

A Pilot Plant Investigation of

THE RECOVERY OF LEAD AND ZINC

from Cyprus Anvil samples

submitted by

004032

CYPRUS ANVIL MINING CORPORATION

Progress Report No. 6 (Volume II)

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NOTE:

This report refers to the samples as received.

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DETAILS OF TESTS

Test No. PP-1

1. Grinding

1.1. Purpose:

A preliminary test to evaluate the steel ball load in the mill and the cyclone size. The grind was to be 60% minus 200 mesh.

1.2. Method:

The minus 12.7 mm ore was ground in a 1219 mm x 914 mm Hendy ball mill containing 544.2 kg steel balls. The mill discharge was classified in a P-50 Dorr cyclone. The cyclone underflow was returned to the mill and the overflow was pumped to the lead conditioner. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 435.6 kilograms per hour. Samples were taken every 20 minutes in the last two hours of operation.

1.2.1. Flowsheet Equipment

Ore bin, Merrick weightometer, feed conveyor, 1219 mm x 914 mm Hendy mill, Linatex pump, P-50 Dorr cyclone.

1.2.2. Classification Equipment

Primary Grind

Hendy mill:	P-50 Dorr Cyclone	50.8 mm diameter
		15.9 mm vortex
		12.7 mm apex

Lead Concentrate Regrind

Hardinge Conical Mill:	Krebs Cyclone	25 mm diameter
		12.7 mm vortex
		3.2 mm apex

Zinc Concentrate Regrind

Denver Mill:	Dorr Cyclone	25 mm diameter
		6.35 mm vortex
		3.2 mm apex

1.2.3. Mill Load

<u>Hendy Mill:</u>	362.8 kg	76.2 mm steel balls
	181.4 kg	50.8 mm steel balls
	0.0 kg	25.4 mm steel balls

Total	544.2 kg
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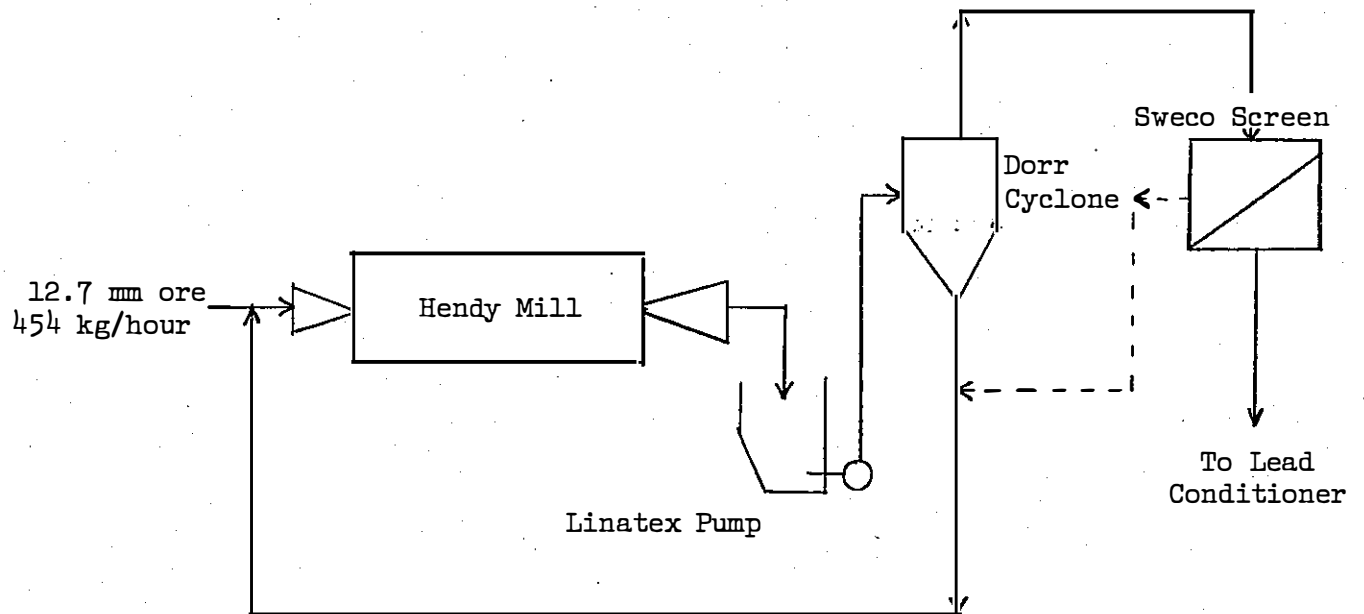
<u>Hardinge Mill:</u>	90.7 kg	50.8 mm steel balls
	90.7 kg	25.4 mm steel balls

	181.4 kg
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<u>Denver Mill:</u>	113.4 kg	25.4 mm steel balls
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Test No. PP-1 - Continued

1.3. Flowsheet:



Test No. PP-1 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed: Minus 12.7 mm ore at 1.0 percent moisture content

Feed Rate: 435.6 dry kilograms per hour

Mill Speed: 32 r.p.m., 80.5 percent of critical speed

Mill Load: 76.2 mm balls 362.8 kilograms
 50.8 mm balls 181.4 kilograms
 Total 544.2 kilograms

Operating Time: Total 7.5 hours, test period 2 hours

Mill Feed: Total 3267 kilograms, test period 871 kilograms

Circulating Load: Cyclone underflow: 527.7 percent
 Sweco oversize: 197.2 percent
 Total 724.9 percent

Pulp Densities:	gpl	% Solids
Mill Discharge	2170	71
Cyclone Overflow	1387	37
Cyclone Underflow	2833	84

Average Power: Gross 5.70 kilowatts
 No Load 1.93 kilowatts
 Net 3.77 kilowatts

Net Power Consumption: 8.66 kilowatt-hours per tonne of 12.7 mm feed

Work Index: 10.45

Cyclone Overflow K₈₀: 107.6 micrometers

1.4.1.1. Classification Data

Grinding Mill: Hendy

Cyclone: P-50 Dorr 50.8 mm diameter
 15.9 mm vortex
 12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recircu- lating Load, %
		400 Mesh	200 Mesh	gpl	% Solids	
Cyclone Feed	3594	13.6	29.8	2077	68	-
Cyclone Overflow	1295	44.2	64.6	1387	37	-
Cyclone Underflow	2299	7.6	22.9	2833	84	724.9

Test No. PP-1 - Continued

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical.
 Regrind Feed: Pb rougher concentrate plus Pb 1st cleaner scavenger concentrate.
 Mill Speed: 30 r.p.m., 65 percent of critical speed
 Mill Load: 50 mm balls 90.7 kilograms
 25 mm balls 90.7 kilograms
 Total 181.4 kilograms

Average Power: Not calculated

1.4.2.1. Classification Data

Cyclone Krebs: 25 mm diameter
 12.7 mm vortex
 3.2 mm apex

Product	Density	
	gpl	% Solids
Mill Discharge	1360	33

1.4.3. Zinc Regrind Mill Report

Regrind Mill: Denver
 Regrind Feed: Zn Rougher concentrate plus Zn 1st cleaner scavenger concentrate
 Mill Speed: 58 r.p.m., 70 percent of critical speed
 Mill Load: 25 mm balls 113.4 kg

1.4.3.1. Classification Data

Cyclone: Dorr 25 mm diameter
 6.35 mm vortex
 3.2 mm apex

Product	Density	
	gpl	% Solids
Mill Discharge	1380	36

Test No. PP-1 - Continued

1.4.4. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8 inch	1.6	1.6	98.4
3 mesh	13.7	15.3	84.7
4	9.5	24.8	75.2
6	9.1	33.9	66.1
8	7.2	41.1	58.9
10	5.4	46.5	53.5
14	5.6	52.1	47.9
20	5.0	57.1	42.9
28	7.4	64.5	35.5
35	6.8	71.3	28.7
48	6.3	77.6	22.4
65	4.3	81.9	18.1
100	3.6	85.5	14.5
- 100	14.5	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.3	0.6	99.4
28	0.8	1.4	98.6
35	1.8	3.2	96.8
48	4.9	8.1	91.9
65	9.5	17.6	82.4
100	16.2	33.8	66.2
150	17.8	51.6	48.4
200	18.6	70.2	29.8
270	8.3	78.5	21.5
400	7.9	86.4	13.6
- 400	13.6	100.0	-
Total	100.0	-	-

Test No. PP-1 - Continued

1.4.4. Screen Analyses:

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.1	0.1	99.9
10	0.1	0.2	99.8
14	0.4	0.6	99.4
20	0.5	1.1	98.9
28	1.1	2.2	97.8
35	2.0	4.2	95.8
48	5.5	9.7	90.3
65	12.4	22.1	77.9
100	18.0	40.1	59.9
150	19.8	59.9	40.1
200	17.2	77.1	22.9
270	10.8	87.9	12.1
400	4.5	92.4	7.6
- 400	7.6	100.0	-
Total	100.0	-	-

Hendy Cyclone Overflow

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.5	1.2	98.8
48	1.4	2.6	97.4
65	2.7	5.3	94.7
100	6.4	11.7	88.3
150	9.7	21.4	78.6
200	14.0	35.4	64.6
270	8.7	44.1	55.9
400	11.7	55.8	44.2
- 400	44.2	100.0	-
Total	100.0	-	-

Specific Gravity = 4.17

Test No. PP-1 - Continued

1.4.4. Screen Analyses:

Pb 3rd Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 22.8 μ m	11.8	11.8	88.2
17.7	8.7	20.5	79.5
12.3	11.0	31.5	68.5
8.5	10.2	41.7	58.3
6.5	9.8	51.5	48.5
- 6.5	48.5	100.0	-
Total	100.0	-	-

Specific Gravity = 5.68

Zn 4th Cleaner Concentrate

+ 28.6 μ m	4.2	4.2	95.8
22.1	6.0	10.2	89.8
15.5	15.2	25.4	74.6
10.6	19.2	44.6	55.4
8.2	12.3	56.9	43.1
- 8.2	43.1	100.0	-
Total	100.0	-	-

Specific Gravity = 3.99

Test No. PP-1 - Continued

2. Flotation

2.1. Purpose:

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

2.2. Method:

The flotation circuit consisted of a lead flotation circuit, followed by a zinc flotation circuit. The flotation feed was conditioned, and lead rougher and scavenger concentrates were floated with A-343 and R-242 in a soda ash circuit. The lead concentrate was reground in a Hardinge conical mill, with soda ash and cyanide and cleaned three times with additions of cyanide in open circuit cleaning. The lead 1st cleaner tailing was scavenged. The scavenger concentrate was returned to the lead rougher feed, and the tailing was fed to the zinc circuit. The lead combined tailing was conditioned with lime and CuSO_4 , and zinc rougher and scavenger concentrates were floated with collector Z-11 and frother MIBC. The zinc rougher concentrate was reground in the small Denver mill with additions of CuSO_4 and lime and was cleaned four times in open circuit cleaning. The circuit was operated for a period of 7.5 hours. Grab samples were taken at the end of the test run.

2.2.1. Flotation Equipment

Lead Circuit

Conditioner:	95 & Denver
Pb Rougher:	4 Denver No. 8 cells
Pb Scavenger:	6 Wemco No. 6 cells
Pb 1st Cleaner:	3 Denver No. 5 cells
Pb 1st Cleaner Scav.:	6 Denver No. 5 cells
Pb 2nd Cleaner:	2 Denver No. 5 cells
Pb 3rd Cleaner:	1 Denver No. 5 cell

Zinc Circuit

Conditioner:	227 & Denver Conditioner
Zn Rougher:	4 Denver No. 8 cells
Zn Scavenger:	4 Denver No. 8 cells
Zn 1st Cleaner:	3 Denver No. 7 cells
Zn 1st Cleaner Scav.:	3 Denver No. 7 cells
Zn 2nd Cleaner:	2 Denver No. 7 cells
Zn 3rd Cleaner:	1 Denver No. 7 cell
Zn 4th Cleaner:	1 Denver No. 7 cell

Test No. PP-1 - Continued

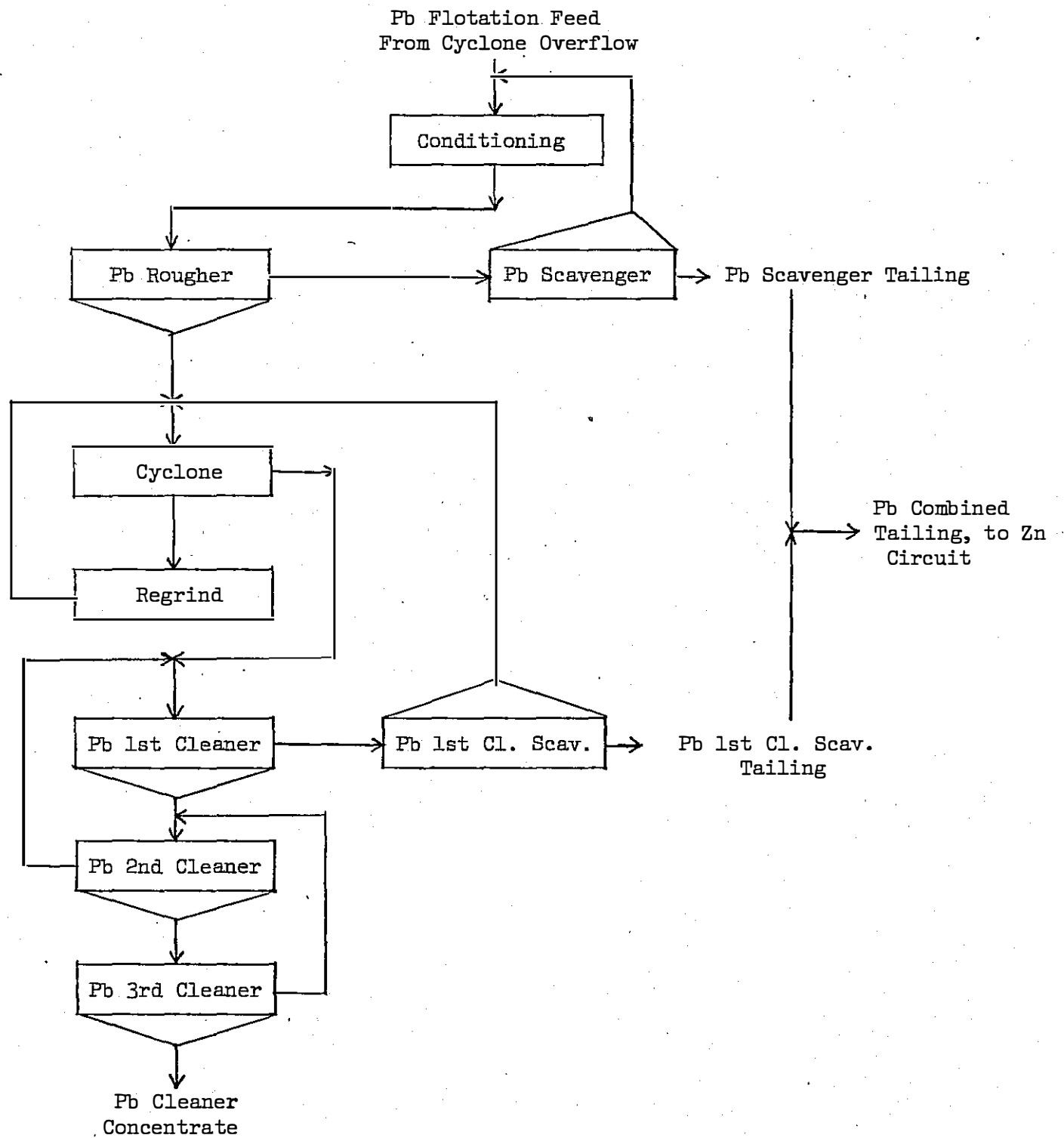
2.2.2. Flotation Reagents

Type	Rate, g/tonne	Circuit	Point of Addition
Na ₂ CO ₃	1350	Lead	Hendy Mill
NaCN	132	Lead	Hendy Mill
A-343	16.8	Lead	Pb Conditioner
R-242	5.65	Lead	Pb Conditioner
MIBC	56.9	Lead	Pb Rougher Feed
A-343	13.5	Lead	Pb Scavenger Feed
R-242	18.7	Lead	Pb Scavenger Feed
Na ₂ CO ₃	756	Lead	Pb Regrind Feed
NaCN	54.4	Lead	Pb Regrind Feed
R-242	9.78	Lead	Pb 1st Cl. Scav. Feed
Ca(OH) ₂	1198	Zinc	Zn Conditioner Feed
CuSO ₄	413	Zinc	Zn Conditioner
A-343	56.1	Zinc	Zn Rougher Feed
MIBC	125	Zinc	Zn Rougher Feed
A-343	13.8	Zinc	Zn Scavenger Feed
MIBC	33.5	Zinc	Zn Scavenger Feed
Ca(OH) ₂	1719	Zinc	Zn Regrind
Z-200	18.3	Zinc	Zn 1st Cleaner
A-343	8.95	Zinc	Zn 1st Cleaner Scav.
MIBC	53.2	Zinc	Zn 1st Cleaner Scav.

Test No. PP-1 - Continued

2.3. Flowsheet

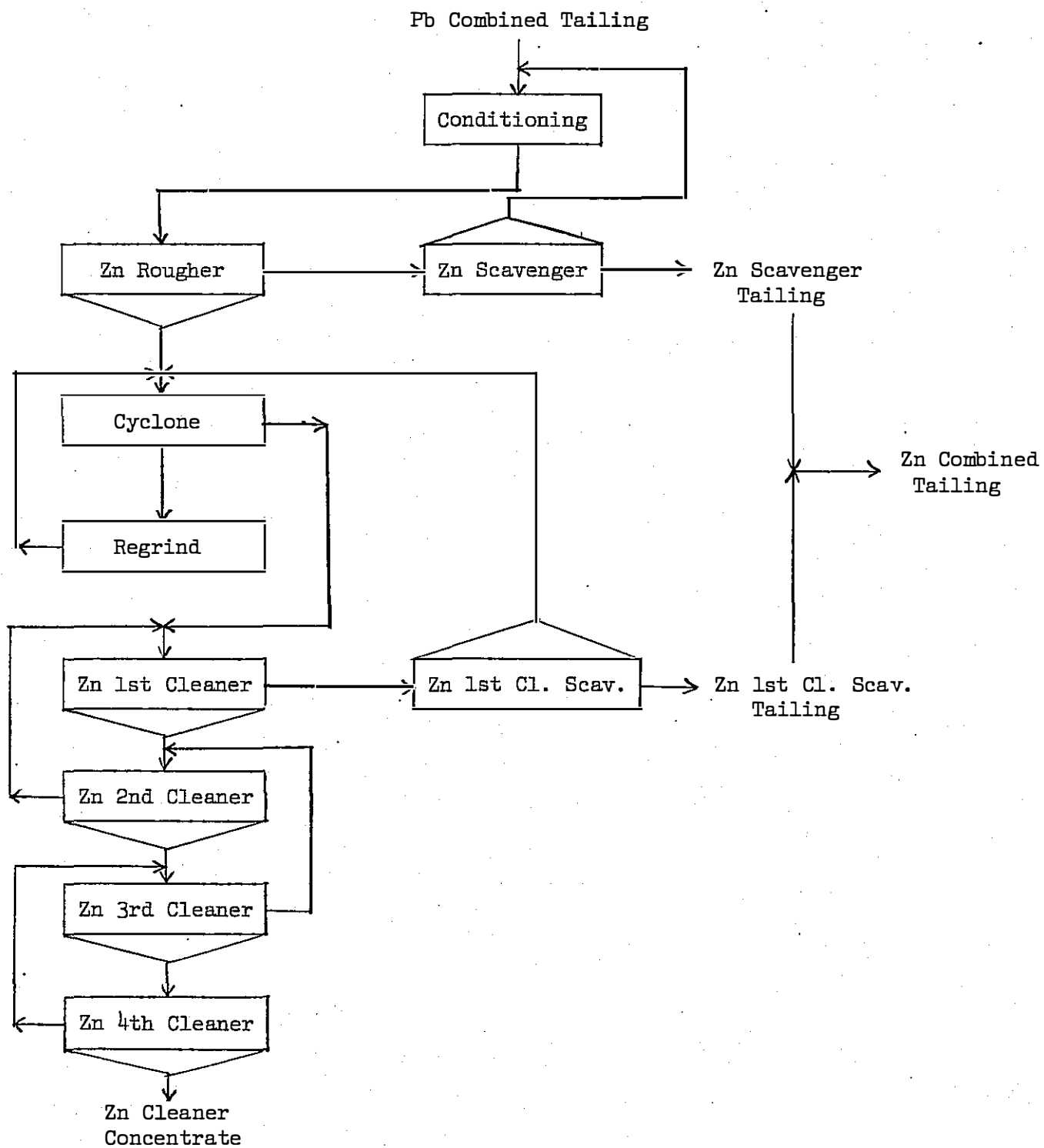
(a) Lead Circuit



Test No. PP-1 - Continued

2.3. Flowsheet:

(b) Zinc Circuit



Test No. PP-1 - Continued

2.4. Results:

2.4.1. Observations: The circuit stabilized at the last one hour of operation.
Final flotation products were sampled.

2.4.2. pH and Pulp Density

Product	Pulp Density, gpl	pH
Pb Rougher Feed	1300	9.6
Pb Scavenger Tailing	1340	9.5
Pb 1st Cleaner	-	10.8
Pb 1st Cl. Scav. Tail.	1020	-
Pb Combined Tailing	1270	-
Pb 2nd Cleaner	-	10.2
Pb 3rd Cleaner	-	9.7
Zn Rougher	-	10.6
Zn Scavenger Tailing	1230	10.5
Zn 1st Cleaner	-	12.1
Zn 1st Cl. Scav. Tail.	1030	-
Zn Combined Tailing	1200	-
Zn 2nd Cleaner	-	11.6
Zn 3rd Cleaner	-	10.3
Zn 4th Cleaner	-	9.7

2.4.3. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Hendy Cyclone Overflow	2.27	3.94
Pb Combined Tailing	0.67	3.92
Pb 1st Cleaner Scav. Tailing	13.7	7.63
Pb 3rd Cleaner Concentrate	68.2	2.18
Zn 1st Cl. Scavenger Tailing	3.79	5.54
Zn 4th Cleaner Concentrate	0.67	53.6
Zn Combined Tailing	0.70	1.06

Test No. PP-1 - Continued

2.4.4. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb 3rd Cleaner Concentrate	2.33	68.2	2.18	70.0	1.3
Zn 4th Cleaner Concentrate	5.43	0.67	53.6	1.6	73.9
Zn Combined Tailing	92.24	0.70	1.06	28.4	24.8
Cyclone Overflow	100.00	2.27	3.94	100.0	100.0

Test No. PP-2

1. Grinding

1.1. Purpose:

To repeat conditions of test PP-1, but replace 50 mesh Sweco screen with 35 mesh screen.

