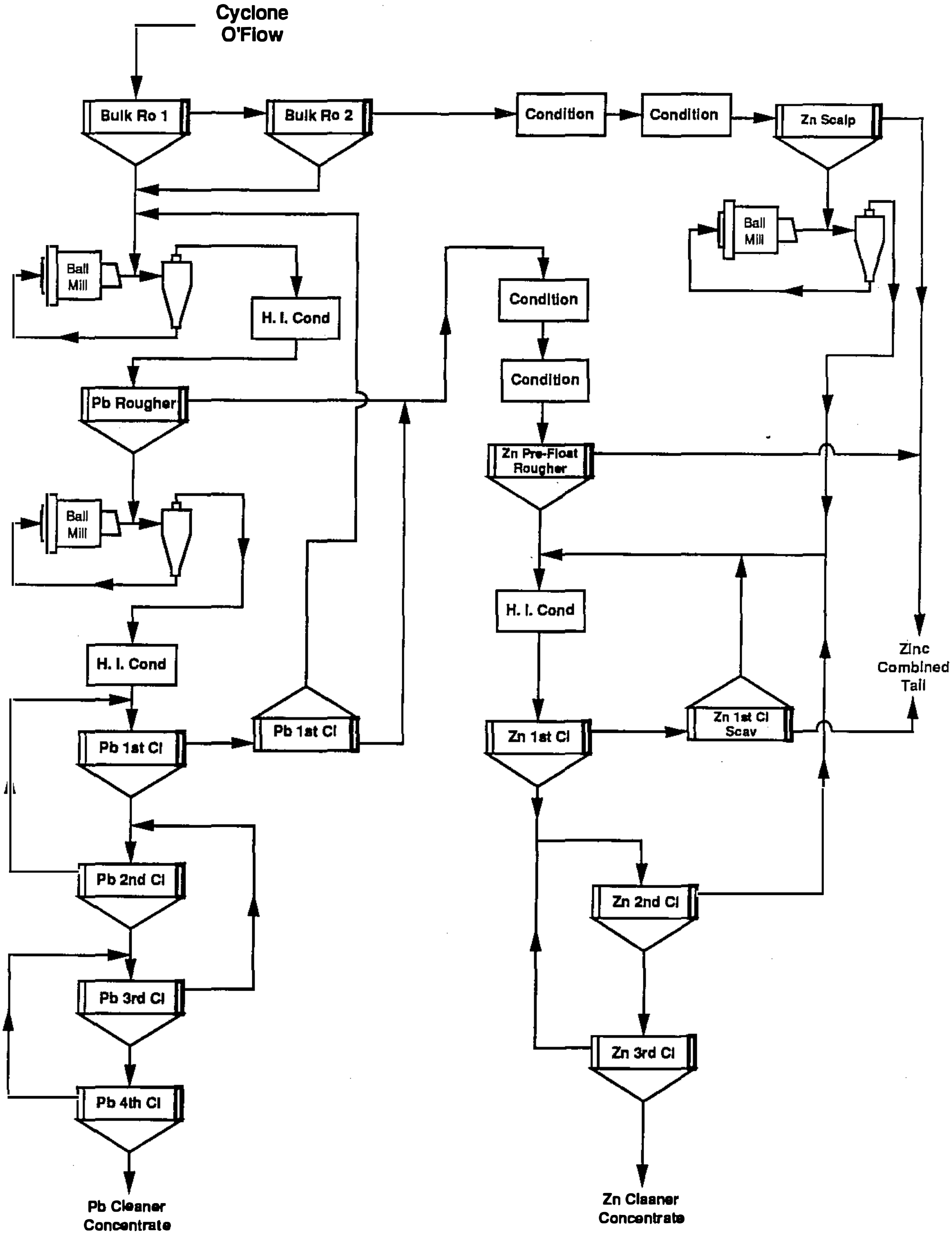


FIGURE NO. 14 : Test PP-8 flowsheet

Discussion - Continued

4.3.3.3. Reagent Types

The following reagent modifications were made:

- Altemative Zn depressants $ZnSO_4$ and NaCN were substituted for SD200/NaCN in Test PP-4. No advantage was noted in using these depressants.

- Alternative collector combinations were tested as follows:
  - : A317 + CA830/Thiourea in Tests PP-1 to 5.
  - : A317 alone with limited addition of R242 In Test PP-6.
  - : A317 alone in Test PP-9.
  - : A317/3418A (70:30) with limited addition of R242 in Tests PP-7 and 8.

In general, no particular advantage was noted in any of the above collector combinations.

4.3.4. Zinc Flotation

Zinc flotation was reasonably successful, and to a certain extent problems in the zinc circuit were directly related to problems in the lead circuit. In general, zinc circuit results can be summarized as follows:

- Maximum recoveries obtained were 82-88%. Product grades ranged from 44-54 % Zn, except in Tests PP-8 and 9 where lead metallurgical problems were extensive.

- Lead levels in the zinc concentrates were reasonably low, <1.5 % except when major losses of Pb to the Zn circuit were experienced, primarily due to flowsheet configuration.

- Silver recoveries in the zinc concentrate were 40-60 %.

The following parameters were examined:
- zinc circuit configuration.
- lead circuit configuration

Two major zinc circuit modifications were made:
- The zinc scalp and prefloat stages were combined.
- The point of recycle of the Zn 1st cleaner scavenger concentrate was varied.

4.3.4.1. Zn Circuit Configuration

Zinc Rougher Flotation:

Single stage zinc rougher flotation was examined in Test PP-6. The zinc scalp and zinc prefloat flotation stages were eliminated, and the semi-bulk and Pb rougher tails were combined and floated in a rougher stage (Figure 15).

This configuration resulted in the following:

- Overall zinc recovery was reduced to 72 %, with combined tail grades of almost 3 % Zn.

- The advantage of using the two stage arrangement was confirmed in this test, as the fine zinc in the Pb rougher tail tended to float more favourably under different pH conditions than did the zinc in the semi-bulk tail. Time did not permit examination of the PP-6 flowsheet during the laboratory testwork phase of the project and therefore the possibility of optimization or the advantage of this flowsheet cannot be assessed.

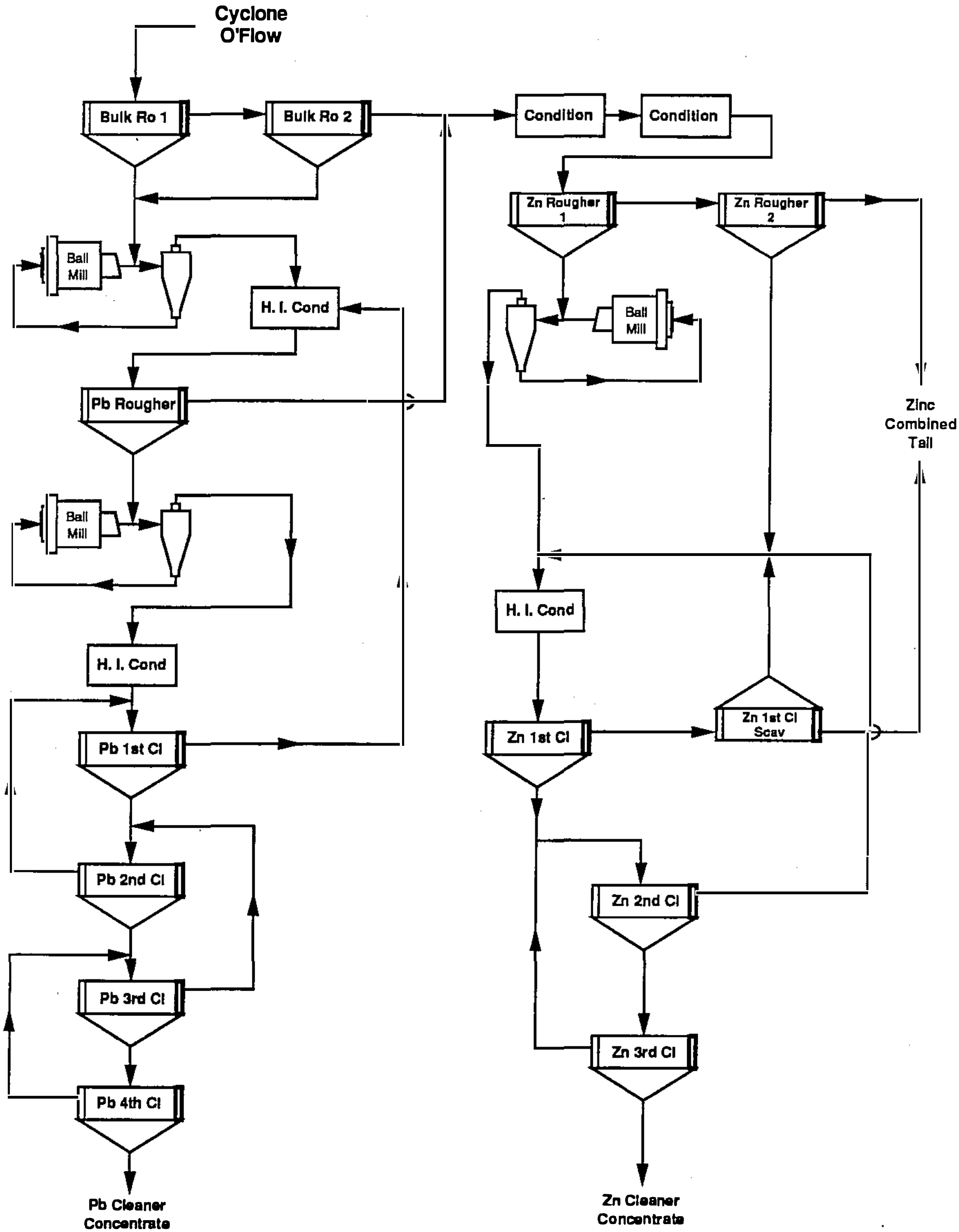


FIGURE NO. 15 : Test PP-6 flowsheet

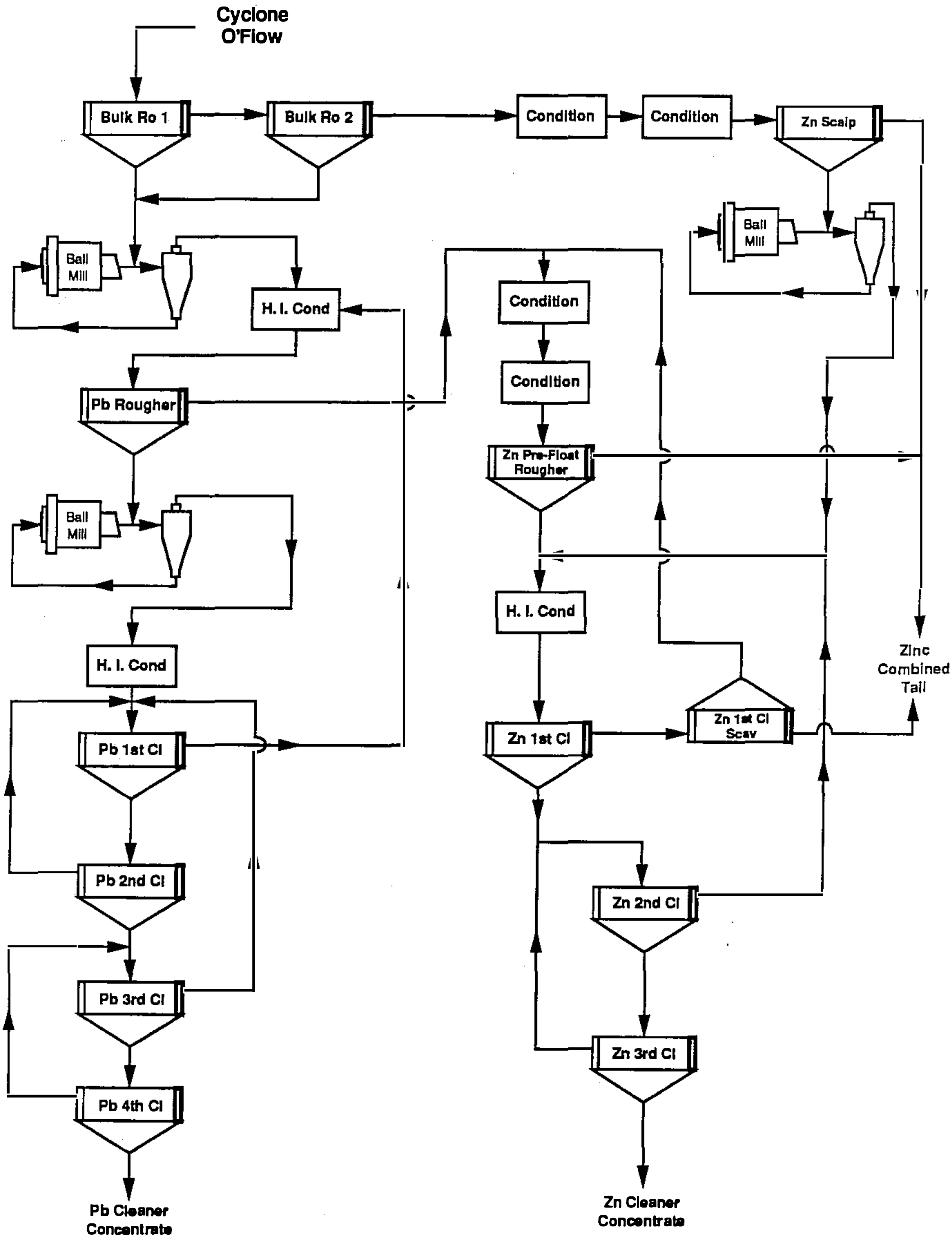


FIGURE NO. 16 : Flowsheet with recycle of Zn cleaner scavenger concentrate to the Zn prefloat

Discussion - Continued

Zinc Cleaner Scavenger Recycle

Throughout the testwork, operation of the zinc prefloat circuit was very difficult. In order to simplify the operation, recycle of the zinc 1st cleaner scavenger concentrate was switched from the Zn prefloat (Tests PP-1 to 4, Figure No. 16) to the zinc cleaner conditioner in Tests PP-5 to 9.

Quantitative assessment of the affect of this modification was not made.

4.3.4.2. Pb Circuit Configurations

The flowsheet used in the lead circuit affected the zinc circuit operation in the following ways:

- Direction of the Pb 1st cleaner tall or 1st cleaner scavenger tail to the Zn prefloat stage resulted in the following problems:
  - adsorption of cupric sulphate by carbonaceous material led to added in reduced activation and reduced flotation of zinc.
  - lead in the lead circuit tails tended to report to the final zinc concentrate. Lead levels in the Zn concentrate increased from <1.5 % to 2.4 % (PP-8) and 5.9 % (PP-7, without scavenging of the Pb 1st cleaner tail).

As a result of these data, the possibility of open circuit lead cleaning cannot be considered without extensive optimization.

4.3.5. Other Sampling

The following samples were collected throughout the course of the pilot plant. These samples included the following:

Bulk Concentrates

The Pb and zinc concentrates from PP-4, 5, 7 and 8 were collected. Some of the concentrates were used in liquid/solid separation testwork.

Most of the concentrates were stored in plastic drums, and some were filtered and stored in bags. No inventory was prepared.

Tailings

The Zn combined tails and the combined Zn cleaner scavenger and Zn scalp tails of Test PP-8 were collected. About 130 kg of solids (as thickened slurry) of each sample were collected. Some of the combined tails and Cl Scav/Scalp Tails were used in liquid/solid separation testwork. Most of the combined tails was sent to Dr. John Mitchell of Queen's University for backfill testwork.

Backfill

A barrel of cyclone undersize product from the backfill testwork section of Test PP-5 (approximately >500 kg solids) was sent to Dr. John Mitchell of Queen's University for backfill testwork.

Details of backfill preparation conditions and results are summarized in Tests PP-5 and 6 Test Details.

Discussion - Continued

5. Bench Scale Testwork

Bench scale flotation testwork, mineralogical examination, and size determinations were conducted on the initial pilot plant ores and products in order to determine the following:

Flotation

- Flotation during pilot plant operation (Tests F-1 to F-7, performed after PP-6) to confirm that processing problems were not due to the ore sample. This testwork also involved the testing of alternative reagents.
- Flotation after the end of the initial pilot plant operation to identify possible reasons for the metallurgical problems in the initial pilot plant. These tests included:
  - Locked cycle flotation to determine if extended cycling resulted in deterioration in metallurgical results.
  - Variation in semi-bulk regrind fineness, semi-bulk flotation retention time, and Pb rougher high intensity conditioning time.
  - Flotation of each of the four ores used in the initial pilot plant operation (i.e. PP Composite 1, Rock Type 5, Rock Type 4, and Upper Medium ore).

Size Determinations

Various pilot plant and bench scale products were sized by cyclosizer. These products included the following:

- semi-bulk concentrate
- semi-bulk regrind products
- Pb rougher feed
- Pb rougher regrind products
- Pb 1st cleaner feed.

Mineralogy

Various pilot plant products were examined by optical microscopy or scanning electron microprobe. The products included:

- semi-bulk concentrate
- semi-bulk regrind product
- Pb rougher feed and product
- Pb rougher regrind product
- Pb 1st cleaner feed and tail
- Zn prefloat concentrate and tail.

5.1. Flotation

Bench scale reagent stocks were used in Tests F-1A, F-1, and F-2. Pilot plant reagent stocks were used thereafter.

Discussion - Continued

5.1.1. Flotation of Ores Used in the Pilot Plant

Batch flotation tests were conducted on Pilot Plant Rock Type 5, Pilot Plant Rock Type 4, Upper Medium ore, and PP Composite 1 (blend of 5:4:Upper Medium, 70:20:10).

Results are summarized in Table No. 47 (with A317 collector used for semi-bulk and lead circuit flotation, without a secondary collector).

TABLE NO. 47 :
Flotation of Pilot Plant Ores

Test No.	Ore	Product	Weight %	Assays % Pb	Assays % Zn	% Distribution Pb	% Distribution Zn
F-9	PP Comp No. 1	PbCl Conc	4.28	57.1	2.79	76.6	9.3
		Pb Ro Conc	18.20	15.0	10.7	85.5	21.1
		Pb Ro Tail	18.14	0.74	16.0	4.3	31.5
		Semi-bulk Ro Tail	63.66	0.51	6.87	10.2	47.4
		Head (Calc)	100.00	3.19	9.20	100.0	100.0
F-11	PP Rock Type 5	Pb Cl Conc	3.14	64.5	1.54	68.6	0.5
		Pb Ro Conc	10.90	21.1	6.63	77.9	6.9
		Zn Cl Conc	12.74	0.62	52.2	2.7	63.4
		Zn 1st Cl Conc	21.06	0.85	38.2	6.1	76.6
		ZnComb Tail	49.92	0.57	0.44	9.6	2.1
		Head (Calc)	100.00	2.95	10.5	100.0	100.0
F-12	PP Rock Type 4	Pb Cl Conc	2.62	70.6	1.85	73.8	0.6
		Pb Ro Conc	10.67	20.3	10.7	86.5	14.9
		Zn Cl Conc	12.10	0.61	51.0	2.9	80.5
		Zn 1st Cl Conc	16.28	0.69	38.7	4.5	82.2
		Zn Comb Tail	60.68	0.27	0.25	6.4	2.0
		Head (Calc)	100.00	2.50	7.67	100.0	100.0
F-13	PP Upper Medium	Pb Cl Conc*	2.63	63.3	2.42	73.2	0.8
		Pb Ro Conc	10.34	19.2	10.8	87.7	14.4
		Zn Cl Conc	12.14	0.74	50.7	4.0	79.3
		Zn 1st Cl Conc	16.34	0.82	39.0	5.9	82.1
		ZnComb Tail	60.90	0.13	0.27	3.5	2.1
		Head (Calc)	100.00	2.27	7.76	100.0	100.0

* 3 cleaners only

The test data showed the following:

- Lead concentrates were produced with reasonably good lead grades, except with PP Composite 1. Lead recoveries were 68-77 %.
- Zinc concentrates were produced with reasonably good Zn grades (although Zn cleaner flotation was not conducted in Test F-9). Zn recoveries were good for Ore Type 4 and the Upper Medium ores, but relatively low, 63 % for Rock Type 5.
- The testwork confirmed that the flowsheet and reagent scheme were suitable for treatment of the various ore types.

Discussion - Continued

5.1.2. Locked Cycle Flotation of Lead and Zinc Concentrates

Two locked cycle flotation tests conducted on PP Composite 1 ore. The tests used A317 as the sole lead collector. Two zinc flowsheets were used, with recycle of the Zn cleaner scavenger concentrate to the Zn prefloat (similar to the flowsheet in Figure No. 16) and with recycle to the Zn 1st cleaner conditioner (similar to Figure 11).

Ten cycles were conducted in Test F-15 to determine whether a circulating load of zinc would build up with extended cycling, as was evident in the pilot plant.

Test results are summarized in Table No. 48.

TABLE NO. 48 :
Locked Cycle Results

Test No.	Recycle of Cl Scav Conc	Product	Weight %	Assays %		% Distribution	
				Pb	Zn	Pb	Zn
F15	To Zn 1st Cl Cond	Pb Cleaner Conc	4.2	59.0	1.76	79.3	0.8
		Zn Cleaner Conc	14.1	0.71	47.7	3.2	70.9
		Zn Combined Tail	81.8	0.66	3.28	17.4	28.3
		Head (Calc)	100.00	3.09	9.47	100.0	100.0
F17	To Zn Prefloat Cond 1	Pb Cleaner Conc	4.3	60.2	1.81	81.0	0.8
		Zn Cleaner Conc	16.7	0.72	54.4	3.8	94.3
		Zn Combined Tail	79.0	0.61	0.59	15.2	4.9
		Head (Calc)	100.00	3.18	9.60	100.0	100.0

Comparable lead concentrate grades were achieved in both tests. In Test F-15, recycle of the Zn cleaner scavenger concentrate to the Zn 1st cleaner, combined with insufficient collector addition to the 1st cleaner, lead to excessive zinc loss to the cleaner scavenger tails. This problem was corrected in Test F-17.

Metallurgical results with PP Composite 1 ore were therefore comparable to those achieved for the bench scale ore samples. Possible causes for problems in the initial pilot plant operation were not indicated in ten cycles of locked cycle flotation as no zinc buildup was evident.

5.1.3. Effect of Secondary Collector

Various secondary collectors were examined, including 3418A (as A317/3418A, 70:30) CA830/Thiourea (4:1), and R242. Test results are summarized in Table No. 49.

Discussion - Continued

TABLE NO. 49 :
Effect of Secondary Collector

Test No.	Ore	Secondary Collector	Product	Weight %	Assays %		% Dist'n	
					Pb	Zn	Pb	Zn
F-8	PP Comp 1	A317/3418A 70:30	Pb Cleaner Conc	1.40	52.1	1.99	24.4	0.3
			Pb Rougher Conc	14.05	17.0	7.83	80.0	11.7
			Pb Ro + Scav Conc	18.04	13.6	8.73	82.2	16.8
			Pb Scav Tail	14.22	1.16	15.1	5.5	22.9
			Semi-bulk Tail	71.73	0.60	8.56	14.5	65.4
			Head (Calc)	100.00	2.98	9.40	100.0	100.0
F-9	PP Comp 1	None	Pb Cleaner Conc	4.28	57.1	2.79	76.6	9.3
			Pb Rougher Conc	18.20	15.0	10.7	85.5	21.1
			Pb Rougher Tail	18.14	0.74	16.0	4.3	31.5
			Semi-bulk Tail	63.66	0.51	6.87	10.2	47.4
			Head (Calc)	100.00	3.19	9.20	100.0	100.0
F-10	PP Comp 1	CA830/Thiourea 4:1	Pb Cleaner Conc	3.00	70.5	1.13	69.2	0.4
			Pb Rougher Conc	10.41	23.2	6.47	79.1	7.0
			Zn Cleaner Conc	12.16	0.65	50.1	2.6	63.8
			Zn 1st Cleaner Conc	24.63	1.03	33.7	8.3	86.9
			Zn Combined Tail	47.66	0.48	0.31	7.5	1.5
			Head (Calc)	100.00	3.05	9.50	100.0	100.0
F-11	PP Rock Type 5	None	Pb Cleaner Conc	3.14	64.5	1.54	68.6	0.5
			Pb Rougher Conc	10.90	21.1	6.63	77.9	6.9
			Zn Cleaner Conc	12.74	0.62	52.2	2.7	63.4
			Zn 1st Cleaner Conc	21.06	0.85	38.2	6.1	76.6
			Zn Combined Tail	49.92	0.57	0.44	9.6	2.1
			Head (Calc)	100.00	2.95	10.5	100.0	100.0
F-3	PP Rock Type 5	CA830/Thiourea 4:1	Pb Cleaner Conc	3.69	65.4	1.56	70.9	0.6
			Pb Rougher Conc	22.11	13.3	10.5	86.6	23.6
			Pb Rougher Tail	20.37	0.74	18.0	4.4	37.4
			Semi-bulk Tail	57.51	0.53	6.63	9.0	38.9
			Head (Calc)	100.00	3.41	9.80	100.0	100.0
F-5	PP Rock Type 5	R242	Pb Cleaner Conc	2.98	69.6	0.95	62.3	0.3
			Pb Rougher Conc	11.84	22.4	6.61	79.7	8.1
			Pb Rougher Tail	19.08	1.22	14.8	6.9	29.3
			Semi-bulk Tail	69.07	0.64	8.73	13.3	62.5
			Head (Calc)	100.00	3.33	9.60	100.0	100.0
F-7	PP Rock Type 5	A317/3418A 70:30	Pb Cleaner Conc	2.65	66.2	1.43	58.0	0.4
			Pb Rougher Conc	12.36	20.3	7.37	83.1	9.4
			Pb Rougher Tail	15.93	1.27	18.6	6.7	30.5
			Semi-bulk Tail	71.72	0.61	8.27	14.6	61.3
			Head (Calc)	100.00	3.02	9.70	100.0	100.0

Discussion - Continued

Tests F-3, F-5 and F-7 were conducted after pilot plant Test PP-6, and before PP-7. The other tests were conducted after the 1st pilot plant.

The results showed the following:

Pilot Plant Rock Type 5

Secondary collector type did not significantly affect product grade. CA830/Thiourea gave results equivalent to those with A317 alone, although the Pb rougher was less selective. R242 and A317/3418A gave relatively low recoveries. (Note that Test F-11 was conducted with coarser regrinds, without obvious effect).

As a result of this testwork, collector A317/3418A collector was used in Tests PP-7 and 8, based upon its providing equivalent product grade.

PP Composite 1

Test F-8 with A317/3418A provided very low cleaner recovery. This was the initial test on this ore blend, and the froth seemed slimey. Subsequent tests were conducted with shorter regrinding times.

Use of collector CA830/Thiourea yielded a Pb product grade of over 70 % and a 69 % recovery. Therefore, the CA830/Thiourea provided a higher grade with slightly lower recovery.

Note that pilot plant reagent stocks were used in Test F-3. A similar test, F-1 was conducted with bench scale stocks. A higher grade concentrate was achieved in Test F-1 at a lower recovery. The Pb rougher concentrate grade was quite low in Test F-3, 13.3 % Pb. Based upon this, and upon most other tests conducted with pilot plant reagents, it was concluded that no real difference existed between results achieved with either pilot plant or bench scale reagents.

5.1.4. Effect of Carbon Prefloat (PP Rock Type 5 Ore)

One test was conducted with a carbon prefloat, as had been completed in Tests PP-3 and 4 in the pilot plant. MIBC was used as the frother. Test results are shown in Table No. 50.

TABLE NO. 50 :
Effect of Carbon Prefloat

Test No.	Product	Weight %	Assays %		% Distribution	
			Pb	Zn	Pb	Zn
F-2	Pb Cleaner Conc	1.69	69.6	2.21	35.6	0.4
	Pb Rougher Conc	9.04	20.8	11.3	56.9	10.6
	Zn Cleaner Conc	10.57	1.00	48.9	3.2	53.6
	Zn 1st Cleaner Conc	21.83	1.23	33.5	8.1	75.9
	Zn Combined Tail	46.79	0.45	0.50	6.4	2.4
	C Prefloat Conc	9.44	8.59	8.71	24.5	8.5
	Head (Calc)	100.00	3.31	9.64	100.0	100.0

Discussion - Continued

Recoveries were extremely low due to very high losses in the C prefloat concentrate. This was also found to be the case in pilot plant operation.

No further carbon prefloat tests were conducted. The remaining testwork was conducted after the initial pilot plant operation In an attempt to determine causes for, or to duplicate the poor metallurgical results.

5.1.5. Effect of Pilot Plant Versus Bench Scale Grinding (Rock Type 5)

One test was conducted on pilot plant ground ore. The cyclone overflow product of Test PP-2 (after grinding in Na_2CO_3 and collectors). Frother was added and a semi-bulk float was conducted in a lab float cell. The semi-bulk concentrate was reground for 40 minutes, high intensity conditioned for 15 minutes, and a Pb rougher flotation completed. Further cleaning was not pursued. Test results for Test F-1A, F-6 and PP-2 are compared In Table No. 51.

TABLE NO. 51 :
Effect of Pilot Plant Primary Grinding

Test No.	Primary Grind Type	K_{80}, µm	Product	Weight %	Assays % Pb	Assays % Zn	% Distribution Pb	% Distribution Zn
F-1A (bench scale flot'n)	Pilot Plant	57	Pb Rougher Conc	12.10	22.7	7.08	80.1	8.6
			Pb Rougher Tail	19.33	1.18	12.2	6.7	23.6
			Semi-bulk Conc	31.43	9.50	10.2	86.8	32.2
			Semi-bulk Tail	68.57	0.66	9.86	13.2	67.8
			Head (Calc)	100.00	3.43	9.98	100.0	100.0
PP-2	Pilot Plant	57	Pb Rougher Conc	-	11.9	12.7	-	-
			Pb Rougher Tail	-	1.72	4.95	-	-
			Semi-bulk Conc	-	11.6	11.6	-	-
			Semi-bulk Tail	-	0.67	9.71	-	-
			Head (Calc)	-	3.39	9.92	-	-
F-3	Bench	80	Pb Rougher Conc	11.06	19.3	6.09	77.4	6.9
			Pb Rougher Tail	17.48	1.08	13.5	6.8	24.3
			Semi-bulk Conc	28.53	8.14	10.6	84.2	31.2
			Semi-bulk Tail	71.47	0.61	9.36	15.8	68.8
			Head (Calc)	100.00	2.76	9.70	100.0	100.0

The data indicated that there was no difference in flotation results due to pilot plant or batch primary grinding. Pilot plant Pb rougher flotation was much less selective than In the lab.

Discussion - Continued

5.1.6. Modified Locked Cycle Flotation

Test F-18 was conducted with the following purpose:

- To determine whether extended semi-bulk and Pb rougher retention times, combined with finer primary grinding, would result in decreased selectivity against zinc.

Test conditions were similar to those in Tests F-15 and 17, with the following changes:

- Primary grind increased from 15 to 22 minutes (i.e. 80 % -81 µm and 58 µm respectively which resulted in semi-bulk concentrates of 80% - 60 µm and 43 µm respectively.
- Semi-bulk retention time extended to 8 minutes from 4.5 minutes.
- Pb rougher retention time extended from 3.5 to 6 minutes.

Test results are shown in Table No. 51.

TABLE NO. 51 :
Results of Test F-18 Locked Cycle Flotation

Test No.	Product	Weight %	Assays %		% Distribution	
			Pb	Zn	Pb	Zn
F-18	Pb Cleaner Conc	6.28	41.6	3.19	81.9	2.1
	Pb Rougher Tail	28.19	0.96	15.6	8.5	46.5
	Semi-bulk Tail	65.53	0.46	7.41	9.6	51.4
	Head (Calc)	100.00	3.19	9.46	100.0	100.0

The results indicated the following:

- Increased zinc flotation did occur, but the increase was quite limited, and a great decrease in selectivity against zinc was not obtained. Selectivity against pyrite was however, significantly decreased.
- The Pb rougher concentrate in the final cycle was 10.0 % Pb and 8.48 % Zn, which was less selective than in previous batch tests. This mainly reflects increased flotation of pyrite.
- No increase in zinc flotation was noted, as zinc level in the concentrates did not appreciably increase from the level in the first 3 cycles.

Although the test conditions caused a significant deterioration in metallurgy, pilot plant results with respect to significant decrease in selectivity against zinc were not duplicated.

5.1.6.1. Locked Cycle Test Stability

The total weights of the final products of each cycle were surveyed to determine the stability of the locked cycle tests. The results are shown in Table No. 52.

These data confirmed that steady state was essentially achieved after 6-7 cycles, although weight totals were lower than 100 % in some later cycles in some of the tests.

Discussion - Continued

TABLE NO. 52 :
Locked Cycle Stability

Cycle	Total Products, % of Feed Weight		
	Test F-15	Test F-17	Test F-18
A	83	76	85
B	89	86	87
C	94	92	95
D	98	96	92
E	97	96	100
F	98	96	95
G	100	-	96
H	103	-	99
I	99	-	-
J	97	-	-

5.1.7. Other Flotation Variables

The remaining three flotation tests were conducted to examine the following:

- Semi-bulk regrind time and its effect on Pb circuit flotation (Tests F-19 and 21).
- Pb rougher high intensity conditioning time (Test F-20).

These tests were conducted to determine whether extended conditioning would lead to reduced selectivity, and whether selectivity deteriorates with finer semi-bulk concentrate grinding.

Regrind times in Tests F-19 and 21 were 60 minutes and 15 minutes respectively (varied from 35 minutes). Conditioning in Test F-20 was increased from 15 to 30 minutes.

Test results are summarized in Tables No. 53 and 54.

TABLE NO. 53 :
Effect of Semi-Bulk Regrind Time

Test No.	Regrind min	Product	Weight %	Assays %		% Distribution	
				Pb	Zn	Pb	Zn
F-19	15	Pb Cleaner Conc	4.13	54.4	3.15	71.5	1.3
		Pb Rougher Conc	24.21	11.2	15.7	86.2	37.8
		Pb Rougher Tail	14.15	0.89	9.61	4.0	13.5
		Semi-bulk Conc	38.36	7.40	13.4	90.2	51.3
		Semi-bulk Tail	61.64	0.50	7.95	9.8	48.7
		Head (Calc)	100.00	3.14	10.1	100.0	100.0
F-10	35	Pb Cleaner Conc	3.00	70.5	1.13	69.2	0.4
		Pb Rougher Conc	10.41	23.2	6.47	79.1	7.0
		Semi-bulk + Pb Ro Tail	89.59	0.71	9.91	20.9	93.0
		Head (Calc)	100.00	3.05	9.50	100.0	100.0

TABLE NO. 53 : Continued

Test No.	Regrind min	Product	Weight %	Assays % Pb	Assays % Zn	% Distribution Pb	% Distribution Zn
F-21	60	Pb Cleaner Conc	2.85	62.1	1.54	56.5	0.5
		Pb Rougher Conc	16.39	15.7	8.67	82.5	14.9
		Pb Rougher Tail	21.88	1.00	16.9	7.0	38.7
		Semi-bulk Conc	38.27	7.29	13.4	89.5	53.6
		Semi-bulk Tail	61.73	0.53	7.18	10.5	46.4
		Head (Calc)	100.00	3.13	9.55	100.0	100.0

TABLE NO. 54 :
<u>Effect of Pb H.I. Conditioning Time</u>

Test No.	Cond Time min	Product	Weight %	Assays % Pb	Assays % Zn	% Distribution Pb	% Distribution Zn
F-10	15	Pb Cleaner Conc	3.00	70.5	1.13	69.2	0.4
		Pb Rougher Conc	10.41	23.2	6.47	79.1	7.0
		Semi-bulk + Pb Ro Tail	89.59	0.71	9.91	20.9	93.0
		Head (Calc)	100.00	3.05	9.50	100.0	100.0
F-20	30	Pb Cleaner Conc	3.99	57.0	2.22	72.7	0.9
		Pb Rougher Conc	17.77	14.9	8.98	84.5	16.4
		Pb Rougher Tail	20.88	0.82	17.1	5.5	36.8
		Semi-bulk Conc	38.65	7.29	13.4	90.0	53.2
		Semi-bulk Tail	61.35	0.51	7.40	10.0	46.8
		Head (Calc)	100.00	3.12	9.71	100.0	100.0

The data demonstrated the following:

<u>Semi-bulk Regrind</u>

Coarser regrinding (size distribution not measured) resulted in slightly poorer selectivity against zinc. Very fine regrinding (size distribution not measured) did not reduce selectivity. (These tests were conducted to try to simulate "overgrinding" in the pilot plant grinding where Pb may concentrate in the cyclone underflow and be overground. A real simulation was, of course, difficult to achieve).

<u>H.I. Conditioning</u>

Increased high intensity conditioning may have resulted in some limited decrease in selectivity against zinc.

This testwork also failed to duplicate pilot plant results.

Discussion - Continued

5.2. Size and Metal Distributions

Cyclosizer size and metal distributions were determined on a number of pilot plant and locked cycle products. The testwork was conducted in order to determine whether the pilot plant products were significantly different than the equivalent bench scale products. Specifically, did continuous regrinding in the pilot plant lead to overgrinding of galena, leading to activation of zinc.

The following products were tested:

- semi-bulk concentrate
- semi-bulk regrind product
- Pb rougher feed
- Pb rougher regrind product
- Pb 1st cleaner feed.

Semi-Bulk Concentrate

The semi-bulk concentrates for PP-6, PP-9 and F-14 were sized and the size fractions were assayed for Pb and Zn. Results are shown in Table No. 55.

TABLE NO. 55 :
Semi-Bulk Concentrate Size and Metal Distributions

PP-6 Bulk Concentrate

Mesh	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
208	0.0	0	0	0.0	0.0
147	0.8	11.5	8.18	0.7	0.5
104	1.0	21.7	9.41	1.6	0.8
74	2.1	19.3	9.34	2.9	1.6
53	4.6	18.8	8.55	6.3	3.1
38	7.6	15.9	9.06	8.8	5.5
31.5	2.9	44.3	3.11	9.3	0.7
24.4	8.4	18.4	8.37	11.2	5.6
17.0	13.7	12.2	13	12.1	14.2
11.7	14.6	11.3	14.9	12.0	17.4
9.0	6.2	10.3	16.4	4.6	8.1
-9.0	38.1	11	14	30.4	42.5
Total	100.0	13.8	12.5	100.0	100.0

TABLE NO. 55 : Continued

PP-9 Bulk Concentrate

Mesh	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
208	0.0	0	0	0.0	0.0
147	0.0	0	0	0.0	0.0
104	0.5	15.2	7.4	0.4	0.3
74	1.4	21.7	8.78	1.5	1.1
53	3.3	22.4	8.04	3.5	2.4
38	5.8	24.5	7.66	6.8	4.0
31.0	3.5	57	2.22	9.5	0.7
24.0	8.2	33.4	6.39	13.1	4.8
16.8	13.5	25.2	10.1	16.2	12.4
11.5	15.5	17.9	13.4	13.2	18.9
8.9	6.7	16.3	14.5	5.2	8.8
-8.9	41.6	15.4	12.3	30.6	46.5
Total	100.0	20.9	11.0	100.0	100.0

F-14 Bulk Concentrate

Mesh	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
208	0.0	0	0	0.0	0.0
147	1.0	7.81	11.1	0.9	0.9
104	3.9	8.08	10.9	3.6	3.3
74	8.1	8.79	10.7	8.1	6.8
53	10.6	9.13	10.8	11.0	8.9
38	11.3	9.14	11.4	11.8	10.0
31.9	2.4	33.4	4.14	9.1	0.8
24.8	8.5	10.8	11.9	10.5	7.9
17.3	12.7	8.03	15.9	11.6	15.7
11.9	11.7	7.17	16.4	9.6	15.0
9.2	4.6	6.67	16.2	3.5	5.8
-9.2	25.2	7.03	12.7	20.2	24.9
Total	100.0	8.76	12.8	100.0	100.0

Discussion - Continued

The testwork indicated the following:

- The pilot plant semi-bulk concentrates were considerably finer than the bench scale concentrate. This was in part due to finer primary grinding in the pilot plant (approximately 80 % - 32 µm and 26 µm in PP-6 and 9 respectively, as compared with 80 % - 58 µm in the lab). However, there was no particular concentration of Pb or Zn in the very fine fractions.

Other Products

Size and metal distributions for all other products are shown in Table No. 56. The other products indicated the following:

- The pilot plant semi-bulk and Pb regrind products were in all cases coarser than the lab regrinds. This contradicted the thinking during and after the initial pilot plant, that the pilot plant regrinding was too fine.
- A reduction in pilot plant semi-bulk and Pb regrinding fineness, which was done in Test PP-7, therefore was likely detrimental to lead metallurgy, since finer grinding was required.

TABLE NO. 56 :
Size and Metal Distributions of Regrind Products, Pb Rougher Feed and Pb 1st Cleaner Feed

F-16 Bulk Concentrate Reground

Size microns	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn	Cumulative % Passing Wt	Cumulative % Passing Pb	Cumulative % Passing Zn
32.0	0.0	0	0	0.0	0.0	100.0	100.0	100.0
24.8	0.4	24.3	4.92	1.2	0.2	99.6	98.8	99.8
17.3	4.3	14.6	6.36	7.9	2.2	95.3	90.9	97.7
11.9	16.7	9.04	9.98	18.9	13.3	78.6	72.1	84.4
9.2	11.8	7	12.4	10.3	11.6	66.8	61.7	72.7
-9.2	66.7	7.4	13.7	61.7	72.7	-	-	-
Total	100.0	8.0	12.6	100.0	100.0	-	-	-

PP-9 Bulk Regrind Overflow

Size microns	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn	Cumulative % Passing Wt	Cumulative % Passing Pb	Cumulative % Passing Zn
31.3	3.4	29.5	5.8	5.6	1.8	96.6	94.4	98.2
24.3	6.5	24.3	7.48	8.8	4.3	90.1	85.6	93.9
16.9	13.4	21.1	9.58	15.8	11.4	76.7	69.8	82.5
11.6	17.1	16.8	12.3	16.0	18.7	59.6	53.8	63.7
9.0	8.5	15.8	13.3	7.5	10.1	51.1	46.3	53.6
-9.0	51.0	16.3	11.8	46.3	53.6	-	-	-
Total	100.0	17.9	11.2	100.0	100.0	-	-	-

TABLE NO. 56 : Continued

F-15 Pb Rougher Feed

Size microns	Weight %	Assays, % Pb	Zn	% Distribution Pb	Zn	Cumulative % Passing Wt	Pb	Zn
31.8	0.0	0	0	0.0	0.0	100.0	100.0	100.0
24.6	0.3	15.4	10	0.7	0.3	99.7	99.3	99.7
17.2	2.9	13.4	6.75	6.2	1.8	96.8	93.1	97.9
11.8	12.4	7.62	9.35	15.0	10.7	84.4	78.1	87.3
9.1	10.1	5.72	10.9	9.2	10.1	74.3	69.0	77.2
-9.1	74.3	5.86	11.3	69.0	77.2	-	-	-
Total	100.0	6.3	10.9	100.0	100.0	-	-	-

PP-8 Pb Rougher Feed

Size microns	Weight %	Assays, % Pb	Zn	% Distribution Pb	Zn	Cumulative % Passing Wt	Pb	Zn
32.0	4.4	18.4	7.91	8.7	2.4	95.6	91.3	97.6
24.8	6.6	13.4	11.4	9.5	5.1	89.0	81.9	92.5
17.3	13.3	9.98	14.1	14.2	12.8	75.7	67.6	79.7
11.0	18.4	7.51	15.1	14.8	18.9	57.3	52.9	60.8
9.2	9.0	6.97	15.5	6.7	9.5	48.3	46.1	51.3
-9.2	48.3	8.92	15.6	46.1	51.3	-	-	-
Total	100.0	9.3	14.7	100.0	100.0	-	-	-

F-6 Pb Concentrate Reground

Size microns	Weight %	Assays, % Pb	Zn	% Distribution Pb	Zn	Cumulative % Passing Wt	Pb	Zn
30.6	0.0	0	0	0.0	0.0	100.0	100.0	100.0
23.7	0.2	0	0	0.0	0.0	99.8	100.0	100.0
16.6	0.5	0	0	0.0	0.0	99.3	100.0	100.0
11.4	3.7	30.8	3.4	6.0	1.9	95.6	94.0	98.1
8.8	5.7	25.3	4.1	7.5	3.6	89.9	86.5	94.5
-8.8	89.9	18.4	6.8	86.5	94.5	-	-	-
Total	100.0	19.1	6.5	100.0	100.0	-	-	-

PP-9 Pb Regrind Cyclone Overflow

Size microns	Weight %	Assays, % Pb	Zn	% Distribution Pb	Zn	Cumulative % Passing Wt	Pb	Zn
30.5	0.0	0	0	0.0	0.0	100.0	100.0	100.0
23.7	0.3	30.6	9.88	0.4	0.1	99.7	99.6	99.9
16.5	3.1	21.4	16.7	2.5	2.0	96.6	97.1	97.8
11.4	16.4	15.6	23.6	9.8	15.3	80.2	87.3	82.6
8.8	12.6	17.1	26.2	8.3	13.0	67.6	79.0	69.6
-8.8	67.6	30.5	26.1	79.0	69.6	-	-	-
Total	100.0	26.1	25.4	100.0	100.0	-	-	-

TABLE NO. 56 : Continued

F-15 Pb 1st Cleaner Feed

Size microns	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn	Cumulative % Passing Wt	Cumulative % Passing Pb	Cumulative % Passing Zn
31.1	0.0	0	0	0.0	0.0	100.0	100.0	100.0
24.1	0.2	24.4	10.3	0.3	0.3	99.8	99.7	99.7
16.8	0.8	19.5	5.02	1.1	0.6	99.0	98.6	99.1
11.6	6.9	15.6	4.78	7.5	5.0	92.1	91.1	94.1
8.9	8.4	14.7	5.54	8.6	7.1	83.7	82.5	87.0
-8.9	83.7	14.2	6.83	82.5	87.0	-	-	-
Total	100.0	14.4	6.6	100.0	100.0	-	-	-

PP-8 Pb 1st Cleaner Feed

Size microns	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn	Cumulative % Passing Wt	Cumulative % Passing Pb	Cumulative % Passing Zn
32.3	0.0	0	0	0.0	0.0	100.0	100.0	100.0
25.0	2.4	24.4	10.3	5.9	1.3	97.6	94.1	98.7
17.5	11.5	10.8	15.4	12.4	9.4	86.1	81.7	89.3
12.0	21.0	8.15	16.1	17.1	18.0	65.1	64.5	71.3
9.3	10.8	7.36	17.8	8.0	10.2	54.3	56.6	61.1
-9.3	54.3	10.4	21.2	56.6	61.1	-	-	-
Total	100.0	10.0	18.8	100.0	100.0	-	-	-

- No particular concentration of Pb or Zn was noted in the finer fractions of any of these products. The question of overgrinding, resulting in lead sliming, could not be assessed from cyclosizer data.
- A sedigraph subsieve sizer was used on the -9 μm fractions of each product. These data indicated that there was no difference in the size distributions of the very fine size ranges (i.e. down to 1 μm) between pilot plant and bench scale products.

In summary, the sizing data did not indicate any major difference in pilot plant and bench scale products, other than that relatively coarse regrinding in the pilot plant may have led to a slight reduction in selectivity. However, the data did not explain the extremely poor selectivity in the pilot plant.

Discussion - Continued

5.3. Mineralogy

Three sets of samples were submitted for mineralogical examination. The mineralogical reports are presented in the following sections:

5.3.1. PP-6 Pb 1st Cleaner Tail

A sample of Pb 1st cleaner tail from PP-6 was submitted for mineralogical examination. Polished section 3210 was prepared and examined with the following results: Sphalerite and to a much lesser extent galena occur with pyrite and gangue minerals. Traces only of graphite and covellite were observed. A grain count was made of the galena particles with the following results:

Galena Association	Grain Size 1-10 µm		Grain Size 10-30 µm		Grain Size >30 µm diam	
	No. of grains	% by area	No. of grains	% by area	No. of grains	% by area
Liberated	69	21	24	45	-	-
assoc with pyrite	17	5	4	8	1	10
assoc with sphalerite	11	3	3	5	-	-
assoc with gangue	2	<1	0	0	-	-
		30 %		60 %		10 %

From the table, it is evident that about 66 % of the galena is liberated, 23 % associated with pyrite and 8 % as composite grains with sphalerite.

The sphalerite has a similar association as galena, i.e. mostly liberated in grains up to 30 µm diameter with the remainder generally attached to or enclosed in pyrite.

The examination confirmed that the fine regrinding used in Test PP-6 resulted in liberation of most of the galena from sphalerite, and less complete liberation from pyrite.

5.3.2. PP-6 and PP-9 Pb Circuit Tails and Zn Prefloat Products

Additional PP-6 and 9 lead circuit tails, along with Zn prefloat products were submitted for examination after PP-9 in order to determine possible causes for poor Pb metallurgy. Specifically, the degree of liberation of galena from sphalerite was examined.

Discussion - Continued

The samples included:

1. Test 4086 - 6	Pb 1st Cl Tail
2. Test 4086 - 6	Pb Ro Tail
3. Test 4086 - 9	Zn Prefloat Conc
4. Test 4086 - 9	Zn Prefloat Tail
5. Test 4086 - 9	Pb 1st Cl Tail
6. Test 4086 - 9	Pb Ro Tail

A portion of each sample was briquetted and polished for microscopic examination using reflected light. A portion of the Test 6 Pb 1st Cl Tail and the Test 9 Pb 1st Cl Tail were placed in refractive index oil on a petrographic slide for transmitted light microscopic examination. Visual estimates of the volume percent distribution by association were made. The presence of relatively high percentages of galena , pyrite and sphalerite in the 1 to 5 micrometre size range made difficult the accurate detennination of the percent distribution.

Both pyrite and sphalerite commonly contain attachments and inclusions of galena. The attachments were more common on the pyrite and the inclusions more common in sphalerite. These galena particles ranged in size from a maximum of 20 to smaller than 2 micrometres. Consequently galena, pyrite and sphalerite were common in the finer/smaller size ranges.

Galena was present in all samples as liberated galena, i.e. a particle 85 percent of the surface of which was galena; as mixed particles associated more commonly with pyrite but also as tri-mineral mixtures of which sphalerite was the third component. The amount of galena present in such mixtures ranged from approximately 30 percent to less than 5 percent of the particle. Occasional smears or thin coatings of galena on pyrite - rarely galena on sphalerite - were observed. Galena was present also as inclusions - more commonly in sphalerite than in pyrite but certainly present in both species. Consequently, galena will report in any concentrate or other fraction containing pyrite and/or sphalerite. The size of the galena inclusions can vary between 15 and smaller than 1 micrometre. Conversely, pyrite and sphalerite will report in all products containing galena. The question of the possibility of the softer galena being smeared on pyrite and sphalerite surfaces during grinding to K_{80} equals minus 25 micrometres begs a positive answer to account for the presence of apparently totally liberated and apparently inclusion-free sphalerite and pyrite in galena products.

Liberated galena, sphalerite and pyrite were present in all samples. Transmitted light microscopy showed that some of the apparently liberated sphalerite in the cleaner tailings did contain minute inclusion and attachments of opaque particles. From the reflected microscopy it was assumed that a large proportion of these inclusions and attachments were galena particles but not all of them were thought to be enough to result in non-selective flotation characteristics.

Discussion - Continued

The results of the examination are tabulated below as volume percent distribution by mineral association of galena and the other minerals by particle size. Each table then shows the distribution by association of galena over size ranges of 1 to 10; 10 to 30 and greater than 30 micrometres, respectively. N.B. The maximum grain size of any particle measured was 42 micrometres.

TABLE NO. 57 :
Distribution of Galena in Test No. 6 Pb 1st Cl Tail

Association	Wgt % of sample	% Association by size range by association		
		1 - 10 μm	10 - 30 μm	>30 μm
Liberated	0.6	40	60	-
with pyrite	2.6	30	70	-
with sphalerite	0.8	70	30	-
with gangue	<.1	-	100	-

TABLE NO. 58 :
Distribution of Galena in Test No. 6 Pb Ro Tail

Association	Wgt % of sample	% Association by size range by association		
		1 - 10 μm	10 - 30 μm	>30 μm
Liberated	0.6	40	60	-
with pyrite	2.6	30	70	-
with sphalerite	0.8	70?	30?	-
with gangue	<.5	-	100	-

TABLE NO. 59 :
Distribution of Galena in Test No. 9 Zn Prefloat Conc

Association	Wgt % of sample	% Association by size range by association		
		1 - 10 μm	10 - 30 μm	>30 μm
Liberated	5	80	20	-
with pyrite	3	20	70	10
with sphalerite	1	15	75	10
with gangue	0.2	-	85	15

TABLE NO. 60 :
Distribution of Galena in Test No. 9 Zn Prefloat Tail

Association	Wgt % of sample	% Association by size range by association		
		1 - 10 μm	10 - 30 μm	>30 μm
Liberated	1.5	80	20	-
with pyrite	0.6	25	70	5
with sphalerite	0.1	15	80	5
with gangue	0.1	-	100	-

Discussion - Continued

TABLE NO.61 :
Distribution of Galena in Test No. 9 Pb 1st Cl Tail

Association	Wgt % of sample	% Association by size range by association 1 - 10 µm	10 - 30 µm	>30 µm
Liberated	22	85	15	<1
with pyrite	4	5	90	5
with sphalerite	1	<5	85	10
with gangue	<1	-	100	-

TABLE NO. 62 :
Distribution of Galena in Test No. 9 Pb Ro Tail

Association	Wgt % of sample	% Association by size range by association 1 - 10 µm	10 - 30 µm	>30 µm
Liberated	2	70	30	<1
with pyrite	3	10	50	40
with sphalerite	1	25	60	15
with gangue	<1	-	100	-

5.3.3. Comparison of Pilot Plant and Bench Scale Products

Samples of pilot plant (PP-8 and 9) and bench scale tests (F-6, 15 and 16) were submitted to determine whether there were significant differences between comparable pilot plant and bench scale products in terms of size distributions and liberation.

The ten samples submitted were identified as:

1. Test F-6 — Pb Ro Tail
2. Test F-6 — Pb Ro Conc
3. Test F-15 — Pb 1st Cl Feed Comp
4. Test F-15 — Pb Ro Feed Comp
5. Test F-16 — Semi-bulk Conc Regrind
6. Test PP-8 — Pb Ro Feed
7. Test PP-8 — Pb 1st Cl Feed
8. Test PP-9 — Semi-bulk Regrind Cyclone O'Flow
9. Test PP-9 — Pb Regrind Cyclone O'Flow
10. Test F-15 — Pb 1st Cl Tail.

A portion of each sample was mounted and polished as a polished thin section for reflected and transmitted light microscopy. These sections were prepared with particular care and attention to reduce the number of particles counted as binary grains which were discrete grains of opaque sulphides in simple contact with galena. We did not conduct a grain or point count and did not pay attention to the minus 5 micrometre particles.

Discussion - Continued

All of the samples contained sphalerite in amount ranging from an estimated 10 % to more than 40 %. The parameters of the examination were restricted to identification of any free/liberated sphalerite, an estimation of the amount of such sphalerite as a percentage of the total sphalerite in each sample and an attempt to identify the cause/reason for the presence of free sphalerite in each sample. Free sphalerite was any particle 80 % of which was sphalerite.

The percentage of sphalerite present as free sphalerite ranged from 5 % to more than 70 % of the sphalerite in each sample. Sample PP-9 Pb Regrind Cyclone O'Flow contained the most sphalerite and the most free sphalerite. Examination by optical microscopy failed to yield any cause or reason for the presence of the free sphalerite in the Pb products.

The percentage of sphalerite present as free sphalerite in each sample is tabulated below.

	Sample		% Sphalerite as free sphalerite
1.	PTS 1470	F-6 Pb Ro Tail	20
2.	PTS 1471	F-6 Pb Ro Conc	5
3.	PTS 1472	F-15 Pb 1st Cl Feed Comp	40
4.	PTS 1473	F-15 Pb Ro Feed Comp	30
5.	PTS 1474	F-16 Semi-bulk Conc Regr	60
6.	PTS 1475	PP-8 Pb Ro Feed	65
7.	PTS 1476	PP-8 Pb 1st Cl Feed	>65
8.	PTS 1477	PP-9 Semi-bulk Regr Cyc O/F	35
9.	PTS 1478	PP-9 Pb Regr Cyc O/F	>75
10.	PTS 1479	F-15 Pb 1st Cl Tail	40

These percentages are visual estimates and do not necessarily include all of the minus 5 µm fraction of each sample. Items 1, 3, 6, 7, 9 and 10 were selected for analysis/examination by scanning electron microscope in a further attempt to discover factors causing the sphalerite to float with the galena. Items 6 and 9, PP-8 Pb Ro Feed and PP-9 Pb Regr Cyc O/F were actually checked - the former cursorily and the latter in some detail.

The results obtained showed:

1. The presence of partial rimming of sphalerite by galena - a feature observed during optical microscopic examination.

2. The presence of galena as a few nanometer sized particles on the sphalerite surfaces.

3. The presence of possible zinc sulphate on the surfaces of some sphalerite particles.

Item 1 was reported in our earlier report on examination of test products. Item 2 probably occurs in both bench scale and pilot plant test products (requires confirmation). Item 3 was checked for by submitting four products for analysis for soluble zinc with the following results.

Discussion - Continued

Product	% Sol Zn
F-6 Pb Ro Conc	0.034
PP-15 Pb 1st Cl Feed	0.023
PP-9 Semi-Bulk Regr Cyc O/F	0.026
PP-9 Pb Regr Cyc	0.017

The examination of the ten products listed above did not add to the results reported in our Progress Report on two Test 6 and four Test 9 products examined during the last week of January 1991.

The presence of zinc as sulphate is insignificant and not believed to be enough to account for all of the sphalerite in the Pb products: however, it would appear necessary to check more zinc mineral grains in more sections using the scanning electron microscope.

Any further mineralogical work must include examination of pairs of corresponding products i.e. bench scale test product and corresponding pilot plant test product. The examination should include:

- Petrographic examination of polished thin sections of cyclosizer fractions of corresponding products.
- Possible SEM scans of selected pairs of corresponding thin sections.

To date, our examinations have shown nothing which would/could account for the presence of all of the free sphalerite particles in the Pb products.

The scanning electron microscopy results - which are appended - neither add to nor detract from the information reported thus far.

In summary, the examinations showed the following:

- Pilot plant product size and metal distributions were not noticeably different from those of equivalent bench scale products. Determination of such differences in distribution, however, was hindered by the difficulty in viewing the very fine particles.
- A significant difference in liberation characteristics of the pilot plant and bench scale products was not observed.
- Examination of samples by scanning electron microscopy did show some thin galena rims on some sphalerite particles (pilot plant products). Problems with the SEM did not, however, allow a similar examination to be made of bench scale products.

5.3.4. SEM Examination

The SEM examination is described in detail in this section.

Six polished thin sections were selected for a preliminary examination by scanning electron microscopy. The purpose of the SEM-EDS-IA investigation was to characterize factors causing the sphalerite to float with galena in the Pb rougher-cleaner circuit, particularly for the pilot plant testwork.

Discussion - Continued

The samples under investigation are identified as follows:

PTS 1475	PP-8 Pb Ro Feed
PTS 1476	PP-8 Pb 1st Cl Feed
PTS 1478	PP-9 Pb Regrind Cyclone O/Flow
PTS 1470	F-6 Pb Ro Tail
PTS 1472	F-15 Pb 1st Cl Feed
PTS 1479	F-15 Pb 1st Cl Tail

Each polished thin section was covered with a 10-15 second application of gold using a sputter coater to avoid charging by the electron beam. The sections were individually examined by scanning electron microscopy using secondary and backscatter electron images; typically the latter to enhance atomic number contrast between sphalerite and pyrite. The composition of the grains of interest were confirmed by energy-dispersive x-ray analysis accompanied by five-channel x-ray mapping of the field of view.

Only two polished sections were examined during the initial SEM-EDS study due to the time and equipment constraints. A cursory examination of the PP-8 Pb Ro Feed (PTS #1475) was followed by a more detailed study of PP-9 Pb Regrind Cyc O/F (PTS #1478). The preliminary data reported sphalerite occurring in the following associations.

1. Binary middling particles or unliberated sphalerite intergrown with galena or galena-pyrite.
2. Apparently liberated particles of sphalerite. The latter were characterized as three types:

   (a) sphalerite exhibiting dark rims, typically discontinuous, or patchy cleavage/fracture controlled surface oxidation. SEM-EDS analysis indicated spectra essentially identical to the host sphalerite implying a zinc sulphate composition.

   (b) Sphalerite displaying extremely fine-grained discontinuous cements or blebs of galena along the grain periphery.

   (c) Liberated sphalerite exhibiting NIL mineralogical factors for poor selectivity.

The oxidation rims and incipient galena coatings typically ranged in thickness from less than 100 nanometers to less than 500 nanometers (<0.1 - 0.5 micrometers). The submicrometer fracture or grain boundary cementation textures were also reported from the pyrite. In both cases, the proportion of galena was transitional to clearly nonliberated binary galena-sphalerite particles identified with the optical microscope.

Further investigation will be required to characterize and compare the presence of similar particles in the remaining samples of both bench and pilot products.

In summary, flotation, sizing, and mineralogical examination did not identify any factor that led to the poor initial pilot plant metallurgy.

Discussion - Continued

6. Continuous Pilot Plant Results

6.1. Primary Grinding

6.1.1. Rod Mill

The rod mill grinding results are presented in Table No. 63.

TABLE NO. 63 :
Rod Mill Grinding Data

Test No.	Feed					Mill Disch g/L	Product			Power	
	Rate kg/h	Cons kg	Cum % Passing -48 mesh	Cum % Passing -200 mesh	K_{80} µm		Cum % Pass -200 mesh	Cum % Pass -400 mesh	K_{80} µm	input kWh/t	Work Index (metric)
PP-10	590	5605	29.7	19.5	4087	2098	42.9	28.7	326	3.4	8.6
PP-11	604	4832	31.2	20.8	3967	2101	42.8	29.7	334	3.3	8.6
PP-12	590	4720	32.6	21.5	3711	2109	47.1	33.6	299	2.6	6.4
PP-13	598	4784	29.6	19.6	4002	2098	43.4	29.2	314	3.3	8.2
PP-14	601	4808	28.4	18.6	4141	2109	44.9	31.0	305	3.3	7.9
PP-15	600	4800	31.1	20.5	4252	2103	44.4	31.0	328	3.3	8.2
PP-16	603	6030	29.4	19.2	4447	2100	43.3	30.0	341	3.1	7.8
PP-17	596	5960	27.4	17.5	4577	2108	39.8	27.8	404	3.4	9.8
Total	-	41539	-	-	-	-	-	-	-	-	-

Rod Charge = 305 kg for Tests PP-10 to 17.

A total of 35.6 tonnes of PP Composite 2 ore (PP-10 to 16) and 6.0 tonnes of Raise 2 ore (PP-17) were processed.

Power input was generally just over 3.0 kWh/t. Bond index values were 6.4-8.6 (metric) for PP Composite 2 and almost 10 for Raise 2 ore. Reduction of the mill load (305 kg reduced from 400 kg in Tests PP-1 to 9) and increase of the feed rate (600 kg/h on average as compared with 525 kg/h in Tests PP-1 to 9) resulted in a reduction of rod mill power input to 3.3 kWh/t from 5 kWh/t. This was accompanied by a very slight coarsening of the grind (K_{80} = 300-330 µm in PP-10 to 17 from K_{80} = 250-295 µm in PP-1 to 9).

6.1.2. Ball Mil and Overall

The results of ball mill grinding are shown in Table No. 64.

Discussion - Continued

TABLE NO. 64 :
Ball Mill Grinding Data

Test	Ball Chg kg	Pulp Densities, g/L Mill Disch	Cycl* U/Flow	Cycl* O/Flow	Circ Load %	Product Cum % Pass -200 mesh	-400 mesh	K_{80} µm	Power Ball Mill Input kWh/t	Ball Mill Work Index	Overall Input kWh/t	Overall Work Index*
PP10	400	2167	-	1322	950	87.1	64.4	59	7.8	10.5	11.3	9.8
PP11	400	2122	2337	1304	-	84.3	60.3	64	7.2	10.2	10.5	9.6
PP12	400	2128	2372	1309	1464	85.3	59.2	63	7.2	10.6	9.9	9.0
PP13	400	1968	2804	1297	428	76.1	55.2	84	7.7	14.6	11.0	11.8
PP14	400	2052	2798	1282	-	83.3	61.4	67	7.7	11.9	11.0	10.3
PP15	400	1986	2817	1300	304	75.3	53.4	88	7.7	14.9	10.9	12.0
PP16	400	2248	2843	1272	903	90.5	72.3	49	7.5	8.4	10.5	8.2
PP17	500	2574	2764	1254	414	89.2	70.4	52	9.2	10.3	12.6	10.1

*screen oversize and undersize respectively in Tests PP-10 to 12.

PP Composite 2 Ore, Cyclone Classification, "Standard" Flowsheet

The ball mill power input levels in Tests PP-13 to 15 were 7.7 kWh/t, and the work index values were over 14 in two of the three tests. Overall power input and work index values were 11 kWh/t and 9-12 (metric) respectively.

There was considerable variability in grind product fineness. Two of the three tests provided relatively coarse products (K_{80} = 84-88 µm), which were very close to the target values. Each of these tests had reasonably low circulating loads of 300-430 %. Test PP-14 had a finer grind (K_{80} = 67 µm) and a relatively low ball mill index. No circulating load was calculated for this test.

PP Composite 2 Ore, Screen Classification, "Standard" Flowsheet

High circulating loads (950-1464 %) were calculated in Tests PP-10 to 12. Insufficient screen area (0.82 m^2) was available to handle the feed, and the screen was generally flooded.

The data showed the following:

- grind products were generally finer (K_{80} = 59-64 µm) with screen classification. Ball mill and total power input and work index values were generally lower than with cyclone classification.

PP Composite 2 Ore, Cyclone Classification, "Revised" Flowsheet

Revision of the milling flowsheet by feeding the rod mill discharge to the ball mill feed in PP-16 resulted in the following:

- The grinding circuit product was quite fine, K_{80} = 49 µm.
- Work index and power input levels were lower than with the "standard" flowsheet.
- Circulating load increased considerably to 900 %.

Discussion - Continued

Raise 2 Ore, Cyclone Classification, "Revised" Flowsheet

One test, PP-17, was conducted with Raise 2 ore using the "revised" flowsheet and an increased ball load (500 kg, as opposed to 400 kg in PP-10 to 16). The test results indicated the following:

- Grinding fineness was similar to that of PP Composite 2, using the same flowsheet.
- Power input and Bond index values were generally a little higher than for the other ore, in part due to increased steel load. This ore may be slightly harder than PP Composite 2 ore.

In summary, screen classification was not very efficient due to insufficient capacity. The target grind was achieved in two of the three tests with cyclone classification.

Comparison of these data with those in the initial pilot plant operation showed the following:

- Overall work indices with cyclone classification were lower in the latter testwork (9.0 - 12.0 as compared with 11.5-15.3). These values were still quite a bit higher than for SAG milling of similar ore samples.
- Grind product sizes were variable in each pilot plant operation, but overall were a bit coarser in the continuous plant (i.e. K_{80} = >80 µm in two of the three tests with cyclone classification, "standard" flowsheet).

6.2. Regrinding

6.2.1. Semi-Bulk Concentrate Regrind

The results of the semi-bulk concentrate regrinding stage are presented in Table No. 65.

TABLE NO. 65 :
Semi-Bulk Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm
PP10	1730	1646	1170	65.2	44.9	27	91.7	66.2	13
PP11	1673	1443	1210	57.3	36.1	31	79.6	52.1	17
PP12	1846	1916	1226	57.7	36.2	31	81.8	56.8	16
PP13	1750	1822	1212	61.2	40.3	29	88.5	60.5	14
PP14	1748	1720	1230	59.0	37.2	29	83.4	54.7	16
PP15	1722	1734	1212	60.2	38.1	28	83.9	57.6	15
PP16	1741	1687	1129	59.9	39.7	29	80.5	54.1	17
PP17	1816	1776	1130	61.7	40.5	27	94.0	68.2	12

Circulating load in Test PP-17 = 351 %
Ball charge 400 kg for Tests PP-10 to 17.

Discussion - Continued

The fineness of the semi-bulk concentrates were K_{80} = 27-31 µm. Grind products were 13-17 µm for PP Composite 2 ore (Tests PP-10 to 16) and 12 µm for the Raise 2 ore. The target grind of 11-12 µm was therefore not quite achieved.

Circuit operation was quite steady in Tests PP-14 to 17. In Tests PP-10 to 13, frequent problems with cyclone plugging were encountered. This disrupted the stability of the regrinding and the flotation circuits. Circulating load in Test PP-17 was calculated as 351 %.

Comparison of the initial and continuous pilot plant circuit operation and data revealed the following:

- pulp densities in the continuous pilot plant were generally higher than in the initial operation.
- grind products were roughly similar in each test series.

6.2.2. Lead Concentrate Regrind

Lead rougher concentrate regrinding results are shown in Table No. 66.

TABLE NO. 66 :
Pb Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm
PP10	1996	1940	1148	92.6	66.9	12	97.1	71.2	11
PP11	2173	2323	1245	90.3	58.9	14	96.0	68.1	12
PP12	2050	2056	1240	94.1	57.2	13	95.6	59.5	13
PP13	2018	2000	1190	93.7	58.4	13	94.8	55.4	13
PP14	1996	1984	1204	90.6	57.4	14	97.0	81.1	11
PP15	1994	1964	1194	91.6	58.3	14	97.9	68.4	11
PP16	2054	2086	1202	93.3	66.0	12	96.8	72.8	11
PP17	1951	1961	1183	98.2	76.6	9	99.3	80.2	9

Ball charge 200 kg for Tests PP-10 to 17.

Grind product fineness was K_{80} = 11-13 µm for PP Composite 2 ore and K_{80} = 9 µm for Raise 2 ore. The target grind of K_{80} = <9 to 9 µm was therefore not quite achieved except in Test PP-17. During the testwork, a finer regrind was desired, but additional balls could not be added to the mill.

Circuit operation was generally stable in Tests PP-14 to 17. Grinding and flotation operation in PP-10 to 13 was frequently disrupted by cyclone plugging.

Circulating load in Test PP-17 was not calculated but was undoubtedly high considering the inefficiency of the grind.

Comparison of continuous and initial pilot plant test results indicated the following:

- circuit pulp densities were similar
- grind fineness was similar under similar conditions.

Discussion - Continued

6.2.3. Zn Scalp Concentrate Regrind

Zinc scalp regrind results are summarized in Table No. 67.

TABLE NO. 67 :
Zn Regrind Mill Grinding Data

Test	Pulp Densities, g/L			Feed			Product		
	Mill Disch	Cycl U/Flow	Cycl O/Flow	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm	Cum % Pass 16-18 µm	Cum % Pass 9-10 µm	K_{80} µm
PP10	2258	2254	1184	40.7	33.4	56	61.5	42.2	26
PP11	1973	2046	1295	28.5	20.7	85	56.6	38.7	31
PP12	2088	2064	1188	36.0	26.8	65	65.6	44.3	24
PP13	1610	1698	1130	28.5	21.8	115	56.4	41.1	37
PP14	2190	2200	1226	29.8	22.8	109	59.7	41.4	28
PP15	2328	2334	1240	33.5	25.9	101	56.2	38.3	32
PP16	1820	1823	1348	29.0	22.9	121	38.2	25.1	46
PP17	2253	2279	1259	35.5	24.9	73	63.8	41.5	24

Circulating load in Tests PP-17 = 211 %
Ball charge = 225 kg PP-10, 275 kg PP-11, 305 kg PP-12 to 17

The zinc scalp concentrate was quite coarse (K_{80} = >100 µm in most tests). The data seemed to indicate the following:

- The second Zn scalp bank of cells floated a relatively coarse product. This also seemed to be the case in Tests PP-8 and 9 which used two banks.
- Cyclone classification in the primary grinding resulted in coarser scalp concentrate products than screen classification.
- Raise 2 ore scalp concentrate was relatively fine.

Grind products in the continuous operation were K_{80} = 24-46 µm. Coarser grind products were a reflection of circulating load conditions from test to test and of the coarseness of the scalp concentrate. For example, in Test PP-16, concentrate and reground products were K_{80} = 121 and 46 µm respectively. In Test PP-12, grind feed and product had K_{80} values of 65 and 24 µm respectively.

The grind fineness in Test PP-17 (Raise 2 ore) was K_{80} = 24 µm. The circulating load in Test PP-17 was calculated as 211 %.

In general, circuit operation after PP-13 was steady, without cyclone plugging. Pulp densities were similar to those in Tests PP-1 to 9.

Discussion - Continued

6.3. Flotation

The overall metallurgical results are shown in Table No. 68.

TABLE NO. 68 :
Continuous Pilot Plant Metallurgical Results

Test No.	Product	Weight %	Assays, %, g/t Pb	Zn	Ag	% Distribution Pb	Zn	Ag
10	Pb 4th Cleaner Concentrate	3.40	76.9	2.57	169	77.9	1.0	10.4
	Zn 3rd Cleaner Concentrate	18.60	1.27	45.6	166	7.0	92.8	55.6
	Zn Combined Tails	77.99	0.65	0.73	24.2	15.1	6.2	34.0
	Derrick Screen U'Size	100.00	3.36	9.14	62.2	100.0	100.0	100.0
11	Pb 4th Cleaner Concentrate	2.83	76.7	5.06	224	69.2	1.5	10.2
	Zn 3rd Cleaner Concentrate	17.42	1.76	49.4	178	9.8	90.7	49.9
	Zn Combined Tails	79.75	0.83	0.93	31.1	21.1	7.8	39.9
	Derrick Screen U'Size	100.00	3.14	9.49	60.9	100.0	100.0	100.0
12	Pb 4th Cleaner Concentrate	2.88	74.0	6.08	321	64.1	1.9	14.4
	Zn 3rd Cleaner Concentrate	15.56	2.45	50.4	177	11.4	82.9	43.0
	Zn Combined Tails	81.56	1.00	1.77	33.5	24.5	15.3	42.6
	Derrick Screen U'Size	100.00	3.33	9.46	60.5	100.0	100.0	100.0
13	Pb 4th Cleaner Concentrate	2.84	76.4	3.44	180	69.2	1.0	9.9
	Zn 3rd Cleaner Concentrate	16.20	1.77	53.4	164	9.1	89.3	51.6
	Zn Combined Tails	80.95	0.84	1.16	24.5	21.7	9.7	38.5
	Cyclone Overflow	100.00	3.14	9.69	59.6	100.0	100.0	100.0
14	Pb 4th Cleaner Concentrate	3.32	63.9	6.35	168	68.8	2.2	8.8
	Zn 3rd Cleaner Concentrate	16.55	1.69	52.0	197	9.1	89.9	51.7
	Zn Combined Tails	80.13	0.85	0.95	31.1	22.1	7.9	39.5
	Cyclone Overflow	100.00	3.08	9.58	58.9	100.0	100.0	100.0
15	Pb 4th Cleaner Concentrate	2.89	75.3	2.6	196	67.4	0.8	9.5
	Zn 3rd Cleaner Concentrate	16.45	1.75	52.3	175	8.9	89.6	48.1
	Zn Combined Tails	80.66	0.95	1.14	31.5	23.7	9.6	42.4
	Cyclone Overflow	100.00	3.23	9.60	58.7	100.0	100.0	100.0
16	Pb 4th Cleaner Concentrate	3.57	70.8	3.61	180	78.3	1.3	13.2
	Zn 4th Cleaner Concentrate	17.40	1.26	55.0	168	6.8	94.7	60.1
	Zn Combined Tails	79.03	0.61	0.51	16.4	14.9	4.0	26.7
	Cyclone Overflow	100.00	3.23	10.1	62.2	100.0	100.0	100.0
17	Pb 4th Cleaner Concentrate	2.60	74.4	5.31	263	69.0	2.2	16.4
	Zn 4th Cleaner Concentrate	10.72	2.85	53.3	156	10.9	89.3	40.3
	Zn Combined Tails	86.68	0.65	0.63	20.7	20.1	8.5	43.2
	Cyclone Overflow	100.00	2.80	6.40	44.2	100.0	100.0	100.0

Metallurgical results were much improved over those in the initial pilot plant operation.

Silver recoveries of about 60 % were obtained. The metallurgical results from the pilot plant are compared with those obtained in the bench scale testwork in Table No. 69.

Discussion - Continued

TABLE NO. 69 :
Comparison of Laboratory and Pilot Plant Results

Test No.	Test Type	Product	Weight %	Assays %, g/t			% Distribution		
				Pb	Zn	Ag	Pb	Zn	Ag
F-17	Laboratory Continuous	Pb Concentrate	4.3	60.2	1.81	-	81.0	0.6	-
		Zn Concentrate	16.7	0.72	54.4	-	3.8	94.3	-
		Combined Tail	79.0	0.61	0.59	-	15.2	4.9	-
		Feed	100.0	3.18	9.6	-	100.0	100.0	-
PP16	Pilot Plant Continuous	Pb Concentrate	3.57	70.8	3.61	180	78.3	1.3	13.2
		Zn Concentrate	17.40	1.26	55.0	168	6.8	94.7	60.1
		Combined Tail	79.03	0.61	0.51	16.4	14.9	4.0	26.7
		Feed	100.00	3.20	10.1	62.2	100.0	100.0	100.0

Reasons for improved results in this pilot plant operation include the following:

- Continuous operation allowed the circuit to become stabilized and stability was maintained.
- Revised collector additions to the ball mill and semi-bulk feed (i.e. most of the collectors were added to semi-bulk feed, and relatively little was added to the ball mill) resulted in increased stability in the semi-bulk flotation circuit.
- A better understanding of the effects of reagents on lead and zinc flotation resulted in much improved control of reagents. Specifically, this included control of frother in the lead circuit and control of the zinc circuit with lime/$CuSO_4$ additions (Zn prefloat) and with an additional depressant (SD200).
- The higher feed rate (600 kg/h) resulted in improved stability in the lead 2nd, 3rd and 4th cleaners.

6.3.1. Semi-Bulk Flotation

Flotation recoveries were similar to the best recoveries in the initial plant operation, with tailings of 0.7-0.9 % Pb. Recoveries were still slightly lower than those achieved in the lab work (i.e. 0.61 % Pb). Recoveries were consistent throughout the run, and fairly constant concentrate grades of 12-16 % Pb were obtained.

Increased stability was due to the following factors:

- Collector additions to the ball mill were reduced, with most of the reagents added directly to the semi-bulk feed.
- Constant collector and frother additions.

It was noted that recoveries obtained with screen classification were higher (i.e. 0.68-0.74 % Pb in the tail) than those obtained with cyclone classification (0.87 - 0.93 % Pb).

Discussion - Continued

6.3.2. Lead Flotation

Lead circuit flotation was extremely selective, with final concentrate grades greater than 70 % in 8 of the 9 tests. Zinc grades in the concentrates ranged from 2.5-6.4 %.

Lead recoveries ranged from 67-78%. Recoveries were relatively low since concentrate grades were quite high. A grade recovery relationship was not firmly established in the testwork. A calculated grade-recovery relationship was generated, and is shown in the abstract (Figure No. 1). Grade versus recovery for the pilot plant and locked cycle testwork is compared in Figure No. 17.