1.2. Method:

Similar to test PP-1, except that 50 mesh Sweco screen deck was replaced with 35 mesh deck. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 433.6 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.

1.3. Flowsheet:

As for test PP-1.

1.4. Results:

1.4.1. Observations:

The circuit was stable during the test run, except that the amount of Sweco oversize product was high during the test run. The power in the regrinding mills was not calculated.

1.4.2. Ball Mill Report

Feed:	Minus 12.7 mm ore at 1.0 percent moisture content	
Feed Rate:	433.6 dry kilograms per hour	
Mill Speed:	32 r.p.m., 80.5 percent of critical speed	
Mill Load:	76.2 mm balls	362.8 kilograms
	50.8 mm balls	181.4 kilograms
	Total	544.2 kilograms
Operating Time:	Total 7.5 hours, test period 2 hours	
Mill Feed:	Total 3252 kilograms, test period 867 kilograms	
Circulating Load:	Cyclone Underflow:	522.0 percent
	Sweco Oversize:	95.1 percent
	Total:	617.1 percent
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2180 71
	Cyclone Overflow	1402 38
	Cyclone Underflow	2828 84
Average Power:	Gross	5.82 kilowatts
	No Load	1.93 kilowatts
	Net	3.89 kilowatts
Net Power Consumption:	8.93 kilowatt-hours per tonne of 12.7 mm feed	
Work Index:	10.26	
Cyclone Overflow K ₈₀ :	104 micrometers	

Test No. PP-2 - Continued

1.4.2.1. Classification Data

Grinding Mill: Hendy.
Cyclone: P-50 Dorr 50.8 mm diameter
15.9 mm vortex
12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recirculating Load, %
		400 Mesh	200 Mesh	gpl	% Solids	
Cyclone Feed	3110	8.2	24.0	2072	68	-
Cyclone Overflow	846	45.0	66.9	1402	38	-
Cyclone Underflow	2264	14.1	31.3	2828	84	617.1

1.4.3. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical
Regrind Feed: Pb rougher concentrate plus Pb 1st cleaner scavenger concentrate
Feed Rate: 19.86 calculated kilograms per hour of concentrate
Mill Speed: 30 r.p.m., 65 percent of critical speed
Mill Load: 50 mm balls 90.7 kilograms
25 mm balls 90.7 kilograms
Total 181.4 kilograms
Average Power: not calculated

1.4.3.1. Classification Data

Cyclone: Krebs: 25 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 Mesh	20 μ m	gpl	% Solids
Regrind Feed	-	66.7	45.0	-	-
Mill Discharge	-	78.7	44.3	-	-
Cyclone Overflow	19.9	-	82.1	1070	8
Cyclone Underflow	-	70.5	40.2	1760	55

Test No. PP-2 - Continued

1.4.4. Zinc Regrind Mill Report

Regrind Mill: Denver
 Regrind Feed: Zn rougher concentrate + Zn 1st cleaner scavenger concentrate
 Feed Rate: 29.0 calculated kilograms per hour of concentrate
 Mill Speed: 58 r.p.m., 70 percent of critical speed
 Mill Load: 25 mm balls 113.4 kg
 Average Power: not calculated

1.4.4.1. Classification Data

Cyclone: Dorr 25 mm diameter
 6.35 mm vortex
 3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	gpl	% Solids
Regrind Feed	29.0	58.0	39	-	-
Cyclone Overflow	-	-	71	1150	17
Cyclone Underflow	-	54.7	20	1825	59
Mill Discharge	-	71.5	36	-	-

Test No. PP-2 - Continued

1.4.5. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8 inch	11.5	11.5	88.5
3 mesh	14.8	26.3	73.7
4	7.8	34.1	65.9
6	7.8	41.9	58.1
8	6.7	48.6	51.4
10	6.6	55.2	44.8
14	5.4	60.6	39.4
20	4.7	65.3	34.7
28	6.2	71.5	28.5
35	5.6	77.1	22.9
48	5.1	82.2	17.8
65	3.5	85.7	14.3
100	2.8	88.5	11.5
- 100	11.5	100.0	-
Total	100.0	-	-

Mill Discharge

+ 8	0.1	0.1	99.9
10	0.2	0.3	99.7
14	0.3	0.6	99.4
20	0.4	1.0	99.0
28	1.0	2.0	98.0
35	2.0	4.0	96.0
48	5.6	9.6	90.4
65	12.0	21.6	78.4
100	17.7	39.3	60.7
150	19.8	59.1	40.9
200	16.9	76.0	24.0
270	10.7	86.7	13.3
400	4.9	91.6	8.4
- 400	8.4	100.0	-
Total	100.0	-	-

Test No. PP-2 - Continued

1.4.5. Screen Analyses:

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.3	0.5	99.5
28	0.8	1.3	98.7
35	1.4	2.7	97.3
48	4.5	7.2	92.8
65	10.5	17.7	82.3
100	15.9	33.6	66.4
150	18.5	52.1	47.9
200	16.6	68.7	31.3
270	11.4	80.1	19.9
400	5.8	85.9	14.1
- 400	14.1	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 48	2.1	2.1	97.9
65	2.7	4.8	95.2
100	5.7	10.5	89.5
150	8.5	19.0	81.0
200	14.1	33.1	66.9
270	9.2	42.3	57.7
400	12.7	55.0	45.0
- 400	45.0	100.0	-
Total	100.0	-	-

Pb Rougher Concentrate

+ 65 mesh	1.2	1.2	98.8
100	3.1	4.3	96.7
150	3.2	7.5	92.5
200	5.9	13.4	86.6
270	7.1	20.5	79.5
400	12.8	33.3	66.7
25.3 μ m	12.4	45.7	54.3
19.6	9.3	55.0	45.0
13.7	10.4	65.4	34.6
9.4	8.6	74.0	26.0
7.3	5.3	79.3	20.7
- 7.3	20.7	100.0	-
Total	100.0	-	-

Test No. PP-2 - Continued

1.4.5. Screen Analyses:

Pb Rougher Concentrate - Specific Gravity = 4.88

Pb Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.2	0.2	99.8
100	0.6	0.8	99.2
150	1.1	1.9	98.1
200	2.8	4.7	95.3
270	5.0	9.7	90.3
400	11.6	21.3	78.7
25.5 μ m	18.6	39.9	60.1
19.8	15.8	55.7	44.3
13.8	18.9	74.6	25.4
9.5	12.6	87.2	12.8
7.3	3.8	91.0	9.0
- 7.3	9.0	100.0	-
Total	100.0	-	-

Specific Gravity = 4.79

Pb Regrind Cyclone Underflow

+ 65 mesh	0.3	0.3	99.7
100	0.5	0.8	99.2
150	1.8	2.6	97.4
200	3.8	6.4	93.6
270	6.6	13.0	87.0
400	16.5	29.5	70.5
25.4 μ m	15.1	44.6	55.4
19.7	15.2	59.8	40.2
13.7	18.3	78.1	21.9
9.4	11.3	89.4	10.6
7.3	3.2	92.6	7.4
- 7.3	7.4	100.0	-
Total	100.0	-	-

Specific Gravity = 4.78

Test No. PP-2 - Continued

1.4.5. Screen Analyses:

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 25.6 μ m	10.5	10.5	89.5
19.9	7.4	17.9	82.1
13.9	12.5	30.4	69.6
9.5	22.2	52.6	47.4
7.4	12.6	65.2	34.8
- 7.4	34.8	100.0	-
Total	100.0	-	-

Specific Gravity = 4.81

Zn Rougher Concentrate

+ 65 mesh	1.1	1.1	98.9
100	3.6	4.7	95.3
150	6.4	11.1	88.9
200	9.2	20.3	79.7
270	9.2	29.5	70.5
400	12.5	42.0	58.0
28.4 μ m	6.0	48.0	52.0
22.1	9.7	57.7	42.3
15.4	10.6	68.3	31.7
10.6	8.0	76.3	23.7
8.2	4.7	81.0	19.0
- 8.2	19.0	100.0	-
Total	100.0	-	-

Specific Gravity = 4.11

Zn Regrind Discharge

+ 100 mesh	0.3	0.3	99.7
150	0.9	1.2	98.8
200	3.0	4.2	95.8
270	6.2	10.4	89.6
400	18.1	28.5	71.5
28.3 μ m	12.8	41.3	58.7
21.9	18.8	60.1	39.9
15.3	13.6	73.7	26.3
10.5	7.7	81.4	18.6
8.1	4.0	85.4	14.6
- 8.1	14.6	100.0	-
Total	100.0	-	-

Specific Gravity = 4.12

Test No. PP-2 - Continued

1.4.5. Screen Analyses:

Zn Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.3	0.3	99.7
100	2.7	3.0	97.0
150	4.7	7.7	92.3
200	7.6	15.3	84.7
270	10.3	25.6	74.4
400	19.7	45.3	54.7
28.2 μ m	13.8	59.1	40.9
21.9	17.9	77.0	23.0
15.3	9.6	86.6	13.4
10.5	3.8	90.4	9.6
8.1	1.7	92.1	7.9
- 8.1	7.9	100.0	-
Total	100.0	-	-

Specific Gravity = 4.08

Zn Cyclone Overflow

+ 28.7 μ m	7.8	7.8	92.2
22.3	14.9	22.7	77.3
15.5	21.6	44.3	55.7
10.7	16.1	60.4	39.6
8.3	9.0	69.4	30.6
- 8.3	30.6	100.0	-
Total	100.0	-	-

Specific Gravity = 4.00

Test No. PP-2 - Continued

2. Flotation

2.1. Purpose: To adjust the reagent additions in the lead and zinc flotation circuits.

2.2. Method: The following changes were made in the lead and zinc flotation circuits:

a) Lead Circuit

1. Increased soda ash and NaCN to the Hendy mill feed.
2. Added collector Z-11 to the lead regrind and to the lead 1st cleaner scavenger feed.

b) Zinc Circuit

1. Added CuSO_4 to the zinc regrind mill.
2. Added frother A-1210 to the zinc flotation. This frother was replaced with MIBC due to voluminous froth in the zinc cleaning.

The circuit was operated for a period of 7.5 hours and sampled every 30 minutes in the last 2 hours of operation .

2.2.1. Flotation Equipment: As for test PP-1.

2.2.2. Flotation Reagents:

Type	Rate, g/tonne	Circuit	Point of Addition
Na_2CO_3	5347	Lead	Hendy Mill
NaCN	185	Lead	Hendy Mill
A-343	16.2	Lead	Pb Conditioner
R-242	5.2	Lead	Pb Conditioner
MIBC	58.9	Lead	Pb Rougher Feed
A-343	13.8	Lead	Pb Scavenger Feed
R-242	20.9	Lead	Pb Scavenger Feed
Na_2CO_3	803	Lead	Pb Regrind Feed
NaCN	52.9	Lead	Pb Regrind Feed
A-343	5.88	Lead	Pb Regrind Mill
A-343	7.33	Lead	Pb 1st Cleaner Scav. Feed
R-242	7.06	Lead	Pb 1st Cleaner Scav. Feed
$\text{Ca}(\text{OH})_2$	1695	Zinc	Zn Conditioner Feed
CuSO_4	554	Zinc	Zn Conditioner
A-343	55.4	Zinc	Zn Rougher Feed
MIBC	140.6	Zinc	Zn Rougher Feed
A-343	17.4	Zinc	Zn Scavenger Feed
Z-200	15.3	Zinc	Zn Scavenger Feed
MIBC	54.8	Zinc	Zn Scavenger Feed
$\text{Ca}(\text{OH})_2$	1674	Zinc	Zn Regrind
CuSO_4	110.7	Zinc	Zn Regrind
A-343	8.37	Zinc	Zn 1st Cleaner Scavenger
Z-200	9.20	Zinc	Zn 1st Cleaner Scavenger
MIBC	130	Zinc	Zn 1st Cleaner Scavenger

Test No. PP-2 - Continued

2.3. Flowsheet: As for test PP-1.

2.4. Results:

2.4.1. Observations: The lead flotation circuit was stable during the test run. The addition of frother A-1210 to the zinc circuit resulted in a voluminous froth in the zinc cleaning and was replaced with MIBC.

2.4.2. pH and Pulp Density

Product	Pulp Density, g/l	pH
Pb Rougher Feed	1350	9.0
Pb Scavenger Tailing	1365	9.0
Pb 1st Cleaner	-	10.3
Pb 1st Cleaner Scav. Tail.	1030	10.2
Pb Combined Tailing	1295	-
Pb 2nd Cleaner	-	10.0
Pb 3rd Cleaner	-	9.3
Zn Rougher Feed	1230	10.5
Zn Scavenger Tailing	1225	10.4
Zn 1st Cleaner	-	11.9
Zn 1st Cleaner Scav. Tail.	1035	11.8
Zn Combined Tailing	1080	-
Zn 2nd Cleaner	-	11.3
Zn 3rd Cleaner	-	9.8
Zn 4th Cleaner	-	9.5

2.4.3. Pulp Temperature

Product	Temperature, °C
Pb Rougher	27
Zn Rougher	25

Test No. PP-2 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Hendy Cyclone Overflow	2.44	3.84
Pb Rougher Concentrate	39.1	6.89
Pb Rougher Tailing	0.99	3.84
Pb Scavenger Concentrate	6.43	7.88
Pb Scavenger Tailing	0.65	3.70
Pb Combined Tailing	0.68	3.68
Pb 1st Cleaner Concentrate	52.8	5.45
Pb 1st Cleaner Tailing	6.31	10.5
Pb 1st Cleaner Scav. Conc.	8.78	10.9
Pb 1st Cleaner Scav. Tailing	5.19	10.2
Pb 2nd Cleaner Concentrate	59.3	4.78
Pb 3rd Cleaner Concentrate	60.8	4.25
Zn Rougher Feed	0.75	4.54
Zn Rougher Concentrate	1.40	43.1
Zn Scavenger Concentrate	2.17	20.0
Zn Scavenger Tailing	0.61	0.75
Zn 1st Cleaner Concentrate	0.99	49.4
Zn 1st Cleaner Tailing	3.74	7.68
Zn 1st Cleaner Scav. Conc.	5.76	21.9
Zn 1st Cleaner Scav. Tailing	2.47	1.76
Zn 2nd Cleaner Concentrate	0.76	52.4
Zn 3rd Cleaner Concentrate	0.60	53.9
Zn 4th Cleaner Concentrate	0.65	51.9
Zn Combined Tailing	0.66	0.76

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb 3rd Cleaner Concentrate	2.97	60.8	4.25	73.9	3.3
Zn 3rd Cleaner Concentrate	5.60	0.60	53.9	1.4	78.6
Zn Combined Tailing	91.43	0.66	0.76	24.7	18.1
Cyclone Overflow	100.00	2.44	3.84	100.0	100.0

Test No. PP-2 - Continued

2.4.6. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	4.58	39.1	6.89	73.4	8.2
Pb Combined Tailing	95.42	0.68	3.68	26.6	91.8
Hendy Cyclone Overflow	100.00	2.44	3.84	100.0	100.0
Zn Rougher Concentrate	6.69	1.40	43.1	3.5	80.6
Zn Combined Tailing	90.34	0.66	0.76	22.6	16.1
Pb Combined Tailing	97.03	0.68	3.68	26.1	96.7

Test No. PP-3

1. Grinding

1.1. Purpose:

To produce a finer cyclone overflow product.

1.2. Method:

An additional 544 kilograms of steel balls were added to the Hendy mill. The added steel load distribution was as follows:

76.2 mm balls	=	2.72 kg
50.8 mm balls	=	181.4 kg
25.4 mm balls	=	90.6 kg

The grinding circuit operated for a period of 7.5 hours at a feed rate of 433.8 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.

1.3. Flowsheet:

As for test PP-1.

1.4. Results:

1.4.1. Observations:

The operation of the grinding circuit was stable during the test run.

1.4.2. Ball Mill Report

Feed: Minus 12.7 mm ore at 0.5 percent moisture content

Feed Rate: 433.8 dry kilograms per hour

Mill Speed: 32 r.p.m., 80.5 percent of critical speed

Mill Load:	76.2 mm balls	365.5 kilograms
	50.8 mm balls	362.8 kilograms
	25.4 mm balls	90.6 kilograms
	Total	818.9 kilograms

Operating Time: Total 7.5 hours, test period 2 hours

Mill Feed: Total 3254 kilograms, test period 868 kilograms

Circulating Load: Cyclone underflow 468.4 percent

Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
Mill Discharge	2166	71
Cyclone Overflow	1392	37
Cyclone Underflow	2770	83

Average Power:	Gross	10.45 kilowatts
	No Load	1.93 kilowatts
	Net	8.52 kilowatts

Net Power Consumption: 19.6 kilowatt-hours per tonne of 12.7 mm feed

Work Index: 17.24

Cyclone Overflow K_{80} : 64.3 micrometers

Test No. PP-3 - Continued

1.4.2.1. Classification Data

Grinding Mill: Hendy
Cyclone: P-50 Dorr 50.8 mm diameter
15.9 mm vortex
12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recirculating Load, %
		400 mesh	200 mesh	gpl	% Solids	
Cyclone Feed	2466	23.6	52.4	2078	68	-
Cyclone Overflow	434	60.2	86.8	1392	37	-
Cyclone Underflow	2032	16.0	43.7	2770	83	468.4

1.4.3. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical
Regrind Feed: Pb rougher concentrate + lead 1st cleaner scavenger concentrate
Feed Rate: 26.2 calculated kilograms per hour of concentrate
Mill Speed: 30 r.p.m., 65 percent of critical speed
Mill Load: 50 mm balls 90.7 kilograms
25 mm balls 90.7 kilograms
Total 181.4 kilograms
Average Power: Not calculated

1.4.3.1. Classification Data

Cyclone: Krebs: 25 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	g/l	% Solids
Regrind Feed	-	83.2	58.8	-	-
Mill Discharge	-	77.8	42.2	-	-
Cyclone Overflow	26.2	-	78.0	1070	8
Cyclone Underflow	-	79.4	42.0	1955	64

Test No. PP-3 - Continued

1.4.4. Zinc Regrind Mill Report

Regrind Mill: Denver
Regrind Feed: Zn rougher concentrate + Zn 1st Cl. Scav. Conc.
Feed Rate: 35.1 calculated kilograms per hour of concentrate
Mill Speed: 58 r.p.m., 70 percent of critical speed
Mill Load: 25 mm balls 113.4 kg
Average Power: Not calculated

1.4.4.1. Classification Data

Cyclone: Dorr 25.0 mm diameter
6.35 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	gpl	% Solids
Regrind Feed	35.1	72.0	48	-	-
Cyclone Overflow	-	-	91	1070	8.5
Cyclone Underflow	-	78.1	29	1955	64
Zn Regrind Mill Discharge	-	83.5	34	-	-

Test No. PP-3 - Continued

1.4.5. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8 inch	8.7	8.7	91.3
3 mesh	15.5	24.2	75.8
4	11.1	35.3	64.7
6	6.7	42.0	58.0
8	5.3	47.3	52.7
10	4.9	52.2	47.8
14	4.5	56.7	43.3
20	4.3	61.0	39.0
28	6.0	67.0	33.0
35	5.9	72.9	27.1
48	5.7	78.6	21.4
65	4.3	82.9	17.1
100	3.0	85.9	14.1
- 100	14.1	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.2	0.5	99.5
28	0.5	1.0	99.0
35	0.8	1.8	98.2
48	1.9	3.7	96.3
65	4.1	7.8	92.2
100	7.7	15.5	84.5
150	13.2	28.7	71.3
200	18.9	47.6	52.4
270	18.2	65.8	34.2
400	10.6	76.4	23.6
- 400	23.6	100.0	-
Total	100.0	-	-

Test No. PP-3 - Continued

1.4.5. Screen Analyses:

P-50 Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.1	0.1	99.9
10	0.3	0.4	99.6
14	0.4	0.8	99.2
20	0.4	1.2	98.8
28	0.6	1.8	98.2
35	1.0	2.8	97.2
48	2.3	5.1	94.9
65	4.5	9.6	90.4
100	9.1	18.7	81.3
150	13.9	32.6	67.4
200	23.7	56.3	43.7
270	13.6	69.9	30.1
400	16.0	84.0	16.0
- 400	16.0	100.0	-
Total	100.0	-	-

P-50 Cyclone Overflow

+ 48	0.2	0.2	99.8
65	0.4	0.6	99.4
100	1.4	2.0	98.0
150	3.4	5.4	94.6
200	7.8	13.2	86.8
270	13.4	26.6	73.4
400	13.2	39.8	60.2
- 400	60.2	100.0	-
Total	100.0	-	-

Pb Rougher Concentrate

+ 65 mesh	0.2	0.2	99.8
100	0.4	0.6	99.4
150	0.8	1.4	98.6
200	2.4	3.8	96.2
270	4.4	8.2	91.8
400	8.6	16.8	83.2
+ 26.4 μ m	13.4	30.2	69.8
20.4	11.0	41.2	58.8
14.3	12.8	54.0	46.0
9.8	11.0	65.0	35.0
7.6	6.8	71.8	28.2
- 7.6	28.2	100.0	-
Total	100.0	-	-

Specific Gravity = 4.62

Test No. PP-3 - Continued

1.4.5. Screen Analyses:

Pb Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.2	0.2	99.8
100	0.3	0.5	99.5
150	0.6	1.1	98.9
200	2.3	3.4	96.6
270	5.5	8.9	91.1
400	13.3	22.2	77.8
26.3 μ m	19.6	41.8	58.2
20.4	16.0	57.8	42.2
14.2	18.1	75.9	24.1
9.8	11.6	87.5	12.5
7.6	4.4	91.9	8.1
- 7.6	8.1	100.0	-
Total	100.0	-	-

Specific Gravity = 4.54

Pb Regrind Cyclone Underflow

+ 65 mesh	-	-	100.0
100	0.2	0.2	99.8
150	0.4	0.6	99.4
200	2.1	2.7	97.3
270	5.6	8.3	91.7
400	12.3	20.6	79.4
26.3 μ m	20.9	41.5	58.5
20.4	16.5	58.0	42.0
14.2	18.1	76.1	23.9
9.8	11.4	87.5	12.5
7.6	4.1	91.6	8.4
- 7.6	8.4	100.0	-
Total	100.0	-	-

Specific Gravity = 4.54

Test No. PP-3 - Continued

1.4.5. Screen Analyses:

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 26.1 μ m	14.3	14.3	85.7
20.3	7.7	22.0	78.0
14.1	10.8	32.8	67.2
9.7	13.5	46.3	53.7
7.5	9.8	56.1	43.9
- 7.5	43.9	100.0	-
Total	100.0	-	-

Specific Gravity = 4.69

Zn Rougher Concentrate

+ 65 mesh	0.3	0.3	99.7
100	0.8	1.1	98.9
150	2.0	3.1	96.9
200	5.2	8.3	91.7
270	7.6	15.9	84.1
400	12.1	28.0	72.0
28.5 μ m	8.2	36.2	63.8
22.1	11.3	47.5	52.5
15.4	12.7	60.2	39.8
10.6	10.0	70.2	29.8
8.2	5.7	75.9	24.1
- 8.2	24.1	100.0	-
Total	100.0	-	-

Specific Gravity = 4.12

Zn Regrind Discharge

+ 65 mesh	0.2	0.2	99.8
100	0.2	0.4	99.6
150	0.5	0.9	99.1
200	1.8	2.7	97.3
270	3.6	6.3	93.7
400	10.2	16.5	83.5
28.3 μ m	13.8	30.3	69.7
21.9	23.6	53.9	46.1
15.3	25.8	79.7	20.3
10.5	9.5	89.2	10.8
8.1	2.4	91.6	8.4
- 8.1	8.4	100.0	-
Total	100.0	-	-

Test No. PP-3 - Continued

1.4.5. Screen Analyses:

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.2	0.2	99.8
100	0.6	0.8	99.2
150	1.2	2.0	98.0
200	2.6	4.6	95.4
270	5.2	9.8	90.2
400	12.1	21.9	78.1
28.3 μ m	14.4	36.3	63.7
21.9	24.6	60.9	39.1
15.3	25.0	85.9	14.1
10.5	7.8	93.7	6.3
8.1	1.3	95.0	5.0
- 8.1	5.0	100.0	-
Total	100.0	-	-

Specific Gravity = 4.09

Zn Regrind Cyclone Overflow

+ 29.2 μ m	2.0	2.0	98.0
22.7	3.8	5.8	94.2
15.8	10.7	16.5	83.5
10.9	18.4	34.9	65.1
8.4	13.8	48.7	51.3
- 8.4	51.3	100.0	-
Total	100.0	-	-

Specific Gravity = 3.95

Test No. PP-3 - Continued

2. Flotation

2.1. Purpose: To investigate the effect of finer primary grinding on lead and zinc flotation.

2.2. Method: The fineness of the primary grind was increased from 65% minus 200 mesh to 87% minus 200 mesh. The reagent additions in the lead and zinc flotation were adjusted as follows:

- 1) Increased Na_2CO_3 and NaCN additions to the primary grind.
- 2) Increased Z-11 additions to the regrind mill feed and 1st cleaner scavenger feed.
- 3) Added NaCN to the Pb 2nd cleaner feed.
- 4) Added Z-200 to the zinc rougher feed.

The flotation circuit was operated for a period of 7.5 hours and sampled every 30 minutes in the last 1.5 hours of operation.

2.2.1. Flotation Equipment: As for test PP-1.

2.2.2. Flotation Reagents:

Type	Rate, g/tonne	Circuit	Point of Addition
Na_2CO_3	8963	Lead	Hendy Mill
NaCN	247	Lead	Hendy Mill
A-343	20.9	Lead	Pb Conditioner
R-242	8.1	Lead	Pb Conditioner
MIBC	58.4	Lead	Pb Rougher Feed
A-343	13.8	Lead	Pb Scavenger Feed
R-242	14.0	Lead	Pb Scavenger Feed
Na_2CO_3	726	Lead	Pb Regrind Feed
NaCN	56.0	Lead	Pb Regrind Feed
A-343	11.2	Lead	Pb Regrind Mill
A-343	11.2	Lead	Pb 1st Cleaner Scav. Feed
R-242	13.6	Lead	Pb 1st Cleaner Scav. Feed
NaCN	20.1	Lead	Pb 2nd Cleaner Feed
$\text{Ca}(\text{OH})_2$	1881	Zinc	Zn Conditioner Feed
CuSO_4	622	Zinc	Zn Conditioner
A-343	62.2	Zinc	Zn Rougher Feed
Z-200	13.6	Zinc	Zn Rougher
MIBC	140.6	Zinc	Zn Rougher
A-343	13.8	Zinc	Zn Scavenger Feed
Z-200	25.7	Zinc	Zn Scavenger Feed
MIBC	54.8	Zinc	Zn Scavenger Feed
$\text{Ca}(\text{OH})_2$	1701	Zinc	Zn Regrind
CuSO_4	111.3	Zinc	Zn Regrind
Z-200	19.4	Zinc	Zn 1st Cleaner
A-343	21.2	Zinc	Zn 1st Cleaner Scavenger
MIBC	112	Zinc	Zn 1st Cleaner Scavenger

Test No. PP-3 - Continued

2.3. Flowsheet: As for test PP-1.

2.4. Results:

2.4.1. Observations: The flotation circuit was quite stable during the test run.
Higher additions of collector Z-11 to the lead regrind and cleaner scavenger stages resulted in lower lead final concentrate grade.

2.4.2. pH and Pulp Density

Product	Pulp Density g/l	pH
Pb Rougher Feed	1335	9.6
Pb Scavenger Tailing	1400	9.5
Pb 1st Cleaner	-	10.1
Pb 1st Cleaner Scav. Tailing	1040	10.0
Pb Combined Tailing	1295	-
Pb 2nd Cleaner	-	10.0
Pb 3rd Cleaner	-	9.7
Zn Rougher Feed	1220	10.0
Zn Scavenger Tailing	1215	9.9
Zn 1st Cleaner	-	11.8
Zn 1st Cleaner Scav. Tailing	1010	11.7
Zn Combined Tailing	1145	-
Zn 2nd Cleaner	-	10.9
Zn 3rd Cleaner	-	9.6
Zn 4th Cleaner	-	9.2

2.4.3. Pulp Temperature

Product	Temperature, °C
Pb Rougher	30
Zn Rougher	28

Test No. PP-3 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Hendy Cyclone Overflow	2.33	3.73
Pb Rougher Concentrate	29.8	7.73
Pb Rougher Tailing	0.77	3.85
Pb Scavenger Concentrate	3.72	7.37
Pb Scavenger Tailing	0.56	3.56
Pb Combined Tailing	0.56	3.74
Pb 1st Cleaner Concentrate	54.7	5.18
Pb 1st Cleaner Tailing	7.14	10.5
Pb 1st Cleaner Scav. Conc.	9.58	11.1
Pb 1st Cleaner Scav. Tailing	4.18	9.14
Pb 2nd Cleaner Concentrate	56.8	4.96
Pb 3rd Cleaner Concentrate	59.4	4.43
Zn Rougher Feed	0.64	4.26
Zn Rougher Concentrate	1.05	39.4
Zn Scavenger Concentrate	3.72	7.37
Zn Scavenger Tailing	0.54	0.43
Zn 1st Cleaner Concentrate	0.72	51.5
Zn 1st Cleaner Tailing	2.74	11.4
Zn 1st Cleaner Scav. Conc.	3.85	29.9
Zn 1st Cleaner Scav. Tailing	2.61	3.28
Zn 2nd Cleaner Concentrate	0.54	51.8
Zn 3rd Cleaner Concentrate	0.45	52.6
Zn 4th Cleaner Concentrate	0.43	53.5
Zn Combined Tailing	0.55	0.50

Test No. PP-3 - Continued

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb 3rd Cleaner Concentrate	3.04	59.4	4.43	77.4	3.6
Zn 4th Cleaner Concentrate	5.87	0.43	53.5	1.1	84.2
Zn Combined Tailing	91.09	0.55	0.50	21.5	12.2
Hendy Cyclone Overflow	100.00	2.33	3.73	100.0	100.0

Two-Product Formula

Pb Rougher Concentrate	6.05	29.8	7.73	77.4	11.7
Pb Combined Tailing	93.95	0.56	3.74	22.6	88.3
Hendy Cyclone Overflow	100.00	2.33	3.73	100.0	100.0
Zn Rougher Concentrate	8.08	1.05	39.4	3.3	84.5
Zn Combined Tailing	88.88	0.55	0.50	19.3	11.9
Pb Combined Tailing	96.96	0.56	3.74	22.6	96.4

Test No. PP-4

1. Grinding

1.1. Purpose: To produce a finer cyclone overflow product.

1.2. Method: The following changes were made in the grinding circuit:

- 1) Decreased pulp density to the cyclone overflow.
- 2) Decreased feed rate.

The grinding circuit was operated for a period of 7.5 hours at a feed rate of 405.8 kilograms per hour. Samples were taken every 30 minutes in the last 2 hours of operation.

1.3. Flowsheet: As for test PP-1.

1.4. Results:

1.4.1. Observations: The grinding circuit was stable during the test run.

1.4.2. Ball Mill Report

Feed: Minus 12.7 mm ore at 0.7 percent moisture content

Feed Rate: 405.8 dry kilograms per hour

Mill Speed: 32 r.p.m., 80.5 percent of critical speed

Mill Load:	76.2 mm balls	365.5 kilograms
	50.8 mm balls	362.8 kilograms
	25.4 mm balls	90.6 kilograms
	Total	818.9 kilograms

Operating Time: Total 7.5 hours, test period 3 hours

Mill Feed: Total 3044 kilograms, test period 1217 kilograms

Circulating Load: Cyclone underflow 490.9 percent

Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
Mill Discharge	2043	67
Cyclone Overflow	1257	27
Cyclone Underflow	2749	82

Average Power:	Gross	10.14 kilowatts
	No Load	1.93 kilowatts
	Net	8.21 kilowatts

Net Power Consumption: 20.2 kilowatt-hours per tonne of 12.7 mm feed

Work Index: 14.67

Cyclone Overflow K₈₀: 45.4 micrometers

Test No. PP-4 - Continued

1.4.2.1. Classification Data

Grinding Mill: Hendy
Cyclone: P-50 Dorr 50.8 mm diameter
15.9 mm vortex
12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recircu- lating Load, %
		400 mesh	200 mesh	g/l	% Solids	
Cyclone Feed	2398	23.8	53.6	1943	64	-
Cyclone Overflow	406	71.7	91.6	1257	27	-
Cyclone Underflow	1992	13.6	45.9	2749	82	490.9

1.4.3. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical
Regrind Feed: Pb rougher concentrate + Pb 1st cleaner scavenger concentrate
Feed Rate: 23.1 calculated kilograms per hour of concentrate
Mill Speed: 30 r.p.m., 65 percent of critical speed
Mill Load: 50 mm balls 90.7 kilograms
25 mm balls 90.7 kilograms
Total 181.4 kilograms
Average Power: Not calculated

1.4.3.1. Classification Data

Cyclone: Krebs 25 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	g/l	% Solids
Regrind Feed	-	86.0	60.0	-	-
Mill Discharge	-	76.2	40.5	-	-
Cyclone Overflow	23.1	98.6	83.0	1060	8
Cyclone Underflow	-	76.0	39.5	1880	64

Test No. PP-4 - Continued

1.4.4. Zinc Regrind Mill Report

Regrind Mill: Denver
Regrind Feed: Zinc rougher concentrate + Zn 1st cleaner Scavenger concentrate
Feed Rate: 28.2 calculated kilograms per hour of concentrate
Mill Speed: 58 r.p.m., 70 percent of critical speed
Mill Load: 25 mm balls 113.4 kg
Average Power: Not calculated

1.4.4.1. Classification Data

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	g/l	% Solids
Regrind Feed	28.2	79.1	56.5	-	-
Cyclone Overflow	-	99.6	89.0	1100	12
Cyclone Underflow	-	78.8	28.5	1713	55
Mill Discharge	-	86.3	35.0	-	-

Test No. PP-4 - Continued

1.4.5. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8 inch	12.4	12.4	87.6
3 mesh	14.7	27.1	72.9
4	15.9	43.0	57.0
6	8.7	51.7	48.3
8	5.9	57.6	42.4
10	5.0	62.6	37.4
14	4.0	66.6	33.4
20	4.0	70.6	29.4
28	4.8	75.4	24.6
35	4.1	79.5	20.5
48	4.2	83.7	16.3
65	3.4	87.1	12.9
100	2.2	89.3	10.7
- 100	10.7	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 8	0.1	0.1	99.9
10	0.3	0.4	99.6
14	0.2	0.6	99.4
20	0.2	0.8	99.2
28	0.4	1.2	98.8
35	0.6	1.8	98.2
48	1.5	3.3	96.7
65	3.2	6.5	93.5
100	7.0	13.5	86.5
150	11.5	25.0	75.0
200	21.4	46.4	53.6
270	13.9	60.3	39.7
400	15.9	76.2	23.8
- 400	23.8	100.0	-
Total	100.0	-	-

Test No. PP-4 - Continued

1.4.5. Screen Analyses:

P-50 Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.3	0.3	99.7
10	0.2	0.5	99.5
14	0.3	0.8	99.2
20	0.4	1.2	98.8
28	0.7	1.9	98.1
35	1.0	2.9	97.1
48	2.1	5.0	95.0
65	4.4	9.4	90.6
100	8.4	17.8	82.2
150	14.6	32.4	77.6
200	21.7	54.1	45.9
270	21.0	75.1	24.9
400	11.3	86.4	13.6
- 400	13.6	100.0	-
Total	100.0	-	-

P-50 Cyclone Overflow

+ 48	0.1	0.1	99.9
65	0.2	0.3	99.7
100	0.7	1.0	99.0
150	1.8	2.8	97.2
200	5.6	8.4	91.6
270	6.3	14.7	85.3
400	13.6	28.3	71.7
- 400	71.7	100.0	-
Total	100.0	-	-

Pb Rougher Concentrate

+ 65 mesh	0.3	0.3	99.7
100	0.3	0.6	99.4
150	0.4	1.0	99.0
200	1.6	2.6	97.4
270	3.3	5.9	94.1
400	8.1	14.0	86.0
25.6 μ m	14.0	28.0	72.0
19.9	12.0	40.0	60.0
13.9	13.6	53.6	46.4
9.5	11.2	64.8	35.2
7.4	6.6	71.4	28.6
- 7.4	28.6	100.0	-
Total	100.0	-	-

Specific Gravity = 4.76

Test No. PP-4 - Continued

1.4.5. Screen Analyses:

Pb Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	0.2	0.2	99.8
150	0.2	0.4	99.6
200	2.4	2.8	97.2
270	5.8	8.6	91.4
400	15.2	23.8	76.2
27.5 μ m	16.1	39.9	60.1
21.3	17.5	57.4	42.6
14.9	20.2	77.6	22.4
10.2	11.7	89.3	10.7
7.9	3.4	92.7	7.3
- 7.9	7.3	100.0	-
Total	100.0	-	-

Specific Gravity = 4.23

Pb Regrind Cyclone Underflow

+ 150 mesh	0.4	0.4	99.6
200	1.9	2.3	97.7
270	6.4	8.7	91.3
400	15.3	24.0	76.0
27.5 μ m	17.6	41.6	58.4
21.3	17.6	59.2	40.8
14.9	19.8	79.0	21.0
10.2	10.7	89.7	10.3
7.9	3.0	92.7	7.3
- 7.9	7.3	100.0	-
Total	100.0	-	-

Specific Gravity = 4.27

Pb Regrind Cyclone Overflow

+ 400 mesh	1.4	1.4	98.6
27.1 μ m	8.1	9.5	90.5
21.1	6.2	15.7	84.3
14.7	17.8	33.5	66.5
10.1	18.2	51.7	48.3
7.8	11.6	63.3	36.7
- 7.8	36.7	100.0	-
Total	100.0	-	-

Specific Gravity = 4.41

Test No. PP-4 - Continued

1.4.5. Screen Analyses:

Zn Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	-	-	100.0
100	0.4	0.4	99.6
150	0.9	1.3	98.7
200	3.4	4.7	95.3
270	5.7	10.4	89.6
400	10.5	20.9	79.1
28.7 μ m	7.6	28.5	71.5
22.3	11.0	39.5	60.5
15.5	14.0	53.5	46.5
10.7	12.2	65.7	34.3
8.3	6.9	72.6	27.4
- 8.3	27.4	100.0	-
Total	100.0	-	-

Specific Gravity = 4.06

Zn Regrind Discharge

+ 200 mesh	0.9	0.9	99.1
270	2.8	3.7	96.3
400	10.0	13.7	86.3
28.7 μ m	14.3	28.0	72.0
22.3	26.3	54.3	45.7
15.5	26.0	80.3	19.7
10.7	7.2	87.5	12.5
8.3	2.4	89.9	10.1
- 8.3	10.1	100.0	-
Total	100.0	-	-

Specific Gravity = 4.02

Zn Regrind Cyclone Underflow

+ 150 mesh	0.4	0.4	99.6
200	1.7	2.1	97.9
270	5.3	7.4	92.6
400	13.8	21.2	78.8
28.6 μ m	14.0	35.2	64.8
22.2	27.0	62.2	37.8
15.5	23.6	85.8	14.2
10.7	5.8	91.6	8.4
8.2	1.5	93.1	6.9
- 8.2	6.9	100.0	-
Total	100.0	-	-

Test No. PP-4 - Continued

1.4.5. Screen Analyses:

Zn Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 400 mesh	0.4	0.4	99.6
29.1 μ m	1.1	1.5	98.5
22.6	3.8	5.3	94.7
15.7	14.2	19.5	80.5
10.8	20.4	39.9	60.1
8.4	12.6	52.5	47.5
- 8.4	47.5	100.0	-
Total	100.0	-	-

Specific Gravity = 3.98

Test No. PP-4 - Continued

2. Flotation

2.1. Purpose: Attempt to improve lead concentrate recovery using finer primary grind.

2.2. Method: The circuit was similar to test PP-3, except that soda ash was added to the lead 3rd cleaner feed and pH of the zinc rougher and 3rd cleaner was increased.
The circuit was operated for a period of 7.5 hours and sampled every 30 minutes in the last 3 hours of operation.