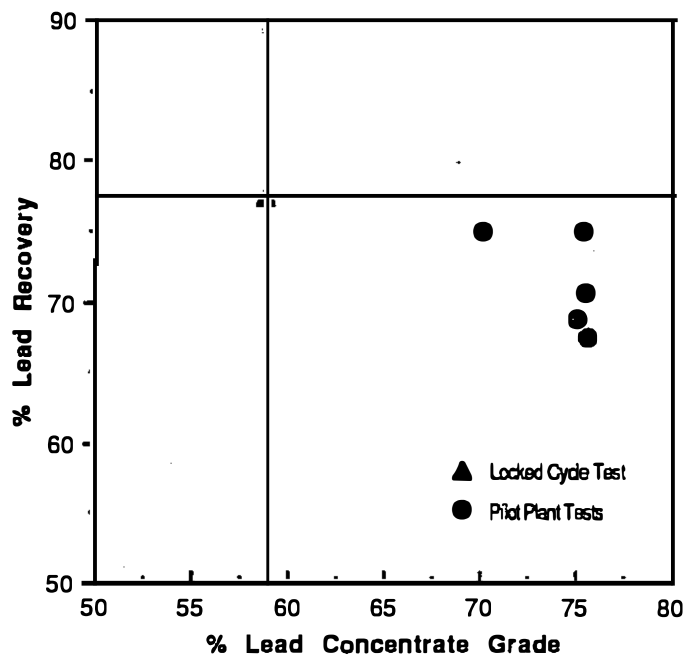


FIGURE NO. 17 : Zinc concentrate grade vs recovery - Comparison of results

It is interesting to observe the selectivity towards zinc in the lead circuit. Lead and zinc data for pilot plant and bench scale flotation are summarized in Table No. 70.

Discussion - Continued

TABLE NO. 70 :
Comparison of Pb Rougher & 1st Cleaner Circuits for the Pilot Plant & Bench Scale Testwork

Test No.	Pb Rougher							Pb 1st Cleaner			
	Concentrate					Tailing		Concentrate		Tailing	
	Wgt %*	% Pb Grade	% Zn Grade	% Pb Rec'y*	% Zn Rec'y*	% Pb Grade	% Zn Grade	% Pb Grade	% Zn Grade	% Pb Grade	% Zn Grade
PP-6	75	14.7	21.8	97	92	2.85	5.16	18.2	23.4	3.79	11.0
PP-16	64	18.0	29.5	96	81	3.05	12.6	27.9	28.5	10.6	32.3
F-6**	39	19.3	6.09	92	22	1.08	13.5	-	-	-	-
F-10	-	-	-	-	-	-	-	41.5	3.83	0.90	2.50

* stage recoveries
**Rock Type 5 ore

These data showed the following:

- Selectivity in the rougher and 1st cleaner was markedly better in the continuous pilot plant, but was much poorer than in the bench scale.
- This confirmed observations made during continuous pilot plant operation, that the rougher and 1st and 2nd cleaner concentrates were relatively high in zinc, and that a great deal of the upgrading to +70 % grade was achieved in the 3rd and 4th cleaners.

The main variables that were studied included the following:

- primary grind classification
- effect of recycle water
- ore sample.

6.3.2.1. Effect of Primary Grind Classification

The first three tests were conducted with screen classification to determine if poor metallurgical results in the initial pilot plant were due to overgrinding of barite and lead in the primary grinding circuit.

The very consistent metallurgical results in Tests PP-10 to 12 and PP-13 to 15 indicated that cyclone classification did not result in any noticeable deterioration of lead metallurgy (it was noted that semi-bulk lead recoveries were slightly higher with screen classification, as discussed in section 6.3.1).

The data also indicated the following:

- metallurgical results were largely independent of the fineness of the primary grind in the range tested (i.e. K8o = 50 to 88 μm). This confirmed that the flowsheet was flexible and able to handle large variations in grinding results.
- Use of the "modified" grinding flowsheet (i.e. rod mill discharge to ball mill feed) did not result in any change in metallurgical response.

Discussion - Continued

6.3.2.2. Effect of Recycle Water

Recycle water was used in Test PP-16 as follows:

- Scavenger tail water, directly from the thickener underflow, was pumped to a head tank which supplied the rod mill feed, rod mill discharge pump, and ball mill discharge pump. Fresh water supplemented this recycle water, and the ratio of recycle to fresh water was calculated as 62:38.
- All tailings from Tests PP-1 to 15 had been collected in a dedicated tailings pond. Some of the PP-1 to 9 water had leaked out through holes in the plastic liner. Therefore, most of the pond water was from the continuous pilot testwork.

The pond water was pumped to the flotation pilot plant water supply system. The pump delivered insufficient pressure to properly run all of the launder sprays, so that some town water had to be used. The ratio of pond water : town water was not determined, but was undoubtedly considerably greater than 50 %.

Recycle water analyses are shown in Table No .71.

TABLE NO. 71 :
Recycle Water Analyses

Element	Assays, ppm	
	Pond Water	Thickener O/Flow
Cu	9.75	0.32
Fe	0.08	0.05
CN_T	6.59	0.01
SO_4	112	265
S_T	258	223

The results for Test PP-16 did not indicate any deterioration in metallurgy due to recycle water. A high lead product grade and an excellent Pb recovery of 78 % were obtained.

6.3.2.3. Ore Sample

Test PP-17 was conducted with Raise 2 ore, which was low in Pb and Zn levels but otherwise similar to the ore composite in terms of sulphur, iron, and barite levels. The test was conducted using the "modified" grinding flowsheet, i.e. rod mill discharge fed to ball mill feed.

Test results were good with a 74 % Pb product grade and 69 % Pb recovery. The data and observations made during the test indicated the following:

- The Pb rougher and 1st cleaner concentrates appeared to be much more selective than for the PP Composite ore, due in part to the decreased zinc grade of the ore.

Product grades for the rougher and cleaning ciruict are shown in Table No. 72.

Discussion - Continued

TABLE NO. 72 :
Test PP-17 Rougher and Cleaner Product Grades

Test No.	Stage	Assays, %					
		Stage Feed		Concentrate		Tailing	
		Pb	Zn	Pb	Zn	Pb	Zn
PP-17	Pb Rougher	19.7	18.3	26.9	23.6	3.95	6.24
	Pb 1st Cleaner	34.5	23.8	42.8	22.0	20.7	25.6
	Pb 2nd Cleaner	-	-	53.3	17.1	43.4	22.5
	Pb 3rd Cleaner	-	-	66.3	9.28	53.1	17.3
	Pb 4th Cleaner	66.3	9.24	77.4	5.31	67.4	9.28

Comparison of the data in Table No. 72 (Raise 2 ore) with that in Table No. 70 (PP Composite 2 ore) reveals the increased selectivity in PP-17.

- Due to the increased selectivity, considerably increased collector and frother additions in the semi-bulk circuit were required.

In summary, the flotation characteristics of the low grade Raise 2 ore were somewhat different from those of the composite, but the basic flowsheet and reagent scheme were successfully used without major modification.

6.3.3. Zinc Flotation

The overall metallurgical results are shown in Table No. 68. An overall comparison of the results with locked cycle results is shown in Figure No. 18.

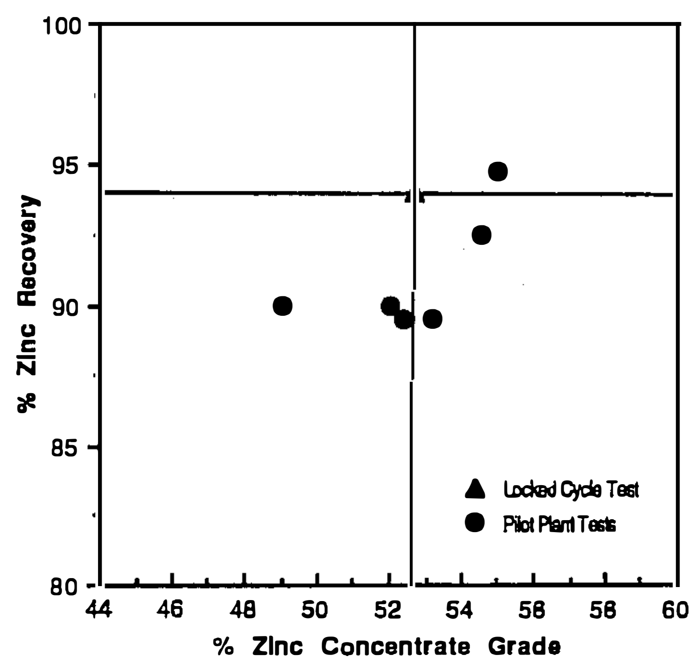


FIGURE NO. 18 : Zinc concentrate grade vs recovery - Comparison of results

Discussion - Continued

In general, operation of the zinc circuit was more stable and produced considerably better metallurgical results than in the initial pilot plant tests for the following reasons:

- improved lead circuit metallurgy resulted in more complete rejection of zinc which reported to Zn prefloat flotation.
- improved distribution of the prefloat conditioning arrangement and reagent levels resulted in improved metallurgical results from the Zn prefloat.
- Addition of a pyrite depressant (SD200) and substitution of DF1012 frother in the last two tests yielded high product grades (55 % Zn).
- Introduction of a 4th cleaner.
- Continuous operation.

The major variables examined included the following:

- Zn prefloat reagents and conditioning
- depressant and frother types
- Zn regrind fineness.

6.3.3.1. Zinc Prefloat Reagents and Conditioning

The zinc prefloat conditioning was conducted as follows:

-	PP-10 to 12 :	1st Conditioner	- lime
		2nd Conditioner	- $CuSO_4$
		Flotation Feed	- collectors
-	PP-13 to 17:	1st Conditioner	- lime + $CuSO_4$
		2nd Conditioner	- collectors

Circuit reagent additions were adjusted as follows:

-	PP-10 to 12 :	$Ca(OH)_2$	>700 g/t
		$CuSO_4$	160-180 g/t
		A317	50-120 g/t
-	PP-13 to 17 :	$Ca(OH)_2$	<300 g/t
		$CuSO_4$	160-180 g/t
		A317	<35 g/t (72 g/t in PP-13)

These conditioning and reagent changes resulted in the following:

- Greatly improved prefloat circuit froths, with a greater quantity of sphalerite evident. This was due to the improved conditions for flotation of zinc (i.e. pH 10.2, reduced from 11.2).
- Zn prefloat tail grades were reduced from >3.5 % Zn to about 2.0-2.2 % Zn in the later tests.
- Overall product grades or recoveries were not obviously affected.

Discussion - Continued

In general, feed grades to the prefloat circuit were variable, ranging from 6-17 % Zn. This depended upon operation of the Pb rougher. Zn prefloat concentrate grades were also variable, 7-36 % and were dependent somewhat upon feed grade. They did not seem to be directly affected by the changes made in the conditioning/reagent additions.

6.3.3.2. Depressant and Frother Types

Depressant SD200 and frother DF1012 were used in Tests PP-16 and 17. (Recycle water was also used in PP-16, and PP-17 was with Raise 2 ore). The reagents were added as follows:

- SD200 added to the Zn 1st cleaner (H.I. conditioner) and to the 2nd cleaner feed.
- DF1012 was substituted for DF250.

The reagent changes resulted in the following:

- Overall product grade was increased in Test PP-16 to 55 % Zn from the 52-53% level achieved in the previous tests. Zinc recovery was 94.7 %, which was higher than in any previous test.
- Product grade was 53.3 % in Test PP-17 with the lower grade ore. A high lead content (2.85 % Pb) was obtained. This likely could have been reduced by improving Pb recovery in Pb rougher flotation.
- Higher lime additions were required in PP-17 to maintain pH levels.

6.3.3.3. Zinc Regrind Fineness

Product grade was not evidently controlled by grind fineness. However, a finer regrind product was desired and would have likely resulted in improvement of product grade.

This cannot be confirmed by pilot plant or bench scale test data as limited testing was conducted on the effect of regrind fineness on zinc metallurgical results.

6.3.4. Concentrate Assays

The concentrate from Tests PP-16 and 17 were analysed for 37 elements. Assay results are presented in Table No. 73.

Discussion - Continued

TABLE NO. 73 :
Concentrate Analyses

Element		Assays % PP-16 Pb Conc	PP-16 Zn Conc	PP-17 Pb Conc	PP-17 Zn Conc
Lead	Pb	70.2	1.24	74.7	2.84
Zinc	Zn	3.48	54.8	5.10	53.3
Copper	Cu	0.016	0.079	0.007	0.065
Iron	Fe	4.55	5.87	2.20	6.00
Nickel	Ni	<0.002	<0.002	<0.002	0.002
Bismuth	Bi	<0.002	<0.002	<0.002	<0.002
Cadmium	Cd	0.025	0.33	0.047	0.34
Cobalt	Co	<0.002	<0.002	<0.002	<0.002
Chromium	Cr	<0.002	<0.002	<0.002	<0.002
Arsenic	As	<0.001	<0.001	<0.001	<0.001
Antimony	Sb	0.008	<0.002	0.011	<0.002
Tin	Sn	<0.001	<0.001	<0.001	<0.001
Gallium	Ga	0.0001	0.0003	<0.0001	0.0003
Germanium	Ge	<0.0010	0.0043	<0.0010	0.0107
Indium	In	<0.002	<0.002	<0.002	<0.002
Manganese	Mn	0.003	0.024	0.003	0.035
Mercury	Hg	0.0010	0.013	0.0013	0.0058
Molybdenum	Mo	<0.002	<0.002	<0.002	<0.002
Thallium	Tl	0.005	0.010	0.004	0.007
Thorium	Th	<0.001	<0.001	<0.001	<0.001
Selenium	Se	<0.0003	<0.0003	0.0004	<0.0003
Tellurium	Te	<0.0003	0.0014	<0.0003	0.0006
Uranium	U	<0.001	<0.001	<0.001	<0.001
Gold	Au g/t	0.13	<0.02	0.05	0.03
Silver	Ag g/t	171	166	263	157
Titanium	TiO_2	<0.10	<0.10	<0.10	<0.10
Silicon	SiO_2	0.49	0.64	<0.20	0.94
Aluminum	Al_2O_3	<0.10	<0.10	<0.10	0.13
Calcium	CaO	0.03	0.08	0.07	0.10
Magnesium	MgO	<0.01	<0.01	<0.01	<0.01
Sodium	Na_2O	0.002	0.005	<0.002	0.003
Potassium	K_2O	0.013	0.012	<0.002	0.009
Fluorine	F	<0.01	0.02	0.04	0.03
Chlorine	Cl	0.0081	0.013	0.0038	0.014
Sulphur	S	18.2	35.6	16.9	34.2
Phosphorus	P	0.0064	0.0029	0.0015	0.0048
Carbon	C	1.29	0.28	0.20	0.44
Insoluble		0.70	2.36	0.13	2.47
L.O.I. (1000°C)		10.3	18.4	8.64	18.5
	Total	98.3	99.0	99.3	98.4

Discussion - Continued

6.3.5. Other Sampling

A variety of samples were taken throughout the course of the pilot plant for various purposes. These samples are discussed as follows:

Bulk Concentrates:

The lead and zinc concentrates from all of the pilot plant runs were collected as follows:

PP-10 to 16: All collected and combined. Some of the concentrate samples were used in filtration and thickening tests.

PP-17 : All collected and saved separately from PP-10 to 16 concentrates.

The concentrate samples were stored in plastic drums, were not filtered, and no inventory has been made.

In addition, two filtered samples of Pb and Zn concentrates were sent to Curragh Resouces for flow moisture tests (10 kg each).

Tailings:

The following tailing samples were collected:

PP-15 : Zn prefloat tail (~150 kg) for environmental testwork (Lakefield Research)

PP-15 : Zn combined tail (~150 kg) for environmental testwork (Lakefield Research). One barrel was also collected for liquid/solid separation testwork.

PP-15 : Zn scalp tail (2 barrels) was also collected for liquid/solid separation and desliming testwork.

PP-15 : Zn scalp tail water (1 barrel) was collected. A 2 L sample was filtered on a 0.45 µm filter, acidified, and sent to Rescan for environmental testwork.

PP-1 to 17 : Pond water (2 barrels) was collected at the end of the pilot plant.

Barium Assay Samples:

Samples of Test PP-17 cyclone overflow and Zn scalp products were collected for barium assays. The samples included the following:

- Primary cyclone overflow
- Semi-bulk, Pb and Zn regrind cyclone overflows
- Semi-bulk tail, Zn scalp concentrate and Zn scalp tail

About 2.5-5 kg of each sample was collected, and was saved at Lakefield Research.

Discussion - Continued

Mineralogy:

Samples of Tests PP-16 and PP-17 products were sent to Curragh Resources for possible Ag mineralogy testwork. The samples included the following:

- Pb cleaner concentrate
- Zn cleaner concentrate
- Zn cleaner scavenger tail
- Zn prefloat tail (also, PP-15 prefloat tail)
- Zn scalp tail.

Slimes:

A sample of Zn scalp tail from Test PP-15 was cycloned at about 1300 gpL and the slimes were sent to Rescan for environmental testwork.

Details of the test and size analysis are shown in Test PP-15 Test Details.

DESCRIPTION OF PILOT PLANT EQUIPMENT

1. Primary Grinding Circuit

1.1. Equipment

1. Marcy Rod Mill
2. Hendy Ball Mill
3. Dorr P50 Cyclone
4. Derrick Model J18-72A-35M Screen
5. Sweco 610 mm Screen
6. Sala Slurry Transfer Pumps

1.2. Description

1.2.1. Marcy Rod Mill

The Marcy rod mill is a low-discharge overflow mill with a diameter of 640 mm, a length of 1220 mm inside liners and a total volume of 0.357 m^3. There are six liners, 25 mm thick, with a centrally located wave rising about 25 mm above the liner face. The mill is driven by a 5.6 kW electric motor, through sheaves and v-belts to pinion and bull gears. The mill speed was 38.6 rpm or 71% of critical speed.

a) Power Calculations

The total power is measured by a Sangamo Type KYWP meter, equipped with a rate meter and a cumulative meter. Power readings are based on instantaneous timed rate readings of the disc in the meter. The time interval during which the rotating disc made a specified number of revolutions is measured with a stopwatch. A nominal efficiency of 90 % is assumed for the power transmission. Thus the gross power is 95 % of the total power. The no-load power is calculated in the same manner, but with the mill operating empty. Net power is equal to the gross power minus the no-load power.

b) Rod Charge

The following rod charges were used:

• Tests PP-1 to 9:	200 kg of 62 mm rods
	200 kg of 37-50 mm rods
• Tests PP-10 to 17:	155 kg of 62 mm rods
	150 kg of 37-50 mm rods

Equipment - Continued

1.2.2. Hendy Ball Mill

The Joshua Hendy mill is a grate discharge mill with a diameter of 1219 mm, a length of 914 mm inside liners and a total volume of 0.847 m^3. The grate has an open area of 16% of the total grate area in the form of slots 88 mm wide. Pulp passing through the grate is conveyed by radial lifters and discharged through the trunnion. Since the liners have been worn smooth, 25 mm square lifter bars are installed at intervals of 200 mm. The mill is driven by a 18.7 kW electric motor, through sheaves and v-belts to pinion and bull gears. The mill speed is 31 rpm or 77% of critical speed. The mill is equipped with a 3 mesh trommel.

a) Power Calculations

The total power is measured by a Sangamo Type KYWP meter, equipped with a rate meter and a cumulative meter. Power readings are based on instantaneous timed rate readings of the disc in the meter. The time interval during which the rotating disc made a specified number of revolutions is measured with a stopwatch. A nominal efficiency of 90% is assumed for the power transmission. Thus the gross power is 90% of the total power. The no-load power is calculated in the same manner, but the mill operating empty. Net power is equal to the gross power minus the no-load power.

b) Ball Charge

The following steel charges were used:

• Tests PP-1 to 9:	250 kg of 50 mm balls
	150 kg of 25 mm balls
• Tests PP-10 to 16:	288 kg of 50 mm balls
	112 kg of 25 mm balls
- Test PP-17:	388 kg of 50 mm balls
	112 kg of 25 mm balls

1.2.3. Dorr P50 Cyclone

A single 50 Dorr cyclone was used in the primary grinding circuit. The cyclone dimensions were as follows:

Inside diameter	50 mm
Bottom of vortex to apex	295 mm
Vortex finder	19 mm
Apex size	11 to 16 mm
Inlet	12 mm x 12 mm

Equipment - Continued

The apex and vortex sizes used were 12.5 mm and 19.1 mm respectively. The cyclone feeds were the rod mill-ball mill discharges in Tests No. PP-1 to 9 and PP-13-15, and the rod mill discharge alone in Tests PP-16 to 17. A screen was used for classification in Tests PP-16 and 17.

1.2.4. Derrick Model J18-72A-35M Screen

The combined rod mill-ball mill discharges were classified on a Derrick J18-72A-35M screen in Tests PP-10 to 12. The screen was equipped with a 3 HP high speed vibrating motor (3600 rpm) and water sprays. A 3 panel deck of screens was used. Screen area was 1830 mm x 460 mm (0.82 cubic metres). Screen aperature size was 109μm (approx. 150 mesh).

1.2.5. Sweco 610 mm Screen

A 610 mm Sweco Vibro-Energy Separator was used to protect the flotation circuit from very coarse material in the event of cyclone plugging. The screen used had an aperature of 522 μm (30 mesh).

1.2.6. Sala Slurry Transfer Pumps

Several 38 mm Sala mm slurry transfer pumps were used in the circuit.

2. Regrinding Circuit

2.1. Equipment

1. Sala Ball Mill
2. Hazen Quinn Ball Mill
3. Mozley C124 Cyclone
4. Dorr P25 Cyclones
5. Hardinge Conical Ball Mill
6. Dorr P50 Cyclone
7. Krebs PC1-1181 Cyclones
8. Denver Ball Mill
9. Sala Slurry Transfer Pumps

Equipment - Continued

2.2. Description

2.2.1. Sala Ball Mill

The Sala ball mill is a overflow-discharge mill with inside dimensions of 635 mm diameter and 1 090 mm length and a total volume of 0.34 m^3. The Linatex rubber lining is smooth with six equally spaced lifter bars 25 mm high by 50 mm wide. The mill is on rubberized rollers, which are driven by torque-arm speed reducers and V-belts from two 3.7 kW electric motors. The mill speed is 36.8 rpm or 69% of critical speed.

a) Power Calculations

The total power is measured by a Sangamo Type KYWP meter, equipped with a rate meter and a cumulative meter. Power readings are based on instantaneous timed rate readings of the disc in the meter. The time interval during which the rotating disc made a specified number of revolutions is measured with a stopwatch. A nominal efficiency of 95% is assumed for the power transmission. Thus the gross power is 95% of the total power. The no-load power is calculated in the same manner, but with the mill operating empty. Net power is equal to the gross power minus the no-load power.

The mill was used in the semi bulk regrind circuit in Tests PP-1 to 6 and PP-10 to 17. Ball charges were 550 kg of 25-38 mm balls in Tests PP-1 to 5, 200 kg of 25 mm balls in Tests PP- 7 to 9, and 400 kg of 25 mm balls in Tests PP-10 to 17

2.2.2 Hazen Quinn Ball Mill

The Hazen Quinn mill is a low discharge overflow mill with an inside diameter of 405 mm and a length of 810 mm. There are six liners, 10 mm thick with Ni-hard lifters located above the inner face. The mill is driven by a 2.2 kW motor through cut-tooth spur gear, pinion, reducer and V-belt drive. The mill speed is about 45 rpm or 85% of critical speed.

The mill was used in the semi bulk regrind circuit in Tests PP-7 to 9 with 200 kg of 25 mm balls, and in the lead regrind circuit in Tests PP-10 to 17 with 200 kg of 25 mm balls.

2.2.3. Mozley C124 Cyclone

Cyclone dimensions are listed below:

Diameter	:	50 mm
Length (bottom of vortex to apex)	:	340 mm
Vortex Finder	:	8, 11, 14 and 19 mm
Apex	:	3.0, 4.5, 6.4, and 8.0 mm

A single Mozley 50 mm cyclone was used in the semi bulk regrind circuit in Tests PP-1 to 9, and in Test PP-10 in the zinc scalp concentrate regrind circuit. The apex and vortex sizes were 6.4 mm and 14 mm respectively. In addition, the cyclone was used in the lead rougher concentrate regrind circuit in Test PP-6, with 6.4 mm apex and 19.1 mm vortex sizes.

Equipment - Continued

2.2.4. Dorr P25 Cyclones

Cyclone dimensions were as follows:

inside diameter	25.4 mm
Bottom of vortex to apex	216 mm
Vortex finder	8 mm
Apex sizes	5 mm

The cyclones, operated in parallel, were used in the semi bulk regrinding circuit in Tests PP-10 to 17, and in the zinc scalp concentrate regrind circuit in Tests PP-1 to 9. Apex and vortex sizes used were 5 mm and 8 mm respectively.

2.2.5. Hardinge Conical Ball Mill

The Hardinge Conical mill consists of two conical end sections and a 205 mm long cylindrical center section and has a total volume of 0.348 m^3. The diameter of the center section is 905 mm between liners. The rubber liners are smooth, without wave or lifter bars. Pulp is discharged from the mill by gravity through the trunnion. The mill drive consists of a 5.6 kW motor with sheaves, v-beits, pinion and bull gears. The mill speed is 33.7 rpm or 75.7 % of critical speed. The mill is equipped with a 6 mesh trommel screen.

The mill was used in Tests PP-1 to 6 to as the lead rougher concentrate regrind mill. The initial mill charge consisted of 580 kg of 25-38 mm steel balls.,

2.2.6. Dorr P50 Cyclone

The Dorr P50 cyclone was described in Section 1.2.3. It was used in the lead regrind circuit in Test PP-6. The apex and vortex sizes were 6.4 mm and 19.1 mm respectively.

2.2.7. Krebs PC1-1181 25 mm Cyclones

Cyclone dimensions are as follows:

Diameter	:	25 mm
Length (bottom of vortex to apex)	:	286, 272, 257 mm
Vortex Finder	:	8 mm
Apex	:	3.0, 4.6, 6.1 mm

Two of the cyclones were used (in parallel) in the lead rougher concentrate regrind circuit in all tests except Test PP-6. (in Test PP-6, a single Dorr 50 mm cyclone was used). The apex and vortex sizes were 6.4 mm and 7 mm respectively. In addition, two of the cyclones were used in parallel in the zinc scalp concentrate regrind circuit in Tests PP-11 to 17, with 6.4 mm apex and 7 mm vortex sizes.

Equipment - Continued

2.2.8. Denver Ball Mills

The Denver ball mill has an inside diameter of 405 mm and a length of 810 mm. The mill shell is constructed of 13 mm steel and there are no liners. The pulp discharges through the trunnion by gravity. The mill is driven by a 2.2 kW motor through a bull gear, pinion, speed reducer and a V-belt drive. The mill is operated at about 40 rpm or 77% of critical speed.

These mills were used in the lead regrind circuit in Tests PP-7 to 9 (with 200 kg of 25 mm balls), and in the zinc regrind circuit in all of the tests. The ball charges in the zinc regrind mill were 225 kg of 25 mm balls in Tests PP-1 to 10, 275 kg of 25 mm balls in Test PP-11, and 305 kg of 25 mm balls in Tests PP-12 to 17.

2.2.9. Sala Slurry Transfer Pumps

Several 38 mm Sala mm slurry transfer pumps were used in the circuit.

3. Flotation Circuit

3.1. Equipment

Conditioners

1. Lakefield Research 500 L High Intensity Conditioners
2. Lakefield Research 300 L High Intensity Conditioner
3. Hazen Quinn 500 L Conditioner
4. Hazen Quinn 250 L Conditioner
5. Denver 250 L Conditioners

Flotation Cells

6. Denver No. D8 Flotation Cells
7. Agitair No. 15 Flotation Cells
8. Denver No. D7 Cell-to-Cell Flotation Cells
9. Denver No. D7 Sub-A Flotation Cells
10. Denver No. DR7 Flotation Cells
11. Denver No. D5 Flotation Cells
12. Sala and Minpro Slurry Transfer Pumps

Equipment - Continued

3.2. Description

Conditioners

3.2.1. Lakefield Research 500L High Intensity Conditioners

The tank dimensions are 890 mm diameter by 1065 mm depth. Side outlets provide capacities of 300 L, 400 L and 500 L. The tanks are rubber-lined. Agitation is imparted by a single six-bladed impeller and a 15 HP motor, and driven with belts.

One of the tanks was used to condition the lead rougher feed with collector and frother. A second tank was used in all of the tests except Test PP-1 to condition the zinc 1st cleaner feed with collector.

Impeller sizes, speeds and tank capacities in all tests were as follows:

Lead Rougher Conditioner: 483 mm diameter impeller; 490 rpm; 400L capacity.

Zinc Cleaner Conditioner: 406 mm diameter impeller; 483 rpm; 400 L capacity.

3.2.2. Lakefield Research 300L High Intensity Conditioner

The tank dimensions are 760 mm diameter by 915 mm depth. Side outlets provide capacities of 200L, 250L and 300L. The tank is rubber-lined. Agitation is imparted by a single six-bladed impeller and a 7.5 HP motor and driven with belts. The tank is equipped with a controller to provide a variable speed capability.

The tank was used to condition the lead 1st cleaner feed with collector . The impeller size was 279 mm diameter, and the shaft speed was about 305 rpm in all tests. The tank capacity used was 200 L in Tests PP-1 to 9, and 300 L in Tests PP-10 to 17.

3.2.3. Hazen Quinn 500 LConditioners

Two Hazen Quinn variable speed conditioning tanks were used for as the first zinc scalp conditioner. Tank dimensions are 890 mm diameter by 1065 mm depth, with a variable weir overflow of 200 L, 400 L and 500 L. The 400 L capacity was used.

Agitation is provided by a 5 HP motor, and the speed can be adjusted with a speed controller.

3.2.4. Hazen Quinn 300 L Conditioner

A smaller Hazen Quinn tank was used as the 2nd zinc scalp conditioner. Tank dimensions are 735 mm diameter by 895 mm depth. Weir overflows are 250 L, 175 L and 100 L, with the 250 L overflow being used.

Agitation was by a 3 HP motor and the speed can be adjusted with a speed controller.

Equipment - Continued

3.2.5. Denver 250 L Conditioners

The tank dimensions are 610 mm diameter by 915 mm depth with side outlets for 100 L, 150 L or 200 L capacity. The agitation is imparted by 2 opposed-pitch three-bladed axial-flow impellers of 230 mm and 125 mm diameter (upper and lower respectively) rotating at a shaft speed of approximately 585 rpm. The drive is from a 2.2 kW motor through v-belts and pulley.

Two of the tanks were used in the zinc prefloat circuit. In Tests PP-1 to 12, the first tank was used to condition the Zn prefloat feed with lime, and cupric sulphate was added to the 2nd tank . In Tests PP-13 to 17, the first tank was used to condition the Zn prefloat feed with lime and cupric sulphate, and collectors were added to the 2nd tank.

A volume of 200 L for both tanks was used in all tests.

Flotation Cells

3.2.6. Denver No. D8 Flotation Cells

Two banks of Denver No. D8 cells served as semi bulk cells in all tests. D8 cells were also used in the zinc circuit, as follows:

- In Tests PP-1 to 5 and in PP-7, a single bank of Denver D8 cells was used for the zinc scalp. In Tests PP-8 and 9, two banks of Denver D8's were used as the zinc scalp cells.
- In Tests PP-1 to 5 and in PP-7, a single bank of Denver D8 cells was used for the zinc scalp. In Tests PP-8 and 9, two banks of Denver D8's were used as the zinc scalp cells. In Tests PP-10 to 17, a bank of Minpro D8 cells was used as the first zinc scalp rougher cells and a bank of Denver D8 cells was used as the second zinc scalp rougher cells.
- In Test PP-6, the zinc scalp and zinc prefloat circuits were replaced by a two stage zinc rougher circuit. A bank of Denver D8 cells was used as the 2nd rougher (Agitair 15 cells were used as the first rougher.
- In Tests PP-3 and 4, a single bank of Denver D8 cells was used to float carbon in the carbon prefloat circuit.

Each cell has a volume of 78 L, and there are 4 cells to a bank. Air is supplied by a Roots-Connersville blower. The Minpro cells are similar to the Denver cells, but the Minpro cells have a controllable gate for each cell which enables quick adjustment of froth levels.

Equipment - Continued

3.2.7. Agitair No. 15 Flotation Flotation Cells

Two banks of Agitair No. 15 cells were used during the pilot plant testwork. One bank of cells was used as the first lead rougher in all tests. The other bank was used as the zinc prefloat cells in all Tests except Test PP-6 . In Test PP-6, this bank served as the first zinc rougher. Each bank has 6 cells, each cell with a volume of 32 L.

Air is supplied by a Roots-Connersville blower.

3.2.8. Denver No. D7 Cell-to-Cell Flotation Cells

Each cell has a volume of 28 L, with 4 cells to a bank. Air is supplied by Roots-Connersville blower. The cells were used as follows:

- A bank of 4 cells was used as the lead 2nd rougher in Tests PP-7 and 10-17.
- A bank of 4 cells was used as the lead 1st cleaner scavenger in Test PP8.

3.2.9. Denver No. D7 Sub-A Flotation Cells

Each cell has a volume of 28 L. The cells were used as follows:

- A bank of Denver No. D7 Sub A cells was used as the lead 1st cleaner in all tests, except PP-1. Four to six cells were used.
- A bank of 6 Denver No. D7 Sub A cells was used as the zinc 1st cleaner in all tests.
- Denver No. D7 Sub A cells were used for zinc 2nd cleaning. Three cells were used in Tests PP-1 to 12, and 2 cells were used thereafter.
- Denver No. D7 Sub A cells were used for zinc 3rd cleaning. Two cells were used in Tests PP-1 to 12, and 1 cell was used thereafter.
- Denver No. D7 Sub A cells were used for zinc 4th cleaning. One cell was used in Tests PP-11 to 17. A zinc 4th cleaner was not included in the flowsheet in Tests PP-1 to 10.

3.2.10. Denver No. DR7 Flotation Cells

Each cell has a volume of 28 L. Air is supplied by Roots-Connersville blower. The cells were used as follows:

- Zinc 1st cleaner cells. A bank of 6 cells was used in all tests. However, the last cell did not generally produce froth.

- Zinc 1st cleaner scavenger cells. A bank of 6 cells was used in Tests PP-2 to 17. The circuit was not operational in Test PP-1.

Equipment - Continued

3.2.11. Denver No. D5 Flotation Cells

Each Denver No. D5 cell has a volume of 11 L. The cells were used in all tests as the lead 2nd, 3rd, and 4th cleaner cells. The number of cells used in each test was as follows:

- 2nd Cleaner - 4 cells in all tests except PP-1. In PP-1, the 2nd cleaner was 3 cells.

- 3rd Cleaner - 3 cells in Tests PP-2 to 9 and 2 cells in Tests PP-10 to 17. In PP-1, the 3rd cleaner was 3 cells.

- 4th Cleaner - 2 cells in Tests PP-2 to 9 and 1 cell in Tests PP-10 to 17. There was not a 4th cleaner in Test PP-1.

3.2.12. Slurry Transfer Pumps

Several 38 mm Sala and Minpro 25 mm or 38 mm slurry transfer pumps were used in the circuit.

4. Liquid/Solid Separation

4.1. Equipment

1. Sala Tank Thickener

4.2. Description

4.2.1. Sala Tank Thickener

The 2130 mm diameter thickener is 1520 mm deep, with a cone angle of 170°, giving a volume of 5180 L. It is driven by a 0.76 kW motor through a gear reducer, V-belts, pulley and worm gear. The thickener was used to thicken the zinc scalp tails in all tests, and the thickener products were pumped to the tailings pond. In Test PP-16, the thickener overflow water was recycled to the primary grinding circuit.

DETAILS OF PILOT PLANT TESTWORK

TEST NO. PP-1

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: Preliminary test with Rock Type 5 ore to evaluate the mechanical operation of the equipment and to assess the effect of the steel loads on grinding.

1.1.2. Method: The ore was ground in a conventional rod mill-ball mill circuit with the ball mill operating in closed circuit with a cyclone. Collector and soda ash were added to the grinding circuit. The cyclone overflow product was pumped to the Pb-Zn semi-bulk flotation circuit.

1.1.2.1. Flowsheet Equipment

1. Marcy Rod Mill : 1220 mm x 640 mm diameter
2. Hendy Ball Mill : 1219 mm x 914 mm diameter
3. Kason : 610 mm diameter screen equipped with a 30 mesh deck.

1.1.2.2. Mill Loads

Rod Mill:	200 kg of 62 mm rods
	200 kg of 37-50 mm rods
Ball Mill:	250 kg of 50 mm balls
	150 kg of 25 mm balls

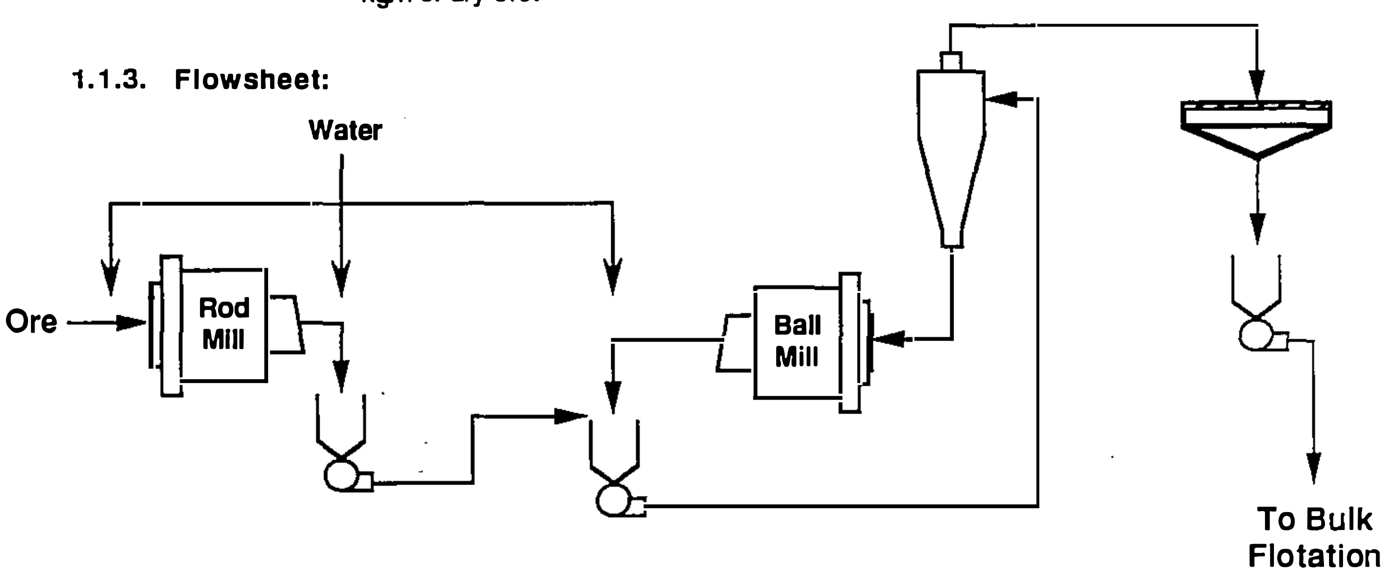
1.1.2.3. Classification Equipment

1.	Dorr P50 cyclone :	50 mm diameter
		12.5 mm apex
		19.1 mm vortex

1.1.2.4. Circuit Operation

The circuit was operated for a period of 5.5 hours and was sampled every 15 minutes during the last 1.0 hour of operation. The average feed rate was 544 kg/h of dry ore.

1.1.3. Flowsheet:



Test PP-1 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-1

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	3.7	0.5	0.5	99.5
6,680	3	36.2	4.8	5.3	94.7
4,699	4	107.0	14.3	19.7	80.3
3,327	6	88.8	11.9	31.6	68.4
2,362	8	77.8	10.4	42.0	58.0
1,651	10	70.7	9.5	51.4	48.6
1,168	14	52.6	7.0	58.5	41.5
833	20	35.7	4.8	63.3	36.7
589	28	30.1	4.0	67.3	32.7
417	35	24.6	3.3	70.6	29.4
295	48	17.9	2.4	73.0	27.0
208	65	16.2	2.2	75.2	24.8
147	100	17.3	2.3	77.5	22.5
104	150	16.5	2.2	79.7	20.3
74	200	17.5	2.3	82.0	18.0
53	270	18.9	2.5	84.6	15.4
38	400	17.8	2.4	86.9	13.1
-38	-400	97.5	13.1	100.0	-
	Total	746.8	100.0	-	-

Product: Rod Mill Discharge Test No: PP-1

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.2	0.1	0.1	99.9
1,168	14	0.9	0.3	0.4	99.6
833	20	2.4	0.8	1.1	98.9
589	28	8.8	2.9	4.0	96.0
417	35	20.7	6.7	10.7	89.3
295	48	27.6	9.0	19.7	80.3
208	65	35.6	11.6	31.3	68.7
147	100	33.5	10.9	42.2	57.8
104	150	28.7	9.3	51.5	48.5
74	200	25.2	8.2	59.7	40.3
53	270	23.5	7.6	67.3	32.7
38	400	18.6	6.0	73.4	26.6
-38	-400	81.9	26.6	100.0	-
	Total	307.6	100.0	-	-

Test PP-1 - Continued

1.1.4. Size Analyses: Continued

Product: Hendy Cyclone Overflow Test No: PP-1

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	2.5	1.3	1.3	98.7
208	65	2.8	1.4	2.7	97.3
147	100	7.7	3.9	6.6	93.4
104	150	14.6	7.4	14.0	86.0
74	200	23.8	12.1	26.1	73.9
53	270	31.5	16.0	42.1	57.9
38	400	28.9	14.7	56.7	43.3
-38	-400	85.3	43.3	100.0	-
	Total	197.1	100.0	-	-

Product: Hendy Cyclone Overflow Test No: PP-1 Taken at 13:30 pm

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	1.6	1.6	1.6	98.4
147	100	2.5	2.4	4.0	96.0
104	150	4.7	4.6	8.6	91.4
74	200	8.0	7.8	16.4	83.6
53	270	11.0	10.7	27.1	72.9
38	400	11.1	10.8	37.9	62.1
-38	-400	63.8	62.1	100.0	-
	Total	102.7	100.0	-	-

1.1.5. Observations:

Circuit operation was quite stable, and the desired grind was essentially achieved (i.e. 80 % - 87 μm).

Test PP-1 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: Regrinding of semi-bulk, Pb rougher, and Zn scalp concentrates.

1.2.2. Method: Each of the semi-bulk, Pb rougher and Zn scalp concentrates were sent to the mill discharge pump. The concentrate, along with the mill discharge, were pumped to the cyclone. Cyclone underflow was fed to the mill, and the overflow was sent to flotation (see flowsheet, section 2.3.).

1.2.2.1. Flowsheet Equipment

Semi-bulk Regrind :	Sala Ball Mill 1067 mm x 610 mm diameter
Pb Ro Conc Regrind:	Hardinge Conical Ball Mill 205 mm long cylinder x 914 mm diameter
Zn Scalp Conc Regrind:	Denver Ball Mill 812 mm x 406 mm diameter

1.2.2.2. Mill Loads

Semi-bulk Regrind :	550 kg of 25 mm - 38 mm balls
Pb Regrind :	580 kg of 25 mm - 38 mm balls
Zn Regrind :	225 kg of 25 mm - 38 mm balls

1.2.2.3. Classification Equipment

Semi-bulk Regrind :	Mozley C124 Cyclone	50 mm diameter 6.4 mm apex 14.0 mm vortex
Pb Regrind :	2 x Krebs 25 mm Cyclones	25 mm diameter 6.4 mm apex 7.0 mm vortex
Zn Regrind:	2 x Dorr P25 Cyclones	25 mm diameter 5.0 mm apex 8.0 mm vortex

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/FLow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-bulk Sala	-	1293	-	1175	Semi-bulk Conc Cycl O/Flow	-	-	-	-
Pb-Hardinge	-	1400	-	1110	Pb Ro Conc Cycl O/Flow	90.1	79.2	57.4	19
Zn-Denver	-	1555	-	1210	Zn Scalp Conc Cycl O/Flow	-	-	-	-

Test PP-1 - Continued

1.2.3. Flowsheet: See section 2.3.

1.2.4. Size Analyses:

Product: Pb Rougher Conc Test No: PP-1 S.G.- 4.72

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.30	0.6	0.6	99.4
31.0µ	1.81	3.6	4.2	95.8
24.0	2.85	5.7	9.9	90.1
16.7	5.44	10.9	20.8	79.2
11.5	7.75	15.5	36.3	63.7
8.9	3.13	6.3	42.6	57.4
-8.9	28.72	57.4	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:
The regrinding circuits performed steadily, without mechanical problems.
The semi-bulk concentrate regrind feed chute leaked for most of the run.

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	1.3	% moisture	
Primary Rod Mill Feed	544	drykg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	200	kg of 62mm dia. rods	
	200	kg of 37-50mm dia. rods	
Rod Mill Discharge:	2,098 g/L	(68 % Sol at SG 4.25)	
	80.3	% minus 48 mesh	
	40.3	% minus 200 mesh	
Input Power:	20.3	3 disc revolutions	
	4.79 kW	95% drive efficiency)	
Average Power:	4.55 kW	Gross	
	1.771	No Load	
	2.78	Net	
Net Power Usage:	5.1		
K80 Feed:	4699	microns	
K80 Product:	295	microns	
W. Index (metric):	11.7		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	544	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	250	kg of 50mm balls	
	150	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	2,103 g/L	(69 % Sol at SG 4.25)	
	-	% minus 48 mesh	
	-	% minus 200 mesh	
Circulating Load	NA	%	
Input Power:	14.16	sec for 3 disc revolutions	
	6.86 kW	95% drive efficiency)	
Average Power:	6.52 kW	Gross	
	1.60	No Load	
	4.92	Net	
Net Power Usage:	9.1	kWh/t	
K80 Feed:	295	microns	
K80 Product:	87	microns	
W. Index (metric):	18.5		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	14.2 kWh/t
K80 Feed:	4699 microns
K80 Product:	87 microns
Work Index :	15.3 metric
Flot. Feed :	73.9% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	544	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	550	kg of 25-38 mm balls	
	550	kg total	
Ball Mill Discharge:	2,103 g/L		
Input Power:	8.88	sec for 3 disc revolutions	
	4.38 kW	95% drive efficiency)	
Average Power:	4.16 kW	Gross	
	1.18	No Load	
	2.98	Net	
K80 Feed:	NA	microns	
K80 Product:	NA	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	544	kg/h	
H.Conical. Mill Speed:	33.7	rpm	(75.7 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	580	kg of 25-38 mm balls	
	580	kg total	
Ball Mill Discharge:	1,400 g/L	(36 % Sol at SG 4.72)	
Input Power:	31.54	sec for 3 disc revolutions	
	3.08 kW	95% drive efficiency)	
Average Power:	2.93 kW	Gross	
	1.20	No Load	
	1.73	Net	
K80 Feed:	19	microns	
K80 Product:	NA	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	544	kg/h	
Denver Mill 2 Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	225	kg of 25 mm balls	
	225	kg total	
Ball Mill Discharge:	1,555 g/L		
Input Power:	25.60	sec for 3 disc revolutions	
	1.52 kW	95% drive efficiency)	
Average Power:	1.44 kW	Gross	
	0.62	No Load	
	0.83	Net	
K80 Feed:	NA	microns	
K80 Product:	NA	microns	

2. FLOTATION

2.1. Purpose: Preliminary test to fill the circuit, to test the mechanical operation of the equipment, and to make a preliminary evaluation of reagent additions.

2.2. Method:

a) The semi-bulk concentrate was floated with collectors A317 and CA830/ Thiourea mixture and with MIBC frother, followed by regrinding in closed circuit in a Sala ball mill.

b) The reground product was conditioned with depressant SD200/cyanide In a high intensity conditioner and a lead rougher concentrate was floated with the A317-CA830/Thlourea-MIBC reagents. The concentrate was reground In closed circuit In a Hardinge Conical mill. The Pb rougher tail was pumped to the zinc flotation clrucit.

c) The reground product was conditioned with collectors and frothers in a high intensity conditioner and a lead 1st cleaner concentrate was floated. The 1st cleaner concentrate was cleaned three more times, producing a final lead 4th cleaner concentràte.
The 4th, 3rd and 2nd cleaner tails were recycled to the previous cleaner. The 1st cleaner tails were recycled to the Pb rougher conditioner.

d) The semi-bulk rougher tail was conditioned In a Denver conditioner with lime and cupric sulphate and a zinc scalp concentrate was floated with A350 and M2030 collectors and DF250 frother. The zinc scalp tall was pumped to a Sala thickener, and the thickened tailings were pumped to the tailings pond.

e) The zinc scalp concentrate was reground in a closed circuit in a Denver ball mill.

f) The Pb rougher tail was conditioned in Denver conditioners with lime and cupric sulphate and a zinc prefloat concentrate was floated with the A350-M2030-DF250 reagents. The prefloat tails were pumped to tailings.

g) The reground zinc scalp concentrate and the zinc prefloat concentrate were pumped to the Zn 1st cleaner without conditioning (the high intensity conditioner was not operated in PP-1) and a zinc 1st cleaner concentrate was floated. The 1st cleaner concentrate was cleaned twice. The Zn 3rd cleaner tail was recirculated to the Zn 2nd cleaner, and the 2nd cleaner tail was recycled to the Zn 1st cleaner conditioner.
The Zn 1st cleaner tail was not scavenged in PP-1.

h) The final plant tailings consisted of the Zn scalp tall, the Zn prefioat tail, and the Zn 1st cleaner scavenger tall. These tailings were collected in a lined pond for eventual recycle of water to the plant.

Test PP-1 - Continued

2.2.1. Flowsheet Equipment

Bulk Flotation :

Bulk Rougher 1	Denver D8 cells, bank of 4 cells
Bulk Rougher 2	Denver D8 cells, bank of 4 cells

Pb Flotation :

Pb Ro Conditioner	Lakefield Research 500L High Intensity Conditioner
Pb Rougher	Agitair 15 cells, bank of 6 cells
Pb 1st Cl Conditioner	Lakefield Reseach 300L High Intensity Conditioner
Pb 1st Cleaner	Denver D7 cells - 4 cells
Pb 2nd Cleaner	Denver D5 cells - 4 cells
Pb 3rd Cleaner	Denver D5 cells - 3 cells
Pb 4th Cleaner	Denver D5 cells - 2 cells

Zn Flotation :

Zn Prefloat	Agitair 15 cells, bank of 6 cells
Zn Scalp Cond 1	Hazen Quinn 400L conditioners
Zn Scalp Cond 2	Hazen Quinn 150L conditioner
Zn Scalp	Denver D8 cells, bank of 4 cells
Zn Prefloat Cond 1	Denver 200L conditioner
Zn Prefloat Cond 2	Denver 200L conditioner
Zn 1st Cleaner	Denver DR7 cells, bank of 6 cells
Zn 2nd Cleaner	Denver D7 Sub-A cells - 3 cells
Zn 3rd Cleaner	Denver D7 Sub-A cells - 2 cells

Liquid/Solid Separation :

Zn Scalp Tails	Sala 5180 L tank thickener

2.2.2. Conditioning Parameters

Conditioner	Type	Volume L	Impeller diameter	Speed rpm
Pb Rougher	High intensity	400	483mm	490
Pb 1st Cleaner	High Intensity	200	279 mm	305
Zn Scalp 1	Conventional	400	-	-
Zn Scalp 2	Conventional	150	-	-
Zn Prefloat 1	Conventional	200	-	-
Zn Prefloat 2	Conventional	200	-	-

2.2.3. Circuit Operation

The circuit was operated for a period of 5.5 hours, and was sampled every 15 minutes during the last 0.5 hours of operation.

TEST PP-1

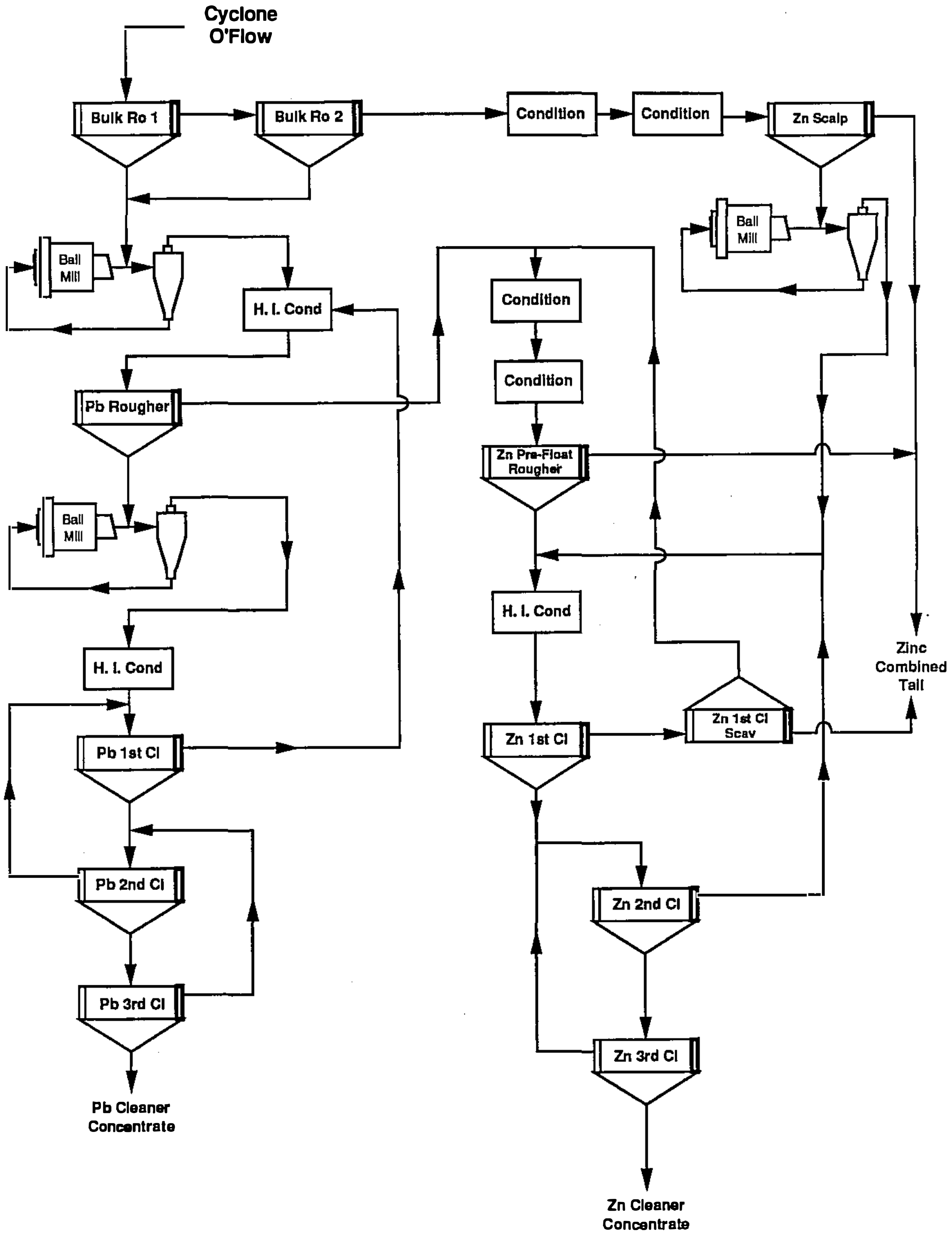
2.2.4. Flotation Reagents:

Point of Addition	Reagent Name	Solution Strength %	Rate mL/min	g/t
Bulk and Pb Circuits:				
Rod Mill Feed	Na2CO3	10.0	204.0	2250
Ball Mill Feed	A317	1.0	50.0	55
Bulk Rougher 1 Feed	CA830/TH	1.0	20.0	22
Bulk Rougher 1 Feed	MIBC	2.0	15.0	33
Bulk Rougher 2 Feed	CA830/TH	1.0	10.0	11
Bulk Rougher 2 Feed	A317	1.0	9.0	10
Bulk Rougher 2 Feed	MIBC	2.0	5.0	11
Bulk Concentrate Regrind Mill Feed	Na2CO3	10.0	300.0	3309
Bulk Concentrate Regrind Mill Feed	SD200/NaCN	4.0	64.0	282
Pb Rougher H.I. Conditioner	CA830/TH	1.0	6.6	7
Pb Rougher H.I. Conditioner	A317	1.0	17.0	19
Pb Rougher H.I. Conditioner	MIBC	2.0	2.1	5
Pb Rougher Cell 4	A317	1.0	0.0	0
Pb Rougher Cell 4	MIBC	100.0	0.0	0
Pb Concentrate Regrind Mill Feed	SD200/NaCN	4.0	63.0	278
Pb 1st Cleaner H.I. Conditioner	CA830/TH	1.0	17.0	19
Pb 1st Cleaner H.I. Conditioner	A317	1.0	8.3	9
Pb 1st Cleaner H.I. Conditioner	MIBC	2.0	2.0	4
Pb 1st Cleaner Cell 3	CA830/TH	1.0	4.2	5
Pb 2nd Cleaner Feed	SD200/NaCN	4.0	15.4	68
Pb 2nd Cleaner Cell 2	CA830/TH	2.0	4.2	9
Pb 3rd Cleaner Feed	SD200/NaCN	4.0	14.0	62
Zinc Circuit:				
Zn Scalp Conditioner 1 Feed	Ca(OH)2	10.0	100.0	1103
Zn Scalp Conditioner 2 Feed	CuSO4.5H2O	10.0	83.5	921
Zn Scalp Feed *	M2030	100.0	12.0	7
Zn Scalp Feed	A317	1.0	35.0	39
Zn Scalp Feed	DF250	2.0	0.0	0
Zn Scalp Cell 3 *	M2030	100.0	6.0	3
Zn Scalp Cell 3	A317	1.0	4.4	5
Zn Scalp Conc. Regrind Mill Feed	Ca(OH)2	10.0	41.0	452
Zn Scalp Conc. Regrind Mill Feed	CuSO4.5H2O	10.0	14.0	154
Zn Prefloat Conditioner 1 Feed	Ca(OH)2	10.0	60.0	662
Zn Prefloat Conditioner 2 Feed	CuSO4.5H2O	10.0	43.0	474
Zn Prefloat Feed *	M2030	100.0	12.0	7
Zn Prefloat Feed	A317	1.0	21.0	23
Zn Prefloat Feed	DF250	2.0	12.0	26
Zn Prefloat Cell 3 *	M2030	100.0	5.5	3
Zn Prefloat Cell 3	A317	5.0	4.2	23
Zn 1st Cleaner H.I. Conditioner *	M2030	100.0	10.0	6
Zn 1st Cleaner H.I. Conditioner	A317	5.0	12.5	69
Zn 1st Cleaner Feed	DF250	2.0	0.0	0
Zn 2nd Cleaner Feed	Ca(OH)2	10.0	41.0	452
Zn 3rd Cleaner Feed	Ca(OH)2	10.0	23.0	254

* Drops per minute

Feed Rate= 544 kg/h

2.3. Flowsheet:



Test PP-1 - Continued

2.4. Results:

2.4.1. Observations

Mechanical difficulties were encountered in the lead and zinc flotation circuits. The following problems were experienced:

- The Pb 1st cleaner circuit was shut down halfway through the run due to motor problems, and these cells were bypassed. The 1st, 2nd, and 3rd cleaning stages were therefore performed in Denver D5 cells, resulting in a shortage of 1st cleaner capacity. A high circulating load therefore existed until late in the run.
- The zinc cleaner high intensity conditioner was not operated until the very end of the run.
- The zinc 1st cleaner scavenger circuit was not operated.
- One cell in the Zn 2nd cleaner circuit worked intermittently.
- Some reagent additions in the zinc circuit were not stabilized until about 1-2 hours before sampling.

Semi-bulk flotation operation was satisfactory. Lead cleaner flotation was disrupted by reduced cleaner capacity, leading to a considerable circulating load.
Zinc scalp flotation recovery was low, but was corrected by the end of the run with increased collector/frother additions and with the other cell adjustments. Zinc cleaning was hampered by cell mechanical problems (i.e. 2nd cleaner), lack of the cleaner scavenger operation, and lack of high intensity conditioning.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2098	10.5	-
Ball Mill Discharge	2103	-	-
Cyclone Underflow	2760	-	-
Cyclone Overflow	1335	10.2	15
Semi-Bulk Rougher Tail	1285	9.9	-
Semi-Bulk Regrind Discharge	1293	-	-
Semi-Bulk Cyclone Underflow	-	-	-
Semi-Bulk Regrind Cycl O/Flow	1175	-	-
Pb Rougher Feed	1103	10.6	21
Pb Rougher Tail	1040	-	-
Pb Regrind Discharge	1400	-	-
Pb Regrind Cyclone Underflow	-	-	-
Pb Regrind Cyclone Overflow	1110	-	-
Pb 1st Cleaner	-	10.3	-
Pb 1st Cleaner Tail	1030	-	-
Pb 2nd Cleaner Feed	-	9.9	-
Pb 3rd Cleaner Feed	-	9.8	-
Pb 4th Cleaner Feed	-	*	-
Zn Scalp Feed	-	8.7	18
Zn Scalp Tail	1275	-	-
Zn Regrind Discharge	1555	-	-
Zn Regrind Cyclone Underflow	-	-	-
Zn Regrind Cyclone Overflow	1210	-	-
Zn Prefloat Feed	-	10.5	-
Zn Prefloat Tail	1030	-	-
Zn 1st Cleaner Feed	1060	10.8	-
Zn Cleaner Scvenger Tail	-	-	-
Zn 2nd Cleaner Feed	-	11.7	-
Zn 3rd Cleaner Feed	-	11.9	-
Thickener Underflow	1430	-	-

* no Pb 4th cleaner

Test PP-1 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
15:30	Pb 4th Cleaner Concentrate	41.1	4.88
	Zn 3rd Cleaner Concentrate	0.97	52.6
	Zn 1st Cleaner Tail*	1.40	6.19
	Zn Prefloat Tail	1.69	1.39
	Zn Scalp Tail	0.77	7.52
	Zn Combined Tail	-	-
	Cyclone Overflow	3.34	9.97

* Zn 1st cleaner scavenger cells did not operate.

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Cyclone Overflow	3.21	9.72	64.6
Semi-Bulk Rougher Concentrate	14.3	10.1	-
Semi-Bulk Rougher Tail	0.90	10.0	-
Pb Rougher Concentrate	27.3	5.70	-
Pb Rougher Tail	2.29	13.2	-
Pb 3rd Cleaner Concentrate*	44.3	3.45	147
Zn Scalp Concentrate	0.91	49.5	-
Zn Scalp Tail	0.85	7.59	-
Zn Prefloat Concentrate	1.57	31.6	-
Zn Prefloat Tail	1.94	1.59	-
Zn 1st Cleaner Tail**	1.64	6.45	-
Zn Combined Tail	0.94	5.93	47.7
Zn 3rd Cleaner Concentrate	0.79	53.8	163

* 3 lead cleaners only
** Zn 1st cleaner scavenger cells did not operate.

2.4.5. Metallurgical Results

A mass balance was not calculated.

TEST NO. PP-2

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As for Test PP-1.

1.1.2. Method: As for Test PP-1.

1.1.2.1. Flowsheet Equipment

As for Test PP-1.

1.1.2.2. Mill Loads

As for Test PP-1.

1.1.2.3. Classification Equipment

As for Test PP-1.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 6.0 hours and was sampled every 30 minutes during the last 2.0 hours of operation. The average feed rate was 525 kg/h of dry ore.

1.1.3. Flowsheet: As for Test PP-1.

Test PP-2 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-2

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	3.3	0.4	0.4	99.6
6,680	3	56.1	6.1	6.4	93.6
4,699	4	118.3	12.8	19.3	80.7
3,327	6	109.1	11.8	31.1	68.9
2,362	8	89.4	9.7	40.8	59.2
1,651	10	80.6	8.7	49.5	50.5
1,168	14	65.4	7.1	56.6	43.4
833	20	46.2	5.0	61.6	38.4
589	28	39.8	4.3	65.9	34.1
417	35	32.2	3.5	69.4	30.6
295	48	24.4	2.6	72.0	28.0
208	65	22.2	2.4	74.4	25.6
147	100	21.0	2.3	76.7	23.3
104	150	20.1	2.2	78.9	21.1
74	200	21.0	2.3	81.2	18.8
53	270	24.7	2.7	83.8	16.2
38	400	21.4	2.3	86.1	13.9
-38	-400	127.9	13.9	100.0	-
	Total	923.1	100.0	-	-

Product: Rod Mill Discharge Test No: PP-2

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	1.0	0.4	0.4	99.6
833	20	2.4	1.0	1.5	98.5
589	28	6.0	2.6	4.1	95.9
417	35	12.8	5.6	9.7	90.3
295	48	17.0	7.4	17.0	83.0
208	65	20.2	8.8	25.8	74.2
147	100	23.1	10.0	35.9	64.1
104	150	21.1	9.2	45.0	55.0
74	200	17.6	7.7	52.7	47.3
53	270	17.8	7.7	60.4	39.6
38	400	14.7	6.4	66.8	33.2
-38	-400	76.3	33.2	100.0	-
	Total	230.0	100.0	-	-

Test PP-2 - Continued

1.1.4. Size Analyses: Continued

Product: Cyclone Overflow Test No: PP-2

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	2.0	1.1	1.1	98.9
147	100	3.1	1.7	2.7	97.3
104	150	6.0	3.2	6.0	94.0
74	200	11.9	6.4	12.4	87.6
53	270	20.0	10.7	23.1	76.9
38	400	20.8	11.2	34.3	65.7
-38	-400	122.4	65.7	100.0	-
	Total	186.2	100.0	-	-

1.1.5. Observations: Circuit operation was quite stable. The grind was finer in Test PP-2 than in Test PP-1, with a K_{80} value of 57 µm.

1.2. Regrinding Circuits:

1.2.1. Purpose: As in Test PP-1, with the semi-bulk and Pb regrind mill feed diluted.

1.2.2. Method: As in Test PP-1, but water was added to the semi-bulk and Pb regrind mills to coarsen the grinds.

1.2.2.1. Flowsheet Equipment

As for Test PP-1.

1.2.2.2. Mill Loads

As for Test PP-1.

1.2.2.3. Classification Equipment

As for Test PP-1.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/FLow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Bulk-Sala	-	1558	1840	1145	Bulk Conc Cycl O/Flow	79.4 96.5	67.8 87.2	47.6 63.5	26 14
Pb-Hardinge	-	1910	2050	1138	Pb Ro Conc Cycl O/Flow	96.5 99.8	88.8 99.0	65.8 81.9	13 9
Zn-Denver	-	2293	2338	1273	Zn Scalp Conc Cycl O/Flow	47.5 90.1	36.5 79.2	24.8 57.4	56 18

1.2.3. Flowsheet: As in Test PP-1.

Test PP-2 - Continued

1.2.4. Size Analyses:

4086 ar

Product: Zn. Scalp Conc Test No: PP-2 S.G.- 4.41

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	1.25	2.5	2.5	97.5
200	4.65	9.3	11.8	88.2
270	7.35	14.7	26.5	73.5
32.3μ	7.19	14.4	40.9	59.1
25.1	5.83	11.7	52.5	47.5
17.5	5.47	10.9	63.5	36.5
12.0	4.37	8.7	72.2	27.8
9.3	1.47	2.9	75.2	24.8
-9.3	12.42	24.8	100.0	-
Total	50.00	100.0	-	-

Product: Pb Regrind Cyclone Overflow Test No: PP-2 S.G.- 4.37

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
32.0μ	0.00	0.0	0.0	100.0
24.8	0.11	0.2	0.2	99.8
17.3	0.37	0.7	1.0	99.0
11.9	3.74	7.5	8.4	91.6
9.2	4.85	9.7	18.1	81.9
-9.2	40.93	81.9	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-2 S.G.- 4.42

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
32.3μ	0.52	1.0	1.0	99.0
25.1	1.23	2.5	3.5	96.5
17.5	3.83	7.7	11.2	88.8
12.0	7.19	14.4	25.5	74.5
9.3	4.35	8.7	34.2	65.8
-9.3	32.88	65.8	100.0	-
Total	50.00	100.0	-	-

Project No: 4086 ar

Product: Bulk Regrind Cyclone Overflow Test No: PP-2 S.G.- 4.52

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.7μ	0.54	1.1	1.1	98.9
24.6	1.22	2.4	3.5	96.5
17.2	4.63	9.3	12.8	87.2
11.8	7.83	15.7	28.4	71.6
9.1	4.01	8.0	36.5	63.5
-9.1	31.77	63.5	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Rougher Conc Test No: PP-2 S.G.- 4.46

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	2.83	5.7	5.7	94.3
32.0μ	3.69	7.4	13.0	87.0
24.8	3.76	7.5	20.6	79.4
17.3	5.83	11.7	32.2	67.8
11.9	7.14	14.3	46.5	53.5
9.2	2.94	5.9	52.4	47.6
-9.2	23.81	47.6	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-2 S.G.- 4.41

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.30	0.6	0.6	99.4
32.3μ	1.81	3.6	4.2	95.8
25.1	2.85	5.7	9.9	90.1
17.5	5.44	10.9	20.8	79.2
12.0	7.75	15.5	36.3	63.7
9.3	3.13	6.3	42.6	57.4
-9.3	28.72	57.4	100.0	-
Total	50.00	100.0	-	-

Test PP-2 - Continued

1.2.5. Observations:

Circuit operation was satisfactory. The regrind products were as follows:

Bulk Regrind:	80 % -14 µm which was roughly similar to that achieved In the lab testwork.
Pb Regrind:	80 % -9 µm, which was roughly that achieved in the lab testwork.
Zn Regrind :	80 % -18 µm.

1.3. Results:

1.3.1. Primary Ro Mill Report:

Rod Mill Feed	2.0	% moisture
Primary Rod Mill Feed	525	dry kg/h
Mill Speed:	38.6	rpm (71 % of critical speed)
Rod Load:	200	kg of 62mm dia. rods
	200	kg of37-50mm dia. rods
Rod Mill Discharge:	2,099 g/L	(68 % Sol at SG 4.25)
	83	% minus 48 mesh
	47.3	% minus 200 mesh
Input Power:	20.11	3 disc revolutions
	4.83 kW	95% drive efficiency)
Average Power:	4.59 kW	Gross
	1.771	No Load
	2.82	Net
Net Power Usage:	5.4	
K80 Feed:	4299	microns
K80 Product:	260	microns
W. Index (metric):	11.5	

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	525	kg/h
Mill Speed:	31	rpm (77 % of critical speed)
Ball Load:	250	kg of 50mm balls
	150	kg of 25 mm balls
	400	kg total
Ball Mill Discharge:	2,100 g/L	(68 % Sol at SG 4.25)
	-	% minus 48 mesh
	-	% minus 200 mesh
Circulating Load	NA	%
Input Power:	14.54	sec for 3 disc revolutions
	6.69 kW	95% drive efficiency)
Average Power:	6.35 kW	Gross
	1.60	No Load
	4.75	Net
Net Power Usage:	9.1	kWh/t
K80 Feed:	260	microns
K80 Product:	58	microns
W. Index (metric):	13.1	

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	14.4 kWh/t
K80 Feed:	4299 microns
K80 Product:	58 microns
Work Index :	12.4 metric
Flot. Feed :	87.6% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	525	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	550	kg of 25-38 mm balls	
	550	kg total	
Ball Mill Discharge:	1,558 g/L	(46 % Sol at SG 4.49)	
Input Power:	8.72	sec for 3 disc revolutions	
	4.46 kW	95% drive efficiency)	
Average Power:	4.24kW	Gross	
	1.18	No Load	
	3.06	Net	
K80 Feed:	26	microns	
K80 Product:	14	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	525	kg/h	
H.Conical. Mill Speed:	33.7	rpm	(75.7 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	580	kg of 25-38 mm balls	
	580	kg total	
Ball Mill Discharge:	1,910 g/L	(62 % Sol at SG 4.40)	
Input Power:	29.46	sec for 3 disc revolutions	
	3.30 kW	95% drive efficiency)	
Average Power:	3.13 kW	Gross	
	1.20	No Load	
	1.94	Net	
K80 Feed:	13	microns	
K80 Product:	9	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	525	kg/h	
Denver Mill 2 Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	225	kg of 25 mm balls	
	225	kg total	
Ball Mill Discharge:	2,293 g/L	(73 % Sol at SG 4.41)	
Input Power:	26.47	sec for 3 disc revolutions	
	1.47 kW	95% drive efficiency)	
Average Power:	1.40 kW	Gross	
	0.62	No Load	
	0.78	Net	
K80 Feed:	56	microns	
K80 Product:	18	microns	

2. FLOTATION

2.1. Purpose: Adjustment of reagent levels.

2.2. Method: Similar to that in Test PP-1, but all equipment was operating. (The Zn H.I. conditioner was operated from the beginning of the run and the Zn cleaner scavenger cells were operated from about 10:30-11:00). A bank of 4 Denver DR7 (cell to cell) cells was used for the Pb 1st cleaner and the three sets of Denver D5 cells was used for the 2nd-4th cleaners, as was done at the start of PP-1.
Reagent additions were generally increased throughout the circuit. Zn scalp collector additions were especially increased and frother was introduced to the scalp feed.
The Pb 3rd cleaner tail was recycled to the Pb 1st cleaner feed.
MIBC solution strength was increased from 2 to 100%.

2.2.1. Flowsheet Equipment

As in Test PP-1, but with all equipment operating. (Note that the Zn 2nd cleaner cell 2 operated intermittently until late in the run).

2.2.2. Conditioning Parameters

Conditioner	Type	Volume L	Impeller diameter	Speed rpm
Pb Rougher	High Intensity	400	483 mm	490
Pb 1st Cleaner	High Intensity	200	279 mm	305
Zn Scalp 1	Conventional	400	-	-
Zn Scalp 2	Conventional	150	-	-
Zn Prefloat 1	Conventional	200	-	-
Zn Prefloat 2	Conventional	200	-	-
Zn 1st Cleaner	High Intensity	400	406 mm	483

2.2.3. Circuit Operation

The circuit was operated for a period of 6.0 hours, and was sampled every 30 minutes during the last 2.0 hours of operation.