2.2.1. Flotation Equipment: As for test PP-1.

2.2.2. Flotation Reagents:

Type	Rate, g/tonne	Circuit	Point of Addition
Na ₂ CO ₃	9670	Lead	Hendy Mill
NaCN	263	Lead	Hendy Mill
A-343	14.9	Lead	Hendy Mill
A-343	21.9	Lead	Pb Conditioner
R-242	8.9	Lead	Pb Conditioner
MIBC	62.4	Lead	Pb Rougher Feed
A-343	15.0	Lead	Pb Scavenger Feed
R-242	14.9	Lead	Pb Scavenger Feed
Na ₂ CO ₃	798	Lead	Pb Re grind Feed
NaCN	59.1	Lead	Pb Re grind Feed
A-343	11.5	Lead	Pb Re grind Mill
A-343	36.1	Lead	Pb 1st Cl. Scav. Feed
R-242	4.3	Lead	Pb 1st Cl. Scav. Feed
Na ₂ CO ₃	347	Lead	Pb 3rd Cleaner
Ca(OH) ₂	4288	Zinc	Zn Conditioner Feed
CuSO ₄	609	Zinc	Zn Conditioner
A-343	66.5	Zinc	Zn Rougher Feed
Z-200	8.3	Zinc	Zn Rougher Feed
MIBC	150	Zinc	Zn Rougher Feed
A-343	14.8	Zinc	Zn Scavenger Feed
Z-200	25.6	Zinc	Zn Scavenger Feed
MIBC	58.6	Zinc	Zn Scavenger Feed
Ca(OH) ₂	1582	Zinc	Zn Re grind
CuSO ₄	118.3	Zinc	Zn Re grind
Z-200	19.8	Zinc	Zn 1st Cleaner
A-343	7.5	Zinc	Zn 1st Cleaner Scav.
MIBC	128.6	Zinc	Zn 1st Cleaner Scav.
Ca(OH) ₂	207	Zinc	Zn 3rd Cleaner

2.3. Flowsheet: As for test PP-1.

Test No. PP-4 - Continued

2.4. Results:

2.4.1. Observations: The lead flotation was satisfactory except that the lead cleaning deteriorated due to high pyrite recirculating load in the lead 1st cleaner scavenger stage.
The froth conditions in the zinc rougher were poor and a high zinc tailing assay may be expected.

2.4.2. pH and Pulp Density

Product	Pulp Density g/l	pH
Pb Rougher Feed	1286	9.9
Pb Scavenger Tailing	1300	9.8
Pb 1st Cleaner	-	10.4
Pb 1st Cleaner Scav. Tailing	1040	10.3
Pb Combined Tailing	1220	-
Pb 2nd Cleaner	-	10.4
Pb 3rd Cleaner	-	10.7
Zn Rougher Feed	1180	10.9
Zn Scavenger Tailing	1190	10.7
Zn 1st Cleaner	-	12.0
Zn 1st Cleaner Scav. Tailing	1030	11.8
Zn Combined Tailing	1120	-
Zn 2nd Cleaner	-	11.4
Zn 3rd Cleaner	-	11.4
Zn 4th Cleaner	-	10.6

2.4.3. Pulp Temperature

Product	Temperature, °C
Pb Rougher	27
Zn Rougher	26

Test No. PP-4 - Continued

2.4.4. Chemical Analyses

Product	Assays, %			
	Pb	Zn	Oxide Pb	Oxide Zn
Hendy Cyclone Overflow	2.30	3.75	0.36	0.23
Pb Rougher Concentrate	31.4	7.34	-	-
Pb Rougher Tailing	0.75	3.79	-	-
Pb Scavenger Concentrate	4.35	7.17	-	-
Pb Scavenger Tailing	0.48	3.64	-	-
Pb Combined Tailing	0.54	3.66	-	-
Pb 1st Cleaner Concentrate	50.0	6.16	-	-
Pb 1st Cleaner Tailing	5.62	10.2	-	-
Pb 1st Cleaner Scav. Conc.	13.2	11.2	-	-
Pb 1st Cleaner Scav. Tailing	3.62	9.24	-	-
Pb 2nd Cleaner Concentrate	49.9	6.03	-	-
Pb 3rd Cleaner Concentrate	57.4	4.95	-	-
Zn Rougher Feed	0.63	5.01	-	-
Zn Rougher Concentrate	0.72	43.1	-	-
Zn Scavenger Concentrate	1.40	13.3	-	-
Zn Scavenger Tailing	0.53	0.53	-	-
Zn 1st Cleaner Concentrate	0.48	52.0	-	-
Zn 1st Cleaner Tailing	1.49	23.2	-	-
Zn 1st Cleaner Scav. Conc.	0.98	41.5	-	-
Zn 1st Cleaner Scav. Tailing	2.05	6.03	-	-
Zn 2nd Cleaner Concentrate	0.40	52.1	-	-
Zn 3rd Cleaner Concentrate	0.34	52.5	-	-
Zn 4th Cleaner Concentrate	0.27	53.2	-	-
Zn Combined Tailing	0.56	0.62	-	-

Test No. PP-4 - Continued

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb 3rd Cleaner Concentrate	3.09	57.4	4.95	77.1	4.1
Zn 4th Cleaner Concentrate	5.70	0.27	53.2	0.7	80.8
Zn Combined Tailing	91.21	0.56	0.62	22.2	15.1
Hendy Cyclone Overflow	100.00	2.30	3.75	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Concentrate	5.70	31.4	7.34	77.9	10.8
Pb Combined Tailing	94.30	0.54	3.66	22.1	89.2
Hendy Cyclone Overflow	100.00	2.30	3.75	100.0	100.0
Zn Rougher Concentrate	6.94	0.72	43.1	2.1	80.8
Zn Combined Tailing	89.97	0.56	0.62	20.8	15.1
Pb Combined Tailing	96.91	0.54	3.66	22.9	95.9

Test No. PP-5

1. Grinding

1.1. Purpose: To repeat conditions of test PP-4.

1.2. Method: Similar to test PP-4. The circuit was operated for a period of 7.5 hours at a feed rate of 412 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.

1.3. Flowsheet: As for test PP-1.

1.4. Results:

1.4.1. Observations: The 50 mm Dorr cyclone was plugged several times during the test run and the grinding circuit was shut down for 1.5 hours. This resulted in unstable grinding.

1.4.2. Ball Mill Report

Feed: Minus 12.7 mm ore at 0.8 percent moisture content

Feed Rate: 412.0 dry kilograms per hour

Mill Speed: 32 r.p.m., 80.5 percent of critical speed

Mill Load: 76.2 mm balls 365.5 kilograms

50.8 mm balls 362.8 kilograms

25.4 mm balls 90.6 kilograms

Total 818.9 kilograms

Operating Time: Total 7.5 hours, test period 2.0 hours

Mill Feed: Total 3090 kilograms, test period 824 kilograms

Circulating Load: Cyclone underflow 252.1 percent

Pulp Densities:

	<u>gpl</u>	<u>% Solids</u>
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Mill Discharge	1672	53
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Cyclone Overflow	1308	31
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Cyclone Underflow	1748	56
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Average Power: Gross 9.98 kilowatts

No Load 1.93 kilowatts

Net 8.05 kilowatts

Net Power Consumption: 19.5 kilowatt-hours per tonne of 12.7 mm feed.

Work Index: 22.26

Cyclone Overflow K₈₀: 100.5 micrometers

Test No. PP-5 - Continued

1.4.2.1. Classification Data

Grinding Mill Hendy

Cyclone: P-50 Dorr 50.8 mm diameter
15.9 mm vortex
12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recirculating Load, %
		400 mesh	200 mesh	gpl	% Solids	
Cyclone Feed	1451	38.5	58.0	1534	46	-
Cyclone Overflow	412	45.7	68.4	1308	31	-
Cyclone Underflow	1039	31.9	49.1	1748	56	252.1

1.4.3. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical

Regrind Feed: Pb Rougher Concentrate

Feed Rate: 25.0 calculated kilograms per hour of concentrate

Mill Speed: 30 r.p.m., 65 percent of critical speed

Mill Load: 50 mm balls 90.7 kilograms

25 mm balls 90.7 kilograms

Total 191.4 kilograms

Average Power: Gross 2.14 kilowatts

No Load 0.95 kilowatts

Net 1.19 kilowatts

Net Power Consumption: 2.89 kilowatt-hours per tonne of flotation feed

1.4.3.1. Classification Data

Cyclone: Krebs 25 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	gpl	% Solids
Regrind Feed	-	65.7	50.5	-	-
Mill Discharge	-	64.1	32.6	-	-
Cyclone Overflow	25.0	99.2	95.3	1025	3
Cyclone Underflow	-	64.0	30.0	2210	67

Test No. PP-5 - Continued

1.4.4. Zinc Regrind Mill Report

Regrind Mill: Denver
 Regrind Feed: Zn rougher concentrate + Zn 1st Cl. Scav. Conc.
 Feed Rate: 30.2 calculated kilograms per hour of concentrate
 Mill Speed: 58 r.p.m., 70 percent of critical speed
 Mill Load: 25 mm balls 113.4 kg
 Average Power: Not calculated

1.4.4.1. Classification Data

Cyclone: Dorr 25 mm diameter
 6.35 mm vortex
 3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	gpl	% Solids
Regrind Feed	30.2	60.3	42	-	-
Cyclone Overflow	-	99.2	81	1050	6
Cyclone Underflow	-	66.9	26	1680	53
Mill Discharge	-	78.8	38	-	-

Test No. PP-5 - Continued

1.4.5. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8 inch	14.2	14.2	85.8
3 mesh	6.9	21.1	78.9
4	9.6	30.7	69.3
6	6.7	37.4	62.6
8	6.5	43.9	56.1
10	5.6	49.5	50.5
14	5.4	54.9	45.1
20	4.9	59.8	40.2
28	6.1	65.9	34.1
35	5.4	71.3	28.7
48	5.8	77.1	22.9
65	4.5	81.6	18.4
100	3.5	85.1	14.9
- 100	14.9	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 8	0.2	0.2	99.8
10	0.3	0.5	99.5
14	0.3	0.8	99.2
20	0.3	1.1	98.9
28	0.5	1.6	98.4
35	0.9	2.5	97.5
48	2.1	4.6	95.4
65	4.3	8.9	91.1
100	8.3	17.2	82.8
150	10.2	27.4	72.6
200	14.6	42.0	58.0
270	8.5	50.5	49.5
400	11.0	61.5	38.5
- 400	38.5	100.0	-
Total	100.0	-	-

Test No. PP-5 - Continued

1.4.5. Screen Analyses:

P-50 Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.8	0.8	99.2
10	0.6	1.4	98.6
14	0.5	1.9	98.1
20	0.6	2.5	97.5
28	1.0	3.5	96.5
35	1.4	4.9	95.1
48	3.5	8.4	91.6
65	6.7	15.1	84.9
100	10.5	25.6	74.4
150	11.3	36.9	63.1
200	14.0	50.9	49.1
270	7.5	58.4	41.6
400	9.7	68.1	31.9
- 400	31.9	100.0	-
Total	100.0	-	-

P-50 Cyclone Overflow

+ 48	1.8	1.8	98.2
65	3.1	4.9	95.1
100	6.0	10.9	89.1
150	8.9	19.8	80.2
200	11.8	31.6	68.4
270	12.4	44.0	56.0
400	10.3	54.3	45.7
- 400	45.7	100.0	-
Total	100.0	-	-

Test No. PP-5 - Continued

1.4.5. Screen Analyses:

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	5.1	5.1	94.9
100	5.6	10.7	89.3
150	5.8	16.5	83.5
200	6.7	23.2	76.8
270	5.3	28.5	71.5
400	5.8	34.3	65.7
26.1 μ m	8.8	43.1	56.9
20.3	6.4	49.5	50.5
14.1	7.8	57.3	42.7
9.7	7.6	64.9	35.1
7.5	5.8	70.7	29.3
- 7.5	29.3	100.0	-
Total	100.0	-	-

Specific Gravity = 4.67

Pb Regrind Discharge

+ 65 mesh	0.5	0.5	99.5
100	0.6	1.1	98.9
150	3.2	4.3	95.7
200	5.6	9.9	90.1
270	8.8	18.7	81.3
400	17.2	35.9	64.1
26.7 μ m	14.8	50.7	49.3
20.7	16.7	67.4	32.6
14.4	17.8	85.2	14.8
9.9	7.8	93.0	7.0
7.7	1.8	94.8	5.2
- 7.7	5.2	100.0	-
Total	100.0	-	-

Specific Gravity = 4.50

Test No. PP-5 - Continued

1.4.5. Screen Analyses:

Pb Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.3	0.3	99.7
100	1.7	2.0	98.0
150	3.6	5.6	94.4
200	6.4	12.0	88.0
270	8.1	20.1	79.9
400	15.9	36.0	64.0
26.5 μ m	17.0	53.0	47.0
20.5	17.0	70.0	30.0
14.3	17.2	87.2	12.8
9.9	7.0	94.2	5.8
7.6	1.5	95.7	4.3
- 7.6	4.3	100.0	-
Total	100.0	-	-

Specific Gravity = 4.57

Pb Regrind Cyclone Overflow

+ 400 mesh	0.8	0.8	99.2
27.1 μ m	1.2	2.0	98.0
21.0	2.7	4.7	95.3
14.7	5.3	10.0	90.0
10.1	12.0	22.0	78.0
7.8	12.8	34.8	65.2
- 7.8	65.2	100.0	-
Total	100.0	-	-

Test No. PP-5 - Continued

1.4.5. Screen Analyses:

Zn Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	3.8	3.8	96.2
150	8.0	11.8	88.2
200	10.5	22.3	77.7
270	8.6	30.9	69.1
400	8.8	39.7	60.3
28.5 μ m	6.1	45.8	54.2
22.1	8.7	54.5	45.5
15.4	9.9	64.4	35.6
10.6	8.0	72.4	27.6
8.2	4.6	77.0	23.0
- 8.2	23.0	100.0	-
Total	100.0	-	-

Specific Gravity = 4.12

Zn Regrind Discharge

+ 150 mesh	0.8	0.8	99.2
200	3.2	4.0	96.0
270	5.2	9.2	90.8
400	12.0	21.2	78.8
28.1 μ m	12.7	33.9	66.1
21.8	20.7	54.6	45.4
15.2	21.7	76.3	23.7
10.4	10.5	86.8	13.2
8.1	2.8	89.6	10.4
- 8.1	10.4	100.0	-
Total	100.0	-	-

Specific Gravity = 4.15

Test No. PP-5 - Continued

1.4.5. Screen Analyses:

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.2	0.2	99.8
100	0.6	0.8	99.2
150	2.2	3.0	97.0
200	6.0	9.0	91.0
270	7.9	16.9	83.1
400	16.2	33.1	66.9
28.1 μ m	12.0	45.1	54.9
21.8	20.6	65.7	34.3
15.2	20.0	85.7	14.3
10.4	7.9	93.6	6.4
8.1	1.6	95.2	4.8
- 8.1	4.8	100.0	-
Total	100.0	-	-

Specific Gravity = 4.17

Zn Regrind Cyclone Overflow

+ 400 mesh	1.2	1.2	98.8
29.1 μ m	3.0	4.2	95.8
22.5	8.0	12.2	87.8
15.7	18.2	30.4	69.6
10.8	19.1	49.5	50.5
8.4	11.3	60.8	39.2
- 8.4	39.2	100.0	-
Total	100.0	-	-

Specific Gravity = 3.98

Test No. PP-5 - Continued

2. Flotation

2.1. Purpose: To investigate the effect of closed circuit lead cleaning using a fine primary grind.

2.2. Method: The following circuit changes were made:

a) Lead Circuit

- 1) The 1st cleaner scavenger stage was omitted from the lead circuit and the lead 1st cleaner tailing was recycled to the lead conditioner.
- 2) The soda ash addition to the Hendy mill feed was decreased but in the last three hours of the test run was increased due to increased rate of pyrite flotation.
- 3) The lead scavenger stage was carried out in a bank of 6 Agitair cells instead of Wemco 1+1 cells.

b) Zinc Circuit

- 1) Decrease CuSO_4 addition to the zinc conditioner.
- 2) Decreased pH of the zinc rougher from 10.9 to 10.4.

The circuit was operated for a period of 7.5 hours and sampled every 30 minutes in the last two hours of operation.

2.2.1. Flotation Equipment:

As for test PP-1, except that the bank of Wemco 1+1 cells in the lead scavenger was replaced by a bank of Agitair cells. The 6 Denver No. 5 cells used for the lead scavenger cleaner stage were removed from the circuit.

Test No. PP-5 - Continued

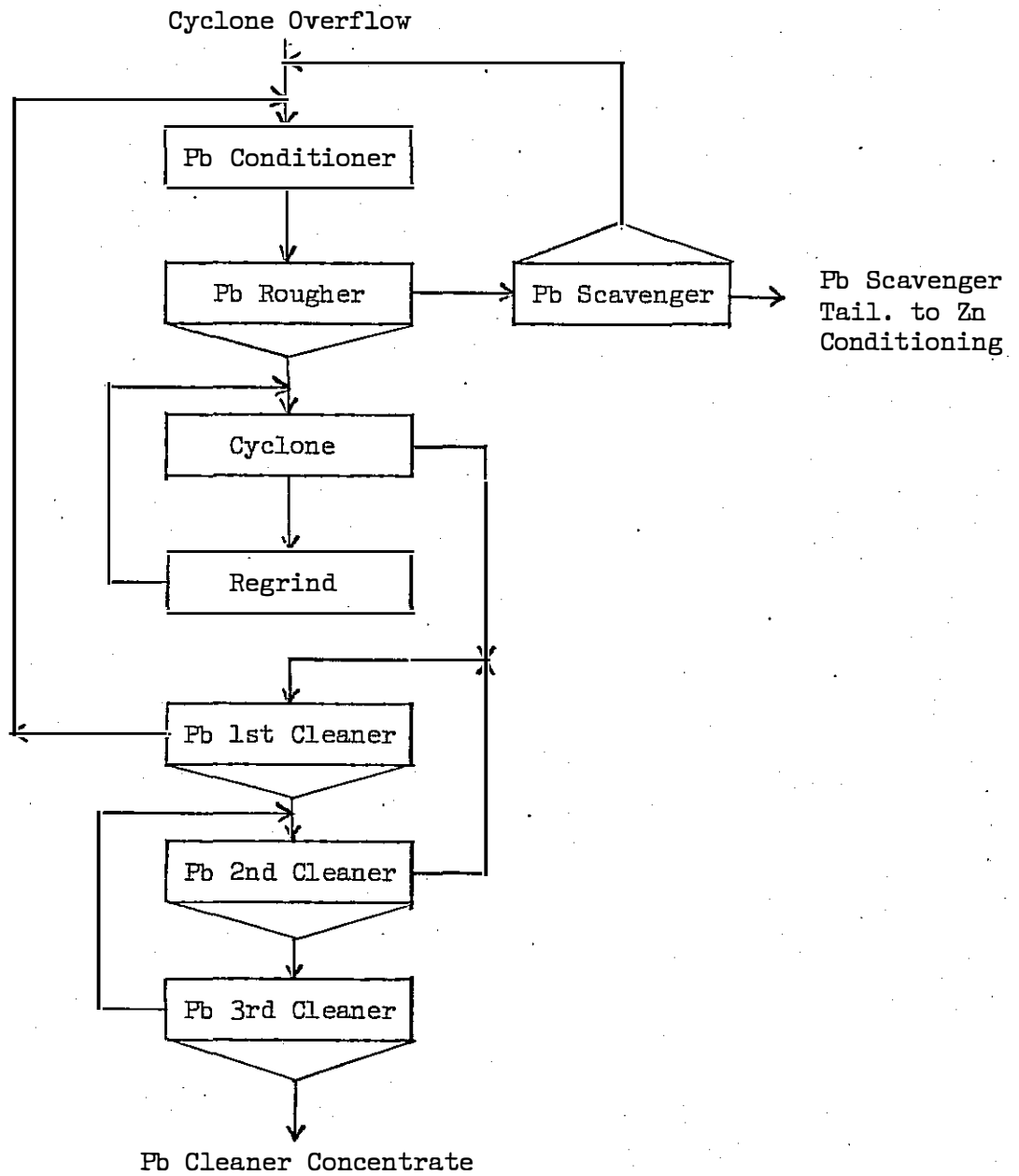
2.2.2. Flotation Reagents

Type	Rate, g/tonne	Circuit	Point of Addition
Na ₂ CO ₃	14520	Lead	Hendy Mill
NaCN	264	Lead	Hendy Mill
A-343	14.5	Lead	Hendy Mill
A-343	22.2	Lead	Pb Conditioner
R-242	8.9	Lead	Pb Conditioner
MIBC	60.1	Lead	Pb Rougher Feed
A-343	22.0	Lead	Pb Scavenger Feed
R-242	22.2	Lead	Pb Scavenger Feed
Na ₂ CO ₃	786	Lead	Pb Regrind Feed
NaCN	57.2	Lead	Pb Regrind Feed
A-343	11.9	Lead	Pb Regrind Mill
R-242	4.4	Lead	Pb Regrind Mill
Na ₂ CO ₃	358	Lead	Pb 2nd Cleaner Feed
NaCN	21.1	Lead	Pb 2nd Cleaner Feed
Ca(OH) ₂	3604	Zinc	Zn Conditioner Feed
CuSO ₄	466	Zinc	Zn Conditioner Feed
A-343	72.8	Zinc	Zn Rougher Feed
Z-200	30.6	Zinc	Zn Rougher Feed
MIBC	148	Zinc	Zn Rougher Feed
A-343	21.8	Zinc	Zn Scavenger Feed
Z-200	26.0	Zinc	Zn Scavenger Feed
MIBC	57.7	Zinc	Zn Scavenger Feed
Ca(OH) ₂	1704	Zinc	Zn Regrind
CuSO ₄	117	Zinc	Zn Regrind
Z-200	20.4	Zinc	Zn 1st Cleaner
A-343	23.9	Zinc	Zn 1st Cleaner Scavenger
MIBC	88.8	Zinc	Zn 1st Cleaner Scavenger
Ca(OH) ₂	244	Zinc	Zn 3rd Cleaner Feed

Test No. PP-5 - Continued

2.3. Flowsheet:

a) Lead Circuit



b) Zinc Circuit:

As for test PP-1.

Test No. PP-5 - Continued

2.4. Results

2.4.1. Observations: The lead flotation was not stable during the test run, due to the problems in the grinding circuit. The froth in the lead rougher was voluminous and carried coarse pyrite and fine galena. The zinc floated selectively but the froth conditions in the zinc rougher were not stable.

2.4.2. pH and Pulp Density

Product	Pulp Density, g/l	pH
Pb Rougher Feed	1265	10.1
Pb Scavenger Tailing	1135	10.1
Pb 1st Cleaner	-	10.4
Pb 2nd Cleaner	-	10.4
Pb 3rd Cleaner	-	10.0
Zn Rougher Feed	1215	10.5
Zn Scavenger Tailing	1135	10.4
Zn 1st Cleaner	-	12.1
Zn 1st Cleaner Scav. Tailing	1010	12.0
Zn Combined Tailing	1095	-
Zn 2nd Cleaner	-	11.6
Zn 3rd Cleaner	-	11.4
Zn 4th Cleaner	-	11.1

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher	25
Zn Rougher	23

Test No. PP-5 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Hendy Cyclone Overflow	2.29	3.70
Pb Rougher Concentrate	28.6	7.42
Pb Rougher Tailing	0.93	3.94
Pb Scavenger Concentrate	5.44	7.72
Pb Scavenger Tailing	0.59	3.75
Pb 1st Cleaner Concentrate	40.3	6.07
Pb 1st Cleaner Tailing	12.8	9.03
Pb 2nd Cleaner Concentrate	46.1	5.53
Pb 3rd Cleaner Concentrate	56.5	3.75
Zn Rougher Feed	0.63	4.36
Zn Rougher Concentrate	1.13	39.0
Zn Scavenger Concentrate	1.68	10.6
Zn Scavenger Tailing	0.56	0.69
Zn 1st Cleaner Concentrate	0.79	47.9
Zn 1st Cleaner Tailing	2.27	10.0
Zn 1st Cleaner Scav. Concentrate	3.11	23.2
Zn 1st Cleaner Scav. Tailing	1.94	2.02
Zn 2nd Cleaner Concentrate	0.61	49.1
Zn 3rd Cleaner Concentrate	0.49	49.5
Zn 4th Cleaner Concentrate	0.53	50.0
Zn Combined Tailing	0.56	0.87

Test No. PP-5 - Continued

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb 3rd Cleaner Concentrate	3.10	56.5	3.75	76.4	3.1
Zn 4th Cleaner Concentrate	5.58	0.53	50.0	1.3	75.4
Zn Combined Tailing	91.32	0.56	0.87	22.3	21.5
Hendy Cyclone Overflow	100.00	2.29	3.70	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Concentrate	6.07	28.6	7.42	75.8	11.3
Pb Scavenger Tailing	93.93	0.59	3.75	24.2	88.7
Hendy Cyclone Overflow	100.00	2.29	3.70	100.0	100.0
Zn Rougher Concentrate	7.32	1.13	39.0	3.4	76.2
Zn Combined Tailing	89.58	0.56	0.87	20.2	20.7
Pb Scavenger Tailing	96.90	0.59	3.75	23.6	96.9

Test No. PP-6

1. Grinding

1.1. Purpose: To repeat conditions of test PP-5 at steady grind and slightly increased pulp density in the cyclone overflow.

1.2. Method: Similar to test PP-5, except that the pulp density in the cyclone overflow increased slightly. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 419 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.

1.3. Flowsheet: As for test PP-1.

1.4. Results:

1.4.1. Observations: The cyclone operation was poor during the 1st 3 hours of operation. At 10 a.m. the mill was stopped and the cyclone was replaced. The circuit was stable for the remainder of the testwork.

1.4.2. Ball Mill Report

Feed: Minus 12.7 mm ore at 0.9 percent moisture content

Feed Rate: 418.8 dry kilograms per hour

Mill Speed: 32 r.p.m., 80.5 percent of critical speed

Mill Load: 76.2 mm balls 365.5 kilograms

50.8 mm balls 362.8 kilograms

25.4 mm balls 90.6 kilograms

Total 818.9 kilograms

Operating Time: Total 7.5 hours, test period 2.0 hours

Mill Feed: Total 3141 kilograms, test period 838 kilograms

Circulating Load: Cyclone underflow 699.6 percent

Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
Mill Discharge	2246	73
Cyclone Overflow	1311	31
Cyclone Underflow	2780	82

Average Power: Gross 9.86 kilowatts

No Load 1.93 kilowatts

Net 7.93 kilowatts

Net Power Consumption: 18.9 kilowatt-hours per tonne of 12.7 mm feed

Work Index: 15.04

Cyclone Overflow K₈₀: 52.0 micrometers

Test No. PP-6 - Continued

1.4.2.1. Classification Data

Grinding Mill: Hendy
Cyclone: P-50 Dorr 50.8 mm diameter
15.9 mm vortex
12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recirculating Load, %
		400 mesh	200 mesh	gpl	% Solids	
Cyclone Feed	3349	25.6	52.7	2132	70	-
Cyclone Overflow	419	68.0	87.9	1311	31	-
Cyclone Underflow	2930	18.3	49.1	2780	82	699.6

1.4.3. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical
Regrind Feed: Pb rougher concentrate
Feed Rate: 22.0 calculated kilograms per hour of concentrate
Mill Speed: 30 r.p.m., 65 percent of critical speed
Mill Load: 50 mm balls 90.7 kilograms
25 mm balls 90.7 kilograms
Total 181.4 kilograms
Average Power: Gross 2.14 kilowatts
No Load 0.95 kilowatts
Net 1.19 kilowatts
Net Power Consumption: 2.84 kilowatt-hours per tonne of flotation feed

1.4.3.1. Classification Data

Cyclone: Krebs 25 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	gpl	% Solids
Regrind Feed	-	84.1	64.1	-	-
Mill Discharge	-	59.8	23.8	-	-
Cyclone Overflow	22.0	99.3	95.5	1045	5.5
Cyclone Underflow	-	57.2	20.3	2470	74

Test No. PP-6 - Continued

1.4.4. Zinc Regrind Mill Report

Regrind Mill: Denver
Regrind Feed: Zn Rougher Concentrate + Zn 1st Cleaner Scav. Conc.
Feed Rate: 36.6 calculated kilograms per hour concentrate
Mill Speed: 58 r.p.m., 70 percent of critical speed
Mill Load: 25 mm balls 113.4 kg
Average Power: not calculated

1.4.4.1. Classification Data

Cyclone: Dorr 25 mm diameter
6.35 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	gpl	% Solids
Regrind Feed	36.6	80.3	58	-	-
Cyclone Overflow	-	99.9	93	1075	9
Cyclone Underflow	-	79.9	31	1870	63
Mill Discharge	-	86.5	41	-	-

Test No. PP-6 - Continued

1.4.5. Screen Analyses

Hendy Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8 inch	2.7	2.7	97.3
3 mesh	13.3	16.0	84.0
4	9.6	25.6	74.4
6	7.1	32.7	67.3
8	6.4	39.1	60.9
10	5.6	44.7	55.3
14	5.2	49.9	50.1
20	4.9	54.8	45.2
28	7.0	61.8	38.2
35	6.7	68.5	31.5
48	6.5	75.0	25.0
65	4.5	79.5	20.5
100	3.8	83.3	16.7
- 100	16.7	100.0	-
Total	100.0	-	-

Hendy Discharge

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.6	1.0	99.0
35	1.0	2.0	98.0
48	2.2	4.2	95.8
65	3.8	8.0	92.0
100	7.7	15.7	84.3
150	11.6	27.3	72.7
200	20.0	47.3	52.7
270	12.0	59.3	30.7
400	15.1	74.4	25.6
- 400	25.6	100.0	-
Total	100.0	-	-

Test No. PP-6 - Continued

1.4.5. Screen Analyses:

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.2	0.2	99.8
10	0.2	0.4	99.6
14	0.2	0.6	99.4
20	0.3	0.9	99.1
28	0.5	1.4	98.6
35	0.8	2.2	97.8
48	2.2	4.4	95.6
65	4.8	9.2	90.8
100	8.4	17.6	82.4
150	13.9	31.5	68.5
200	19.4	50.9	49.1
270	18.9	69.8	30.2
400	11.9	81.7	18.3
- 400	18.3	100.0	-
Total	100.0	-	-

Hendy Cyclone Overflow

+ 48	0.2	0.2	99.8
65	0.3	0.5	99.5
100	1.2	1.7	98.3
150	3.0	4.7	95.3
200	7.4	12.1	87.9
270	6.8	18.9	81.1
400	13.1	32.0	68.0
- 400	68.0	100.0	-
Total	100.0	-	-

Test No. PP-6 - Continued

1.4.5. Screen Analyses:

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 48	0.1	0.1	99.9
65	0.3	0.4	99.6
100	1.1	1.5	98.5
150	3.3	4.8	95.2
200	7.0	11.8	88.2
270	11.3	23.1	76.9
400	11.6	34.7	65.3
- 400	65.3	100.0	-
Total	100.0	-	-

Pb Rougher Concentrate

+ 65 mesh	0.2	0.2	99.8
100	0.4	0.6	99.4
150	1.0	1.6	98.4
200	2.6	4.2	95.8
270	4.1	8.3	91.7
400	7.6	15.9	84.1
25.8 μ m	10.9	26.8	73.2
20.0	9.1	35.9	64.1
13.9	11.2	47.1	52.9
9.6	10.8	57.9	42.1
7.4	7.2	65.1	34.9
- 7.4	34.9	100.0	-
Total	100.0	-	-

Specific Gravity = 4.77

Test No. PP-6 - Continued

1.4.5. Screen Analyses:

Pb Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	0.6	0.6	99.4
150	2.2	2.8	97.2
200	6.4	9.2	90.8
270	12.2	21.4	78.6
400	18.8	40.2	59.8
25.8 μ m	18.5	58.7	41.3
20.0	17.5	76.2	23.8
13.9	13.6	89.8	10.2
9.6	4.1	93.9	6.1
7.4	1.0	94.9	5.1
- 7.4	5.1	100.0	-
Total	100.0	-	-

Specific Gravity = 4.85

Pb Regrind Cyclone Underflow

+ 100 mesh	1.1	1.1	98.9
150	3.0	4.1	95.9
200	7.7	11.8	88.2
270	11.4	23.2	76.8
400	19.6	42.8	57.2
25.8 μ m	19.3	62.1	37.9
20.0	17.6	79.7	20.3
13.9	13.6	93.3	6.7
9.6	3.4	96.7	3.3
7.4	0.6	97.3	2.7
- 7.4	2.7	100.0	-
Total	100.0	-	-

Specific Gravity = 4.86

Test No. PP-6 - Continued

1.4.5. Screen Analyses:

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 400 mesh	0.7	0.7	99.3
27.3 μ m	1.4	2.1	97.9
21.2	1.6	3.7	96.3
14.8	5.1	8.8	91.2
10.1	11.6	20.4	79.6
7.8	13.2	33.6	66.4
- 7.8	66.4	100.0	-
Total	100.0	-	-

Specific Gravity = 4.36

Zn Rougher Concentrate

+ 65 mesh	0.1	0.1	99.9
100	0.6	0.7	99.3
150	1.4	2.1	97.9
200	3.7	5.8	94.2
270	4.8	10.6	89.4
400	9.1	19.7	80.3
28.6 μ m	6.8	26.5	73.5
22.2	10.0	36.5	63.5
15.5	13.8	50.3	49.7
10.7	12.6	62.9	37.1
8.2	6.9	69.8	30.2
- 8.2	30.2	100.0	-
Total	100.0	-	-

Specific Gravity = 4.08

Test No. PP-6 - Continued

1.4.5. Screen Analyses:

Zn Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 150 mesh	0.2	0.2	99.8
200	0.7	0.9	99.1
270	2.8	3.7	96.3
400	9.8	13.5	86.5
28.5 μ m	11.4	24.9	75.1
22.1	25.8	50.7	49.3
15.4	31.4	82.1	17.9
10.6	8.4	90.5	9.5
8.2	2.2	92.7	7.3
- 8.2	7.3	100.0	-
Total	100.0	-	-

Specific Gravity = 4.12

Zn Regrind Cyclone Underflow

+ 100 mesh	0.2	0.2	99.8
150	0.7	0.9	99.1
200	3.0	3.9	96.1
270	4.7	8.6	91.4
400	11.5	20.1	79.9
28.1 μ m	10.6	30.7	69.3
21.8	25.5	56.2	43.8
15.2	29.9	86.1	13.9
10.4	7.3	93.4	6.6
8.1	1.3	94.7	5.3
- 8.1	5.3	100.0	-
Total	100.0	-	-

Specific Gravity = 4.14

Zn Regrind Cyclone Overflow

+ 400 mesh	0.1	0.1	99.9
29.2 μ m	0.6	0.7	99.3
22.7	2.1	2.8	97.2
15.8	10.7	13.5	86.5
10.9	19.4	32.9	67.1
8.4	13.4	46.3	53.7
- 8.4	53.7	100.0	-
Total	100.0	-	-

Specific Gravity = 3.93

Test No. PP-6 - Continued

2. Flotation

2.1. Purpose: To improve lead concentrate grade and recovery.

2.2. Method: The following changes were made in the circuit:

a) Lead Circuit

- 1) Returned lead 1st cleaner scavenger stage to the circuit.
The cleaner scavenger concentrate was returned to the regrind mill feed and the tailing was recycled to the lead rougher feed.
- 2) Slightly decreased collector additions to the regrind mill feed.

b) Zinc Circuit

- 1) Added small amount of frother 1012 to the zinc rougher feed.

The circuit was operated for a period of 7.5 hours and sampled every 30 minutes in the last two hours of operation.

2.2.1. Flotation Equipment: As for test PP-1, except that the lead scavenger was carried out in a bank of Agitair cells.

2.2.2. Flotation Reagents

Type	Rate, g/tonne	Circuit	Point of Addition
Na ₂ CO ₃	8668	Lead	Hendy Mill
NaCN	258	Lead	Hendy Mill
A-343	15.8	Lead	Hendy Mill
A-343	17.6	Lead	Pb Conditioner
R-242	8.5	Lead	Pb Conditioner
MIBC	59.6	Lead	Pb Rougher Feed
A-343	52.0	Lead	Pb Scavenger Feed
R-242	11.0	Lead	Pb Scavenger Feed
Na ₂ CO ₃	904	Lead	Pb Regrind Feed
A-343	14.5	Lead	Pb Regrind Mill
R-242	4.5	Lead	Pb Regrind Mill
Na ₂ CO ₃	372	Lead	Pb 1st Cleaner Scav.
NaCN	21.8	Lead	Pb 2nd Cleaner Feed
Ca(OH) ₂	4226	Zinc	Zn Conditioner Feed
CuSO ₄	716	Zinc	Zn Conditioner Feed
A-343	71.6	Zinc	Zn Rougher Feed
Z-200	30.1	Zinc	Zn Rougher Feed
1012C	3.7	Zinc	Zn Rougher Feed
MIBC	146	Zinc	Zn Rougher Feed
A-343	21.5	Zinc	Zn Scavenger Feed
Z-200	25.1	Zinc	Zn Scavenger Feed
MIBC	56.7	Zinc	Zn Scavenger Feed
Ca(OH) ₂	1268	Zinc	Zn Regrind
CuSO ₄	115	Zinc	Zn Regrind
Z-200	21.5	Zinc	Zn 1st Cleaner
CuSO ₄	236	Zinc	Zn 1st Cleaner Scav.
A-343	14.0	Zinc	Zn 1st Cleaner Scav.
MIBC	113.5	Zinc	Zn 1st Cleaner Scav.
Ca(OH) ₂	240	Zinc	Zn 3rd Cleaner Feed

2.3. Flowsheet:

a) Lead Circuit



b) Zinc Circuit:

Test No. PP-6 - Continued

2.4. Results:

2.4.1. Observations: The lead and zinc flotation was stable during the test run. However, the circuit continued to have poor frothing properties.

2.4.2. pH and Pulp Density

Product	Pulp Density g/l	pH
Pb Rougher Feed	1240	9.7
Pb Scavenger Tailing	1240	9.6
Pb 1st Cleaner	-	10.4
Pb 2nd Cleaner	-	10.2
Pb 3rd Cleaner	-	10.5
Zn Rougher Feed	1195	10.8
Zn Scavenger Tailing	1185	10.5
Zn 1st Cleaner	-	11.8
Zn 1st Cleaner Scav. Tailing	1020	11.6
Zn Combined Tailing	1145	-
Zn 2nd Cleaner	-	10.8
Zn 3rd Cleaner	-	10.9
Zn 4th Cleaner	-	9.9

2.4.3. Pulp Temperatures

Product	Temperature °C
Pb Rougher	25
Zn Rougher	24

Test No. PP-6 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Hendy Cyclone Overflow	2.39	3.87
Pb Rougher Concentrate	35.2	7.03
Pb Rougher Tailing	0.94	4.11
Pb Scavenger Concentrate	7.58	8.61
Pb Scavenger Tailing	0.57	4.22
Pb 1st Cleaner Concentrate	46.1	4.87
Pb 1st Cleaner Tailing	16.6	8.74
Pb 1st Cleaner Scav. Conc.	22.3	8.30
Pb 1st Cleaner Scav. Tailing	9.83	9.41
Pb 2nd Cleaner Concentrate	52.1	4.28
Pb 3rd Cleaner Concentrate	59.6	3.04
Zn Rougher Feed	0.64	4.84
Zn Rougher Concentrate	0.94	40.6
Zn Scavenger Concentrate	1.55	15.00
Zn Scavenger Tailing	0.56	0.56
Zn 1st Cleaner Concentrate	0.59	50.7
Zn 1st Cleaner Tailing	1.85	20.4
Zn 1st Cleaner Scav. Concentrate	1.56	39.1
Zn 1st Cleaner Scav. Tailing	2.04	3.84
Zn 2nd Cleaner Concentrate	0.43	52.8
Zn 3rd Cleaner Concentrate	0.38	53.1
Zn 4th Cleaner Concentrate	0.37	54.1
Zn Combined Tailing	0.60	0.61

Test No. PP-6 - Continued

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb 3rd Cleaner Concentrate	3.06	59.6	3.04	76.3	2.4
Zn 4th Cleaner Concentrate	5.96	0.37	54.1	0.9	83.3
Zn Combined Tailing	90.98	0.60	0.61	22.8	14.3
Hendy Cyclone Overflow	100.00	2.39	3.87	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Concentrate	5.26	35.2	7.03	77.4	8.5
Pb Scavenger Tailing	94.73	0.57	4.22	22.6	91.5
Hendy Cyclone Overflow	100.00	2.39	3.87	100.0	100.0
Zn Rougher Concentrate	8.75	0.94	40.6	3.2	84.7
Zn Combined Tailing	88.19	0.60	0.61	20.5	12.9
Pb Scavenger Tailing	96.94	0.57	4.22	23.7	97.6

Test No. PP-7

1. Grinding

1.1. Purpose: To repeat conditions of test PP-6.

1.2. Method: As for test PP-6. The grinding circuit was operated for a period of 6 hours at a feed rate of 412 kilograms per hour. Samples were taken every 30 minutes in the last hour of operation.

1.3. Flowsheet: As for test PP-1.

1.4. Results:

1.4.1. Observations: The grinding circuit was stable during the test run. At 3:00 p.m. the cyclone overflow pump was plugged up and for this reason the test was terminated.