TEST PP-2

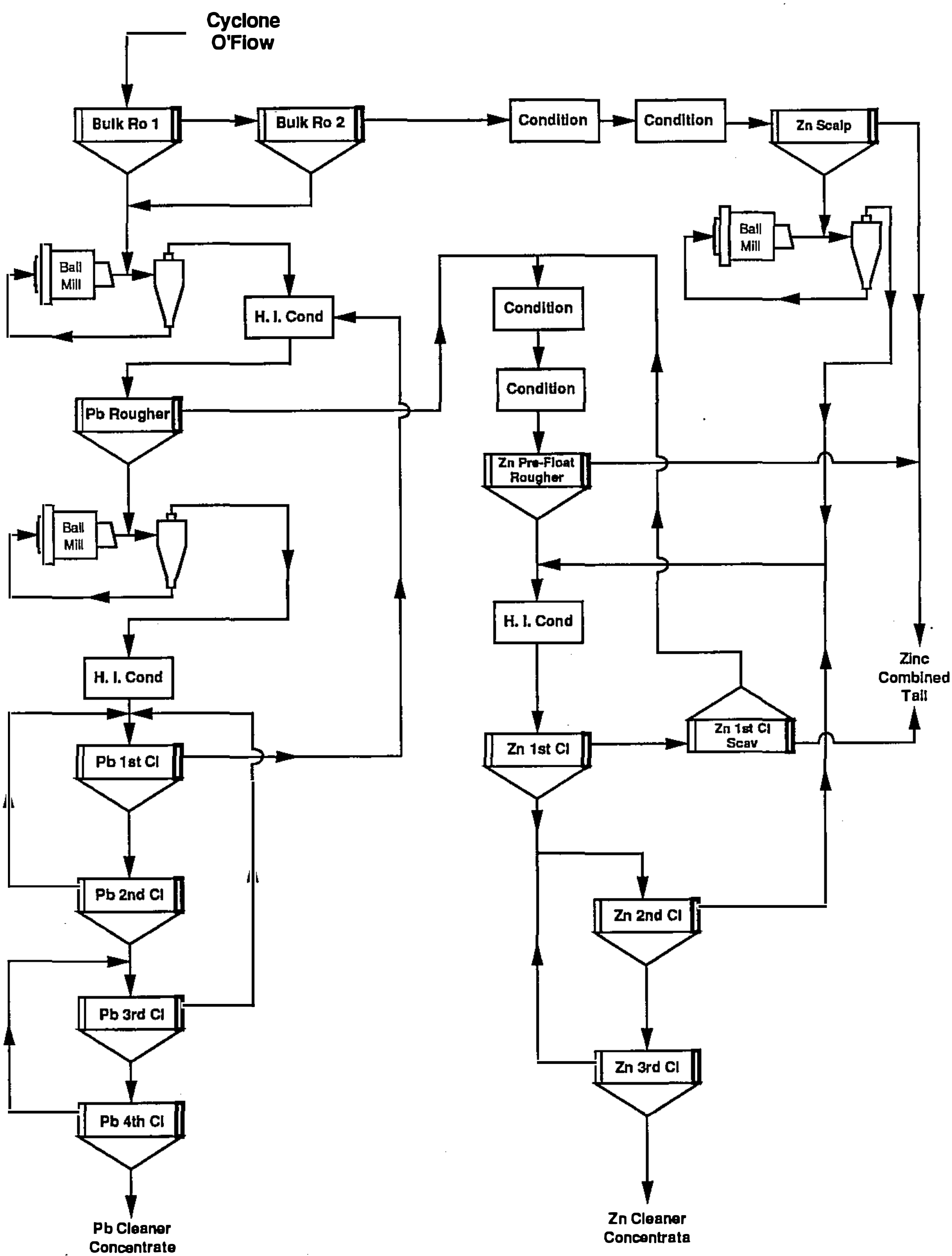
2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	207.5	2371
Ball Mill Feed		A317	1.0	80.0	91
Bulk Rougher 1 Feed		CA830/TH	1.0	40.0	46
Bulk Rougher 1 Feed	*	MIBC	100.0	40.0	23
Bulk Rougher 2 Feed		CA830/TH	1.0	20.0	23
Bulk Rougher 2 Feed		A317	1.0	20.0	23
Bulk Rougher 2 Feed	*	MIBC	100.0	19.1	11
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	30.0	343
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	70.0	320
Pb Rougher H.I. Conditioner		CA830/TH	1.0	30.0	34
Pb Rougher H.I. Conditioner		A317	1.0	60.0	69
Pb Rougher H.I. Conditioner	*	MIBC	100.0	10.4	6
Pb Rougher Cell 4		A317	1.0	10.0	11
Pb Rougher Cell 4	*	MIBC	100.0	5.9	3
Pb Concentrate Regrind Mill Feed		SD200/NaCN	4.0	80.6	368
Pb 1st Cleaner H.I. Conditioner		CA830/TH	1.0	16.9	19
Pb 1st Cleaner H.I. Conditioner		A317	1.0	39.6	45
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	4.0	2
Pb 1st Cleaner Cell 3		CA830/TH	1.0	4.2	5
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	30.0	137
Pb 2nd Cleaner Cell 3		CA830/TH	1.0	4.2	5
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	30.0	137
Pb 3rd Cleaner Cell 2		CA830/TH	2.0	0.0	0
Pb 4th Cleaner Feed		SD200/NaCN	4.0	30.0	137
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	65.5	749
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	83.0	949
Zn Scalp Feed	*	M2030	100.0	12.0	7
Zn Scalp Feed		A317	1.0	50.3	57
Zn Scalp Feed	*	DF250	100.0	120.0	69
Zn Scalp Cell 3	*	M2030	100.0	6.0	3
Zn Scalp Cell 3		A317	1.0	10.0	11
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	16.3	186
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	16.0	183
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	57.1	653
Zn Prefloat Conditioner 2 Feed		CuSO4.5H2O	10.0	41.0	469
Zn Prefloat Feed	*	M2030	100.0	12.0	7
Zn Prefloat Feed		A317	1.0	40.0	46
Zn Prefloat Feed		DF250	100.0	8.0	5
Zn Prefloat Cell 3	*	M2030	100.0	0.0	0
Zn Prefloat Cell 3		A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	8.0	5
Zn 1st Cleaner H.I. Conditioner		A317	5.0	13.0	74
Zn 1st Cleaner Feed		DF250	100.0	10.0	6
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	0.0	0
Zn 1st Cleaner Scavenger Feed		A317	5.0	9.8	56
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	45.1	515
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	18.5	211

* Drops per minute

Feed Rate= 525 kg/h

2.3. Flowsheet:



Test PP-2 - Continued

2.4. Results:

2.4.1. Observations

Mechanical difficulties were experienced with the 2nd cell of the Zn 2nd cleaner. The cell motor worked intermittently, but was fixed prior to sampling. Zinc scalp recoveries were greatly increased with increased reagent and with an increase in the cell level with weir bars.
Lead grades in the final concentrate were generally less than 50% (grab samples), but grade did increase to 67% in the last grab. Zinc product grades were generally less than 50%. Zinc recoveries were increased over those in Test PP-1.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2099	10.6	-
Ball Mill Discharge	2100	-	-
Cyclone Underflow	2770	-	-
Cyclone Overflow	1345	10.3	-
Semi-bulk Rougher Tail	1380	10.0	-
Semi-bulk Regrind Discharge	1558	-	-
Semi-bulk Regrind Cycl U/Flow	1840	-	-
Semi-Bulk Regrind Cycl O/Flow	1145	-	-
Pb Rougher Feed	1078	9.9	20
Pb Rougher Tail	1035	-	-
Pb Regrind Discharge	1910	-	-
Pb Regrind Cyclone Underflow	2050	-	-
Pb Regrind Cyclone Overflow	1138	-	-
Pb 1st Cleaner Feed	-	9.8	-
Pb 1st Cleaner Tail	1048	-	-
Pb 2nd Cleaner Feed	-	9.9	-
Pb 3rd Cleaner Feed	-	9.9	-
Pb 4th Cleaner Feed	-	10.0	-
Zn Scalp Feed	-	10.6	-
Zn Scalp Tail	1308	-	-
Zn Regrind Discharge	2293	-	-
Zn Regrind cyclone Underflow	2338	-	-
Zn Regrind Cyclone Overflow	1273	-	-
Zn Prefloat Feed	-	10.7	-
Zn Prefloat Tail	1023	-	-
Zn 1st Cleaner Feed	1115	11.5	-
Zn Cleaner Scavenger Tail	1038	11.5	-
Zn 2nd Cleaner Feed	-	12.0	-
Zn 3rd Cleaner Feed	-	12.2	-
Thickener Underflow	1505	-	-

Test PP- 2 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
11:30	Pb 4th Cleaner Conc	45.4	2.71
	Zn 3rd Cleaner Conc	1.85	57.3
	Zn Cleaner Scav Tail	2.56	11.1
	Zn Prefloat Tail	3.05	0.84
	Zn Scalp Tail	0.64	1.10
	Cyclone Overflow	3.38	10.1
12:30	Pb 4th Cleaner Conc	62.7	3.48
	Zn 3rd Cleaner Conc	1.82	54.4
	Zn Cleaner Scav Tail	1.73	1.62
	Zn Prefloat Tail	2.42	1.35
	Zn Scalp Tail	0.82	6.96
	Cyclone Overflow	3.49	10.1
1:30	Pb 4th Cleaner Conc	47.4	13.0
	Zn 3rd Cleaner Conc	1.66	49.7
	Zn Cleaner Scav Tail	1.18	0.70
	Zn Prefloat Tail	1.86	2.26
	Zn Scalp Tail	0.59	1.17
	Cyclone Overflow	3.23	9.64
2:30	Pb 4th Cleaner Conc	20.6	23.4
	Zn 3rd Cleaner Conc	1.35	48.1
	Zn Cleaner Scav Tail	0.94	0.51
	Zn Prefloat Tail	1.37	1.74
	Zn Scalp Tail	0.38	0.35
	Cyclone Overflow	3.55	10.1
3:30	Pb 4th Cleaner Conc	50.8	11.6
	Zn 3rd Cleaner Conc	0.99	49.5
	Zn Cleaner Scav Tail	0.97	0.64
	Zn Prefloat Tail	1.42	1.33
	Zn Scalp Tail	0.36	0.28
	Cyclone Overflow	3.54	10.2
4:30	Pb 4th Cleaner Conc	69.4	5.14
	Zn 3rd Cleaner Conc	1.03	49.5
	Zn Cleaner Scav Tail	0.97	0.65
	Zn Prefloat Tail	1.51	4.27
	Zn Scalp Tail	0.37	0.33
	Cyclone Overflow	3.55	10.1

Test PP-2 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Cyclone Overflow	3.39	9.92	62.2
Semi-bulk Concentrate	11.6	11.6	-
Semi-bulk Tail	0.67	9.71	-
Semi-bulk Regrind Cyclone O/Flow	11.9	11.1	-
Pb Rougher Feed	7.63	9.74	-
Pb Rougher Concentrate	11.9	12.7	-
Pb Rougher Tall	1.72	4.95	-
Pb 1st Cleaner Concentrate	18.0	25.3	-
Pb 1st Cleaner Tail	4.04	9.60	-
Pb Regrind Cyclone Overflow	11.2	12.7	-
Pb 4th Cleaner Concentrate	50.2	12.8	175
Zn Scalp Concentrate	1.03	19.6	-
Zn Scalp Tall	0.38	0.30	-
Zn Regrind Cyclone Overflow	0.96	19.9	-
Zn Prefloat Feed	1.73	4.46	-
Zn Prefloat Concentrate	2.00	8.19	-
Zn Prefloat Tall	1.51	2.56	-
Zn 1st Cleaner Feed	1.24	16.1	-
Zn Cleaner Scavenger Concentrate	1.90	3.76	-
Zn Cleaner Scavenger Tail	0.98	0.63	41.3
Zn Combined Tall	0.53	0.52	15.5
Zn 3rd Cleaner Concentrate	0.98	50.4	182

2.4.5. Metallurgical Results

Product	Weight	Assays, %, g/t			% Distribution		
	%	Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	5.60	50.2	12.8	175	82.9	7.2	18.3
Zn 3rd Cleaner Concentrate	17.47	0.98	50.4	182	5.0	88.7	59.4
Zn Combined Tails	76.93	0.53	0.52	15.5	12.0	4.0	22.3
Head(calc)	100.00	3.39	9.92	62.2	100.0	100.0	100.0

TEST NO. PP-3

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As for Test PP-2, but with changed reagent addition points in the grinding circuit due to the inclusion of carbon preflotation in the flotation circuit.

1.1.2. Method: As for Test PP-1, but collector A317 was added to the carbon prefloat tail instead of to the ball mill. Carbonate was added to the rod mill as in Tests PP-1 and 2.

1.1.2.1. Flowsheet Equipment

As for Test PP-1.

1.1.2.2. Mill Loads

As for Test PP-1.

1.1.2.3. Classification Equipment

As for Test PP-1.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 7.5 hours and was sampled every 30 minutes during the last 2.0 hours of operation. The average feed rate was 529 kg/h of dry ore.

1.1.3. Flowsheet: As for Test PP-1.

Test PP-3 - Continued

1.1.4. Size Analyses

Product: Rod Mill Feed Test No: PP-3

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	30.6	5.9	5.9	94.1
4,699	4	79.6	15.4	21.3	78.7
3,327	6	55.5	10.7	32.0	68.0
2,362	8	46.9	9.0	41.0	59.0
1,651	10	48.7	9.4	50.4	49.6
1,168	14	36.2	7.0	57.4	42.6
833	20	26.7	5.1	62.5	37.5
589	28	21.4	4.1	66.7	33.3
417	35	17.6	3.4	70.0	30.0
295	48	13.4	2.6	72.6	27.4
208	65	11.5	2.2	74.9	25.1
147	100	12.3	2.4	77.2	22.8
104	150	11.5	2.2	79.4	20.6
74	200	12.1	2.3	81.8	18.2
53	270	13.2	2.5	84.3	15.7
38	400	12.1	2.3	86.7	13.3
-38	-400	69.2	13.3	100.0	-
	Total	518.5	100.0	-	-

Product: Rod Mill Discharge Test No: PP-3

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.1	0.0	0.0	100.0
1,168	14	1.0	0.4	0.5	99.5
833	20	2.6	1.1	1.6	98.4
589	28	6.7	2.9	4.5	95.5
417	35	13.9	6.0	10.5	89.5
295	48	18.3	7.9	18.4	81.6
208	65	21.4	9.3	27.7	72.3
147	100	22.6	9.8	37.4	62.6
104	150	19.5	8.4	45.9	54.1
74	200	17.8	7.7	53.6	46.4
53	270	16.3	7.0	60.6	39.4
38	400	14.7	6.4	67.0	33.0
-38	-400	76.4	33.0	100.0	-
	Total	231.3	100.0	-	-

Test PP-3 - Continued

1.1.4. Size Analyses: Continued

Product: Cyclone Overflow Test No: PP-3

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	2.5	1.4	1.4	98.6
147	100	3.8	2.1	3.4	96.6
104	150	7.3	4.0	7.4	92.6
74	200	13.3	7.3	14.7	85.3
53	270	18.8	10.3	24.9	75.1
38	400	20.1	11.0	35.9	64.1
-38	-400	117.6	64.1	100.0	-
	Total	183.4	100.0	-	-

1.1.5. Observations: Circuit operation was quite stable.

Test PP-3 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: As in Test PP-2.

1.2.2. Method: As in Test PP-2.

1.2.2.1. Flowsheet Equipment

As for Test PP-1.

1.2.2.2. Mill Loads

As for Test PP-1.

1.2.2.3. Classification Equipment

As for Test PP-1.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Sala	-	1500	1530	1140	Semi-bulk Conc Cycl O/Flow	72.5 88.0	57.5 85.1	34.0 58.0	32 17
Pb-Hardinge	-	2125	2065	1160	Pb Ro Conc Cycl O/Flow	97.2 99.8	91.9 99.0	73.4 92.3	11 <9
Zn-Denver	-	2290	2360	1315	Zn Scalp Conc Cycl O/Flow	48.7 66.6	38.5 49.7	27.2 32.0	57 31

1.2.3. Flowsheet: As in Test PP-1.

Test PP-3 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-3 S.G.- 4.63

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	4.36	8.7	8.7	91.3
31.3μ	4.65	9.3	18.0	82.0
24.3	4.76	9.5	27.5	72.5
16.9	7.49	15.0	42.5	57.5
11.6	8.36	16.7	59.2	40.8
9.0	3.37	6.7	66.0	34.0
-9.0	17.01	34.0	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-3 S.G.- 4.63

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.3μ	0.71	1.4	1.4	98.6
24.3	5.31	10.6	12.0	88.0
16.9	1.44	2.9	14.9	85.1
11.6	9.25	18.5	33.4	66.6
9.0	4.31	8.6	42.0	58.0
-9.0	28.98	58.0	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-3 S.G.- 4.53

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.5μ	0.54	1.1	1.1	98.9
24.4	0.86	1.7	2.8	97.2
17.0	2.65	5.3	8.1	91.9
11.7	5.90	11.8	19.9	80.1
9.1	3.35	6.7	26.6	73.4
-9.1	36.70	73.4	100.0	-
Total	50.00	100.0	-	-

Test PP-3 - Continued

1.2.4. Size Analyses:

Product: Pb Regrind Cyclone Overflow Test No: PP-3 S.G.- 4.56

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.5μ	0.00	0.0	0.0	100.0
24.4	0.09	0.2	0.2	99.8
17.0	0.42	0.8	1.0	99.0
11.7	1.63	3.3	4.3	95.7
9.1	1.69	3.4	7.7	92.3
-9.1	46.17	92.3	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc Test No: PP-3 S.G.- 4.38

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	2.19	4.4	4.4	95.6
200	3.81	7.6	12.0	88.0
270	6.39	12.8	24.8	75.2
32.3μ	7.84	15.7	40.5	59.5
25.1	5.41	10.8	51.3	48.7
17.5	5.10	10.2	61.5	38.5
12.0	4.22	8.4	69.9	30.1
9.3	1.42	2.8	72.8	27.2
-9.3	13.62	27.2	100.0	-
Total	50.00	100.0	-	-

Product: Zn Scalp Tail Test No: PP-3 S.G.- 3.98

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
100	1.72	3.4	3.4	96.6
150	2.05	4.1	7.5	92.5
200	3.13	6.3	13.8	86.2
270	3.07	6.1	19.9	80.1
33.5μ	4.50	9.0	28.9	71.1
26.0	4.83	9.7	38.6	61.4
18.2	5.87	11.7	50.3	49.7
12.5	5.51	11.0	61.4	38.6
9.6	2.02	4.0	65.4	34.6
-9.6	17.30	34.6	100.0	-
Total	50.00	100.0	-	-

Test PP-3 - Continued

1.2.4. Size Analyses:

Product: Zn. Regrind Cyclone Overflow   Test No: PP-3   S.G.- 4.40

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	1.64	3.3	3.3	96.7
32.3μ	6.12	12.2	15.5	84.5
25.1	8.95	17.9	33.4	66.6
17.5	8.44	16.9	50.3	49.7
12.0	6.63	13.3	63.6	36.4
9.3	2.23	4.5	68.0	32.0
-9.3	15.99	32.0	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Prefloat Tail   Test No: PP-3   S.G.- 4.30

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
32.7μ	0.28	0.7	0.7	99.3
25.3	0.35	0.9	1.7	98.3
17.7	1.33	3.5	5.1	94.9
12.2	3.70	9.7	14.9	85.1
9.4	2.45	6.4	21.3	78.7
-9.4	29.97	78.7	100.0	-
Total	38.08	100.0	-	-

Product: Zn. Cleaner Scav Tail   Test No: PP-3   S.G.- 4.49

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	1.87	3.7	3.7	96.3
3.19μ	5.58	11.2	14.9	85.1
24.7	7.70	15.4	30.3	69.7
17.2	8.29	16.6	46.9	53.1
11.9	6.71	13.4	60.3	39.7
9.2	2.40	4.8	65.1	34.9
-9.2	17.45	34.9	100.0	-
Total	50.00	100.0	-	-

Test PP-3 - Continued

1.2.4. Size Analyses:

Product: Zn Combined Tail   Test No: PP-3   S.G.- 4.07

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
100	1.63	3.3	3.3	96.7
150	1.32	2.6	5.9	94.1
200	3.13	6.3	12.2	87.8
270	4.18	8.4	20.5	79.5
34.0μ	4.50	9.0	29.5	70.5
26.4	4.86	9.7	39.2	60.8
18.4	5.76	11.5	50.8	49.2
12.7	5.38	10.8	61.5	38.5
9.8	2.06	4.1	65.6	34.4
-9.8	17.18	34.4	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:

Circuit operation was stable. The zinc regrind product was coarser than in PP-2 (i.e. 80 % -31 μm instead of 18 μm). This was in part due to decreased feed to the circuit due to zinc losses in the carbon prefloat.
The Pb regrind was extremely fine, finer than 80 % -9 μm.

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	1.5	% moisture	
Primary Rod Mill Feed	529	drykg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	200	kg of 62mm dia. rods	
	200	kg of 37-50mm dia. rods	
Rod Mill Discharge:	2,098 g/L	(68 % Sol at SG 4.25)	
	81.6	% minus 48 mesh	
	46.4	% minus 200 mesh	
Input Power:	20.54	3 disc revolutions	
	4.73 kW	95% drive efficiency)	
Average Power:	4 50 kW	Gross	
	1.771	No Load	
	2.72	Net	
Net Power Usage:	5.2		
K80 Feed:	4355	microns	
K80 Product:	275	microns	
W. Index (metric):	11.4		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	529	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	250	kg of 50mm balls	
	150	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	2,103 g/L	(69 % Sol at SG 4.25)	
	-	% minus 48 mesh	
	-	% minus 200 mesh	
Circulating Load	NA	%	
Input Power:	14.68	sec for 3 disc revolutions	
	6.62 kW	95% drive efficiency)	
Average Power:	6.29 kW	Gross	
	1.60	No Load	
	4.69	Net	
Net Power Usage:	8.9	kWh/t	
K80 Feed:	275	microns	
K80 Product:	62	microns	
W. Index (metric):	13.3		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	14.0 kWh/t
K80 Feed:	4355 microns
K80 Product:	62 microns
Work Index :	12.5 metric
Flot. Feed :	85.3% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Ore Feed Rate:	529	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	550	kg of 25-38 mm balls	
	550	kg total	
Ball Mill Discharge:	1,500 g/L	(43 % Sol at SG	4.63)
Input Power:	8.72	sec for 3 disc revolutions	
	4.46 kW	95% drive efficiency)	
Average Power:	4.24 kW	Gross	
	1.18	No Load	
	3.06	Net	
K80 Feed:	32	microns	
K80 Product:	17	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Ore Feed Rate:	529	kg/h	
H.Conical. Mill Speed:	33.7	rpm	(75.7 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	580	kg of 25-38 mm balls	
	580	kg total	
Ball Mill Discharge:	2,125 g/L	(68 % Sol at SG	4.55)
Input Power:	30.80	sec for 3 disc revolutions	
	3.16 kW	95% drive efficiency)	
Average Power:	3.00 kW	Gross	
	1.20	No Load	
	1.80	Net	
K80 Feed:	11	microns	
K80 Product:	9	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Ore Feed Rate:	529	kg/h	
Denver Mill 2 Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	225	kg of 25 mm balls	
	225	kg total	
Ball Mill Discharge:	2,290 g/L	(73 % Sol at SG	4.39)
Input Power:	26.74	sec for 3 disc revolutions	
	1.45 kW	95% drive efficiency)	
Average Power:	1.38 kW	Gross	
	0.62	No Load	
	0.77	Net	
K80 Feed:	57	microns	
K80 Product:	31	microns	

2. FLOTATION

2.1. Purpose: To determine the effect of carbon preflotation on lead and zinc metallurgy.

2.2. Method: Similar to Test PP-2 but with the following changes:

• Dowfroth 250 frother was added to the cyclone overflow, and carbon was floated. The carbon concentrate was discarded, and MIBC, A317 and CA830/ Thiourea were added to the tails, which were pumped to bulk flotation.
• Later in the run, DF250 was replaced by MIBC in the carbon prefloat.
• The strength of the A317 collector was increased to 5%. The strength of the CA830/Thiourea reagent was increased to 2 %.

2.2.1. Flowsheet Equipment

As in Test PP-2, but with a bank of Denver D8 flotation cells as carbon prefloat cells.

2.2.2. Conditioning Parameters

As in Test PP-2.

2.2.3. Circuit Operation

The circuit was operated for a period of 7.5 hours, and was sampled every 15 minutes during the last 1.0 hour of operation.

TEST PP-3

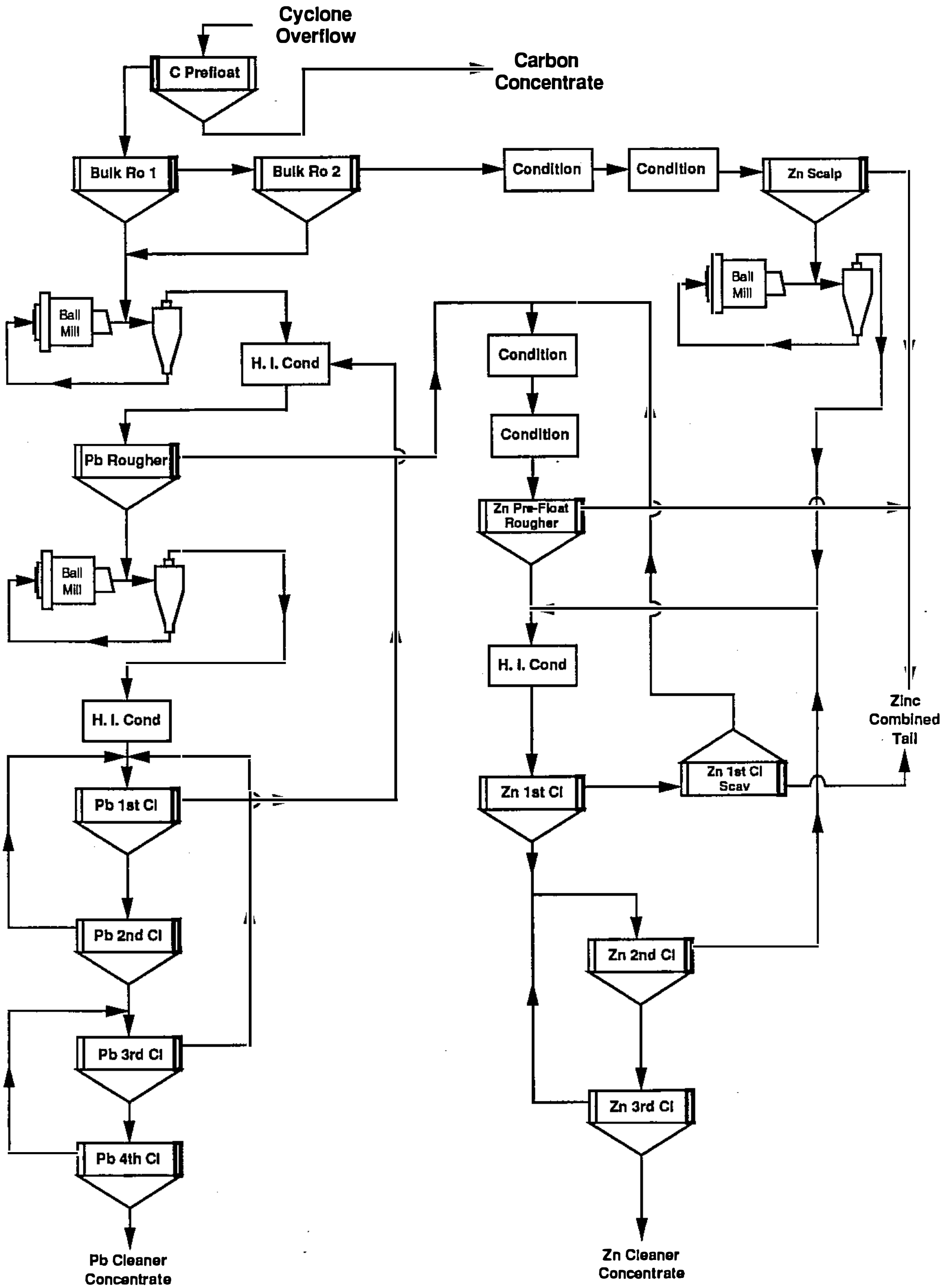
2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	200.0	2268
Carbon Prefloat Feed	*	DF 250	100.0	64.0	36
Bulk Rougher 1 Feed		CA830/TH	2.0	20.0	45
Bulk Rougher 1 Feed		A317	5.0	14.0	79
Bulk Rougher 1 Feed	*	MIBC	100.0	19.8	11
Bulk Rougher 2 Feed		CA830/TH	2.0	10.0	23
Bulk Rougher 2 Feed		A317	5.0	5.0	28
Bulk Rougher 2 Feed	*	MIBC	100.0	18.3	10
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	10.0	113
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	90.0	408
Pb Rougher H.I. Conditioner		CA830/TH	2.0	17.8	40
Pb Rougher H.I. Conditioner		A317	5.0	16.0	91
Pb Rougher H.I. Conditioner	*	MIBC	100.0	10.5	6
Pb Rougher Cell 4		A317	5.0	2.8	16
Pb Rougher Cell 4	*	MIBC	100.0	5.3	3
Pb Cocnentrate Regrind Mill Feed		SD200/NaCN	4.0	80.0	384
Pb 1st Cleaner H.I. Conditioner		CA830/TH	2.0	8.2	19
Pb 1st Cleaner H.I. Conditioner		A317	5.0	4.0	23
Pb 1st Cleaner Cell 3		CA830/TH	2.0	3.0	7
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	20.0	91
Pb 2nd Cleaner Cell 3		CA830/TH	2.0	2.0	5
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	21.0	95
Pb 3rd Cleaner Cell 2		CA830/TH	2.0	0.0	0
Pb 4th Cleaner Feed		SD200/NaCN	4.0	20.0	91
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	45.5	516
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	84.0	953
Zn Scalp Feed	*	M2030	100.0	12.0	7
Zn Scalp Feed		A317	5.0	10.0	57
Zn Scalp Feed	*	DF250	100.0	120.0	68
Zn Scalp Cell 3	*	M2030	100.0	6.0	3
Zn Scalp Cell 3		A317	5.0	2.0	11
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	52.8	599
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	15.8	179
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	128.0	1452
Zn Prefloat Conditioner 2 Feed		CuSO4.5H2O	10.0	65.0	737
Zn Prefloat Feed	*	M2030	100.0	12.0	7
Zn Prefloat Feed		A317	5.0	12.5	71
Zn Prefloat Cell 3	*	M2030	100.0	2.3	1
Zn Prefloat Cell 3		A317	5.0	9.2	52
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	8.0	5
Zn 1st Cleaner H.I. Conditioner		A317	5.0	12.5	71
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	0.0	0
Zn 1st Cleaner Scavenger Feed		A317	5.0	0.0	0
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	85.5	970
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	46.3	525

* Drops per minute

Feed Rate= **529** kg/h

2.3. Flowsheet:



Test PP-3 - Continued

2.4. Results:

2.4.1. Observations

The carbon prefloat resulted in fairly high Pb, and especially high zinc losses, but did lead to a noticeable reduction in carbon in the Pb circuit. Selectivity against zinc in the lead circuit was diminished. Zinc circuit flotation was fairly good.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2098	10.5	-
Ball Mill Discharge	2103	-	-
Cyclone Underflow	2764	-	-
Cyclone Overflow	1349	10.2	15
Semi-bulk Rougher Tail	1315	9.8	-
Semi-bulk Regrind Discharge	1500	-	-
Semi-bulk Regrind Cycl U/Flow	1530	-	-
Semi-bulk Regrind Cycl O/Flow	1140	-	-
Pb Rougher Feed	1055	9.6	23
Pb Rougher Tail	1030	-	-
Pb Regrind Discharge	2125	-	-
Pb Regrind Cyclone U/Flow	2065	-	-
Pb Regrind Cyclone O/Flow	1160	-	-
Pb 1st Cleaner	-	9.6	-
Pb 1st Cleaner Tail	1055	-	-
Pb 2nd Cleaner Feed	-	9.8	-
Pb 3rd Cleaner Feed	-	9.8	-
Pb 4th Cleaner Feed	-	9.7	-
Zn Scalp Feed	-	9.9	18
Zn Scalp Tail	1225	-	-
Zn Regrind Discharge	2290	-	-
Zn Regrind Cyclone U/Flow	2360	-	-
Zn Regrind Cyclone O/Flow	1315	-	-
Zn Prefloat Feed	-	11.7	-
Zn Prefloat Tail	1020	-	-
Zn 1st Cleaner Feed	1075	11.9	-
Zn Cleaner Scavenger Tail	1095	11.9	-
Zn 2nd Cleaner Feed	-	12.2	-
Zn 3rd Cleaner Feed	-	12.2	-
Thickener Underflow	1690	-	-

Test PP- 3 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
9:30	Pb 4th Cleaner Conc	69.6	2.84
	Zn 3rd Cleaner Conc	1.72	51.6
	Zn Cleaner Scav Tail	1.00	0.89
	Zn Prefloat Tail	1.62	2.44
	Zn Scalp Tail	0.53	0.48
10:30	Pb 4th Cleaner Conc	31.0	31.2
	Zn 3rd Cleaner Conc	1.61	41.3
	Zn Cleaner Scav Tail	1.04	0.80
	Zn Prefloat Tail	1.63	1.48
	Zn Scalp Tail	0.50	0.41
11:30	Pb 4th Cleaner Conc	38.8	24.5
	Zn 3rd Cleaner Conc	1.48	51.1
	Zn Cleaner Scav Tail	1.17	1.67
	Zn Prefloat Tail	1.73	2.10
	Zn Scalp Tail	0.63	0.50
12:30	Pb 4th Cleaner Conc	51.9	15.5
	Zn 3rd Cleaner Conc	1.41	51.3
	Zn Cleaner Scav Tail	1.30	1.17
	Zn Prefloat Tail	1.71	5.05
	Zn Scalp Tail	0.51	0.42
13:30	Pb 4th Cleaner Conc	33.4	22.6
	Zn 3rd Cleaner Conc	1.67	46.0
	Zn Cleaner Scav Tail	1.22	1.38
	Zn Prefloat Tail	1.69	3.59
	Zn Scalp Tail	0.51	0.34
14:30	Pb 4th Cleaner Conc	54.7	11.1
	Zn 3rd Cleaner Conc	1.27	55.1
	Zn Cleaner Scav Tail	1.34	2.81
	Zn Prefloat Tail	1.94	6.20
	Zn Scalp Tail	0.60	0.37
15:30	Pb 4th Cleaner Conc	61.7	10.5
	Zn 3rd Cleaner Conc	1.39	53.7
	Zn Cleaner Scav Tail	1.40	4.17
	Zn Prefloat Tail	2.05	4.17
	Zn Scalp Tail	0.56	0.35

Test PP-3 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Cyclone Overflow	3.41	10.1	68.0
Carbon Prefloat Concentrate	5.65	6.14	95.9
Carbon Prefloat Tail	3.22	9.88	64.7
Semi-bulk Concentrate	15.2	18.1	-
Semi-bulk Tail	0.96	8.56	-
Semi-bulk Regrind Cyclone O/Flow	15.7	18.8	-
Pb Rougher Feed	8.86	22.8	-
Pb Rougher Concentrate	11.4	27.2	-
Pb Rougher Tail	2.89	10.6	-
Pb 1st Cleaner Concentrate	23.9	32.1	-
Pb 1st Cleaner Tail	6.90	26.2	-
Pb Regrind Cyclone O/Flow	14.1	26.8	-
Pb 4th Cleaner Concentrate	57.1	13.2	152
Zn Scalp Concentrate	1.34	19.1	-
Zn Scalp Tail	0.54	0.39	-
Zn Regrind Cyclone O/Flow	1.34	17.7	-
Zn Prefloat Feed	2.50	11.8	-
Zn Prefloat Concentrate	2.84	22.6	-
Zn Prefloat Tail	2.21	3.84	-
Zn 1st Cleaner Feed	1.63	16.8	-
Zn Cleaner Scavenger Concentrate	2.22	13.0	-
Zn Cleaner Scavenger Tail	1.49	3.26	-
Zn Combined Tail	0.85	1.16	28.2
Zn 3rd Cleaner Concentrate	1.37	52.5	192

- C Prefloat concentrate and tail = 4.41 and 0.43 % C(g) respectively.

2.4.5. Metallurgical Results

Carbon Prefloat

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
C Prefloat Concentrate *	7.80	5.65	6.14	95.9	12.3	4.7	11.1
C Prefloat Tail	92.20	3.42	10.6	64.8	87.7	95.3	88.9
Cyclone Overflow	100.00	3.59	10.3	67.2	100.0	100.0	100.0
Cyclone Overflow	100.00	3.41	10.1	68.0	-	-	-

Pb-Zn

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	4.07	57.1	13.2	152	73.6	5.5	10.8
Zn 3rd Cleaner Concentrate	16.03	1.37	52.5	192	7.0	86.0	53.7
Zn Combined Tails	72.10	0.85	1.16	28.2	19.4	8.5	35.5
C Prefloat Tail	92.20	3.42	10.61	64.8	100.0	100.0	100.0

Overall

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
C Prefloat Concentrate *	7.80	5.65	6.14	95.9	12.3	4.7	11.5
Pb 4th Cleaner Concentrate	4.07	57.1	13.2	152	64.6	5.2	9.5
Zn 3rd Cleaner Concentrate	16.03	1.37	52.5	192	6.1	82.0	47.5
Zn Combined Tails	72.10	0.85	1.16	28.2	17.1	8.1	31.4
Cyclone Overflow	100.00	3.59	10.3	64.8	100.0	100.0	100.0

* Weight % based on C Prefloat Pb assays

TEST NO. PP-4

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As for Test PP-3.

1.1.2. Method: As for Test PP-3.

1.1.2.1. Flowsheet Equipment

As for Test PP-1.

1.1.2.2. Mill Loads

As for Test PP-1.

1.1.2.3. Classification Equipment

As for Test PP-1.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 7.0 hours and was sampled every 30 minutes during the last 2.0 hours of operation. The average feed rate was 521 kg/h of dry ore.

1.1.3. Flowsheet: As for Test PP-1.

Test PP-4 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-4

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	2.6	0.5	0.5	99.5
6,680	3	55.4	10.1	10.6	89.4
4,699	4	97.2	17.7	28.3	71.7
3,327	6	64.1	11.7	39.9	60.1
2,362	8	46.2	8.4	48.4	51.6
1,651	10	47.1	8.6	56.9	43.1
1,168	14	31.8	5.8	62.7	37.3
833	20	22.0	4.0	66.7	33.3
589	28	18.3	3.3	70.1	29.9
417	35	14.8	2.7	72.8	27.2
295	48	11.6	2.1	74.9	25.1
208	65	10.1	1.8	76.7	23.3
147	100	11.1	2.0	78.7	21.3
104	150	10.8	2.0	80.7	19.3
74	200	11.2	2.0	82.7	17.3
53	270	12.2	2.2	85.0	15.0
38	400	11.2	2.0	87.0	13.0
-38	-400	71.4	13.0	100.0	-
	Total	549.1	100.0	-	-

Product: Rod Mill Discharge Test No: PP-4

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
1,651	10	0.3	0.1	0.1	99.9
1,168	14	1.3	0.4	0.5	99.5
833	20	3.8	1.3	1.8	98.2
589	28	9.6	3.2	5.0	95.0
417	35	18.9	6.2	11.2	88.8
295	48	23.9	7.9	19.1	80.9
208	65	29.8	9.8	28.9	71.1
147	100	29.0	9.6	38.5	61.5
104	150	24.8	8.2	46.7	53.3
74	200	22.2	7.3	54.0	46.0
53	270	21.2	7.0	61.0	39.0
38	400	19.1	6.3	67.3	32.7
-38	-400	99.0	32.7	100.0	-
	Total	302.9	100.0	-	-

Test PP-4 - Continued

1.1.4. **Size Analyses: Continued**

Product: Cyclone Overflow Test No: PP-4

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
417	35	0.4	0.3	0.3	99.7
295	48	0.8	0.5	0.8	99.2
208	65	2.1	1.4	2.1	97.9
147	100	4.5	2.9	5.1	94.9
104	150	7.5	4.9	9.9	90.1
74	200	11.2	7.3	17.2	82.8
53	270	15.6	10.1	27.3	72.7
38	400	15.9	10.3	37.6	62.4
-38	-400	96.3	62.4	100.0	-
	Total	154.3	100.0	-	-

1.1.5. **Observations:** Circuit operation was stable.

1.2. Regrinding Circuits:

1.2.1. Purpose: To increase the coarseness of the semi-bulk and Pb regrind products by reducing ball loads.

1.2.2. Method: The ball loads were reduced as follows:

Semi-bulk Regrind : 350 kg of balls were removed to reduce the load from 550 kg to 200 kg of balls

Pb Regrind : 405 kg of balls were removed to reduce the load from 580 kg to 175 kg of balls.

All of the balls were later returned to the mill.

1.2.2.1. Flowsheet Equipment

As for Test PP-1.

1.2.2.2. Mill Loads

Semi-bulk Regrind : 200 kg
Pb Regrind : 175 kg (initial); 580 kg (final)
Zn Regrind: 225 kg (as in Test PP-1).

1.2.2.3. Classification Equipment

As for Test PP-1.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Bulk-Sala	-	1490	1460	1280	Feed Cycl O/Flow	68.0 92.1	51.4 78.2	28.5 49.9	35 18
Pb-Hardinge	-	2050	2060	1170	Feed Cycl O/Flow	91.9 98.9	81.8 94.6	57.5 58.3	16 13
Zn-Denver	-	2475	2460	1180	Feed Cycl O/Flow	43.2 74.1	34.9 57.9	25.4 39.2	70 28

1.2.3. Flowsheet: As in Test PP-1.

Test PP-4 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-4 S.G.- 4.56

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	4.56	9.1	9.1	90.9
31.8μ	5.51	11.0	20.1	79.9
24.6	5.92	11.8	32.0	68.0
17.2	8.29	16.6	48.6	51.4
11.8	8.35	16.7	65.3	34.7
9.1	3.13	6.3	71.5	28.5
-9.1	14.24	28.5	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-4 S.G.- 4.56

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.27	0.5	0.5	99.5
31.8μ	1.30	2.6	3.1	96.9
24.6	2.40	4.8	7.9	92.1
17.2	6.95	13.9	21.8	78.2
11.8	9.64	19.3	41.1	58.9
9.1	4.49	9.0	50.1	49.9
-9.1	24.95	49.9	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-4 S.G.- 4.71

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.2μ	1.63	3.3	3.3	96.7
24.2	2.42	4.8	8.1	91.9
16.9	5.04	10.1	18.2	81.8
11.6	7.51	15.0	33.2	66.8
8.9	4.65	9.3	42.5	57.5
-8.9	28.75	57.5	100.0	-
Total	50.00	100.0	-	-

Test PP-4 - Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-4 S.G.- 4.70

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.2μ	0.21	0.4	0.4	99.6
24.2	0.36	0.7	1.1	98.9
16.9	2.12	4.2	5.4	94.6
11.6	10.36	20.7	26.1	73.9
8.9	7.80	15.6	41.7	58.3
-8.9	29.15	58.3	100.0	-
Total	50.00	100.0	-	-

Product: PP-4 Pb 4th Cleaner Concentrate S.G.- 5.71

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
27.7μ	0.41	0.8	0.8	99.2
21.4	1.29	2.6	3.4	96.6
14.9	5.96	11.9	15.3	84.7
10.3	11.26	22.5	37.8	62.2
7.9	5.69	11.4	49.2	50.8
-7.9	25.39	50.8	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc Test No: PP-4 S.G.- 4.33

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	3.28	6.6	6.6	93.4
200	5.97	11.9	18.5	81.5
270	9.30	18.6	37.1	62.9
32.8μ	5.33	10.7	47.8	52.2
25.4	4.52	9.0	56.8	43.2
17.7	4.14	8.3	65.1	34.9
12.2	3.47	6.9	72.0	28.0
9.4	1.28	2.6	74.6	25.4
-9.4	12.71	25.4	100.0	-
Total	50.00	100.0	-	-

Test PP-4 - Continued

1.2.4. Size Analyses : Continued

Product: Zn. Regrind Cyclone Overflow Test No: PP-4 S.G.- 4.34

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	1.42	2.8	2.8	97.2
32.8μ.	4.42	8.8	11.7	88.3
25.4	7.11	14.2	25.9	74.1
17.7	8.11	16.2	42.1	57.9
12.2	6.92	13.8	56.0	44.0
9.4	2.42	4.8	60.8	39.2
-9.4	19.60	39.2	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:

Reduction in the bulk regrinding ball load lead to coarsening of the Pb regrind product to 80 % -13 μm (from <9 μm).

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	1.99	% moisture	
Primary Rod Mill Feed	521	kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	200	kg of 62mm dia. rods	
	200	kg of 37-50mm dia. rods	
Rod Mill Discharge:	2,096 g/L	(68 % Sol at SG	4.25)
	80.9	% minus 48 mesh	
	46.0	% minus 200 mesh	
Input Power:	20.5	3 disc revolutions	
	4.74 kW	95% drive efficiency)	
Average Power:	4.50 kW	Gross	
	1.771	No Load	
	2.73	Net	
Net Power Usage:	5.2		
K80 Feed:	5328	microns	
K80 Product:	285	microns	
W. Index (metric):	11.5		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	521	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	250	kg of 50mm balls	
	150	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,924 g/L	(63 % Sol at SG	4.25)
	-	% minus 48 mesh	
	-	% minus 200 mesh	
Circulating Load	NA	%	
Input Power:	14.83	sec for 3 disc revolutions	
	6.55 kW	95% drive efficiency)	
Average Power:	6.23 kW	Gross	
	1.60	No Load	
	4.63	Net	
Net Power Usage:	8.9	kWh/t	
K80 Feed:	285	microns	
K80 Product:	68	microns	
W. Index (metric):	14.3		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	14.1 kWh/t
K80 Feed:	5328 microns
K80 Product:	68 microns
Work Index :	13.1 metric
Flot. Feed :	82.8% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Ore Feed Rate:	521	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25-38 mm balls	
	200	kg total	
Ball Mill Discharge:	1,490 g/L	(42 % Sol at SG	4.56)
Input Power:	9.06	sec for 3 disc revolutions	
	4.29 kW	95% drive efficiency)	
Average Power:	4.08 kW	Gross	
	1.18	No Load	
	2.90	Net	
K80 Feed:	35	microns	
K80 Product:	18	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Ore Feed Rate:	521	kg/h	
H.Conical. Mill Speed:	33.7	rpm	(75.7 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	580	kg of 25-38 mm balls	
	580	kg total	
Ball Mill Discharge:	2,050 g/L	(65 % Sol at SG	4.71)
Input Power:	69.29	sec for 3 disc revolutions	
	1.40 kW	95% drive efficiency)	
Average Power:	1.33 kW	Gross	
	1.20	No Load	
	0.14	Net	
K80 Feed:	16	microns	
K80 Product:	13	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Ore Feed Rate:	521	kg/h	
Denver Mill 2 Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	225	kg of 25 mm balls	
	225	kg total	
Ball Mill Discharge:	2,475 g/L	(77 % Sol at SG	4.34)
Input Power:	26.91	sec for 3 disc revolutions	
	1.44 kW	95% drive efficiency)	
Average Power:	1.37 kW	Gross	
	0.62	No Load	
	0.76	Net	
K80 Feed:	70	microns	
K80 Product:	28	microns	

2. FLOTATION

2.1. Purpose: Similar to Test PP-3, with adjustment of reagents and reagent levels and with reduced ball loads in the semi-bulk and Pb regrind mills (load in the Pb regrind mill was restored to its original level at 12:00).

2.2. Method: Similar to Test PP-3 but with the following changes:

- Reduction in ball loads in the semi-bulk and Pb regrind mills.
- The Pb 3rd cleaner tall was recycled to the Pb 2nd cleaner instead of to the Pb 1st cleaner.

2.2.1. Flowsheet Equipment

As in Test PP-3.

2.2.2. Conditioning Parameters

As in Test PP-3.

2.2.3. Circuit Operation

The circuit was operated for a period of 7.5 hours, and was sampled every 15 minutes during the last 1.0 hour of operation.

TEST PP-4

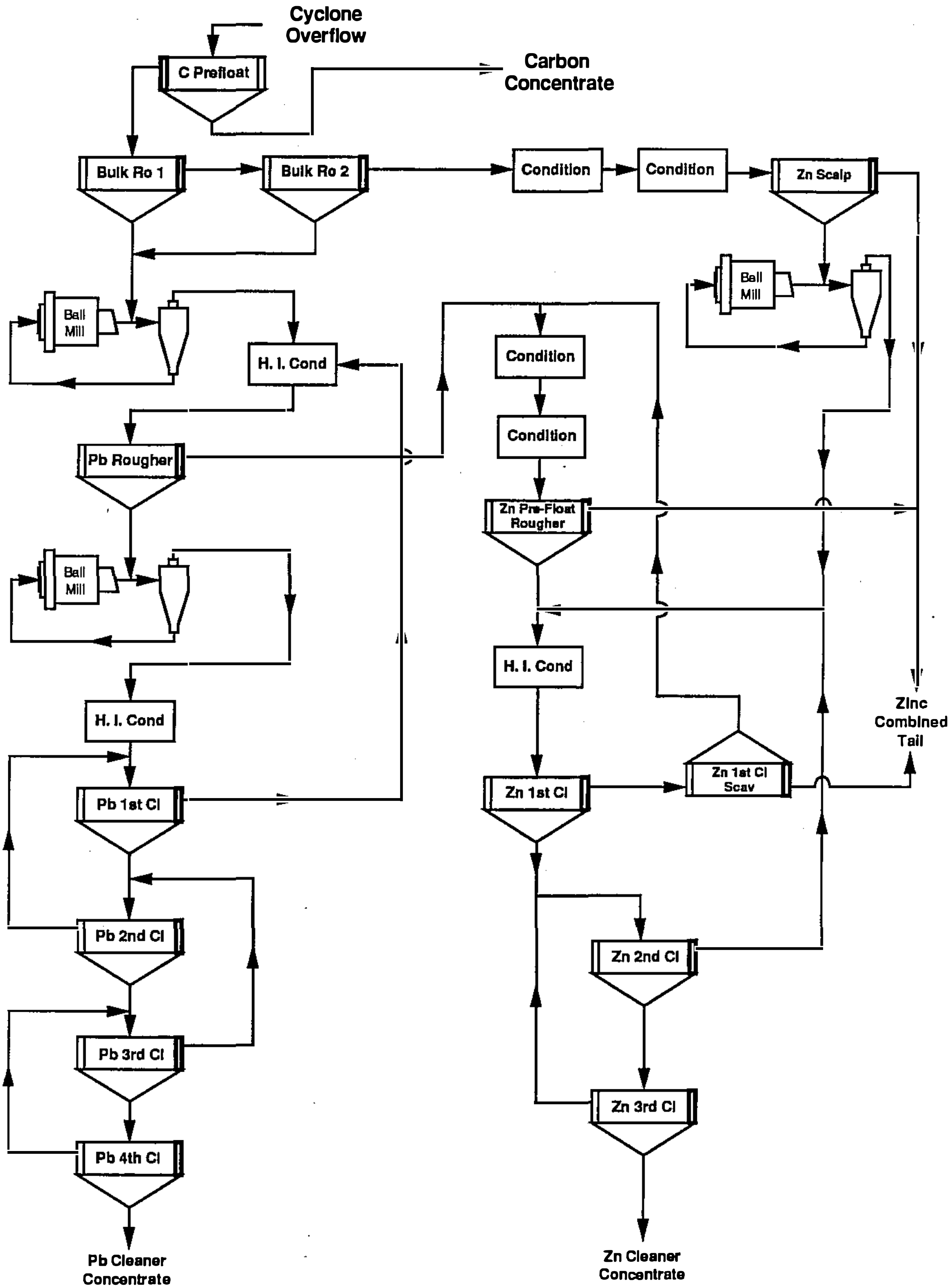
2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	250.0	2879
Carbon Prefloat Feed	*	MIBC	100.0	30.8	18
Bulk Rougher 1 Feed		CA830/TH	2.0	20.0	46
Bulk Rougher 1 Feed		A317	5.0	12.0	69
Bulk Rougher 1 Feed	*	MIBC	100.0	20.5	12
Bulk Rougher 2 Feed		CA830/TH	2.0	9.5	22
Bulk Rougher 2 Feed		A317	5.0	5.3	31
Bulk Rougher 2 Feed	*	MIBC	100.0	21.0	12
Bulk Concentrate Regrind Mill Feed		ZnSO4	10.0	63.0	726
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	0.0	0
Pb Rougher H.I. Conditioner		CA830/TH	2.0	16.8	39
Pb Rougher H.I. Conditioner		A317	5.0	5.3	31
Pb Rougher H.I. Conditioner	*	MIBC	100.0	23.3	13
Pb Rougher Cell 4		A317	5.0	2.0	12
Pb Rougher Cell 4	*	MIBC	100.0	5.0	3
Pb Concentrate Regrind Mill Feed		NaCN	10.0	19.5	225
Pb 1st Cleaner H.I. Conditioner		CA830/TH	2.0	8.7	20
Pb 1st Cleaner H.I. Conditioner		A317	5.0	0.0	0
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	0.0	0
Pb 1st Cleaner Cell 3		CA830/TH	2.0	0.0	0
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	20.0	92
Pb 2nd Cleaner Cell 3		CA830/TH	2.0	2.0	5
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	19.8	91
Pb 3rd Cleaner Cell 2		CA830/TH	2.0	0.0	0
Pb 4th Cleaner Feed		SD200/NaCN	4.0	20.0	92
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	47.3	545
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	83.0	956
Zn Scalp Feed	*	M2030	100.0	12.0	7
Zn Scalp Feed		A317	5.0	10.0	58
Zn Scalp Feed	*	DF250	100.0	120.0	69
Zn Scalp Cell 3	*	M2030	100.0	6.0	3
Zn Scalp Cell 3		A317	5.0	2.0	12
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	54.0	622
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	16.0	184
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	282.0	3248
Zn Prefloat Conditioner 2 Feed		CuSO4.5H2O	10.0	144.3	1662
Zn Prefloat Feed	*	M2030	100.0	12.0	7
Zn Prefloat Feed		A317	5.0	8.0	46
Zn Prefloat Cell 4	*	M2030	100.0	0.0	0
Zn Prefloat Cell 4		A317	5.0	3.9	22
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	10.8	6
Zn 1st Cleaner H.I. Conditioner		A317	5.0	13.0	75
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	0.0	0
Zn 1st Cleaner Scavenger Feed		A317	5.0	0.0	0
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	67.5	777
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	52.9	609

* Drops per minute

Feed Rate= 521 kg/h

2.3. Flowsheet:



Test PP-4 - Continued

2.4. Results:

2.4.1. Observations

Pb and Zn losses were again high in the carbon prefloat product. Selectivity against zinc was not improved with coarser regrinding. Addition of $ZnSO_4$ and cyanide to the Pb regrind in the latter half of the run did not noticeably improve the metallurgical results.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2096	10.5	-
Ball Mill Discharge	1924	-	-
Cyclone Underflow	2756	-	-
Cyclone Overflow	1314	10.0	14
Semi-bulk Rougher Tail	1250	9.7	-
Semi-bulk Regrind Discharge	1490	-	-
Semi-bulk Regrind Cycl U/Flow	1460	-	-
Semi-bulk Regrind Cycl O/Flow	1280	-	-
Pb Rougher Feed	1065	9.4	17
Pb Rougher Tail	1015	-	-
Pb Regrind Discharge	2050	-	-
Pb Regrind Cyclone U/Flow	2060	-	-
Pb Regrind Cyclone O/Flow	1170	-	-
Pb 1st Cleaner	-	9.5	-
Pb 1st Cleaner Tail	1050	-	-
Pb 2nd Cleaner Feed	-	9.6	-
Pb 3rd Cleaner Feed	-	9.4	-
Pb 4th Cleaner Feed	-	9.7	-
Zn Scalp Feed	-	10.0	17
Zn Scalp Tail	1230	-	-
Zn Regrind Discharge	2475	-	-
Zn Regrind Cyclone U/Flow	2460	-	-
Zn Regrind Cyclone O/Flow	1180	-	-
Zn Prefloat Feed	-	11.9	-
Zn Prefloat Tail	1015	-	-
Zn 1st Cleaner Feed	1115	11.7	-
Zn Cleaner Scavenger Tail	1075	11.7	-
Zn 2nd Cleaner Feed	-	12.0	
Zn 3rd Cleaner Feed	-	12.1	-
Thickener Underflow	1460	-	-

Test PP- 4 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
10:00	Pb 4th Cleaner Conc	65.0	6.03
	Zn 3rd Cleaner Conc	1.36	53.9
	Zn Cleaner Scav Tail	1.57	3.96
	Zn Prefloat Tail	2.57	9.08
	Zn Scalp Tail	1.78	4.88
	Zn Combined Tail	-	-
11:00	Pb 4th Cleaner Conc	48.0	23.6
	Zn 3rd Cleaner Conc	1.41	50.3
	Zn Cleaner Scav Tail	1.45	1.92
	Zn Prefloat Tail	3.14	5.50
	Zn Scalp Tail	0.46	0.42
	Zn Combined Tail	1.72	2.43
12:00	Pb 4th Cleaner Conc	30.5	33.6
	Zn 3rd Cleaner Conc	2.24	49.8
	Zn Cleaner Scav Tail	1.07	1.00
	Zn Prefloat Tail	2.83	5.78
	Zn Scalp Tail	0.46	0.39
	Zn Combined Tail	1.79	2.15
1:00	Pb 4th Cleaner Conc	44.6	26.2
	Zn 3rd Cleaner Conc	2.90	51.6
	Zn Cleaner Scav Tail	1.14	1.81
	Zn Prefloat Tail	2.86	9.14
	Zn Scalp Tail	0.50	0.39
	Zn Combined Tail	1.18	1.87
2:00	Pb 4th Cleaner Conc	52.1	19.2
	Zn 3rd Cleaner Conc	2.74	51.5
	Zn Cleaner Scav Tail	1.19	1.34
	Zn Prefloat Tail	2.09	16.1
	Zn Scalp Tail	0.53	0.41
	Zn Combined Tail	1.19	2.07
3:00	Pb 4th Cleaner Conc	59.3	15.6
	Zn 3rd Cleaner Conc	2.14	52.1
	Zn Cleaner Scav Tail	1.66	2.11
	Zn Prefloat Tail	2.42	16.3
	Zn Scalp Tail	0.62	0.47
	Zn Combined Tail	1.09	1.96
4:00	Pb 4th Cleaner Conc	70.0	9.94
	Zn 3rd Cleaner Conc	2.07	51.8
	Zn Cleaner Scav Tail	1.28	2.56
	Zn Prefloat Tail	2.07	5.85
	Zn Scalp Tail	0.55	0.39
	Zn Combined Tail	1.07	1.59

Test PP-4 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Cyclone Overflow	3.19	9.38	67.5
Carbon Prefloat Concentrate	5.64	6.16	126.8
Carbon Prefloat Tail	3.15	9.85	66.9
Semi-bulk Concentrate	12.2	21.5	-
Semi-bulk Tail	0.96	7.12	-
Semi-bulk Regrind Cyclone O/Flow	12.3	21.4	-
Pb Rougher Feed	12.9	25.6	-
Pb Rougher Concentrate	17.9	31.2	-
Pb Rougher Tail	3.17	8.25	-
Pb 1st Cleaner Concentrate	18.7	40.8	-
Pb 1st Cleaner Tail	14.2	32.6	-
Pb Regrind Cyclone Overflow	17.0	32.0	-
Pb 4th Cleaner Concentrate	53.9	19.4	150
Zn Scalp Concentrate	1.52	14.4	-
Zn Scalp Tail	0.50	0.41	-
Zn Regrind Cyclone Overflow	1.46	15.0	-
Zn Prefloat Feed	2.98	9.29	-
Zn Prefloat Concentrate	4.10	13.4	-
Zn Prefloat Tail	2.45	6.76	-
Zn 1st Cleaner Feed	1.93	15.8	-
Zn Cleaner Scavenger Concentrate	2.61	11.8	-
Zn Cleaner Scavenger Tail	1.65	2.60	-
Zn Combined Tail	1.09	1.88	40.5
Zn 3rd Cleaner Concentrate	1.89	50.2	179

Carbon Prefloat concentrate and tail = 1.00 and 0.60 % C(graphite) respectively.

2.4.5. Metallurgical Results

Carbon Prefloat

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
C Prefloat Concentrate *	12.70	5.64	6.16	127	18.9	7.5	21.0
C Prefloat Tail	87.30	3.53	11.0	69.3	81.1	92.5	79.0
Cyclone Overflow (calc)	100.00	3.80	10.4	76.6	100.0	100.0	100.0
Cyclone Overflow (assay)	100.00	3.19	9.38	67.5	-	-	-

Pb-Zn

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	3.80	53.9	19.4	150	66.5	7.7	9.4
Zn 3rd Cleaner Concentrate	15.18	1.89	50.2	179	9.3	79.0	44.9
Zn Combined Tails	68.32	1.09	1.88	40.5	24.2	13.3	45.7
C Prefloat Tail	87.30	3.53	11.00	69.3	100.0	100.0	100.0

Overall

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
C Prefloat Concentrate *	12.70	5.64	6.16	127	18.9	7.5	21.0
Pb 4th Cleaner Concentrate	3.80	53.9	19.4	150	54.0	7.1	7.4
Zn 3rd Cleaner Concentrate	15.18	1.89	50.2	179	7.6	73.1	35.4
Zn Combined Tails	68.32	1.09	1.88	40.5	19.6	12.3	36.1
Cyclone Overflow	100.00	3.80	10.4	76.6	100.0	100.0	100.0

* Weight % based on C Prefloat Zn assays

TEST NO. PP-5

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As for Test PP-1.

1.1.2. Method: As for Test PP-1.

1.1.2.1. Flowsheet Equipment

As for Test PP-1.

1.1.2.2. Mill Loads

As for Test PP-1.

1.1.2.3. Classification Equipment

As for Test PP-1.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 7.5 hours and was sampled every 30 minutes during the last 2.0 hours of operation. The average feed rate was 525 kg/h of dry ore.

1.1.3. Flowsheet: As for Test PP-1.

Test PP-5 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-5

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	36.8	6.9	6.9	93.1
4,699	4	96.6	18.2	25.2	74.8
3,327	6	57.8	10.9	36.1	63.9
2,362	8	47.3	8.9	45.0	55.0
1,651	10	53.2	10.0	55.1	44.9
1,168	14	31.0	5.9	60.9	39.1
833	20	23.1	4.4	65.3	34.7
589	28	19.8	3.7	69.0	31.0
417	35	16.6	3.1	72.2	27.8
295	48	12.3	2.3	74.5	25.5
208	65	11.9	2.2	76.8	23.2
147	100	11.1	2.1	78.8	21.2
104	150	11.1	2.1	80.9	19.1
74	200	11.4	2.2	83.1	16.9
53	270	18.5	3.5	86.6	13.4
38	400	7.8	1.5	88.1	11.9
-38	-400	63.2	11.9	100.0	-
	Total	529.5	100.0	-	-

Product: Rod Mill Discharge Test No: PP-5

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.2	0.1	0.1	99.9
1,168	14	1.1	0.4	0.5	99.5
833	20	3.0	1.2	1.7	98.3
589	28	7.8	3.1	4.8	95.2
417	35	16.0	6.3	11.1	88.9
295	48	21.0	8.3	19.3	80.7
208	65	24.9	9.8	29.1	70.9
147	100	24.3	9.6	38.7	61.3
104	150	21.1	8.3	47.0	53.0
74	200	19.2	7.6	54.5	45.5
53	270	18.2	7.2	61.7	38.3
38	400	16.2	6.4	68.1	31.9
-38	-400	81.2	31.9	100.0	-
	Total	254.2	100.0	-	-

Test PP-5 - Continued

1.1.4. Size Analyses: Continued

Product: Ball Mill Discharge   Test No: PP-5

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	0.0	0.0	0.0	100.0
833	20	0.2	0.1	0.1	99.9
589	28	0.7	0.3	0.4	99.6
417	35	3.0	1.5	1.9	98.1
295	48	7.5	3.7	5.6	94.4
208	65	16.8	8.3	13.9	86.1
147	100	32.2	15.9	29.8	70.2
104	150	40.2	19.8	49.7	50.3
74	200	36.1	17.8	67.5	32.5
53	270	25.7	12.7	80.2	19.8
38	400	13.3	6.6	86.7	13.3
-38	-400	26.9	13.3	100.0	-
	Total	202.6	100.0	-	-

Product: Cyclone Overflow   Test No: PP-5

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	2.1	1.1	1.1	98.9
208	65	2.9	1.5	2.5	97.5
147	100	6.5	3.3	5.8	94.2
104	150	11.7	5.9	11.8	88.2
74	200	18.0	9.1	20.9	79.1
53	270	22.9	11.6	32.6	67.4
38	400	22.3	11.3	43.9	56.1
-38	-400	110.4	56.1	100.0	-
	Total	196.8	100.0	-	-

1.1.5. Observations: Circuit operation was stable. The grind K_{80} value was 75 μm.

Test PP-5 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: As for Test PP-4.

1.2.2. Method: As in Test PP-4.

1.2.2.1. Flowsheet Equipment

As for Test PP-1.

1.2.2.2. Mill Loads

As for Test PP-4.

1.2.2.3. Classification Equipment

As for Test PP-1.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL Mill Disch	Cycl U/Flow	Cycl O/Flow	Size Distributions Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Bulk-Sala	-	1175	1220	1150	Feed Cycl O/Flow	78.5 95.5	67.3 86.2	48.5 63.0	25 14
Pb-Hardinge	-	1690	1610	1040	Feed Cycl O/Flow	95.9 99.6	89.4 98.3	73.0 92.2	12 <9
Zn-Denver	-	2350	2370	1260	Feed Cycl O/Flow	49.7 81.8	38.7 62.6	27.5 39.8	57 25

1.2.3. Flowsheet: As in Test PP-1.

Test PP-5 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-5 S.G.- 4.71

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	2.36	4.7	4.7	95.3
31.2μ	4.54	9.1	13.8	86.2
24.2	3.84	7.7	21.5	78.5
16.9	5.61	11.2	32.7	67.3
11.6	6.86	13.7	46.4	53.6
9.0	2.54	5.1	51.5	48.5
-9.0	24.25	48.5	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-5 S.G.- 4.60

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.7μ	0.80	1.6	1.6	98.4
24.6	1.43	2.9	4.5	95.5
17.1	4.65	9.3	13.8	86.2
11.8	7.69	15.4	29.1	70.9
9.1	3.91	7.8	37.0	63.0
-9.1	31.52	63.0	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-5 S.G.-4.41

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
32.6μ	0.85	1.7	1.7	98.3
25.3	1.21	2.4	4.1	95.9
17.6	3.25	6.5	10.6	89.4
12.1	5.41	10.8	21.4	78.6
9.4	2.79	5.6	27.0	73.0
-9.4	36.49	73.0	100.0	-
Total	50.00	100.0	-	-

Test PP-5 - Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-5 S.G.- 4.21

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
33.6μ	0.00	0.0	0.0	100.0
26.1	0.19	0.4	0.4	99.6
18.2	0.65	1.3	1.7	98.3
12.5	2.01	4.0	5.7	94.3
9.7	1.05	2.1	7.8	92.2
-9.7	46.10	92.2	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc Test No: PP-5 S.G.- 4.33

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	2.38	4.8	4.8	95.2
200	3.71	7.4	12.2	87.8
270	6.08	12.2	24.3	75.7
32.8μ	7.53	15.1	39.4	60.6
25.4	5.44	10.9	50.3	49.7
17.7	5.50	11.0	61.3	38.7
12.2	4.36	8.7	70.0	30.0
9.4	1.23	2.5	72.5	27.5
-9.4	13.77	27.5	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-5 S.G.- 4.34

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.77	1.5	1.5	98.5
33.9μ	2.30	4.6	6.1	93.9
26.3	6.04	12.1	18.2	81.8
18.3	9.58	19.2	37.4	62.6
12.6	8.53	17.1	54.4	45.6
9.7	2.89	5.8	60.2	39.8
-9.7	19.89	39.8	100.0	-
Total	50.00	100.0	-	-

Test PP-5 - Continued

1.2.4. Size Analyses: Continued

Product: B F Cyclone Underflow Test No: PP-5 S.G.- 4.06

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
65m	4.94	2.6	2.6	97.4
100	8.12	4.2	6.8	93.2
150	15.63	8.2	15.0	85.0
200	25.35	13.2	28.2	71.8
270	33.79	17.6	45.8	54.2
400	33.55	17.5	63.4	36.6
34.3μ	15.99	8.3	71.7	28.3
26.6	24.11	12.6	84.3	15.7
18.6	23.14	12.1	96.4	3.6
12.8	5.04	2.6	99.0	1.0
9.9	0.35	0.2	99.2	0.8
-9.9	1.59	0.8	100.0	-
Total	191.60	100.0	-	-

1.2.5. Observations:

The Pb regrind circuit operation was difficult as the high Pb rougher concentrate volume led to frequent overflowing of the regrind cyclone feed pump.

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	1.5	% moisture	
Primary Rod Mill Feed	525	kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	200	kg of 62mm dia. rods	
	200	kg of 37-50mm dia. rods	
Rod Mill Discharge:	2,094 g/L	(68 % Sol at SG	4.25)
	80.7	% minus 48 mesh	
	45.5	% minus 200 mesh	
Input Power:	20.89	3 disc revolutions	
	4.65 kW	95% drive efficiency)	
Average Power:	4.42 kW	Gross	
	1.771	No Load	
	2.65	Net	
Net Power Usage:	5.0		
K80 Feed:	4732	microns	
K80 Product:	286	microns	
W. Index (metric):	11.3		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	525	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	250	kg of 50mm balls	
	150	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,941 g/L	(63 % Sol at SG	4.25)
	-	% minus 48 mesh	
	-	% minus 200 mesh	
Circulating Load	NA	%	
Input Power:	14.78	sec for 3 disc revolutions	
	6.58 kW	95% drive efficiency)	
Average Power:	6.25 kW	Gross	
	1.60	No Load	
	4.65	Net	
Net Power Usage:	8.9	kWh/t	
K80 Feed:	286	microns	
K80 Product:	77	microns	
W. Index (metric):	16.1		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	13.9 kWh/t
K80 Feed:	4732 microns
K80 Product:	77 microns
Work Index :	14.0 metric
Flot. Feed :	79.1% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	525	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25-38 mm balls	
	200	kg total	
Ball Mill Discharge:	1,175 g/L	(19 % Sol at SG	4.66)
Input Power:	9.04	sec for 3 disc revolutions	
	4.30 kW	95% drive efficiency)	
Average Power:	4.09 kW	Gross	
	1.18	No Load	
	2.91	Net	
K80 Feed:	25	microns	
K80 Product:	14	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	525	kg/h	
H.Conical. Mill Speed:	33.7	rpm	(75.7 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	580	kg of 25-38 mm balls	
	580	kg total	
Ball Mill Discharge:	1,690 g/L	(53 % Sol at SG	4.31)
Input Power:	70.90	sec for 3 disc revolutions	
	1.37 kW	95% drive efficiency)	
Average Power:	1.30 kW	Gross	
	1.20	No Load	
	0.11	Net	
K80 Feed:	12	microns	
K80 Product:	9	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	525	kg/h	
Denver Mill 2 Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	225	kg of 25 mm balls	
	225	kg total	
Ball Mill Discharge:	2,350 g/L	(75 % Sol at SG	4.34)
Input Power:	26.50	sec for 3 disc revolutions	
	1.47 kW	95% drive efficiency)	
Average Power:	1.39 kW	Gross	
	0.62	No Load	
	0.78	Net	
K80 Feed:	57	microns	
K80 Product:	25	microns	

2. FLOTATION

2.1. Purpose: Similar to Test PP-2, with adjustment of reagents and Zn Flowsheet

2.2. Method: The Zn cleaner scavenger concentrate was recycled to the Zn 1st cleaner high Intensity conditioner rather than to Zn prefloat conditioner 1.
The Zn scalp tails from the thickener were cycloned and collected for backfill.

2.2.1. Flowsheet Equipment

As in Test PP-2.

2.2.2. Conditioning Parameters

As in Test PP-2.

2.2.3. Circuit Operation

The circuit was operated for a period of 7.5 hours, and was sampled every 30 minutes during the last 1.0 hour of operation.

TEST PP-5

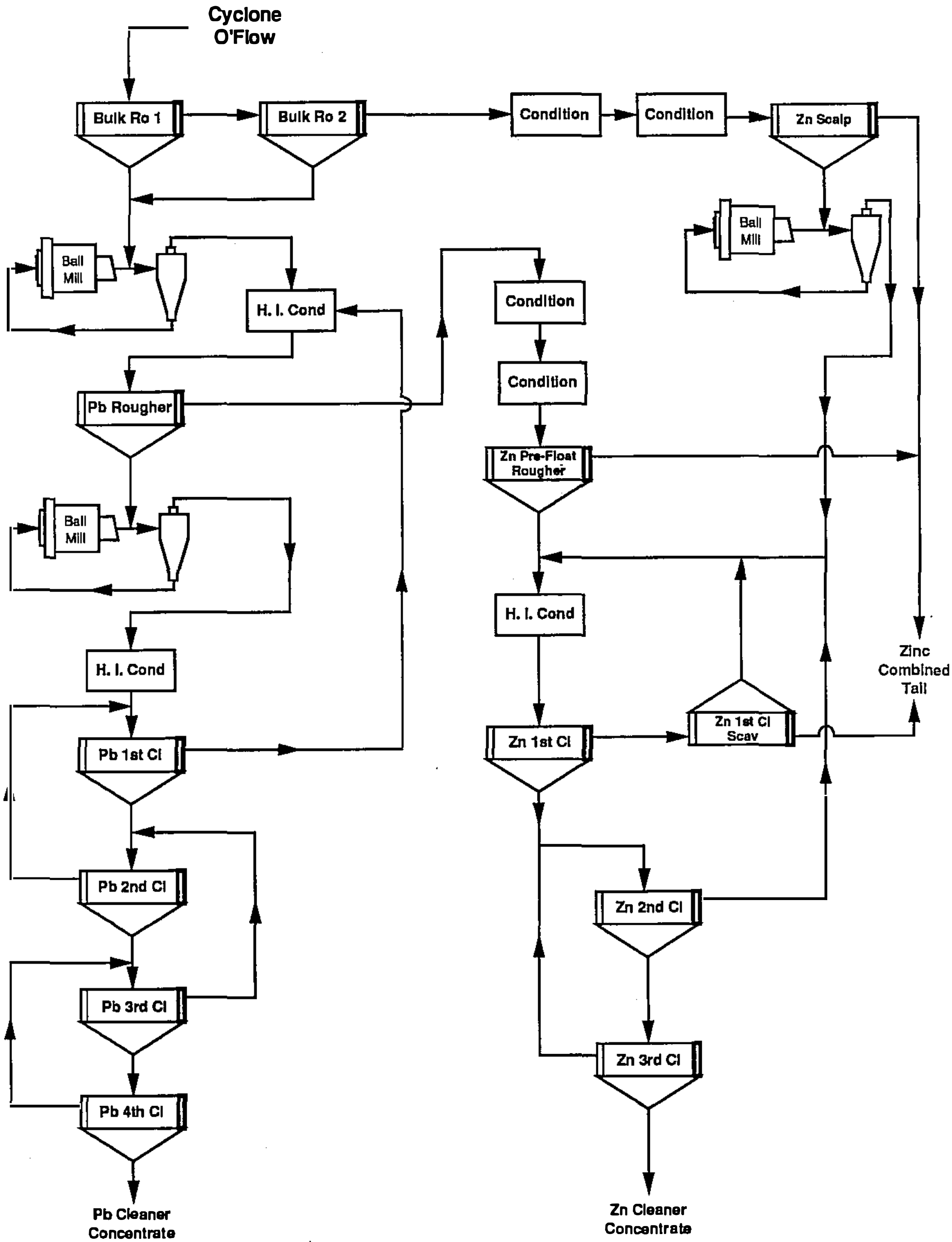
2.2.4. Flotation Reagents:

Point of Addition	Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:				
Rod Mill Feed	Na2CO3	10.0	208.0	2377
Ball Mill Feed	A317	5.0	8.5	49
Bulk Rougher 1 Feed	CA830/TH	2.0	8.8	20
Bulk Rougher 1 Feed *	MIBC	100.0	35.5	20
Bulk Rougher 2 Feed	CA830/TH	2.0	6.0	14
Bulk Rougher 2 Feed	A317	5.0	8.0	46
Bulk Rougher 2 Feed *	MIBC	100.0	16.0	9
Bulk Concentrate Regrind Mill Feed	Na2CO3	10.0	24.5	280
Bulk Concentrate Regrind Mill Feed	SD200/NaCN	4.0	55.6	254
Pb Rougher H.I. Conditioner	CA830/TH	2.0	18.0	41
Pb Rougher H.I. Conditioner	A317	5.0	8.0	46
Pb Rougher H.I. Conditioner *	MIBC	100.0	10.8	6
Pb Rougher Cell 5	A317	5.0	6.8	39
Pb Rougher Cell 5 *	MIBC	100.0	10.5	6
Pb Concentrate Regrind Mill Feed	SD200/NaCN	4.0	62.5	286
Pb Concentrate Regrind Mill Feed	Na2CO3	10.0	10.2	117
Pb 1st Cleaner H.I. Conditioner	CA830/TH	2.0	4.0	9
Pb 1st Cleaner H.I. Conditioner	A317	5.0	2.0	11
Pb 1st Cleaner H.I. Conditioner *	MIBC	100.0	4.0	2
Pb 1st Cleaner Cell 3	CA830/TH	2.0	0.0	0
Pb 2nd Cleaner Feed	SD200/NaCN	4.0	20.0	91
Pb 2nd Cleaner Cell 3	CA830/TH	2.0	0.0	0
Pb 3rd Cleaner Feed	SD200/NaCN	4.0	15.0	69
Pb 3rd Cleaner Cell 2	CA830/TH	2.0	0.0	0
Pb 4th Cleaner Feed	SD200/NaCN	4.0	15.0	69
Zinc Circuit:				
Zn Scalp Conditioner 1 Feed	Ca(OH)2	10.0	60.0	686
Zn Scalp Conditioner 2 Feed	CuSO4.5H2O	10.0	80.0	914
Zn Scalp Feed *	M2030	100.0	12.0	7
Zn Scalp Feed	A317	5.0	12.0	69
Zn Scalp Feed *	DF250	100.0	70.0	40
Zn Scalp Cell 3 *	M2030	100.0	6.0	3
Zn Scalp Cell 3	A317	5.0	2.0	11
Zn Scalp Conc. Regrind Mill Feed	Ca(OH)2	10.0	50.0	571
Zn Scalp Conc. Regrind Mill Feed	CuSO4.5H2O	10.0	15.0	171
Zn Prefloat Conditioner 1 Feed	Ca(OH)2	10.0	40.0	457
Zn Prefloat Conditioner 2 Feed	CuSO4.5H2O	10.0	30.0	343
Zn Prefloat Feed *	M2030	100.0	12.0	7
Zn Prefloat Feed	A317	5.0	6.0	34
Zn Prefloat Cell 4 *	M2030	100.0	0.0	0
Zn Prefloat Cell 4	A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner *	M2030	100.0	10.0	6
Zn 1st Cleaner H.I. Conditioner	A317	5.0	12.7	73
Zn 1st Cleaner Scavenger Feed *	M2030	100.0	0.0	0
Zn 1st Cleaner Scavenger Feed	A317	5.0	2.0	11
Zn 2nd Cleaner Feed	Ca(OH)2	10.0	61.0	697
Zn 3rd Cleaner Feed	Ca(OH)2	10.0	40.0	457

* Drops per minute

Feed Rate= **525** **kg/h**

2.3. Flowsheet:



2.4. Results:

2.4.1. Observations

Selectivity in the Pb rougher was improved with elimination of the Carbon preflotation. However, selectivity against Zn in the cleaners was generally poor and seemed to deteriorate as the run progressed. Unstable operation was experienced due to loss of concentrate in the Pb regrind pump due to heavy pulling of the Pb rougher.
The Pb rougher was pulled quite hard to reduce lead and zinc losses to the Zn prefloat tail.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2094	10.3	-
Ball Mill Discharge	1941	-	-
Cyclone Underflow	2271	-	-
Cyclone Overflow	1305	9.9	14
Semi-bulk Rougher Tail	1260	9.7	-
Semi-bulk Regrind Discharge	1175	-	-
Semi-bulk Regrind Cycl U/Flow	1220	-	-
Semi-bulk Regrind Cycl O/Flow	1150	-	-
Pb Rougher Feed	1035	9.6	20
Pb Rougher Tail	1010	-	-
Pb Regrind Discharge	1690	-	-
Pb Regrind Cyclone U/Flow	1610	-	-
Pb Regrind Cyclone O/Flow	1040	-	-
Pb 1st Cleaner	-	9.6	-
Pb 1st Cleaner Tail	1030	-	-
Pb 2nd Cleaner Feed	-	9.5	-
Pb 3rd Cleaner Feed	-	9.5	-
Pb 4th Cleaner Feed	-	9.4	-
Zn Scalp Feed	-	10.3	16
Zn Scalp Tail	1185	-	-
Zn Regrind Discharge	2350	-	-
Zn Regrind Cyclone U/Flow	2370	-	-
Zn Regrind Cyclone O/Flow	1260	-	-
Zn Prefloat Feed	-	11.2	-
Zn Prefloat Tail	1010	-	-
Zn 1st Cleaner Feed	1075	11.7	-
Zn Cleaner Scavenger Tail	1050	11.6	-
Zn 2nd Cleaner Feed	-	11.9	
Zn 3rd Cleaner Feed	-	11.9	-
Thickener Underflow	1540	-	-

Test PP- 5 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
9:30	Pb 4th Cleaner Conc	75.1	1.92
	Zn 3rd Cleaner Conc	2.92	56.4
	Zn Cleaner Scav Tail	2.67	9.68
	Zn Prefloat Tail	2.83	1.82
	Zn Scalp Tail	0.95	2.04
	Zn Combined Tail	1.47	3.47
10:30	Pb 4th Cleaner Conc	51.3	14.4
	Zn 3rd Cleaner Conc	2.78	52.0
	Zn Cleaner Scav Tail	1.97	2.22
	Zn Prefloat Tail	3.13	1.33
	Zn Scalp Tail	0.80	1.05
	Zn Combined Tail	2.10	1.71
11:30	Pb 4th Cleaner Conc	50.9	16.1
	Zn 3rd Cleaner Conc	1.54	57.3
	Zn Cleaner Scav Tail	2.02	1.91
	Zn Prefloat Tail	3.00	1.04
	Zn Scalp Tail	0.88	1.06
	Zn Combined Tail	1.10	1.13
12:30	Pb 4th Cleaner Conc	48.8	18.1
	Zn 3rd Cleaner Conc	2.24	49.8
	Zn Cleaner Scav Tail	1.49	2.45
	Zn Prefloat Tail	3.39	0.84
	Zn Scalp Tail	0.81	0.97
	Zn Combined Tail	2.54	2.46
13:30	Pb 4th Cleaner Conc	62.2	8.54
	Zn 3rd Cleaner Conc	2.18	51.1
	Zn Cleaner Scav Tail	2.60	1.87
	Zn Prefloat Tail	3.74	1.99
	Zn Scalp Tail	0.76	0.88
	Zn Combined Tail	2.78	1.90
14:30	Pb 4th Cleaner Conc	63.7	9.57
	Zn 3rd Cleaner Conc	2.01	50.7
	Zn Cleaner Scav Tail	3.07	1.68
	Zn Prefloat Tail	4.44	3.52
	Zn Scalp Tail	0.90	1.36
	Zn Combined Tail	1.50	1.56
15:30	Pb 4th Cleaner Conc	52.5	16.9
	Zn 3rd Cleaner Conc	1.48	57.2
	Zn Cleaner Scav Tail	2.25	2.04
	Zn Prefloat Tail	3.04	1.44
	Zn Scalp Tail	0.70	0.83
	Zn Combined Tail	1.39	1.17

Test PP-5 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Cyclone Overflow	3.30	9.94	68.7
Semi-bulk Concentrate	23.2	8.79	-
Semi-bulk Tail	1.22	9.62	-
Semi-bulk Regrind Cyclone O/Flow	20.3	9.83	-
Pb Rougher Feed	13.7	11.0	-
Pb Rougher Concentrate	16.9	13.1	-
Pb Rougher Tail	4.07	2.47	-
Pb 1st Cleaner Concentrate	19.8	26.4	-
Pb 1st Cleaner Tail	7.68	13.4	-
Pb Regrind Cyclone O/Flow	14.9	13.7	-
Pb 4th Cleaner Concentrate	51.5	19.0	164
Zn Scalp Concentrate	1.87	25.6	-
Zn Scalp Tail	0.66	0.92	-
Zn Regrind Cyclone Overflow	1.79	27.9	-
Zn Prefloat Feed	3.96	2.58	-
Zn Prefloat Concentrate	4.29	3.57	-
Zn Prefloat Tail	3.15	1.93	-
Zn 1st Cleaner Feed	2.55	22.1	-
Zn 1st Cleaner Concentrate	-	-	
Zn Cleaner Scavenger Conc	3.92	16.7	-
Zn Cleaner Scavenger Tail	3.09	4.47	-
Zn Combined Tail	1.35	1.74	35.5
Zn 3rd Cleaner Concentrate	1.31	54.2	166

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	3.90	51.5	19	164	60.9	7.5	10.8
Zn 3rd Cleaner Concentrate	14.35	1.31	54.2	166	5.7	78.2	40.2
Zn Combined Tails	81.75	1.35	1.74	35.5	33.4	14.3	49.0
Head(calc)	100.00	3.30	9.94	68.7	100.0	100.0	100.0

Test PP-5 - Continued

3. Backfill Testwork

TEST BF-1

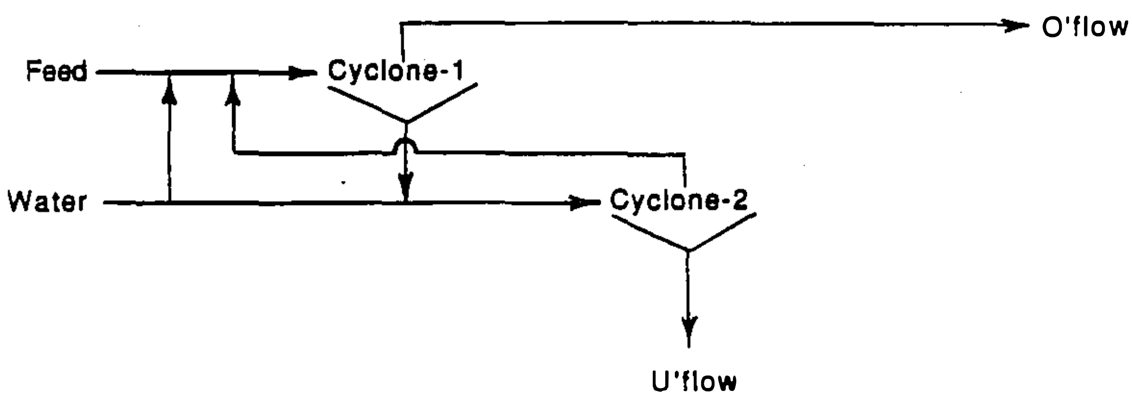
Feed Material: Zn Scalp Thickener Underflow (PP5)

Cyclone 1: Dorrclone P50; 50 mm diameter
18 mm vortex
6 mm apex

Cyclone 2: Krebs Model 1-1181 25 mm diameter
6 mm vortex
4.5 mm apex

Time min.	Percolation Rate		Pulp Densities, g/L		
	Ind. mL	Cm/h	Feed	U/Flow	O/Flow
0	-	-	1380	2340	1020
15	15	7.5	-	-	-
30	13	6.6	-	-	-
60	28	7.0	-	-	-
120	45	5.6	-	-	-

Flowsheet:



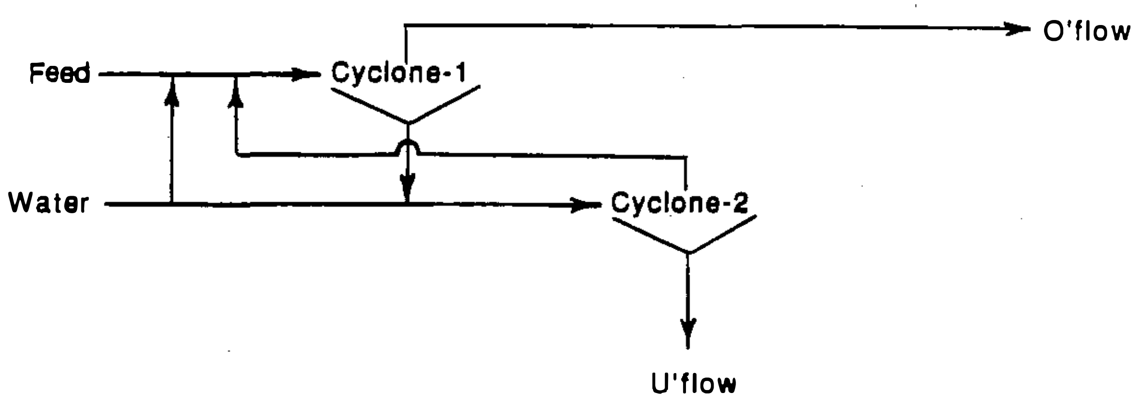
Test PP-5 - Continued

TEST BF-2

Feed Material:	Zn Scalp Tail Thickener Underflow (PP5)	
Cyclone 1:	Dorrclone P50;	50 mm diameter 18 mm vortex 6 mm apex
Cyclone 2:	Krebs Model 1-1181	25 mm diameter 6 mm vortex 3 mm apex

Time min.	Percolation Rate		Pulp Densities, g/L			Remarks
	Ind. mL	Cm/h	Feed	U/Flow	O/Flow	
0	-	-	1350	2230	1030	1 1/2 drums sands
15	35	17.5	-	-	-	collected in drums
30	20	10.0	-	-	-	labelled: Backfill Sands
60	31	7.7	-	-	-	PP-5
120	89	11.2	-	-	-	PP-5/6

Flowsheet:



Product: B.F. Cyclone Underflow Test No: PP -5

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.5	0.3	0.3	99.7
208	65	3.5	1.9	2.2	97.8
147	100	7.7	4.3	6.5	93.5
104	150	14.5	8.1	14.6	85.4
74	200	23.2	12.9	27.5	72.5
53	270	31.1	17.3	44.7	55.3
38	400	30.8	17.1	61.9	38.1
-38	-400	68.6	38.1	100.0	-
	Total	179.9	100.0	-	-

Product: B.F. Feed Test No: PP-5

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	1.3	1.0	1.0	99.0
147	100	3.5	2.7	3.7	96.3
104	150	6.5	5.0	8.7	91.3
74	200	10.4	8.0	16.7	83.3
53	270	13.8	10.6	27.3	72.7
38	400	13.5	10.4	37.6	62.4
-38	-400	81.2	62.4	100.0	-
	Total	130.2	100.0	-	-

Product: B F Cyclone Overflow Test No: PP-5 S.G.-4.15

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
33.7µ	0.00	0.0	0.0	100.0
26.2	0.41	0.8	0.8	99.2
18.2	1.72	3.4	4.3	95.7
12.5	7.56	15.1	19.4	80.6
9.7	3.70	7.4	26.8	73.2
-9.7	36.61	73.2	100.0	-
Total	50.00	100.0	-	-

TEST NO. PP-6

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As for Test PP-1.