1.4.2. Ball Mill Report

Feed: Minus 12.7 mm ore at 0.6 percent moisture content

Feed Rate: 412.1 dry kilograms per hour

Mill Speed: 32 r.p.m., 80.5 percent of critical speed

Mill Load: 76.2 mm balls 365.5 kilograms

50.8 mm balls 362.8 kilograms

25.4 mm balls 90.6 kilograms

Total 818.9 kilograms

Operating Time: Total 6 hours, test period 1 hour

Mill Feed: Total 2473 kilograms, test period 412.1 kilograms

Circulating Load: Cyclone underflow 623 percent

Pulp Densities:

	<u>gpl</u>	<u>% Solids</u>
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Mill Discharge	2135	71.5
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Cyclone Overflow	1254	26.9
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Cyclone Underflow	2790	83.1
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Average Power: Gross 9.78 kilowatts

No Load 1.93 kilowatts

Net 7.85 kilowatts

Net Power Consumption: 19.33 kilowatt-hours per tonne of 12.7 mm feed

Work Index: 15.04

Cyclone Overflow K₈₀: 50.3 micrometers

Test No. PP-7 - Continued

1.4.2.1. Classification Data

Grinding Mill: Hendy
Cyclone: P-50 Dorr 50.8 mm diameter
15.9 mm vortex
12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recircu- lating Load, %
		400 mesh	200 mesh	gpl	% Solids	
Cyclone Feed.	2944.4	22.0	51.9	2052	68.0	-
Cyclone Overflow	412.1	70.8	91.4	1254	26.9	-
Cyclone Underflow	2532.3	15.8	47.4	2790	83.1	623

1.4.3. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical
Regrind Feed: Pb rougher concentrate + Pb 1st Cl. Scav. Concentrate
Feed Rate: 27.3 calculated kilograms per hour of concentrate
Mill Speed: 30 r.p.m., 65 percent of critical speed
Mill Load: 50 mm balls 90.7 kilograms
25 mm balls 90.7 kilograms
Total 181.4 kilograms
Average Power: Gross 2.02 kilowatts
No Load 0.95 kilowatts
Net 1.07 kilowatts

Net Power Consumption: 2.60 kilowatt-hours per tonne of flotation feed

1.4.3.1. Classification Data

Cyclone: Krebs 25 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	gpl	% Solids
Regrind Feed	-	85.8	65.1	-	-
Mill Discharge	-	68.6	20.3	-	-
Cyclone Overflow	27.3	98.6	94.5	1060	7.1
Cyclone Underflow	-	64.8	19.2	2600	75.0

Test No. PP-7 - Continued

1.4.4. Zinc Regrind Mill Report

Regrind Mill: Denver.
 Regrind Feed: Zinc Rougher Concentrate + Zn 1st Cl. Scav. Conc.
 Feed Rate: 26.2 calculated kilograms per hour of concentrate
 Mill Speed: 58 r.p.m., 70 percent of critical speed
 Mill Load: 25 mm balls 113.4 kg
 Average Power: Not calculated

1.4.4.1. Classification Data

Cyclone: P-25 Dorr 25.0 mm diameter
 6.35 mm vortex
 3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	gpl	% Solids
Regrind Feed	26.2	79.9	54	-	-
Cyclone Overflow	-	99.6	78	1085	10.5
Cyclone Underflow	-	78.6	18	1650	51.5
Mill Discharge	-	86.2	29	-	-

Test No. PP-7 - Continued

1.4.5. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8 inch	8.2	8.2	91.8
3 mesh	10.1	18.3	81.7
4	10.3	28.6	71.4
6	7.8	36.4	63.6
8	6.2	42.6	57.4
10	6.0	48.6	51.4
14	5.5	54.1	45.9
20	4.8	58.9	41.1
28	6.9	65.8	34.2
35	6.3	72.1	27.9
48	6.0	78.1	21.9
65	4.4	82.5	17.5
100	3.0	85.5	14.5
- 100	14.5	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.1	0.3	99.7
28	0.3	0.6	99.7
35	0.5	1.1	98.9
48	1.5	2.6	97.4
65	3.5	6.1	93.9
100	7.6	13.7	86.3
150	12.7	26.4	73.6
200	21.7	48.1	51.9
270	14.1	62.2	37.8
400	15.8	78.0	22.0
- 400	22.0	100.0	-
Total	100.0	-	-

Test No. PP-7 - Continued

1.4.5. Screen Analyses:

P-50 Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.1	0.1	99.9
10	0.2	0.3	99.7
14	0.1	0.4	99.6
20	0.1	0.5	99.5
28	0.4	0.9	99.1
35	0.7	1.6	98.4
48	1.9	3.5	96.5
65	3.6	7.1	92.9
100	8.3	15.4	84.6
150	12.0	27.4	72.6
200	25.2	52.6	47.4
270	14.6	67.2	32.8
400	17.0	84.2	15.8
- 400	15.8	100.0	-
Total	100.0	-	-

P-50 Cyclone Overflow

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.1	0.3	99.7
28	0.1	0.4	99.6
35	0.1	0.5	99.5
48	0.1	0.6	99.4
65	0.2	0.8	99.2
100	0.7	1.5	98.5
150	2.1	3.6	96.4
200	5.0	8.6	91.4
270	9.4	18.0	82.0
400	11.2	29.2	70.8
- 400	70.8	100.0	-
Total	100.0	-	-

Test No. PP-7 - Continued

1.4.5. Screen Analyses:

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 48	0.1	0.1	99.9
65	0.2	0.3	99.7
100	0.9	1.2	98.8
150	2.4	3.6	96.4
200	5.9	9.5	90.5
270	11.0	20.5	79.5
400	12.4	32.9	67.1
- 400	67.1	100.0	-
Total	100.0	-	-

Pb Rougher Concentrate

+ 65 mesh	0.3	0.3	99.7
100	0.6	0.9	99.1
150	0.8	1.7	98.3
200	2.5	4.2	95.8
270	3.8	8.0	92.0
400	6.2	14.2	85.8
26.5 μ m	11.7	25.9	74.1
20.5	8.9	34.9	65.1
14.3	12.6	47.4	52.6
9.9	12.8	60.2	39.8
7.6	7.8	68.0	32.0
- 7.6	32.0	100.0	-
Total	100.0	-	-

Specific Gravity = 4.53

Test No. PP-7 - Continued

1.4.5. Screen Analyses:

Pb Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	0.2	0.2	99.8
150	0.8	1.0	99.0
200	3.9	4.9	95.1
270	8.7	13.6	86.4
400	17.8	31.4	68.6
25.3 μ m	27.8	59.2	40.8
19.6	20.5	79.7	20.3
13.7	12.2	91.9	8.1
9.4	2.9	94.8	5.2
7.3	0.8	95.6	4.4
- 7.3	4.4	100.0	-
Total	100.0	-	-

Specific Gravity = 4.92

Pb Regrind Cyclone Underflow

+ 100 mesh	0.3	0.3	99.7
150	0.9	1.2	98.8
200	4.4	5.6	94.4
270	10.6	16.2	83.8
400	19.0	35.2	64.8
25.2 μ m	26.2	61.4	38.6
19.5	19.4	80.8	19.2
13.6	11.2	92.0	8.0
9.4	2.9	94.9	5.1
7.7	0.7	95.6	4.4
- 7.7	4.4	100.0	-
Total	100.0	-	-

Specific Gravity = 4.93

Test No. PP-7 - Continued

1.4.5. Screen Analyses:

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 400 mesh	1.4	1.4	98.6
28.1 μ m	1.2	2.6	97.4
21.8	1.8	4.4	95.6
15.2	13.2	17.6	82.4
10.4	23.1	40.7	59.3
8.1	13.2	53.9	46.1
- 8.1	46.1	100.0	-
Total	100.0	-	-

Specific Gravity = 4.14

Zn Rougher Concentrate

+ 100 mesh	0.4	0.4	99.6
150	1.2	1.6	98.4
200	3.2	4.8	95.2
270	4.9	9.7	90.3
400	10.4	20.1	79.9
28.9 μ m	7.2	27.3	72.7
22.4	11.4	38.7	61.3
17.0	15.8	54.5	45.5
10.7	12.6	67.1	32.9
8.3	6.7	73.8	26.2
- 8.3	26.2	100.0	-
Total	100.0	-	-

Specific Gravity = 4.05

Test No. PP-7 - Continued

1.4.5. Screen Analyses:

Zn Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	0.8	0.8	99.2
270	2.6	3.4	96.6
400	10.4	13.8	86.2
28.1 μ m	18.1	31.9	68.1
21.8	31.2	63.1	36.9
15.2	22.2	85.3	14.7
10.5	5.1	90.4	9.6
8.1	2.0	92.4	7.6
- 8.1	7.6	100.0	-
Total	100.0	-	-

Specific Gravity = 4.14

Zn Regrind Cyclone Underflow

+ 150 mesh	0.5	0.5	99.5
200	1.8	2.3	97.7
270	4.2	6.5	93.5
400	14.9	21.4	78.6
28.1 μ m	20.5	41.9	58.1
21.8	34.3	76.2	23.8
15.2	16.0	92.0	8.0
10.5	2.6	94.8	5.2
8.1	0.8	95.6	4.4
- 8.1	4.4	100.0	-
Total	100.0	-	-

Specific Gravity = 4.17

Zn Regrind Cyclone Overflow

+ 400 mesh	0.4	0.4	99.6
28.9 μ m	1.8	2.2	97.8
22.4	7.4	9.6	90.4
17.0	25.6	35.2	64.8
10.7	19.4	54.6	45.4
8.3	10.2	64.8	35.2
- 8.3	35.2	100.0	-
Total	100.0	-	-

Specific Gravity = 4.06

Test No. PP-7 - Continued

2. Flotation

- 2.1. Purpose: To investigate the effect of increased zinc cleaning time and to improve lead concentrate grade.
- 2.2. Method: The following changes were made in the lead and zinc flotation circuits:
- a) Lead Circuit
1. Increased the cyanide addition to the lead regrinding mill feed.
 2. Slightly decreased the pulp density in the lead 2nd and 3rd cleaner feeds.
- b) Zinc Circuit
1. Increased zinc 2nd and 3rd cleaning times.
 2. Replaced collector Z-200 with collector R-208.

2.2.1. Flotation Equipment:

Similar to test PP-5, except that one Denver No. 7 cell was added to the zinc 2nd cleaner and zinc 3rd cleaner stages.

2.2.2. Flotation Reagents:

Type	Rate, g/tonne	Circuit	Point of Additions
Na ₂ CO ₃	8668	Lead	Hendy Mill Feed
NaCN	259.5	Lead	Hendy Mill Feed
A-343	14.0	Lead	Hendy Mill Feed
A-343	21.5	Lead	Pb Conditioner
R-242	9.0	Lead	Pb Conditioner
MIBC	60.9	Lead	Pb Rougher Feed
A-343	51.9	Lead	Pb Scavenger Feed
R-242	10.0	Lead	Pb Scavenger Feed
Na ₂ CO ₃	778.4	Lead	Pb Regrind Mill Feed
NaCN	86.3	Lead	Pb Regrind Mill Feed
A-343	11.0	Lead	Pb Regrind Mill Pump
Na ₂ CO ₃	319.4	Lead	Pb 3rd Cleaner Feed
NaCN	20.5	Lead	Pb 1st Cleaner Scav. Feed
Lime	3612.8	Zinc	Zn Conditioner Feed
CuSO ₄	723.6	Zinc	Zn Conditioner
A-343	76.8	Zinc	Zn Rougher Feed Pump
MIBC	149.2	Zinc	Zn Rougher Feed Pump
R-208	37.9	Zinc	Zn Rougher Feed
D-1012	5.0	Zinc	Zn Rougher Feed
A-343	21.5	Zinc	Zn Scavenger Feed
MIBC	59.9	Zinc	Zn Scavenger Feed
R-208	41.9	Zinc	Zn Scavenger Feed
Lime	1372.3	Zinc	Zn Regrind Mill Feed
CuSO ₄	114.8	Zinc	Zn Regrind Mill Feed
Z-200	-	Zinc	Zn 1st Cleaner Feed
A-343	2.5	Zinc	Zn 1st Cleaner Scav. Feed
MIBC	74.9	Zinc	Zn 1st Cleaner Scav. Feed
Lime	254.5	Zinc	Zn 3rd Cleaner Feed

Test No. PP-7 - Continued

2.3. Flowsheet: As for test PP-6.

2.4. Results:

2.4.1. Observations: The lower pulp density in the lead cleaning improved lead concentrate grade significantly. The addition of collector R-208 to the zinc rougher improved the froth conditions slightly.

2.4.2. pH and Pulp Density:

Product	Pulp Density, g/l	pH
Pb Rougher Feed	1200	9.7
Pb Scavenger Tailing	1200	9.6
Pb 1st Cleaner Feed	1060	10.3
Pb 2nd Cleaner Feed	-	10.1
Pb 3rd Cleaner Feed	-	10.5
Pb 1st Cleaner Scav. Feed	-	10.2
Zn Rougher Feed	1170	10.3
Zn Scavenger Feed	1160	10.2
Zn 1st Cleaner Scav. Feed	-	11.5
Zn 2nd Cleaner Feed	-	10.8
Zn 3rd Cleaner Feed	-	10.4
Zn 4th Cleaner Feed	-	11.3
Zn 1st Cleaner Scav. Tailing	1010	-
Zn Combined Tailing	1130	-

2.4.3. Pulp Temperature

Product	Temperature, °C
Pb Rougher Feed	24
Zn Rougher Feed	23

Test No. PP-7 - Continued

2.4.4. Chemical Analyses

Product	Assays, %		
	Pb	Zn	Fe
Hendy Cyclone Overflow	2.48	4.04	33.6
Pb Rougher Concentrate	29.7	7.74	17.5
Pb Rougher Tailing	0.95	4.19	34.0
Pb Scavenger Concentrate	6.15	8.38	28.4
Pb Scavenger Tailing	0.56	3.96	34.2
Kason Undersize	2.37	3.84	33.8
Pb 1st Cleaner Concentrate	45.8	7.09	8.89
Pb 1st Cleaner Tailing	17.0	9.54	18.6
Pb 1st Cleaner Scav. Conc.	23.5	9.22	14.0
Pb 1st Cleaner Scav. Tailing	9.66	9.63	22.7
Pb 2nd Cleaner Concentrate	63.4	4.51	5.47
Pb 3rd Cleaner Concentrate	66.2	3.80	4.52
Zn Rougher Feed	0.62	4.65	33.6
Zn Rougher Concentrate	0.81	46.4	14.1
Zn Scavenger Concentrate	1.58	16.2	27.3
Zn Scavenger Tailing	0.57	0.86	36.0
Zn 1st Cleaner Concentrate	0.61	50.4	11.2
Zn 1st Cleaner Tailing	1.90	18.7	24.9
Zn 1st Cleaner Scav. Conc.	1.59	37.9	15.5
Zn 1st Cleaner Scav. Tailing	2.09	3.50	31.8
Zn 2nd Cleaner Concentrate	0.50	51.40	10.8
Zn 3rd Cleaner Concentrate	0.53	51.60	10.5
Zn Combined Tailing	0.58	0.99	35.6
Zn 4th Cleaner Concentrate	0.41	51.7	10.3

Test No. PP-7 - Continued

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %			% Distribution	
		Pb	Zn	Fe	Pb	Zn
Pb 3rd Cleaner Concentrate	2.74	66.2	3.8	4.5	76.6	2.7
Zn 4th Cleaner Concentrate	5.47	0.41	51.7	10.3	0.9	73.6
Zn Combined Tailing	91.79	0.58	0.99	35.6	22.5	23.7
Kason Undersize	100.00	2.37	3.84	33.4	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Concentrate	6.21	29.7	7.74	-	77.8	11.4
Pb Scavenger Tailing	93.79	0.56	3.96	-	22.2	88.6
Cyclone Overflow (Meas.)	100.00	2.37	3.84	-	100.0	100.0
(calc.)	-	2.37	4.19	-	-	-
Zn Rougher Concentrate	6.36	0.81	46.4	-	2.1	74.5
Zn Combined Tailing	90.90	0.58	0.99	-	21.3	22.8
Pb Scav. Tail. (Meas.)	97.26	0.56	3.96	-	23.4	97.3
(calc.)	-	0.59	3.96	-	24.3	99.9

Test No. PP-8

1. Grinding

1.1. Purpose: To repeat conditions of test PP-6 and PP-7.

1.2. Method: As for tests PP-6 and PP-7. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 406.2 kilograms per hour. Samples were taken every 20 minutes in the last two hours of operation.

1.3. Flowsheet: As for test PP-1.

1.4. Results:

1.4.1. Observations: The grinding circuit was stable during the test run.

1.4.2. Ball Mill Report

Feed: Minus 12.7 mm ore at 0.6 percent moisture content

Feed Rate: 406.2 dry kilograms per hour

Mill Speed: 32 r.p.m., 80.5 percent of critical speed

Mill Load: 76.2 mm balls 365.5 kilograms

50.8 mm balls 362.8 kilograms

25.4 mm balls 90.6 kilograms

Total 818.9 kilograms

Operating Time: Total 7.5 hours, test period 2 hours

Mill Feed: Total 3046.5 kilograms, test period 812.4 kilograms

Circulating Load: Cyclone underflow: 614.5 percent

Pulp Densities:

	<u>g/l</u>	<u>% Solids</u>
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Mill Discharge 2120 69.2

Cyclone Overflow 1254 26.8

Cyclone Underflow 2766 84.1

Average Power: Gross 9.97 kilowatts

No Load 1.93 kilowatts

Net 8.04 kilowatts

Net Power Consumption: 19.80 kilowatt-hours per tonne of 12.7 mm feed

Work Index: 16.30

Cyclone Overflow K₈₀: 55.8 micrometers

Test No. PP-8 - Continued

1.4.2.1. Classification Data

Grinding Mill: Hendy
 Cyclone: P-50 50.8 mm diameter
 15.9 mm vortex
 12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recircu- lating Load, %
		400 mesh	200 mesh	gpl	% Solids	
Cyclone Feed	3012.0	22.0	53.0	2044	67.1	-
Cyclone Overflow	406.2	64.5	88.3	1254	26.8	-
Cyclone Underflow	2605.8	15.5	45.9	2766	84.1	614.5

1.4.3. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical
 Regrind Feed: Pb rougher concentrate + Pb 1st cl. scav. conc.
 Feed Rate: 21.2 calculated kilograms per hour of concentrate
 Mill Speed: 30 r.p.m., 65 percent of critical speed
 Mill Load: 50 mm balls 90.7 kilograms
 25 mm balls 90.7 kilograms
 Total 181.4 kilograms
 Average Power: Gross 2.14 kilowatts
 No Load 0.95 kilowatts
 Net 1.19 kilowatts
 Net Power Consumption: 2.93 kilowatt-hours per tonne of flotation feed

1.4.3.1. Classification Data

Cyclone: Krebs 25 mm diameter
 12.7 mm vortex
 3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	gpl	% Solids
Regrind Feed	-	75.8	56.6	-	-
Mill Discharge	-	62.9	23.5	-	-
Cyclone Overflow	21.2	97.4	85.0	1040	4.8
Cyclone Underflow	-	59.3	19.0	2580	75.1

Test No. PP-8 - Continued

1.4.4. Zinc Regrind Mill Report

Regrind Mill: Denver Mill
Regrind Feed: Zn Rougher Concentrate + Zn 1st Cl. Scav. Conc.
Feed Rate: 37.8 calculated kilograms per hour of concentrate
Mill Speed: 58 r.p.m., 70 percent of critical speed
Mill Load: 25 mm balls 113.4 kg
Average Power: Not calculated

1.4.4.1. Classification Data

Cyclone: P-25 Dorr 25 mm diameter
6.35 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	gpl	% Solids
Cyclone Overflow	-	96.2	81	1100	12.0
Cyclone Underflow	-	63.4	20	1640	51.3
Regrind Feed	37.8	67.8	46	-	-
Mill Discharge	-	73.0	27	-	-

Test No. PP-8 - Continued

1.4.5. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8 inch	7.1	7.1	92.9
3 mesh	12.7	19.8	80.2
4	11.7	31.5	68.5
6	8.0	39.5	60.5
8	6.4	45.9	54.1
10	5.3	51.2	48.8
14	5.4	56.6	43.4
20	5.1	61.7	38.3
28	6.1	67.8	32.2
35	5.4	73.2	26.8
48	5.5	78.7	21.3
65	4.5	83.2	16.8
100	2.9	86.1	13.9
- 100	13.9	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.2	0.5	99.5
28	0.5	1.0	99.0
35	0.7	1.7	98.3
48	1.7	3.4	96.6
65	4.2	7.6	92.4
100	7.6	15.2	84.8
150	13.0	28.2	71.8
200	18.8	47.0	53.0
270	19.4	66.4	33.6
400	11.6	78.0	22.0
- 400	22.0	100.0	-
Total	100.0	-	-

Test No. PP-8 - Continued

1.4.5. Screen Analyses

P-50 Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.2	0.2	99.8
10	0.3	0.5	99.5
14	0.2	0.7	99.3
20	0.4	1.1	98.9
28	0.6	1.7	98.3
35	0.9	2.6	97.4
48	2.1	4.7	95.3
65	4.3	9.0	91.0
100	8.6	17.6	82.4
150	13.3	30.9	69.1
200	23.2	54.1	45.9
270	14.2	68.3	31.7
400	16.2	84.5	15.5
- 400	15.5	100.0	-
Total	100.0	-	-

P-50 Cyclone Overflow

+ 14	0.1	0.1	99.9
20	0.1	0.2	99.8
28	0.1	0.3	99.7
35	0.1	0.4	99.6
48	0.1	0.5	99.5
65	0.3	0.8	99.2
100	1.1	1.9	98.1
150	3.1	5.0	95.0
200	6.7	11.7	88.3
270	11.4	23.1	76.9
400	12.4	35.5	64.5
- 400	64.5	100.0	-
Total	100.0	-	-

Test No. PP-8 - Continued

1.4.5. Screen Analyses:

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 48	0.1	0.1	99.9
65	0.2	0.3	99.7
100	1.0	1.3	98.7
150	2.4	3.7	96.3
200	7.0	10.7	89.3
270	7.1	17.8	82.2
400	13.5	31.3	68.7
- 400	68.7	100.0	-
Total	100.0	-	-

Pb Rougher Concentrate

+ 65	1.4	1.4	98.6
100	1.4	2.8	97.2
150	1.6	4.4	95.6
200	3.6	8.0	92.0
270	5.5	13.5	86.5
400	10.7	24.2	75.8
26.8 μ m	9.7	33.9	66.1
20.8	9.5	43.4	56.6
14.5	12.0	55.4	44.6
10.0	10.5	65.9	34.1
7.7	6.8	72.7	27.3
- 7.7	27.3	100.0	-
Total	100.0	-	-