1.1.2. Method: As for Test PP-1.

1.1.2.1. Flowsheet Equipment

As for Test PP-1.

1.1.2.2. Mill Loads

As for Test PP-1.

1.1.2.3. Classification Equipment

As for Test PP-1.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 7.0 hours and was sampled every 30 minutes during the last 2.0 hours of operation. The average feed rate was 524 kg/h of dry ore.

1.1.3. Flowsheet: As for Test PP-1.

Test PP-6 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-6

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	47.6	7.9	7.9	92.1
4,699	4	78.1	13.0	20.9	79.1
3,327	6	67.9	11.3	32.1	67.9
2,362	8	48.1	8.0	40.1	59.9
1,651	10	56.2	9.3	49.4	50.6
1,168	14	39.4	6.5	56.0	44.0
833	20	29.8	4.9	60.9	39.1
589	28	27.5	4.6	65.5	34.5
417	35	22.8	3.8	69.2	30.8
295	48	17.1	2.8	72.1	27.9
208	65	16.4	2.7	74.8	25.2
147	100	14.2	2.4	77.2	22.8
104	150	13.2	2.2	79.3	20.7
74	200	13.9	2.3	81.7	18.3
53	270	15.8	2.6	84.3	15.7
38	400	14.1	2.3	86.6	13.4
-38	-400	80.7	13.4	100.0	-
	Total	602.8	100.0	-	-

Product: Rod Mill Discharge Test No: PP-6

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	1.0	0.3	0.3	99.7
833	20	2.9	1.0	1.3	98.7
589	28	7.8	2.6	3.9	96.1
417	35	17.3	5.7	9.6	90.4
295	48	22.6	7.5	17.1	82.9
208	65	29.4	9.7	26.8	73.2
147	100	30.1	9.9	36.7	63.3
104	150	26.1	8.6	45.3	54.7
74	200	23.8	7.9	53.2	46.8
53	270	23.1	7.6	60.8	39.2
38	400	19.6	6.5	67.3	32.7
-38	-400	98.9	32.7	100.0	-
	Total	302.6	100.0	-	-

Test PP-6 - Continued

1.1.4. Size Analyses: Continued

Product: Ball Mill Discharge   Test No: PP-6

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	0.0	0.0	0.0	100.0
833	20	0.0	0.0	0.0	100.0
589	28	1.0	0.4	0.4	99.6
417	35	3.8	1.4	1.8	98.2
295	48	9.4	3.5	5.3	94.7
208	65	20.7	7.7	13.1	86.9
147	100	42.3	15.8	28.9	71.1
104	150	55.4	20.7	49.6	50.4
74	200	48.5	18.1	67.7	32.3
53	270	33.7	12.6	80.3	19.7
38	400	15.9	5.9	86.3	13.7
-38	-400	36.7	13.7	100.0	-
	Total	267.4	100.0	-	-

Product: Cyclone U/F   Test No: PP-6

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
833	20	1.2	0.4	0.4	99.6
589	28	2.4	0.9	1.3	98.7
417	35	6.7	2.4	3.8	96.2
295	48	13.1	4.8	8.5	91.5
208	65	23.1	8.4	16.9	83.1
147	100	47.8	17.4	34.4	65.6
104	150	59.2	21.6	55.9	44.1
74	200	48.4	17.6	73.6	26.4
53	270	33.2	12.1	85.7	14.3
38	400	15.9	5.8	91.5	8.5
-38	-400	23.4	8.5	100.0	-
	Total	274.4	100.0	-	-

Test PP-6 - Continued

1.1.4. Size Analyses: Continued

Product: Cyclone Overflow   Test No: PP-6

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	1.5	0.8	0.8	99.2
147	100	2.5	1.4	2.3	97.7
104	150	5.4	3.1	5.3	94.7
74	200	10.0	5.7	11.0	89.0
53	270	17.4	9.9	20.8	79.2
38	400	17.5	9.9	30.8	69.2
-38	-400	122.2	69.2	100.0	-
	Total	176.5	100.0	-	-

1.1.5. Observations:

Grind:
Circuit operation was fairly stable but some variation in feed rate (500-550 kg/h) was experienced from 14:30 to 15:30 due to temperature fluctuations around the feeder electronics.

Test PP-6 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: As for Test PP-4.

1.2.2. Method: As in Test PP-4, but a single 50 mm cyclone was used in the Pb regrind circuit instead of 2 x 25 mm cyclones.

1.2.2.1. Flowsheet Equipment

As for Test PP-1.

1.2.2.2. Mill Loads

As for Test PP-4.

1.2.2.3. Classification Equipment

As for Test PP-1, but a Dorr P50 50 mm cyclone was used in the Pb regrind circuit, with a 6 mm apex and a 19.1 mm vortex.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Bulk-Sala	-	2140	2200	1135	Feed Cycl O/Flow	72.4 98.8	59.2 94.4	38.6 67.8	31 12
Pb-Hardinge	-	1920	1935	1160	Feed Cycl O/Flow	98.2 99.4	92.0 97.1	62.9 75.8	17 10
Zn-Denver	-	1450	1580	1260	Feed Cycl O/Flow	50.7 67.5	42.0 55.6	31.1 38.5	68 36

1.2.3. Flowsheet: As in Test PP-1.

Test PP-6 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-6 S.G.- 4.61

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	3.82	7.6	7.6	92.4
31.7μ	5.14	10.3	17.9	82.1
24.6	4.82	9.6	27.6	72.4
17.1	6.62	13.2	40.8	59.2
11.8	7.27	14.5	55.3	44.7
9.1	3.05	6.1	61.4	38.6
-9.1	19.28	38.6	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-6 S.G.- 4.55

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.8μ	0.00	0.0	0.0	100.0
24.6	0.60	1.2	1.2	98.8
17.2	2.22	4.4	5.6	94.4
11.8	7.65	15.3	20.9	79.1
9.1	5.64	11.3	32.2	67.8
-9.1	33.89	67.8	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-6 S.G.-4.53

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.8μ	0.29	0.6	0.6	99.4
24.6	0.59	1.2	1.8	98.2
17.2	3.10	6.2	8.0	92.0
11.8	9.15	18.3	26.3	73.7
9.1	5.40	10.8	37.1	62.9
-9.1	31.47	62.9	100.0	-
Total	50.00	100.0	-	-

Product: Pb Regrind Cyclone Overflow Test No: PP-6 S.G.- 4.55

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.8μ	0.00	0.0	0.0	100.0
24.6	0.30	0.6	0.6	99.4
17.2	1.13	2.3	2.9	97.1
11.8	5.68	11.4	14.2	85.8
9.1	4.98	10.0	24.2	75.8
-9.1	37.91	75.8	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Rougher Conc Test No: PP-6 S.G.- 4.32

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
150	3.72	7.4	7.4	92.6
200	4.92	9.8	17.3	82.7
270	5.73	11.5	28.7	71.3
32.8μ	5.68	11.4	40.1	59.9
25.4	4.60	9.2	49.3	50.7
17.7	4.35	8.7	58.0	42.0
12.2	4.02	8.0	66.0	34.0
9.4	1.43	2.9	68.9	31.1
-9.4	15.55	31.1	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-6 S.G.- 4.39

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	4.63	9.3	9.3	90.7
32.6μ	6.11	12.2	21.5	78.5
25.3	5.51	11.0	32.5	67.5
17.6	5.96	11.9	44.4	55.6
12.1	6.04	12.1	56.5	43.5
9.4	2.48	5.0	61.5	38.5
-9.4	19.27	38.5	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:

Substitution of a single 50 mm cyclone in the Pb regrind circuit resulted in improved operation of the circuit.

Grind fineness was very slightly coarser (80 % -10 μm instead of finer than 80 % -9 μm).

The change in the zinc circuit yielded a higher feed to the zinc regrind, resulting in a coarser grind (80% -36 μm).

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	1.9	% moisture	
Primary Rod Mill Feed	524	kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	200	kg of 62mm dia. rods	
	200	kg of 37-50mm dia. rods	
Rod Mill Discharge:	2,098 g/L	(68 % Sol at SG	4.25)
	82.9	% minus 48 mesh	
	46.8	% minus 200 mesh	
Input Power:	21.01	3 disc revolutions	
	4.63 kW	95% drive efficiency)	
Average Power:	4.40 kW	Gross	
	1.771	No Load	
	2.62	Net	
Net Power Usage:	5.0		
K80 Feed:	4795	microns	
K80 Product:	264	microns	
W. Index (metric):	10.6		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	524	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	250	kg of 50mm balls	
	150	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,936 g/L	(63 % Sol at SG	4.25)
	94.7	% minus 48 mesh	
	32.3	% minus 200 mesh	
Circulating Load	692	%	
Input Power:	14.49	sec for 3 disc revolutions	
	6.71 kW	95% drive efficiency)	
Average Power:	6.37 kW	Gross	
	1.60	No Load	
	4.77	Net	
Net Power Usage:	9.1	kWh/t	
K80 Feed:	264	microns	
K80 Product:	53	microns	
W. Index (metric):	12.0		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	14.1 kWh/t
K80 Feed:	4795 microns
K80 Product:	53 microns
Work Index :	11.5 metric
Flot. Feed :	89.0% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	524	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25-38 mm balls	
	200	kg total	
Ball Mill Discharge:	2,140 g/L	(68 % Sol at SG 4.58)	
Input Power:	8.93	sec for 3 disc revolutions	
	4.35 kW	95% drive efficiency)	
Average Power:	4.14 kW	Gross	
	1.18	No Load	
	2.96	Net	
K80 Feed:	31	microns	
K80 Product:	12	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	524	kg/h	
H.Conical. Mill Speed:	33.7	rpm	(75.7 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	580	kg of 25-38 mm balls	
	580	kg total	
Ball Mill Discharge:	1,920 g/L	(61 % Sol at SG 4.54)	
Input Power:	70.73	sec for 3 disc revolutions	
	1.37 kW	95% drive efficiency)	
Average Power:	1.31 kW	Gross	
	1.20	No Load	
	0.11	Net	
K80 Feed:	17	microns	
K80 Product:	10	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	524	kg/h	
Denver Mill 2 Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	225	kg of 25 mm balls	
	225	kg total	
Ball Mill Discharge:	1,450 g/L	(40 % Sol at SG 4.36)	
Input Power:	25.42	sec for 3 disc revolutions	
	1.53 kW	95% drive efficiency)	
Average Power:	1.45 kW	Gross	
	0.62	No Load	
	0.84	Net	
K80 Feed:	68	microns	
K80 Product:	36	microns	

2. FLOTATION

2.1. Purpose: To test the effect of lead and zinc Flowsheet configurations on lead and zinc metallurgy.

2.2. Method:

i) Separate zinc scalp and prefloat stages were eliminated, with zinc rougher flotation substituted. Cells were changed as follows:

- 6 Agitair 15 cells (formerly Zn prefloat) were Zn rougher 1 cells
- 4 Denver D8 cells (formerly Zn scalp) were Zn rougher 2 cells

The combined Pb rougher tail and semi-bulk tail were the feed to the Zn rougher. The Zn rougher concentrate was fed to the Zn regrind circuit.

ii) The SD200/cyanide depressant additions were made in the semi-bulk and Pb regrind mill discharges from the mill feeds.

iii) Use of the CA830/Thiourea was discontinued; $ZnSO_4$ and NaCN were not used.

iv) Backfill testwork continued, with cycloning of the scavenger tail from the thickener.

2.2.1. Flowsheet Equipment

As in Test PP-2, but the Agitair 15 cells were used as Zn rougher 1 cells, and the Denver D8 cells were used as the Zn rougher 2 cells.

2.2.2. Conditioning Parameters

As in Test PP-2, but the Zn scalp conditioners were used as the Zn rougher conditioner. The Zn prefloat conditioners were not operated.

2.2.3. Circuit Operation

The circuit was operated for a period of 7.0 hours, and was sampled every 30 minutes during the last 1.0 hour of operation.

TEST PP-6

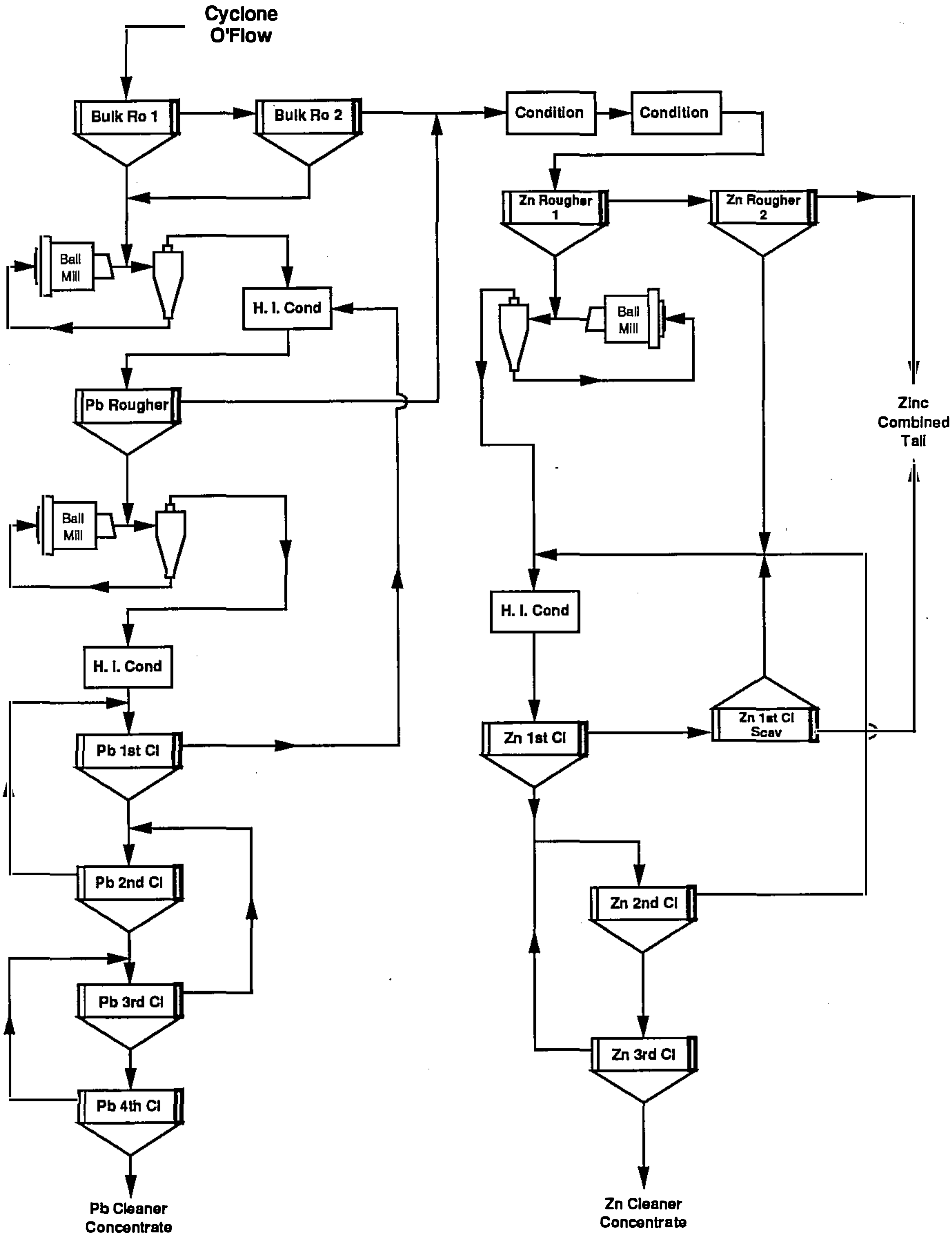
2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	208.0	2377
Ball Mill Feed		A317	5.0	16.3	93
Bulk Rougher 1 Feed		CA830/TH	2.0	0.0	0
Bulk Rougher 1 Feed		A317	5.0	0.0	0
Bulk Rougher 1 Feed	*	MIBC	100.0	50.5	29
Bulk Rougher 2 Feed		CA830/TH	2.0	0.0	0
Bulk Rougher 2 Feed		A317	5.0	10.0	57
Bulk Rougher 2 Feed	*	MIBC	100.0	14.5	8
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	10.0	114
Bulk Concentrate Regrind Mill Disch.		SD200/NaCN	4.0	75.0	343
Bulk Concentrate Regrind Mill Feed	*	R242	100.0	5.0	7
Pb Rougher H.I. Conditioner		CA830/TH	2.0	0.0	0
Pb Rougher H.I. Conditioner		A317	5.0	8.0	46
Pb Rougher H.I. Conditioner	*	MIBC	100.0	14.3	8
Pb Rougher Cell 5		A317	5.0	6.0	34
Pb Rougher Cell 5	*	MIBC	100.0	11.3	6
Pb Concentrate Regrind Mill Disch.		SD200/NaCN	4.0	71.3	326
Pb Concentrate Regrind Mill Feed		Na2CO3	10.0	9.7	111
Pb Concentrate Regrind Mill Feed	*	R242	100.0	0.0	0
Pb 1st Cleaner H.I. Conditioner		A317	5.0	0.0	0
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	4.0	2
Pb 1st Cleaner Cell 3		A317	5.0	0.0	0
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	30.0	137
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	25.0	114
Pb 4th Cleaner Feed		SD200/NaCN	4.0	20.0	91
Zinc Circuit:					
Zn Rougher 1 Conditioner 1 Feed		Ca(OH)2	10.0	100.0	1143
Zn Rougher 1 Conditioner 2 Feed		CuSO4.5H2O	10.0	92.0	1051
Zn Rougher 1 Feed	*	M2030	100.0	10.0	6
Zn Rougher 1 Feed		A317	5.0	15.0	86
Zn Rougher 1 Feed	*	DF250	100.0	0.0	0
Zn Rougher 2 Feed	*	M2030	100.0	0.0	0
Zn Rougher 2 Feed		A317	5.0	12.0	69
Zn Rougher 2 Cell 4	*	M2030	100.0	6.0	3
Zn Rougher 2 Cell 4	*	A317	5.0	2.0	0.1
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	80.0	914
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	15.0	171
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	10.3	6
Zn 1st Cleaner H.I. Conditioner		A317	5.0	13.0	74
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	0.0	0
Zn 1st Cleaner Scavenger Feed		A317	5.0	2.0	11
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	72.0	823
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	37.0	423

* Drops per minute

Feed Rate= 525 kg/h

2.3. Flowsheet:



Test PP-6 - Continued

2.4. Results:

2.4.1. Observations

Selectivity in the Pb rougher was improved somewhat by 13:30 and Pb concentrates of >65% Pb (by X-Met) were achieved.
Zn losses were relatively high late in the run, as the Zn Cl Scavenger Tail was >5% Zn, and the combined tail was 2.5-4.0 % Zn.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2099	10.2	-
Ball Mill Discharge	1938	-	-
Cyclone Underflow	2758	-	-
Cyclone Overflow	1305	9.6	13
Semi-bulk Rougher Tail	1260	9.4	-
Semi-bulk Regrind Discharge	2140	-	-
Semi-bulk Regrind Cyc U/Flow	2200	-	-
Semi-bulk Regrind Cyc O/Flow	1135	-	-
Pb Rougher Feed	1075	9.6	19
Pb Rougher Tail	1030	-	-
Pb Regrind Discharge	1920	-	-
Pb Regrind Cyclone U/Flow	1935	-	-
Pb Regrind Cyclone O/Flow	1160	-	-
Pb 1st Cleaner	-	9.7	-
Pb 1st Cleaner Tail	1060	-	-
Pb 2nd Cleaner Feed	-	9.9	-
Pb 3rd Cleaner Feed	-	9.7	-
Pb 4th Cleaner Feed	-	9.6	-
Zn Rougher 1 Feed	1155	10.6	13
Zn Rougher 1 Tail	-	-	-
Zn Rougher 2 Feed	-	10.6	-
Zn Rougher 2 Tail	1060	-	-
Zn Regrind Discharge	1450	-	-
Zn Regrind Cyclone U/Flow	1580	-	-
Zn Regrind Cyclone O/Flow	1260	-	-
Zn 1st Cleaner Feed	1145	11.7	-
Zn Cleaner Scavenger Tail	1145	11.6	-
Zn 2nd Cleaner Feed	-	11.9	-
Zn 3rd Cleaner Feed	-	11.9	-
Thickener Underflow	1260	-	-

Test PP- 6 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
9:30	Pb 4th Cleaner Conc	36.5	15.4
	Zn 3rd Cleaner Conc	1.85	58.3
	Zn Scavenger Tail	0.78	0.80
	Zn Cl Scavenger Tail	2.07	3.56
	Zn Combined Tail	1.77	1.63
10:30	Pb 4th Cleaner Conc	20.7	27.5
	Zn 3rd Cleaner Conc	2.25	54.6
	Zn Scavenger Tail	0.44	0.72
	Zn Cl Scavenger Tail	2.02	3.08
	Zn Combined Tail	1.68	1.78
11:30	Pb 4th Cleaner Conc	41.4	18.5
	Zn 3rd Cleaner Conc	2.17	57.1
	Zn Scavenger Tail	0.61	0.55
	Zn Cl Scavenger Tail	1.64	1.35
	Zn Combined Tail	1.12	0.99
12:30	Pb 4th Cleaner Conc	45.4	15.8
	Zn 3rd Cleaner Conc	2.67	50.3
	Zn Scavenger Tail	0.99	1.49
	Zn Cl Scavenger Tail	1.40	1.72
	Zn Combined Tail	0.79	1.38
13:30	Pb 4th Cleaner Conc	55.8	13.2
	Zn 3rd Cleaner Conc	2.31	49.5
	Zn Scavenger Tail	1.00	1.26
	Zn Cl Scavenger Tail	1.71	1.98
	Zn Combined Tail	1.69	1.60
14:30	Pb 4th Cleaner Conc	74.8	4.11
	Zn 3rd Cleaner Conc	2.04	55.3
	Zn Scavenger Tail	0.98	1.63
	Zn Cl Scavenger Tail	2.50	5.98
	Zn Combined Tail	1.12	2.58
15:30	Pb 4th Cleaner Conc	65.7	7.17
	Zn 3rd Cleaner Conc	2.12	53.6
	Zn Scavenger Tail	0.91	1.16
	Zn Cl Scavenger Tail	2.56	10.6
	Zn Combined Tail	1.48	4.00

Test PP-6 - Continued

2.4.4. Shift Sample Assays

Product	Assays, %, g/t					
	Pb	Zn	Ag	Fe	Ba	C
Cyclone Overflow	3.4	9.95	66.8	13.7	22.1	0.71
Bulk Rougher Concentrate	13.9	12.1	-	25	2.24	1.04
Bulk Rougher Tall	0.87	9.76	-	11.7	24.7	0.57
Bulk Regrind Cyclone Overflow	14.9	18.8	-	20.2	1.06	1.86
Pb Rougher Feed	11.3	17.6	-	21.8	1.28	2.02
Pb Rougher Concentrate	14.7	21.8	-	18.6	0.6	2.2
Pb Rougher Tall	2.85	5.16	-	30.3	3.78	1.4
Pb Regrind Cyclone Overflow	13.5	19.7	-	20.6	0.63	1.95
Pb 1st Cleaner Concentrate	18.2	23.4	-	15.6	0.39	2.28
Pb 1st Cleaner Tall	3.79	11	-	28.7	1.43	1.84
Pb 4th Cleaner Concentrate	57.7	10.3	171	7.06	0.2	0.85
Zn Rougher Feed	1.16	9.12	-	14.4	23.1	0.73
Zn Rougher 1 Concentrate	1.77	34.7	-	15	2.96	0.56
Zn Rougher 1 Tall	0.95	1.32	-	13.5	28.5	0.84
Zn Rougher 2 Concentrate	1.94	6.81	-	32.8	3.8	0.71
Zn Rougher 2 Tall	0.84	0.82	-	11.7	30.1	0.81
Zn Combined Tall	1.04	2.9	40	15	25.6	0.68
Zn Regrind Cyclone Overflow	1.82	28.1	-	18.8	3.26	0.58
Zn 1st Cleaner Feed	1.85	27.5	-	19.7	3.09	0.6
Zn Cleaner Scavenger Concentrate	2.51	14.6	-	23.6	2.64	1.38
Zn Cleaner Scavenger Tall	1.89	12	-	29.8	4.58	0.43
Zn 3rd Cleaner Concentrate	1.52	52.3	179	4.67	0.89	0.87

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	4.05	57.7	10.3	171	68.7	4.2	10.8
Zn 3rd Cleaner Concentrate	13.66	1.52	52.3	179	6.1	71.8	38.0
Zn Combined Tails	82.29	1.04	2.9	40	25.2	24.0	51.2
Head(calc)	100.00	3.40	9.95	66.8	100.0	100.0	100.0

Test PP-6 - Continued

3. Backfill Testwork

TEST BF-3

Feed Material: Zn Scavenger Tail Thickener Underflow (PP6)

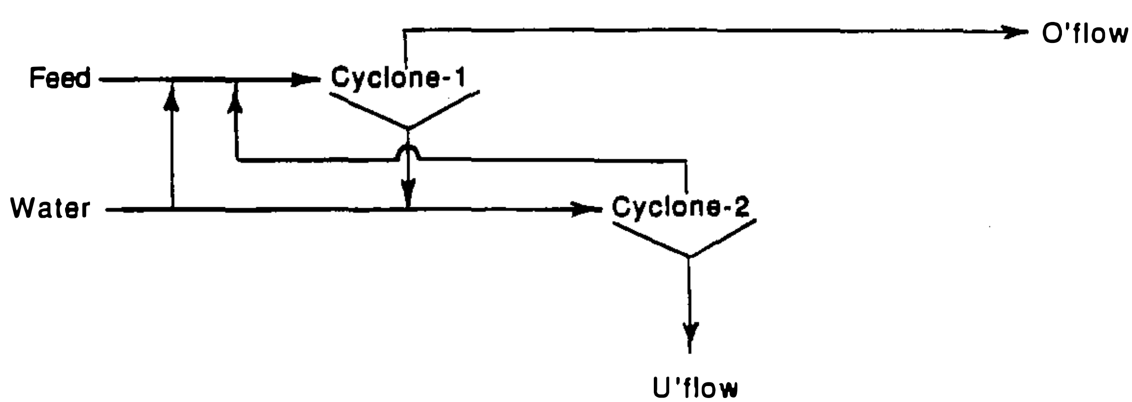
Cyclone 1: Dorrclone P50; 50 mm diameter
18 mm vortex
6 mm apex

Cyclone 2: Krebs Model 1-1181 25 mm diameter
6 mm vortex
4.5 mm apex

Time min.	Percolation Rate		Pulp Densities, g/L		
	Ind. mL	Cm/h	Feed	U/Flow	O/Flow
0	-	-	1340	2190	1010
15	18	9.0	-	-	-
30	-	-	-	-	-
60	83	10.5	-	-	-
120	92	11.5	-	-	-
180	84	10.6	-	-	-
240	95	11.9	-	-	-
300	94	11.8	-	-	-

Solids height in column: 34.5 cm
Solids weight In column: 586.6 g

Flowsheet:



Product: Sands Test No: BF-3

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
295	48	6.4	2.6	2.6	97.4
208	65	11.8	4.8	7.4	92.6
147	100	19.2	7.8	15.2	84.8
104	150	26.9	11.0	26.2	73.8
74	200	37.3	15.2	41.4	58.6
53	270	47.1	19.2	60.6	39.4
38	400	48.7	19.8	80.4	19.6
-38	-400	48.1	19.6	100.0	-
	Total	245.5	100.0	-	-

Test PP-6 - Continued

TEST BF-4

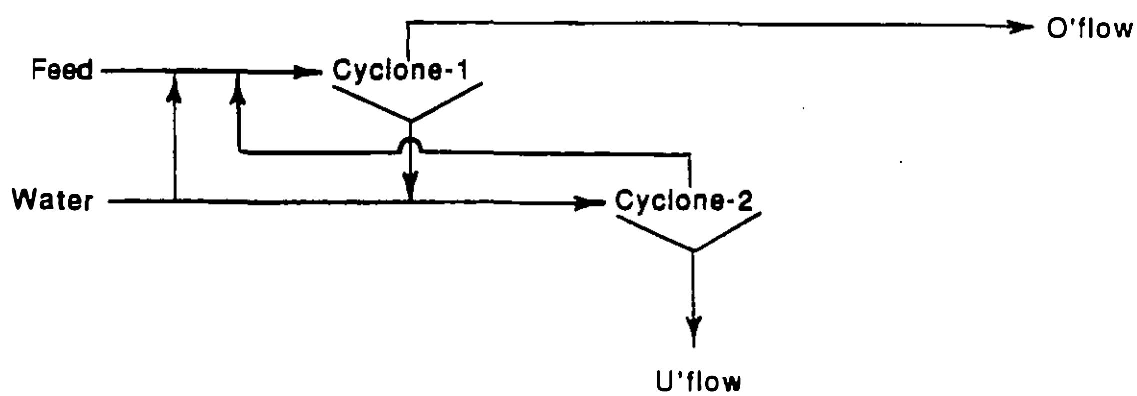
Feed Material: Zn Scavenger Tall Thickener Underflow (PP6)

Cyclone 1:	Dorrclone P50;	50 mm diameter 18 mm vortex 6 mm apex
Cyclone 2:	Krebs Model 1-1181	25 mm diameter 6 mm vortex 3 mm apex

Time min.	Percolation Rate		Pulp Densities, g/L			Remarks
	Ind. mL	Cm/h	Feed	U/Flow	O/Flow	
0	-	-	1350	2225	1015	1 1/2 drums sands
15	18	9.0	-	-	-	collected in drums
30	-	-	-	-	-	labelled: Backfill sands
60	89	11.2	-	-	-	PP-5/6
120	99	12.4	-	-	-	PP-6
180	105	13.2	-	-	-	
240	108	13.6	-	-	-	
300	107	13.5	-	-	-	

Solids height in column: 34.5 cm
Solids weight in column: 615.2 g

Flowsheet:



Product: B.F. Cyclone Underflow Test No: PP-6

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.8	0.3	0.3	99.7
208	65	6.5	2.7	3.0	97.0
147	100	13.2	5.5	8.5	91.5
104	150	29.1	12.0	20.5	79.5
74	200	39.3	16.2	36.8	63.2
53	270	49.7	20.5	57.3	42.7
38	400	42.4	17.5	74.8	25.2
-38	-400	60.9	25.2	100.0	-
	Total	241.9	100.0	-	-

Product: B.F. Cyclone Feed Test No: PP-6

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	2.7	1.4	1.4	98.6
147	100	4.5	2.3	3.7	96.3
104	150	9.6	4.9	8.6	91.4
74	200	16.3	8.4	17.0	83.0
53	270	24.0	12.3	29.3	70.7
38	400	25.0	12.8	42.1	57.9
-38	-400	112.8	57.9	100.0	-
	Total	194.9	100.0	-	-

Product: B F Cyclone Overflow Test No: PP-6 S.G.-4.16

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
33.7µ	0.35	0.7	0.7	99.3
26.2	1.38	2.8	3.5	96.5
18.2	6.49	13.0	16.4	83.6
12.5	10.11	20.2	36.7	63.3
9.7	3.94	7.9	44.5	55.5
-9.7	27.73	55.5	100.0	-
Total	50.00	100.0	-	-

Product: Sands Test No: BF-4

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
295	48	4.5	2.0	2.0	98.0
208	65	12.5	5.6	7.6	92.4
147	100	18.2	8.2	15.8	84.2
104	150	38.8	17.5	33.3	66.7
74	200	36.2	16.3	49.6	50.4
53	270	47.0	21.1	70.7	29.3
38	400	33.6	15.1	85.8	14.2
-38	-400	31.5	14.2	100.0	-
	Total	222.3	100.0	-	-

TEST NO. PP-7

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As for Test PP-1.

1.1.2. Method: As for Test PP-1.

1.1.2.1. Flowsheet Equipment

As for Test PP-1.

1.1.2.2. Mill Loads

As for Test PP-1.

1.1.2.3. Classification Equipment

As for Test PP-1.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 7.0 hours and was sampled every 30 minutes during the last 2.0 hours of operation. The average feed rate was 525 kg/h of dry ore.

1.1.3. Flowsheet: As for Test PP-1.

Test PP-7 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-7

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	58.0	9.5	9.5	90.5
4,699	4	112.3	18.5	28.0	72.0
3,327	6	73.2	12.0	40.0	60.0
2,362	8	47.7	7.8	47.9	52.1
1,651	10	55.2	9.1	57.0	43.0
1,168	14	35.6	5.9	62.8	37.2
833	20	26.1	4.3	67.1	32.9
589	28	21.2	3.5	70.6	29.4
417	35	17.2	2.8	73.4	26.6
295	48	13.3	2.2	75.6	24.4
208	65	12.3	2.0	77.6	22.4
147	100	11.9	2.0	79.6	20.4
104	150	11.9	2.0	81.5	18.5
74	200	12.7	2.1	83.6	16.4
53	270	16.8	2.8	86.4	13.6
38	400	11.1	1.8	88.2	11.8
-38	-400	71.6	11.8	100.0	-
	Total	608.1	100.0	-	-

Product: Rod Mill Discharge Test No: PP-7

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	1.8	0.7	0.7	99.3
833	20	3.5	1.3	2.0	98.0
589	28	8.9	3.4	5.4	94.6
417	35	16.4	6.2	11.6	88.4
295	48	22.3	8.5	20.1	79.9
208	65	21.3	8.1	28.2	71.8
147	100	26.5	10.1	38.3	61.7
104	150	21.6	8.2	46.5	53.5
74	200	19.5	7.4	54.0	46.0
53	270	18.3	7.0	60.9	39.1
38	400	16.0	6.1	67.0	33.0
-38	-400	86.7	33.0	100.0	-
	Total	262.8	100.0	-	-

Test PP-7- Continued

1.1.4. Size Analyses: Continued

Product: Ball Mill Discharge Test No: PP-7

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	0.0	0.0	0.0	100.0
833	20	0.0	0.0	0.0	100.0
589	28	1.0	0.5	0.5	99.5
417	35	2.9	1.5	2.1	97.9
295	48	7.3	3.9	6.0	94.0
208	65	14.6	7.8	13.8	86.2
147	100	30.6	16.3	30.1	69.9
104	150	37.6	20.1	50.2	49.8
74	200	34.3	18.3	68.5	31.5
53	270	23.8	12.7	81.2	18.8
38	400	12.0	6.4	87.6	12.4
-38	-400	23.2	12.4	100.0	-
	Total	187.3	100.0	-	-

Product: Cyclone Underflow Test No: PP-7

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
833	20	2.4	0.6	0.6	99.4
589	28	4.6	1.1	1.7	98.3
417	35	11.5	2.8	4.5	95.5
295	48	20.6	5.0	9.5	90.5
208	65	40.2	9.8	19.3	80.7
147	100	72.6	17.7	37.0	63.0
104	150	89.5	21.8	58.8	41.2
74	200	66.3	16.1	74.9	25.1
53	270	49.0	11.9	86.9	13.1
38	400	21.0	5.1	92.0	8.0
-38	-400	32.9	8.0	100.0	-
	Total	410.6	100.0	-	-

Test PP-7- Continued

1.1.4. Size Analyses: Continued

Product: Cyclone Overflow Test No: PP-7

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	5.8	2.8	2.8	97.2
147	100	7.9	3.8	6.7	93.3
104	150	13.7	6.7	13.3	86.7
74	200	20.3	9.9	23.2	76.8
53	270	23.7	11.5	34.7	65.3
38	400	21.7	10.6	45.3	54.7
-38	-400	112.4	54.7	100.0	-
	Total	205.5	100.0	-	-

1.1.5. Observations:

Circuit operation was stable. The cyclone overflow was slightly coarser than in previous tests, 80 % -82 μm.

Test PP-7 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: To examine the effect of reduced grinding capacity in the semi-bulk and Pb regrinding circuits.

1.2.2. Method: The Sala bulk regrind mill and the Hardinge conical Pb regrind mills were replaced by smaller mills. Ball loads were not significantly reduced, but 25 mm balls were used, replacing the 25-38 mm balls previously used.

1.2.2.1. Flowsheet Equipment

The semi-bulk regrind mill was a 812 mm x 406 mm diameter Hazen Quinn mill. The Pb regrind mill was a 812 mm x 406 mm diameter Denver mill.

1.2.2.2. Mill Loads

Semi-bulk Regrind : 200 kg of 25 mm balls
Pb Regrind : 200 kg of 25 mm balls
Zn Regrind : As for Test PP-1.

1.2.2.3. Classification Equipment

As for Test PP-1, with the two 25 mm Krebs cyclones being returned to the circuit.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Hazen Quinn	-	1210	1220	1110	Feed Cycl O/Flow	84.8 95.0	74.7 85.4	54.3 62.3	20 15
Pb-Denver	-	1220	1210	1070	Feed Cycl O/Flow	94.9 97.0	86.3 90.2	63.2 67.0	15 13
Zn-Denver	-	2235	2215	1365	Feed Cycl O/Flow	50.4 77.9	38.6 58.3	25.6 36.9	57 26

1.2.3. Flowsheet: As in Test PP-1.

Test PP-7 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-7 S.G.- 4.59

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	1.34	2.7	2.7	97.3
31.7μ	3.33	6.7	9.3	90.7
24.6	2.94	5.9	15.2	84.8
17.1	5.04	10.1	25.3	74.7
11.8	6.99	14.0	39.3	60.7
9.1	3.23	6.5	45.7	54.3
-9.1	27.13	54.3	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-7 S.G.- 4.59

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.7μ	0.82	1.6	1.6	98.4
24.6	1.70	3.4	5.0	95.0
17.1	4.78	9.6	14.6	85.4
11.8	7.83	15.7	30.3	69.7
9.1	3.74	7.5	37.7	62.3
-9.1	31.13	62.3	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-7 S.G.-4.47

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
32.2μ	0.87	1.7	1.7	98.3
25.0	1.67	3.3	5.1	94.9
17.4	4.33	8.7	13.7	86.3
12.0	7.50	15.0	28.7	71.3
9.3	4.02	8.0	36.8	63.2
-9.3	31.61	63.2	100.0	-
Total	50.00	100.0	-	-

Test PP-7- Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-7 S.G.- 4.36

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
32.7μ	0.55	1.1	1.1	98.9
25.4	0.96	1.9	3.0	97.0
17.7	3.38	6.8	9.8	90.2
12.2	7.40	14.8	24.6	75.4
9.4	4.19	8.4	33.0	67.0
-9.4	33.52	67.0	100.0	-
Total	50.00	100.0	-	-

Product: Zn Scalp Conc Test No: PP-7 S.G.- 4.39

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
150	2.28	4.6	4.6	95.4
200	4.23	8.5	13.0	87.0
270	6.45	12.9	25.9	74.1
32.6μ	6.11	12.2	38.1	61.9
25.3	5.74	11.5	49.6	50.4
17.6	5.88	11.8	61.4	38.6
12.1	4.86	9.7	71.1	28.9
9.3	1.65	3.3	74.4	25.6
-9.3	12.80	25.6	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-7 S.G.- 4.42

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.92	1.8	1.8	98.2
32.5μ	3.26	6.5	8.4	91.6
25.2	6.89	13.8	22.1	77.9
17.6	9.77	19.5	41.7	58.3
12.1	8.14	16.3	58.0	42.0
9.3	2.58	5.2	63.1	36.9
-9.3	18.44	36.9	100.0	-
Total	50.00	100.0	-	-

Test PP-7- Continued

1.2.4. Size Analyses: Continued

Product: PP-7 Zn 3rd Cleaner Concentrate S.G.- 4.35

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.58	1.2	1.2	98.8
32.7μ	2.97	5.9	7.1	92.9
25.4	6.22	12.4	19.5	80.5
17.7	9.46	18.9	38.5	61.5
12.2	8.41	16.8	55.3	44.7
9.4	3.31	6.6	61.9	38.1
-9.4	19.05	38.1	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:

The smaller regrind mills operated satisfactorily, with a slight coarsening of the grinds. The Pb cyclone overflow was 80 % -13 μm, as compared to 80 % 9 μm previously.

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	1.5	% moisture	
Primary Rod Mill Feed	525	kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	200	kg of 62mm dia. rods	
	200	kg of 37-50mm dia. rods	
Rod Mill Discharge:	2,099 g/L	(68 % Sol at SG	4.25)
	79.9	% minus 48 mesh	
	46.0	% minus 200 mesh	
Input Power:	20.57	3 disc revolutions	
	4.73 kW	95% drive efficiency)	
Average Power:	4.49 kW	Gross	
	1.771	No Load	
	2.72	Net	
Net Power Usage:	5.2		
K80 Feed:	5202	microns	
K80 Product:	287	microns	
W. Index (metric):	11.5		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	525	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	250	kg of 50mm balls	
	150	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,903 g/L	(62 % Solat SG	4.25)
	94	% minus 48 mesh	
	31.5	% minus 200 mesh	
Circulating Load	417	%	
Input Power:	14.25	sec for 3 disc revolutions	
	6.82 kW	95% drive efficiency)	
Average Power:	6.48 kW	Gross	
	1.60	No Load	
	4.88	Net	
Net Power Usage:	9.3	kWh/t	
K80 Feed:	287	microns	
K80 Product:	82	microns	
W. Index (metric):	18.1		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	14.5 kWh/t
K80 Feed:	5202 microns
K80 Product:	82 microns
Work Index :	15.0 metric
Flot. Feed :	76.8% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	525	kg/h	
Denver Mill 2 Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	1,210 g/L	(22 % Sol at SG	4.59)
Input Power:	31.00	sec for 3 disc revolutions	
	1.25 kW	95% drive efficiency)	
Average Power:	1.19 kW	Gross	
	0.62	No Load	
	0.58	Net	
K80 Feed:	20	microns	
K80 Product:	15	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	525	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	1,220 g/L	(23 % Sol at SG	4.42)
Input Power:	85.59	sec for 3 disc revolutions	
	1.14 kW	95% drive efficiency)	
Average Power:	1.08 kW	Gross	
	0.69	No Load	
	0.39	Net	
K80 Feed:	15	microns	
K80 Product:	13	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	525	kg/h	
Denver Mill 1 Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	225	kg of 25 mm balls	
	225	kg total	
Ball Mill Discharge:	2,235 g/L	(71 % Sol at SG	4.41)
Input Power:	26.22	sec for 3 disc revolutions	
	1.48 kW	95% drive efficiency)	
Average Power:	1.41 kW	Gross	
	0.61	No Load	
	0.80	Net	
K80 Feed:	57	microns	
K80 Product:	26	microns	

2. FLOTATION

2.1. Purpose: To test the effect of an extended Pb rougher, an open Pb 1st cleaner, coarser bulk and Pb regrinding, and a new collector, 317/3418A in the semi-bulk and Pb circuits.

2.2. Method: The following equipment and Flowsheet changes were made:

i) An additional bank of cells was used to extend the Pb rougher. The rougher tall was pumped to the Zn prefloat conditioners as usual.

ii) The Pb 1st cleaner tail was sent to the Zn prefloat conditioners in the first half of the run.

iii) The Pb 1st cleaner tail was recycled to the 2nd Pb rougher bank late in the test run (i.e. just before the sampling period).

iv) The SD200/cyanide depressant additions were returned to the semi-bulk and Pb regrind feeds.

v) 317/3418A (70:30) was used in the semi-bulk and Pb circuits.

vi) Collector R242 was added to the semi-bulk and Pb regrinds.

vii) 317/3418A was added to the 1st semi-bulk flotation.

2.2.1. Flowsheet Equipment

As in Test PP-2, but with the following changes:

i) The second lead rougher was 4 Denver DR7 cells.
ii) The Pb 1st cleaner was 6 Denver D7 cells.

2.2.2. Conditioning Parameters

As in Test PP-2.

2.2.3. Circuit Operation

The circuit was operated for a period of 7.0 hours, and was sampled every 30 minutes during the last 1.0 hour of operation.

TEST PP-7

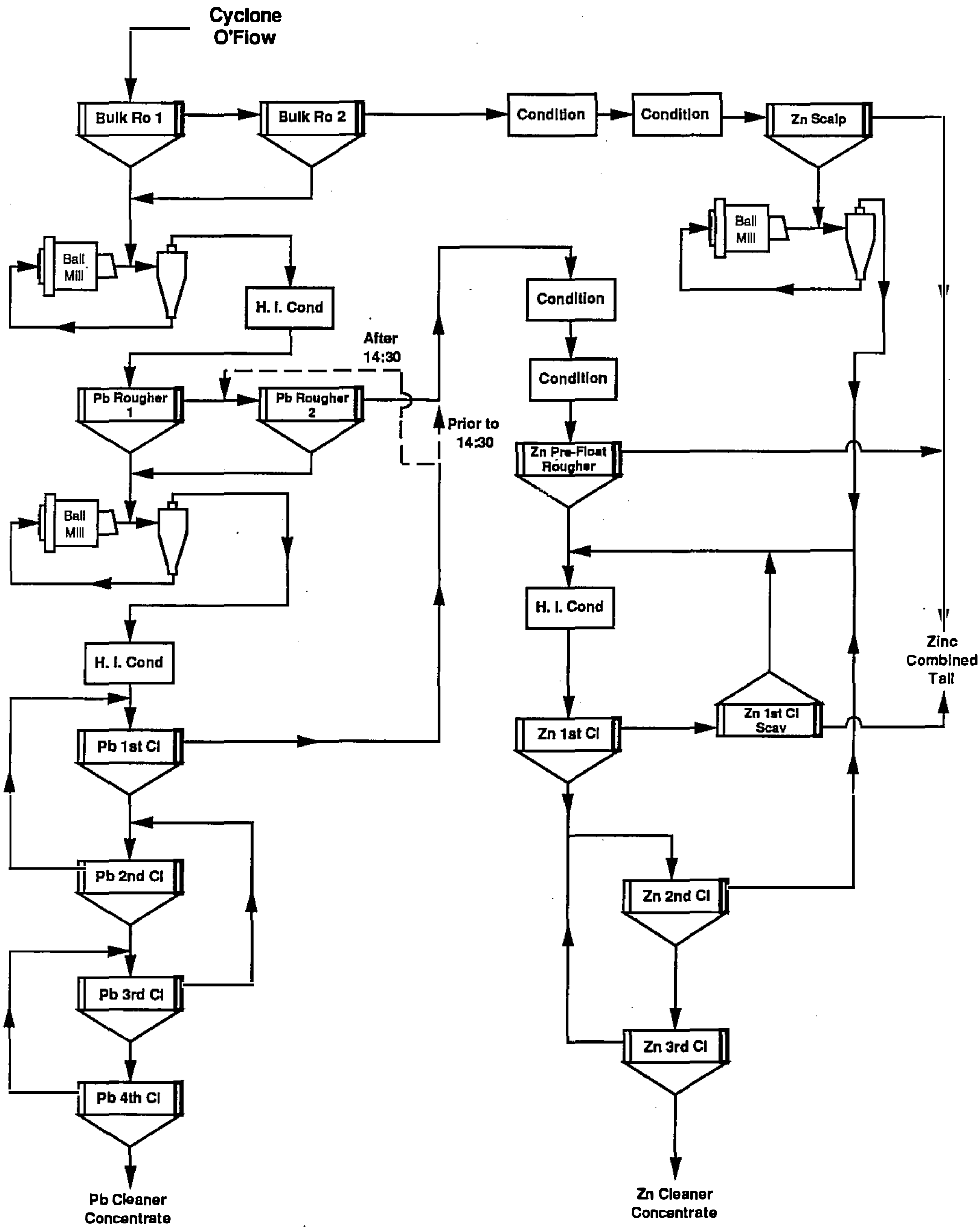
2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	208.0	2377
Ball Mill Feed		A317/3418A	5.0	15.0	86
Bulk Rougher 1 Feed		CA830/TH	2.0	0.0	0
Bulk Rougher 1 Feed		A317/3418A	5.0	10.0	57
Bulk Rougher 1 Feed	*	MIBC	100.0	50.0	29
Bulk Rougher 2 Feed		CA830/TH	2.0	0.0	0
Bulk Rougher 2 Feed		A317/3418A	5.0	15.0	86
Bulk Rougher 2 Feed	*	MIBC	100.0	15.3	9
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	10.0	114
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	75.0	343
Bulk Concentrate Regrind Mill Feed	*	R242	100.0	5.0	7
Pb Rougher H.I. Conditioner		CA830/TH	2.0	0.0	0
Pb Rougher H.I. Conditioner		A317/3418A	5.0	15.0	86
Pb Rougher H.I. Conditioner	*	MIBC	100.0	14.3	8
Pb Rougher Cell 7		A317/3418A	5.0	2.0	11
Pb Rougher Cell 7	*	MIBC	100.0	6.0	3
Pb Concentrate Regrind Mill Feed		SD200/NaCN	4.0	75.8	347
Pb Concentrate Regrind Mill Feed		Na2CO3	10.0	10.0	114
Pb Concentrate Regrind Mill Feed	*	R242	100.0	7.0	10
Pb 1st Cleaner H.I. Conditioner		A317/3418A	5.0	20.0	114
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	16.0	9
Pb 1st Cleaner Cell 3		A317/3418A	5.0	3.0	17
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	31.7	145
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	20.5	94
Pb 4th Cleaner Feed		SD200/NaCN	4.0	15.4	70
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	60.0	686
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	80.0	914
Zn Scalp Feed	*	M2030	100.0	12.0	7
Zn Scalp Feed		A317	5.0	15.0	86
Zn Scalp Feed	*	DF250	100.0	100.0	57
Zn Scalp Cell 3	*	M2030	100.0	6.0	3
Zn Scalp Cell 3		A317	5.0	6.0	34
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	50.0	571
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	15.0	171
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	40.0	457
Zn Prefloat Conditioner 2 Feed		CuSO4.5H2O	10.0	40.0	457
Zn Prefloat Feed	*	M2030	100.0	12.0	7
Zn Prefloat Feed		A317	5.0	6.0	34
Zn Prefloat Cell 4	*	M2030	100.0	0.0	0
Zn Prefloat Cell 4		A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	10.0	6
Zn 1st Cleaner H.I. Conditioner		A317	5.0	15.0	86
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	0.0	0
Zn 1st Cleaner Scavenger Feed		A317	5.0	5.8	33
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	87.3	998
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	38.3	438

* Drops per minute

Feed Rate= 525 kg/h

2.3. Flowsheet:



Test PP-7- Continued

2.4. Results:

2.4.1. Observations

Inclusion of the extended lead rougher resulted in a circulating load. High Pb grades were achieved in some grab samples, but product grades were quite variable from 40-60 % Pb.
Pb content in the Zn concentrate was quite high, >6%, due to introduction open circuit Pb cleaning (i.e. Pb cleaner scavenger to the zinc prefloat).

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2099	10.3	-
Ball Mill Discharge	1903	-	-
Cyclone Underflow	2755	-	-
Cyclone Overflow	1286	9.8	13
Semi-bulk Rougher Tail	1250	9.5	-
Semi-bulk Regrind Discharge	1210	-	-
Semi-bulk Regrind Cyc U/Flow	1220	-	-
Semi-bulk Regrind Cyc O/Flow	1110	-	-
Pb Rougher Feed	1060	9.9	19
Pb Rougher Tail	1010	-	-
Pb Regrind Discharge	1220	-	-
Pb Regrind Cyclone U/Flow	1210	-	-
Pb Regrind Cyclone O/Flow	1070	-	-
Pb 1st Cleaner	-	9.9	-
Pb 1st Cleaner Tail	1015	-	-
Pb 2nd Cleaner Feed	-	9.8	-
Pb 3rd Cleaner Feed	-	9.8	-
Pb 4th Cleaner Feed	-	9.7	-
Zn Scalp Feed	-	10.2	-
Zn Scalp Tail	1170	-	-
Zn Regrind Discharge	2235	-	-
Zn Regrind Cyclone U/Flow	2215	-	-
Zn Regrind Cyclone O/Flow	1365	-	-
Zn Prefloat Feed	-	10.9	15
Zn Prefloat Tail	1015	-	-
Zn 1st Cleaner Feed	1150	11.6	-
Zn Cleaner Scavenger Tail	1060	11.5	-
Zn 2nd Cleaner Feed	-	11.8	-
Zn 3rd Cleaner Feed	-	11.8	-
Thickener Underflow	1330	-	-

Test PP- 7 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
9:30	Pb 4th Cleaner Conc	57.5	5.07
	Zn 3rd Cleaner Conc	5.35	51.3
	Zn Cleaner Scavenger Tail	3.42	8.37
	Zn Prefloat Tail	5.63	14.5
	Zn Scalp Tail	1.59	4.40
	Zn Combined Tail	3.27	7.19
10:30	Pb 4th Cleaner Conc	63.5	7.20
	Zn 3rd Cleaner Conc	3.12	52.9
	Zn Cleaner Scavenger Tail	4.73	6.39
	Zn Prefloat Tail	4.43	2.29
	Zn Scalp Tail	1.19	1.38
	Zn Combined Tail	2.82	3.77
11:30	Pb 4th Cleaner Conc	67.5	5.50
	Zn 3rd Cleaner Conc	3.80	50.5
	Zn Cleaner Scavenger Tail	2.25	1.63
	Zn Prefloat Tail	3.38	1.30
	Zn Scalp Tail	1.24	1.39
	Zn Combined Tail	1.91	1.34
12:30	Pb 4th Cleaner Conc	57.0	8.41
	Zn 3rd Cleaner Conc	4.66	47.7
	Zn Cleaner Scavenger Tail	2.74	1.44
	Zn Prefloat Tail	3.22	1.09
	Zn Scalp Tail	1.11	1.11
	Zn Combined Tail	1.62	1.25
13:00	Pb 4th Cleaner conc	67.6	4.85
13:30	Pb 4th Cleaner Conc	63.0	7.00
	Zn 3rd Cleaner Conc	6.43	48.9
	Zn Cleaner Scavenger Tail	2.43	1.76
	Zn Prefloat Tail	2.60	5.00
	Zn Scalp Tail	1.15	1.09
	Zn Combined Tail	2.30	1.52
14:00	Pb 4th Cleaner conc	40.1	23.4
14:30	Pb 4th Cleaner Conc	1.94	1.47
	Zn 3rd Cleaner Conc	1.34	1.77
	Zn Cleaner Scavenger Tail	2.74	4.08
	Zn Prefloat Tail	2.16	2.25
	Zn Scalp Tail	6.53	47.9
	Zn Combined Tail	55.8	14.1
15:00	Pb 4th Cleaner conc	61.1	9.80
15:30	Pb 4th Cleaner Conc	51.0	11.8
	Zn 3rd Cleaner Conc	6.73	43.1
	Zn Cleaner Scavenger Tail	1.66	1.43
	Zn Prefloat Tail	2.00	1.99
	Zn Scalp Tail	1.59	1.27
	Zn Combined Tail	1.25	1.18

Test PP-7 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Cyclone Overflow	3.34	10.0	73.3
Semi-bulk Concentrate	23.4	8.59	-
Semi-bulk Tall	1.49	9.94	-
Semi-bulk Regrind Cyclone O/Flow	22.5	8.95	-
Pb Rougher Feed	20.0	8.67	-
Pb Rougher Concentrate	18.0	8.87	-
Pb Rougher Tall	2.14	1.65	-
Pb 1st Cleaner Concentrate	18.1	13.8	-
Pb 1st Cleaner Tail	3.36	3.17	-
Pb Regrind Cyclone O/Flow	14.9	9.33	-
Pb 4th Cleaner Concentrate	55.5	10.7	189
Zn Scalp Concentrate	2.40	27.4	-
Zn Scalp Tall	0.87	1.10	-
Zn Regrind Cyclone Overflow	2.91	26.3	-
Zn Prefloat Feed	2.60	2.49	-
Zn Prefloat Concentrate	3.30	4.17	-
Zn Prefloat Tail	1.75	1.56	-
Zn 1st Cleaner Concentrate	4.58	19.2	-
Zn Cleaner Scavenger Conc	5.44	8.32	-
Zn Cleaner Scavenger Tail	1.90	1.74	-
Zn Combined Tall	1.17	1.16	38.4
Zn 3rd Cleaner Concentrate	5.94	44.2	164

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	2.23	55.5	10.7	189	37.1	2.4	6.3
Zn 3rd Cleaner Concentrate	20.04	5.94	44.2	164	35.6	88.6	49.1
Zn Combined Tails	77.72	1.17	1.16	38.4	27.2	9.0	44.6
Head(calc)	100.00	3.34	10.0	73.3	100.0	100.0	100.0

TEST NO. PP-8

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As for Test PP-1.

1.1.2. Method: As for Test PP-1.

1.1.2.1. Flowsheet Equipment

As for Test PP-1.

1.1.2.2. Mill Loads

As for Test PP-1.

1.1.2.3. Classification Equipment

As for Test PP-1.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 6.7 hours and was sampled every 30 minutes during the last 2.0 hours of operation. The average feed rate was 539 kg/h of dry ore.

1.1.3. Flowsheet: As for Test PP-1.

Test PP-8 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-8

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	24.5	4.2	4.2	95.8
4,699	4	70.0	12.1	16.3	83.7
3,327	6	58.6	10.1	26.4	73.6
2,362	8	48.5	8.3	34.7	65.3
1,651	10	60.8	10.5	45.2	54.8
1,168	14	43.9	7.6	52.7	47.3
833	20	32.2	5.5	58.3	41.7
589	28	27.8	4.8	63.1	36.9
417	35	22.6	3.9	66.9	33.1
295	48	17.2	3.0	69.9	30.1
208	65	16.7	2.9	72.8	27.2
147	100	14.7	2.5	75.3	24.7
104	150	13.9	2.4	77.7	22.3
74	200	14.6	2.5	80.2	19.8
53	270	17.5	3.0	83.2	16.8
38	400	14.6	2.5	85.7	14.3
-38	-400	82.8	14.3	100.0	-
	Total	580.9	100.0	-	-

Product: Rod Mill Discharge Test No: PP-8

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
1,651	10	0.4	0.2	0.2	99.8
1,168	14	0.9	0.4	0.5	99.5
833	20	2.7	1.1	1.7	98.3
589	28	7.2	3.0	4.7	95.3
417	35	14.8	6.2	10.9	89.1
295	48	18.5	7.7	18.6	81.4
208	65	20.7	8.7	27.3	72.7
147	100	25.8	10.8	38.1	61.9
104	150	21.7	9.1	47.2	52.8
74	200	18.5	7.7	54.9	45.1
53	270	18.3	7.7	62.6	37.4
38	400	14.8	6.2	68.7	31.3
-38	-400	74.7	31.3	100.0	-
	Total	239.0	100.0	-	-

Test PP-8- Continued

1.1.4. Size Analyses: Continued

Product: Ball Mill Discharge Test No: PP-8

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	0.0	0.0	0.0	100.0
833	20	0.0	0.0	0.0	100.0
589	28	0.6	0.3	0.3	99.7
417	35	2.2	1.3	1.6	98.4
295	48	5.9	3.4	5.0	95.0
208	65	13.2	7.6	12.6	87.4
147	100	27.8	15.9	28.5	71.5
104	150	36.8	21.1	49.6	50.4
74	200	32.8	18.8	68.4	31.6
53	270	22.2	12.7	81.1	18.9
38	400	11.2	6.4	87.6	12.4
-38	-400	21.7	12.4	100.0	-
	Total	174.4	100.0	-	-

Product: Cyclone Underflow Test No: PP-8

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
833	20	0.7	0.3	0.3	99.7
589	28	1.7	0.7	1.0	99.0
417	35	5.9	2.4	3.3	96.7
295	48	10.3	4.1	7.5	92.5
208	65	21.5	8.6	16.1	83.9
147	100	39.7	15.9	32.0	68.0
104	150	50.3	20.2	52.2	47.8
74	200	45.7	18.4	70.6	29.4
53	270	33.0	13.3	83.9	16.1
38	400	16.1	6.5	90.3	9.7
-38	-400	24.1	9.7	100.0	-
	Total	249.0	100.0	-	-

Test PP-8- Continued

1.1.4. Size Analyses: Continued

Product: Cyclone Overflow Test No: PP-8

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	2.0	1.2	1.2	98.8
147	100	3.2	1.9	3.0	97.0
104	150	6.2	3.6	6.6	93.4
74	200	11.7	6.8	13.5	86.5
53	270	19.1	11.1	24.6	75.4
38	400	19.1	11.1	35.7	64.3
-38	-400	110.3	64.3	100.0	-
	Total	171.6	100.0	-	-

1.1.5. Observations:

Circuit operation was stable.

Test PP-8 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: As in Test PP-7.

1.2.2. Method: As in Test PP-7.

1.2.2.1. Flowsheet Equipment

As in Test PP-7.

1.2.2.2. Mill Loads

As in Test PP-7.

1.2.2.3. Classification Equipment

As for Test PP-7.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Hazen Quinn	-	1690	1770	1280	Feed* Cycl O/Flow	72.5 87.5	58.4 72.9	36.9 46.4	30 20
Pb-Denver	-	2105	2385	1205	Feed Cycl O/Flow	88.4 95.1	74.6 87.1	46.3 66.3	20 13
Zn-Denver	-	2325	2365	1250	Feed Cycl O/Flow	34.6 73.9	26.8 55.5	19.4 36.7	82 28

* Semi-bulk concentrate; recycled Pb 1st Cl Conc not included in feed size analysis.

1.2.3. Flowsheet: See section 2.3. Recycled Pb 1st Cl Scav Conc to semi-bulk regrind cyclone.

Test PP-8 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-8 S.G.- 4.62

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	3.21	6.4	6.4	93.6
31.5µ	5.42	10.8	17.3	82.7
24.4	5.13	10.3	27.5	72.5
17.1	7.05	14.1	41.6	58.4
11.7	7.67	15.3	57.0	43.0
9.1	3.08	6.2	63.1	36.9
-9.1	18.44	36.9	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-8 S.G.- 4.57

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.8µ	2.54	5.1	5.1	94.9
24.6	3.70	7.4	12.5	87.5
17.1	7.30	14.6	27.1	72.9
11.8	9.45	18.9	46.0	54.0
9.1	3.80	7.6	53.6	46.4
-9.1	23.21	46.4	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-8 S.G.-4.59

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.40	0.8	0.8	99.2
31.7µ	2.03	4.1	4.9	95.1
24.6	3.38	6.8	11.6	88.4
17.1	6.89	13.8	25.4	74.6
11.8	9.64	19.3	44.7	55.3
9.1	4.51	9.0	53.7	46.3
-9.1	23.15	46.3	100.0	-
Total	50.00	100.0	-	-

Test PP-8 - Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-8 S.G.- 4.66

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.3μ	0.79	1.6	1.6	98.4
24.3	1.65	3.3	4.9	95.1
16.9	4.00	8.0	12.9	87.1
11.6	5.65	11.3	24.2	75.8
9.0	4.76	9.5	33.7	66.3
-9.0	33.15	66.3	100.0	-
Total	50.00	100.0	-	-

Product: Zn Scalp Conc Test No: PP-8 S.G.- 4.45

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	4.89	9.8	9.8	90.2
200	7.85	15.7	25.5	74.5
270	8.92	17.8	43.3	56.7
32.2μ	6.44	12.9	56.2	43.8
25.0	4.61	9.2	65.4	34.6
17.4	3.87	7.7	73.2	26.8
12.0	2.85	5.7	78.9	21.1
9.3	0.87	1.7	80.6	19.4
-9.3	9.70	19.4	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-8 S.G.- 4.40

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	1.43	2.9	2.9	97.1
32.6μ	4.05	8.1	11.0	89.0
25.3	7.57	15.1	26.1	73.9
17.6	9.21	18.4	44.5	55.5
12.1	7.05	14.1	58.6	41.4
9.4	2.35	4.7	63.3	36.7
-9.4	18.34	36.7	100.0	-
Total	50.00	100.0	-	-

Test PP-8- Continued

1.2.4. Size Analyses: Continued

Product: PP-8 Zn Scalp + Cl Scav Tails S.G.- 4.10

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	3.04	6.1	6.1	93.9
200	2.34	4.7	10.8	89.2
270	3.40	6.8	17.6	82.4
34.1μ	4.08	8.2	25.7	74.3
26.4	4.87	9.7	35.5	64.5
18.5	6.06	12.1	47.6	52.4
12.7	5.54	11.1	58.7	41.3
9.8	1.54	3.1	61.7	38.3
-9.8	19.13	38.3	100.0	-
Total	50.00	100.0	-	-

Product: PP-8 Zn Combined Tail S.G.- 4.13

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	3.02	6.0	6.0	94.0
200	1.90	3.8	9.8	90.2
270	3.17	6.3	16.2	83.8
34.0μ	3.61	7.2	23.4	76.6
26.4	4.72	9.4	32.8	67.2
18.4	6.19	12.4	45.2	54.8
12.7	5.77	11.5	56.8	43.2
9.8	1.82	3.6	60.4	39.6
-9.8	19.80	39.6	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:

Circuit operation was stable.

The zinc regrind was similar to that in Test PP-7, and the semi-bulk and Pb regrinds were coarser than in Test PP-7.

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	1.9	% moisture	
Primary Rod Mill Feed	528	kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	200	kg of 62mm dia. rods	
	200	kg of 37-50mm dia. rods	
Rod Mill Discharge:	2,103 g/L	(69 % Sol at SG 4.25)	
	81.4	% minus 48 mesh	
	45.1	% minus 200 mesh	
Input Power:	20.04	3 disc revolutions	
	4.85 kW	95% drive efficiency)	
Average Power:	4.61 kW	Gross	
	1.771	No Load	
	2.84	Net	
Net Power Usage:	5.4		
K80 Feed:	3787	microns	
K80 Product:	275	microns	
W. Index (metric):	12.2		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	528	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	250	kg of 50mm balls	
	150	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,915 g/L	(62 % Sol at SG 4.25)	
	95.0	% minus 48 mesh	
	31.6	% minus 200 mesh	
Circulating Load	1119	%	
Input Power:	14.51	sec for 3 disc revolutions	
	6.70 kW	95% drive efficiency)	
Average Power:	6.4	Gross	
	1.60	No Load	
	4.76	Net	
Net Power Usage:	9.0	kWh/t	
K80 Feed:	275	microns	
K80 Product:	60	microns	
W. Index (metric):	13.1		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	14.4 kWh/t
K80 Feed:	3787 microns
K80 Product:	60 microns
Work Index :	12.8 metric
Flot. Feed :	86.5% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	528	kg/h	
Denver Mill 2 Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	1,690 g/L	(52 % Sol at SG	4.60)
Input Power:	34.06	sec for 3 disc revolutions	
	1.14 kW	95% drive efficiency)	
Average Power:	1.08 kW	Gross	
	0.62	No Load	
	0.47	Net	
K80 Feed:	25	microns	
K80 Product:	18	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	528	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	1,870 g/L	(59 % Sol at SG	4.63)
Input Power:	74.03	sec for 3 disc revolutions	
	1.31 kW	95% drive efficiency)	
Average Power:	1.25 kW	Gross	
	0.69	No Load	
	0.56	Net	
K80 Feed:	14	microns	
K80 Product:	11	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	528	kg/h	
Denver Mill 1 Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	225	kg of 25 mm balls	
	225	kg total	
Ball Mill Discharge:	2,190 g/L	(70 % Sol at SG	4.43)
Input Power:	26.52	sec for 3 disc revolutions	
	1.47 kW	95% drive efficiency)	
Average Power:	1.39 kW	Gross	
	0.61	No Load	
	0.78	Net	
K80 Feed:	82	microns	
K80 Product:	28	microns	

2. FLOTATION

2.1. Purpose: To examine the effect of scavenging of the 1st cleaner tail.

2.2. Method:

i) The lead rougher was restored to 6 cells from 10 cells in Test PP-7.

ii) The Pb 1st cleaner tail was scavenged. The concentrate was recycled to the semi-bulk regrind cyclone. The tall was sent to the Zn prefloat conditioners along with the Pb rougher tall.

iii) The Zn scalp was extended with a second bank of cells.

iv) R242 was added to the primary ball mill. Its use in the semi-bulk and Pb regrind circuit was discontinued before the sample period.

v) Semi-bulk and Pb circuit collector was A317/3418A.

vi) Samples of tailings (combined tail and Zn cleaner scavenger - Zn scalp tall were collected for backfill testwork.

vii) Samples of tailings water were analysed for impurities.

2.2.1. Flowsheet Equipment

i) The Pb rougher was restored to 6 Agitair A15 cells.
ii) The Pb 1st cleaner was 6 Denver D7 cells, but reduced to 4 cells later in the run.
iii) The Pb 1st cleaner scavenger was 4 Denver DR7 cells.

2.2.2. Conditioning Parameters

As in Test PP-2.

2.2.3. Circuit Operation

The circuit was operated for a period of 7.0 hours, and was sampled every 30 minutes during the last 1.0 hour of operation.

TEST PP-8

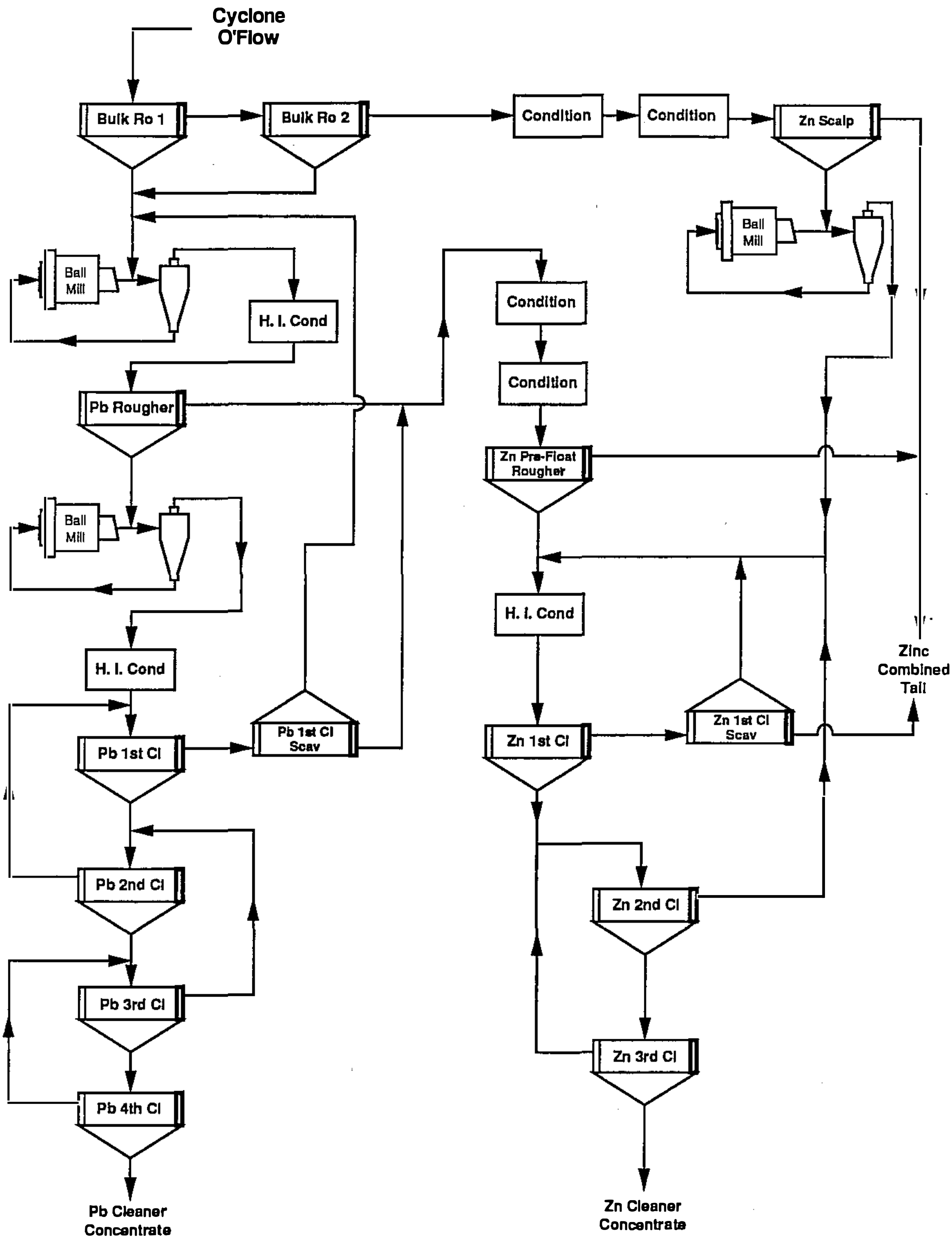
2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	208.0	2364
Ball Mill Feed		A317/3418A	5.0	18.0	102
Ball Mill Feed	*	R242	100.0	6.5	9
Bulk Rougher 1 Feed		CA830/TH	2.0	0.0	0
Bulk Rougher 1 Feed		A317/3418A	5.0	11.0	63
Bulk Rougher 1 Feed	*	MIBC	100.0	50.0	28
Bulk Rougher 2 Feed		CA830/TH	2.0	0.0	0
Bulk Rougher 2 Feed		A317/3418A	5.0	11.0	63
Bulk Rougher 2 Feed	*	MIBC	100.0	16.3	9
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	30.0	341
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	97.5	443
Pb Rougher H.I. Conditioner		CA830/TH	2.0	0.0	0
Pb Rougher H.I. Conditioner		A317/3418A	5.0	15.0	85
Pb Rougher H.I. Conditioner	*	MIBC	100.0	10.0	6
Pb Rougher Cell 5		A317/3418A	5.0	3.0	17
Pb Rougher Cell 5	*	MIBC	100.0	6.0	3
Pb Concentrate Regrind Mill Feed		SD200/NaCN	4.0	133.0	605
Pb Concentrate Regrind Mill Feed		Na2CO3	10.0	9.7	110
Pb 1st Cleaner H.I. Conditioner		A317/3418A	5.0	12.9	73
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	16.0	9
Pb 1st Cl. Scavenger Feed		A317/3418A	5.0	6.0	34
Pb 1st Cl. Scavenger Feed		MIBC	100.0	26.0	15
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	33.8	154
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	35.0	159
Pb 4th Cleaner Feed		SD200/NaCN	4.0	26.4	120
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	60.0	682
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	80.0	909
Zn Scalp Feed	*	M2030	100.0	10.5	6
Zn Scalp Feed		A317	5.0	15.3	87
Zn Scalp Feed	*	DF250	100.0	92.0	52
Zn Scalp Cell 5	*	M2030	100.0	6.3	4
Zn Scalp Cell 5		A317	5.0	5.7	32
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	49.3	560
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	13.3	151
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	41.3	469
Zn Prefloat Conditioner 2 Feed		CuSO4.5H2O	10.0	42.0	477
Zn Prefloat Feed	*	M2030	100.0	11.5	7
Zn Prefloat Feed		A317	5.0	6.0	34
Zn Prefloat Cell 4	*	M2030	100.0	0.0	0
Zn Prefloat Cell 4		A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	10.0	6
Zn 1st Cleaner H.I. Conditioner		A317	5.0	15.0	85
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	0.0	0
Zn 1st Cleaner Scavenger Feed		A317	5.0	6.0	34
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	111.3	1265
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	41.3	469

* Drops per minute

Feed Rate= 528 kg/h

2.3. Flowsheet:



Test PP-8- Continued

2.4. Results:

2.4.1. Observations

A high circulating load around the Pb rougher was built up, due to very selective flotation. Numerous reagent changes were made just prior to and during the sample period. Specifically, carbonate was increased to increase Pb rougher and 1st cleaner pH, and depressant levels were sharply increased. However, selectivity against zinc was not Improved.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2103	10.3	-
Ball Mill Discharge	1915	-	-
Cyclone Underflow	2760	-	-
Cyclone Overflow	1304	9.7	12
Semi-bulk Rougher Tail	1210	9.5	-
Semi-bulk Regrind Discharge	1690	-	-
Semi-bulk Regrind Cyc U/Flow	1770	-	-
Semi-bulk Regrind Cyc O/Flow	1280	-	-
Pb Rougher Feed	1160	10.1	19
Pb Rougher Tail	1050	-	-
Pb Regrind Discharge	1870	-	-
Pb Regrind Cyclone U/Flow	1780	-	-
Pb Regrind Cyclone O/Flow	1270	-	-
Pb 1st Cleaner	-	10.0	-
Pb 1st Cleaner Tail	1055	-	-
Pb 2nd Cleaner Feed	-	9.8	-
Pb 3rd Cleaner Feed	-	9.8	-
Pb 4th Cleaner Feed	-	9.8	-
Zn Scalp Feed	-	10.2	14
Zn Scalp Tail	1155	-	-
Zn Regrind Discharge	2190	-	-
Zn Regrind Cyclone U/Flow	2160	-	-
Zn Regrind Cyclone O/Flow	1330	-	-
Zn Prefloat Feed	-	10.8	-
Zn Prefloat Tail	1010	-	-
Zn 1st Cleaner Feed	1090	11.7	-
Zn Cleaner Scavenger Tail	1030	11.5	-
Zn 2nd Cleaner Feed	-	11.9	-
Zn 3rd Cleaner Feed	-	11.6	-
Thickener Underflow	2160	-	-

Test PP- 8 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, % Pb	Assays, % Zn
10:30	Pb 4th Cleaner Conc	53.0	11.6
	Zn 3rd Cleaner Conc	3.96	48.6
	Zn Cleaner Scavenger Tail	1.90	1.28
	Zn Prefloat Tail	3.19	1.11
	Zn Scalp Tail	1.08	0.96
	Zn Combined Tail	1.45	0.86
11:30	Pb 4th Cleaner Conc	60.8	12.2
	Zn 3rd Cleaner Conc	3.71	44.2
	Zn Cleaner Scavenger Tail	1.70	1.10
	Zn Prefloat Tail	2.00	2.37
	Zn Scalp Tail	0.84	0.81
	Zn Combined Tail	1.54	1.05
12:30	Pb 4th Cleaner Conc	48.6	18.4
	Zn 3rd Cleaner Conc	4.49	47.0
	Zn Cleaner Scavenger Tail	1.68	1.69
	Zn Prefloat Tail	2.21	2.53
	Zn Scalp Tail	0.85	0.55
	Zn Combined Tail	1.47	1.02
13:00	Pb 4th Cleaner Conc	48.6	16.3
13:30	Pb 4th Cleaner Conc	40.3	22.1
	Zn 3rd Cleaner Conc	3.46	47.2
	Zn Cleaner Scavenger Tail	1.65	1.57
	Zn Prefloat Tail	1.82	2.63
	Zn Scalp Tail	0.98	1.02
	Zn Combined Tail	1.55	1.47
14:30	Pb 4th Cleaner Conc	47.5	22.6
	Zn 3rd Cleaner Conc	2.62	50.3
	Zn Cleaner Scavenger Tail	1.52	1.17
	Zn Prefloat Tail	1.56	1.65
	Zn Scalp Tail	0.73	0.87
	Zn Combined Tail	1.06	0.90
15:30	Pb 4th Cleaner Conc	28.1	35.1
	Zn 3rd Cleaner Conc	3.21	48.0
	Zn Cleaner Scavenger Tail	1.22	1.37
	Zn Prefloat Tail	1.23	2.88
	Zn Scalp Tail	0.73	0.98
	Zn Combined Tail	1.04	1.22

Test PP-8 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Cyclone Overflow	3.50	9.84	62.8
Semi-bulk Concentrate	11.2	15.0	-
Semi-bulk Tail	0.77	7.88	-
Semi-bulk Regrind Cyclone O/Flow	15.9	15.5	-
Pb Rougher Feed	9.39	13.9	-
Pb Rougher Concentrate	12.6	16.9	-
Pb Rougher Tail	1.42	4.66	-
Pb 1st Cleaner Concentrate	13.5	22.6	-
Pb 1st Cleaner Tail	4.08	6.61	-
Pb Cleaner Scav Concentrate	5.44	9.84	-
Pb Cleaner Scav Tail	2.33	1.95	-
Pb Regrind Cyclone O/Flow	10.3	14.6	-
Pb 4th Cleaner Concentrate	23.6	31.5	145
Zn Scalp Concentrate	1.30	19.5	-
Zn Scalp Tail	0.44	0.43	-
Zn Regrind Cyclone O/Flow	1.36	20.1	-
Zn Prefloat Feed	1.79	3.43	-
Zn Prefloat Concentrate	2.79	3.00	-
Zn Prefloat Tail	1.29	3.47	-
Zn 1st Cleaner Feed	1.85	11.4	-
Zn 1st Cleaner Concentrate	-	-	-
Zn Cleaner Scavenger Conc	2.12	3.95	-
Zn Cleaner Scavenger Tail	1.10	0.92	-
Zn Combined Tail	0.79	0.83	24.6
Zn 3rd Cleaner Concentrate	2.38	38.8	162

Effluent Water	Cu	Fe	S_T	$SO_4^=$
Zn Cl Scav Tail	1.02	0.08	48.4	41.6
Zn Prefloat Tail	17.8	0.89	34.4	58.6
Zn Scalp Tail	0.06	0.09	111	139.
Zn Combined Tail	10.5	0.17	86.7	78.1
Pond Water*	13.5	0.18	80.2	72.4

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	10.84	23.6	31.5	145	73.1	34.7	27.0
Zn 3rd Cleaner Concentrate	14.98	2.38	38.8	162	10.2	59.1	41.7
Zn Combined Tails	74.19	0.79	0.83	24.6	16.7	6.3	31.3
Head(calc)	100.00	3.50	9.84	62.8	100.0	100.0	100.0

TEST NO. PP-9

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: Grinding of the PP Composite No. 2 ore blend: PP Rock Type 5 ore 70 %, PP Rock Type 4 ore 20 %, Upper Medium PP ore, 10 %.

1.1.2. Method: As for Test PP-1.

1.1.2.1. Flowsheet Equipment

As for Test PP-1.

1.1.2.2. Mill Loads

As for Test PP-1.

1.1.2.3. Classification Equipment

As for Test PP-1.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 9.0 hours and was sampled every 30 minutes during the last 2.5 hours of operation. The average feed rate was 523 kg/h of dry ore.

1.1.3. Flowsheet: As for Test PP-1.

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-9

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	3.2	0.5	0.5	99.5
6,680	3	29.9	4.4	4.8	95.2
4,699	4	85.2	12.4	17.3	82.7
3,327	6	70.7	10.3	27.6	72.4
2,362	8	54.6	8.0	35.5	64.5
1,651	10	75.6	11.0	46.6	53.4
1,168	14	51.5	7.5	54.1	45.9
833	20	38.5	5.6	59.7	40.3
589	28	33.4	4.9	64.6	35.4
417	35	27.3	4.0	68.5	31.5
295	48	19.7	2.9	71.4	28.6
208	65	16.6	2.4	73.8	26.2
147	100	16.7	2.4	76.3	23.7
104	150	15.3	2.2	78.5	21.5
74	200	16.2	2.4	80.9	19.1
53	270	17.9	2.6	83.5	16.5
38	400	16.4	2.4	85.9	14.1
-38	-400	96.8	14.1	100.0	-
	Total	685.5	100.0	-	-

Product: Rod Mill Discharge Test No: PP-9

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	1.2	0.5	0.5	99.5
833	20	2.7	1.1	1.5	98.5
589	28	6.8	2.6	4.2	95.8
417	35	14.0	5.4	9.6	90.4
295	48	17.0	6.6	16.2	83.8
208	65	21.4	8.3	24.6	75.4
147	100	26.6	10.4	34.9	65.1
104	150	22.7	8.8	43.8	56.2
74	200	20.7	8.1	51.8	48.2
53	270	19.4	7.6	59.4	40.6
38	400	16.8	6.5	65.9	34.1
-38	-400	87.6	34.1	100.0	-
	Total	256.9	100.0	-	-

Test PP-9- Continued

1.1.4. Size Analyses: Continued

Product: Ball Mill Discharge Test No: PP-9

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
589	28	0.7	0.3	0.3	99.7
417	35	2.2	1.1	1.4	98.6
295	48	6.0	3.0	4.4	95.6
208	65	14.0	6.9	11.3	88.7
147	100	31.5	15.6	26.9	73.1
104	150	41.7	20.7	47.6	52.4
74	200	38.6	19.1	66.7	33.3
53	270	26.3	13.0	79.7	20.3
38	400	13.7	6.8	86.5	13.5
-38	-400	27.2	13.5	100.0	-
	Total	201.9	100.0	-	-

Product: Cyclone Underflow Test No: PP-9

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
833	20	0.7	0.3	0.3	99.7
589	28	1.6	0.6	0.8	99.2
417	35	4.4	1.6	2.5	97.5
295	48	9.6	3.5	6.0	94.0
208	65	23.1	8.5	14.5	85.5
147	100	42.7	15.7	30.2	69.8
104	150	57.1	21.0	51.2	48.8
74	200	52.7	19.4	70.6	29.4
53	270	38.0	14.0	84.6	15.4
38	400	18.0	6.6	91.2	8.8
-38	-400	24.0	8.8	100.0	-
	Total	271.9	100.0	-	-

Test PP-9- Continued

1.1.4. Size Analyses: Continued

Product: Cyclone Overflow Test No: PP-9

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	2.7	1.2	1.2	98.8
147	100	4.4	2.0	3.2	96.8
104	150	9.2	4.2	7.4	92.6
74	200	16.7	7.6	15.1	84.9
53	270	24.5	11.2	26.3	73.7
38	400	26.0	11.9	38.1	61.9
-38	-400	135.4	61.9	100.0	-
	Total	218.9	100.0	-	-

1.1.5. Observations: Circuit operation was stable.

Test PP-9 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: As in Test PP-7.

1.2.2. Method: As In Test PP-7.

1.2.2.1. Flowsheet Equipment

As In Test PP-7.

1.2.2.2. Mill Loads

As In Test PP-7.

1.2.2.3. Classification Equipment

As for Test PP-7.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Hazen Quinn	-	1458	1453	1230	Feed Cycl O/Flow	77.9 90.5	64.8 77.6	42.7 52.3	25 18
Pb-Denver	-	2105	2385	1205	Feed Cycl O/Flow	94.0 99.6	86.0 96.9	60.4 70.0	14 11
Zn-Denver	-	2325	2365	1250	Feed Cycl O/Flow	38.6 74.0	29.4 56.1	19.8 35.9	82 28

1.2.3. Flowsheet: As in Test PP-1.

Test PP-9 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-9 S.G.- 4.84

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	2.16	4.3	4.3	95.7
30.7μ	4.53	9.1	13.4	86.6
23.8	4.36	8.7	22.1	77.9
16.6	6.55	13.1	35.2	64.8
11.4	7.72	15.4	50.6	49.4
8.8	3.33	6.7	57.3	42.7
-8.8	21.35	42.7	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-9 S.G.- 4.75

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.24	0.5	0.5	99.5
31.1μ	1.50	3.0	3.5	96.5
24.1	3.03	6.1	9.5	90.5
16.8	6.42	12.8	22.4	77.6
11.6	8.64	17.3	39.7	60.3
8.9	4.00	8.0	47.7	52.3
-8.9	26.17	52.3	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-9 S.G.-4.99

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
30.0μ	1.25	2.5	2.5	97.5
23.3	1.73	3.5	6.0	94.0
16.2	4.01	8.0	14.0	86.0
11.2	8.17	16.3	30.3	69.7
8.6	4.62	9.2	39.6	60.4
-8.6	30.22	60.4	100.0	-
Total	50.00	100.0	-	-

Test PP-9 - Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-9 S.G.- 4.94

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
30.3μ	0.00	0.0	0.0	100.0
23.5	0.19	0.4	0.4	99.6
16.4	1.36	2.7	3.1	96.9
11.3	7.94	15.9	19.0	81.0
8.7	5.52	11.0	30.0	70.0
-8.7	34.99	70.0	100.0	-
Total	50.00	100.0	-	-

Product: Zn Scalp Conc Test No: PP-9 S.G.- 4.45

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
150	4.98	10.0	10.0	90.0
200	6.76	13.5	23.5	76.5
270	7.66	15.3	38.8	61.2
32.2μ	6.34	12.7	51.5	48.5
25.0	4.97	9.9	61.4	38.6
17.4	4.57	9.1	70.6	29.4
12.0	3.64	7.3	77.8	22.2
9.3	1.16	2.3	80.2	19.8
-9.3	9.92	19.8	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-9 S.G.- 4.42

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	1.23	2.5	2.5	97.5
32.2μ	4.34	8.7	11.1	88.9
25.0	7.42	14.8	26.0	74.0
17.4	8.94	17.9	43.9	56.1
12.0	7.44	14.9	58.7	41.3
9.3	2.66	5.3	64.1	35.9
-9.3	17.97	35.9	100.0	-
Total	50.00	100.0	-	-

Test PP-9- Continued

1.2.5. Observations:

Circuit operation was stable.
Regrind sizes were similar to those in Tests PP-7 and 8 with Ore Type 5, although the Pb regrind was a bit finer.

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	2.0	% moisture	
Primary Rod Mill Feed	523	kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	200	kg of 62mm dia. rods	
	200	kg of 37-50mm dia. rods	
Rod Mill Discharge:	2,097 g/L	(68 % Sol at SG 4.25)	
	83.8	% minus 48 mesh	
	48.2	% minus 200 mesh	
Input Power:	20.28	3 disc revolutions	
	4.79 kW	95% drive efficiency)	
Average Power:	4.55 kW	Gross	
	1.771	No Load	
	2.78	Net	
Net Power Usage:	5.3		
K80 Feed:	4271	microns	
K80 Product:	251	microns	
W. Index (metric):	11.1		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	523	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	250	kg of 50mm balls	
	150	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,910 g/L	(62 % Sol at SG 4.25)	
	95.6	% minus 48 mesh	
	33.3	% minus 200 mesh	
Circulating Load	567	%	
Input Power:	14.55	sec for 3 disc revolutions	
	6.68 kW	95% drive efficiency)	
Average Power:	6.35 kW	Gross	
	1.60	No Load	
	4.75	Net	
Net Power Usage:	9.1	kWh/t	
K80Feed:	251	microns	
K80 Product:	64	microns	
W. Index (metric):	14.7		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	14.4 kWh/t
K80 Feed:	4271 microns
K80 Product:	64 microns
Work Index :	13.1 metric
Flot. Feed :	84.9% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	523	kg/h	
Denver Mill 2 Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	1,458 g/L		(40 % Sol at SG 4.80)
Input Power:	34.48		sec for 3 disc revolutions
	1.13 kW		95% drive efficiency)
Average Power:	1.07 kW	Gross	
	0.62	No Load	
	0.46	Net	
K80 Feed:	25	microns	
K80 Product:	18	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	523	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	2,105 g/L		(66 % Sol at SG 4.97)
Input Power:	69.42		sec for 3 disc revolutions
	1.40 kW		95% drive efficiency)
Average Power:	1.33 kW	Gross	
	0.69	No Load	
	0.64	Net	
K80 Feed:	14	microns	
K80 Product:	11	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	523	kg/h	
Denver Mill 1 Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	225	kg of 25 mm balls	
	225	kg total	
Ball Mill Discharge:	2,325 g/L		(74 % Sol at SG 4.44)
Input Power:	26.61		sec for 3 disc revolutions
	1.46 kW		95% drive efficiency)
Average Power:	1.39 kW	Gross	
	0.61	No Load	
	0.78	Net	
K80 Feed:	79	microns	
K80 Product:	28	microns	

2. FLOTATION

2.1. Purpose: Flotation of the Ore Blend with an extended Pb 1st cleaner circuit, and without Pb 1st cleaner scavenger flotation.

2.2. Method: The following changes were made:

i) The Flowsheet used In Test PP-5 was used, with recycle of the Pb 1st cleaner tail to the Pb rougher H.I. conditioner.

ii) The Pb 1st cleaner scavenger was eliminated.

iii) Collector A317 was used in the semi-bulk-lead circuit, without the 3418A. R242 was not used.

The 1st semi-bulk flotation cells were surveyed, with lip samples of the concentrate and the tail being assayed for Pb and Zn.

2.2.1. Flowsheet Equipment

The Pb 1st cleaner used a bank of 4 Denver D7 cells and a bank of 4 Denver DR7 cells.

2.2.2. Conditioning Parameters

As In Test PP-1.

2.2.3. Circuit Operation

The circuit was operated for a period of 8.0 hours, and was sampled every 30 minutes during the last 1.0 hour of operation.

TEST PP-9

2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	198.5	2277
Ball Mill Feed		A317	5.0	5.8	33
Bulk Rougher 1 Feed		CA830/TH	2.0	0.0	0
Bulk Rougher 1 Feed		A317	5.0	2.0	11
Bulk Rougher 1 Feed	*	MIBC	100.0	43.8	25
Bulk Rougher 2 Feed		CA830/TH	2.0	0.0	0
Bulk Rougher 2 Feed		A317	5.0	6.0	34
Bulk Rougher 2 Feed	*	MIBC	100.0	10.0	6
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	19.0	218
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	104.3	479
Pb Rougher H.I. Conditioner		CA830/TH	2.0	0.0	0
Pb Rougher H.I. Conditioner		A317	5.0	6.8	39
Pb Rougher H.I. Conditioner	*	MIBC	100.0	4.0	2
Pb Rougher Cell 5		A317	5.0	3.0	17
Pb Rougher Cell 5	*	MIBC	100.0	6.7	4
Pb Concentrate Regrind Mill Feed		SD200/NaCN	4.0	75.0	344
Pb Concentrate Regrind Mill Feed		Na2CO3	10.0	24.7	283
Pb 1st Cleaner H.I. Conditioner		A317	5.0	0.0	0
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	4.0	2
Pb 2nd Cleaner Feed		Na2CO3	10.0	19.2	220
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	30.0	138
Pb 3rd Cleaner Feed		A317	5.0	0.3	2
Pb 3rd Cleaner Feed		MIBC	1.0	1.3	1
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	25.0	115
Pb 4th Cleaner Feed		SD200/NaCN	4.0	20.0	92
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	78.5	901
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	100.0	1147
Zn Scalp Feed	*	M2030	100.0	14.0	8
Zn Scalp Feed		A317	5.0	22.0	126
Zn Scalp Feed	*	DF250	100.0	85.0	49
Zn Scalp Cell 5	*	M2030	100.0	7.8	4
Zn Scalp Cell 5		A317	5.0	8.0	46
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	50.5	579
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	14.0	161
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	60.0	688
Zn Prefloat Conditioner 2 Feed		CuSO4.5H2O	10.0	40.0	459
Zn Prefloat Feed	*	M2030	100.0	15.3	9
Zn Prefloat Feed		A317	5.0	11.6	67
Zn Prefloat Cell 3	*	M2030	100.0	5.0	3
Zn Prefloat Cell 3		A317	5.0	6.0	34
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	10.4	6
Zn 1st Cleaner H.I. Conditioner		A317	5.0	15.0	86
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	0.0	0
Zn 1st Cleaner Scavenger Feed		A317	5.0	6.0	34
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	108.2	1241
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	49.2	564

* Drops per minute

Feed Rate= 523 kg/h

Test PP-9- Continued

2.3. Flowsheet: As for Test PP-5.

2.4. Results: 2.4.1. Observations

Zn selectivity was extremely poor in the Pb circuit. It was extremely difficult to obtain any consistent level of froth in the Pb 3rd and 4th cleaners without collector and frother additions.

Mechanical electrical troubles reduced the Pb 1st cleaner cells to 7 from 8 at 15:00, just one hour before sampling.
The semi-bulk collector and frother were sharply decreased just before commencement of sampling in an effort to improve selectivity.
The Zn scalp and prefloat collectors were increased at the start of the sampling period due to high losses as indicated in the grab assays.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2097	10.6	-
Ball Mill Discharge	1910	-	-
Cyclone Underflow	2770	-	-
Cyclone Overflow	1300	10.0	13
Semi-bulk Rougher Tail	1240	9.8	-
Semi-bulk Regrind Discharge	1458	-	-
Semi-bulk Regrind Cyc U/Flow	1453	-	-
Semi-bulk Regrind Cyc O/Flow	1230	-	-
Pb Rougher Feed	1090	10.1	10
Pb Rougher Tail	1058	-	-
Pb Regrind Discharge	2105	-	-
Pb Regrind Cyclone U/Flow	2385	-	-
Pb Regrind Cyclone O/Flow	1205	-	-
Pb 1st Cleaner	-	10.2	-
Pb 1st Cleaner Tail	1068	-	-
Pb 2nd Cleaner Feed	-	10.0	-
Pb 3rd Cleaner Feed	-	10.0	-
Pb 4th Cleaner Feed	-	9.9	-
Zn Scalp Feed	-	10.4	15
Zn Scalp Tail	1155	-	-
Zn Regrind Discharge	2325	-	-
Zn Regrind Cyclone U/Flow	2365	-	-
Zn Regrind Cyclone O/Flow	1250	-	-
Zn Prefloat Feed	-	11.4	-
Zn Prefloat Tail	1025	-	-
Zn 1st Cleaner Feed	1113	11.8	-
Zn Cleaner Scavenger Tail	1065	11.6	-
Zn 2nd Cleaner Feed	-	12.3	-
Zn 3rd Cleaner Feed	-	12.0	-
Thickener Underflow	1150	-	-

Test PP-9 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
11:30	Pb 4th Cleaner Conc	46.7	22.9
	Zn 3rd Cleaner Conc	1.32	55.0
	Zn Cleaner Scavenger Tail	1.14	1.18
	Zn Prefloat Tail	1.79	1.61
	Zn Scalp Tail	0.64	1.41
	Zn Combined Tail	0.85	1.66
	Pb Rougher Conc	16.7	19.0
12:30	Pb 4th Cleaner Conc	51.0	18.0
	Zn 3rd Cleaner Conc	1.70	45.8
	Zn Cleaner Scavenger Tail	0.94	0.77
	Zn Prefloat Tail	1.53	2.71
	Zn Scalp Tail	0.45	0.47
	Zn Combined Tail	0.75	0.80
	Pb Rougher Conc	17.1	19.5
13:30	Pb 4th Cleaner Conc	57.6	18.4
	Zn 3rd Cleaner Conc	1.92	38.5
	Zn Cleaner Scavenger Tail	0.86	0.57
	Zn Prefloat Tail	1.75	5.08
	Zn Scalp Tail	1.43	2.95
	Zn Combined Tail	0.44	0.40
	Pb Rougher Conc	19.4	20.9
14:30	Pb 4th Cleaner Conc	56.1	20.7
	Zn 3rd Cleaner Conc	2.26	42.3
	Zn Cleaner Scavenger Tail	1.10	0.74
	Zn Prefloat Tail	1.50	4.06
	Zn Scalp Tail	0.47	0.34
	Zn Combined Tail	0.92	1.25
	Pb Rougher Conc	22.1	21.4
15:30	Pb 4th Cleaner Conc	45.1	26.3
	Zn 3rd Cleaner Conc	2.61	39.4
	Zn Cleaner Scavenger Tail	1.32	1.20
	Zn Prefloat Tail	2.21	6.60
	Zn Scalp Tail	0.46	0.39
	Zn Combined Tail	0.90	1.25
	Pb Rougher Conc	23.9	24.5
16:30	Pb 4th Cleaner Conc	27.0	42.4
	Zn 3rd Cleaner Conc	3.52	48.0
	Zn Cleaner Scavenger Tail	1.66	1.97
	Zn Prefloat Tail	2.58	8.06
	Zn Scalp Tail	0.42	0.33
	Zn Combined Tail	1.17	1.73
	Pb Rougher Conc	30.3	20.9

Test PP-9 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Semi-bulk Ro Conc 1 Cell 1 Conc	26.2	8.11	-
Semi-Bulk Ro Conc 1 Cell 2	17.0	9.97	-
Semi-Bulk Ro Conc 1 Cell 3	9.91	11.9	-
Semi-Bulk Ro Conc Cell 4	8.21	12.6	-
Semi-Bulk Rougher 1 Tail	0.91	9.07	-

2.4.5. Metallurgical Results

Product	Weight	Assays, %, g/t			% Distribution		
	%	Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	8.43	25.2	42.1	188	64.4	37.7	23.8
Zn 3rd Cleaner Concentrate	9.85	3.3	47.3	173	9.9	49.5	25.5
Zn Combined Tails	81.71	1.04	1.48	41.4	25.8	12.8	50.7
Head(calc)	100.00	3.30	9.42	64.3	100.0	100.0	100.0

TEST NO. PP-10

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: Grinding of the PP Composite No. 2 ore (-9.5 mm) using a screen for classification.

1.1.2. Method: The ore feed rate was about 600 kg/hour. The ore was ground in the rod mill, and the rod mill discharge was pumped to the ball mill discharge pump. The combined ball mill-rod mill discharges were pumped to a Derrick 150 mesh (aperature 109 µm) screen. The screen undersize was fed to the ball mill and the screen undersize was pumped to semi-bulk flotation.
The ball mill steel charge was increased to 400 kg prior to the sampling period. Ball mill discharge pulp densities were generally kept above 2100-2200 g/L through this testwork.

1.1.2.1. Flowsheet Equipment

Marcy Rod Mill, Hendy Ball Mill

1.1.2.2. Mill Loads

Rod Mill :	155 kg of 62 mm rods 150 kg of 38-50 mm rods
Ball Mill :	188 kg of 50 mm balls, with another 100 kg added prior to sampling 112 kg of 25 mm balls

1.1.2.3. Classification Equipment

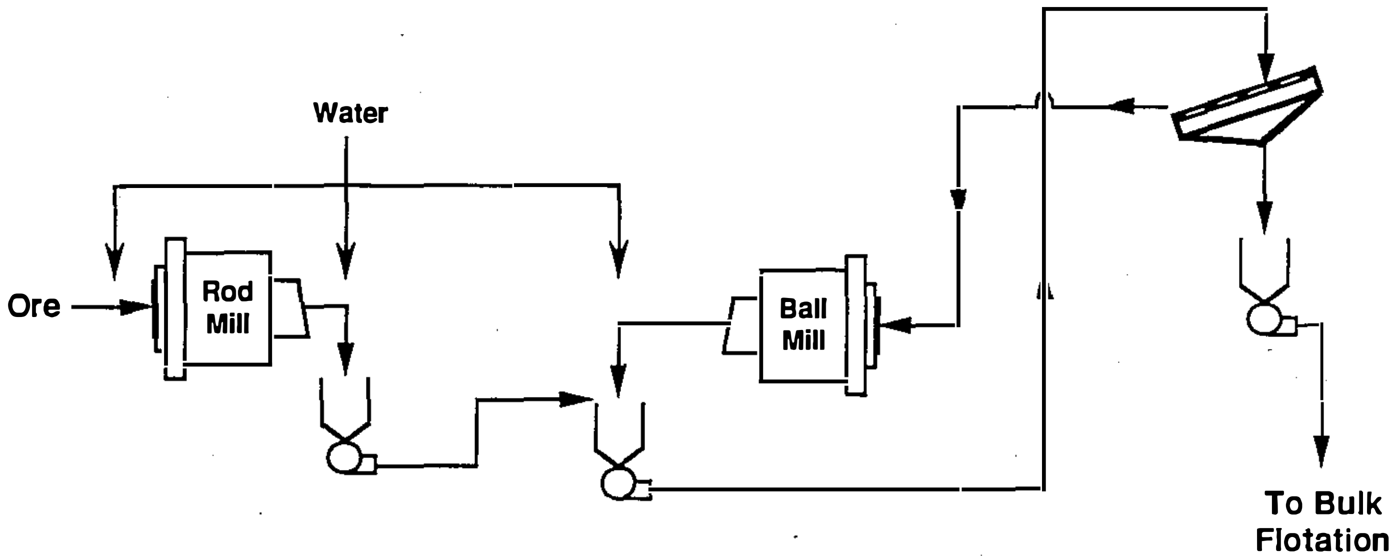
Derrick J18-72A-35M vibrating screen supplied with three1 09 µm aperature Derrick DF165 (approximately 150 mesh) screens, with a water spray.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 9.5 hours and was sampled every 30 minutes during the last 4.0 hours of operation. The average feed rate was 590 kg/h of dry ore.

Test PP-10 - Continued

1.1.3. Flowsheet:



1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-10

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	7.7	0.9	0.9	99.1
6,680	3	33.1	3.8	4.7	95.3
4,699	4	96.3	11.2	15.9	84.1
3,327	6	105.1	12.2	28.1	71.9
2,362	8	65.8	7.6	35.7	64.3
1,651	10	95.9	11.1	46.8	53.2
1,168	14	60.8	7.0	53.9	46.1
833	20	44.9	5.2	59.1	40.9
589	28	39.0	4.5	63.6	36.4
417	35	33.0	3.8	67.4	32.6
295	48	24.8	2.9	70.3	29.7
208	65	21.8	2.5	72.8	27.2
147	100	22.4	2.6	75.4	24.6
104	150	21.1	2.4	77.9	22.1
74	200	23.0	2.7	80.5	19.5
53	270	25.5	3.0	83.5	16.5
38	400	23.5	2.7	86.2	13.8
-38	-400	118.9	13.8	100.0	-
	Total	862.6	100.0	-	-

Test PP-10 - Continued

1.1.4. Size Analyses: Continued

Product: Rod Mill Discharge Test No: PP-10

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.5	0.2	0.2	99.8
1,168	14	1.7	0.6	0.7	99.3
833	20	5.4	1.8	2.5	97.5
589	28	12.5	4.1	6.6	93.4
417	35	22.4	7.3	13.9	86.1
295	48	26.3	8.6	22.5	77.5
208	65	29.9	9.8	32.3	67.7
147	100	28.7	9.4	41.7	58.3
104	150	24.7	8.1	49.8	50.2
74	200	22.3	7.3	57.1	42.9
53	270	23.6	7.7	64.8	35.2
38	400	19.9	6.5	71.3	28.7
-38	-400	87.7	28.7	100.0	-
	Total	305.6	100.0	-	-

Product: Ball Mill Discharge Test No: PP-10

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
589	28	2.7	0.8	0.8	99.2
417	35	8.4	2.5	3.4	96.6
295	48	20.3	6.1	9.5	90.5
208	65	43.2	13.0	22.5	77.5
147	100	76.4	23.1	45.6	54.4
104	150	82.5	24.9	70.5	29.5
74	200	35.7	10.8	81.3	18.7
53	270	19.2	5.8	87.1	12.9
38	400	10.7	3.2	90.3	9.7
-38	-400	32.1	9.7	100.0	-
	Total	331.2	100.0	-	-

Test PP-10 - Continued

1.1.4. Size Analyses: Continued

Product: Derrick Screen Oversize Test No: PP-10

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
833	20	1.3	0.4	0.4	99.6
589	28	3.4	1.1	1.5	98.5
417	35	10.6	3.3	4.8	95.2
295	48	22.6	7.1	12.0	88.0
208	65	45.8	14.5	26.4	73.6
147	100	67.0	21.2	47.6	52.4
104	150	76.1	24.0	71.7	28.3
74	200	40.4	12.8	84.4	15.6
53	270	16.5	5.2	89.6	10.4
38	400	8.5	2.7	92.3	7.7
-38	-400	24.3	7.7	100.0	-
	Total	316.5	100.0	-	-

Product: Derrick Screen Undersize Test No: PP-10

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	2.2	1.3	1.3	98.7
147	100	2.8	1.6	2.9	97.1
104	150	3.5	2.1	5.0	95.0
74	200	13.4	7.9	12.9	87.1
53	270	19.5	11.5	24.3	75.7
38	400	19.2	11.3	35.6	64.4
-38	-400	109.6	64.4	100.0	-
	Total	170.2	100.0	-	-

Test PP-10 - Continued

1.1.4. Size Analyses: Continued

Product: Derrick Screen U'size (11:30 Grab) PP-10

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
208	65	2.4	1.3	1.3	98.7
147	100	3.1	1.6	2.9	97.1
104	150	5.0	2.6	5.5	94.5
74	200	24.8	13.1	18.6	81.4
53	270	31.5	16.6	35.3	64.7
38	400	24.9	13.1	48.4	51.6
-38	-400	97.8	51.6	100.0	-
	Total	189.5	100.0	-	-

1.1.5. Observations: A feed rate of 600 kg was used, which was higher than in previous tests PP-1 to 9.
The circulating load was extremely high and the screen was flooded. Additional balls were therefore added. (The screen vibration direction was reversed after two hours of operation).
The screen undersize prior to the extra ball addition was 80% -70 µm (grab sample); and was 80 % -59 µm after the addition (shift sample).

Test PP-10 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: Regrinding of the semi-bulk, Pb rougher, and Zn scalp concentrates.

1.2.2. Method: Similar to Tests PP-6 to 9, Project 4086 with the following changes:

- the Sala mill was used for semi-bulk regrinding
- the zinc regrinding circuit used a 50 mm cyclone and the Pb regrind and Zn regrind were classified with two 25 mm cyclones.

1.2.2.1. Flowsheet Equipment

Semi-Bulk Regrind :	Sala ball mill, 1067 mm x 610 m diameter
Pb Regrind :	Hazen Quinn ball mill, 812 mm x 406 mm diameter
Zn Regrind :	Denver ball mill, 812 mm x 406 mm diameter

1.2.2.2. Mill Loads

Semi-Bulk Regrind :	400 kg of -25 mm balls (100 kg added after 45 hours)
Pb Regrind :	200 kg of 25 mm balls
Zn Regrind :	225 kg of 25 mm balls

1.2.2.3. Classification Equipment

Semi-Bulk Regrind :	2 x 25 mm Dorr cyclones	25 mm diameter 5 mm apex 8 mm vortex
Pb Regrind :	2 x 25 mm Krebs cyclones	25 mm diameter 6.4 mm apex 7 mm vortex
Zn Regrind :	50 mm Mozley cyclone	50 mm diameter 6.4 mm apex 14 mm vortex

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Sala	-	1730	1646	1170	Feed Cycl O/Flow	77.3 98.3	65.2 91.7	44.9 66.2	27 13
Pb-Hazen Quinn	-	1996	1940	1148	Feed Cycl O/Flow	98.0 99.6	92.6 97.1	66.9 71.2	12 11
Zn-Denver	-	2258	2254	1184	Feed Cycl O/Flow	49.8 79.2	40.7 61.5	33.4 42.2	56 26

Test PP-10 - Continued

1.2.3. Flowsheet: See section 2.3. (as in Tests PP-1 to 9).

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-10 S.G.- 4.65

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	2.24	4.5	4.5	95.5
31.8µ	5.17	10.3	14.8	85.2
24.6	3.95	7.9	22.7	77.3
17.2	6.02	12.0	34.8	65.2
11.8	7.27	14.5	49.3	50.7
9.1	2.90	5.8	55.1	44.9
-9.1	22.45	44.9	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-10 S.G.- 4.64

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.8µ	0.24	0.5	0.5	99.5
24.6	0.62	1.2	1.7	98.3
17.2	3.28	6.6	8.3	91.7
11.8	7.86	15.7	24.0	76.0
9.1	4.90	9.8	33.8	66.2
-9.1	33.10	66.2	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-10 S.G.-4.72

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.5µ	0.00	0.0	0.0	100.0
24.4	0.99	2.0	2.0	98.0
17.0	2.70	5.4	7.4	92.6
11.7	7.49	15.0	22.4	77.6
9.0	5.38	10.8	33.1	66.9
-9.0	33.44	66.9	100.0	-
Total	50.00	100.0	-	-

Test PP-10- Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-10 S.G.- 4.61

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.8μ	0.00	0.0	0.0	100.0
24.6	0.21	0.4	0.4	99.6
17.2	1.25	2.5	2.9	97.1
11.8	7.15	14.3	17.2	82.8
9.1	5.81	11.6	28.8	71.2
-9.1	35.58	71.2	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc Test No: PP-10 S.G.- 4.36

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
150	1.00	2.0	2.0	98.0
200	5.54	11.1	13.1	86.9
270	6.93	13.9	26.9	73.1
31.0μ	6.95	13.9	40.8	59.2
25.5	4.67	9.3	50.2	49.8
17.8	4.55	9.1	59.3	40.7
12.2	2.92	5.8	65.1	34.9
9.4	0.74	1.5	66.6	33.4
-9.4	16.70	33.4	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-10 S.G.- 4.33

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.96	1.9	1.9	98.1
33.1μ	3.39	6.8	8.7	91.3
25.6	6.07	12.1	20.8	79.2
17.9	8.84	17.7	38.5	61.5
12.3	7.37	14.7	53.3	46.7
9.5	2.26	4.5	57.8	42.2
-9.5	21.11	42.2	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations: Problems were encountered with cyclones plugging which disrupted the stability of the flotation circuits.

Test No. PP-10

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	2.4	% moisture	
Primary Rod Mill Feed	590	dry kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	155	kg of 62mm dia. rods	
	150	kg of 37-50mm dia. rods	
	305	kg total	
Rod Mill Discharge:	2,098 g/L	(68 % Sol at SG	4.25)
	42.9	% minus 48 mesh	
	28.7	% minus 200 mesh	
Input Power:	24.33	3 disc revolutions	
	4.00 kW	95% drive efficiency)	
Average Power:	3.80 kW	Gross	
	1.771	No Load	
	2.02	Net	
Net Power Usage:	3.4		
K80 Feed:	4087	microns	
K80 Product:	326	microns	
W. Index (metric):	8.6		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	590	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	288	kg of 50mm balls	
	112	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	2,167 g/L	(70 % Sol at SG	4.25)
	90.5	% minus 48 mesh	
	18.7	% minus 200 mesh	
Circulating Load	950	%	
Input Power:	14.86	sec for 3 disc revolutions	
	6.54 kW	95% drive efficiency)	
Average Power:	6.21 kW	Gross	
	1.60	No Load	
	4.61	Net	
Net Power Usage:	7.8	kWh/t	
K80 Feed:	326	microns	
K80 Product:	59	microns	
W. Index (metric):	10.5		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	11.3 kWh/t
K80 Feed:	4087 microns
K80 Product:	59 microns
Work Index :	9.8 metric
Flot. Feed :	87.1% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	590	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	400	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,730 g/L		(53 % Sol at SG 4.77)
Input Power:	10.37		sec for 3 disc revolutions
	3.75 kW		95% drive efficiency)
Average Power:	3.56 kW	Gross	
	1.18	No Load	
	2.38	Net	
K80 Feed:	27	microns	
K80 Product:	13	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	590	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	1,996 g/L		(64 % Sol at SG 4.61)
Input Power:	27.79		sec for 3 disc revolutions
	1.40 kW		95% drive efficiency)
Average Power:	1.33 kW	Gross	
	0.69	No Load	
	0.64	Net	
K80 Feed:	12	microns	
K80 Product:	11	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	590	kg/h	
Denver Mill Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	225	kg of 25 mm balls	
	225	kg total	
Ball Mill Discharge:	2,258 g/L		(72 % Sol at SG 4.38)
Input Power:	70.16		sec for 3 disc revolutions
	1.39 kW		95% drive efficiency)
Average Power:	1.32 kW	Gross	
	0.61	No Load	
	0.70	Net	
K80 Feed:	56	microns	
K80 Product:	26	microns	

2. FLOTATION

2.1. Purpose: Flotation of screen classified feed.

2.2. Method: The circuit and operation were similar to that in Test PP-5, Project 4086, with the following changes:

- The Pb rougher consisted of two banks : 6 Agitair 15 cells, and 4 Denver D7 tank cells.
- The Pb 1st cleaner consisted of 5 Denver D7 sub-A cells
- The Pb 4th cleaner consisted of only 1 Denver D5 cell
- The Zn scalp circuit consisted of two banks of Denver D8 cells.

The reagent scheme for semi-bulk/Pb flotation was similar to that in Test PP-1 with CA830/Thiourea as a secondary collector. The reagent scheme for zinc flotation was similar to that in Test PP-5.

2.2.1. Flowsheet Equipment

Semi-bulk Flotation:

Semi-bulk Rougher 1 :	Denver D8 cells, bank of 4 cells
Semi-bulk Rougher 2 :	Denver D8 cells, bank of 4 cells

Pb Flotation:

Pb Ro Conditioner:	Lakefield Research 500L High Intensity Conditioner
Pb Rougher 1:	Agitair 15 cells, bank of 6 cells
Pb Rougher 2:	Denver D7 tank cells, bank of 4 cells
Pb Cl Conditioner:	Lakefield Research 300L High Intensity Conditioner
Pb 1st Cleaner:	Denver D7 Sub-A cells, 5 cells
Pb 2nd Cleaner:	Denver D5 Sub-A cells, 4 cells
Pb 3rd Cleaner:	Denver D5 Sub-A cells, 2 cells
Pb 4th Cleaner:	Denver D5 Sub-A cells, 1 cell

Zn Flotation:

Zn Scalp Cond 1:	Hazen Quinn 400L Conditioner
Zn Scalp Cond 2:	Hazen Quinn 300L Conditioner
Zn Scalp 1:	Minpro D8 cells, bank of 4 cells
Zn Scalp 2:	Minpro D8 cells, bank of 4 cells
Zn Prefloat Cond 1:	Denver 200L Conditioner
Zn Prefloat Cond 2:	Denver 250L Conditioner
Zn Prefloat:	Agitair 15 cells, bank of 6 cells
Zn 1st Cl Conc:	Lakefield Research 500L High Intensity Conditioner
Zn 1st Cleaner:	Denver DR7 cells, 5 cells
Zn 1st Cl Scav:	Denver DR7 cells, bank of 6 cells
Zn 2nd Cleaner:	Denver D7 Sub-A cells, 3 cells
Zn 3rd Cleaner:	Denver D7 Sub-A cells, 2 cells

Liquid/Solid Separation:

Zn Scalp Tails :	Sala 5180 L tank thickener

Test PP-10 - Continued

2.2.2. Conditioning Parameters

Conditioner	Type	Volume L	Impeller diameter	Speed rpm
Pb Rougher	High intensity	400	483 mm	490
Pb 1st Cleaner	High intensity	300	279 mm	305
Zn Scalp 1	Conventional	400	-	-
Zn Scalp 2	Conventional	150	-	-
Zn Prefloat 1	Conventional	200	-	-
Zn Prefloat 2	Conventional	200	-	-
Zn 1st Cleaner	High Intensity	400	406 mm	483

2.2.3. Circuit Operation

The circuit was operated for a period of 9.5 hours, and was sampled every 30 minutes during the last 4.0 hours of operation.

TEST PP-10

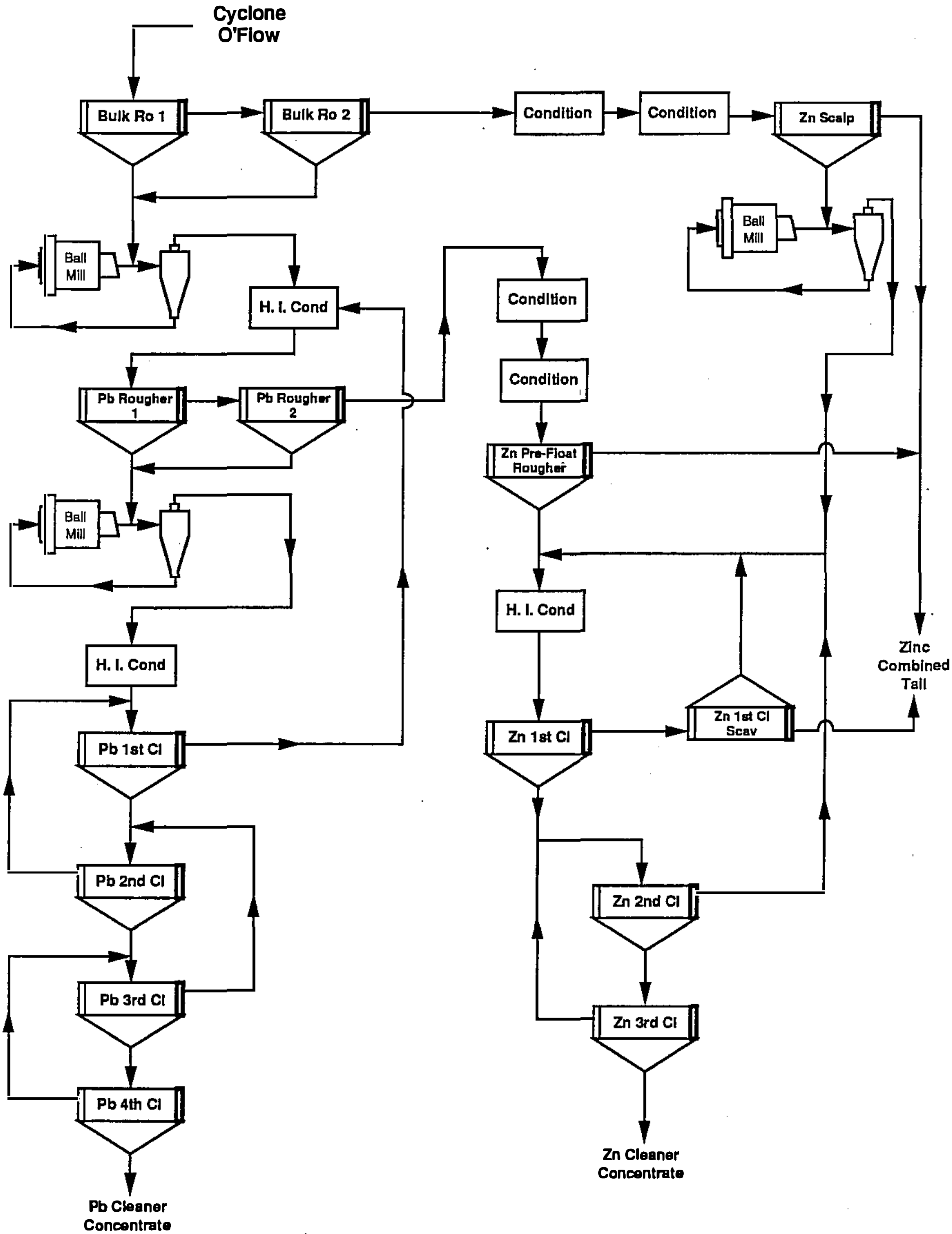
2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	250.0	2542
Ball Mill Feed		CA830/TH	2.0	5.0	10
Ball Mill Feed		A317	5.0	2.0	10
Bulk Rougher 1 Feed		CA830/TH	2.0	9.0	18
Bulk Rougher 1 Feed		A317	5.0	10.0	51
Bulk Rougher 1 Feed	*	MIBC	100.0	42.6	22
Bulk Rougher 2 Feed		CA830/TH	2.0	3.2	7
Bulk Rougher 2 Feed		A317	5.0	2.0	10
Bulk Rougher 2 Feed	*	MIBC	100.0	6.7	3
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	29.1	296
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	73.2	298
Pb Rougher H.I. Conditioner		CA830/TH	2.0	7.0	14
Pb Rougher H.I. Conditioner		A317	5.0	13.7	70
Pb Rougher 1 Feed	*	MIBC	100.0	23.7	12
Pb Rougher 2 Feed		CA830/TH	2.0	4.7	10
Pb Rougher 2 Feed		A317	5.0	0.0	0
Pb Rougher 2 Feed	*	MIBC	100.0	18.6	9
Pb Concentrate Regrind Mill Feed		Na2CO3	10.0	10.0	102
Pb Concentrate Regrind Mill Feed		SD200/NaCN	4.0	105.0	427
Pb 1st Cleaner H.I. Conditioner		CA830/TH	2.0	15.8	32
Pb 1st Cleaner H.I. Conditioner		A317	5.0	2.0	10
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	14.1	7
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	20.4	83
Pb 2nd Cleaner Feed		MIBC	100.0	0.0	0
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	19.8	81
Pb 3rd Cleaner Feed		MIBC	100.0	0.0	0
Pb 4th Cleaner Feed		SD200/NaCN	4.0	40.2	164
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	68.0	692
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	91.9	935
Zn Scalp 1 Feed	*	M2030	100.0	14.8	8
Zn Scalp 1 Feed		A317	5.0	14.6	74
Zn Scalp 1 Feed	*	DF250	100.0	75.6	38
Zn Scalp 2 Feed	*	M2030	100.0	6.0	3
Zn Scalp 2 Feed		A317	5.0	1.0	5
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	61.3	623
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	16.4	167
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	90.6	921
Zn Prefloat Conditioner 2 Feed		CuSO4.5H2O	10.0	39.8	405
Zn Prefloat Feed	*	M2030	100.0	14.0	7
Zn Prefloat Feed		A317	5.0	10.0	51
Zn Prefloat Cell 4	*	M2030	100.0	0.0	0
Zn Prefloat Cell 4		A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	14.4	7
Zn 1st Cleaner H.I. Conditioner		A317	5.0	16.0	81
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	1.0	1
Zn 1st Cleaner Scavenger Feed		A317	5.0	2.3	12
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	158.0	1607
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	132.0	1342

* Drops per minute

Feed Rate= 590 kg/h

2.3. Flowsheet:



Test PP-10- Continued

2.4. Results:

2.4.1. Observations

Flotation stability was frequently disrupted by cyclone plugging. However, good Pb product grades were generally obtained (by X-Met). Zinc product grades were generally less than 50% (by X-Met) and recoveries were good.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2167	11.2	-
Ball Mill Discharge	2173	-	-
Screen U/Size/Semi-bulk Feed	1322	10.7	14
Semi-bulk 2 Tail	1272	10.5	-
Semi-bulk Regrind Mill Disch	1730	-	-
Semi-bulk Regrind Cyc U/Flow	1646	-	-
Semi-bulk Regrind Cyc O/Flow	1170	-	-
Pb Rougher 1 Feed	1082	10.5	20
Pb Rougher 2 Tail	1040	-	-
Pb Regrind Mill Discharge	1996	-	-
Pb Regrind Cyclone U/Flow	1940	-	-
Pb Regrind Cyclone O/Flow	1148	-	-
Pb 1st Cleaner Feed	-	10.6	-
Pb 1st Cleaner Tail	1084	-	-
Pb 2nd Cleaner	-	10.6	-
Pb 3rd Cleaner	-	10.6	-
Pb 4th Cleaner	-	10.6	-
Zn Scalp 1 Feed	-	11.0	16
Zn Scalp 2 Tail	1240	-	-
Zn Regrind Mill Discharge	2258	-	-
Zn Regrind Cyclone U/Flow	2254	-	-
Zn Regrind Cyclone O/Flow	1184	-	-
Zn Prefloat Feed	-	11.7	-
Zn Prefloat Tail	1024	-	-
Zn 1st Cleaner Feed	1122	12.5	-
Zn 1st Cleaner Scav Feed	-	-	-
Zn 1st Cleaner Scav Tail	1082	-	-
Zn 2nd Cleaner	-	12.7	-
Zn 3rd Cleaner	-	12.7	-
Thickener Underflow	1040	-	-

Test PP- 10 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
21:30	Pb 4th Cleaner Conc	49.0	9.0
	Zn 4th Cleaner Conc	1.11	51.0
	Zn 1st Cleaner Scav Tail	-	-
	Zn Prefloat Tail	-	-
	Zn Scalp Tail	-	-
	Zn Combined Tail	0.45	0.38
22:30	Pb 4th Cleaner Conc	60.2	7.60
	Zn 4th Cleaner Conc	0.96	48.9
	Zn 1st Cleaner Scav Tail	0.81	0.51
	Zn Prefloat Tail	2.40	1.06
	Zn Scalp Tail	0.29	0.25
	Zn Combined Tail	0.90	0.46
23:30	Pb 4th Cleaner Conc	75.7	2.27
	Zn 4th Cleaner Conc	0.99	45.8
	Zn 1st Cleaner Scav Tail	0.81	0.41
	Zn Prefloat Tail	2.04	1.22
	Zn Scalp Tail	0.31	0.40
	Zn Combined Tail	0.55	0.34
24:30	Pb 4th Cleaner Conc	68.6	3.74
	Zn 4th Cleaner Conc	1.04	51.4
	Zn 1st Cleaner Scav Tail	0.87	0.62
	Zn Prefloat Tail	2.28	1.67
	Zn Scalp Tail	0.37	0.23
	Zn Combined Tail	0.87	0.70
1:00	Pb 4th Cleaner Conc	62.7	6.19
1:30	Pb 4th Cleaner Conc	66.4	4.18
	Zn 4th Cleaner Conc	1.09	46.3
	Zn 1st Cleaner Scav Tail	0.81	0.78
	Zn Prefloat Tail	2.11	6.12
	Zn Scalp Tail	0.37	0.33
	Zn Combined Tail	0.79	1.48
2:00	Pb 4th Cleaner Conc	67.0	2.39
2:30	Pb 4th Cleaner Conc	71.8	1.70
	Zn 4th Cleaner Conc	1.12	48.7
	Zn 1st Cleaner Scav Tail	0.88	1.11
	Zn Prefloat Tail	2.16	5.69
	Zn Scalp Tail	0.23	0.30
	Zn Combined Tail	0.76	0.62
3:00	Pb 4th Cleaner Conc	75.7	1.78
3:30	Pb 4th Cleaner Conc	72.6	2.51
	Zn 4th Cleaner Conc	0.92	47.2
	Zn 1st Cleaner Scav Tail	0.76	0.96
	Zn Prefloat Tail	2.21	2.59
	Zn Scalp Tail	0.25	0.20
	Zn Combined Tail	0.72	0.72

Test PP-10 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t			
	Pb	Zn	Ag	Ba
Screen Undersize/Semi-bulk Feed	3.36	9.14	62.2	26.8
Semi-bulk Concentrate	16.5	11.7	-	-
Semi-bulk Tail	0.68	9.36	-	-
Semi-bulk Regrind Cyclone O/Flow	15.6	11.9	-	-
Pb Rougher Feed	11.4	17.8	-	-
Pb Rougher Concentrate	21.2	25.7	-	-
Pb Rougher Tail	3.39	9.61	-	-
Pb Regrind Cyclone Overflow	16.9	22.8	-	-
Pb 1st Cleaner Concentrate	33.7	24.3	-	-
Pb 1st Cleaner Tail	7.26	24.6	-	-
Pb 4th Cleaner Concentrate	76.9	2.57	169	-
Zn Scalp Concentrate	1.06	20.6	-	-
Zn Scalp Tail	0.33	0.18	-	-
Zn Regrind Cyclone Overflow	1.10	20.6	-	-
Zn Prefloat Feed	2.45	4.98	-	-
Zn Prefloat Concentrate	3.66	7.42	-	-
Zn Prefloat Tail	1.72	3.42	-	-
Zn 1st Cleaner Feed	1.15	16.4	-	-
Zn 1st Cleaner Scav Conc	1.64	4.87	-	-
Zn 1st Cleaner Scav Tail	0.85	0.79	-	-
Zn Combined Tail	0.65	0.73	24.6	-
Zn 3rd Cleaner Concentrate	1.27	45.6	167	-

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	3.40	76.9	2.57	169	77.9	1.0	10.4
Zn 3rd Cleaner Concentrate	18.60	1.27	45.6	166	7.0	92.8	55.6
Zn Combined Tails	77.99	0.65	0.73	24.2	15.1	6.2	34.0
Derrick Screen U'Size	100.00	3.36	9.14	62.2	100.0	100.0	100.0

TEST NO. PP-11

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As for Test PP-10.

1.1.2. Method: As for Test PP-10.

1.1.2.1. Flowsheet Equipment

As for Test PP-10.

1.1.2.2. Mill Loads

As for Test PP-10.

1.1.2.3. Classification Equipment

As for Test PP-10.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 8.0 hours and was sampled every 30 minutes during the last 4.0 hours of operation. The average feed rate was 604 kg/h of dry ore.

1.1.3. Flowsheet: As for Test PP-10.

Test PP-11 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed   Test No: PP-11

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	24.3	4.6	4.6	95.4
4,699	4	73.2	13.9	18.5	81.5
3,327	6	51.5	9.8	28.3	71.7
2,362	8	41.4	7.8	36.1	63.9
1,651	10	48.6	9.2	45.3	54.7
1,168	14	35.9	6.8	52.1	47.9
833	20	27.9	5.3	57.4	42.6
589	28	23.9	4.5	61.9	38.1
417	35	20.2	3.8	65.8	34.2
295	48	15.7	3.0	68.8	31.2
208	65	12.8	2.4	71.2	28.8
147	100	14.1	2.7	73.9	26.1
104	150	13.3	2.5	76.4	23.6
74	200	14.9	2.8	79.2	20.8
53	270	16.2	3.1	82.3	17.7
38	400	14.8	2.8	85.1	14.9
-38	-400	78.7	14.9	100.0	-
	Total	527.4	100.0	-	-

Product: Rod Mill Discharge   Test No: PP-11

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	1.6	0.5	0.5	99.5
833	20	5.3	1.7	2.2	97.8
589	28	14.4	4.6	6.8	93.2
417	35	25.4	8.1	14.9	85.1
295	48	27.6	8.8	23.8	76.2
208	65	31.6	10.1	33.9	66.1
147	100	28.1	9.0	42.9	57.1
104	150	24.1	7.7	50.6	49.4
74	200	20.7	6.6	57.2	42.8
53	270	22.2	7.1	64.3	35.7
38	400	18.7	6.0	70.3	29.7
-38	-400	92.9	29.7	100.0	-
	Total	312.6	100.0	-	-

Test PP-11- Continued

1.1.4. Size Analyses: Continued

Product: Derrick.Screen Underflow Test No: PP-11

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	1.4	1.4	1.4	98.6
147	100	1.9	1.9	3.3	96.7
104	150	2.8	2.8	6.0	94.0
74	200	9.7	9.6	15.7	84.3
53	270	12.7	12.6	28.2	71.8
38	400	11.6	11.5	39.7	60.3
-38	-400	60.8	60.3	100.0	-
	Total	100.9	100.0	-	-

1.1.5. Observations:

As for Test PP-10, but the screen was overloaded.

1.2. Regrinding Circuits:

1.2.1. Purpose: As in Test PP-10.

1.2.2. Method: Similar to that in Test PP-10, but the Zn regrind cyclone was changed to two Krebs 25 mm cyclones, and additional balls were added to the Zn regrind mill.

1.2.2.1. Flowsheet Equipment

As in Test PP-10.

1.2.2.2. Mill Loads

Semi-bulk Regrind:	As for Test PP-10.
Pb Regrind:	As for Test PP-10.
Zn Regrind:	275 kg of 25 mm balls (50 kg added)

1.2.2.3. Classification Equipment

Semi-bulk Regrind:	As for Test PP-10.	
Pb Regrind:	As for Test PP-10.	
Zn Regrind:	2 x 25 mm Krebs cyclones	25 mm diameter 6.4 mm apex 7 mm vortex

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Sala	-	1673	1443	1210	Feed Cycl O/Flow	71.8 93.6	57.3 79.6	36.1 52.1	31 17
Pb-Hazen	-	2173	2323	1245	Feed Cycl O/Flow	97.3 99.3	90.3 96.0	58.9 68.1	14 12
Zn-Denver	-	1973	2046	1295	Feed Cycl O/Flow	36.2 71.6	28.5 56.6	20.7 38.7	85 31

1.2.3. Flowsheet: As in Test PP-10.

Test PP-11 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-11 S.G.- 4.69

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	2.86	5.7	5.7	94.3
31.5μ	6.19	12.4	18.1	81.9
24.5	5.06	10.1	28.2	71.8
17.1	7.24	14.5	42.7	57.3
11.7	7.75	15.5	58.2	41.8
9.1	2.85	5.7	63.9	36.1
-9.1	18.05	36.1	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-11 S.G.- 4.69

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.5μ	1.27	2.5	2.5	97.5
24.5	1.94	3.9	6.4	93.6
17.1	6.97	13.9	20.4	79.6
11.7	9.88	19.8	40.1	59.9
9.1	3.89	7.8	47.9	52.1
-9.1	26.05	52.1	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-11 S.G.-4.63

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.8μ	0.68	1.4	1.4	98.6
24.6	0.65	1.3	2.7	97.3
17.2	3.51	7.0	9.7	90.3
11.8	10.10	20.2	29.9	70.1
9.1	5.62	11.2	41.1	58.9
-9.1	29.44	58.9	100.0	-
Total	50.00	100.0	-	-

Test PP-11- Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-11 S.G.- 4.67

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.6μ	0.00	0.0	0.0	100.0
24.5	0.34	0.7	0.7	99.3
17.1	1.66	3.3	4.0	96.0
11.7	8.11	16.2	20.2	79.8
9.1	5.83	11.7	31.9	68.1
-9.1	34.06	68.1	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc Test No: PP-11 S.G.- 4.39

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
150	6.37	12.7	12.7	87.3
200	6.49	13.0	25.7	74.3
270	6.61	13.2	38.9	61.1
32.9μ	7.70	15.4	54.3	45.7
25.5	4.71	9.4	63.8	36.2
17.8	3.85	7.7	71.5	28.5
12.2	2.92	5.8	77.3	22.7
9.4	1.02	2.0	79.3	20.7
-9.4	10.33	20.7	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-11 S.G.- 4.41

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	2.77	5.5	5.5	94.5
32.9μ	5.35	10.7	16.2	83.8
25.5	6.09	12.2	28.4	71.6
17.8	7.51	15.0	43.4	56.6
12.2	6.63	13.3	56.7	43.3
9.4	2.30	4.6	61.3	38.7
-9.4	19.35	38.7	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:

Frequent cyclone plugging continued. The Zn scalp concentrate feed to regrinding was considerably coarser than in previous tests (i.e. 80 % -85 μm).

Test No. PP-11

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	2.1	% moisture	
Primary Rod Mill Feed	604	dry kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	155	kg of 62mm dia. rods	
	150	kg of 37-50mm dia. rods	
	305	kg total	
Rod Mill Discharge:	2,101 g/L	(69 % Sol at SG 4.25)	
	42.8	% minus 48 mesh	
	29.7	% minus 200 mesh	
Input Power:	24.43	3 disc revolutions	
	3.98 kW	95% drive efficiency)	
Average Power:	3.78 kW	Gross	
	1.771	No Load	
	2.01	Net	
Net Power Usage:	3.3		
K80 Feed:	3967	microns	
K80 Product:	334	microns	
W. Index (metric):	8.6		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	604	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	288	kg of 50mm balls	
	112	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	2,122 g/L	(69 % Sol at SG 4.25)	
	-	% minus 48 mesh	
	-	% minus 200 mesh	
Circulating Load	-	%	
Input Power:	15.52	sec for 3 disc revolutions	
	6.26 kW	95% drive efficiency)	
Average Power:	5.95 kW	Gross	
	1.60	No Load	
	4.35	Net	
Net Power Usage:	7.2	kWh/t	
K80 Feed:	334	microns	
K80 Product:	64	microns	
W. Index (metric):	10.2		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	10.5 kWh/t
K80 Feed:	3967 microns
K80 Product:	64 microns
Work Index :	9.6 metric
Flot. Feed :	84.3% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	604	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	400	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,673 g/L	(51 % Sol at SG 4.77)	
Input Power:	10.28	sec for 3 disc revolutions	
	3.78 kW	95% drive efficiency)	
Average Power:	3.59 kW	Gross	
	1.18	No Load	
	2.41	Net	
K80 Feed:	31	microns	
K80 Product:	17	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	604	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	2,173 g/L	(69 % Sol at SG 4.61)	
Input Power:	27.92	sec for 3 disc revolutions	
	1.39 kW	95% drive efficiency)	
Average Power:	1.32 kW	Gross	
	0.69	No Load	
	0.63	Net	
K80 Feed:	14	microns	
K80 Product:	12	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	604	kg/h	
Denver Mill Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	275	kg of 25 mm balls	
	275	kg total	
Ball Mill Discharge:	1,973 g/L	(64 % Sol at SG 4.38)	
Input Power:	73.00	sec for 3 disc revolutions	
	1.33 kW	95% drive efficiency)	
Average Power:	1.26 kW	Gross	
	0.61	No Load	
	0.65	Net	
K80 Feed:	85	microns	
K80 Product:	31	microns	

2. FLOTATION

2.1. Purpose: Similar to that in Test PP-10.

2.2. Method: Similar to that of Test PP-10, but a zinc 4th cleaner was added. No changes in reagents were made.

2.2.1. Flowsheet Equipment

As In Test PP-10, but the Zn 4th cleaner concentrate consisted of a single Denver D7 Sub-A cell.

2.2.2. Conditioning Parameters

As in Test PP-10.

2.2.3. Circuit Operation

The circuit was operated for a period of 8.0 hours, and was sampled every 30 minutes during the last 4.0 hours of operation.

TEST PP-11

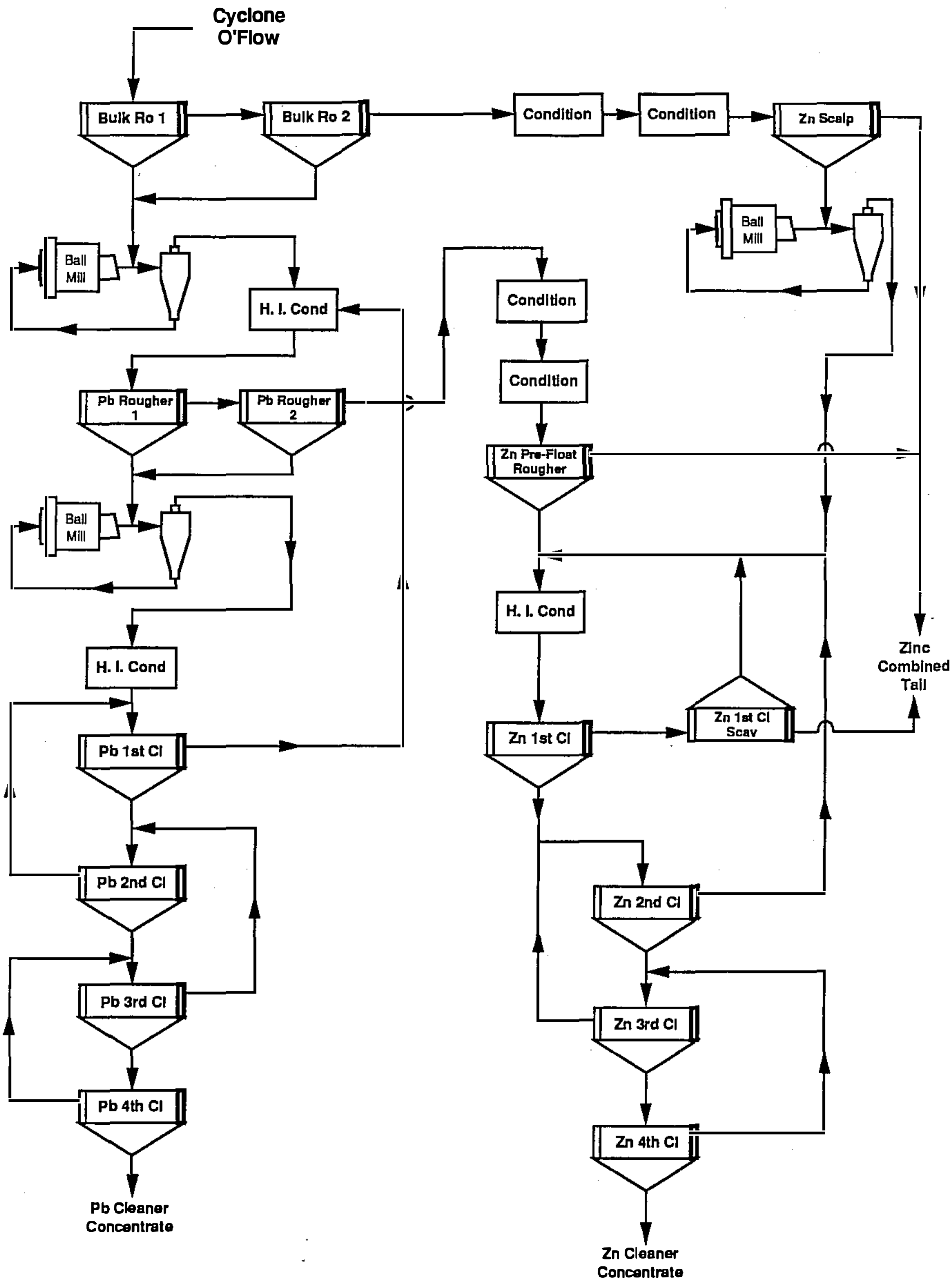
2.2.4. Flotation Reagents:

Point of Addition	Reagent Name	Solution Strength %	Rate mL/min	g/t
Bulk and Pb Circuits:				
Rod Mill Feed	Na2CO3	10.0	252.0	2503
Ball Mill Feed	CA830/TH	2.0	5.1	10
Ball Mill Feed	A317	5.0	2.4	12
Bulk Rougher 1 Feed	CA830/TH	2.0	10.5	21
Bulk Rougher 1 Feed	A317	5.0	10.1	50
Bulk Rougher 1 Feed *	MIBC	100.0	42.0	21
Bulk Rougher 2 Feed	CA830/TH	2.0	4.9	10
Bulk Rougher 2 Feed	A317	5.0	2.0	10
Bulk Rougher 2 Feed *	MIBC	100.0	5.7	3
Bulk Concentrate Regrind Mill Feed	Na2CO3	10.0	34.4	342
Bulk Concentrate Regrind Mill Feed	SD200/NaCN	4.0	86.1	342
Pb Rougher H.I. Conditioner	CA830/TH	2.0	9.4	19
Pb Rougher H.I. Conditioner	A317	5.0	12.6	63
Pb Rougher 1 Feed *	MIBC	100.0	24.3	12
Pb Rougher 2 Feed	CA830/TH	2.0	4.8	10
Pb Rougher 2 Feed	A317	5.0	0.0	0
Pb Rougher 2 Feed *	MIBC	100.0	21.5	11
Pb Concentrate Regrind Mill Feed	Na2CO3	10.0	10.1	100
Pb Concentrate Regrind Mill Feed	SD200/NaCN	4.0	91.1	362
Pb 1st Cleaner H.I. Conditioner	CA830/TH	2.0	18.9	38
Pb 1st Cleaner H.I. Conditioner	A317	5.0	2.0	10
Pb 1st Cleaner H.I. Conditioner *	MIBC	100.0	15.5	8
Pb 2nd Cleaner Feed	SD200/NaCN	4.0	20.0	79
Pb 2nd Cleaner Feed	MIBC	100.0	0.0	0
Pb 3rd Cleaner Feed	SD200/NaCN	4.0	20.0	79
Pb 3rd Cleaner Feed	MIBC	100.0	0.0	0
Pb 4th Cleaner Feed	SD200/NaCN	4.0	39.9	159
Zinc Circuit:				
Zn Scalp Conditioner 1 Feed	Ca(OH)2	10.0	66.0	656
Zn Scalp Conditioner 2 Feed	CuSO4.5H2O	10.0	92.1	915
Zn Scalp 1 Feed *	M2030	100.0	15.4	8
Zn Scalp 1 Feed	A317	5.0	13.8	69
Zn Scalp 1 Feed *	DF250	100.0	72.6	36
Zn Scalp 2 Feed *	M2030	100.0	9.1	5
Zn Scalp 2 Feed	A317	5.0	0.0	0
Zn Scalp Conc. Regrind Mill Feed	Ca(OH)2	10.0	98.5	978
Zn Scalp Conc. Regrind Mill Feed	CuSO4.5H2O	10.0	16.6	165
Zn Prefloat Conditioner 1 Feed	Ca(OH)2	10.0	88.9	883
Zn Prefloat Conditioner 2 Feed	CuSO4.5H2O	10.0	46.1	458
Zn Prefloat Feed *	M2030	100.0	14.3	7
Zn Prefloat Feed	A317	5.0	17.8	88
Zn Prefloat Feed *	DF250	100.0	0.0	0
Zn Prefloat Cell 3 *	M2030	100.0	0.0	0
Zn Prefloat Cell 3	A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner *	M2030	100.0	15.9	8
Zn 1st Cleaner H.I. Conditioner	A317	5.0	18.6	92
Zn 1st Cleaner Scavenger Feed *	M2030	100.0	2.6	1
Zn 1st Cleaner Scavenger Feed	A317	5.0	2.2	11
Zn 2nd Cleaner Feed	Ca(OH)2	10.0	57.8	574
Zn 3rd Cleaner Feed	Ca(OH)2	10.0	14.0	139
Zn 4th Cleaner Feed	Ca(OH)2	10.0	7.8	77

* Drops per minute

Feed Rate= 604 kg/h

2.3. Flowsheet:



Test PP-11 - Continued

2.4. Results:

2.4.1. Observations

Stability continued to be disrupted somewhat by cyclone plugging. High Pb grades and reasonably high Zn (i.e. >50%) grades were generally obtained in the X-Met grabs.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2101	10.8	-
Ball Mill Discharge	2122	-	-
Cyclone Underflow	2337	-	-
Cyclone O'Flow/Semi-bulk Feed	1304	-	-
Screen U'size/Semi-bulk Feed	-	10.4	14
Semi-bulk 2 Tail	1261	10.1	-
Semi-bulk Regrind Mill Disch	1673	-	-
Semi-bulk Regrind Cyc U'Flow	1443	-	-
Semi-bulk Regrind Cyc O'Flow	1210	-	-
Pb Rougher 1 Feed	1131	10.2	19
Pb Rougher 2 Tail	1043	-	-
Pb Regrind Mill Discharge	2173	-	-
Pb Regrind Cyclone U'Flow	2323	-	-
Pb Regrind Cyclone O'Flow	1245	-	-
Pb 1st Cleaner feed	-	10.2	-
Pb 1st Cleaner Tail	1166	-	-
Pb 2nd Cleaner	-	10.2	-
Pb 3rd Cleaner	-	10.2	-
Pb 4th Cleaner	-	10.2	-
Zn Scalp 1 Feed	-	10.7	19
Zn Scalp 2 Tail	1219	-	-
Zn Regrind Mill Discharge	1973	-	-
Zn Regrind Cyclone U'Flow	2046	-	-
Zn Regrind Cyclone O'Flow	1295	-	-
Zn Prefloat Feed	-	11.3	-
Zn Prefloat Tail	1015	-	-
Zn 1st Cleaner Feed	1125	11.6	-
Zn 1st Cleaner Scav Feed	-	11.8	-
Zn 1st Cleaner Scav Tail	1060	-	-
Zn 2nd Cleaner	-	11.4	-
Zn 3rd Cleaner	-	11.8	-
Thickener Underflow	1234	-	-

Test PP-11 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
4:00	Pb 4th Cleaner conc	73.3	1.66
4:30	Pb 4th Cleaner Conc	71.6	1.66
	Zn 4th Cleaner Conc	1.07	48.4
	Zn 1st Cleaner Scav Tail	1.29	1.62
	Zn Prefloat Tail	2.25	7.82
	Zn Scalp Tail	0.30	0.20
	Zn Combined Tail	0.97	1.55
5:30	Pb 4th Cleaner Conc	69.7	2.27
	Zn 4th Cleaner Conc	1.16	46.9
	Zn 1st Cleaner Scav Tail	0.96	2.29
	Zn Prefloat Tail	2.26	4.23
	Zn Scalp Tail	0.27	0.51
	Zn Combined Tail	0.65	1.14
6:30	Pb 4th Cleaner Conc	71.4	2.99
	Zn 4th Cleaner Conc	1.27	45.2
	Zn 1st Cleaner Scav Tail	0.97	1.76
	Zn Prefloat Tail	2.16	4.81
	Zn Scalp Tail	0.30	0.26
	Zn Combined Tail	1.43	2.84
7:00	Pb 4th Cleaner Conc	74.0	1.63
	Zn 4th Cleaner Conc	1.07	51.8
	Zn 1st Cleaner Scav Tail	0.95	1.27
	Zn Prefloat Tail	2.47	4.68
	Zn Scalp Tail	0.34	0.15
	Zn Combined Tail	1.59	2.56
7:30	Pb 4th Cleaner Conc	72.1	1.75
	Zn 4th Cleaner Conc	1.00	57.5
	Zn 1st Cleaner Scav Tail	0.95	1.16
	Zn Prefloat Tail	1.42	1.60
	Zn Scalp Tail	0.32	0.21
	Zn Combined Tail	0.70	0.85
8:30	Pb 4th Cleaner Conc	69.5	3.16
	Zn 4th Cleaner Conc	1.22	54.5
	Zn 1st Cleaner Scav Tail	0.79	0.86
	Zn Prefloat Tail	1.34	3.19
	Zn Scalp Tail	0.31	0.33
	Zn Combined Tail	0.52	0.63
9:30	Pb 4th Cleaner Conc	71.6	3.17
	Zn 4th Cleaner Conc	1.44	51.6
	Zn 1st Cleaner Scav Tail	1.11	1.34
	Zn Prefloat Tail	2.13	1.99
	Zn Scalp Tail	0.41	0.41
	Zn Combined Tail	0.81	1.04
10:30	Pb 4th Cleaner Conc	71.3	4.42
	Zn 4th Cleaner Conc	1.57	48.1
	Zn 1st Cleaner Scav Tail	1.35	2.09
	Zn Prefloat Tail	1.86	6.19
	Zn Scalp Tail	0.38	0.31
	Zn Combined Tail	0.93	1.15

Test PP-11 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
11:30	Pb 4th Cleaner Conc	69.1	6.40
	Zn 4th Cleaner Conc	0.89	51.7
	Zn 1st Cleaner Scav Tail	1.35	2.07
	Zn Prefloat Tail	1.71	1.69
	Zn Scalp Tail	0.41	0.27
	Zn Combined Tail	0.75	0.81

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Screen U'Size/Semi-bulk Feed	3.14	9.49	60.9
Semi-bulk Concentrate	13.8	16.1	-
Semi-bulk Tail	0.74	8.17	-
Semi-bulk Regrind Cyclone O'Flow	12.8	16.0	-
Pb Rougher Feed	13.2	24.0	-
Pb Rougher Concentrate	15.5	28.7	-
Pb Rougher Tail	2.29	5.87	-
Pb Regrind Cyclone O'Flow	17.6	27.9	-
Pb 1st Cleaner Concentrate	33.0	26.2	-
Pb 1st Cleaner Tail	12.8	28.0	-
Pb 4th Cleaner Concentrate	76.7	5.06	224
Zn Scalp Concentrate	1.34	22.9	-
Zn Scalp Tail	0.42	0.31	-
Zn Regrind Cyclone O'Flow	1.28	22.1	-
Zn Prefloat Feed	2.67	6.86	-
Zn Prefloat Concentrate	3.52	13.7	-
Zn Prefloat Tail	2.10	3.88	-
Zn 1st Cleaner Feed	1.95	17.7	-
Zn 1st Cleaner Scavenger Conc	2.34	10.1	-
Zn 1st Cleaner Scavenger Tail	1.30	1.92	-
Zn Combined Tail	0.83	0.93	31.1
Zn 4th Cleaner	1.76	49.4	178

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	2.83	76.7	5.06	224	69.2	1.5	10.2
Zn 3rd Cleaner Concentrate	17.42	1.76	49.4	178	9.8	90.7	49.9
Zn Combined Tails	79.75	0.83	0.93	31.1	21.1	7.8	39.9
Derrick Screen U'Size	100.00	3.14	9.49	60.9	100.0	100.0	100.0

TEST NO. PP-12

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As for Test PP-10.