Specific Gravity = 4.52

Test No. PP-8 - Continued

1.4.5. Screen Analyses:

Pb Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	0.2	0.2	99.8
150	0.6	0.8	99.2
200	3.7	4.5	95.5
270	9.1	13.6	86.4
400	23.5	37.1	62.9
25.5 μ m	20.2	57.3	42.7
19.7	19.2	76.5	23.5
13.8	12.2	88.7	11.3
9.5	4.2	92.9	7.1
7.3	1.3	94.2	5.8
- 7.3	5.8	100.0	-
Total	100.0	-	-

Specific Gravity = 4.93

Pb Regrind Cyclone Underflow

+ 65 mesh	0.1	0.1	99.9
100	0.2	0.3	99.7
150	1.0	1.3	98.7
200	4.2	5.5	94.5
270	11.2	16.7	83.3
400	24.0	40.7	59.3
25.7 μ m	21.4	62.1	37.9
19.9	18.9	81.0	19.0
13.9	11.0	92.0	8.0
9.5	3.4	95.4	4.6
7.4	0.9	96.3	3.7
- 7.4	3.7	100.0	-
Total	100.0	-	-

Specific Gravity = 4.87

Test No. PP-8 - Continued

1.4.5. Screen Analyses:

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 400 mesh	2.6	2.6	97.4
28.2 μ m	2.8	5.4	94.6
21.8	8.4	13.8	86.2
15.2	14.2	28.0	72.0
10.2	12.2	40.2	59.8
8.1	11.1	51.3	48.7
- 8.1	48.7	100.0	-
Total	100.0	-	-

Specific Gravity = 4.19

Zn Rougher Concentrate

+ 65 mesh	0.6	0.6	99.4
100	1.2	1.8	98.2
150	2.4	4.2	95.8
200	6.0	10.2	89.8
270	8.2	18.4	81.6
400	13.8	32.2	67.8
28.2 μ m	6.2	38.4	61.6
21.8	11.1	49.5	50.5
15.2	13.3	62.8	37.2
10.5	10.0	72.8	27.2
8.1	5.6	78.4	21.6
- 8.1	21.6	100.0	-
Total	100.0	-	-

Specific Gravity = 4.18

Test No. PP-8 - Continued

1.4.5. Screen Analyses:

Zn Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	0.3	0.3	99.7
150	0.9	1.2	98.8
200	2.6	3.8	96.2
270	5.6	9.4	90.6
400	17.6	27.0	73.0
28.2 μ m	12.7	39.7	60.3
21.8	26.0	65.7	34.3
15.2	19.0	84.7	15.3
10.5	5.2	89.9	10.1
8.1	2.0	91.9	8.1
- 8.1	8.1	100.0	-
Total	100.0	-	-

Specific Gravity = 4.19

Zn Regrind Cyclone Underflow

+ 100 mesh	0.6	0.6	99.4
150	0.9	1.5	98.5
200	5.6	7.1	92.9
270	7.7	14.8	85.2
400	21.8	36.6	63.4
28.2 μ m	12.2	48.8	51.2
21.8	25.4	74.2	25.8
15.2	16.1	90.3	9.7
10.5	3.2	93.5	6.5
8.1	1.0	94.5	5.5
- 8.1	5.5	100.0	-
Total	100.0	-	-

Specific Gravity = 4.18

Zn Regrind Cyclone Overflow

+ 400 mesh	3.8	3.8	96.2
29.1 μ m	1.7	5.5	94.5
22.5	7.0	12.5	87.5
15.7	17.5	30.0	70.0
10.8	19.8	39.8	50.2
8.3	11.3	61.1	38.9
- 8.3	38.9	100.0	-
Total	100.0	-	-

Specific Gravity = 4.00

Test No. PP-8 - Continued

2. Flotation

2.1. Purpose:

- 1) To investigate the effect of longer cleaning time in the lead cleaning.
- 2) To improve froth conditions in the zinc rougher and scavenger stages.

2.2. Method:

The lead 1st, 2nd and 3rd cleaning times were increased by 50% and the Pb 1st cleaner scavenger time increased from 14 minutes to 32 minutes. In the zinc rougher and scavenger stages, frother D-1012 was added, and the additions of MIBC were decreased. The circuit was operated for a period of 7.5 hours and sampled every 30 minutes in the last two hours of operation.

2.2.1. Flotation Equipment: As for test PP-6, except that the Pb cleaning capacity was changed as follows:

Pb 1st Cleaner	6 Denver No. 5 cells
Pb 2nd Cleaner	4 Denver No. 5 cells
Pb 3rd Cleaner	2 Denver No. 1 cells
Pb 1st Scavenger	6 Wemco No. 12 cells

2.2.2. Flotation Reagents:

Type	Rate, g/tonne	Circuit	Point of Addition
Na ₂ CO ₃	8797.73	Lead	Hendy Mill Feed
NaCN	270.96	Lead	Hendy Mill Feed
A-343	14.47	Lead	Hendy Mill Feed
A-343	23.45	Lead	Pb Conditioner
R-242	8.98	Lead	Pb Conditioner
MIBC	60.88	Lead	Pb Rougher Feed Pump
A-343	50.90	Lead	Pb Scavenger Feed
R-242	11.98	Lead	Pb Scavenger Feed
NaCN	83.83	Lead	Pb Regrind Mill Feed
Na ₂ CO ₃	584.83	Lead	Pb Regrind Mill Feed
A-343	11.48	Lead	Pb Cyclone Regrind Pump
NaCN	21.96	Lead	Pb 1st Cl. Scav. Feed
Na ₂ CO ₃	439.12	Lead	Pb 2nd Cleaner Feed
Lime	3373.24	Zinc	Zn Conditioner Feed
CuSO ₄	879.74	Zinc	Zn Conditioner
A-343	87.82	Zinc	Zn Rougher Feed
R-208	37.43	Zinc	Zn Rougher Feed
MIBC	151.20	Zinc	Zn Rougher Feed
D-1012	18.96	Zinc	Zn Rougher Feed
A-343	21.96	Zinc	Zn Scavenger Feed
D-1012	88.32	Zinc	Zn Scavenger Feed
MIBC	26.44	Zinc	Zn Scavenger Feed
R-208	8.84	Zinc	Zn Scavenger Feed
Lime	1685.62	Zinc	Zn Regrind Feed
CuSO ₄	219.56	Zinc	Zn Regrind Feed
Z-200	22.95	Zinc	Zn 1st Cleaner Feed
A-343	35.93	Zinc	Zn 1st Cl. Scav. Feed
MIBC	24.95	Zinc	Zn 1st Cl. Scav. Feed
CuSO ₄	58.38	Zinc	Zn 1st Cl. Scav. Feed
Lime	234.03	Zinc	Zn 3rd Cleaner Feed

Test No. PP-8 - Continued

2.3. Flowsheet

As for test PP-6

2.4. Results:

2.4.1. Observations: The increased cleaning capacity in the lead circuit resulted in lower lead concentrate grade. The cleaning was more difficult to control. The additions of frother D-1012 in the zinc scavenger resulted in an improved froth conditions in the zinc rougher and scavenger stage.

2.4.2. pH and Pulp Density

Product	Pulp Density g/l	pH
Pb Rougher Feed	1200	9.8
Pb Scavenger Tailing	1190	9.75
Pb 1st Cleaner Scav. Feed	-	10.05
Pb 1st Cleaner Feed	-	10.2
Pb 2nd Cleaner Feed	-	9.95
Pb 3rd Cleaner Feed	-	10.2
Zn Rougher Feed	1150	10.3
Zn Scavenger Feed	1150	10.2
Zn 1st Cleaner Scav. Feed	-	11.7
Zn 1st Cleaner Feed	1100	11.8
Zn 2nd Cleaner Feed	-	10.6
Zn 3rd Cleaner Feed	-	9.6
Zn 4th Cleaner Feed	-	11.3
Zn 1st Cleaner Scav. Tailing	1030	-
Zn Combined Tailing	1090	-

2.4.3. Pulp Temperature

Product	Temperature, °C
Pb Rougher Feed	23.3
Zn Rougher Feed	23.0

Test No. PP-8 - Continued

2.4.4. Chemical Analyses

Products	Assays, %		
	Pb	Zn	Fe
Hendy Cyclone Overflow	2.32	4.08	33.6
Pb Rougher Concentrate	34.0	7.23	15.6
Pb Rougher Tailing	0.99	4.13	33.5
Pb Scavenger Concentrate	6.24	8.28	29.2
Pb Scavenger Tailing	0.58	3.85	33.6
Kason Undersize	2.36	3.83	32.8
Pb 1st Cleaner Concentrate	40.1	7.17	11.0
Pb 1st Cleaner Tailing	20.6	10.2	18.0
Pb 1st Cleaner Scav. Conc.	22.7	10.4	16.4
Pb 1st Cleaner Scav. Tailing	8.21	8.99	24.3
Pb 2nd Cleaner Concentrate	50.6	5.83	8.33
Pb 3rd Cleaner Concentrate	61.2	3.90	5.71
Zn Rougher Feed	0.69	4.03	33.9
Zn Rougher Concentrate	1.07	36.2	18.8
Zn Scavenger Concentrate	1.46	4.46	34.0
Zn Scavenger Tailing	0.54	0.39	34.8
Zn 1st Cleaner Concentrate	0.96	49.8	12.3
Zn 1st Cleaner Tailing	1.70	6.55	32.6
Zn 1st Cleaner Scav. Conc.	1.99	12.0	30.5
Zn 1st Cleaner Scav. Tailing	1.33	2.47	32.8
Zn 2nd Cleaner Concentrate	0.86	50.2	11.6
Zn 3rd Cleaner Concentrate	0.80	50.7	11.3
Zn Combined Tailing	0.55	0.42	35.0
Zn 4th Cleaner Concentrate	0.64	51.3	10.8

Test No. PP-8 - Continued

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Cleaner Concentrate	2.98	61.20	3.90	77.2	3.0
Zn Cleaner Concentrate	6.50	0.64	51.30	1.7	87.1
Zn Combined Tailing	90.52	0.55	0.42	21.1	9.9
Kason Undersize	100.00	2.36	3.83	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Concentrate	5.21	34.0	7.23	76.3	9.4
Pb Scavenger Tailing	94.79	0.58	3.85	23.7	90.6
Cyclone Overflow (Meas.)	100.0	2.32	4.08	100.0	100.0
(calc.)	100.0	2.32	4.03	-	-
Zn Rougher Concentrate	9.30	1.07	36.2	3.9	87.4
Zn Combined Tailing	87.72	0.55	0.42	18.9	9.6
Pb Scavenger Tailing (Meas.)	97.02	0.58	3.85	22.8	97.0
(calc.)	-	0.59	3.85	25.0	97.5

Test No. PP-9

1. Grinding

1.1. Purpose: To produce a finer primary grind product.

1.2. Method: The following changes were made in the grinding circuit:

- 1) Added 90.7 kilograms of 25.4 mm balls to the mill.
- 2) Decreased feed rate from 410 kg/h to 368.6 kg/hour.

The grinding circuit was operated for a period of 7.5 hours and sampled every 30 minutes in the last two hours of operation.

1.3. Flowsheet: As for test PP-1.

1.4. Results:

1.4.1. Observations: The P-50 Dorr cyclone plugged at 10:30 a.m. and was unplugged at 10:40 a.m. The circuit stabilized after 11:00 a.m. and was stable for the remainder of the test run.

1.4.2. Ball Mill Report

Feed: Minus 12.7 mm ore at 0.6 percent moisture content

Feed Rate: 368.6 dry kilograms per hour

Mill Speed: 32 r.p.m., 80.5 percent of critical speed

Mill Load: 76.2 mm balls 365.5 kilograms

50.8 mm balls 362.8 kilograms

25.4 mm balls 181.3 kilograms

Total 909.6 kilograms

Operating Time: Total 7.5 hours, test period 2 hours

Mill Feed: Total 2764.5 kilograms, test period 737.2 kilograms

Circulating Load: Cyclone underflow 569.12 percent

Pulp Densities:

	<u>gpl</u>	<u>% Solids</u>
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Mill Discharge 2032 67.9

Cyclone Overflow 1254 26.3

Cyclone Underflow 2584 80.3

Average Power: Gross 10.69 kilowatts

No Load 1.93 kilowatts

Net 8.76 kilowatts

Net Power Consumption: 23.8 kilowatt-hours per tonne of 12.7 mm feed

Work Index: 17.64

Cyclone Overflow K_{80} : 45.4 micrometers

Test No. PP-9 - Continued

1.4.2.1. Classification Data

Grinding Mill: Hendy
Cyclone: Krebs 50.8 mm diameter
15.9 mm vortex
12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recirculating Load, %
		400 mesh	200 mesh	gpl	% Solids	
Cyclone Feed	2466.4	30.0	62.7	1976	64.6	-
Cyclone Overflow	368.6	75.6	92.9	1254	26.3	-
Cyclone Underflow	2097.8	20.8	58.0	2584	80.3	569.1

1.4.3. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical
Regrind Feed: Pb Rougher Concentrate + Pb 1st Cl. Scav. Conc.
Feed Rate: 22.4 calculated kilograms per hour of concentrate
Mill Speed: 30 r.p.m., 65 percent of critical speed
Mill Load: 50 mm balls 90.7 kilograms
25 mm balls 90.7 kilograms
Total 181.4 kilograms
Average Power: Not calculated

1.4.3.1. Classification Data

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	gpl	% Solids
Regrind Feed	-	87.9	68.5	-	-
Mill Discharge	-	66.4	22.0	-	-
Cyclone Overflow	22.4	98.1	91.0	1120	12.7
Cyclone Underflow	-	65.8	21.8	2510	74.3

Test No. PP-9 - Continued

1.4.4. Zinc Regrind Mill Report

Regrind Mill: Denver Mill
 Regrind Feed: Zinc Rougher Concentrate + Zn 1st Cleaner Scav. Conc.
 Feed Rate: 37.2 calculated kilograms per hour of concentrate
 Mill Speed: 58 r.p.m., 70 percent of critical speed
 Mill Load: 25 mm balls 113.4 kg
 Average Power: Not calculated

1.4.4.1. Classification Data

Cyclone: P-25 Dorr 25 mm diameter
 6.35 mm vortex
 3.25 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 μ m	gpl	% Solids
Cyclone Overflow	-	99.4	83	1110	13.0
Cyclone Underflow	-	69.5	21	1736	55.5
Regrind Feed	37.2	75.7	50	-	-
Mill Discharge	-	72.5	30	-	-

Test No. PP-9 - Continued

1.4.5. Screen Analyses:

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8 inch	2.1	2.1	97.9
3 mesh	12.5	14.6	85.4
4	9.7	24.3	75.7
6	8.7	33.0	67.0
8	7.0	40.0	60.0
10	7.1	47.1	52.9
14	5.9	53.0	47.0
20	5.2	58.2	41.8
28	7.5	65.7	34.3
35	6.8	72.5	27.5
48	6.1	78.6	21.4
65	4.0	82.6	17.4
100	3.5	86.1	13.9
- 100	13.9	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.6	1.3	98.7
48	1.2	2.5	97.5
65	2.3	4.8	95.2
100	5.3	10.1	89.9
150	9.0	19.1	80.9
200	18.2	37.3	62.7
270	13.5	50.8	49.2
400	19.2	70.0	30.0
- 400	30.0	100.0	-
Total	100.0	-	-

Test No. PP-9 - Continued

1.4.5. Screen Analyses

P-50 Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.2	0.2	99.8
10	0.2	0.4	99.6
14	0.3	0.7	99.3
20	0.3	1.0	99.0
28	0.4	1.4	98.6
35	0.6	2.0	98.0
48	1.3	3.3	96.7
65	3.1	6.4	93.6
100	6.1	12.5	87.5
150	11.2	23.7	76.3
200	18.3	42.0	58.0
270	21.8	63.8	36.2
400	15.4	79.2	20.8
- 400	20.8	100.0	-
Total	100.0	-	-

P-50 Cyclone Overflow

+ 48	0.1	0.1	99.9
65	0.1	0.2	99.8
100	0.6	0.8	99.2
150	1.4	2.2	97.8
200	4.9	7.1	92.9
270	5.6	12.7	87.3
400	11.7	24.4	75.6
- 400	75.6	100.0	-
Total	100.0	-	-

Test No. PP-9 - Continued

1.4.5. Screen Analyses:

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65	0.1	0.1	99.9
100	0.4	0.5	99.5
150	1.6	2.1	97.9
200	4.4	6.5	93.5
270	9.0	15.5	84.5
400	11.0	26.5	73.5
- 400	73.5	100.0	-
Total	100.0	-	-

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.2	0.2	99.8
100	0.2	0.4	99.6
150	0.4	0.8	99.2
200	1.4	2.2	97.8
270	3.1	5.3	94.7
400	6.8	12.1	87.9
27.5 μ m	9.0	21.1	78.9
21.3	8.3	29.4	70.6
14.9	13.1	42.5	57.5
10.2	14.3	56.8	43.2
7.9	8.8	65.6	34.4
- 7.9	34.4	100.0	-
Total	100.0	-	-

Specific Gravity = 4.22

Test No. PP-9 - Continued

1.4.5. Screen Analyses:

Pb Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.2	0.2	99.8
100	0.3	0.5	99.5
150	0.6	1.1	98.9
200	2.8	3.9	96.1
270	6.7	10.6	89.4
400	23.0	33.6	66.4
25.1 μ m	23.5	57.1	42.9
19.4	21.1	78.2	21.8
13.6	12.8	91.1	8.9
9.3	3.3	94.3	5.7
7.2	1.0	95.3	4.7
- 7.2	4.7	100.0	-
Total	100.0	-	-

Specific Gravity = 5.03

Pb Regrind Cyclone Underflow

+ 100 mesh	0.2	0.2	99.8
150	0.5	0.7	99.3
200	3.0	3.7	96.3
270	8.2	11.9	88.1
400	22.3	34.2	65.8
25.1 μ m	23.1	57.3	42.7
19.4	20.9	78.2	21.8
13.6	13.0	91.2	8.8
9.3	3.5	94.7	5.3
7.2	1.0	95.7	4.3
- 7.2	4.3	100.0	-
Total	100.0	-	-

Specific Gravity = 5.03

Test No. PP-9 - Continued

1.4.5. Screen Analyses:

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 400 mesh	1.9	1.9	98.1
28.3 μ m	0.4	2.3	97.7
22.0	1.8	4.1	95.9
15.3	13.0	17.1	82.9
10.5	21.6	38.7	61.3
8.1	13.2	51.9	48.1
- 8.1	48.1	100.0	-
Total	100.0	-	-

Specific Gravity = 4.12

Zn Rougher Concentrate

+ 65 mesh	0.1	0.1	99.9
100	0.6	0.7	99.3
150	1.5	2.2	97.8
200	4.3	6.5	93.5
270	6.2	12.7	87.3
400	11.6	24.3	75.7
28.3 μ m	8.7	33.0	67.0
22.0	12.4	45.4	54.6
15.3	14.6	60.0	40.0
10.5	11.1	71.1	28.9
8.1	5.7	76.8	23.2
- 8.1	23.2	100.0	-
Total	100.0	-	-

Specific Gravity = 4.09

Test No. PP-9 - Continued

1.4.5. Screen Analyses:

Zn Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 150 mesh	0.6	0.6	99.4
200	3.9	4.5	95.5
270	5.7	10.2	89.8
400	17.3	27.5	72.5
28.2 μ m	9.2	36.7	63.3
21.8	24.1	60.8	39.2
15.2	23.5	84.3	15.7
10.5	6.0	90.3	9.7
8.1	2.0	92.3	7.7
- 8.1	7.7	100.0	-
Total	100.0	-	-

Specific Gravity = 4.19

Zn Regrind Cyclone Underflow

+ 100 mesh	0.1	0.1	99.9
150	0.4	0.5	99.5
200	4.0	4.5	95.5
270	6.5	11.0	89.0
400	19.5	30.5	69.5
28.6 μ m	10.3	40.8	59.2
22.2	24.6	65.4	34.6
15.5	22.4	87.8	12.3
10.6	4.9	92.7	7.3
8.2	1.4	94.1	5.9
- 8.2	5.9	100.0	-
Total	100.0	-	-

Specific Gravity = 4.09

Zn Regrind Cyclone Overflow

+ 400 mesh	0.6	0.6	99.4
28.7 μ m	2.2	2.8	97.2
22.3	6.6	9.4	90.6
15.5	21.2	30.6	69.4
10.7	20.9	51.5	48.5
8.3	10.6	62.1	37.9
- 8.3	37.9	100.0	-
Total	100.0	-	-

Specific Gravity = 3.99

Test No. PP-9 - Continued

2. Flotation:

2.1. Purpose:

To repeat the conditions of test PP-8 using a finer primary grind and with reagent adjustments in the lead and zinc flotation.

2.2. Method:

The following changes were made in the lead and zinc circuits:

Pb Circuit

- 1) Omitted collector R-242 from the lead rougher and scavenger.
- 2) Increased collector Z-11 to the lead rougher feed.

Zn Circuit

- 1) Omitted MIBC from the zinc scavenger feed.
- 2) Omitted lime from the Zn 3rd cleaner feed and CuSO_4 from the zinc 1st cleaner scavenger feed.
- 3) Decreased pulp density in the Zn 2nd cleaner feed.

The circuit was operated for a period of 7.5 hours and sampled every 30 minutes in the last 2 hours of operation.

2.2.1. Flotation Equipment:

As for test PP-8.