1.1.2. Method: As for Test PP-10.

1.1.2.1. Flowsheet Equipment

As for Test PP-10.

1.1.2.2. Mill Loads

As for Test PP-10.

1.1.2.3. Classification Equipment

As for Test PP-10.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 8.0 hours and was sampled every 30 minutes during the last 4.0 hours of operation. The average feed rate was 590 kg/h of dry ore.

1.1.3. Flowsheet: As for Test PP-10.

Test PP-12 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-12

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	20.0	4.0	4.0	96.0
4,699	4	58.2	11.6	15.6	84.4
3,327	6	49.5	9.9	25.5	74.5
2,362	8	43.0	8.6	34.0	66.0
1,651	10	46.7	9.3	43.3	56.7
1,168	14	35.0	7.0	50.3	49.7
833	20	26.8	5.3	55.7	44.3
589	28	23.2	4.6	60.3	39.7
417	35	20.1	4.0	64.3	35.7
295	48	15.5	3.1	67.4	32.6
208	65	13.4	2.7	70.1	29.9
147	100	13.3	2.7	72.7	27.3
104	150	13.9	2.8	75.5	24.5
74	200	14.9	3.0	78.5	21.5
53	270	15.9	3.2	81.6	18.4
38	400	13.2	2.6	84.3	15.7
-38	-400	78.9	15.7	100.0	-
	Total	501.5	100.0	-	-

Product: Rod Mill Discharge Test No: PP-12

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	2.4	0.8	0.8	99.2
833	20	4.8	1.5	2.3	97.7
589	28	12.4	3.9	6.2	93.8
417	35	21.6	6.9	13.1	86.9
295	48	23.7	7.5	20.6	79.4
208	65	26.9	8.5	29.2	70.8
147	100	28.2	9.0	38.1	61.9
104	150	23.7	7.5	45.6	54.4
74	200	22.8	7.2	52.9	47.1
53	270	22.5	7.1	60.0	40.0
38	400	20.2	6.4	66.4	33.6
-38	-400	105.7	33.6	100.0	-
	Total	314.9	100.0	-	-

Test PP-12- Continued

1.1.4. Size Analyses: Continued

Product: Ball Mill Discharge   Test No: PP-12

Microns	Mesh	Weight Grams	% Weight		
			Ind.	Cum.	Passing
589	28	2.2	1.0	1.0	99.0
417	35	6.6	3.0	4.0	96.0
295	48	14.5	6.6	10.6	89.4
208	65	27.5	12.5	23.0	77.0
147	100	45.5	20.6	43.6	56.4
104	150	53.9	24.4	68.0	32.0
74	200	29.2	13.2	81.3	18.8
53	270	12.0	5.4	86.7	13.3
38	400	6.4	2.9	89.6	10.4
-38	-400	23.0	10.4	100.0	-
	Total	220.8	100.0	-	-

Product: Derrick Screen Underflow   Test No: PP-12

Microns	Mesh	Weight Grams	% Weight		
			Ind.	Cum.	Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	2.2	1.0	1.0	99.0
147	100	2.6	1.2	2.2	97.8
104	150	4.5	2.0	4.2	95.8
74	200	23.4	10.6	14.7	85.3
53	270	32.1	14.5	29.2	70.8
38	400	25.6	11.5	40.8	59.2
-38	-400	131.4	59.2	100.0	-
	Total	221.8	100.0	-	-

Test PP-12 - Continued

1.1.4. Size Analyses: Continued

Product: Derrick Screen Overflow Test No: PP-12

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
833	20	0.9	0.4	0.4	99.6
589	28	2.7	1.1	1.4	98.6
417	35	10.2	4.0	5.5	94.5
295	48	19.2	7.6	13.1	86.9
208	65	29.7	11.8	24.8	75.2
147	100	54.9	21.8	46.6	53.4
104	150	60.1	23.8	70.4	29.6
74	200	31.7	12.6	83.0	17.0
53	270	12.1	4.8	87.8	12.2
38	400	6.0	2.4	90.1	9.9
-38	-400	24.9	9.9	100.0	-
	Total	252.4	100.0	-	-

1.1.5. Observations: As for Test PP-10 and 11. A very high circulating load was calculated.

Test PP-12 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: As In Test PP-11.

1.2.2. Method: As In Test PP-10, but with an increased ball load in the Zn regrind.

1.2.2.1. Flowsheet Equipment

As in Test PP-10.

1.2.2.2. Mill Loads

Semi-bulk Regrind: As for Test PP-10.
Pb Regrind: As for Test PP-10.
Zn Regrind: 305 kg of 25 mm balls (30 kg added)

1.2.2.3. Classification Equipment

As In Test PP-11.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 μm	16-18 μm	9-10 μm	K_{80} μm
Semi-Bulk Sala	-	1846	1916	1226	Feed Cycl O/Flow	72.3 94.1	57.7 81.8	36.2 56.8	31 16
Pb-Hazen	-	2050	2056	1240	Feed Cycl O/Flow	98.8 99.5	94.1 95.6	57.2 59.5	13 13
Zn-Denver	-	2088	2064	1188	Feed Cycl O/Flow	45.2 81.9	36.0 65.6	26.8 44.3	65 24

1.2.3. Flowsheet: As in Test PP-10.

Test PP-12 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-12 S.G.- 4.68

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	3.08	6.2	6.2	93.8
31.5μ	5.67	11.3	17.5	82.5
24.5	5.11	10.2	27.7	72.3
17.1	7.29	14.6	42.3	57.7
11.7	7.78	15.6	57.9	42.1
9.1	2.99	6.0	63.8	36.2
-9.1	18.08	36.2	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-12 S.G.- 4.68

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.5μ	0.88	1.8	1.8	98.2
24.5	2.08	4.2	5.9	94.1
17.1	6.15	12.3	18.2	81.8
11.7	8.35	16.7	34.9	65.1
9.1	4.15	8.3	43.2	56.8
-9.1	28.39	56.8	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-12 S.G.-4.63

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.8μ	0.00	0.0	0.0	100.0
24.6	0.62	1.2	1.2	98.8
17.2	2.31	4.6	5.9	94.1
11.8	10.91	21.8	27.7	72.3
9.1	7.56	15.1	42.8	57.2
-9.1	28.60	57.2	100.0	-
Total	50.00	100.0	-	-

Test PP-12- Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-12 S.G.- 4.62

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.8μ	0.00	0.0	0.0	100.0
24.6	0.27	0.5	0.5	99.5
17.2	1.94	3.9	4.4	95.6
11.8	10.68	21.4	25.8	74.2
9.1	7.38	14.8	40.5	59.5
-9.1	29.73	59.5	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc Test No: PP-12 S.G.- 4.39

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	3.35	6.7	6.7	93.3
200	5.37	10.7	17.4	82.6
270	5.06	10.1	27.6	72.4
32.9μ	8.17	16.3	43.9	56.1
25.5	5.44	10.9	54.8	45.2
17.8	4.61	9.2	64.0	36.0
12.2	3.56	7.1	71.1	28.9
9.4	1.05	2.1	73.2	26.8
-9.4	13.39	26.8	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-12 S.G.- 4.39

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	1.03	2.1	2.1	97.9
32.9μ	3.03	6.1	8.1	91.9
25.5	5.00	10.0	18.1	81.9
17.8	8.16	16.3	34.4	65.6
12.2	7.68	15.4	49.8	50.2
9.4	2.96	5.9	55.7	44.3
-9.4	22.14	44.3	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:

As in Tests PP-10 and 11. The semi-bulk regrind pulp densities were higher than in Tests PP-10 and 11.
Cyclone plugging was mainly experienced in the Zn regrind.

Test No. PP-12

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	3.6	% moisture	
Primary Rod Mill Feed	590	dry kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	155	kg of 62mm dia. rods	
	150	kg of 37-50mm dia. rods	
	305	kg total	
Rod Mill Discharge:	2,109 g/L	(69 % Sol at SG	4.25)
	47.1	% minus 48 mesh	
	33.6	% minus 200 mesh	
Input Power:	27.74	3 disc revolutions	
	3.50 kW	95% drive efficiency)	
Average Power:	3.33 kW	Gross	
	1.771	No Load	
	1.56	Net	
Net Power Usage:	2.6		
K80 Feed:	3711	microns	
K80 Product:	299	microns	
W. Index (metric):	6.4		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	590	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	288	kg of 50mm balls	
	112	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	2,128 g/L	(69 % Sol at SG	4.25)
	89.4	% minus 48 mesh	
	18.8	% minus 200 mesh	
Circulating Load	1464	%	
Input Power:	15.76	sec for 3 disc revolutions	
	6.17 kW	95% drive efficiency)	
Average Power:	5.86 kW	Gross	
	1.60	No Load	
	4.26	Net	
Net Power Usage:	7.2	kWh/t	
K80 Feed:	299	microns	
K80 Product:	63	microns	
W. Index (metric):	10.6		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	9.9 kWh/t
K80 Feed:	3711 microns
K80 Product:	63 microns
Work Index :	9.0 metric
Flot. Feed :	85.3% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	590	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	400	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,846 g/L	(58 % Sol at SG	4.77)
Input Power:	10.30	sec for 3 disc revolutions	
	3.77 kW	95% drive efficiency)	
Average Power:	3.59 kW	Gross	
	1.18	No Load	
	2.41	Net	
K80 Feed:	31	microns	
K80 Product:	16	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	590	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	2,050 g/L	(65 % Sol at SG	4.61)
Input Power:	27.59	sec for 3 disc revolutions	
	1.41 kW	95% drive efficiency)	
Average Power:	1.34 kW	Gross	
	0.69	No Load	
	0.65	Net	
K80 Feed:	13.2	microns	
K80 Product:	12.6	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	590	kg/h	
Denver Mill Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	305	kg of 25 mm balls	
	305	kg total	
Ball Mill Discharge:	2,088 g/L	(68 % Sol at SG	4.38)
Input Power:	57.73	sec for 3 disc revolutions	
	1.68 kW	95% drive efficiency)	
Average Power:	1.60 kW	Gross	
	0.61	No Load	
	0.99	Net	
K80 Feed:	65	microns	
K80 Product:	24	microns	

2. FLOTATION

2.1. Purpose: Similar to that in Test PP-11.

2.2. Method: As In Test PP-11.

2.2.1. Flowsheet Equipment

As in Test PP-11.

2.2.2. Conditioning Parameters

As In Test PP-10.

2.2.3. Circuit Operation

The circuit was operated for a period of 8.0 hours, and was sampled every 30 minutes during the last 4.0 hours of operation.

TEST PP-12

2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	247.2	2514
Ball Mill Feed		CA830/TH	2.0	5.0	10
Ball Mill Feed		A317	5.0	2.1	11
Bulk Rougher 1 Feed		CA830/TH	2.0	9.0	18
Bulk Rougher 1 Feed		A317	5.0	9.4	48
Bulk Rougher 1 Feed	*	MIBC	100.0	45.7	23
Bulk Rougher 2 Feed		CA830/TH	2.0	4.2	9
Bulk Rougher 2 Feed		A317	5.0	2.0	10
Bulk Rougher 2 Feed	*	MIBC	100.0	4.1	2
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	30.7	312
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	89.7	365
Pb Rougher H.I. Conditioner		CA830/TH	2.0	8.6	17
Pb Rougher H.I. Conditioner		A317	5.0	8.1	41
Pb Rougher 1 Feed	*	MIBC	100.0	11.6	6
Pb Rougher 2 Feed		CA830/TH	2.0	3.2	7
Pb Rougher 2 Feed		A317	5.0	0.0	0
Pb Rougher 2 Feed	*	MIBC	100.0	15.6	8
Pb Concentrate Regrind Mill Feed		Na2CO3	10.0	10.1	103
Pb Concentrate Regrind Mill Feed		SD200/NaCN	4.0	89.9	366
Pb 1st Cleaner H.I. Conditioner		CA830/TH	2.0	19.8	40
Pb 1st Cleaner H.I. Conditioner		A317	5.0	2.1	11
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	16.0	8
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	20.0	81
Pb 2nd Cleaner Feed		MIBC	100.0	0.0	0
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	20.3	83
Pb 3rd Cleaner Feed		MIBC	100.0	0.0	0
Pb 4th Cleaner Feed		SD200/NaCN	4.0	38.9	158
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	67.0	681
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	91.3	928
Zn Scalp 1 Feed	*	M2030	100.0	13.6	7
Zn Scalp 1 Feed		A317	5.0	14.2	72
Zn Scalp 1 Feed	*	DF250	100.0	83.3	32
Zn Scalp 2 Feed	*	M2030	100.0	6.0	3
Zn Scalp 2 Feed		A317	5.0	0.0	0
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	80.7	821
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	16.8	171
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	68.6	698
Zn Prefloat Conditioner 2 Feed		CuSO4.5H2O	10.0	47.1	479
Zn Prefloat Feed	*	M2030	100.0	14.0	7
Zn Prefloat Feed		A317	5.0	23.8	121
Zn Prefloat Feed	*	DF250	100.0	0.0	0
Zn Prefloat Cell 3	*	M2030	100.0	0.0	0
Zn Prefloat Cell 3		A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	15.7	8
Zn 1st Cleaner H.I. Conditioner		A317	5.0	22.3	113
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	2.2	1
Zn 1st Cleaner Scavenger Feed		A317	5.0	2.2	11
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	73.6	748
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	9.3	95
Zn 4th Cleaner Feed		Ca(OH)2	10.0	14.1	143

* Drops per minute

Feed Rate= 590 kg/h

Test PP-12 - Continued

2.3. Flowsheet: As In Test PP-11.

2.4. Results: 2.4.1. Observations

Relatively non-selective Pb flotation occurred in the first half of the run (i.e. Pb 4th Cleaner Concentrates of 6.10 % Zn). The problem was fixed mainly by reducing MIBC additions halfway through the sample period. Zn recovery during the sampling period was low.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp ℃
Rod Mill Discharge	2109	10.8	-
Ball Mill Discharge	2128	-	-
Screen Oversize	2372	-	-
Screen U'Size/Semi-bulk Feed	1309	10.3	15
Semi-bulk 2 Tail	1262	10.3	-
Semi-bulk Regrind Mill Disch	1846	-	-
Semi-bulk Regrind Cyc U'Flow	1916	-	-
Semi-bulk Regrind Cyc O'Flow	1226	-	-
Pb Rougher 1 Feed	1130	10.2	18
Pb Rougher 2 Tail	1056	-	-
Pb Regrind Mill Discharge	2050	-	-
Pb Regrind Cyclone U'Flow	2056	-	-
Pb Regrind Cyclone O'Flow	1240	-	-
Pb 1st Cleaner Feed	-	10.2	-
Pb 1st Cleaner Tail	1166	-	-
Pb 2nd Cleaner	-	10.2	-
Pb 3rd Cleaner	-	10.1	-
Pb 4th Cleaner	-	10.3	-
Zn Scalp 1 Feed	-	10.7	19
Zn Scalp 2 Tail	1226	-	-
Zn Regrind Mill Discharge	2088	-	-
Zn Regrind Cyclone U'Flow	2064	-	-
Zn Regrind Cyclone O'Flow	1188	-	-
Zn Prefloat Feed	-	11.3	-
Zn Prefloat Tail	1012	-	-
Zn 1st Cleaner Feed	1116	11.7	-
Zn 1st Cleaner Scav Feed	-	11.8	-
Zn 1st Cleaner Scav Tail	1050	-	-
Zn 2nd Cleaner	-	12.0	-
Zn 3rd Cleaner	-	11.8	-
Thickener Underflow	-	-	-

Test PP-12 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
12:30	Pb 4th Cleaner Conc	42.1	18.8
	Zn 4th Cleaner Conc	0.94	56.6
	Zn 1st Cleaner Scav Tail	1.55	3.68
	Zn Prefloat Tail	2.18	2.86
	Zn Scalp Tail	0.60	0.41
	Zn Combined Tail	0.66	1.02
13:30	Pb 4th Cleaner Conc	65.1	8.28
	Zn 4th Cleaner Conc	0.83	55.1
	Zn 1st Cleaner Scav Tail	1.53	3.08
	Zn Prefloat Tail	1.87	1.88
	Zn Scalp Tail	0.46	0.55
	Zn Combined Tail	0.82	1.22
15:30	Pb 4th Cleaner Conc	65.1	7.69
	Zn 4th Cleaner Conc	0.94	56.6
	Zn 1st Cleaner Scav Tail	1.47	3.82
	Zn Prefloat Tail	2.06	2.25
	Zn Scalp Tail	0.50	0.77
	Zn Combined Tail	0.74	1.57
16:30	Pb 4th Cleaner Conc	64.5	9.36
	Zn 4th Cleaner Conc	1.48	49.6
	Zn 1st Cleaner Scav Tail	1.57	2.98
	Zn Prefloat Tail	2.34	3.18
	Zn Scalp Tail	0.50	1.01
	Zn Combined Tail	0.84	1.43
17:00	Pb 4th Cleaner Conc	67.8	6.01
	Zn 4th Cleaner Conc	1.53	44.7
	Zn 1st Cleaner Scav Tail	1.38	2.41
	Zn Prefloat Tail	2.47	3.05
	Zn Scalp Tail	0.48	1.13
	Zn Combined Tail	0.89	1.64
17:30	Pb 4th Cleaner Conc	66.4	6.48
	Zn 4th Cleaner Conc	1.28	50.5
	Zn 1st Cleaner Scav Tail	1.43	3.33
	Zn Prefloat Tail	2.34	5.22
	Zn Scalp Tail	0.52	0.97
	Zn Combined Tail	0.86	1.81
18:30	Pb 4th Cleaner Conc	-	-
	Zn 4th Cleaner Conc	1.25	55.3
	Zn 1st Cleaner Scav Tail	1.66	6.44
	Zn Prefloat Tail	2.48	1.33
	Zn Scalp Tail	0.44	1.29
	Zn Combined Tail	1.01	3.73
19:30	Pb 4th Cleaner Conc	78.8	2.00
	Zn 4th Cleaner Conc	1.84	53.3
	Zn 1st Cleaner Scav Tail	1.39	2.83
	Zn Prefloat Tail	3.01	9.70
	Zn Scalp Tail	0.50	0.51
	Zn Combined Tail	1.17	2.62

Test PP-12 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Screen U'Size/Semi-bulk Feed	3.33	9.46	60.5
Semi-bulk Concentrate	12.2	16.5	-
Semi-bulk Tail	0.74	8.01	-
Semi-bulk Regrind Cyc O'Flow	13.6	15.8	-
Pb Rougher Feed	13.5	29.2	-
Pb Rougher Concentrate	17.4	33.6	-
Pb Rougher Tail	3.99	17.1	-
Pb Regrind Cyclone O'Flow	17.5	33.3	-
Pb 1st Cleaner Concentrate	36.6	26.0	-
Pb 1st Cleaner Tail	13.9	36.0	-
Pb 4th Cleaner Concentrate	74.0	6.08	321
Zn Scalp Concentrate	1.26	22.7	-
Zn Scalp Tail	0.46	0.39	-
Zn Regrind Cyclone O'Flow	1.37	21.1	-
Zn Prefloat Feed	3.84	16.3	-
Zn Prefloat Concentrate	4.61	23.9	-
Zn Prefloat Tail	2.70	6.48	-
Zn 1st Cleaner Feed	2.47	21.0	-
Zn 1st Cleaner Scav Conc	2.81	18.1	-
Zn 1st Cleaner Scav Tail	1.61	3.78	-
Zn Combined Tail	1.00	1.77	33.5
Zn 4th Cleaner	2.45	50.4	177

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	2.88	74	6.08	321	64.1	1.9	14.4
Zn 3rd Cleaner Concentrate	15.56	2.45	50.4	177	11.4	82.9	43.0
Zn Combined Tails	81.56	1	1.77	33.5	24.5	15.3	42.6
Derrick Screen U'Size	100.00	3.33	9.46	60.5	100.0	100.0	100.0

TEST NO. PP-13

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: To determine the effect of classification with a cyclone instead of by screening.

1.1.2. Method: As for Test PP-10, but with a cyclone instead of with the Derrick screen.

1.1.2.1. Flowsheet Equipment

As for Test PP-10, but with a Sweco vibrating screen (30 mesh) prior to the semi-bulk flotation feed pump.

1.1.2.2. Mill Loads

As for Test PP-10.

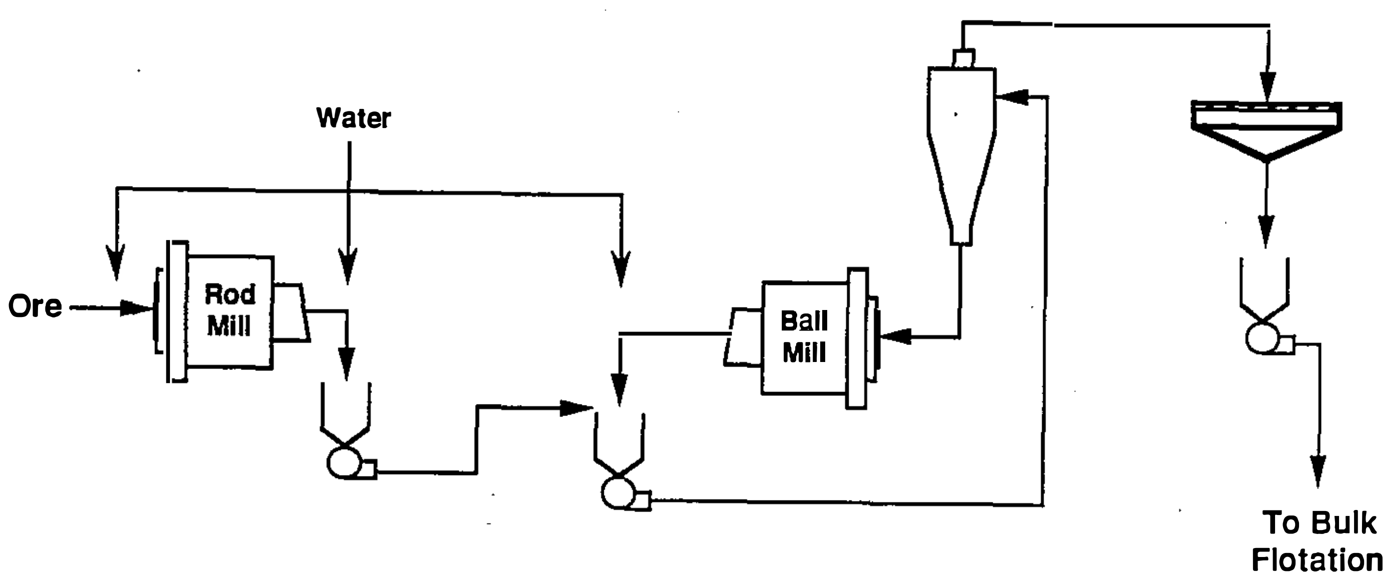
1.1.2.3. Classification Equipment

Dorr P50 Cyclone :	50 mm diameter
	12.5 mm apex
	19.1 mm vortex

1.1.2.4. Circuit Operation

The circuit was operated for a period of 8.0 hours and was sampled every 30 minutes during the last 4.0 hours of operation. The average feed rate was 598 kg/h of dry ore.

1.1.3. Flowsheet:



Test PP-13 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-13

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	46.5	5.6	5.6	94.4
4,699	4	102.6	12.3	17.9	82.1
3,327	6	79.3	9.5	27.4	72.6
2,362	8	76.9	9.2	36.6	63.4
1,651	10	77.9	9.3	45.9	54.1
1,168	14	61.0	7.3	53.2	46.8
833	20	45.7	5.5	58.7	41.3
589	28	39.1	4.7	63.4	36.6
417	35	33.0	4.0	67.3	32.7
295	48	25.3	3.0	70.4	29.6
208	65	21.8	2.6	73.0	27.0
147	100	20.5	2.5	75.4	24.6
104	150	20.2	2.4	77.8	22.2
74	200	21.6	2.6	80.4	19.6
53	270	24.9	3.0	83.4	16.6
38	400	23.0	2.8	86.2	13.8
-38	-400	115.4	13.8	100.0	-
	Total	834.7	100.0	-	-

Product: Rod Mill Discharge Test No: PP-13

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
1,651	10	0.3	0.1	0.1	99.9
1,168	14	1.4	0.5	0.7	99.3
833	20	4.1	1.6	2.2	97.8
589	28	10.5	4.0	6.2	93.8
417	35	19.1	7.3	13.5	86.5
295	48	22.2	8.5	22.0	78.0
208	65	25.1	9.6	31.6	68.4
147	100	24.9	9.5	41.2	58.8
104	150	21.2	8.1	49.3	50.7
74	200	19.0	7.3	56.6	43.4
53	270	20.0	7.7	64.2	35.8
38	400	17.3	6.6	70.8	29.2
-38	-400	76.2	29.2	100.0	-
	Total	261.3	100.0	-	-

Test PP-13- Continued

1.1.4. Size Analyses: Continued

Product: Ball Mill Discharge Test No: PP-13

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
589	28	2.9	1.0	1.0	99.0
417	35	5.7	2.1	3.1	96.9
295	48	14.1	5.1	8.2	91.8
208	65	29.2	10.5	18.7	81.3
147	100	48.7	17.5	36.2	63.8
104	150	54.6	19.7	55.9	44.1
74	200	43.6	15.7	71.6	28.4
53	270	31.1	11.2	82.8	17.2
38	400	16.5	5.9	88.7	11.3
-38	-400	31.4	11.3	100.0	-
	Total	277.8	100.0	-	-

Product: Cyclone Underflow Test No: PP-13

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
833	20	2.0	0.6	0.6	99.4
589	28	4.4	1.3	1.8	98.2
417	35	12.0	3.4	5.2	94.8
295	48	22.0	6.3	11.5	88.5
208	65	42.4	12.0	23.5	76.5
147	100	71.5	20.3	43.8	56.2
104	150	73.7	20.9	64.8	35.2
74	200	49.2	14.0	78.8	21.2
53	270	36.0	10.2	89.0	11.0
38	400	16.1	4.6	93.6	6.4
-38	-400	22.6	6.4	100.0	-
	Total	351.9	100.0	-	-

1.1.4. Size Analyses: Continued

Product: Cyclone Overflow Test No: PP-13

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	2.3	1.0	1.0	99.0
208	65	4.8	2.0	3.0	97.0
147	100	10.0	4.2	7.3	92.7
104	150	16.5	7.0	14.3	85.7
74	200	22.6	9.6	23.9	76.1
53	270	22.7	9.6	33.5	66.5
38	400	26.6	11.3	44.8	55.2
-38	-400	129.8	55.2	100.0	-
	Total	235.3	100.0	-	-

1.1.5. Observations: A much lower circulating load (428%) was calculated for the ball mill with the cyclone. The primary grind was coarser than in the three previous tests (i.e. 80% -84 µm).

Test PP-13 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: As in Test PP-12.

1.2.2. Method: As in Test PP-12.

1.2.2.1. Flowsheet Equipment

As in Test PP-10.

1.2.2.2. Mill Loads

As in Test PP-12.

1.2.2.3. Classification Equipment

As in Test PP-11.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Sala	-	1750	1822	1212	Feed Cycl O/Flow	74.9 96.9	61.2 88.5	40.3 60.5	29 14
Pb-Hazen	-	2018	2000	1190	Feed Cycl O/Flow	98.4 99.3	93.7 94.8	58.4 55.4	13 13
Zn-Denver	-	1610	1698	1130	Feed Cycl O/Flow	35.5 69.4	28.5 56.4	21.8 41.1	115 37

1.2.3. Flowsheet: As in Test PP-10.

Test PP-13 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-13 S.G.- 4.80

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	3.03	6.1	6.1	93.9
31.1μ	4.99	10.0	16.0	84.0
24.1	4.51	9.0	25.1	74.9
16.8	6.86	13.7	38.8	61.2
11.6	7.66	15.3	54.1	45.9
8.9	2.82	5.6	59.7	40.3
-8.9	20.13	40.3	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-13 S.G.- 4.73

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.3μ	0.50	1.0	1.0	99.0
24.3	1.05	2.1	3.1	96.9
16.9	4.22	8.4	11.5	88.5
11.6	8.98	18.0	29.5	70.5
9.0	5.02	10.0	39.5	60.5
-9.0	30.23	60.5	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-13 S.G.-4.66

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.6μ	0.32	0.6	0.6	99.4
24.5	0.48	1.0	1.6	98.4
17.1	2.37	4.7	6.3	93.7
11.7	10.37	20.7	27.1	72.9
9.1	7.25	14.5	41.6	58.4
-9.1	29.21	58.4	100.0	-
Total	50.00	100.0	-	-

Test PP-13- Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-13 S.G.- 4.62

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.8μ	0.15	0.3	0.3	99.7
24.6	0.20	0.4	0.7	99.3
17.2	2.25	4.5	5.2	94.8
11.8	12.29	24.6	29.8	70.2
9.1	7.39	14.8	44.6	55.4
-9.1	27.72	55.4	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc Test No: PP-13 S.G.- 4.40

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
100	6.4	12.9	12.9	87.1
150	5.29	10.6	23.5	76.5
200	5.73	11.5	34.9	65.1
270	4.96	9.9	44.8	55.2
32.9μ	5.84	11.7	56.5	43.5
25.5	4.01	8.0	64.5	35.5
17.8	3.47	6.9	71.5	28.5
12.2	2.71	5.4	76.9	23.1
9.4	0.67	1.3	78.2	21.8
-9.4	10.88	21.8	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-13 S.G.- 4.41

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	6.14	12.3	12.3	87.7
32.9μ	4.28	8.6	20.8	79.2
25.5	4.87	9.7	30.6	69.4
17.8	6.49	13.0	43.6	56.4
12.2	6.01	12.0	55.6	44.4
9.4	1.67	3.3	58.9	41.1
-9.4	20.54	41.1	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:

Cyclone plugging, especially the Zn regrind cyclone was still a problem. The Zn scalp concentrate feed to regrinding and the regrind product was relatively coarse, 80% - 37 μm.

Test No. PP-13

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	2.0	% moisture	
Primary Rod Mill Feed	598	dry kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	155	kg of 62mm dia. rods	
	150	kg of 37-50mm dia. rods	
	305	kg total	
Rod Mill Discharge:	2,098 g/L	(68 % Sol at SG	4.25)
	43.4	% minus 48 mesh	
	29.2	% minus 200 mesh	
Input Power:	24.49	3 disc revolutions	
	3.97 kW	95% drive efficiency)	
Average Power:	3.77 kW	Gross	
	1.771	No Load	
	2.00	Net	
Net Power Usage:	3.3		
K80 Feed:	4002	microns	
K80 Product:	314	microns	
W. Index (metric):	8.2		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	598	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	288	kg of 50mm balls	
	112	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,968 g/L	(64 % Sol at SG	4.25)
	91.8	% minus 48 mesh	
	28.4	% minus 200 mesh	
Circulating Load	428	%	
Input Power:	14.91	sec for 3 disc revolutions	
	6.52 kW	95% drive efficiency)	
Average Power:	6.19 kW	Gross	
	1.60	No Load	
	4.59	Net	
Net Power Usage:	7.7	kWh/t	
K80 Feed:	314	microns	
K80 Product:	84	microns	
W. Index (metric):	14.6		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	11.0 kWh/t
K80 Feed:	4002 microns
K80 Product:	84 microns
Work Index :	11.8 metric
Flot. Feed :	76.1% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	598	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	400	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,750 g/L	(54 % Sol at SG 4.77)	
Input Power:	10.33	sec for 3 disc revolutions	
	3.76 kW	95% drive efficiency)	
Average Power:	3.58 kW	Gross	
	1.18	No Load	
	2.40	Net	
K80 Feed:	29	microns	
K80 Product:	14	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	598	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	2,018 g/L	(64 % Sol at SG 4.61)	
Input Power:	27.65	sec for 3 disc revolutions	
	1.41 kW	95% drive efficiency)	
Average Power:	1.34kW	Gross	
	0.69	No Load	
	0.65	Net	
K80 Feed:	13.2	microns	
K80 Product:	13.1	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	598	kg/h	
Denver Mill Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	305	kg of 25 mm balls	
	305	kg total	
Ball Mill Discharge:	1,610 g/L	(49 % Sol at SG 4.38)	
Input Power:	58.47	sec for 3 disc revolutions	
	1.66 kW	95% drive efficiency)	
Average Power:	1.58 kW	Gross	
	0.61	No Load	
	0.97	Net	
K80 Feed:	115	microns	
K80 Product:	37	microns	

2. FLOTATION

2.1. Purpose: Flotation of cyclone classified ore.

2.2. Method: Similar to Tests PP-11 and 12, but the following changes were made:

- some modifications of the Pb circuit reagents were made. The 4th cleaner depressant SD200/cyanide was reduced, and frother was reduced in Pb rougher 1 and Pb 1st cleaner. MIBC was increased in Pb rougher 2.
- in the zinc circuit, the zinc 2nd and 3rd cleaners were reduced from 3 cells to 2 and from 2 cells to 1 respectively.
- During the sampling period, lime and $CuSO_4$ additions were made to the 1st prefioat conditioner, instead of $CuSO_4$ to the 2nd conditioner. Collectors were added to the 2nd conditioner instead of to the prefloat feed. The lime to the zinc prefloat was roughly halved.

2.2.1. Flowsheet Equipment

As in Test PP-11, but with 2 Zn 2nd cleaner cells and 1 Zn 3rd cleaner cell.

2.2.2. Conditioning Parameters

As in Test PP-10.

2.2.3. Circuit Operation

The circuit was operated for a period of 8.0 hours, and was sampled every 30 minutes during the last 4.0 hours of operation.

TEST PP-13

2.2.4. Flotation Reagents:

Point of Addition	Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:				
Rod Mill Feed	Na2CO3	10.0	250.0	2508
Ball Mill Feed	CA830/TH	2.0	4.9	10
Ball Mill Feed	A317	5.0	2.0	10
Bulk Rougher 1 Feed	CA830/TH	2.0	10.2	20
Bulk Rougher 1 Feed	A317	5.0	10.3	52
Bulk Rougher 1 Feed *	MIBC	100.0	44.0	22
Bulk Rougher 2 Feed	CA830/TH	2.0	4.1	8
Bulk Rougher 2 Feed	A317	5.0	2.0	10
Bulk Rougher 2 Feed *	MIBC	100.0	2.7	1
Bulk Concentrate Regrind Mill Feed	Na2CO3	10.0	30.0	301
Bulk Concentrate Regrind Mill Feed	SD200/NaCN	4.0	83.2	334
Pb Rougher H.I. Conditioner	CA830/TH	2.0	5.4	11
Pb Rougher H.I. Conditioner	A317	5.0	8.3	42
Pb Rougher 1 Feed *	MIBC	100.0	0.0	0
Pb Rougher 2 Feed	CA830/TH	2.0	8.9	18
Pb Rougher 2 Feed	A317	5.0	0.0	0
Pb Rougher 2 Feed *	MIBC	100.0	77.3	39
Pb Concentrate Regrind Mill Feed	Na2CO3	10.0	10.0	100
Pb Concentrate Regrind Mill Feed	SD200/NaCN	4.0	83.8	336
Pb 1st Cleaner H.I. Conditioner	CA830/TH	2.0	19.6	39
Pb 1st Cleaner H.I. Conditioner	A317	5.0	2.0	10
Pb 1st Cleaner H.I. Conditioner *	MIBC	100.0	0.0	0
Pb 2nd Cleaner Feed	SD200/NaCN	4.0	20.1	81
Pb 2nd Cleaner Feed	MIBC	100.0	0.0	0
Pb 3rd Cleaner Feed	SD200/NaCN	4.0	19.9	80
Pb 3rd Cleaner Feed	MIBC	100.0	0.0	0
Pb 4th Cleaner Feed	SD200/NaCN	4.0	20.0	80
Zinc Circuit:				
Zn Scalp Conditioner 1 Feed	Ca(OH)2	10.0	65.9	661
Zn Scalp Conditioner 2 Feed	CuSO4.5H2O	10.0	90.2	905
Zn Scalp 1 Feed *	M2030	100.0	20.0	10
Zn Scalp 1 Feed	A317	5.0	19.3	97
Zn Scalp 1 Feed *	DF250	100.0	90.0	45
Zn Scalp 2 Feed *	M2030	100.0	6.0	3
Zn Scalp 2 Feed	A317	5.0	0.0	0
Zn Scalp Conc. Regrind Mill Feed	Ca(OH)2	10.0	95.8	961
Zn Scalp Conc. Regrind Mill Feed	CuSO4.5H2O	10.0	16.5	166
Zn Prefloat Conditioner 1 Feed	Ca(OH)2	10.0	29.9	300
Zn Prefloat Conditioner 1 Feed	CuSO4.5H2O	10.0	46.2	464
Zn Prefloat Conditioner 2 Feed *	M2030	100.0	16.0	8
Zn Prefloat Conditioner 2 Feed	A317	5.0	14.4	72
Zn Prefloat Feed *	DF250	100.0	0.0	0
Zn Prefloat Cell 3 *	M2030	100.0	0.0	0
Zn Prefloat Cell 3	A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner *	M2030	100.0	20.0	10
Zn 1st Cleaner H.I. Conditioner	A317	5.0	10.4	52
Zn 1st Cleaner Scavenger Feed *	M2030	100.0	1.0	1
Zn 1st Cleaner Scavenger Feed	A317	5.0	3.9	20
Zn 2nd Cleaner Feed	Ca(OH)2	10.0	60.7	609
Zn 3rd Cleaner Feed	Ca(OH)2	10.0	6.8	68
Zn 4th Cleaner Feed	Ca(OH)2	10.0	18.8	189

* Drops per minute

Feed Rate= **598** **kg/h**

Test PP-13 - Continued

2.3. Flowsheet: As In Test PP-11.

2.4. Results: 2.4.1. Observations

Pb flotation was quite satisfactory. Modification of the zinc circuit did result in some improvement in Zn product grade, but X-Met tail assays were high. However, shift assay results indicated a good (89%) Zn recovery.
Cyclone classification in the primary ball mill circuit did not noticeably affect the metallurgical results.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2098	10.8	-
Ball Mill Discharge	1968	-	-
Cyclone Underflow	2804	-	-
Cyclone O'Flow/Semi-bulk Feed	1297	10.4	14
Semi-bulk 2 Tail	1270	10.2	-
Semi-bulk Regrind Mill Disch	1750	-	-
Semi-bulk Regrind Cyc U'Flow	1822	-	-
Semi-bulk Regrind Cyc O'Flow	1212	-	-
Pb Rougher 1 Feed	1116	10.1	20
Pb Rougher 2 Tail	1010	-	-
Pb Regrind Mill Discharge	2018	-	-
Pb Regrind Cyclone U'Flow	2000	-	-
Pb Regrind Cyclone O'Flow	1190	-	-
Pb 1st Cleaner Feed	-	10.2	-
Pb 1st Cleaner Tail	1090	-	-
Pb 2nd Cleaner	-	10.2	-
Pb 3rd Cleaner	-	10.0	-
Pb 4th Cleaner	-	10.0	-
Zn Scalp 1 Feed	-	10.8	17
Zn Scalp 2 Tail	1230	-	-
Zn Regrind Mill Discharge	1610	-	-
Zn Regrind Cyclone U'Flow	1698	-	-
Zn Regrind Cyclone O'Flow	1130	-	-
Zn Prefloat Feed	-	10.3	-
Zn Prefloat Tail	1010	-	-
Zn 1st Cleaner Feed	1118	11.9	-
Zn 1st Cleaner Scav Feed	-	12.0	-
Zn 1st Cleaner Scav Tail	1138	-	-
Zn 2nd Cleaner	-	12.1	-
Zn 3rd Cleaner	-	11.8	-

Test PP-13 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
20:30	Pb 4th Cleaner Conc	72.4	3.28
	Zn 4th Cleaner Conc	2.90	46.2
	Zn 1st Cleaner Scav Tail	2.18	5.29
	Zn Prefloat Tail	4.27	9.88
	Zn Scalp Tail	0.75	2.90
	Zn Combined Tail	1.13	2.52
21:30	Pb 4th Cleaner Conc	71.4	2.52
	Zn 4th Cleaner Conc	1.65	50.1
	Zn 1st Cleaner Scav Tail	2.13	6.31
	Zn Prefloat Tail	4.60	11.0
	Zn Scalp Tail	1.68	3.13
	Zn Combined Tail	0.67	1.23
22:30	Pb 4th Cleaner Conc	67.9	5.15
	Zn 4th Cleaner Conc	2.40	45.7
	Zn 1st Cleaner Scav Tail	1.83	2.98
	Zn Prefloat Tail	3.35	4.75
	Zn Scalp Tail	0.65	1.16
	Zn Combined Tail	1.27	1.78
23:30	Pb 4th Cleaner Conc	68.0	3.62
	Zn 4th Cleaner Conc	2.32	41.3
	Zn 1st Cleaner Scav Tail	1.42	2.30
	Zn Prefloat Tail	2.63	6.35
	Zn Scalp Tail	0.63	1.05
	Zn Combined Tail	1.05	1.75
24:30	Pb 4th Cleaner Conc	75.6	2.29
	Zn 4th Cleaner Conc	1.24	54.0
	Zn 1st Cleaner Scav Tail	1.58	3.03
	Zn Prefloat Tail	1.97	8.68
	Zn Scalp Tail	0.56	0.78
	Zn Combined Tail	1.01	1.82
1:00	Pb 4th Cleaner Conc	74.1	1.49
1:30	Pb 4th Cleaner Conc	74.4	1.81
	Zn 4th Cleaner Conc	1.18	57.7
	Zn 1st Cleaner Scav Tail	1.68	4.04
	Zn Prefloat Tail	2.20	8.28
	Zn Scalp Tail	0.60	1.09
	Zn Combined Tail	1.08	2.94
2:30	Pb 4th Cleaner Conc	73.1	1.69
	Zn 4th Cleaner Conc	1.40	54.6
	Zn 1st Cleaner Scav Tail	1.31	2.70
	Zn Prefloat Tail	2.68	2.71
	Zn Scalp Tail	0.47	0.68
	Zn Combined Tail	0.89	1.28
3:00	Pb 4th Cleaner conc	63.1	4.72
3:30	Pb 4th Cleaner Conc	65.9	5.58
	Zn 4th Cleaner Conc	1.73	46.9
	Zn 1st Cleaner Scav Tail	1.93	2.56
	Zn Prefloat Tail	2.89	3.19
	Zn Scalp Tail	0.95	0.89
	Zn Combined Tail	1.91	1.41

Test PP-13 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Cyclone Underflow	3.59	10.1	-
Cyclone O'Flow/Semi-bulk Feed	3.14	9.69	59.6
Semi-bulk Concentrate	14.9	14.8	-
Semi-bulk Tail	0.87	8.74	-
Semi-bulk Regrind Cyc O'Flow	14.0	15.1	-
Pb Rougher Feed	12.5	27.7	-
Pb Rougher Concentrate	16.9	32.7	-
Pb Rougher Tail	2.85	12.2	-
Pb Regrind Cyclone O'Flow	16.3	31.4	-
Pb 1st Cleaner Concentrate	32.7	26.5	-
Pb 1st Cleaner Tail	11.6	35.3	-
Pb 4th Cleaner Concentrate	76.4	3.44	180
Zn Scalp Concentrate	1.46	21.4	-
Zn Scalp Tail	0.52	0.42	-
Zn Regrind Cyclone O'Flow	1.37	23.2	-
Zn Prefloat Feed	3.01	10.4	-
Zn Prefloat Concentrate	3.60	18.0	-
Zn Prefloat Tail	2.41	5.94	-
Zn 1st Cleaner Feed	2.23	23.5	-
Zn 1st Cleaner Scav Conc	2.91	13.8	-
Zn 1st Cleaner Scav Tail	1.52	2.81	-
Zn Combined Tail	0.84	1.16	24.5
Zn 4th Cleaner	1.77	53.4	164

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	2.84	76.4	3.44	180	69.2	1.0	9.9
Zn 3rd Cleaner Concentrate	16.20	1.77	53.4	164	9.1	89.3	51.6
Zn Combined Tails	80.95	0.84	1.16	24.5	21.7	9.7	38.5
Cyclone Overflow	100.00	3.14	9.69	59.6	100.0	100.0	100.0

TEST NO. PP-14

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As in Test PP-13.

1.1.2. Method: As for Test PP-13.

1.1.2.1. Flowsheet Equipment

As for Test PP-13.

1.1.2.2. Mill Loads

As for Test PP-10.

1.1.2.3. Classification Equipment

As in Test PP-13.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 8.0 hours and was sampled every 30 minutes during the last 4.0 hours of operation. The average feed rate was 601 kg/h of dry ore.

1.1.3. Flowsheet: As in Test PP-13.

Test PP-14 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-14

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	11.5	5.8	5.8	94.3
4,699	4	25.9	13.0	18.7	81.3
3,327	6	21.7	10.9	29.6	70.5
2,362	8	18.2	9.1	38.7	61.4
1,651	10	20.1	10.1	48.7	51.3
1,168	14	14.1	7.1	55.8	44.3
833	20	10.3	5.2	60.9	39.1
589	28	8.6	4.3	65.2	34.8
417	35	7.3	3.7	68.9	31.1
295	48	5.4	2.7	71.6	28.4
208	65	4.6	2.3	73.9	26.1
147	100	5.0	2.5	76.4	23.6
104	150	4.8	2.4	78.8	21.2
74	200	5.3	2.7	81.4	18.6
53	270	5.3	2.7	84.1	15.9
38	400	5.0	2.5	86.6	13.4
-38	-400	26.9	13.4	100.0	-
	Total	200.0	100.0	-	-

Product: Rod Mill Discharge Test No: PP-14

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.0	0.0	0.0	100.0
1,168	14	1.3	0.7	0.7	99.4
833	20	2.6	1.3	2.0	98.1
589	28	6.8	3.4	5.4	94.7
417	35	16.1	8.1	13.4	86.6
295	48	15.8	7.9	21.3	78.7
208	65	18.8	9.4	30.7	69.3
147	100	18.9	9.5	40.2	59.9
104	150	15.7	7.9	48.0	52.0
74	200	14.2	7.1	55.1	44.9
53	270	14.7	7.4	62.5	37.5
38	400	13.0	6.5	69.0	31.0
-38	-400	62.1	31.0	100.0	-
	Total	200.0	100.0	-	-

Test PP-14- Continued

1.1.4. Size Analyses: Continued

Product: Cyclone Overflow Test No: PP-14

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	3.8	1.9	1.9	98.1
147	100	5.5	2.8	4.7	95.4
104	150	9.6	4.8	9.5	90.6
74	200	14.6	7.3	16.8	83.3
53	270	20.8	10.4	27.2	72.9
38	400	23.0	11.5	38.7	61.4
-38	-400	122.7	61.4	100.0	-
	Total	200.0	100.0	-	-

Product: Cyclone Overflow Test No: PP-14 S.G.- 4.29

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	4.51	9.0	9.0	91.0
200	2.77	5.5	14.6	85.4
270	4.37	8.7	23.3	76.7
33.2μ	6.78	13.6	36.9	63.1
25.7	5.42	10.8	47.7	52.3
18.0	5.70	11.4	59.1	40.9
12.3	5.09	10.2	69.3	30.7
9.5	1.61	3.2	72.5	27.5
-9.5	13.75	27.5	100.0	-
Total	50.00	100.0	-	-

1.1.5. Observations: The cyclone overflow was 80% - 67 μm, a bit finer than in Test PP-13.

Test PP-14 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: As in Test PP-12.

1.2.2. Method: As In Test PP-12.

1.2.2.1. Flowsheet Equipment

As in Test PP-10.

1.2.2.2. Mill Loads

As In Test PP-12.

1.2.2.3. Classification Equipment

As in Test PP-11.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL Mill Disch	Cycl U/Flow	Cycl O/Flow	Size Distributions Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Sala	-	1748	1720	1230	Feed Cycl O/Flow	73.4 94.9	59.0 83.4	37.2 54.7	29 16
Pb-Hazen	-	1996	1984	1204	Feed Cycl O/Flow	97.1 99.5	90.6 97.0	57.4 81.1	14 11
Zn-Denver	-	2190	2200	1226	Feed Cycl O/Flow	36.2 75.1	29.8 59.7	22.8 41.4	109 28

1.2.3. Flowsheet: As in Test PP-10.

Test PP-14 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-14 S.G.- 4.76

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	3.28	6.6	6.6	93.4
31.3μ	5.13	10.3	16.8	83.2
24.3	4.87	9.7	26.6	73.4
16.9	7.22	14.4	41.0	59.0
11.6	7.92	15.8	56.8	43.2
9.0	2.99	6.0	62.8	37.2
-9.0	18.59	37.2	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-14 S.G.- 4.74

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.3μ	0.62	1.2	1.2	98.8
24.3	1.94	3.9	5.1	94.9
16.9	5.72	11.4	16.6	83.4
11.6	9.65	19.3	35.9	64.1
9.0	4.74	9.5	45.3	54.7
-9.0	27.33	54.7	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-14 S.G.-4.56

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
32.0μ	0.49	1.0	1.0	99.0
24.8	0.96	1.9	2.9	97.1
17.3	3.25	6.5	9.4	90.6
11.9	9.84	19.7	29.1	70.9
9.2	6.78	13.6	42.6	57.4
-9.2	28.68	57.4	100.0	-
Total	50.00	100.0	-	-

Test PP-14 - Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-14 S.G.- 4.56

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
32.0µ	0.00	0.0	0.0	100.0
24.8	0.26	0.5	0.5	99.5
17.3	1.26	2.5	3.0	97.0
11.9	7.91	15.8	18.9	81.1
9.2	7.08	14.2	33.0	67.0
-9.2	33.49	67.0	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc Test No: PP-14 S.G.- 4.36

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
100	5.69	11.4	11.4	88.6
150	4.77	9.5	20.9	79.1
200	7.32	14.6	35.6	64.4
270	4.02	8.0	43.6	56.4
33.0µ	6.25	12.5	56.1	43.9
25.6	3.83	7.7	63.8	36.2
17.8	3.21	6.4	70.2	29.8
12.3	2.61	5.2	75.4	24.6
9.5	0.90	1.8	77.2	22.8
-9.5	11.40	22.8	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-14 S.G.- 4.37

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	2.18	4.4	4.4	95.6
33.0µ	4.29	8.6	12.9	87.1
25.6	5.99	12.0	24.9	75.1
17.8	7.68	15.4	40.3	59.7
12.3	6.88	13.8	54.0	46.0
9.5	2.26	4.5	58.6	41.4
-9.5	20.72	41.4	100.0	-
Total	50.00	100.0	-	-

Test PP-14 - Continued

1.2.4. Size Analyses: Continued

Product: Zn Scalp Tail   Test No: PP-14   S.G.- 4.20

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
150	5.29	10.6	10.6	89.4
200	3.08	6.2	16.7	83.3
270	6.61	13.2	30.0	70.0
33.9μ	4.72	9.4	39.4	60.6
26.3	5.24	10.5	49.9	50.1
18.3	5.66	11.3	61.2	38.8
12.6	4.49	9.0	70.2	29.8
9.7	1.20	2.4	72.6	27.4
-9.7	13.71	27.4	100.0	-
Total	50.00	100.0	-	-

Product: Zn Cleaner Scav Tail   Test No: PP-14   S.G.- 4.46

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	1.86	3.7	3.7	96.3
32.5μ	3.00	6.0	9.7	90.3
25.2	4.70	9.4	19.1	80.9
17.6	6.83	13.7	32.8	67.2
12.1	7.33	14.7	47.4	52.6
9.3	2.99	6.0	53.4	46.6
-9.3	23.29	46.6	100.0	-
Total	50.00	100.0	-	-

Product: Zn 4th Cleaner Conc   Test No: PP-14   S.G.- 4.22

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	1.30	2.6	2.6	97.4
33.9μ	3.17	6.3	8.9	91.1
26.3	6.12	12.2	21.2	78.8
18.3	7.90	15.8	37.0	63.0
12.6	6.80	13.6	50.6	49.4
9.7	2.71	5.4	56.0	44.0
-9.7	22.00	44.0	100.0	-
Total	50.00	100.0	-	-

Test PP-14- Continued

1.2.4. Size Analyses: Continued

Product: Pb 4th Cleaner Conc Test No: PP-14 S.G.- 6.25

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
26.6µ	0.00	0.0	0.0	100.0
20.6	0.61	1.2	1.2	98.8
19.4	2.39	4.8	6.0	94.0
9.9	9.04	18.1	24.1	75.9
7.6	6.31	12.6	36.7	63.3
-7.6	31.65	63.3	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations: Plugging of the cyclones was greatly reduced and flotation circuit stability was improved.
The Zn scalp concentrate continued to be coarse (i.e. 80% >100 µm).
However, the regrind product was not particularly coarse, 80% - 28 µm.

Test No. PP-14

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	2.0	% moisture	
Primary Rod Mill Feed	601	dry kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	155	kg of 62mm dia. rods	
	150	kg of 37-50mm dia. rods	
	305	kg total	
Rod Mill Discharge:	2,109 g/L	(69 % Sol at SG 4.25)	
	44.9	% minus 48 mesh	
	31.0	% minus 200 mesh	
Input Power:	24.54	3 disc revolutions	
	3.96 kW	95% drive efficiency)	
Average Power:	3.76 kW	Gross	
	1.771	No Load	
	1.99	Net	
Net Power Usage:	3.3		
K80 Feed:	4141	microns	
K80 Product:	305	microns	
W. Index (metric):	7.9		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	601	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	288	kg of 50mm balls	
	112	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	2,052 g/L	(67 % Sol at SG 4.25)	
	-	% minus 48 mesh	
	-	% minus 200 mesh	
Circulating Load	14.83	%	
Input Power:	14.83	sec for 3 disc revolutions	
	6.55 kW	95% drive efficiency)	
Average Power:	6.23 kW	Gross	
	1.60	No Load	
	4.63	Net	
Net Power Usage:	7.7	kWh/t	
K80 Feed:	305	microns	
K80 Product:	67	microns	
W. Index (metric):	11.9		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	11.0 kWh/t
K80 Feed:	4141 microns
K80 Product:	67 microns
Work Index :	10.3 metric
Flot. Feed :	83.3% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	601	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	400	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,748 g/L	(54 % Sol at SG	4.77)
Input Power:	10.37	sec for 3 disc revolutions	
	3.75 kW	95% drive efficiency)	
Average Power:	3.56 kW	Gross	
	1.18	No Load	
	2.38	Net	
K80 Feed:	29	microns	
K80 Product:	16	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	601	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	1,996 g/L	(64 % Sol at SG	4.61)
Input Power:	27.40	sec for 3 disc revolutions	
	1.42 kW	95% drive efficiency)	
Average Power:	1.35 kW	Gross	
	0.69	No Load	
	0.66	Net	
K80 Feed:	14	microns	
K80 Product:	11	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	601	kg/h	
Denver Mill Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	305	kg of 25 mm balls	
	305	kg total	
Ball Mill Discharge:	2,190 g/L	(70 % Sol at SG	4.38)
Input Power:	57.73	sec for 3 disc revolutions	
	1.68 kW	95% drive efficiency)	
Average Power:	1.60 kW	Gross	
	0.61	No Load	
	0.99	Net	
K80 Feed:	101	microns	
K80 Product:	32	microns	

2. FLOTATION

2.1. Purpose: As in Test PP-13.

2.2. Method: As in Test PP-13. The Pb circuit MIBC and Zn prefloat lime levels were kept low, as in Test PP-13.

2.2.1. Flowsheet Equipment

As in Test PP-13.

2.2.2. Conditioning Parameters

As in Test PP-10.

2.2.3. Circuit Operation

The circuit was operated for a period of 8.0 hours, and was sampled every 30 minutes during the last 4.0 hours of operation.

TEST PP-14

2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	250.7	2503
Ball Mill Feed		CA830/TH	2.0	4.7	9
Ball Mill Feed		A317	5.0	2.0	10
Bulk Rougher 1 Feed		CA830/TH	2.0	9.8	20
Bulk Rougher 1 Feed		A317	5.0	9.8	49
Bulk Rougher 1 Feed	*	MIBC	100.0	40.4	20
Bulk Rougher 2 Feed		CA830/TH	2.0	4.8	10
Bulk Rougher 2 Feed		A317	5.0	2.0	10
Bulk Rougher 2 Feed	*	MIBC	100.0	3.8	2
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	31.6	315
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	83.4	333
Pb Rougher H.I. Conditioner		CA830/TH	2.0	8.4	17
Pb Rougher H.I. Conditioner		A317	5.0	8.1	40
Pb Rougher 1 Feed	*	MIBC	100.0	0.0	0
Pb Rougher 2 Feed		CA830/TH	2.0	14.7	29
Pb Rougher 2 Feed		A317	5.0	0.0	0
Pb Rougher 2 Feed	*	MIBC	100.0	0.0	0
Pb Concentrate Regrind Mill Feed		Na2CO3	10.0	10.1	101
Pb Concentrate Regrind Mill Feed		SD200/NaCN	4.0	82.7	330
Pb 1st Cleaner H.I. Conditioner		CA830/TH	2.0	20.3	41
Pb 1st Cleaner H.I. Conditioner		A317	5.0	2.0	10
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	0.0	0
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	19.8	79
Pb 2nd Cleaner Feed		MIBC	100.0	0.0	0
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	20.4	81
Pb 3rd Cleaner Feed		MIBC	100.0	0.0	0
Pb 4th Cleaner Feed		SD200/NaCN	4.0	20.0	80
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	71.8	717
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	89.0	889
Zn Scalp 1 Feed	*	M2030	100.0	20.0	10
Zn Scalp 1 Feed		A317	5.0	20.7	103
Zn Scalp 1 Feed	*	DF250	100.0	90.4	45
Zn Scalp 2 Feed	*	M2030	100.0	6.6	3
Zn Scalp 2 Feed		A317	5.0	0.0	0
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	84.9	848
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	17.3	173
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	28.0	280
Zn Prefloat Conditioner 1 Feed		CuSO4.5H2O	10.0	56.0	559
Zn Prefloat Conditioner 2	*	M2030	100.0	18.8	9
Zn Prefloat Conditioner 2		A317	5.0	7.1	35
Zn Prefloat Feed	*	DF250	100.0	2.8	1
Zn Prefloat Cell 3	*	M2030	100.0	0.0	0
Zn Prefloat Cell 3		A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	19.2	10
Zn 1st Cleaner H.I. Conditioner		A317	5.0	11.2	56
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	3.0	1
Zn 1st Cleaner Scavenger Feed		A317	5.0	5.0	25
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	36.0	359
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	13.8	138
Zn 4th Cleaner Feed		Ca(OH)2	10.0	10.1	101

* Drops per minute

Feed Rate= **601** **kg/h**

Test PP-14 - Continued

2.3. Flowsheet: As in Test PP-11.

2.4. Results:

2.4.1. Observations

Circuit operation was fairly steady with reasonably low Zn prefloat and Zn cleaner scavenger tail grades indicated by X-Met. High combined tails by X-Met were actually lower. Efforts to increase Zn product grades to 54-55% resulted in an overall product of 52 %.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2109	10.8	-
Ball Mill Discharge	2052	-	-
Cyclone Underflow	2798	-	-
Cyclone O'Flow/Semi-bulk Feed	1282	10.2	15
Semi-bulk 2 Tail	1270	10.0	-
Semi-bulk Regrind Mill Disch	1748	-	-
Semi-bulk Regr Cyc U'Flow	1720	-	-
Semi-bulk Regr Cyc O'Flow	1230	-	-
Pb Rougher 1 Feed	1104	10.1	20
Pb Rougher 2 Tail	1044	-	-
Pb Regrind Mill Discharge	1996	-	-
Pb Regrind Cyclone U'Flow	1984	-	-
Pb Regrind Cyclone O'Flow	1204	-	-
Pb 1st Cleaner Feed	-	10.1	-
Pb 1st Cleaner Tail	1106	-	-
Pb 2nd Cleaner	-	10.1	-
Pb 3rd Cleaner	-	10.0	-
Pb 4th Cleaner	-	10.0	-
Zn Scalp 1 Feed	-	10.8	17
Zn Scalp 2 Tail	1186	-	-
Zn Regrind Mill Discharge	2190	-	-
Zn Regrind Cyclone U'Flow	2200	-	-
Zn Regrind Cyclone O'Flow	1226	-	-
Zn Prefloat Feed	-	10.1	-
Zn Prefloat Tail	1012	-	-
Zn 1st Cleaner Feed	1142	11.6	-
Zn 1st Cleaner Scav Feed	-	11.8	-
Zn 1st Cleaner Scav Tail	1052	-	-
Zn 2nd Cleaner	-	11.9	-
Zn 3rd Cleaner	-	11.8	-

2.4.3. Grab Sample Assays

Time	Product	Assays, % Pb	Assays, % Zn
4:30	Pb 4th Cleaner Conc	-	-
	Zn 4th Cleaner Conc	0.89	60.5
	Zn 1st Cleaner Scav Tail	1.57	3.82
	Zn Prefloat Tail	2.51	3.82
	Zn Scalp Tail	0.49	1.06
	Zn Combined Tail	0.92	2.32
5:00	Pb 4th Cleaner Conc	70.0	1.99
5:30	Pb 4th Cleaner Conc	70.4	3.01
	Zn 4th Cleaner Conc	0.78	59.2
	Zn 1st Cleaner Scav Tail	1.91	4.93
	Zn Prefloat Tail	2.76	3.41
	Zn Scalp Tail	0.62	1.09
	Zn Combined Tail	1.28	2.67
6:30	Pb 4th Cleaner Conc	57.1	7.18
	Zn 4th Cleaner Conc	0.99	56.2
	Zn 1st Cleaner Scav Tail	1.66	3.26
	Zn Prefloat Tail	2.31	1.83
	Zn Scalp Tail	0.67	0.55
	Zn Combined Tail	0.99	1.97
7:30	Pb 4th Cleaner Conc	72.0	1.79
	Zn 4th Cleaner Conc	0.94	54.1
	Zn 1st Cleaner Scav Tail	1.89	4.62
	Zn Prefloat Tail	2.20	5.61
	Zn Scalp Tail	0.53	0.58
	Zn Combined Tail	1.32	3.20
8:00	Zn Combined Tail	1.16	3.07
8:30	Pb 4th Cleaner Conc	48.7	9.51
	Zn 4th Cleaner Conc	1.45	50.2
	Zn 1st Cleaner Scav Tail	1.73	3.68
	Zn Prefloat Tail	2.44	2.19
	Zn Scalp Tail	0.60	0.95
	Zn Combined Tail	1.04	1.89
9:00	Pb 4th Cleaner conc	68.2	3.12
9:30	Pb 4th Cleaner Conc	57.0	6.68
	Zn 4th Cleaner Conc	1.56	53.4
	Zn 1st Cleaner Scav Tail	1.46	1.67
	Zn Prefloat Tail	2.58	2.35
	Zn Scalp Tail	0.08	0.71
	Zn Combined Tail	1.05	1.18
10:30	Pb 4th Cleaner Conc	61.9	4.96
	Zn 4th Cleaner Conc	1.36	51.3
	Zn 1st Cleaner Scav Tail	1.51	1.70
	Zn Prefloat Tail	2.10	3.05
	Zn Scalp Tail	0.72	0.67
	Zn Combined Tail	0.99	1.25
11:30	Pb 4th Cleaner Conc	69.2	3.18
	Zn 4th Cleaner Conc	1.46	50.2
	Zn 1st Cleaner Scav Tail	1.59	1.99
	Zn Prefloat Tail	2.50	3.13
	Zn Scalp Tail	1.00	0.81
	Zn Combined Tail	1.05	1.51

Test PP-14 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t		
	Pb	Zn	Ag
Cyclone O'Flow/Semi-bulk Feed	3.08	9.58	58.9
Semi-bulk Concentrate	13.9	15.1	-
Semi-bulk Tail	0.89	8.72	-
Semi-bulk Regrind Cyc O'Flow	14.0	15.0	-
Pb Rougher Feed	11.3	20.6	-
Pb Rougher Concentrate	17.2	23.7	-
Pb Rougher Tail	2.23	13.1	-
Pb Regrind Cyclone O'Flow	16.8	24.2	-
Pb 1st Cleaner Concentrate	20.2	31.8	-
Pb 1st Cleaner Tail	8.50	26.0	-
Pb 4th Cleaner Concentrate	63.9	6.35	168
Zn Scalp Concentrate	1.51	22.0	-
Zn Scalp Tail	0.44	0.33	-
Zn Regrind Cyclone O'Flow	1.48	22.2	-
Zn Prefloat Feed	2.36	12.7	-
Zn Prefloat Concentrate	2.13	24.4	-
Zn Prefloat Tail	2.56	3.86	-
Zn 1st Cleaner Feed	2.08	20.7	-
Zn 1st Cleaner Scav Conc	2.60	11.9	-
Zn 1st Cleaner Scav Tail	1.43	2.30	-
Zn Combined Tail	0.85	0.95	31.1
Zn 4th Cleaner	1.69	52.0	197

2.4.5. Metallurgical Results

Product	Weight	Assays, %, g/t			% Distribution		
	%	Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	3.32	63.9	6.35	168	68.8	2.2	8.8
Zn 3rd Cleaner Concentrate	16.55	1.69	52	197	9.1	89.9	51.7
Zn Combined Tails	80.13	0.85	0.95	31.1	22.1	7.9	39.5
Cyclone Overflow	100.00	3.08	9.58	58.9	100.0	100.0	100.0

TEST NO. PP-15

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: As In Test PP-13.

1.1.2. Method: As for Test PP-13.

1.1.2.1. Flowsheet Equipment

As for Test PP-13.

1.1.2.2. Mill Loads

As for Test PP-10.

1.1.2.3. Classification Equipment

As in Test PP-13.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 8.0 hours and was sampled every 30 minutes during the last 4.0 hours of operation. The average feed rate was 600 kg/h of dry ore.

1.1.3. Flowsheet: As In Test PP-13.

Test PP-15 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-15

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	23.4	3.0	3.0	97.0
4,699	4	109.5	14.1	17.2	82.8
3,327	6	76.6	9.9	27.0	73.0
2,362	8	63.5	8.2	35.2	64.8
1,651	10	74.0	9.6	44.8	55.2
1,168	14	54.0	7.0	51.8	48.2
833	20	42.3	5.5	57.2	42.8
589	28	36.0	4.6	61.9	38.1
417	35	30.6	4.0	65.8	34.2
295	48	23.7	3.1	68.9	31.1
208	65	19.1	2.5	71.4	28.6
147	100	21.5	2.8	74.1	25.9
104	150	19.9	2.6	76.7	23.3
74	200	21.8	2.8	79.5	20.5
53	270	29.6	3.8	83.3	16.7
38	400	20.3	2.6	86.0	14.0
-38	-400	108.8	14.0	100.0	-
	Total	774.6	100.0	-	-

Product: Rod Mill Discharge Test No: PP-15

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.4	0.1	0.1	99.9
1,168	14	3.2	0.7	0.8	99.2
833	20	7.7	1.7	2.5	97.5
589	28	19.5	4.3	6.9	93.1
417	35	33.5	7.5	14.3	85.7
295	48	38.5	8.6	22.9	77.1
208	65	41.7	9.3	32.2	67.8
147	100	41.1	9.2	41.4	58.6
104	150	34.7	7.7	49.1	50.9
74	200	29.4	6.6	55.6	44.4
53	270	32.7	7.3	62.9	37.1
38	400	27.4	6.1	69.0	31.0
-38	-400	138.9	31.0	100.0	-
	Total	448.7	100.0	-	-

Test PP-15 - Continued

1.1.4. Size Analyses: Continued

Product: Ball Mill Discharge Test No: PP-15

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
589	28	2.6	0.9	0.9	99.1
417	35	8.6	3.0	4.0	96.0
295	48	16.9	6.0	10.0	90.0
208	65	30.1	10.7	20.6	79.4
147	100	50.6	17.9	38.6	61.4
104	150	52.7	18.7	57.2	42.8
74	200	42.7	15.1	72.4	27.6
53	270	29.9	10.6	83.0	17.0
38	400	16.2	5.7	88.7	11.3
-38	-400	31.9	11.3	100.0	-
	Total	282.2	100.0	-	-

Product: Cyclone Underflow Test No: PP-15

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
833	20	1.4	0.6	0.6	99.4
589	28	3.2	1.3	1.9	98.1
417	35	8.9	3.7	5.6	94.4
295	48	19.0	7.9	13.4	86.6
208	65	31.1	12.9	26.3	73.7
147	100	49.1	20.3	46.6	53.4
104	150	48.4	20.0	66.6	33.4
74	200	36.0	14.9	81.4	18.6
53	270	22.8	9.4	90.9	9.1
38	400	10.5	4.3	95.2	4.8
-38	-400	11.6	4.8	100.0	-
	Total	242.0	100.0	-	-

Test PP-15- Continued

1.1.4. Size Analyses: Continued

Product: Cyclone Overflow   Test No: PP-15

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
417	35	0.0	0.0	0.0	100.0
295	48	2.6	1.5	1.5	98.5
208	65	4.1	2.3	3.8	96.2
147	100	8.1	4.6	8.4	91.6
104	150	12.6	7.1	15.5	84.5
74	200	16.4	9.3	24.7	75.3
53	270	19.7	11.1	35.9	64.1
38	400	18.9	10.7	46.6	53.4
-38	-400	94.6	53.4	100.0	-
	Total	177.0	100.0	-	-

Product: Cyclone Overflow   Test No: PP-15   S.G.- 4.31

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	5.79	11.6	11.6	88.4
200	2.63	5.3	16.8	83.2
270	4.26	8.5	25.4	74.6
33.2μ	4.69	9.4	34.7	65.3
25.7	5.03	10.1	44.8	55.2
18.0	5.69	11.4	56.2	43.8
12.3	5.31	10.6	66.8	33.2
9.5	1.91	3.8	70.6	29.4
-9.5	14.69	29.4	100.0	-
Total	50.00	100.0	-	-

1.1.5. Observations: The cyclone overflow product was 80 % -88 μm, coarser than in PP-14 and similar to that in Test PP-15.

1.2. Regrinding Circuits:

1.2.1. Purpose: As in Test PP-12.

1.2.2. Method: As in Test PP-12.

1.2.2.1. Flowsheet Equipment

As in Test PP-10.

1.2.2.2. Mill Loads

As in Test PP-12.

1.2.2.3. Classification Equipment

As in Test PP-11.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Sala	-	1722	1734	1212	Feed Cycl O/Flow	74.7 95.4	60.2 83.9	38.1 57.6	28 15
Pb-Hazen	-	1994	1964	1194	Feed Cycl O/Flow	97.9 99.6	91.6 97.9	58.3 68.4	14 11
Zn-Denver	-	2328	2334	1240	Feed Cycl O/Flow	41.1 70.1	33.5 56.2	25.9 38.3	101 32

1.2.3. Flowsheet: As in Test PP-10.

Test PP-15 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-15 S.G.- 4.68

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	3.21	6.4	6.4	93.6
31.6μ	4.80	9.6	16.0	84.0
24.5	4.65	9.3	25.3	74.7
17.1	7.24	14.5	39.8	60.2
11.7	7.98	16.0	55.8	44.2
9.1	3.06	6.1	61.9	38.1
-9.1	19.06	38.1	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-15 S.G.- 4.77

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.3μ	0.68	1.4	1.4	98.6
24.3	1.63	3.3	4.6	95.4
16.9	5.76	11.5	16.1	83.9
11.6	9.03	18.1	34.2	65.8
9.0	4.12	8.2	42.4	57.6
-9.0	28.78	57.6	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-15 S.G.-4.62

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
32.0μ	0.39	0.8	0.8	99.2
24.8	0.68	1.4	2.1	97.9
17.3	3.13	6.3	8.4	91.6
11.9	9.84	19.7	28.1	71.9
9.2	6.80	13.6	41.7	58.3
-9.2	29.16	58.3	100.0	-
Total	50.00	100.0	-	-

Test PP-15 - Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-15 S.G.- 4.60

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
32.0μ	0.00	0.0	0.0	100.0
24.8	0.20	0.4	0.4	99.6
17.3	0.85	1.7	2.1	97.9
11.9	7.46	14.9	17.0	83.0
9.2	7.31	14.6	31.6	68.4
-9.2	34.18	68.4	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc Test No: PP-15 S.G.- 4.38

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
100	4.83	9.7	9.7	90.3
150	4.28	8.6	18.2	81.8
200	5.94	11.9	30.1	69.9
270	3.83	7.7	37.8	62.2
33.0μ	6.44	12.9	50.6	49.4
25.6	4.15	8.3	58.9	41.1
17.8	3.80	7.6	66.5	33.5
12.3	3.00	6.0	72.5	27.5
9.5	0.79	1.6	74.1	25.9
-9.5	12.94	25.9	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-15 S.G.- 4.38

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	2.98	6.0	6.0	94.0
33.0μ	5.95	11.9	17.9	82.1
25.6	6.00	12.0	29.9	70.1
17.8	6.99	14.0	43.8	56.2
12.3	6.53	13.1	56.9	43.1
9.5	2.40	4.8	61.7	38.3
-9.5	19.15	38.3	100.0	-
Total	50.00	100.0	-	-

Test PP-15 - Continued

1.2.4. Size Analyses: Continued

Product: Zn Scalp Tail Test No: PP-15 S.G.- 4.22

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	6.39	12.8	12.8	87.2
200	3.22	6.4	19.2	80.8
270	6.16	12.3	31.5	68.5
34.0μ	4.68	9.4	40.9	59.1
26.4	5.03	10.1	51.0	49.0
18.4	5.43	10.9	61.8	38.2
12.6	4.73	9.5	71.3	28.7
9.8	1.66	3.3	74.6	25.4
-9.8	12.70	25.4	100.0	-
Total	50.00	100.0	-	-

Product: Zn Cleaner Scav Tail Test No: PP-15 S.G.- 4.47

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	2.96	5.9	5.9	94.1
32.5μ	4.03	8.1	14.0	86.0
25.2	5.34	10.7	24.7	75.3
17.6	6.89	13.8	38.4	61.6
12.1	7.07	14.1	52.6	47.4
9.3	2.52	5.0	57.6	42.4
-9.3	21.19	42.4	100.0	-
Total	50.00	100.0	-	-

Product: Zn Prefloat Tail PP-15 S.G.- 4.31

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	2.88	5.8	5.8	94.2
200	2.71	5.4	11.2	88.8
270	4.27	8.5	19.7	80.3
33.2μ	4.53	9.1	28.8	71.2
25.7	4.94	9.9	38.7	61.3
18.0	5.71	11.4	50.1	49.9
12.3	5.43	10.9	60.9	39.1
9.5	2.12	4.2	65.2	34.8
-9.5	17.41	34.8	100.0	-
Total	50.00	100.0	-	-

Test PP-15- Continued

1.2.4. Size Analyses: Continued

Product: Pb 4th Cleaner Conc   Test No: PP-15   S.G.- 6.83

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
25.2µ	0.00	0.0	0.0	100.0
19.5	0.23	0.5	0.5	99.5
13.6	1.47	2.9	3.4	96.6
9.4	7.25	14.5	17.9	82.1
7.2	4.62	9.2	27.1	72.9
-7.2	36.43	72.9	100.0	-
Total	50.00	100.0	-	-

Product: Zn 4th Cleaner Conc   Test No: PP-15   S.G.- 4.20

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	2.46	4.9	4.9	95.1
33.9µ	3.68	7.4	12.3	87.7
26.3	6.27	12.5	24.8	75.2
18.3	7.32	14.6	39.5	60.5
12.6	6.39	12.8	52.2	47.8
9.7	2.33	4.7	56.9	43.1
-9.7	21.55	43.1	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations: Plugging of the cyclones occurred very rarely. The zinc scalp concentrate was coarse (80% - 101 µm) and the regrind product was also a bit coarse (80 % - 32 µm).

Test No. PP-15

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	2.1	% moisture	
Primary Rod Mill Feed	600	dry kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	155	kg of 62mm dia. rods	
	150	kg of 37-50mm dia. rods	
	305	kg total	
Rod Mill Discharge:	2,103 g/L	(69 % Sol at SG	4.25)
	44.4	% minus 48 mesh	
	31.0	% minus 200 mesh	
Input Power:	24.71	3 disc revolutions	
	3.93 kW	95% drive efficiency)	
Average Power:	3.74 kW	Gross	
	1.771	No Load	
	1.97	Net	
Net Power Usage:	3.3		
K80 Feed:	4252	microns	
K80 Product:	328	microns	
W. Index (metric):	8.2		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	600	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	288	kg of 50mm balls	
	112	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,986 g/L	(65 % Sol at SG	4.25)
	90.0	% minus 48 mesh	
	27.6	% minus 200 mesh	
Circulating Load	304	%	
Input Power:	14.89	sec for 3 disc revolutions	
	6.53 kW	95% drive efficiency)	
Average Power:	6.20 kW	Gross	
	1.60	No Load	
	4.60	Net	
Net Power Usage:	7.7	kWh/t	
K80 Feed:	328	microns	
K80 Product:	88	microns	
W. Index (metric):	14.9		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	10.9 kWh/t
K80 Feed:	4252 microns
K80 Product:	88 microns
Work Index :	12.0 metric
Flot. Feed :	75.3% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	600	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	400	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,722 g/L	(53 % Sol at SG	4.77)
Input Power:	10.36	sec for 3 disc revolutions	
	3.75 kW	95% drive efficiency)	
Average Power:	3.57 kW	Gross	
	1.18	No Load	
	2.39	Net	
K80 Feed:	28	microns	
K80 Product:	15	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	600	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	1,994 g/L	(64 % Sol at SG	4.61)
Input Power:	28.12	sec for 3 disc revolutions	
	1.38 kW	95% drive efficiency)	
Average Power:	1.31 kW	Gross	
	0.69	No Load	
	0.63	Net	
K80 Feed:	14	microns	
K80 Product:	11	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	600	kg/h	
Denver Mill Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	305	kg of 25 mm balls	
	305	kg total	
Ball Mill Discharge:	2,328 g/L	(74 % Sol at SG	4.38)
Input Power:	56.92	sec for 3 disc revolutions	
	1.71 kW	95% drive efficiency)	
Average Power:	1.62 kW	Gross	
	0.61	No Load	
	1.01	Net	
K80 Feed:	101	microns	
K80 Product:	32	microns	

2. FLOTATION

2.1. Purpose: As in Test PP-14.

2.2. Method: As in Test PP-14.

2.2.1. Flowsheet Equipment

As In Test PP-13.

2.2.2. Conditioning Parameters

As In Test PP-10.

2.2.3. Circuit Operation

The circuit was operated for a period of 8.0 hours, and was sampled every 30 minutes during the last 4.0 hours of operation.

TEST PP-15

2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	250.0	2500
Ball Mill Feed		CA830/TH	2.0	4.9	10
Ball Mill Feed		A317	5.0	2.0	10
Bulk Rougher 1 Feed		CA830/TH	2.0	9.4	19
Bulk Rougher 1 Feed		A317	5.0	9.2	46
Bulk Rougher 1 Feed	*	MIBC	100.0	40.7	20
Bulk Rougher 2 Feed		CA830/TH	2.0	4.3	9
Bulk Rougher 2 Feed		A317	5.0	2.1	11
Bulk Rougher 2 Feed	*	MIBC	100.0	3.8	2
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	30.1	301
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	84.4	338
Pb Rougher H.I. Conditioner		CA830/TH	2.0	7.0	14
Pb Rougher H.I. Conditioner		A317	5.0	8.4	42
Pb Rougher H.I. Conditioner	*	MIBC	100.0	0.0	0
Pb Rougher 2 Feed		CA830/TH	2.0	13.2	26
Pb Rougher 2 Feed		A317	5.0	0.0	0
Pb Rougher 2 Feed	*	MIBC	100.0	2.8	1
Pb Concentrate Regrind Mill Feed		Na2CO3	10.0	10.0	100
Pb Concentrate Regrind Mill Feed		SD200/NaCN	4.0	83.8	335
Pb 1st Cleaner H.I. Conditioner		CA830/TH	2.0	19.8	40
Pb 1st Cleaner H.I. Conditioner		A317	5.0	2.0	10
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	0.0	0
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	20.0	80
Pb 2nd Cleaner Feed		MIBC	100.0	0.0	0
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	20.3	81
Pb 3rd Cleaner Feed		MIBC	100.0	0.0	0
Pb 4th Cleaner Feed		SD200/NaCN	4.0	20.2	81
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	67.3	673
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	90.8	908
Zn Scalp 1 Feed	*	M2030	100.0	26.7	13
Zn Scalp 1 Feed		A317	5.0	18.6	93
Zn Scalp 1 Feed	*	DF250	100.0	86.1	43
Zn Scalp 2 Feed	*	M2030	100.0	5.4	3
Zn Scalp 2 Feed		A317	5.0	0.0	0
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	80.7	807
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	16.9	169
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	25.8	258
Zn Prefloat Conditioner 1 Feed		CuSO4.5H2O	10.0	68.6	686
Zn Prefloat Conditioner 2	*	M2030	100.0	13.8	7
Zn Prefloat Conditioner 2		A317	5.0	4.8	24
Zn Prefloat Feed	*	DF250	100.0	5.8	3
Zn Prefloat Cell 3	*	M2030	100.0	0.0	0
Zn Prefloat Cell 3		A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	18.3	9
Zn 1st Cleaner H.I. Conditioner		A317	5.0	10.8	54
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	1.7	1
Zn 1st Cleaner Scavenger Feed		A317	5.0	4.9	25
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	35.7	357
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	12.7	127
Zn 4th Cleaner Feed		Ca(OH)2	10.0	13.3	133

* Drops per minute

Feed Rate= **600** **kg/h**

Test PP-15 - Continued

2.3. Flowsheet: As In Test PP-11.

2.4. Results: 2.4.1. Observations

Zn product grade was 52%. A higher grade was achieved in some grab samples, but was not consistently maintained. Copper flotation in the prefloat seemed dependent on maintaining a copper sulphate addition level of over 40 mL/min (400 g/t).
Samples were taken for Ba assays, sizing, Ag mineralogy, environmental testwork, and backfill studies.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2103	10.8	-
Ball Mill Discharge	1986	-	-
Cyclone Underflow	2817	-	-
Cyclone O'Flow/Semi-bulk Feed	1300	10.3	16
Semi-bulk 2 Tail	1268	10.1	-
Semi-bulk Regrind Mill Disch	1722	-	-
Semi-bulk Regr Cyc U'Flow	1734	-	-
Semi-bulk Regr Cyc O'Flow	1212	-	-
Pb Rougher 1 Feed	1106	10.1	20
Pb Rougher 2 Tail	1048	-	-
Pb Regrind Mill Discharge	1994	-	-
Pb Regrind Cyclone U'Flow	1964	-	-
Pb Regrind Cyclone O'Flow	1194	-	-
Pb 1st Cleaner Feed	-	10.2	-
Pb 1st Cleaner Tail	1104	-	-
Pb 2nd Cleaner	-	10.1	-
Pb 3rd Cleaner	-	10.0	-
Pb 4th Cleaner	-	10.0	-
Zn Scalp 1 Feed	-	10.8	17
Zn Scalp 2 Tail	1210	-	-
Zn Regrind Mill Discharge	2328	-	-
Zn Regrind Cyclone U'Flow	2334	-	-
Zn Regrind Cyclone O'Flow	1240	-	-
Zn Prefloat Feed	-	10.1	-
Zn Prefloat Tail	1018	-	-
Zn 1st Cleaner Feed	1213	11.6	-
Zn 1st Cleaner Scav Feed	-	11.8	-
Zn 1st Cleaner Scav Tail	1064	-	-
Zn 2nd Cleaner	-	11.9	-
Zn 3rd Cleaner	-	11.8	-
Thickener Underflow	2670	-	-

Test PP-15 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
12:30	Pb 4th Cleaner Conc	77.0	2.04
	Zn 4th Cleaner Conc	1.50	51.4
	Zn 1st Cleaner Scav Tail	1.58	2.14
	Zn Prefloat Tail	2.55	2.36
	Zn Scalp Tail	0.70	0.73
	Zn Combined Tail	0.97	1.33
13:30	Pb 4th Cleaner Conc	79.8	1.59
	Zn 4th Cleaner Conc	1.01	58.5
	Zn 1st Cleaner Scav Tail	1.59	3.88
	Zn Prefloat Tail	1.78	5.72
	Zn Scalp Tail	0.60	1.57
	Zn Combined Tail	1.06	2.23
14:30	Pb 4th Cleaner Conc	71.9	3.29
	Zn 4th Cleaner Conc	1.11	56.7
	Zn 1st Cleaner Scav Tail	1.51	2.17
	Zn Prefloat Tail	2.75	2.28
	Zn Scalp Tail	0.71	1.39
	Zn Combined Tail	0.78	1.03
15:30	Pb 4th Cleaner Conc	69.8	3.42
	Zn 4th Cleaner Conc	1.45	52.3
	Zn 1st Cleaner Scav Tail	1.75	2.81
	Zn Prefloat Tail	2.65	3.10
	Zn Scalp Tail	0.80	1.18
	Zn Combined Tail	1.09	1.96
16:30	Pb 4th Cleaner Conc	61.5	3.68
	Zn 4th Cleaner Conc	1.69	44.3
	Zn 1st Cleaner Scav Tail	1.80	3.62
	Zn Prefloat Tail	2.49	2.70
	Zn Scalp Tail	0.90	1.53
	Zn Combined Tail	1.22	2.21
17:30	Pb 4th Cleaner Conc	69.0	3.19
	Zn 4th Cleaner Conc	1.23	50.7
	Zn 1st Cleaner Scav Tail	1.55	2.27
	Zn Prefloat Tail	2.33	1.92
	Zn Scalp Tail	0.59	0.42
	Zn Combined Tail	1.09	1.27
18:30	Pb 4th Cleaner Conc	70.4	2.36
	Zn 4th Cleaner Conc	1.32	56.4
	Zn 1st Cleaner Scav Tail	1.63	3.29
	Zn Prefloat Tail	2.38	2.16
	Zn Scalp Tail	1.09	1.45
	Zn Combined Tail	0.59	0.40
19:30	Pb 4th Cleaner Conc	68.8	3.60
	Zn 4th Cleaner Conc	1.75	51.9
	Zn 1st Cleaner Scav Tail	1.57	2.28
	Zn Prefloat Tail	2.54	2.14
	Zn Scalp Tail	0.61	0.48
	Zn Combined Tail	0.94	1.02

Test PP-15 - Continued

2.4.4. Shift Sample Assays

Product	Assays %, g/t			
	Pb	Zn	Ag	Ba
Cyclone Underflow	-	-	-	21.7
Cyclone O'Flow/Semi-bulk Feed	3.23	9.60	58.7	26.1
Semi-bulk Concentrate	14.1	14.9	-	-
Semi-bulk Tail	0.93	8.92	-	30.5
Semi-bulk Regrind Cyc O'Flow	14.5	14.7	-	2.95
Pb Rougher Feed	12.0	23.4	-	-
Pb Rougher Concentrate	18.0	29.5	-	-
Pb Rougher Tail	3.05	12.6	-	-
Pb Regrind Cyclone O'Flow	17.1	29.4	-	0.52
Pb 1st Cleaner Concentrate	27.9	28.5	-	-
Pb 1st Cleaner Tail	10.6	32.3	-	-
Pb 4th Cleaner Concentrate	75.3	2.60	196	-
Zn Scalp Concentrate	1.55	18.8	-	12.0
Zn Scalp Tail	0.43	0.24	-	45.9
Zn Regrind Cyclone O'Flow	1.50	19.5	-	12.1
Zn Prefloat Feed	2.86	11.0	-	-
Zn Prefloat Concentrate	3.12	22.9	-	-
Zn Prefloat Tail	2.58	2.04	-	-
Zn 1st Cleaner Feed	2.09	23.8	-	-
Zn 1st Cleaner Scav Conc	2.71	17.2	-	-
Zn 1st Cleaner Scav Tail	1.45	2.28	-	-
Zn Combined Tail	0.95	1.14	31.5	-
Zn 4th Cleaner	1.75	52.3	175	-

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	2.89	75.3	2.6	196	67.4	0.8	9.5
Zn 3rd Cleaner Concentrate	16.45	1.75	52.3	175	8.9	89.6	48.1
Zn Combined Tails	80.66	0.95	1.14	31.5	23.7	9.6	42.4
Cyclone Overflow	100.00	3.23	9.60	58.7	100.0	100.0	100.0

Test PP-15- Continued

3. ZN SCALP TAILS DESLIMING

A barrel of PP-15 Zn scalp tails were slurried at 1300 g/L and deslimed in a Krebs 25 mm cyclone. The sands were stored and the slimes were sent to Rescan for environmental testwork.

A size analysis of the slimes is shown below.

Product: Zn Scalp. Tail Slime Test No: PP-15 S.G.- 4.03

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
27.5μ	0.17	0.3	0.3	99.7
21.3	0.28	0.6	0.9	99.1
14.9	0.58	1.2	2.1	97.9
10.2	0.35	0.7	2.8	97.2
7.9	0.20	0.4	3.2	96.8
-7.9	48.42	96.8	100.0	-
Total	50.00	100.0	-	-

TEST NO. PP-16

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: Grinding in recycle water.

1.1.2. Method: The thickener overflow water was used in the grinding circuit. (Roughly 62% of the water in the circuit was recycle water).

Other changes included:

- pumping of the rod mill discharge to the ball mill feed (due to pump plugging) at 3:30 (1.5 hours into the sampling period).
- water was added to the ball mill discharge rather than to the ball mill feed at 3:30.
- additional balls (100 kg 50 mm) were added to the ball mill at 5:15, 45 minutes before the end of the test.

1.1.2.1. Flowsheet Equipment

As for Test PP-13.

1.1.2.2. Mill Loads

As for Test PP-10.

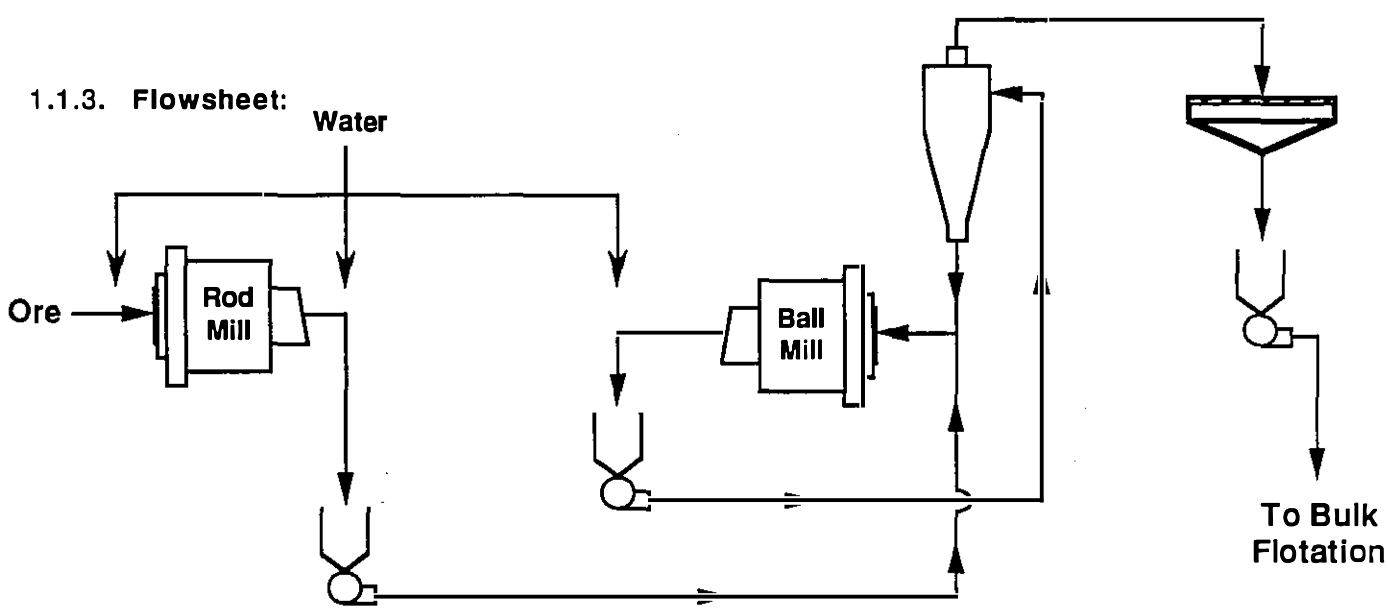
1.1.2.3. Classification Equipment

As in Test PP-13.

1.1.2.4. Circuit Operation

The circuit was operated for a period of 10.0 hours and was sampled every 60 minutes during the last 5.5 hours of operation. The average feed rate was 603 kg/h of dry ore.

1.1.3. Flowsheet:



Test PP-16 - Continued

1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-16

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	2.4	0.3	0.3	99.7
6,680	3	46.4	4.9	5.1	94.9
4,699	4	125.0	13.1	18.2	81.8
3,327	6	98.3	10.3	28.5	71.5
2,362	8	77.4	8.1	36.6	63.4
1,651	10	98.0	10.3	46.8	53.2
1,168	14	66.8	7.0	53.8	46.2
833	20	51.7	5.4	59.2	40.8
589	28	44.3	4.6	63.9	36.1
417	35	36.9	3.9	67.7	32.3
295	48	27.7	2.9	70.6	29.4
208	65	25.9	2.7	73.3	26.7
147	100	23.6	2.5	75.8	24.2
104	150	22.8	2.4	78.2	21.8
74	200	25.2	2.6	80.8	19.2
53	270	32.1	3.4	84.2	15.8
38	400	23.3	2.4	86.6	13.4
-38	-400	128.0	13.4	100.0	-
	Total	955.8	100.0	-	-

Product: Rod Mill Discharge Test No: PP-16

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.6	0.2	0.2	99.8
1,168	14	2.2	0.6	0.8	99.2
833	20	6.2	1.8	2.6	97.4
589	28	15.9	4.6	7.2	92.8
417	35	27.6	8.0	15.1	84.9
295	48	30.8	8.9	24.0	76.0
208	65	30.9	8.9	32.9	67.1
147	100	31.5	9.1	42.0	58.0
104	150	26.1	7.5	49.5	50.5
74	200	24.9	7.2	56.7	43.3
53	270	24.3	7.0	63.7	36.3
38	400	21.7	6.3	70.0	30.0
-38	-400	104.1	30.0	100.0	-
	Total	346.8	100.0	-	-

Test PP-16 - Continued

1.1.4. Size Analyses: Continued

Product: Ball Mill Discharge Test No: PP-16

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
589	28	2.1	0.8	0.8	99.2
417	35	5.3	2.0	2.8	97.2
295	48	14.0	5.4	8.2	91.8
208	65	27.3	10.5	18.7	81.3
147	100	46.0	17.7	36.4	63.6
104	150	47.7	18.3	54.7	45.3
74	200	35.2	13.5	68.2	31.8
53	270	28.2	10.8	79.1	20.9
38	400	16.4	6.3	85.4	14.6
-38	-400	38.1	14.6	100.0	-
	Total	260.3	100.0	-	-

Product: Cyclone Underflow Test No: PP-16

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
833	20	1.4	0.5	0.5	99.5
589	28	3.0	1.1	1.6	98.4
417	35	8.8	3.2	4.8	95.2
295	48	16.8	6.1	10.9	89.1
208	65	33.1	12.0	23.0	77.0
147	100	54.1	19.7	42.6	57.4
104	150	53.8	19.6	62.2	37.8
74	200	37.3	13.6	75.8	24.2
53	270	29.0	10.6	86.4	13.6
38	400	14.9	5.4	91.8	8.2
-38	-400	22.6	8.2	100.0	-
	Total	274.8	100.0	-	-

Test PP-16- Continued

1.1.4. Size Analyses: Continued

Product: Cyclone Overflow Test No: PP-16

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	0.8	0.8	0.8	99.2
147	100	1.3	1.3	2.1	97.9
104	150	2.9	2.9	5.0	95.0
74	200	4.6	4.6	9.5	90.5
53	270	8.0	7.9	17.4	82.6
38	400	10.3	10.2	27.7	72.3
-38	-400	73.0	72.3	100.0	-
	Total	100.9	100.0	-	-

1.1.5. Observations: Problems were experienced with pump plugging due to periodic erratic supply of water.
The calculated circulating load was 90.3%, much higher than in Tests PP-13 and 15.
Grind fineness was 80 % - 49 μm.

Test PP-16 - Continued

1.2. Regrinding Circuits:

1.2.1. **Purpose:** As in Test PP-12.

1.2.2. **Method:** As in Test PP-12.

1.2.2.1. Flowsheet Equipment

As in Test PP-12.

1.2.2.2. Mill Loads

As in Test PP-12.

1.2.2.3. Classification Equipment

As in Test PP-11.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Sala	-	1741	1687	1129	Feed Cycl O/Flow	73.8 92.9	59.9 80.5	39.7 54.1	29 17
Pb-Hazen	-	2054	2086	1202	Feed Cycl O/Flow	97.9 99.1	93.3 96.8	66.0 72.8	12 11
Zn-Denver	-	1820	1823	1348	Feed Cycl O/Flow	35.7 53.4	29.0 38.2	22.9 25.1	121 46

1.2.3. **Flowsheet:** As in Test PP-10.

Test PP-16 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-16 S.G.- 4.69

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	3.21	6.4	6.4	93.6
31.6μ	5.25	10.5	16.9	83.1
24.5	4.66	9.3	26.2	73.8
17.1	6.91	13.8	40.1	59.9
11.7	7.41	14.8	54.9	45.1
9.1	2.72	5.4	60.3	39.7
-9.1	19.84	39.7	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Overflow Test No: PP-16 S.G.- 4.63

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.8μ	1.27	2.5	2.5	97.5
24.6	2.27	4.5	7.1	92.9
17.2	6.22	12.4	19.5	80.5
11.8	9.18	18.4	37.9	62.1
9.1	4.03	8.1	45.9	54.1
-9.1	27.03	54.1	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-16 S.G.-4.68

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.6μ	0.47	0.9	0.9	99.1
24.5	0.56	1.1	2.1	97.9
17.1	2.32	4.6	6.7	93.3
11.7	7.83	15.7	22.4	77.6
9.1	5.80	11.6	34.0	66.0
-9.1	33.02	66.0	100.0	-
Total	50.00	100.0	-	-

Test PP-16 - Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Overflow Test No: PP-16 S.G.- 4.68

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.6μ	0.26	0.5	0.5	99.5
24.5	0.21	0.4	0.9	99.1
17.1	1.11	2.2	3.2	96.8
11.7	6.68	13.4	16.5	83.5
9.1	5.35	10.7	27.2	72.8
-9.1	36.39	72.8	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc Test No: PP-16 S.G.- 4.41

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
65	2.9	5.7	5.7	94.3
100	3.51	7.0	12.8	87.2
150	6.97	13.9	26.7	73.3
200	6.28	12.6	39.3	60.7
270	3.34	6.7	45.9	54.1
32.9μ	5.71	11.4	57.4	42.6
25.5	3.49	7.0	64.3	35.7
17.8	3.35	6.7	71.0	29.0
12.2	2.44	4.9	75.9	24.1
9.4	0.60	1.2	77.1	22.9
-9.4	11.44	22.9	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-16 S.G.- 4.41

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
150	2.86	5.7	5.7	94.3
200	1.93	3.9	9.6	90.4
270	3.23	6.5	16.0	84.0
32.9μ	7.81	15.6	31.7	68.3
25.5	7.45	14.9	46.6	53.4
17.8	7.64	15.3	61.8	38.2
12.2	5.05	10.1	71.9	28.1
9.4	1.46	2.9	74.9	25.1
-9.4	12.57	25.1	100.0	-
Total	50.00	100.0	-	-

Test PP-16- Continued

1.2.4. Size Analyses: Continued

Product: Pb 4th Cleaner Conc Test No: PP-16 S.G.- 6.61

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
25.7μ	0.35	0.7	0.7	99.3
19.9	0.96	1.9	2.6	97.4
13.9	4.27	8.5	11.2	88.8
9.5	9.41	18.8	30.0	70.0
7.4	5.66	11.3	41.3	58.7
-7.4	29.35	58.7	100.0	-
Total	50.00	100.0	-	-

Product: Zn 4th Cleaner Conc Test No: PP-16 S.G.- 4.25

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.74	1.5	1.5	98.5
33.4μ	1.57	3.1	4.6	95.4
25.9	3.77	7.5	12.2	87.8
18.1	6.80	13.6	25.8	74.2
12.4	7.99	16.0	41.7	58.3
9.6	4.35	8.7	50.4	49.6
-9.6	24.78	49.6	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:

Cyclone plug-ups were not a problem.
The zinc regrind feed was quite coarser, K_{80} = 121 μm. The product was also quite coarse, 80 % - 46 μm.
The Zn cyclone overflow was 1348 g/L, higher than in previous tests.

Test No. PP-16

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	2.0	% moisture	
Primary Rod Mill Feed	603	dry kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	155	kg of 62mm dia. rods	
	150	kg of 37-50mm dia. rods	
	305	kg total	
Rod Mill Discharge:	2,100 g/L	(68 % Sol at SG 4.25)	
	43.3	% minus 48 mesh	
	30.0	% minus 200 mesh	
Input Power:	25.55	3 disc revolutions	
	3.80 kW	95% drive efficiency)	
Average Power:	3.61 kW	Gross	
	1.771	No Load	
	1.84	Net	
Net Power Usage:	3.1		
K80 Feed:	4447	microns	
K80 Product:	341	microns	
W. Index (metric):	7.8		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	603	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	288	kg of 50mm balls	
	112	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	2,248 g/L	(73 % Sol at SG 4.25)	
	90.0	% minus 48 mesh	
	27.6	% minus 200 mesh	
Circulating Load	903	%	
Input Power:	15.10	sec for 3 disc revolutions	
	6.44 kW	95% drive efficiency)	
Average Power:	6.12 kW	Gross	
	1.60	No Load	
	4.52	Net	
Net Power Usage:	7.5	kWh/t	
K80 Feed:	341	microns	
K80 Product:	49	microns	
W. Index (metric):	8.4		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	10.5 kWh/t
K80 Feed:	4447 microns
K80 Product:	49 microns
Work Index :	8.2 metric
Flot. Feed :	90.5% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	603	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	400	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,741 g/L	(54 % Sol at SG 4.77)	
Input Power:	10.25	sec for 3 disc revolutions	
	3.79 kW	95% drive efficiency)	
Average Power:	3.60 kW	Gross	
	1.18	No Load	
	2.42	Net	
K80 Feed:	29	microns	
K80 Product:	17	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	603	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	2,054 g/L	(66 % Sol at SG 4.61)	
Input Power:	28.32	sec for 3 disc revolutions	
	1.37 kW	95% drive efficiency)	
Average Power:	1.30 kW	Gross	
	0.69	No Load	
	0.62	Net	
K80 Feed:	12.2	microns	
K80 Product:	10.5	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Bulk Flot'n Feed Rate:	603	kg/h	
Denver Mill Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	305	kg of 25 mm balls	
	305	kg total	
Ball Mill Discharge:	1,820 g/L	(58 % Sol at SG 4.38)	
Input Power:	57.17	sec for 3 disc revolutions	
	1.70 kW	95% drive efficiency)	
Average Power:	1.62 kW	Gross	
	0.61	No Load	
	1.00	Net	
K80 Feed:	121	microns	
K80 Product:	46	microns	

2. FLOTATION

2.1. Purpose: Flotation with recycle water. Tailings water from the tailings pond was recycled to the water additions in the circuit, including launder sprays.

2.2. Method: Similar to Test PP-15, but with recycle water. Low pressure from the pumping system necessitated use of some fresh water. The recycle : fresh water ratio was not determined, but was likely at least 1:1.
Zn circuit frother DF1012 was substituted for DF250.

2.2.1. Flowsheet Equipment

As in Test PP-13.

2.2.2. Conditioning Parameters

As in Test PP-10.

2.2.3. Circuit Operation

The circuit was operated for a period of 10.0 hours, and was sampled every 60 minutes during the last 5.5 hours of operation.

TEST PP-16

2.2.4. Flotation Reagents:

Point of Addition		Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:					
Rod Mill Feed		Na2CO3	10.0	180.0	1791
Ball Mill Feed		CA830/TH	2.0	4.9	10
Ball Mill Feed		A317	5.0	2.0	10
Bulk Rougher 1 Feed		CA830/TH	2.0	9.9	20
Bulk Rougher 1 Feed		A317	5.0	10.1	50
Bulk Rougher 1 Feed	*	MIBC	100.0	19.6	10
Bulk Rougher 2 Feed		CA830/TH	2.0	8.3	17
Bulk Rougher 2 Feed		A317	5.0	8.0	40
Bulk Rougher 2 Feed	*	MIBC	100.0	3.2	2
Bulk Concentrate Regrind Mill Feed		Na2CO3	10.0	29.5	294
Bulk Concentrate Regrind Mill Feed		SD200/NaCN	4.0	83.9	334
Pb Rougher H.I. Conditioner		CA830/TH	2.0	7.5	15
Pb Rougher H.I. Conditioner		A317	5.0	8.5	42
Pb Rougher H.I. Conditioner	*	MIBC	100.0	0.0	0
Pb Rougher 2 Feed		CA830/TH	2.0	12.5	25
Pb Rougher 2 Feed		A317	5.0	0.0	0
Pb Rougher 2 Feed	*	MIBC	100.0	3.6	2
Pb Concentrate Regrind Mill Feed		Na2CO3	10.0	10.0	100
Pb Concentrate Regrind Mill Feed		SD200/NaCN	4.0	84.5	336
Pb 1st Cleaner H.I. Conditioner		CA830/TH	2.0	20.0	40
Pb 1st Cleaner H.I. Conditioner		A317	5.0	2.0	10
Pb 1st Cleaner H.I. Conditioner	*	MIBC	100.0	0.0	0
Pb 2nd Cleaner Feed		SD200/NaCN	4.0	20.0	80
Pb 2nd Cleaner Feed		MIBC	100.0	0.0	0
Pb 3rd Cleaner Feed		SD200/NaCN	4.0	20.0	80
Pb 3rd Cleaner Feed		MIBC	100.0	0.0	0
Pb 4th Cleaner Feed		SD200/NaCN	4.0	20.0	80
Zinc Circuit:					
Zn Scalp Conditioner 1 Feed		Ca(OH)2	10.0	79.8	794
Zn Scalp Conditioner 2 Feed		CuSO4.5H2O	10.0	79.3	789
Zn Scalp 1 Feed	*	M2030	100.0	20.0	10
Zn Scalp 1 Feed		A317	5.0	19.9	99
Zn Scalp 1 Feed	*	DF1012	100.0	100.0	50
Zn Scalp 2 Feed	*	M2030	100.0	5.9	3
Zn Scalp 2 Feed		A317	5.0	0.0	0
Zn Scalp Conc. Regrind Mill Feed		Ca(OH)2	10.0	57.3	570
Zn Scalp Conc. Regrind Mill Feed		CuSO4.5H2O	10.0	16.3	162
Zn Prefloat Conditioner 1 Feed		Ca(OH)2	10.0	26.7	266
Zn Prefloat Conditioner 1 Feed		CuSO4.5H2O	10.0	54.0	537
Zn Prefloat Conditioner 2	*	M2030	100.0	11.8	6
Zn Prefloat Conditioner 2		A317	5.0	4.9	24
Zn Prefloat Feed	*	DF1012	100.0	0.0	0
Zn Prefloat Cell 3	*	M2030	100.0	0.0	0
Zn Prefloat Cell 3		A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner	*	M2030	100.0	20.0	10
Zn 1st Cleaner H.I. Conditioner		A317	5.0	10.0	50
Zn 1st Cleaner H.I. Conditioner	**	SD200	100.0	11.5	54
Zn 1st Cleaner Scavenger Feed	*	M2030	100.0	2.0	1
Zn 1st Cleaner Scavenger Feed		A317	5.0	5.0	25
Zn 2nd Cleaner Feed		Ca(OH)2	10.0	17.0	169
Zn 2nd Cleaner Feed	**	SD200	100.0	5.2	25
Zn 3rd Cleaner Feed		Ca(OH)2	10.0	6.4	64
Zn 4th Cleaner Feed		Ca(OH)2	10.0	13.7	136

* Drops per minute ** Large drops per minute

Feed Rate= 603 **kg/h**

Test PP-16 - Continued

2.3. Flowsheet: As In Test PP-11, (with the scalp tails thickened and the water recycled to grinding).

2.4. Results: 2.4.1. Observations

Product grades and recoveries were excellent in spite of the grinding circuit problems and the erratic grades Indicated by the X-Met. In general, recycle water did not seem to adversely affect the metallurgy.
The effect of using frother DF1012 was not defined, but may have resulted in improved zinc metallurgy.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2100	10.8	-
Ball Mill Discharge	2248	-	-
Cyclone Underflow	2843		-
Cyclone O'Flow/Semi-bulk Feed	1272	10.3	19
Semi-bulk 2 Tail	1276	10.0	-
Semi-bulk Regrind Mill Disch	1741	-	-
Semi-bulk Regr Cyc U'Flow	1687	-	-
Semi-bulk Regr Cyc O'Flow	1129	-	-
Pb Rougher 1 Feed	1083	10.2	22
Pb Rougher 2 Tail	1053	-	-
Pb Regrind Mill Discharge	2054	-	-
Pb Regrind Cyclone U'Flow	2086	-	-
Pb Regrind Cyclone O'Flow	1202	-	-
Pb 1st Cleaner Feed	-	10.3	-
Pb 1st Cleaner Tail	1094	-	-
Pb 2nd Cleaner	-	10.2	-
Pb 3rd Cleaner	-	10.0	-
Pb 4th Cleaner	-	10.0	-
Zn Scalp 1 Feed	-	11.0	20
Zn Scalp 2 Tail	1220	-	-
Zn Regrind Mill Discharge	1820	-	-
Zn Regrind Cyclone U'Flow	2107	-	-
Zn Regrind Cyclone O'Flow	1348	-	-
Zn Prefloat Feed	-	10.2	-
Zn Prefloat Tail	1013	-	-
Zn 1st Cleaner Feed	1215	11.4	-
Zn 1st Cleaner Scav Feed	-	11.4	-
Zn 1st Cleaner Scav Tail	1070	-	-
Zn 2nd Cleaner	-	11.8	-
Zn 3rd Cleaner	-	12.0	-
Thickener Underflow	1823	-	-

Test PP-16 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
20:30	Pb 4th Cleaner Conc	71.1	2.55
	Zn 4th Cleaner Conc	1.74	52.7
	Zn 1st Cleaner Scav Tail	1.55	1.66
	Zn Prefloat Tail	2.24	2.27
	Zn Scalp Tail	1.06	0.75
	Zn Combined Tail	1.09	1.23
21:30	Pb 4th Cleaner Conc	67.2	1.64
	Zn 4th Cleaner Conc	1.72	51.9
	Zn 1st Cleaner Scav Tail	1.65	4.11
	Zn Prefloat Tail	2.47	3.02
	Zn Scalp Tail	0.79	1.19
	Zn Combined Tail	1.11	2.18
22:30	Pb 4th Cleaner Conc	62.0	2.40
	Zn 4th Cleaner Conc	1.64	54.6
	Zn 1st Cleaner Scav Tail	2.08	3.25
	Zn Prefloat Tail	3.19	3.37
	Zn Scalp Tail	0.92	0.83
	Zn Combined Tail	1.25	1.69
23:30	Pb 4th Cleaner Conc	48.7	7.06
	Zn 4th Cleaner Conc	1.84	48.4
	Zn 1st Cleaner Scav Tail	1.59	1.36
	Zn Prefloat Tail	2.87	3.22
	Zn Scalp Tail	0.96	0.90
	Zn Combined Tail	1.02	1.17
24:30	Pb 4th Cleaner Conc	62.0	3.83
	Zn 4th Cleaner Conc	1.88	40.1
	Zn 1st Cleaner Scav Tail	1.57	1.46
	Zn Prefloat Tail	1.97	1.77
	Zn Scalp Tail	1.02	0.75
	Zn Combined Tail	1.20	0.94
1:30	Pb 4th Cleaner Conc	56.8	3.22
	Zn 4th Cleaner Conc	1.96	54.4
	Zn 1st Cleaner Scav Tail	1.25	1.27
	Zn Prefloat Tail	2.55	1.82
	Zn Scalp Tail	1.02	0.89
	Zn Combined Tail	1.13	0.94
2:30	Pb 4th Cleaner Conc	57.3	3.40
	Zn 4th Cleaner Conc	1.47	55.3
	Zn 1st Cleaner Scav Tail	1.64	0.97
	Zn Prefloat Tail	2.46	2.17
	Zn Scalp Tail	1.18	0.53
	Zn Combined Tail	1.22	0.65
3:30	Pb 4th Cleaner Conc	56.0	4.21
	Zn 4th Cleaner Conc	1.81	51.5
	Zn 1st Cleaner Scav Tail	1.86	1.72
	Zn Prefloat Tail	2.44	2.92
	Zn Scalp Tail	1.36	1.36
	Zn Combined Tail	1.66	1.59

Test PP-16 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
4:30	Pb 4th Cleaner Conc	40.8	5.04
	Zn 4th Cleaner Conc	2.09	47.1
	Zn 1st Cleaner Scav Tail	2.99	2.82
	Zn Prefloat Tail	2.13	2.19
	Zn Scalp Tail	1.76	1.82
	Zn Combined Tail	1.48	1.48
5:00	Pb 4th Cleaner Conc	49.2	4.50
	Zn 4th Cleaner Conc	2.51	43.6
5:30	Pb 4th Cleaner Conc	67.3	3.56
	Zn 4th Cleaner Conc	2.02	54.0
	Zn 1st Cleaner Scav Tail	1.62	1.90
	Zn Prefloat Tail	2.67	2.54
	Zn Scalp Tail	1.29	1.30
	Zn Combined Tail	1.58	1.65

2.4.4. Shift Sample Assays

Product	Assays %, g/t			
	Pb	Zn	Ag	Ba
Cyclone Underflow	-	-	-	19.3
Cyclone O'Flow/Semi-bulk Feed	3.23	10.7	62.2	27.0
Semi-bulk Concentrate	15.5	13.5	-	-
Semi-bulk Tail	0.87	9.37	-	-
Semi-bulk Regrind Cyc O'Flow	11.6	13.5	-	-
Pb Rougher Feed	13.3	15.5	-	-
Pb Rougher Concentrate	22.0	17.0	-	-
Pb Rougher Tail	1.99	14.5	-	-
Pb Regrind Cyclone O'Flow	22.1	16.5	-	-
Pb 1st Cleaner Feed	1.64	16.9	-	-
Pb 1st Cleaner Concentrate	36.3	15.4	-	-
Pb 1st Cleaner Tail	15.1	18.6	-	-
Pb 4th Cleaner Concentrate	70.8	3.61	180	-
Zn Scalp Concentrate	1.19	20.4	-	-
Zn Scalp Tail	0.48	0.26	-	-
Zn Regrind Cyclone O'Flow	1.14	19.5	-	-
Zn Prefloat Feed	2.26	12.3	-	-
Zn Prefloat Concentrate	1.87	35.9	-	-
Zn Prefloat Tail	2.19	2.20	-	-
Zn 1st Cleaner Feed	1.64	16.9	-	-
Zn 1st Cleaner Scav Conc	1.58	5.36	-	-
Zn 1st Cleaner Scav Tail	1.06	1.31	-	-
Zn Combined Tail	0.61	0.51	16.4	-
Zn 4th Cleaner	1.26	55.0	168	-

Test PP-16 - Continued

2.4.4.1. Other Assays

Element	Assays, ppm	
	Pond Recycle Water	Thickener O'Flow
Cu	9.75	0.32
Fe	0.08	0.05
CN_T	6.59	0.01
SO_4	112	265
S_T	258	223

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	3.57	70.8	3.61	180	78.3	1.3	13.2
Zn 4th Cleaner Concentrate	17.40	1.26	55	168	6.8	94.7	60.1
Zn Combined Tails	79.03	0.61	0.51	16.4	14.9	4.0	26.7
Cyclone Overflow	100.00	3.23	10.1	62.2	100.0	100.0	100.0

TEST NO. PP-17

1. GRINDING

1.1. Primary Grinding:

1.1.1. Purpose: Grinding of Raise 2 ore (a lower grade ore).

1.1.2. Method: Raise 2 ore (-9.5 mm) was ground in fresh water with the Flowsheet used in Test PP-16.

1.1.2.1. Flowsheet Equipment

As for Test PP-13.

1.1.2.2. Mill Loads

Rod Mill :	As in Test PP-10.
Ball Mill :	388 kg of 50 mm balls
	112 kg of 25 mm balls
	(100 kg of 50 mm balls added)

1.1.2.3. Classification Equipment

As In Test PP-13.

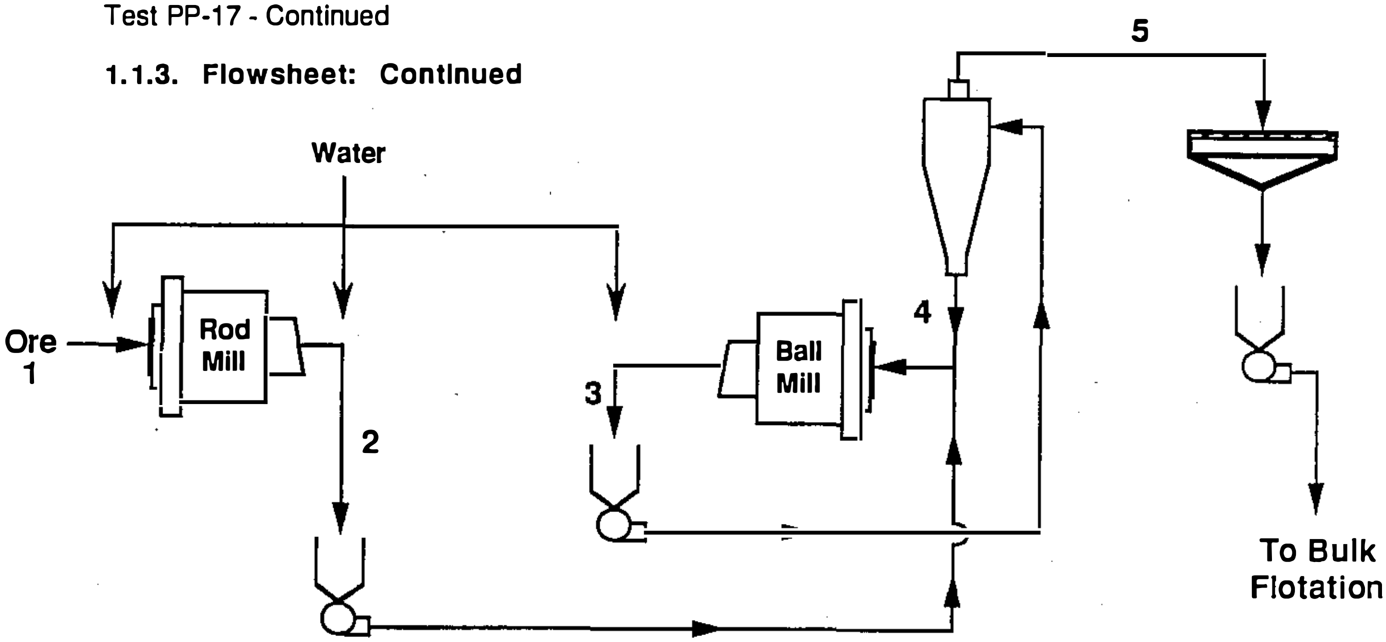
1.1.2.4. Circuit Operation

The circuit was operated for a period of 10.0 hours and was sampled every 30 minutes during the last 4.0 hours of operation. The average feed rate was 596 kg/h of dry ore.

1.1.3. Flowsheet: As in Test PP-16. Stream numbers corresponding to shift sample assay sample numbers are marked (see section 2.4.4.).

Test PP-17 - Continued

1.1.3. Flowsheet: Continued



1.1.4. Size Analyses:

Product: Rod Mill Feed Test No: PP-17

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
13,330	1/2 in	0.0	0.0	0.0	100.0
9,423	3/8 in	0.0	0.0	0.0	100.0
6,680	3	36.9	5.3	5.3	94.7
4,699	4	93.4	13.4	18.7	81.3
3,327	6	76.8	11.0	29.7	70.3
2,362	8	54.0	7.7	37.4	62.6
1,651	10	72.1	10.3	47.7	52.3
1,168	14	50.3	7.2	54.9	45.1
833	20	38.5	5.5	60.4	39.6
589	28	34.6	5.0	65.4	34.6
417	35	29.0	4.2	69.6	30.4
295	48	21.4	3.1	72.6	27.4
208	65	19.7	2.8	75.4	24.6
147	100	17.0	2.4	77.9	22.1
104	150	16.0	2.3	80.2	19.8
74	200	16.4	2.3	82.5	17.5
53	270	19.0	2.7	85.2	14.8
38	400	17.7	2.5	87.8	12.2
-38	-400	85.4	12.2	100.0	-
	Total	698.2	100.0	-	-

Test PP-17- Continued

1.1.4. Size Analyses: Continued

Product: Rod Mill Discharge Test No: PP-17

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
1,651	10	0.9	0.2	0.2	99.8
1,168	14	3.6	0.7	0.9	99.1
833	20	11.5	2.3	3.3	96.7
589	28	28.8	5.9	9.1	90.9
417	35	47.2	9.6	18.7	81.3
295	48	50.3	10.2	28.9	71.1
208	65	47.3	9.6	38.5	61.5
147	100	42.2	8.6	47.1	52.9
104	150	33.7	6.9	54.0	46.0
74	200	30.7	6.2	60.2	39.8
53	270	30.0	6.1	66.3	33.7
38	400	28.8	5.9	72.2	27.8
-38	-400	136.9	27.8	100.0	-
	Total	491.9	100.0	-	-

Product: Ball Mill Discharge Test No: PP-17

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
589	28	3.2	0.9	0.9	99.1
417	35	9.3	2.5	3.3	96.7
295	48	18.7	5.0	8.3	91.7
208	65	35.8	9.6	17.9	82.1
147	100	58.4	15.6	33.5	66.5
104	150	61.4	16.4	49.9	50.1
74	200	51.4	13.7	63.7	36.3
53	270	40.4	10.8	74.5	25.5
38	400	24.8	6.6	81.1	18.9
-38	-400	70.7	18.9	100.0	-
	Total	374.1	100.0	-	-

Test PP-17- Continued

1.1.4. Size Analyses: Continued

Product: Cyclone Underflow Test No: PP-17

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
833	20	0.9	0.3	0.3	99.7
589	28	3.1	0.9	1.2	98.8
417	35	11.1	3.3	4.5	95.5
295	48	22.4	6.7	11.2	88.8
208	65	45.3	13.5	24.7	75.3
147	100	62.4	18.6	43.2	56.8
104	150	63.3	18.8	62.1	37.9
74	200	49.3	14.7	76.7	23.3
53	270	35.7	10.6	87.4	12.6
38	400	18.9	5.6	93.0	7.0
-38	-400	23.5	7.0	100.0	-
	Total	335.9	100.0	-	-

Product: Cyclone Overflow Test No: PP-17

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
417	35	0.0	0.0	0.0	100.0
295	48	0.0	0.0	0.0	100.0
208	65	2.1	1.1	1.1	98.9
147	100	3.2	1.7	2.8	97.2
104	150	5.8	3.1	5.9	94.1
74	200	9.3	4.9	10.8	89.2
53	270	16.3	8.6	19.4	80.6
38	400	19.2	10.2	29.6	70.4
-38	-400	133.2	70.4	100.0	-
	Total	189.1	100.0	-	-

1.1.5. Observations: Additional balls were added as problems with pumps being plugged were experienced in the previous test. The Flowsheet was not changed from Test PP-16.
The grinding circuit operation was stable. The ore was a little coarser (80 % - 4577 µm). The ball mill discharge density was over 2500 g/L, much higher than in the previous tests.
Circulating load was 414 %. The grind product was 80 % - 52 µm.

Test PP-17 - Continued

1.2. Regrinding Circuits:

1.2.1. Purpose: Raise 2 ore regrinding..

1.2.2. Method: As in Test PP-12.

1.2.2.1. Flowsheet Equipment

As in Test PP-12.

1.2.2.2. Mill Loads

As in Test PP-12.

1.2.2.3. Classification Equipment

As in Test PP-11.

1.2.2.4. Operating Conditions

Mill	Feed Rate kg/h	Pulp Densities, gpL			Size Distributions				
		Mill Disch	Cycl U/Flow	Cycl O/Flow	Product	Cumulative % Pass 24-26 µm	16-18 µm	9-10 µm	K_{80} µm
Semi-Bulk Sala	-	1816	1776	1130	Feed Cycl O/Flow	76.3 99.1	61.7 94.0	40.5 68.2	27 12
Pb-Hazen	-	1951	1961	1183	Feed Cycl O/Flow	99.8 99.8	98.2 99.3	76.6 80.2	9 9
Zn-Denver	-	2253	2279	1259	Feed Cycl O/Flow	45.1 81.4	35.5 63.8	24.9 41.5	73 24

1.2.3. Flowsheet: As in Test PP-10.

Test PP-17 - Continued

1.2.4. Size Analyses:

Product: Bulk Rougher Conc Test No: PP-17 S.G.- 4.59

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	2.38	4.8	4.8	95.2
31.9μ	4.61	9.2	14.0	86.0
24.8	4.85	9.7	23.7	76.3
17.3	7.29	14.6	38.3	61.7
11.9	7.39	14.8	53.0	47.0
9.2	3.24	6.5	59.5	40.5
-9.2	20.24	40.5	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Mill Discharge Test No: PP-17 S.G.- 4.99

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.37	0.7	0.7	99.3
30.1μ	2.99	6.0	6.7	93.3
23.3	6.22	12.4	19.2	80.8
16.3	14.86	29.7	48.9	51.1
11.2	13.23	26.5	75.3	24.7
8.7	2.23	4.5	79.8	20.2
-8.7	10.10	20.2	100.0	-
Total	50.00	100.0	-	-

Product: Bulk Regrind Cyclone Underflow Test No: PP-17 S.G.- 4.99

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	1.06	2.1	2.1	97.9
30.1μ	5.14	10.3	12.4	87.6
23.3	7.78	15.6	28.0	72.0
16.3	15.95	31.9	59.9	40.1
11.2	11.96	23.9	83.8	16.2
8.7	1.72	3.4	87.2	12.8
-8.7	6.39	12.8	100.0	-
Total	50.00	100.0	-	-

Test PP-17 - Continued

1.2.4. Size Analyses: Continued

Product: Bulk Regrind Cyclone Overflow Test No: PP-17 S.G.- 4.63

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
31.7μ	0.10	0.2	0.2	99.8
24.6	0.34	0.7	0.9	99.1
17.2	2.58	5.2	6.0	94.0
11.8	7.67	15.3	21.4	78.6
9.1	5.23	10.5	31.8	68.2
-9.1	34.08	68.2	100.0	-
Total	50.00	100.0	-	-

Product: Pb Rougher Conc Test No: PP-17 S.G.-4.88

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
30.7μ	0.00	0.0	0.0	100.0
23.8	0.11	0.2	0.2	99.8
16.6	0.79	1.6	1.8	98.2
11.4	5.38	10.8	12.6	87.4
8.8	5.41	10.8	23.4	76.6
-8.8	38.31	76.6	100.0	-
Total	50.00	100.0	-	-

Product: Pb Regrind Mill Discharge Test No: PP-17 S.G.-5.02

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
30.1μ	0.00	0.0	0.0	100.0
23.3	0.48	1.0	1.0	99.0
16.3	5.36	10.7	11.7	88.3
11.2	19.68	39.4	51.0	49.0
8.7	10.55	21.1	72.1	27.9
-8.7	13.93	27.9	100.0	-
Total	50.00	100.0	-	-

Test PP-17 - Continued

1.2.4. Size Analyses: Continued

Product: Pb Regrind Cyclone Underflow   Test No: PP-17   S.G.- 5.01

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
30.1μ	0.00	0.0	0.0	100.0
23.3	0.56	1.1	1.1	98.9
16.3	5.18	10.4	11.5	88.5
11.2	19.58	39.2	50.6	49.4
8.7	10.76	21.5	72.2	27.8
-8.7	13.92	27.8	100.0	-
Total	50.00	100.0	-	-

Product: Pb Regrind Cyclone Overflow   Test No: PP-17   S.G.- 4.86

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
31.0μ	0.00	0.0	0.0	100.0
24.0	0.08	0.2	0.2	99.8
16.8	0.26	0.5	0.7	99.3
11.5	3.94	7.9	8.6	91.4
8.9	5.64	11.3	19.8	80.2
-8.9	40.08	80.2	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Scalp Conc   Test No: PP-17   S.G.- 4.30

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
65	0.00	0.0	0.0	100.0
100	0.00	0.0	0.0	100.0
150	4.63	9.3	9.3	90.7
200	5.59	11.2	20.4	79.6
270	6.19	12.4	32.8	67.2
33.2μ	6.12	12.2	45.1	54.9
25.9	4.93	9.9	54.9	45.1
18.0	4.81	9.6	64.5	35.5
12.4	3.89	7.8	72.3	27.7
9.5	1.40	2.8	75.1	24.9
-9.5	12.44	24.9	100.0	-
Total	50.00	100.0	-	-

Test PP-17 - Continued

1.2.4. Size Analyses: Continued

Product: Zn Regrind Mill Discharge Test No: PP-17 S.G.- 4.51

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
65	0.00	0.0	0.0	100.0
100	0.00	0.0	0.0	100.0
150	0.77	1.5	1.5	98.5
200	2.39	4.8	6.3	93.7
270	5.25	10.5	16.8	83.2
32.1μ	8.68	17.4	34.2	65.8
24.9	14.92	29.8	64.0	36.0
17.4	7.98	16.0	80.0	20.0
12.0	3.77	7.5	87.5	12.5
9.2	0.85	1.7	89.2	10.8
-9.2	5.39	10.8	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Underflow Test No: PP-17 S.G.- 4.51

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
150	2.24	4.5	4.5	95.5
200	3.29	6.6	11.1	88.9
270	6.25	12.5	23.6	76.4
32.1μ	12.66	25.3	48.9	51.1
24.9	11.80	23.6	72.5	27.5
17.4	6.68	13.4	85.8	14.2
12.0	2.81	5.6	91.5	8.5
9.2	0.60	1.2	92.7	7.3
-9.2	3.67	7.3	100.0	-
Total	50.00	100.0	-	-

Product: Zn. Regrind Cyclone Overflow Test No: PP-17 S.G.- 4.30

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
150	0.00	0.0	0.0	100.0
200	0.00	0.0	0.0	100.0
270	0.86	1.7	1.7	98.3
33.2μ	2.84	5.7	7.4	92.6
25.7	5.62	11.2	18.6	81.4
18.0	8.79	17.6	36.2	63.8
12.4	8.16	16.3	52.5	47.5
9.5	3.00	6.0	58.5	41.5
-9.5	20.73	41.5	100.0	-
Total	50.00	100.0	-	-

Test PP-17- Continued

1.2.4. Size Analyses: Continued

Product: Pb 4th Cleaner Conc Test No: PP-17 S.G.- 6.89

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.00	0.0	0.0	100.0
25.0μ	0.00	0.0	0.0	100.0
19.4	0.09	0.2	0.2	99.8
13.5	1.00	2.0	2.2	97.8
9.3	7.25	14.5	16.7	83.3
7.2	6.41	12.8	29.5	70.5
-7.2	35.25	70.5	100.0	-
Total	50.00	100.0	-	-

Product: Zn 4th Cleaner Conc Test No: PP-17 S.G.- 4.26

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.52	1.0	1.0	99.0
33.4μ	1.52	3.0	4.1	95.9
25.9	4.58	9.2	13.2	86.8
18.1	8.66	17.3	30.6	69.4
12.4	8.41	16.8	47.4	52.6
9.6	3.20	6.4	53.8	46.2
-9.6	23.11	46.2	100.0	-
Total	50.00	100.0	-	-

1.2.5. Observations:

Circuit operation was stable without cyclone plugging.
In general, grind products were a little finer than with the ore blend used in Tests PP-10 to 16.

Test No. PP-17

1.3. Results:

1.3.1. Primary Rod Mill Report:

Rod Mill Feed	1.8	% moisture	
Primary Rod Mill Feed	596	dry kg/h	
Mill Speed:	38.6	rpm	(71 % of critical speed)
Rod Load:	155	kg of 62mm dia. rods	
	150	kg of 37-50mm dia. rods	
	305	kg total	
Rod Mill Discharge:	2,108 g/L	(69 % Sol at SG	4.25)
	39.8	% minus 48 mesh	
	27.8	% minus 200 mesh	
Input Power:	24.27	3 disc revolutions	
	4.00kW	95% drive efficiency)	
Average Power:	3.80 kW	Gross	
	1.771	No Load	
	2.03	Net	
Net Power Usage:	3.4		
K80 Feed:	4577	microns	
K80 Product:	404	microns	
W. Index (metric):	9.8		

1.3.2. Primary Ball Mill Report:

Ball Mill Feed	596	kg/h	
Mill Speed:	31	rpm	(77 % of critical speed)
Ball Load:	288	kg of 50mm balls	
	112	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	2,574 g/L	(80 % Sol at SG	4.25)
	91.7	% minus 48 mesh	
	36.3	% minus 200 mesh	
Circulating Load	414	%	
Input Power:	13.08	sec for 3 disc revolutions	
	7.43 kW	95% drive efficiency)	
Average Power:	7.06 kW	Gross	
	1.60	No Load	
	5.46	Net	
Net Power Usage:	9.2	kWh/t	
K80 Feed:	404	microns	
K80 Product:	52	microns	
W. Index (metric):	10.3		

1.3.3. Overall Primary Grinding Mill Report:

Net Power :	12.6 kWh/t
K80 Feed:	4577 microns
K80 Product:	52 microns
Work Index :	10.1 metric
Flot. Feed :	89.2% -200 mesh

1.3.4. Semi Bulk Concentrate Regrind Mill Report:

Flotation Feed Rate:	596	kg/h	
Sala Mill Speed:	36.8	rpm	(69 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	400	kg of 25 mm balls	
	400	kg total	
Ball Mill Discharge:	1,816 g/L		(57 % Sol at SG 4.77)
Circulating Load:	351	%	
Input Power:	10.41	sec for 3 disc revolutions	
	3.73 kW	95% drive efficiency)	
Average Power:	3.55 kW	Gross	
	1.18	No Load	
	2.37	Net	
K80 Feed:	27	microns	
K80 Product:	12	microns	

1.3.5. Pb Concentrate Regrind Mill Report:

Flotation Feed Rate:	596	kg/h	
H.Q. Mill Speed:	45	rpm	(85 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	200	kg of 25 mm balls	
	200	kg total	
Ball Mill Discharge:	1,951 g/L		(62 % Sol at SG 4.61)
Circulating Load:	2619	%	
Input Power:	27.60	sec for 3 disc revolutions	
	1.41 kW	95% drive efficiency)	
Average Power:	1.34 kW	Gross	
	0.69	No Load	
	0.65	Net	
K80 Feed:	9.5	microns	
K80 Product:	8.6	microns	

1.3.6. Zn Scalp Concentrate Regrind Mill Report:

Flotation Feed Rate:	596	kg/h	
Denver Mill Speed:	40	rpm	(77 % of critical speed)
Ball Load:	0	kg of 50mm balls	
	305	kg of 25 mm balls	
	305	kg total	
Ball Mill Discharge:	2,253 g/L		(72 % Sol at SG 4.38)
Circulating Load:	211	%	
Input Power:	59.00	sec for 3 disc revolutions	
	1.65 kW	95% drive efficiency)	
Average Power:	1.57 kW	Gross	
	0.61	No Load	
	0.95	Net	
K80 Feed:	73	microns	
K80 Product:	24	microns	

2. FLOTATION

2.1. Purpose: Flotation of Raise 2 ore.

2.2. Method: As in Test PP-15, but with Raise 2 ore. Reagent additions to the semi-bulk/ Pb circuits were adjusted, with increased collector and frother added to the ball mill, 1st and 2nd semi-bulk feeds, and to the Pb rougher.
Zn circuit reagents were not significantly adjusted, except for increased lime in the Zn regrind and cleaners.

2.2.1. Flowsheet Equipment

As in Test PP-13.

2.2.2. Conditioning Parameters

As in Test PP-10.

2.2.3. Circuit Operation

The circuit was operated for a period of 10.0 hours, and was sampled every 30 minutes during the last 4 hours of operation.

TEST PP-17

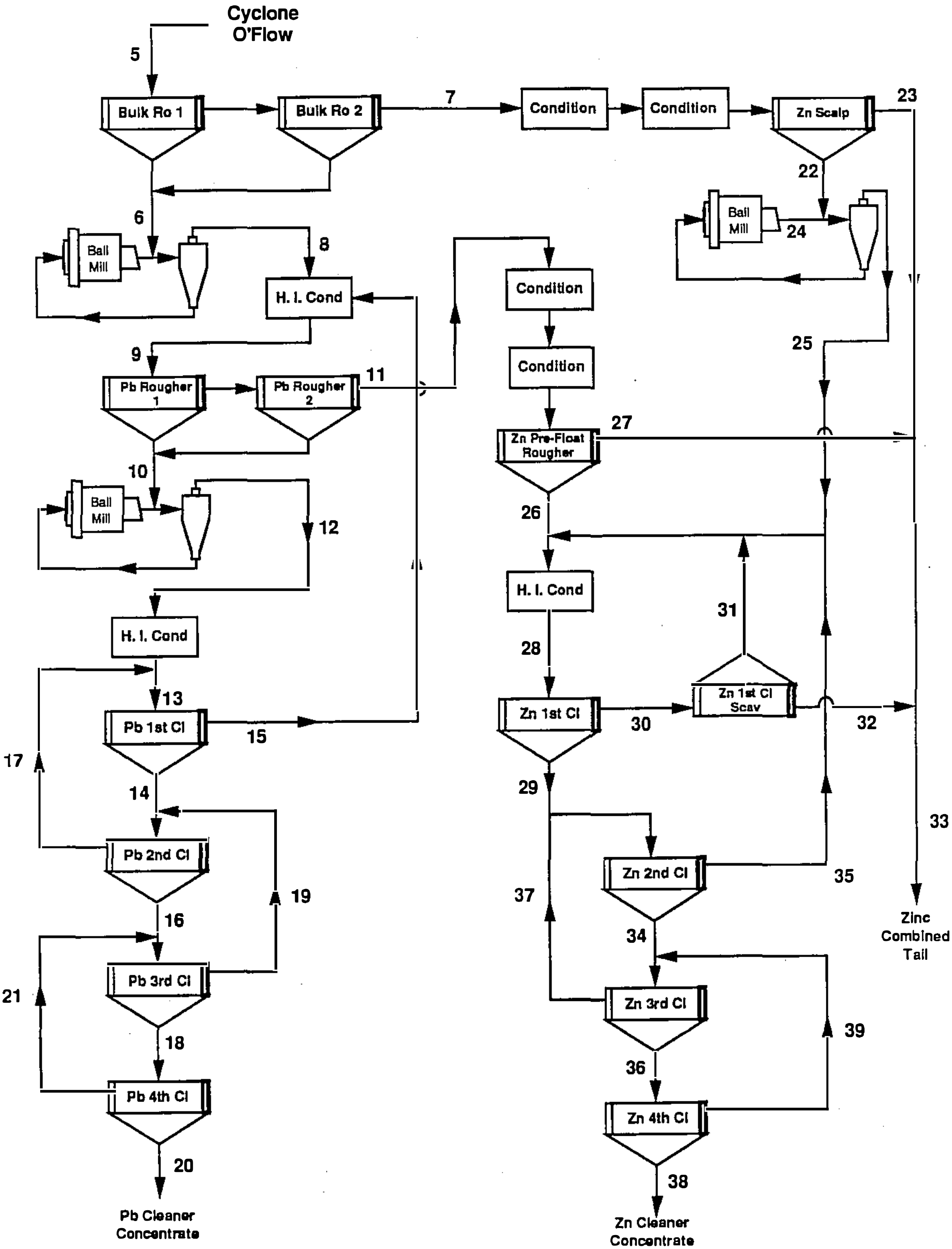
2.2.4. Flotation Reagents:

Point of Addition	Reagent Name	Solution Strength %	Rate mL/min	Rate g/t
Bulk and Pb Circuits:				
Rod Mill Feed	Na2CO3	10.0	180.0	1812
Ball Mill Feed	CA830/TH	2.0	10.7	22
Ball Mill Feed	A317	5.0	8.7	44
Bulk Rougher 1 Feed	CA830/TH	2.0	11.1	22
Bulk Rougher 1 Feed	A317	5.0	12.1	61
Bulk Rougher 1 Feed *	MIBC	100.0	60.9	31
Bulk Rougher 2 Feed	CA830/TH	2.0	9.9	20
Bulk Rougher 2 Feed	A317	5.0	8.3	42
Bulk Rougher 2 Feed *	MIBC	100.0	5.5	3
Bulk Concentrate Regrind Mill Feed	Na2CO3	10.0	31.9	321
Bulk Concentrate Regrind Mill Feed	SD200/NaCN	4.0	84.4	340
Pb Rougher H.I. Conditioner	CA830/TH	2.0	9.0	18
Pb Rougher H.I. Conditioner	A317	5.0	9.5	48
Pb Rougher H.I. Conditioner *	MIBC	100.0	0.0	0
Pb Rougher 2 Feed	CA830/TH	2.0	23.6	48
Pb Rougher 2 Feed	A317	5.0	0.0	0
Pb Rougher 2 Feed *	MIBC	100.0	18.1	9
Pb Concentrate Regrind Mill Feed	Na2CO3	10.0	11.4	115
Pb Concentrate Regrind Mill Feed	SD200/NaCN	4.0	81.8	329
Pb 1st Cleaner H.I. Conditioner	CA830/TH	2.0	20.1	40
Pb 1st Cleaner H.I. Conditioner	A317	5.0	2.1	11
Pb 1st Cleaner H.I. Conditioner *	MIBC	100.0	0.0	0
Pb 2nd Cleaner Feed	SD200/NaCN	4.0	20.1	81
Pb 2nd Cleaner Feed	MIBC	100.0	0.0	0
Pb 3rd Cleaner Feed	SD200/NaCN	4.0	18.7	75
Pb 3rd Cleaner Feed	MIBC	100.0	0.0	0
Pb 4th Cleaner Feed	SD200/NaCN	4.0	17.3	70
Zinc Circuit:				
Zn Scalp Conditioner 1 Feed	Ca(OH)2	10.0	80.3	808
Zn Scalp Conditioner 2 Feed	CuSO4.5H2O	10.0	79.9	804
Zn Scalp 1 Feed *	M2030	100.0	23.4	12
Zn Scalp 1 Feed	A317	5.0	20.6	104
Zn Scalp 1 Feed *	DF1012	100.0	101.3	51
Zn Scalp 2 Feed *	M2030	100.0	5.1	3
Zn Scalp 2 Feed	A317	5.0	0.0	0
Zn Scalp Conc. Regrind Mill Feed	Ca(OH)2	10.0	70.8	713
Zn Scalp Conc. Regrind Mill Feed	CuSO4.5H2O	10.0	17.6	177
Zn Prefloat Conditioner 1 Feed	Ca(OH)2	10.0	28.3	285
Zn Prefloat Conditioner 1 Feed	CuSO4.5H2O	10.0	56.0	564
Zn Prefloat Conditioner 2 *	M2030	100.0	17.5	9
Zn Prefloat Conditioner 2	A317	5.0	4.6	23
Zn Prefloat Feed *	DF1012	100.0	2.4	1
Zn Prefloat Cell 3 *	M2030	100.0	0.0	0
Zn Prefloat Cell 3	A317	5.0	0.0	0
Zn 1st Cleaner H.I. Conditioner *	M2030	100.0	20.7	10
Zn 1st Cleaner H.I. Conditioner	A317	5.0	10.9	55
Zn 1st Cleaner H.I. Conditioner **	SD200	100.0	7.5	36
Zn 1st Cleaner Scavenger Feed *	M2030	100.0	2.3	1
Zn 1st Cleaner Scavenger Feed	A317	5.0	5.1	26
Zn 2nd Cleaner Feed	Ca(OH)2	10.0	23.5	237
Zn 2nd Cleaner Feed **	SD200	100.0	6.9	33
Zn 3rd Cleaner Feed	Ca(OH)2	10.0	19.1	192
Zn 4th Cleaner Feed	Ca(OH)2	10.0	10.3	104

* Drops per minute   ** Large drops per minute

Feed Rate= 596 **kg/h**

2.3. Flowsheet: As in Test PP-11. Stream numbers corresponding to shift assay sample numbers are marked (see section 2.4.4.)



2.4. Results:

2.4.1. Observations

The Pb rougher and 1st cleaner appeared to be extremely selective for Pb compared with the ore used in Tests PP-10 to 16. Collector levels were therefore increased and the froths were pulled more heavily. Heavy pulling of the Pb 1st cleaner was required to provide abundant froth in the final cleaners (light pulling in the early hours of the run resulted in flat, lightly mineralized froths in the 3rd and 4th cleaners).
Pb circuit pH's were generally lower than in Tests PP-10 to 16.
Zn flotation was fairly good, but Pb grade in the zinc product was high, 2.85 % Pb.

2.4.2. Density, pH and Temperature

Product	Density g/L	pH	Temp °C
Rod Mill Discharge	2108	10.2	-
Ball Mill Discharge	2574	-	-
Cyclone Underflow	2764	-	-
Cyclone O'Flow/Semi-bulk Feed	1254	9.5	15
Semi-bulk 2 Tail	1226	9.4	-
Semi-bulk Regrind Mill Disch	1816	-	-
Semi-bulk Regr Cyc U'Flow	1776	-	-
Semi-bulk Regr Cyc O'Flow	1130	-	-
Pb Rougher 1 Feed	1089	10.0	20
Pb Rougher 2 Tail	1038	-	-
Pb Regrind Mill Discharge	1951	-	-
Pb Regrind Cyclone U'Flow	1961	-	-
Pb Regrind Cyclone O'Flow	1183	-	-
Pb 1st Cleaner Feed	-	10.0	-
Pb 1st Cleaner Tail	1085	-	-
Pb 2nd Cleaner	-	10.0	-
Pb 3rd Cleaner	-	9.9	-
Pb 4th Cleaner	-	9.8	-
Zn Scalp 1 Feed	-	10.5	15
Zn Scalp 2 Tail	1189	-	-
Zn Regrind Mill Discharge	2253	-	-
Zn Regrind Cyclone U'Flow	2279	-	-
Zn Regrind Cyclone O'Flow	1259	-	-
Zn Prefloat Feed	-	9.8	-
Zn Prefloat Tail	1020	-	-
Zn 1st Cleaner Feed	1115	11.7	-
Zn 1st Cleaner Scav Feed	-	11.8	-
Zn 1st Cleaner Scav Tail	1053	-	-
Zn 2nd Cleaner	-	12.0	-
Zn 3rd Cleaner	-	11.9	-

Test PP-17 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
6:30	Pb 4th Cleaner Conc	69.0	3.00
	Zn 4th Cleaner Conc	2.28	45.9
	Zn 1st Cleaner Scav Tail	2.37	5.00
	Zn Prefloat Tail	3.28	3.72
	Zn Scalp Tail	1.39	1.46
	Zn Combined Tail	1.81	2.89
7:00	Pb 4th Cleaner Conc	69.1	3.11
7:30	Pb 4th Cleaner Conc	71.3	3.78
	Zn 4th Cleaner Conc	1.80	53.2
	Zn 1st Cleaner Scav Tail	1.96	3.05
	Zn Prefloat Tail	3.11	2.89
	Zn Scalp Tail	1.07	0.74
	Zn Combined Tail	1.28	1.31
8:30	Pb 4th Cleaner Conc	54.5	11.3
	Zn 4th Cleaner Conc	2.35	42.3
	Zn 1st Cleaner Scav Tail	1.75	2.60
	Zn Prefloat Tail	3.34	3.57
	Zn Scalp Tail	1.11	1.23
	Zn Combined Tail	1.25	1.45
	Bulk Tail	1.89	7.00
9:30	Pb 4th Cleaner Conc	53.6	10.7
	Zn 4th Cleaner Conc	1.91	50.9
	Zn 1st Cleaner Scav Tail	1.41	1.80
	Zn Prefloat Tail	2.61	2.47
	Zn Scalp Tail	0.92	0.92
	Zn Combined Tail	0.81	1.08
10:30	Pb 4th Cleaner Conc	70.7	4.07
	Zn 4th Cleaner Conc	2.12	47.2
	Zn 1st Cleaner Scav Tail	1.61	2.20
	Zn Prefloat Tail	3.54	3.43
	Zn Scalp Tail	0.82	0.78
	Zn Combined Tail	1.14	1.23
11:30	Pb 4th Cleaner Conc	62.7	8.02
	Zn 4th Cleaner Conc	2.00	51.1
	Zn 1st Cleaner Scav Tail	1.59	2.33
	Zn Prefloat Tail	3.55	3.77
	Zn Scalp Tail	0.79	1.02
	Zn Combined Tail	1.20	1.50
12:30	Pb 4th Cleaner Conc	56.7	11.3
	Zn 4th Cleaner Conc	2.00	48.7
	Zn 1st Cleaner Scav Tail	1.37	2.26
	Zn Prefloat Tail	3.70	3.38
	Zn Scalp Tail	0.45	0.44
	Zn Combined Tail	0.73	0.92
13:30	Pb 4th Cleaner Conc	57.8	9.78
	Zn 4th Cleaner Conc	2.00	53.4
	Zn 1st Cleaner Scav Tail	1.16	1.69
	Zn Prefloat Tail	3.09	2.18
	Zn Scalp Tail	0.54	0.45
	Zn Combined Tail	0.76	0.82

Test PP-17 - Continued

2.4.3. Grab Sample Assays

Time	Product	Assays, %	
		Pb	Zn
14:30	Pb 4th Cleaner Conc	68.2	3.76
	Zn 4th Cleaner Conc	3.24	48.9
	Zn 1st Cleaner Scav Tail	1.69	1.23
	Zn Prefloat Tail	3.44	2.77
	Zn Scalp Tail	2.25	1.31
	Zn Combined Tail	2.31	1.83
15:30	Pb 4th Cleaner Conc	59.6	5.43
	Zn 4th Cleaner Conc	2.82	47.5
	Zn 1st Cleaner Scav Tail	2.04	1.51
	Zn Prefloat Tail	3.13	2.02
	Zn Scalp Tail	1.70	0.89
	Zn Combined Tail	1.56	1.02

2.4.4. Shift Sample Assays

Product	Stream No.	Assays %, g/t				
		Pb	Zn	Ag	Au	Ba
Rod Mill Feed	1	2.79	6.65	-	-	28.5
Rod Mill Discharge	2	2.90	6.41	-	-	28.5
Ball Mill Discharge	3	3.42	7.10	-	-	23.0
Cyclone U'Flow	4	3.59	7.37	-	-	20.6
Cyc O'Flow/Semi-bulk Feed	5	2.80	6.40	44.2	-	28.2
Semi-bulk Conc	6	16.3	10.6	-	-	-
Semi-bulk Tail	7	0.74	5.72	-	-	-
Semi-bulk Reg Cyc O'Flow	8	14.8	11.1	-	-	-
Pb Rougher Feed	9	19.7	18.3	-	-	-
Pb Rougher Conc	10	26.9	23.6	-	-	-
Pb Rougher Tail	11	3.95	6.24	-	-	-
Pb Reg Cyc O'Flow	12	27.2	24.0	-	-	-
Pb 1st Cleaner Feed	13	34.5	23.8	-	-	-
Pb 1st Cleaner Conc	14	42.8	22.0	-	-	-
Pb 1st Cleaner Tail	15	20.7	25.6	-	-	-
Pb 2nd Cleaner Conc	16	53.3	17.1	-	-	-
Pb 2nd Cleaner Tail	17	43.4	22.5	-	-	-
Pb 3rd Cleaner Conc	18	66.3	9.28	-	-	-
Pb 3rd Cleaner Tail	19	53.1	17.3	-	-	-
Pb 4th Cleaner Conc	20	74.4	5.31	263	0.05	-
Pb 4th Cleaner Tail	21	67.4	9.28	-	-	-
Zn Scalp Concentrate	22	1.41	17.4	-	-	-
Zn Scalp Tail	23	0.33	0.35	-	-	-
Zn Regrind Mill Discharge	24	1.35	11.2	-	-	-
Zn Regrind Cyclone O'Flow	25	1.38	17.3	-	-	-
Zn Prefloat Concentrate	26	6.17	17.5	-	-	-
Zn Prefloat Tail	27	3.11	2.17	-	-	-
Zn 1st Cleaner Feed	28	2.10	18.0	-	-	-
Zn 1st Cleaner Conc	29	2.67	31.8	-	-	-
Zn 1st Cleaner Tail	30	1.56	4.55	-	-	-
Zn 1st Cleaner Scav Conc	31	2.13	8.35	-	-	-
Zn 1st Cleaner Scav Tail	32	1.12	1.37	-	-	-
Zn Combined Tail	33	0.65	0.63	20.7	-	-

Test PP-17 - Continued

2.4.4. Shift Sample Assays - Continued

Product	Stream No.	Assays %, g/t				
		Pb	Zn	Ag	Au	Ba
Zn 2nd Cleaner Conc	34	3.18	42.7	-	-	-
Zn 2nd Cleaner Tail	35	2.77	23.3	-	-	-
Zn 3rd Cleaner Conc	36	3.06	48.6	-	-	-
Zn 3rd Cleaner Tail	37	3.33	37.1	-	-	-
Zn 4th Cleaner Conc	38	2.85	53.3	157	0.03	-
Zn 4th Cleaner Tail	39	3.31	43.4	-	-	-

2.4.5. Metallurgical Results

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb 4th Cleaner Concentrate	2.60	74.4	5.31	263	69.0	2.2	16.4
Zn 4th Cleaner Concentrate	10.72	2.85	53.3	156	10.9	89.3	40.3
Zn Combined Tails	86.68	0.65	0.63	20.7	20.1	8.5	43.2
Cyclone Overflow	100.00	2.80	6.4	44.2	100.0	100.0	100.0

ROCK TYPE 5

BENCH SCALE FLOTATION TESTS

Primary Grind Size Distribution (15 minute grind)

Microns	Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
295	48	0.9	0.5	0.5	99.6
208	65	2.1	1.1	1.5	98.5
147	100	7.2	3.6	5.1	94.9
104	150	14.3	7.2	12.3	87.8
74	200	20.3	10.2	22.4	77.6
53	270	23.6	11.8	34.2	65.8
38	400	22.4	11.2	45.4	54.6
-38	-400	109.2	54.6	100.0	-
	Total	200.0	100.0	-	-

The grind product K_{80} was 80 µm.

TEST NO. F-1A

Purpose: To float PP Rock Type 5 ore ground in the pilot plant (PP-2).

Procedure: Ore ground in the pilot plant with Na_2CO_3/A317/CA830/Thiourea/Frother (PP-2) Semi-bulk/Pb flotation as for Test 99, Project 3889.

Feed: 1730 grams of semi-bulk flotation feed from Test PP-2.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			
	Na_2CO_3	A317	CA830 Thiourea	MIBC	PKD-C	Grind	Cond.	Froth	pH
Grind	~2500	~50	~20	-	-	-	-	-	10.2
Semi-Bulk Ro 1	-	-	-	5	-	-	-	5	-
Semi-Buik Ro 2	-	20	-	5	-	-	1	3	-
	-	5	-	-	-	-	1	1	-
Semi-Bulk Conc Regr	300	-	-	-	300	40	-	-	-
H.I. Conditioning	-	30	20	2.5	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	-	3.5	-

METALLURGICAL RESULTS

Product	Weight g	Weight %	Assays,% Pb	Assays,% Zn	% Distribution Pb	% Distribution Zn
1. Pb Rougher Conc	209.3	12.10	22.7	7.08	80.1	8.6
2. Pb Rougher Tail	334.3	19.33	1.18	12.2	6.7	23.6
3. Bulk Rougher Tail	1186.1	68.57	0.66	9.86	13.2	67.8
Head Calc.	1729.7	100.00	3.43	9.98	100.0	100.0

Combined Products

Products 1+2		31.43	9.5	10.23	86.8	32.2

TEST NO. F-1

Purpose: To repeat the conditions of Test 99 (Project 3889) on the pilot plant Rock Type 5.

Procedure: As for Test 99 (Project 3889).

Feed: 2000 grams of minus 10 mesh PP Rock Type 5 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			
	A317	Na_2CO_3	CA830 Thiourea	MIBC	PKD-C	Grind	Cond.	Froth	pH
Primary Grind	50	2500	20	-	-	15	-	-	-
Semi-Bulk Rougher	25	-	-	22.5	-	-	1	5	10.5
	10	-	-	5	-	-	1	3	-
Semi-Bulk Conc Regr	-	300	-	-	300	40	-	-	-
H.I. Conditioning	50	-	25	-	-	-	15	-	-
Pb Rougher	-	-	-	5	-	-	-	4	10.0
Pb Scavenger	5	-	5	5	-	-	1	1	-
Pb Conc Regrind	-	100	-	-	300	30	-	-	-
H.I. Conditioning	10	-	20	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	-	3	9.5
	5	-	5	5	-	-	1	2	-
Pb 2nd Cleaner	-	-	-	-	75	-	1	2.5	-
Pb 3rd Cleaner	-	-	-	2.5	75	-	1	2.5	-
Pb 4th Cleaner	-	-	-	-	75	-	1	-	9.6
Zn Circuit:	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250				
Condition	800	-	-	-	-	-	5	-	-
	-	1000	-	-	-	-	5	-	11.2
Zn Scalp 1	-	-	40	10	10	-	1	4	-
Zn Scalp 2	-	-	5	5	10	-	1	1.5	10.9
Zn Scalp Regrind	500	200	-	-	-	30	-	-	-
Pb Ro Tails for Zinc Prefloat.									
Condition	750	-	-	-	-	-	5	-	11.4
	-	500	-	-	-	-	5	-	-
Zn Prefloat 1	-	-	25	10	10	-	1	4	11.2
Zn Prefloat 2	-	-	5	5	5	-	1	1.5	-
Combine Zn Scalp Conc + Zn Prefloat Conc.									
H.I. Conditioning	250	-	15	10	5	-	15	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	4	11.3
	-	-	5	5	-	-	1	1	-
Zn 1st Cleaner Scav	-	-	5	5	-	-	1	3	-
Zn 2nd Cleaner	500	-	-	-	-	-	1	4.5	11.8
	-	-	2.5	2.5	-	-	1	1.5	-
Zn 3rd Cleaner	500	-	-	-	-	-	-	5	12.0

Test No. F-1

Product	Weight g	Weight %	Assays,% Pb	Assays,% Zn	% Distribution Pb	% Distribution Zn
1. Pb Cl. Conc.	57.7	2.98	70.3	1.03	61.0	0.3
2. Pb 4th Cl. Tail	21.1	1.09	34.9	3.33	11.1	0.4
3. Pb 3rd Cl. Tail	31.1	1.61	10.2	5.48	4.8	0.9
4. Pb 2nd Cl. Tail	43.5	2.25	3.14	7.28	2.1	1.7
5. Pb 1st Cl. Tail	96.9	5.00	2.1	9.74	3.1	5.0
6. Zn 3rd Cl Conc	251.5	12.99	0.6	52.1	2.3	69.0
7. Zn 3rd Cl Tail	86.3	4.46	1.24	27.1	1.6	12.3
8. Zn 2nd Cl Tail	109.3	5.64	1.35	9.9	2.2	5.7
9. Zn 1st Cl Tail	162.7	8.40	1.08	2.47	2.6	2.1
10. Zn Prefloat Tail	240.3	12.41	1.18	0.84	4.3	1.1
11. Zn Scalp Tail	836.4	43.18	0.4	0.37	5.0	1.6
Head Calc.	1936.8	100.00	3.43	9.81	100.0	100.0

Combined Products

Products 1+2	4.07	60.8	1.65	72.1	0.7
Products 1-3	5.67	46.5	2.73	76.8	1.6
Products 1-4	7.92	34.2	4.02	78.9	3.2
Products 1-5	12.92	21.8	6.23	82.0	8.2
Products 6+7	17.44	0.76	45.7	3.9	81.3
Products6-8	23.08	0.91	37.0	6.1	87.0
Products 6-9	31.48	0.95	27.8	8.7	89.1
Products 10+11	55.59	0.57	0.47	9.3	2.7

Product: Zn Scalp Tail Test No: F1

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
208	65	2.3	1.6	1.6	98.4
147	100	4.0	2.8	4.4	95.6
104	150	7.7	5.4	9.7	90.3
74	200	12.8	8.9	18.6	81.4
53	270	16.5	11.5	30.1	69.9
38	400	18.2	12.6	42.7	57.3
-38	-400	82.4	57.3	100.0	-
	Total	143.9	100.0	-	-

TEST NO. F-2

Purpose: To repeat Test F-1 but do a carbon prefloat before the semi-bulk rougher.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Rock Type 5 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			
	A317	Na_2CO_3	CA830 Thiourea	MIBC	PKD-C	Grind	Cond.	Froth	pH
Primary Grind	-	2500	-	-	-	15	-	-	-
Carbon Prefloat	-	-	-	20	-	-	1	3.5	10.4
	-	-	-	15	-	-	1	2.5	-
Semi-bulk Rougher	20	-	20	-	-	-	-	5	-
Semi-bulk Conc Regr	-	300	-	-	300	40	-	-	-
H.I. Conditioning	40	-	20	-	-	-	15	-	-
Pb Rougher 1	-	-	-	10	-	-	1	4	10
Pb Scavenger	10	-	5	5	-	-	1	2.5	-
Pb Conc Regrind	-	100	-	-	300	30	-	-	-
H.I. Conditioning	10	-	20	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	-	5	9.5
	5	-	5	-	-	-	1	1	-
Pb 2nd Cleaner	-	-	-	-	75	-	1	3	-
Pb 3rd Cleaner	-	-	-	-	50	-	1	-	-
Pb 4th Cleaner	-	-	-	-	25	-	1	-	-
Zn Circuit:	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250				
Condition	800	-	-	-	-	-	5	-	-
	-	1000	-	-	-	-	5	-	-
Zn Scalp 1	-	-	40	10	10	-	1	3	11.4
Zn Scalp 2	-	-	5	5	10	-	1	-	-
Zn Scalp Regrind	500	200	-	-	-	30	-	-	-
Pb Ro Tails for Zinc Prefloat.									
Condition	750	-	-	-	-	-	5	-	11.4
	-	500	-	-	-	-	5	-	-
Zn Prefloat 1	-	-	25	10	10	-	1	4	-
Zn Prefloat 2	-	-	5	5	5	-	1	1.5	-
Combine Zn Scalp Conc + Zn Prefloat Conc.									
H.I. Conditioning	250	-	15	10	5	-	15	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	5	-
	-	-	5	5	5	-	1	2	-
Zn 1st Cleaner Scav	-	-	5	7.5	2.5	-	1	2	-
Zn 2nd Cleaner	500	-	-	-	-	-	1	5.5	-
Zn 3rd Cleaner	500	-	-	-	-	-	1	3.5	-

Test No. F-2

Product	Weight g	Weight %	Assays,% Pb	Assays,% Zn	% Distribution Pb	% Distribution Zn
1. Pb Cl. Conc.	32.9	1.69	69.6	2.21	35.6	0.4
2. Pb 3rd Cl. Tail	16.5	0.85	36.8	6.95	9.4	0.6
3. Pb 2nd Cl. Tail	28.6	1.47	11.6	12.1	5.2	1.8
4. Pb 1st Cl. Tail	97.6	5.02	4.4	14.8	6.7	7.7
5. Zn 3rd Cl Conc	205.3	10.57	1	48.9	3.2	53.6
6. Zn 3rd Cl Tail	58.2	3.00	1.36	30.7	1.2	9.5
7. Zn 2nd Cl Tail	160.6	8.27	1.47	14.8	3.7	12.7
8. Zn 1st Cl Tail	250.4	12.89	1.06	1.99	4.1	2.7
9. Zn Prefloat Tail	88.6	4.56	1.02	2.37	1.4	1.1
10. Zn Scalp Tail	820.3	42.23	0.39	0.29	5.0	1.3
11. Carb. Prefl. Conc.	183.4	9.44	8.59	8.71	24.5	8.5
Head Calc.	1942.4	100.00	3.31	9.64	100.0	100.0

Combined Products

Products 1+2	2.54	58.6	3.79	45.1	1.0
Products 1-3	4.02	41.4	6.84	50.2	2.8
Products 1-4	9.04	20.8	11.26	56.9	10.6
Products 5+6	13.57	1.08	44.9	4.4	63.2
Products 5-7	21.83	1.23	33.5	8.1	75.9
Products 5-8	34.73	1.17	21.8	12.2	78.5
Products 9-10	46.79	0.45	0.5	6.4	2.4
Products 9-11	56.23	1.82	1.87	30.9	10.9

TEST NO. F-3

Purpose: To repeat the conditions of Test F-1 but use pilot plant reagents.

Procedure: As for Test F-2 (pilot plant reagents stocks were used in all subsequent tests).

Feed: 2000 grams of minus 10 mesh PP Rock Type 5 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			
	A317	Na_2CO_3	CA830 Thiourea	MIBC	PKD-C	Grind	Cond.	Froth	pH
Primary Grind	50	2500	20	-	-	15	-	-	-
Semi-Bulk Rougher	25	-	-	22.5	-	-	1	4	-
	10	-	-	5	-	-	1	3.5	-
Semi-Bulk Conc Regr	-	300	-	-	300	40	-	-	-
H.I. Conditioning	50	-	25	-	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	-	5	-
Pb Scavenger	5	-	5	5	-	-	1	2	-
Pb Conc Regrind	-	100	-	-	300	30	-	-	-
H.I. Conditioning	10	-	20	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	-	4.5	9.6
Pb 2nd Cleaner	-	-	-	-	80	-	1	2	-
	-	-	-	2.5	-	-	1	1	-
Pb 3rd Cleaner	-	-	-	2.5	80	-	1	2.5	-
Pb 4th Cleaner	-	-	-	-	80	-	1	2.5	9.4

METALLURGICAL RESULTS

Product	Weight g	Weight %	Assays %,g/t Pb	Assays %,g/t Zn	% Distribution Pb	% Distribution Zn
1 Pb Cl. Conc.	71.9	3.69	65.4	1.56	70.9	0.6
2 Pb 4th Cl. Tail	14.2	0.73	19.6	5.55	4.2	0.4
3 Pb 3rd Cl. Tail	41.3	2.12	7.54	7.69	4.7	1.7
4 Pb 2nd Cl. Tail	73.2	3.76	2.67	9.17	2.9	3.5
5 Pb 1st Cl. Tail	229.8	11.81	1.11	14.5	3.8	17.5
6 Zn Prefloat Conc.	162.0	8.32	0.6	42.9	1.5	36.4
7 Zn Prefloat Tail	234.6	12.05	0.83	0.84	2.9	1.0
8 Bulk Tail	1119.3	57.51	0.53	6.63	9.0	38.9
Head Calc.	1946.3	100.00	3.41	9.8	100.0	100.0

Combined Products

Products 1-2 (Pb 3rd Cl Conc)	4.42	57.85	2.22	75.1	1.0
Products 1-3 (Pb 2nd Cl Conc)	6.55	41.54	3.99	79.8	2.7
Products 1-4(Pb 1st Cl. Conc.)	10.31	27.36	5.88	82.8	6.2
Products 1-5(Pb Ro. Conc.)	22.11	13.34	10.48	86.6	23.6

TEST NO. F-4

Purpose: To repeat the conditions of Test F-3, to produce a semi-bulk concentrate to examine regrind fineness of semi-bulk concentrate.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Rock Type 5 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			
	A317	Na_2CO_3	CA830 Thiourea	MIBC	PKD-C	Grind	Cond.	Froth	pH
Primary Grind	50	2500	20	-	-	15	-	-	-
Semi-Bulk Rougher	25	-	-	22.5	-	-	1	4	-
	10	-	-	5	-	-	1	3.5	-
Semi-Bulk Conc Regr	-	300	-	-	300	40	-	-	-

METALLURGICAL RESULTS

Product	Weight g	Weight %	Assays,% Pb	Assays,% Zn	% Distribution Pb	% Distribution Zn
1. Bulk Conc.	618.3	31.60	9.72	10.9	87.9	35.3
2. Bulk Tail	1338.1	68.40	0.62	9.24	12.1	64.7
Head Calc.	1956.4	100.00	3.50	9.76	100.0	100.0

Product: Bulk Regrind Conc Test No: F-4 S.G.- 4.57

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	Passing
31.8µ	0.00	0.0	0.0	100.0
24.6	0.24	0.5	0.5	99.5
17.2	1.45	2.9	3.4	96.6
11.8	7.20	14.4	17.8	82.2
9.1	4.47	8.9	26.7	73.3
-9.1	36.64	73.3	100.0	-
Total	50.00	100.0	-	-

TEST NO. F-5

Purpose: To repeat the conditions of Test F-4, but replace CA830/Thiourea with 10 g/t of R242.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Rock Type 5 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			
	A317	Na_2CO_3	CA830 Thiourea	MIBC	PKD-C	Grind	Cond.	Froth	pH
Primary Grind	50	2500	28	-	-	15	-	-	-
Semi-Bulk Rougher	25	-	-	22.5	-	-	1	4	-
	10	-	-	5	-	-	1	3.5	-
Semi-Bulk Conc Regr	-	300	-	-	300	40	-	-	-
H.I. Conditioning	50	-	21	-	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	-	4.5	9.7
Pb Conc Regrind	-	100	-	-	300	30	-	-	-
H.I. Conditioning	10	-	7	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	-	4	-
Pb 2nd Cleaner	-	-	-	-	75	-	1	3.5	-
Pb 3rd Cleaner	-	-	-	-	75	-	1	3	-
Pb 4th Cleaner	-	-	-	-	75	-	1	2	-
Zn Prefloat:	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250				
Condition	750	-	-	-	-	-	5	-	-
Condition	-	500	-	-	-	-	5	-	-
Zn Prefloat	-	-	25	10	10	-	1	4	10.8

METALLURGICAL RESULTS

Product	Weight		Assays %,g/t		% Distribution	
	g	%	Pb	Zn	Pb	Zn
1 Pb Cl. Conc.	57.5	2.98	69.6	0.95	62.3	0.3
2 Pb 4th Cl. Tail	11.8	0.61	34.8	3.33	6.4	0.2
3 Pb 3rd Cl. Tail	21.9	1.13	12.9	5.55	4.4	0.7
4 Pb 2nd Cl. Tail	33.6	1.74	5.33	7.36	2.8	1.3
5 Pb 1st Cl. Tail	103.8	5.38	2.43	10.1	3.9	5.6
6 Zn Prefloat Conc.	158.0	8.18	1.24	32.2	3.0	27.3
7 Zn Prefloat Tail	210.5	10.90	1.2	1.81	3.9	2.0
8 Bulk Tail	1333.5	69.07	0.64	8.73	13.3	62.5
Head Calc.	1930.6	100.00	3.33	9.6	100.0	100.0

Combined Products

Products 1-2 (Pb 3rd Cl Conc)	3.59	63.67	1.36	68.6	0.5
Products 1-3 (Pb 2nd Cl Conc)	4.72	51.48	2.36	73.0	1.2
Products 1-4(Pb 1st Cl. Conc.)	6.46	39.06	3.71	75.8	2.5
Products 1-5(Pb Ro. Conc.)	11.84	22.43	6.61	79.7	8.1

TEST NO. F-6

Purpose: To repeat the conditions of Test F-3, to examine semi-bulk regrind fineness.

Procedure: As for Test F-3.

Feed: 2000 grams of minus 10 mesh PP Rock Type 5 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			
	A317	Na_2CO_3	CA830 Thiourea	MIBC	PKD-C	Grind	Cond.	Froth	pH
Primary Grind	50	2500	20	-	-	15	-	-	-
Semi-Bulk Rougher	25	-	-	22.5	-	-	1	4	-
	10	-	-	5	-	-	1	3.5	-
Semi-Bulk Conc Regr	-	300	-	-	300	40	-	-	-
H.I. Conditioning	50	-	25	5	-	-	15	4.5	-
Pb Rougher	-	-	-	5	-	-	-	5	-
Pb Scavenger	5	-	5	5	-	-	1	2	-
	-	100	-	-	300	30	-	-	-

METALLURGICAL RESULTS

Product	Weight g	Weight %	Assays %,g/t Pb	Assays %,g/t Zn	% Distribution Pb	% Distribution Zn
1 Pb Ro. Conc.	205.9	11.06	19.3	6.09	77.4	6.9
2 Pb Ro. Tail	325.5	17.48	1.08	13.5	6.8	24.3
8 Bulk Tail	1330.9	71.47	0.61	9.36	15.8	68.8
Head Calc.	1862.3	100.00	2.76	9.7	100.0	100.0

Combined Products

Products 1-2 (Bulk Ro. Conc)	28.53	8.14	10.63	84.2	31.2

Product: Pb Regrind Rougher Conc   Test No: F-6   S.G.- 4.90

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
30.4μ	0.00	0.0	0.0	100.0
23.5	0.03	0.1	0.1	99.9
16.4	0.14	0.3	0.3	99.7
11.3	1.64	3.3	3.6	96.4
8.7	2.06	4.1	7.7	92.3
-8.7	46.13	92.3	100.0	-
Total	50.00	100.0	-	-

TEST NO. F-7

Purpose: To repeat Test F-1, but replace collector A317 and CA830/Thiourea with collector mixture 70 % A317/30 % 3418A.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Rock Type 5 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317/3418A	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Ro 1	15	-	20	-	-	1	5	10.5
Semi-bulk Ro 2	10	-	5	-	-	1	3	-
Semi-bulk Conc Regr	-	300	-	300	40	-	-	-
H.I. Conditioning	50	-	-	-	-	15	-	-
Pb Rougher	-	-	10	-	-	-	4	10.0
Pb Scavenger	5	-	5	-	-	1	3	-
Pb Conc Regrind	-	100	-	300	30	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	3	9.5
	5	-	10	-	-	1	3	-
Pb 2nd Cleaner	-	-	5	75	-	1	3	9.5
Pb 3rd Cleaner	2.5	-	5	75	-	1	3	-
Pb 4th Cleaner	2.5	-	5	75	-	1	3	-

	Reagents Added, grams per tonne					Time, minutes			
Zn Circuit:	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250	Grind	Cond	Froth	pH
Condition 1	800	-	-	-	-	-	5	-	11.2
Condition 2	-	1000	-	-	-	-	5	-	-
Zn Scalp 1	-	-	40	10	10	-	-	-	-
Pb Ro Tail for Zn Prefloat									
Condition	750	-	-	-	-	-	5	-	11.4
	-	500	-	-	-	-	5	-	-
Zn Prefloat 1	-	-	25	10	10	-	1	4	-
Zn Prefloat 2	-	-	5	5	5	-	1	1.5	-

Test No.F-7

Product	Weight g	Weight %	Assays %,g/t Pb	Assays %,g/t Zn	% Distribution Pb	% Distribution Zn
1 Pb Cl. Conc.	51.1	2.65	66.2	1.43	58.0	0.4
2 Pb 4th Cl. Tail	14.3	0.74	31.3	3.81	7.7	0.3
3 Pb 3rd Cl. Tail	31.3	1.62	18.8	5.43	10.1	0.9
4 Pb 2nd Cl. Tail	31.5	1.63	5.35	7.1	2.9	1.2
5 Pb 1st Cl. Tail	110.4	5.72	2.32	11.2	4.4	6.6
6 Zn Scalp Conc.	508.8	26.36	1.05	22.1	9.2	60.2
7 Zn Prefloat Conc.	144.1	7.47	0.94	38	2.3	29.3
8 Zn Scalp Tail	875.5	45.36	0.36	0.23	5.4	1.1
9 Zn Prefloat Tail	163.3	8.46	1.57	1.38	4.4	1.2
Head Calc.	1930.3	100.00	3.02	9.7	100.0	100.0

Combined Products

Products 1-2 (Pb 3rd Cl Conc)	3.39	58.57	1.95	65.7	0.7
Products 1-3 (Pb 2nd Cl Conc)	5.01	45.70	3.08	75.8	1.6
Products 1-4(Pb 1st Cl. Conc.)	6.64	35.78	4.07	78.7	2.8
Products 1-5(Pb Ro. Conc.)	12.36	20.30	7.37	83.1	9.4
Products 8+9(Comb. Tail)	53.82	0.55	0.41	9.8	2.3

Product: Zn Scalp Conc Reground Test No: F7 S.G.- 4.26

Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
270	0.77	1.5	1.5	98.5
33.4µ	2.32	4.6	6.2	93.8
25.9	4.33	8.7	14.8	85.2
18.1	7.45	14.9	29.7	70.3
12.4	8.10	16.2	45.9	54.1
9.6	3.45	6.9	52.8	47.2
-9.6	23.58	47.2	100.0	-
Total	50.00	100.0	-	-

TEST NO. F-11

Purpose: To repeat the conditions of Test F-9 on Rock Type 5 ore without a secondary collector.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Rock Type 5 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Ro 1	20	-	20	-	-	1	4	-
Semi-bulk Conc Regr	-	300	-	300	35	-	-	-
H.I. Conditioning	50	-	10	-	-	15	-	-
Pb Rougher	-	-	5	-	-	-	3	10.2
Pb Conc Regrind	-	100	-	300	20	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	2	9.6
	5	-	5	-	-	1	2	-
Pb 2nd Cleaner	-	-	5	80	-	1	2.5	9.5
Pb 3rd Cleaner	-	-	5	80	-	1	2	9.4
Pb 4th Cleaner	-	-	5	80	-	1	2	-

	Reagents Added, grams per tonne					Time, minutes			
	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250	Grind	Cond	Froth	pH
Zn Circuit:									
Condition	800	-	-	-	-	-	5	-	-
Condition	-	1000	-	-	-	-	5	-	-
Zn Scalp 1	-	-	40	10	10	-	1	4.5	11.4
Zn Scalp 2	-	-	10	7.5	5	-	1	1.5	-
Zn Scalp Regrind	500	500	-	-	-	30	-	-	-
Pb Rougher Tail for Zn Prefloat.									
Condition	750	-	-	-	-	-	5	-	-
Condition	-	800	-	-	-	-	5	-	-
Zn Prefloat 1	-	-	25	10	10	-	1	4	-
Combine Reground Zn Scalp Conc + Zn Prefloat Conc.									
H. I. Conditioning	250	-	15	10	5	-	15	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	6	11.2
Zn 2nd Cleaner	250	-	-	-	-	-	-	5	-
Zn 3rd Cleaner	250	-	-	-	-	-	-	5	11.4

Test No. F-11

Product	Weight		Assays,%		% Distribution	
	g	%	Pb	Zn	Pb	Zn
1. Pb Cl. Conc.	59.6	3.14	64.5	1.54	68.6	0.5
2. Pb 4th Cl. Tail	8.7	0.46	12.8	5.28	2.0	0.2
3. Pb 3rd Cl. Tail	15.6	0.82	8.97	6.28	2.5	0.5
4. Pb 2nd Cl. Tail	27.7	1.46	3.41	7.99	1.7	1.1
5. Pb 1st Cl. Tail	95.4	5.02	1.79	9.59	3.0	4.6
6. Zn 3rd Cl Conc	241.9	12.74	0.62	52.2	2.7	63.4
7. Zn 3rd Cl Tail	36.5	1.92	1.16	24.1	0.8	4.4
8. Zn 2nd Cl Tail	121.6	6.40	1.23	14.5	2.7	8.8
9. Zn 1st Cl Tail	344.2	18.12	1.05	8.34	6.5	14.4
10. Zn Prefloat Tail	161.4	8.50	0.98	0.94	2.8	0.8
11. Zn Scalp Tail	786.6	41.42	0.48	0.34	6.7	1.3
Head Calc.	1899.2	100.00	2.95	10.5	100.0	100.0

Combined Products

Products 1+2	3.60	57.9	2.02	70.6	0.7
Products 1-3	4.42	48.8	2.81	73.1	1.2
Products 1-4	5.88	37.5	4.10	74.8	2.3
Products 1-5	10.90	21.1	6.63	77.9	6.9
Products 6+7	14.66	0.69	48.5	3.4	67.8
Products6-8	21.06	0.85	38.2	6.1	76.6
Products 6-9	39.18	0.95	24.4	12.6	91.0
Products 10+11	49.92	0.57	0.44	9.6	2.1

PP COMPOSITE 1

<u>BENCH SCALE FLOTATION TESTS</u>

Primary Grind Size Distribution (15 minute grind)

Microns	Mesh	Weight Grams	% Weight Ind.	% Weight Cum.	% Weight Passing
208	65	2.4	1.3	1.3	98.7
147	100	7.0	3.7	5.0	95.0
104	150	14.1	7.5	12.5	87.5
74	200	20.3	10.8	23.3	76.7
53	270	23.4	12.4	35.7	64.3
38	400	21.7	11.5	47.2	52.8
-38	-400	99.4	52.8	100.0	-
	Total	188.3	100.0	-	-

The grind product K_{80} was 81 μm.

TEST NO. F-8

Purpose: To repeat Test F-7, but use PP Composite 1 ore.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Composite 1 prepared from Rock Types.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317/3418A	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Ro 1	15	-	20	-	-	1	4.5	10.5
Semi-bulk Ro 2	10	-	5	-	-	1	3.5	-
Semi-bulk Conc Regr	-	300	-	300	40	-	-	-
H.I. Conditioning	50	-	10	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	2.5	10.3
Pb Scavenger	5	-	5	-	-	1	2	-
Pb Conc Regrind	-	100	-	300	30	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	4	9.7
Pb 1st Cleaner Scav	5	-	7.5	-	-	1	2	-
Pb 2nd Cleaner	-	-	5	75	-	1	3	-
Pb 3rd Cleaner	-	-	5	75	-	1	2.5	-
Pb 4th Cleaner	-	-	5	75	-	1	2.5	-

	Reagents Added, grams per tonne					Time, minutes			
	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250	Grind	Cond	Froth	pH
Zn Circuit:									
Condition	800	-	-	-	-	-	5	-	-
Condition	-	1000	-	-	-	-	5	-	-
Zn Scalp 1	-	-	40	10	10	-	1	3	11.5
Zn Scalp 2	-	-	10	7.5	-	-	1	-	-
Pb Rougher Tail for Zn Prefloat.									
Condition	750	-	-	-	-	-	5	-	11.5
Condition	-	500	-	-	-	-	5	-	-
Zn Prefloat	-	-	25	10	10	-	1	3	-

Test No. F-8

Product	Weight g	%	Assays %,g/t Pb	Zn	% Distribution Pb	Zn
1 Pb Cl. Conc.	27.7	1.40	52.1	1.99	24.4	0.3
2 Pb 4th Cl. Tail	12.0	0.61	48.8	2.41	9.9	0.2
3 Pb 3rd Cl. Tail	27.0	1.36	41.8	3.07	19.1	0.4
4 Pb 2nd Cl. Tall	39.1	1.98	22	5.46	14.6	1.1
5 Pb 1st Cl. Scav. Conc.	20.1	1.02	10.6	7.73	3.6	0.8
6 Pb 1st Cl. Scav. Tail	73.1	3.70	4.92	9.59	6.1	3.8
7 Pb Rougher Scav. Coı	79.0	3.99	1.63	11.9	2.2	5.1
8 Zn Prefloat Conc.	97.8	4.94	0.84	40.8	1.4	21.5
9 Zn Prefloat. Tail	183.6	9.28	1.33	1.45	4.1	1.4
10 Zn Scalp Conc.	584.7	29.56	0.98	20.4	9.7	64.2
11 Zn Scalp Tall	834.2	42.17	0.34	0.26	4.8	1.2
Head Calc.	1978.3	100.00	2.98	9.4	100.0	100.0

Combined Products

Products 1-2 (Pb 3rd Cl Conc)	2.01	51.10	2.12	34.4	0.5
Products 1-3 (Pb 2nd Cl Conc)	3.37	47.34	2.50	53.5	0.9
Products 1-4 (Pb 1st Cl. Conc.)	5.35	37.97	3.60	68.1	2.0
Products 1-7 (Pb Ro. Conc)	14.05	16.97	7.83	80.0	11.7
Products 8+10 (Zn Scalp+Prefloat Concs.)	43.78	1.04	18.69	15.2	87.1

TEST NO. F-9

Purpose: To repeat Test F-8, but include Pb Ro Scav concentrate in regrind and improve cleaning. Also only use A317.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Composite 1 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Ro 1	20	-	20	-	-	1	3.5	10.5
Semi-bulk Ro 2	15	-	7.5	-	-	1	3	-
Semi-bulk Conc Regr	-	300	-	300	35	-	-	-
H.I. Conditioning	50	-	10	-	-	15	-	-
Pb Rougher	-	-	5	-	-	-	3	10.2
Pb Scavenger	5	-	5	-	-	-	1.5	-
Pb Conc Regrind	-	100	-	300	20	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	3	9.8
Pb 1st Cleaner Scav	5	-	7.5	-	-	1	2.5	-
Pb 2nd Cleaner	-	-	5	80	-	1	3	-
Pb 3rd Cleaner	-	-	5	75	-	1	3	-
Pb 4th Cleaner	-	-	7.5	75	-	1	2.5	9.4

	Reagents Added, grams per tonne					Time, minutes			
	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250	Grind	Cond	Froth	pH
Zn Circuit:									
Condition	800	-	-	-	-	-	5	-	-
Condition	-	1000	-	-	-	-	5	-	11.6
Zn Scalp 1	-	-	40	10	10	-	-	2.5	11.4
Zn Scalp 2	-	-	10	7.5	-	-	-	2	-
	-	-	5	5	-	-	-	-	-
Pb Rougher Tail for Zn Prefloat.									
Condition	750	-	-	-	-	-	5	-	11.5
Condition	-	500	-	-	-	-	5	-	-
Zn Prefloat	-	-	25	10	10	-	1	3	-
	-	-	5	5	-	-	-	-	-

Test No.F-9

Product	Weight g	Weight %	Assays %,g/t Pb	Assays %,g/t Zn	% Distribution Pb	% Distribution Zn
1 Pb Cl. Conc.	82.8	4.28	57.1	2.79	76.6	1.3
2 Pb 4th Cl. Tail	21.8	1.13	7.75	10.8	2.7	1.3
3 Pb 3rd Cl. Tail	34.8	1.80	3.24	11	1.8	2.1
4 Pb 2nd Cl. Tail	84.8	4.39	1.55	12.4	2.1	5.9
5 Pb 1st Cl. Tail	127.5	6.60	1.05	14.6	2.2	10.4
6 Zn Prefloat Conc	157.4	8.14	0.65	34.8	1.7	30.7
7 Zn Scalp Conc	411.5	21.29	0.92	20.1	6.1	46.4
8 Zn Prefloat Tail	193.2	10.00	0.83	0.74	2.6	0.8
9 Zn Scalp Tail	819.1	42.38	0.31	0.22	4.1	1.0
Head Calc.	1932.9	100.00	3.19	9.2	100.0	100.0

Combined Products

Products 1-2 (Pb 3rd Cl Conc)	5.41	46.81	4.46	79.4	2.6
Products 1-3 (Pb 2nd Cl Conc)	7.21	35.94	6.09	81.2	4.8
Products 1-4(Pb 1st Cl. Conc.)	11.60	22.93	8.48	83.3	10.7
Products 1-5(Pb Ro. Conc.)	18.20	15.00	10.70	85.5	21.1
Products 6+7 (Zn Comb Conc.)	29.43	0.85	24.17	7.8	77.1
Products 8+9 (Comb. Tail)	52.37	0.41	0.32	6.7	1.8

TEST NO. F-10

Purpose: To repeat Test F-3, with CA830/Thiourea secondary collector.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Composite 1 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			
	A317	Na_2CO_3	CA830 Thiourea	MIBC	PKD-C	Grind	Cond.	Froth	pH
Primary Grind	50	2500	20	-	-	15	-	-	-
Semi-bulk Rougher	15	-	-	22.5	-	-	1	4.5	10.3
Semi-bulk Conc Regr	-	300	-	-	300	35	-	-	-
H.I. Conditioning	50	-	25	-	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	-	2.5	9.7
Pb Scavenger	5	-	5	10	-	-	1	3	-
Pb Conc Regrind	-	100	-	5	300	20	-	-	-
H.I. Conditioning	10	-	20	12.5	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	-	2.5	9.5
	-	-	-	7.5	-	-	1	2	-
Pb 2nd Cleaner	-	-	-	2.5	80	-	1	2.5	-
Pb 3rd Cleaner	-	-	-	5	80	-	1	2	-
Pb 4th Cleaner	-	-	-	-	80	-	1	-	-
Zn Circuit:	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250				
Condition	800	-	-	-	-	-	5	-	-
Condition	-	1000	-	-	-	-	5	-	-
Zn Scalp 1	-	-	40	10	15	-	1	5	11.2
Zn Scalp 2	-	-	10	10	7.5	-	1	1.5	-
Zn Scalp Regrind	500	200	-	-	-	30	-	-	-
Pb Rougher Tail for Zn Prefloat									
Condition	750	-	-	-	-	-	5	-	-
Condition	-	500	-	-	-	-	5	-	11.2
Zn Prefloat 1	-	-	25	10	10	-	1	4	-
Zn Prefloat 2	-	-	10	5	-	-	-	-	-
Combined reground Zn Scalp Conc + Prefloat Conc for Zn cleaning.									
H.I. Conditioning	250	-	15	10	5	-	15	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	4	11.2
	-	-	10	5	-	-	1	3	-
Zn 2nd Cleaner	250	-	-	-	-	-	1	6	11.2
	-	-	-	5	-	-	1	1	-
Zn 3rd Cleaner	250	-	-	-	-	-	1	5	11.4

Test No.F-10

Product	Weight g	Weight %	Assays %,g/t Pb	Assays %,g/t Zn	% Distribution Pb	% Distribution Zn
1 Pb Cl. Conc.	59.6	3.00	70.5	1.13	69.2	0.4
2 Pb 4th Cl. Tail	8.7	0.44	24.8	4.51	3.6	0.2
3 Pb 3rd Cl. Tail	15.6	0.78	8.23	6.47	2.1	0.5
4 Pb 2nd Cl. Tail	27.7	1.39	3.11	7.92	1.4	1.2
5 Pb 1st Cl. Tail	95.4	4.80	1.76	9.56	2.8	4.8
6 Zn Cl. Conc.	241.9	12.16	0.65	50.1	2.6	63.8
7 Zn 3rd Cl. Tail	36.5	1.83	1.29	26.3	0.8	5.1
8 Zn 2nd Cl. Tail	211.6	10.64	1.42	16.2	4.9	18.0
9 Zn 1st Cl. Tail	344.2	17.30	0.9	2.5	5.1	4.5
10 Zn Prefloat Tail	161.4	8.11	1.17	0.72	3.1	0.6
11 Zn Scalp Tail	786.6	39.54	0.34	0.22	4.4	0.9
Head Calc.	1989.2	100.00	3.05	9.5	100.0	100.0

Combined Products

Products 1-2 (Pb 3rd Cl Conc)	3.43	64.68	1.56	72.8	0.6
Products 1-3 (Pb 2nd Cl Conc)	4.22	54.18	2.47	74.9	1.1
Products 1-4(Pb 1st Cl. Conc.)	5.61	41.51	3.83	76.3	2.2
Products 1-5(Pb Ro. Conc.)	10.41	23.19	6.47	79.1	7.0
Products 6+7 (Zn 2nd Cl. Conc.)	14.00	0.73	46.98	3.4	68.9
Products 6-8 (Zn 1st Cl. Conc.)	24.63	1.03	33.69	8.3	86.9
Products 10+11 (Comb. Tail)	47.66	0.48	0.31	7.5	1.5

TEST NO. F-14

Purpose: To produce a semi-bulk concentrate for size and metal distributions. The flotation products were not directly assayed.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Composite 1 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Rougher	15	-	20	-	-	1	3	10.4
	10	-	10	-	-	1	2	-

NO METALLURGICAL RESULTS WERE RECORDED

Test No. F-14 Bulk Rougher Concentrate S.G.- 4.70

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
65	0.00	0.0	0.0	100.0
100	0.98	1.0	1.0	99.0
150	3.89	3.9	4.9	95.1
200	8.13	8.1	13.0	87.0
270	10.62	10.6	23.6	76.4
400	11.26	11.3	34.9	65.1
-400	65.12	65.1	100.0	-
Total	100.00	100.0	-	-

K80=60 µm

TEST NO. F-15

Purpose: To conduct a locked cycle test on PP Composite 1 ore.

Procedure: As shown below.

Feed: 10 x 2000 grams of minus 10 mesh PP Composite 1 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill for each 2 kg charge.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Ro 1	20	-	20	-	-	1	3	-
Semi-bulk Ro 2	10	-	5	-	-	1	1.5	-
Semi-bulk Conc Regr	-	300	-	300	35	-	-	-
H.I. Conditioning	40	-	10	-	-	15	-	-
Pb Rougher	-	-	5	-	-	-	3.5	-
Pb Scavenger	5	-	7.5	-	-	1	0.5	-
Pb Conc Regrind	-	100	-	300	20	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	3	-
Pb 2nd Cleaner	-	-	5	80	-	1	2.5	-
Pb 3rd Cleaner	-	-	5	80	-	1	2	-
Pb 4th Cleaner	-	-	5	80	-	1	2	-
	1.5	-	-	-	-	1	1	-
Note: In the last 3-4 stages add 1 g/t A317 in last cleaner.								

	Reagents Added, grams per tonne					Time, minutes			
	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250	Grind	Cond	Froth	pH
Zn Circuit:									
Condition	800	-	-	-	-	-	5	-	-
Condition	-	1000	-	-	-	-	5	-	-
Zn Scalp 1*	-	-	40	10	10	-	1	4.5	11.4
Zn Scalp 2	-	-	10	7.5	5	-	1	1.5	-
Zn Scalp Regrind	500	500	-	-	-	30	-	-	-
Pb Rougher Tails for Zn Prefloat.									
Condition 1	750	-	-	-	-	-	5	-	-
Condition 2	-	800	-	-	-	-	5	-	-
Zn Prefloat	-	-	25	10	10	-	1	4	11.4
Combine reground Zn Scalp Conc, Zn Prefloat Conc, 1st Cl Scav Conc and 2nd Cl Tails for cleaning.									
H.I. Conditioning	250	-	15	10	5	-	15	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	6	-
	-	-	-	5	-	-	1	1	-
Zn 1st Cleaner Scav	-	-	-	2.5	-	-	1	1	-
Zn 2nd Cleaner **	250	-	-	-	-	-	1	5	11.8
Zn 3rd Cleaner **	250	-	-	-	-	-	1	5	11.8

* feed for this stage was semi-bulk rougher tails from Pb circuit.
**500 g D-1 cells used for 2nd and 3rd stage cleaning.

Test No. F-15

	Product	Weight g	Weight %	Assays,%,g/t Pb	Zn	Ag	% Distribution Pb	Zn	Ag
1	Pb Cl Conc A	63.1	0.3	59.9	1.92	-	6.2	0.1	-
2	Pb Cl Conc B	80.8	0.4	52.6	2.42	-	7.0	0.1	-
3	Pb Cl Conc C	72.1	0.4	60.3	1.83	-	7.2	0.1	-
4	Pb Cl Conc D	76.7	0.4	58.2	1.82	-	7.4	0.1	-
5	Pb Cl Conc E	72.4	0.4	50.2	2.34	-	6.0	0.1	-
6	Pb Cl Conc F	60.0	0.3	61.6	1.71	-	6.1	0.1	-
7	Pb Cl Conc G	67.5	0.3	60.8	1.69	-	6.8	0.1	-
8	Pb Cl Conc H	78.8	0.4	57.9	1.87	-	7.5	0.1	-
9	Pb Cl Conc I	74.9	0.4	59.2	1.72	-	7.3	0.1	-
10	Pb Cl Conc J	66.8	0.3	60.1	1.69	-	6.6	0.1	-
11	Pb 4th Cl Tall J	45.6	0.2	34.4	3.24	-	2.6	0.1	-
12	Pb 3rd Cl Tall J	121.7	0.6	23.5	4.1	-	4.7	0.3	-
13	Pb 2nd Cl Tall J	197.0	1.0	10.4	5.65	-	3.4	0.6	-
14	Pb 1st Cl Tall J	386.5	2.0	4.43	8.42	-	2.8	1.7	-
15	Zn Cl Conc A	219.2	1.1	0.44	58.4	-	0.2	6.9	-
16	Zn Cl Conc B	206.6	1.1	0.52	54.3	-	0.2	6.0	-
17	Zn Cl Conc C	211.5	1.1	0.6	53.1	-	0.2	6.0	-
18	Zn Cl Conc D	247.1	1.3	0.61	51.3	-	0.2	6.8	-
19	Zn Cl Conc E	240.4	1.2	0.74	48.1	-	0.3	6.2	-
20	Zn Cl Conc F	159.4	0.8	0.93	38.2	-	0.2	3.3	-
21	Zn Cl Conc G	235.4	1.2	0.75	46.4	-	0.3	5.9	-
22	Zn Cl Conc H	320.7	1.6	0.62	50.1	-	0.3	8.6	-
23	Zn Cl Conc I	256.2	1.3	0.77	46.0	-	0.3	6.3	-
24	Zn Cl Conc J	245.5	1.2	0.77	46.3	-	0.3	6.1	-
25	Zn 3rd Cl Tall J	79.5	0.4	0.95	35.2	-	0.1	1.5	-
26	Zn 2nd Cl Tall J	148.4	0.8	1.02	30.2	-	0.2	2.4	-
27	Zn 1st Cl Sc Conc J	17.0	0.1	1.37	17.7	-	0.0	0.2	-
28	Zn Pre-Flt Ro Tall A	253.5	1.3	0.86	0.79	-	0.4	0.1	-
29	Zn Pre-Flt Ro Tall B	296.5	1.5	0.95	1.05	-	0.5	0.2	-
30	Zn Pre-Flt Ro Tall C	347.1	1.8	0.93	0.86	-	0.5	0.2	-
31	Zn Pre-Flt Ro Tall D	345.5	1.8	1.02	0.92	-	0.6	0.2	-
32	Zn Pre-Flt Ro Tail E	311.7	1.6	1.06	0.88	-	0.5	0.1	-
33	Zn Pre-Flt Ro Tail F	340.0	1.7	1.13	0.74	-	0.6	0.1	-
34	Zn Pre-Flt Ro Tall G	362.7	1.8	1.17	0.79	-	0.7	0.2	-
35	Zn Pre-Flt Ro Tall H	375.0	1.9	1.19	0.68	-	0.7	0.1	-
36	Zn Pre-Flt Ro Tall I	365.5	1.9	1.19	0.86	-	0.7	0.2	-
37	Zn Pre-Flt Ro Tall J	350.9	1.8	1.22	1.08	-	0.7	0.2	-
38	Zn 1st Cl Sc Tall A	206.5	1.1	1.05	5.1	-	0.4	0.6	-
39	Zn 1st Cl Sc Tall B	289.4	1.5	1.06	9.46	-	0.5	1.5	-
40	Zn 1st Cl Sc Tall C	307.9	1.6	1.04	16	-	0.5	2.6	-
41	Zn 1st Cl Sc Tall D	346.6	1.8	1.04	14.3	-	0.6	2.7	-
42	Zn 1st Cl Sc Tall E	367.2	1.9	1.03	15.1	-	0.6	3.0	-
43	Zn 1st Cl Sc Tall F	482.9	2.5	0.94	22.2	-	0.7	5.8	-
44	Zn 1st Cl Sc Tall G	412.3	2.1	1.00	18	-	0.7	4.0	-
45	Zn 1st Cl Sc Tall H	384.4	2.0	1.15	11.8	-	0.7	2.4	-
46	Zn 1st Cl Sc Tall I	391.1	2.0	1.12	12.6	-	0.7	2.6	-
47	Zn 1st Cl Sc Tall J	360.7	1.8	1.11	13.4	-	0.7	2.6	-
48	Zn Scalp Tall A	881.7	4.5	0.23	0.22	-	0.3	0.1	-
49	Zn Scalp Tall B	858.1	4.4	0.25	0.18	-	0.4	0.1	-
50	Zn Scalp Tall C	886.2	4.5	0.19	0.25	-	0.3	0.1	-
51	Zn Scalp Tall D	892.8	4.5	0.24	0.21	-	0.4	0.1	-
52	Zn Scalp Tall E	890.6	4.5	0.31	0.22	-	0.5	0.1	-
53	Zn Scalp Tall F	859.6	4.4	0.24	0.26	-	0.3	0.1	-
54	Zn Scalp Tall G	865.2	4.4	0.27	0.18	-	0.4	0.1	-
55	Zn Scalp Tall H	845.9	4.3	0.21	0.18	-	0.3	0.1	-
56	Zn Scalp Tall I	845.7	4.3	0.22	0.19	-	0.3	0.1	-
57	Zn Scalp Tall J	872.1	4.4	0.23	0.18	-	0.3	0.1	-
	Head (calc)	19646.1	100.00	3.09	9.47	-	100.0	100.0	-

Combined Products

Product	Weight	Assays,%,g/t			% Distribution		
	%	Pb	Zn	Ag	Pb	Zn	Ag
Comb Pb Conc.1 to 10	3.6	57.9	1.91	-	68.0	0.7	-
Comb Pb Cl Tails 11 to14	3.8	10.91	6.68	-	13.5	2.7	-
Comb Zn Cl.Conc. 15 to24	11.9	0.34	28.0	-	1.3	35.3	-
Comb Zn Cl Tails, Cl Sc Conc. 25 to 27	1.2	1.02	31.0	-	0.4	4.1	-
Comb Zn Pre-Float Ro Tails 28 to 37	17.0	0.56	0.49	-	3.1	0.9	-
Comb Zn Cl Scav Tails 38 to 47	18.1	0.57	8.44	-	3.4	16.1	-
Comb Zn Scalp Tails 48 to 57	44.3	0.15	0.14	-	2.1	0.6	-

Projected Results Cycles H, I, & J

Pb Cleaner Conc	4.2	59.0	1.76	-	79.3	0.8	-
Zn Cleaner Conc	14.1	0.71	47.7	-	3.2	70.9	-
Zn Comb. Tail	81.8	0.66	3.28	-	17.4	28.3	-
Head(calc)	100.0	3.09	9.47	-	100.0	100.0	-

TEST NO. F-16

Purpose: To produce a reground semi-bulk concentrate and reground Zn scalp concentrate for cyclosizer analysis using Test F-15 conditions.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Composite 1 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Ro 1	20	-	20	-	-	1	3	-
Semi-bulk Ro 2	10	-	5	-	-	1	1.5	-
Semi-bulk Conc Regr	-	300	-	300	35	-	-	-

	Reagents Added, grams per tonne					Time, minutes			
	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250	Grind	Cond	Froth	pH
Zn Circuit:									
Condition	800	-	-	-	-	-	-	-	-
Condition	-	1000	-	-	-	-	-	-	-
Zn Scalp 1	-	-	40	10	10	-	1	4.5	-
Zn Scalp 2	-	-	10	7.5	5	-	1	1.5	-
Zn Scalp Regrind	500	500	-	-	-	30	-	-	-

No assays were performed.

Test No. F-16 - Continued

SIZE ANALYSES:

Product: Bulk Conc Reground Test No: F 16 S.G.- 4.57

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.00	0.0	0.0	100.0
32.0μ	0.11	0.2	0.2	99.8
24.8	0.16	0.3	0.5	99.5
17.3	1.95	3.9	4.4	95.6
11.9	8.33	16.7	21.1	78.9
9.2	5.09	10.2	31.3	68.7
-9.2	34.36	68.7	100.0	-
Total	50.00	100.0	-	-

Product: Zn Scalp Conc Reground Test No: F 16 S.G.- 4.29

Mesh	Weight Grams	% Weight Ind.	Cum.	Passing
270	0.52	1.0	1.0	99.0
33.4μ	1.61	3.2	4.3	95.7
25.9	3.60	7.2	11.5	88.5
18.1	7.33	14.7	26.1	73.9
12.4	8.89	17.8	43.9	56.1
9.6	3.71	7.4	51.3	48.7
-9.6	24.34	48.7	100.0	-
Total	50.00	100.0	-	-

TEST NO. F-17

Purpose: To conduct a locked cycle test on PP Composite 1 ore as in Test F-15, but try to improve Zn grade and recovery.

Procedure: As shown below.

Feed: 6 x 2000 grams of minus 10 mesh PP Composite 1 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill for each 2 kg charge.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Rougher	20	-	20	-	-	1	3	10.2
	10	-	5	-	-	1	1.5	-
Semi-bulk Conc Regr	-	300	-	300	35	-	-	-
H.I. Conditioning	40	-	10	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	3	9.7
Pb Scavenger	5	-	7.5	-	-	1	0.5	-
Pb Conc Regrind	-	100	-	300	20	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	3	-
	5	-	5	-	-	-	1	-
Pb 2nd Cleaner	-	-	-	80	-	1	2.5	-
Pb 3rd Cleaner	-	-	5	80	-	1	2	9.4
Pb 4th Cleaner	-	-	5	80	-	1	2	-

	Reagents Added, grams per tonne					Time, minutes			
	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250	Grind	Cond	Froth	pH
Zn Circuit:									
Condition	800	-	-	-	-	-	5	-	-
Condition	-	1000	-	-	-	-	5	-	-
Zn Scalp 1	-	-	40	10	10	-	1	4.5	11.4
Zn Scalp 2	-	-	10	7.5	5	-	1	1.5	-
Zn Scalp Regrind	500	500	-	-	-	30	-	-	-
Pb Rougher Tail for Zn	Prefloat								
Condition	750	-	-	-	-	-	5	-	-
Condition	-	800	-	-	-	-	5	-	-
Zn Prefloat	-	-	25	10	10	-	1	4	11.1
	-	-	10	10	5	-	1	2.5	-
Combine Zn Scalp Cor	c, Zn Preflc	at Conc,	Zn 2nd Cl ˉ	all for H.I.	Conditioning.				
H.I. Conditioning	250	-	25	15	5	-	15	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	4	11.4
	-	-	5	5	-	-	1	2	-
	-	-	5	5	-	-	1	2	-
Zn 2nd Cleaner	250	-	-	-	-	-	1	4	-
Zn 3rd Cleaner	250	-	-	-	-	-	1	3	-

No assays were performed.

Test No. F-17

Product	Weight g	Weight %	Assays,%,g/t Pb	Assays,%,g/t Zn	Assays,%,g/t Ag	% Distribution Pb	% Distribution Zn	% Distribution Ag
1. Pb Cl Conc A	52.8	0.4	68.3	1.34	-	9.6	0.1	-
2. Pb Cl Conc B	71.2	0.6	62.7	1.78	-	11.9	0.1	-
3. Pb Cl Conc C	63.2	0.5	64.3	1.56	-	10.8	0.1	-
4. Pb Cl Conc D	63.3	0.5	61.3	1.76	-	10.3	0.1	-
5. Pb Cl Conc E	76.0	0.6	62.6	1.63	-	12.7	0.1	-
6. Pb Cl Conc F	82.7	0.7	57.2	2.02	-	12.6	0.1	-
7. Pb 4th Cl Tall F	41.1	0.3	29.3	4.09	-	3.2	0.1	-
8. Pb 3rd Cl Tall F	110.8	0.9	18.6	5.18	-	5.5	0.5	-
9. Pb 2nd Cl Tall F	123.7	1.0	8.25	6.65	-	2.7	0.7	-
10. Pb 1st Cl Tall F	288.4	2.4	3.19	9.98	-	2.4	2.5	-
11. Zn Cl Conc A	195.2	1.7	0.54	57.2	-	0.3	9.8	-
12. Zn Cl Conc B	193.0	1.6	0.73	51.9	-	0.4	8.8	-
13. Zn Cl Conc C	302.6	2.6	0.74	52	-	0.6	13.8	-
14. Zn Cl Conc D	298.4	2.5	0.63	55.4	-	0.5	14.5	-
15. Zn Cl Conc E	302.2	2.6	0.74	54.9	-	0.6	14.6	-
16. Zn Cl Conc F	345.7	2.9	0.79	53.1	-	0.7	16.1	-
17. Zn 3rd Cl Tall F	147.1	1.2	1.16	33.1	-	0.5	4.3	-
18. Zn 2nd Cl Tall F	348.6	2.9	1.26	26.2	-	1.2	8.0	-
19. Zn 1st Cl Sc Conc F	87.9	0.7	1.98	10.2	-	0.5	0.8	-
20. Zn Pre-Flt Ro Tall A	172.2	1.5	0.85	1.94	-	0.4	0.3	-
21. Zn Pre-Flt Ro Tall B	298.4	2.5	0.9	1.01	-	0.7	0.3	-
22. Zn Pre-Flt Ro Tall C	335.4	2.8	0.96	0.76	-	0.9	0.2	-
23. Zn Pre-Flt Ro Tall D	329.6	2.8	1.05	0.62	-	0.9	0.2	-
24. Zn Pre-Flt Ro Tall E	345.0	2.9	1.11	0.74	-	1.0	0.2	-
25. Zn Pre-Flt Ro Tall F	295.5	2.5	1.02	0.89	-	0.8	0.2	-
26. Zn 1st Cl Sc Tall A	232.5	2.0	0.89	1.19	-	0.6	0.2	-
27. Zn 1st Cl Sc Tall B	312.2	2.6	0.99	1.81	-	0.8	0.5	-
28. Zn 1st Cl Sc Tall C	293.0	2.5	0.96	1.26	-	0.7	0.3	-
29. Zn 1st Cl Sc Tall D	323.7	2.7	1.04	1.58	-	0.9	0.4	-
30. Zn 1st Cl Sc Tall E	314.2	2.7	1.13	1.57	-	0.9	0.4	-
31. Zn 1st Cl Sc Tall F	314.4	2.7	1.1	1.22	-	0.9	0.3	-
32. Zn Scalp Tall A	845.3	7.1	0.26	0.22	-	0.6	0.2	-
33. Zn Scalp Tall B	826.3	7.0	0.27	0.26	-	0.6	0.2	-
34. Zn Scalp Tall C	816.1	6.9	0.23	0.26	-	0.5	0.2	-
35. Zn Scalp Tall D	874.3	7.4	0.27	0.21	-	0.6	0.2	-
36 Zn Scalp Tall E	853.5	7.2	0.24	0.2	-	0.5	0.1	-
37. Zn Scalp Tall F	852.1	7.2	0.28	0.25	-	0.6	0.2	-
Head (calc)	11827.6	100.0	3.18	9.62	-	100.0	100.0	-

Combined Products

Comb Pb Conc.1 to 6	3.5	62.3	1.71	-	67.9	0.6	-
Comb Pb Cl Talls 7 to 10	4.8	9.23	7.88	-	13.9	3.9	-
Comb Zn Cl.Conc. 11 to16	13.8	0.71	54.0	-	3.1	77.7	-
Comb Zn Cl Talls, Cl Sc Conc. 17 to 19	4.9	1.34	25.5	-	2.1	13.1	-
Comb Zn Pre-Float Ro Talls 20 to 25	15.0	1.00	0.91	-	4.7	1.4	-
Comb Zn Cl Scav Talls 26 to 31	15.1	1.03	1.45	-	4.9	2.3	-
Comb Zn Scalp Talls 32 to 37	42.8	0.26	0.23	-	3.5	1.0	-

Projected Results Cycles D, E, & F

Pb Cleaner Conc	4.3	60.2	1.81	-	81.0	0.8	-
Zn Cleaner Conc	16.7	0.72	54.4	-	3.8	94.3	-
Zn Scav. Tall	79.0	0.61	0.59	-	15.2	4.9	-
Head(calc)	100.0	3.18	9.6	-	100.0	100.0	-

TEST NO. F-18

Purpose: To conduct an 8 cycle locked cycle test on the Pb circuit only to examine the effect of finer grinding and extended semi-bulk rougher flotation.

Procedure: Primary grind increased to 22 minutes (i.e. 80 % - 58 µm) and semi-bulk rougher time increased from 4.5 to 8 minutes. Pb rougher time increased from 3.5 to 6 minutes.

Feed: 4 x 2000 grams of minus 10 mesh PP Composite 1 ore.

Grind: 22 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	22	-	-	-
Semi-bulk Rougher	20	-	20	-	-	1	4	-
	15	-	7.5	-	-	1	4	-
Semi-bulk Conc Regr	-	300	-	300	40	-	-	-
H.I. Conditioning	40	-	12.5	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	5	-
Pb Scavenger	5	-	5	-	-	1	1	-
Pb Conc Regrind	-	100	-	300	20	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	4	-
	10	-	2.5	-	-	-	1	-
Pb 2nd Cleaner	-	-	5	80	-	1	2.5	-
Pb 3rd Cleaner	-	-	5	80	-	1	2	-
Pb 4th Cleaner	-	-	5	80	-	1	2	-

Test No. F-18

	Product	Weight g	Weight %	Assays,%,g/t Pb	Assays,%,g/t Zn	Assays,%,g/t Ag	% Distribution Pb	% Distribution Zn	% Distribution Ag
1	Pb Cl Conc A	92.3	0.59	49.9	2.68	-	9.2	0.2	-
2	Pb Cl Conc B	105.7	0.67	46.2	3.02	-	9.7	0.2	-
3	Pb Cl Conc C	107.3	0.68	46	2.93	-	9.8	0.2	-
4	Pb Cl Conc D	117.6	0.75	41.6	3.44	-	9.8	0.3	-
5	Pb Cl Conc E	126.9	0.81	39.8	3.29	-	10.1	0.3	-
6	Pb Cl Conc F	101.4	0.64	47.5	2.76	-	9.6	0.2	-
7	Pb Cl Conc G	122.1	0.78	42.7	3.07	-	10.4	0.3	-
8	Pb Cl Conc H	117.6	0.75	40.4	3.32	-	9.5	0.3	-
9	Pb 4th Cl Tail H	102.3	0.65	9	6.02	-	1.8	0.4	-
10	Pb 3rd Cl Tail H	177.1	1.13	3.5	7	-	1.2	0.8	-
11	Pb 2nd Cl Tail H	351.4	2.23	2.23	7.44	-	1.6	1.8	-
12	Pb 1st Cl Tail H	391.9	2.49	1.27	10.5	-	1.0	2.8	-
13	Pb Rougher Tail A	404.7	2.57	0.84	15.8	-	0.7	4.3	-
14	Pb Rougher Tail B	454.3	2.89	0.83	16.7	-	0.8	5.1	-
15	Pb Rougher Tail C	534.4	3.40	0.84	15.7	-	0.9	5.6	-
16	Pb Rougher Tail D	537.7	3.42	0.84	16.2	-	0.9	5.9	-
17	Pb Rougher Tail E	644.3	4.10	0.9	16.4	-	1.2	7.1	-
18	Pb Rougher Tail F	641.9	4.08	0.92	15.9	-	1.2	6.9	-
19	Pb Rougher Tail G	588.4	3.74	0.94	15.5	-	1.1	6.1	-
20	Pb Rougher Tail H	629.8	4.00	0.98	15.7	-	1.2	6.6	-
21	Semi-Bulk Tail A	1172.2	7.45	0.45	7.74	-	1.1	6.1	-
22	Semi-Bulk Tail B	1143.0	7.27	0.4	6.3	-	0.9	4.8	-
23	Semi-Bulk Tail C	1218.6	7.75	0.46	7.36	-	1.1	6.0	-
24	Semi-Bulk Tail D	1153.7	7.33	0.42	7.07	-	1.0	5.5	-
25	Semi-Bulk Tail E	1201.4	7.64	0.48	6.69	-	1.2	5.4	-
26	Semi-Bulk Tail F	1127.0	7.16	0.43	6.75	-	1.0	5.1	-
27	Semi-Bulk Tail G	1171.9	7.45	0.48	6.98	-	1.1	5.5	-
28	Semi-Bulk Tail H	1194.7	7.59	0.45	7.84	-	1.1	6.3	-
	Head (calc)	15731.6	100.00	3.19	9.46	-	100.0	100.0	-

Other Assays: Pb 1st Cleaner Tail A: 1.48 % Pb, 11.4% Zn
Pb Rougher Concentrate H: 10.0% Pb, 8.48% Zn

Combined Products

Comb Pb Conc.1 to 8	5.66	43.9	3.08	-	78.1	1.8	-
Comb Pb Cl Tails 9 to 12	6.50	2.76	8.39	-	5.6	5.8	-
Comb Pb Rougher Tails 13 to 20	28.19	0.89	16.0	-	7.9	47.6	-
Comb Semi-Bulk Tails 21 to 28	59.64	0.45	7.10	-	8.4	44.8	-

Projected Results Cycles G & H

Pb Cleaner Conc	6.28	41.6	3.19	-	81.9	2.1	-
Pb Rougher Tail	28.19	0.96	15.6	-	8.5	46.5	-
Semi-Bulk Tails	65.53	0.46	7.41	-	9.6	51.4	-
Head(calc)	100.00	3.19	9.46	-	100.0	100.0	-

Project No: 3889 ar

Product: Bulk Rougher Conc S.G.- 4.55

Mesh	Weight Grams	% Weight		
		Ind.	Cum.	Passing
150	0.78	1.6	1.6	98.4
200	2.25	4.5	6.1	93.9
270	5.27	10.5	16.6	83.4
31.8μ	5.78	11.6	28.2	71.8
24.6	5.88	11.8	39.9	60.1
17.2	7.04	14.1	54.0	46.0
11.8	6.48	13.0	67.0	33.0
9.1	2.32	4.6	71.6	28.4
-9.1	14.20	28.4	100.0	-
Total	50.00	100.0	-	-

TEST NO. F-19

Purpose: To repeat Test F-17 conditions but decrease semi-bulk regrind time to 15 minutes to examine selectivity.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Composite 1 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Rougher	20	-	20	-	-	1	3	10.1
	10	-	5	-	-	1	1.5	-
Semi-bulk Conc Regr	-	300	-	300	15	-	-	-
H.I. Conditioning	40	-	10	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	3.5	9.8
Pb Scavenger	5	-	7.5	-	-	1	1	-
Pb Conc Regrind	-	100	-	300	35	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	2.5	-	-	-	3	9.3
	5	-	5	-	-	-	1	-
Pb 2nd Cleaner	-	-	2.5	80	-	1	2.5	-
Pb 3rd Cleaner	-	-	-	80	-	1	2	9.0
Pb 4th Cleaner	-	-	-	80	-	1	2	-

METALLURGICAL RESULTS

Product	Weight		Assays,%		% Distribution	
	g	%	Pb	Zn	Pb	Zn
1. Pb Cl. Conc.	80.9	4.13	54.4	3.15	71.5	1.3
2. Pb 4th Cl. Tail	17.9	0.91	15.5	8.25	4.5	0.7
3. Pb 3rd Cl. Tail	47.9	2.44	5.32	11.9	4.1	2.9
4. Pb 2nd Cl. Tail	84.4	4.31	1.76	15.8	2.4	6.8
5. Pb 1st Cl. Tail	243.3	12.42	0.93	21.1	3.7	26.0
6. Pb Ro Tail	277.2	14.15	0.89	9.61	4.0	13.5
7. Bulk Ro Tail	1208.0	61.64	0.5	7.95	9.8	48.7
Head Calc.	1959.6	100.00	3.14	10.1	100.0	100.0

Bulk Concentrate Assays = 6.81 %Pb
13.5% Zn

Combined Products

Products 1+2	5.04	47.4	4.07	76.0	2.0
Products 1-3	7.49	33.6	6.63	80.1	4.9
Products 1-4	11.79	22.0	9.98	82.5	11.7
Products 1-5	24.21	11.2	15.68	86.2	37.8

TEST NO. F-20

Purpose: To repeat Test F-17, but increase H.I. conditioning time for semi-bulk concentrate reground product to 30 minutes.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Composite 1 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Rougher	20	-	20	-	-	1	3	10.1
	10	-	5	-	-	1	1.5	-
Semi-bulk Conc Regr	-	300	-	300	35	-	-	-
H.I. Conditioning	40	-	15	-	-	30	-	-
Pb Rougher	-	-	5	-	-	-	4	9.5
Pb Scavenger	5	-	7.5	-	-	1	1	-
Pb Conc Regrind	-	100	-	300	20	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	5	-	-	-	3	9.4
	5	-	5	-	-	-	1	-
Pb 2nd Cleaner	-	-	-	80	-	1	2	-
Pb 3rd Cleaner	-	-	2.5	80	-	1	2	-
Pb 4th Cleaner	-	-	-	80	-	1	2	9.4

METALLURGICAL RESULTS

Product	Weight		Assays,%		% Distribution	
	g	%	Pb	Zn	Pb	Zn
1. Pb Cl. Conc.	77.4	3.99	57	2.22	72.7	0.9
2. Pb 4th Cl. Tail	17.1	0.88	13	6.01	3.7	0.5
3. Pb 3rd Cl. Tail	39.0	2.01	4.7	7.76	3.0	1.6
4. Pb 2nd Cl. Tail	59.7	3.07	2.1	9.67	2.1	3.1
5. Pb 1st Cl. Tail	151.9	7.82	1.22	12.8	3.1	10.3
6. Pb Ro Tail	405.4	20.88	0.82	17.1	5.5	36.8
7. Bulk Ro Tail	1191.5	61.35	0.51	7.4	10.0	46.8
Head Calc.	1942.0	100.00	3.12	9.71	100.0	100.0

Combined Products

Products 1+2	4.87	49.0	2.91	76.4	1.5
Products 1-3	6.87	36.1	4.32	79.4	3.1
Products 1-4	9.95	25.6	5.98	81.5	6.1
Products 1-5	17.77	14.9	8.98	84.5	16.4

TEST NO. F-21

Purpose: To repeat Test F-17 but increase semi-bulk concentrate regrind to 60 minutes.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Composite 1 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Rougher	20	-	20	-	-	1	-	10.4
	10	-	5	-	-	1	-	-
Semi-bulk Conc Regr	-	400	-	300	60	-	-	-
H.I. Conditioning	40	-	12.5	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	3.5	9.9
Pb Scavenger	5	-	5	-	-	1	1	-
Pb Conc Regrind	-	100	-	300	20	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	3	9.6
	5	-	5	-	-	-	1	-
Pb 2nd Cleaner	-	-	2.5	80	-	1	2.5	-
Pb 3rd Cleaner	-	-	-	80	-	1	2	-
Pb 4th Cleaner	-	-	-	80	-	1	2	-

METALLURGICAL RESULTS

Product	Weight		Assays,%		% Distribution	
	g	%	Pb	Zn	Pb	Zn
1. Pb Cl. Conc.	56.1	2.85	62.1	1.54	56.5	0.5
2. Pb 4th Cl. Tail	12.5	0.63	35.9	3.78	7.3	0.3
3. Pb 3rd Cl. Tail	43.4	2.20	14.6	6.19	10.3	1.4
4. Pb 2nd Cl. Tail	69.6	3.53	3.76	9.05	4.2	3.3
5. Pb 1st Cl. Tail	141.6	7.18	1.63	12.5	4.2	9.4
6. Pb Ro Tail	431.3	21.88	1.00	16.9	7.0	38.7
7. Bulk Ro Tail	1217.1	61.73	0.53	7.18	10.5	46.4
Head Calc.	1971.6	100.00	3.13	9.55	100.0	100.0

Combined Products

Products 1+2	3.48	57.3	1.95	63.8	0.7
Products 1-3	5.68	40.8	3.59	74.1	2.1
Products 1-4	9.21	26.6	5.68	78.3	5.5
Products 1-5	16.39	15.7	8.67	82.5	14.9

PP ROCK TYPE 4
AND
UPPER MEDIUM ORE

BENCH SCALE FLOTATION TESTS

TEST NO. F-12

Purpose: To repeat the conditions of Test F-10 using PP Rock Type 4 ore.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh PP Rock Type 4 ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Ro 1	20	-	20	-	-	1	3	10.5
Semi-bulk Ro 2	15	-	7.5	-	-	1	2	-
Semi-bulk Conc Regr	-	300	-	300	35	-	-	-
H.I. Conditioning	50	-	12.5	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	2.5	10.0
Pb Scavenger	5	-	7.5	-	-	1	2	-
Pb Conc Regrind	-	100	-	300	20	-	-	-
H.I. Conditioning	10	-	10	-	-	10	-	-
Pb 1st Cleaner	-	-	5	-	-	-	3	9.7
	5	-	5	-	-	1	0.5	-
Pb 2nd Cleaner	-	-	5	75	-	1	2.5	-
Pb 3rd Cleaner	-	-	2.5	75	-	1	2	-
Pb 4th Cleaner	-	-	2.5	50	-	1	2	-

	Reagents Added, grams per tonne					Time, minutes			
	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250	Grind	Cond	Froth	pH
Zn Circuit:									
Condition	800	-	-	-	-	-	5	-	-
Condition	-	1000	-	-	-	-	5	-	-
Zn Scalp 1	-	-	40	10	10	-	1	3	11.5
Zn Scalp 2	-	-	5	5	5	-	1	1.5	-
Zn Scalp Regrind	500	500	-	-	-	30	-	-	-
Pb Rougher Tail for Zn Prefloat.									
Condition	750	-	-	-	-	-	5	-	-
Condition	-	800	-	-	-	-	5	-	11.4
Zn Prefloat	-	-	35	10	10	-	1	3.5	-
	-	-	5	10	-	-	-	-	-
Combine reground Zn Scalp Conc + Zn Prefloat Conc for cleaning.									
H.I. Conditioning	250	-	25	10	5	-	15	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	4	11.3
	-	-	5	5	-	-	1	1	-
Zn 2nd Cleaner	250	-	-	-	-	-	1	4	11.5
	-	-	5	-	-	-	1	1	-
Zn 3rd Cleaner	250	-	-	-	-	-	1	3.5	-

Test No. F-12

Product	Weight g	Weight %	Assays,% Pb	Assays,% Zn	% Distribution Pb	% Distribution Zn
1. Pb Cl. Conc.	50.4	2.62	70.6	1.85	73.8	0.6
2. Pb 4th Cl. Tail	7.1	0.37	26.6	7.46	3.9	0.4
3. Pb 3rd Cl. Tail	13.5	0.70	11.5	10.5	3.2	1.0
4. Pb 2nd Cl. Tail	32.0	1.66	3.5	12.6	2.3	2.7
5. Pb 1st Cl. Tail	102.6	5.32	1.55	14.7	3.3	10.2
6. Zn 3rd Cl Conc	233.1	12.10	0.61	51	2.9	80.5
7. Zn 3rd Cl Tail	24.7	1.28	1.1	5.6	0.6	0.9
8. Zn 2nd Cl Tail	55.9	2.90	0.86	2.06	1.0	0.8
9. Zn 1st Cl Tail	238.4	12.37	0.51	0.59	2.5	1.0
10. Zn Prefloat Tail	170.1	8.83	1.06	0.82	3.7	0.9
11. Zn Scalp Tail	999.1	51.85	0.13	0.15	2.7	1.0
Head Calc.	1926.9	100.00	2.50	7.67	100.0	100.0

Combined Products

Products 1+2	2.98	65.2	2.54	77.7	1.0
Products 1-3	3.68	55.0	4.06	80.9	1.9
Products 1-4	5.35	39.0	6.71	83.2	4.7
Products 1-5	10.67	20.3	10.70	86.5	14.9
Products 6+7	13.38	0.66	46.7	3.5	81.4
Products6-8	16.28	0.69	38.7	4.5	82.2
Products 6-9	28.65	0.61	22.2	7.0	83.2
Products 10+11	60.68	0.27	0.25	6.4	2.0

TEST NO. F-13

Purpose: To repeat Test F-11 on Cirque Upper Medium ore.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh Upper Medium ore.

Grind: 15 minutes at 65 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A317	Na_2CO_3	MIBC	PKD-C	Grind	Cond.	Froth	
Primary Grind	50	2500	-	-	15	-	-	-
Semi-bulk Ro 1	20	-	20	-	-	1	4	10.5
Semi-bulk Conc Regr	-	300	-	300	35	-	-	-
H.I. Conditioning	50	-	12.5	-	-	15	-	-
Pb Rougher	-	-	-	-	-	-	4	10.1
Pb Scavenger	5	-	5	-	-	1	0.5	-
Pb Conc Regrind	-	100	-	300	20	-	-	-
H.I. Conditioning	10	-	12.5	-	-	10	-	-
Pb 1st Cleaner	-	-	-	-	-	-	3	9.9
Pb 2nd Cleaner	-	-	2.5	75	-	1	2	-
Pb 3rd Cleaner	-	-	-	50	-	1	2	-
Pb 4th Cleaner	-	-	-	50	-	1	2	-

	Reagents Added, grams per tonne					Time, minutes			
	$Ca(OH)_2$	$CuSO_4$	A317	M2030	DF250	Grind	Cond	Froth	pH
Zn Circuit:									
Condition	800	-	-	-	-	-	5	-	-
Condition	-	1000	-	-	-	-	5	-	-
Zn Scalp 1	-	-	40	10	10	-	-	-	11.5
Zn Scalp 2	-	-	5	7.5	5	-	-	-	-
Zn Scalp Regrind	500	500	-	-	-	30	-	-	-
Pb Rougher Tail for Zn Prefloat.									
Condition	750	-	-	-	-	-	5	-	-
Condition	-	800	-	-	-	-	5	-	11.4
Zn Prefloat	-	-	25	10	10	-	-	4	-
	-	-	5	7.5	-	-	1	-	-
Combine reground Zn Scalp Conc + Zn Prefloat Conc for cleaning.									
H.I. Conditioning	250	-	25	10	5	-	15	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	4	11.3
	-	-	-	5	-	-	1	0.5	-
Zn 2nd Cleaner	250	-	-	-	-	-	1	5	11.3
Zn 3rd Cleaner	250	-	-	-	-	-	1	3.5	11.5

Test No. F-13

Product	Weight g	Weight %	Assays,% Pb	Assays,% Zn	% Distribution Pb	% Distribution Zn
1. Pb Cl. Conc.	50.4	2.63	63.3	2.42	73.2	0.8
2. Pb 3rd Cl. Tail	13.5	0.70	15.1	9.11	4.7	0.8
3. Pb 2nd Cl. Tail	32.0	1.67	6.01	12.1	4.4	2.6
4. Pb 1st Cl. Tail	102.6	5.34	2.28	14.8	5.4	10.2
5. Zn 3rd Cl Conc	233.1	12.14	0.74	50.7	4.0	79.3
6. Zn 3rd Cl Tail	24.7	1.29	1.25	7.64	0.7	1.3
7. Zn 2nd Cl Tail	55.9	2.91	0.99	3.96	1.3	1.5
8. Zn 1st Cl Tail	238.4	12.42	0.54	0.88	3.0	1.4
9. Zn Prefloat Tail	170.1	8.86	0.58	0.66	2.3	0.8
10. Zn Scalp Tail	999.1	52.04	0.052	0.2	1.2	1.3
Head Calc.	1919.8	100.00	2.27	7.76	100.0	100.0

Combined Products

Products 1+2	3.33	53.1	3.83	77.9	1.6
Products 1-3	5.00	37.4	6.59	82.3	4.2
Products 1-4	10.34	19.2	10.83	87.7	14.4
Products 5+6	13.43	0.79	46.6	4.7	80.6
Products 5-7	16.34	0.82	39.0	5.9	82.1
Products 5-8	28.76	0.70	22.5	8.9	83.5
Products 9+10	60.90	0.13	0.27	3.5	2.1

CONCENTRATE ANALYSES:

Element		Assays %			
		PP-16 Pb Conc	PP-16 Zn Conc	PP-17 Pb Conc	PP-17 Zn Conc
Lead	Pb	70.2	1.24	74.7	2.84
Zinc	Zn	3.48	54.8	5.10	53.3
Copper	Cu	0.016	0.079	0.007	0.065
Iron	Fe	4.55	5.87	2.20	6.00
Nickel	Ni	<0.002	<0.002	<0.002	0.002
Bismuth	Bi	<0.002	<0.002	<0.002	<0.002
Cadmium	Cd	0.025	0.33	0.047	0.34
Cobalt	Co	<0.002	<0.002	<0.002	<0.002
Chromium	Cr	<0.002	<0.002	<0.002	<0.002
Arsenic	As	<0.001	<0.001	<0.001	<0.001
Antimony	Sb	0.008	<0.002	0.011	<0.002
Tin	Sn	<0.001	<0.001	<0.001	<0.001
Gallium	Ga	0.0001	0.0003	<0.0001	0.0003
Germanium	Ge	<0.0010	0.0043	<0.0010	0.0107
Indium	In	<0.002	<0.002	<0.002	<0.002
Manganese	Mn	0.003	0.024	0.003	0.035
Mercury	Hg	0.0010	0.013	0.0013	0.0058
Molybdenum	Mo	<0.002	<0.002	<0.002	<0.002
Thallium	Tl	0.005	0.010	0.004	0.007
Thorium	Th	<0.001	<0.001	<0.001	<0.001
Selenium	Se	<0.0003	<0.0003	0.0004	<0.0003
Tellurium	Te	<0.0003	0.0014	<0.0003	0.0006
Uranium	U	<0.001	<0.001	<0.001	<0.001
Gold	Au g/t	0.13	<0.02	0.05	0.03
Silver	Ag g/t	171	166	263	157
Titanium	TiO_2	<0.10	<0.10	<0.10	<0.10
Silicon	SiO_2	0.49	0.64	<0.20	0.94
Aluminum	Al_2O_3	<0.10	<0.10	<0.10	0.13
Calcium	CaO	0.03	0.08	0.07	0.10
Magnesium	MgO	<0.01	<0.01	<0.01	<0.01
Sodium	Na_2O	0.002	0.005	<0.002	0.003
Potassium	K_2O	0.013	0.012	<0.002	0.009
Fluorine	F	<0.01	0.02	0.04	0.03
Chlorine	Cl	0.0081	0.013	0.0038	0.014
Sulphur	S	18.2	35.6	16.9	34.2
Phosphorus	P	0.0064	0.0029	0.0015	0.0048
Carbon	C	1.29	0.28	0.20	0.44
Insoluble		0.70	2.36	0.13	2.47
L.O.I. (1000°C)		10.3	18.4	8.64	18.5
	Total	98.3	99.0	99.3	98.4