Test No. PP-9 - Continued

2.2.2. Flotation Reagents

Type	Rate, g/tonne	Circuit	Point of Addition
Na ₂ CO ₃	9660.00	Lead	Hendy Mill Feed
NaCN	290.40	Lead	Hendy Mill Feed
A-343	15.97	Lead	Hendy Mill Feed
A-343	48.40	Lead	Pb Conditioner Feed
MIBC	66.87	Lead	Pb Rougher Feed Pump
A-343	60.88	Lead	Pb Scavenger Feed
NaCN	80.84	Lead	Pb Regrind Mill Feed
Na ₂ CO ₃	1087.82	Lead	Pb Regrind Mill Feed
A-343	12.97	Lead	Pb Regrind Cyclone Pump
NaCN	23.45	Lead	Pb 1st Cleaner Scav. Feed
Na ₂ CO ₃	319.36	Lead	Pb 2nd Cleaner Feed
Lime	3682.62	Zinc	Zn Conditioner Feed
CuSO ₄	968.06	Zinc	Zn Conditioner
R-208	43.91	Zinc	Zn Rougher Feed
D-1012	24.95	Zinc	Zn Rougher Feed
MIBC	164.67	Zinc	Zn Rougher Feed
A-343	96.80	Zinc	Zn Rougher Feed
A-343	24.45	Zinc	Zn Scavenger Feed
D-1012	54.89	Zinc	Zn Scavenger Feed
R-208	9.98	Zinc	Zn Scavenger Feed
Lime	2040.99	Zinc	Zn Regrind Mill Feed
CuSO ₄	234.03	Zinc	Zn Regrind Mill Feed
A-343	23.95	Zinc	Zn 1st Cleaner Scav. Feed
MIBC	4.99	Zinc	Zn 1st Cleaner Scav. Feed
Z-200	24.45	Zinc	Zn 1st Cleaner Feed

2.3. Flowsheet: As for test PP-6.

2.4. Results:

2.4.1. Observations: The omission of collector 242 from the lead circuit improved froth conditions in the lead 1st cleaner scavenger stage. However, fine galena floated more slowly. The zinc flotation was stable during the test run.

Test No. PP-9 - Continued

2.4.2. pH and Pulp Density

Product	pH	Pulp Density, g/l
Pb Rougher Feed	9.8	1200
Pb Scavenger Feed	9.8	-
Pb 1st Cleaner Scav. Feed	10.05	-
Pb 1st Cleaner Feed	10.25	1120
Pb 2nd Cleaner Feed	10.00	-
Pb 3rd Cleaner Feed	10.30	-
Pb Scavenger Tailing	-	1180
Zn Rougher Feed	10.3	1150
Zn Scavenger Feed	10.2	-
Zn 1st Cleaner Scav. Feed	11.7	-
Zn 1st Cleaner Feed	11.9	-
Zn 2nd Cleaner Feed	10.9	-
Zn 3rd Cleaner Feed	9.1	-
Zn 4th Cleaner Feed	8.8	-
Zn Scavenger Tailing	-	1160
Zn 1st Cleaner Scav. Tail.	-	1045
Zn Combined Tailing	-	1180

2.4.3. Pulp Temperature

Product	Temperature, °C
Pb Rougher Feed	24.5
Zn Rougher Feed	24.5

Test No. PP-9 - Continued

2.4.4. Chemical Analyses

Product	Assays, %, g/t			
	Pb	Zn	Ag	Fe
Hendy Cyclone Overflow	2.41	4.06	21.46	-
Pb Rougher Concentrate	30.1	7.08	-	-
Pb Rougher Tailing	1.15	4.32	-	-
Pb Scavenger Tailing	0.62	3.90	-	-
Kason Undersize	2.35	3.88	-	-
Pb 1st Cleaner Concentrate	55.8	4.98	-	-
Pb 1st Cleaner Tailing	23.7	8.08	-	-
Pb 1st Cleaner Scav. Conc.	32.0	7.52	-	-
Pb 1st Cleaner Scav. Tailing	14.2	8.65	-	-
Pb 2nd Cleaner Concentrate	64.8	3.42	-	-
Pb 3rd Cleaner Concentrate	69.1	2.42	501.13	3.67
Zn Rougher Feed	0.68	4.05	-	-
Zn Rougher Concentrate	0.98	34.2	-	-
Zn Scavenger Concentrate	1.27	4.94	-	-
Zn Scavenger Tailing	0.57	0.37	-	-
Zn 1st Cleaner Concentrate	0.62	49.0	-	-
Zn 1st Cleaner Tailing	2.03	6.00	-	-
Zn 1st Cleaner Scav. Conc.	32.0	7.52	-	-
Zn 1st Cleaner Scav. Tailing	1.53	2.44	-	-
Zn 2nd Cleaner Concentrate	0.59	50.3	-	-
Zn 3rd Cleaner Concentrate	0.48	51.1	-	-
Zn Combined Tailing	0.59	0.41	-	-
Zn 4th Cleaner Concentrate	0.43	52.5	38.32	-
Pb 2nd Cleaner Tailing	50.1	5.89	-	-
Zn 2nd Cleaner Tailing	2.57	21.2	-	-
Zn 3rd Cleaner Tailing	2.09	31.7	-	-
Zn 4th Cleaner Tailing	0.99	44.2	-	-

Test No. PP-9 - Continued

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %, g/t			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb Cleaner Concentrate	2.58	69.1	2.42	501.13	75.8	1.6	60.2
Zn Cleaner Concentrate	6.56	0.43	52.5	38.32	1.2	88.8	11.7
Zn Combined Tailing	90.86	0.59	0.41	6.62	23.0	9.6	28.1
Kason Undersize	100.00	2.35	3.88	21.46	100.0	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	6.07	30.1	7.08	75.8	10.5
Pb Scavenger Tailing	93.93	0.62	3.90	24.2	89.5
Cyclone Overflow (Meas.)	-	2.41	4.06	-	-
(calc.)	100.0	2.41	4.09	100.0	100.0
Zn Rougher Concentrate	10.09	0.98	34.2	4.1	84.3
Zn Combined Tailing	87.56	0.59	0.41	21.4	8.7
Zn Flotation Feed (Meas.)	97.65	0.62	3.90	24.2	89.5
(calc.)	97.65	0.63	3.90	25.5	93.0

Test No. PP10

1. Grinding

1.1. Purpose: To repeat conditions of test PP9.

1.2. Method: As for test PP9. The grinding circuit was operated for a period of 8.5 hours at a feed rate of 365.5 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.

1.3. Flowsheet: As for test PP1.

1.4. Results:

1.4.1. Observations

The grinding circuit was very stable during the test run.

Test No. PP10 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed: Minus 12.7 mm ore at 0.6 percent moisture content

Feed Rate: 365.5 dry kilograms per hour

Mill Speed: 32 r.p.m., 80.5 percent of critical speed

Mill Load: 76.2 mm balls 365.5 kilograms

50.8 mm balls 262.8 kilograms

25.4 mm balls 181.3 kilograms

Total 909.6 kilograms

Operating Time: Total 8.5 hours, test period 2 hours

Mill Feed: Total 3106.7 kilograms, test period 731 kilograms

Circulating Load: Cyclone underflow 669.8 percent

Pulp Densities:

	<u>gpl</u>	<u>% Solids</u>
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Mill Discharge	2046	67.2
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Cyclone Overflow	1260	27.2
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Cyclone Underflow	2658	83.3
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Average Power: Gross 10.45 kilowatts

No Load 1.93 kilowatts

Net 8.52 kilowatts

Net Power Consumption: 23.31 kilowatt-hours per tonne of 12.7 mm feed

Work Index: 17.93

Cyclone Overflow K₈₀: 50.3 micrometres

Test No. PP10 - Continued

1. Grinding

1.4.1.2. Classification Data

Grinding Mill Hendy
Cyclone P50 Dorr 50.8 mm diameter
 15.9 mm vortex
 12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recircu- lating Load %
		400 mesh	200 µm	g.p.l.	% Solids	
Cyclone Feed	2813.5	30.4	62.7	1986	65.2	-
Cyclone Overflow	365.5	69.4	91.7	1260	27.2	-
Cyclone Underflow	2448.0	22.1	58.3	2658	83.3	669.8

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical Mill

Regrind Feed: Pb rougher concentrate + Pb 1st cleaner scavenger concentrate

Feed Rate: 18.64 calculated kilograms per hour of concentrate

Mill Speed: 30 r.p.m., 65 percent of critical speed

Mill Load: 50 mm balls 90.7 kilograms
 25 mm balls 90.7 kilograms
 Total 181.4 kilograms

Average Power: Gross 1.90 kilowatts
 No Load 0.95 kilowatts
 Net 0.95 kilowatts

Net Power Consumption: 2.60 kilowatt-hours per tonne of flotation feed

Test No. PP10 - Continued

1. Grinding

1.4.2.1. Classification Data

Cyclone Krebs 25 mm diameter
 12.7 mm vortex
 3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	g.p.l.	% Solids
Regrind Feed	18.64	77.4	56.7	-	-
Mill Discharge	-	67.4	24.0	-	-
Cyclone O'Flow	-	96.7	84.5	1150	16.0
Cyclone U'Flow	-	64.8	20.0	2510	73.3

1.4.3. Zinc Regrind Mill Report

Regrind Mill: Denver Mill
 Regrind Feed: Zn rougher concentrate + Zn 1st cleaner scavenger concentrate
 Feed Rate: 30.66 calculated kilograms per hour of concentrate
 Mill Speed: 58 r.p.m., 70 percent of critical speed
 Mill Load: 25 mm balls 113.4 kg

1.4.3.1. Classification Data

Cyclone P25 Dorr. 25 mm diameter
 6.35 mm vortex
 3.25 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	g.p.l.	% Solids
Cyclone O'Flow	30.66	98.5	83	1130	14.0
Cyclone U'Flow	-	73.6	31	1840	60.0
Regrind Feed	-	74.2	52	-	-
Mill Discharge	-	76.4	36	-	-

Test No. PP10 -- Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	16.0	16.0	84.0
3	10.7	26.7	73.3
4	10.9	37.6	62.4
6	6.5	44.1	55.9
8	5.8	49.9	50.1
10	5.5	55.4	44.6
14	4.7	60.1	39.9
20	4.0	64.1	35.9
28	5.9	70.0	30.0
35	5.5	75.5	24.5
48	5.1	80.6	19.4
65	3.8	84.4	15.6
100	2.8	87.2	12.8
- 100	12.8	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.2	0.6	99.4
35	0.3	0.9	99.1
48	1.1	2.0	98.0
65	2.4	4.4	95.6
100	5.4	9.8	90.2
150	9.0	18.8	81.2
200	18.5	37.3	62.7
270	13.5	50.8	49.2
400	18.8	69.6	30.4
- 400	30.4	100.0	-
Total	100.0	-	-

Test No. PP10 - Continued

1. Grinding

1.5. Screen Analysis

P50 Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.2	0.2	99.8
10	0.2	0.4	99.6
14	0.2	0.6	99.4
20	0.2	0.8	99.2
28	0.3	1.1	98.9
35	0.6	1.7	98.3
48	1.4	3.1	96.9
65	3.0	6.1	93.9
100	6.1	12.2	87.8
150	11.3	23.5	86.5
200	18.2	41.7	58.3
270	21.0	62.7	37.3
400	15.2	77.9	22.1
- 400	22.1	100.0	-
Total	100.0	-	-

P50 Cyclone Overflow

+ 48	0.1	0.1	99.9
65	0.1	0.2	99.8
100	0.7	0.9	99.1
150	2.0	2.9	97.1
200	5.4	8.3	91.7
270	10.1	18.4	81.6
400	12.2	30.6	69.4
- 400	69.4	100.0	-
Total	100.0	-	-

Test No. PP10 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65	0.2	0.2	99.8
100	0.6	0.8	99.2
150	1.9	2.7	97.3
200	4.8	7.5	92.5
270	9.4	16.9	83.1
400	11.0	27.9	72.1
- 400	72.1	100.0	-
Total	100.0	-	-

Test No. PP10 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.1	0.1	99.9
100	0.1	0.2	99.8
150	0.6	0.8	99.2
200	2.9	3.7	96.3
270	6.0	9.7	90.3
400	12.9	22.6	77.4
26.7 μ m	9.8	32.4	67.6
20.7	10.9	43.3	56.7
14.5	14.1	57.4	42.6
9.9	11.9	69.3	30.7
7.7	6.2	75.5	24.5
- 7.7	24.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.47

Pb Regrind Discharge

+ 65 mesh	0.1	0.1	99.9
100	0.1	0.2	99.8
150	0.4	0.6	99.4
200	2.4	3.0	97.0
270	7.5	10.5	89.5
400	22.1	32.6	67.4
25.1 μ m	22.9	55.5	44.5
19.4	20.8	76.3	23.7
13.6	12.9	89.2	10.8
9.3	3.8	93.0	7.0
7.2	1.2	94.2	5.8
- 7.2	5.8	100.0	-
Total	100.0	-	-

Specific Gravity 5.05

Test No. PP10 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.1	0.1	99.9
100	0.2	0.3	99.7
150	0.5	0.8	99.2
200	3.0	3.8	96.2
270	7.3	11.1	88.9
400	24.1	35.2	64.8
24.7 μ m	23.8	59.0	41.0
19.1	21.6	80.6	19.4
13.3	11.2	91.8	8.2
9.2	2.9	94.7	5.3
7.1	1.0	95.7	4.3
- 7.1	4.3	100.0	-
Total	100.0	-	-

Specific Gravity 5.10

Pb Regrind Cyclone Overflow

+ 400 mesh	3.3	3.3	96.7
29.6 μ m	0.6	3.9	96.1
23.0	3.2	7.1	92.9
16.0	16.5	23.6	76.4
11.0	21.7	45.3	54.7
8.5	12.2	57.5	42.5
- 8.5	42.5	100.0	-
Total	100.0	-	-

Specific Gravity 3.84

Test No. FP10 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.1	0.1	99.9
100	0.3	0.4	99.6
150	1.1	1.5	98.5
200	4.1	5.6	94.4
270	6.6	12.2	87.8
400	13.6	25.8	74.2
28.6 μ m	5.9	31.7	68.3
22.2	12.3	44.0	56.0
15.5	15.2	59.2	40.8
10.6	11.5	70.7	29.3
8.2	6.1	76.8	23.2
- 8.2	23.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.10

Zn Regrind Discharge

+ 100 mesh	0.1	0.1	99.9
150	0.4	0.5	99.5
200	2.6	3.1	96.9
270	4.9	8.0	92.0
400	15.6	23.6	76.4
28.2 μ m	8.9	32.5	67.5
21.8	22.6	55.1	44.9
15.2	23.9	79.0	21.0
10.5	9.2	88.2	11.8
8.1	2.8	91.0	9.0
- 8.1	9.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.12

Test No. PP10 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	0.1	0.1	99.9
150	0.4	0.5	99.5
200	3.0	3.5	96.5
270	5.6	9.1	90.9
400	17.3	26.4	73.6
28.6 μ m	10.1	36.5	63.5
22.2	23.7	60.2	39.8
15.5	24.4	84.6	15.4
10.6	8.0	92.6	7.4
8.2	1.8	94.4	5.6
- 8.2	5.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.16

Zn Regrind Cyclone Overflow

+ 400 mesh	1.5	1.5	98.5
29.3 μ m	2.2	3.7	96.3
22.7	6.3	10.0	90.0
15.8	17.6	27.6	72.4
10.9	20.2	47.8	52.2
8.4	11.7	59.5	40.5
- 8.4	40.5	100.0	-
Total	100.0	-	-

Specific Gravity 3.94

Test No. PP10 - Continued

2. Flotation

- 2.1. Purpose:
- 1) To investigate the effect of depressant 1902 additions on the zinc cleaning.
 - 2) To improve lead recovery.
- 2.2. Method:
- Similar to test PP9 except that:
- a) Depressant 1902 was added to the zinc 2nd, 3rd and 4th cleaner feeds.
 - b) The cyanide addition to the Pb regrind mill was omitted and the same amount was added to the cyclone overflow.
 - c) Added collector A-343 to the lead 1st cleaner scavenger feed.

The circuit was operated for a period of 7.5 hours and sampled every 30 minutes in the last two hours of operation.

2.2.1. Flotation Equipment

As for test PP8.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP6.

Test No. PP10 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate	Circuit	Point of Additions
	g/tonne		
Na ₂ CO ₃	9670.62	Lead	Hendy Mill Feed
NaCN	308.88	Lead	Hendy Mill Feed
A-343	16.47	Lead	Hendy Mill Feed
A-343	48.90	Lead	Pb Conditioner Feed
MIBC	67.86	Lead	Pb Rougher Feed
A-343	58.36	Lead	Pb Scavenger Feed
NaCN	97.80	Lead	Pb Regrind Cyclone O/F
Na ₂ CO ₃	1074.35	Lead	Pb Regrind Mill Feed
A-343	12.97	Lead	Pb Cyclone Feed Pump
NaCN	19.96	Lead	Pb 1st Cl. Scav. Feed
Na ₂ CO ₃	324.35	Lead	Pb 2nd Cleaner Feed
A-343	16.47	Lead	Pb 1st Cl. Scav. Feed
MIBC	4.49	Lead	Pb 1st Cl. Scav. Feed
Lime	3123.74	Zinc	Zn Conditioner Feed
CuSO ₄	978.04	Zinc	Zn Conditioner
A-343	97.80	Zinc	Zn Rougher Feed Pump
R-208	43.91	Zinc	Zn Rougher Feed Pump
D-1012	26.44	Zinc	Zn Rougher Feed Pump
A-343	24.45	Zinc	Zn Scavenger Feed
R-208	95.31	Zinc	Zn Scavenger Feed
D-1012	34.43	Zinc	Zn Scavenger Feed
Lime	1761.47	Zinc	Zn Regrind Mill Feed
CuSO ₄	209.58	Zinc	Zn Regrind Mill Feed
MIBC	168.16	Zinc	Zn Rougher Feed
Z-200	36.93	Zinc	Zn 1st Cleaner Feed
A-343	24.95	Zinc	Zn 1st Cl. Scav. Feed
MIBC	76.35	Zinc	Zn 1st Cl. Scav. Feed
D-1902	94.81	Zinc	Zn 2nd Cleaner Feed
D-1902	34.93	Zinc	Zn 3rd Cleaner Feed
D-1902	19.96	Zinc	Zn 4th Cleaner Feed

Test No. PP10 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The flotation circuit was stable during the test run. The addition of depressant D-1902 to the zinc cleaning improved zinc concentrate grade. It was observed that froth in the cleaning was more brittle and heavier mineralized, when D-1902 was added. The addition of collector A-343 to the lead 1st cleaner scavenger stage resulted in slightly lower lead concentrate grade.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.7	1170
Pb Scavenger Feed	9.7	-
Pb 1st Cl. Feed	10.0	1150
Pb 1st Cl. Scav. Feed	10.1	-
Pb 2nd Cleaner Feed	9.9	-
Pb 3rd Cleaner Feed	10.1	-
Pb Scavenger Tail.	-	1140
Zn Rougher Feed	10.1	1130
Zn Scavenger Feed	10.1	-
Zn 1st Cl. Feed	11.6	-
Zn 1st Cl. Scav. Feed	11.7	-
Zn 2nd Cleaner Feed	10.1	-
Zn 3rd Cleaner Feed	8.8	-
Zn 4th Cleaner Feed	8.8	-
Zn Scavenger Tail.	-	1120
Zn Combined Tail.	-	1090
Zn 1st Cl. Scav. Tail.	-	1010

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher Feed	25
Zn Rougher Feed	24

Test No. PP10 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne			
	Pb	Zn	Ag	Fe
Hendy Cyclone O'Flow	2.30	3.90	21.82	--
Pb Rougher Conc.	35.1	6.75	-	-
Pb Rougher Tail.	1.04	4.46	-	-
Pb Scavenger Conc.	4.62	8.36	-	-
Pb Scavenger Tail.	0.56	3.82	-	-
Kason Undersize	2.32	3.79	-	-
Pb 1st Cl. Conc.	45.2	6.33	-	-
Pb 1st Cl. Tail.	15.0	9.43	-	-
Pb 1st Cl. Scav. Conc.	16.8	9.44	-	-
Pb 1st Cl. Scav. Tail.	7.06	9.27	-	-
Pb 2nd Cl. Conc.	58.2	4.51	-	-
Pb 3rd Cl. Conc.	68.2	2.81	486.38	4.61
Zn Rougher Feed	0.65	4.25	-	-
Zn Rougher Conc.	0.85	39.6	-	-
Zn Rougher Tail.	-	-	-	-
Zn Scavenger Conc.	1.26	6.92	-	-
Zn Scavenger Tail.	0.56	0.45	-	-
Zn 1st Cl. Conc.	0.52	48.5	-	-
Zn 1st Cl. Tail.	1.43	9.69	-	-
Zn 1st Cl. Scav. Conc.	1.63	21.80	-	-
Zn 1st Cl. Scav. Tail.	1.61	3.01	-	-
Zn 2nd Cl. Conc.	0.42	51.7	-	-
Zn 4th Cl. Conc.	0.34	52.0	34.86	-
Zn Comb. Tail.	0.57	0.52	-	-
Zn 3rd Cl. Conc.	0.39	51.7	-	-

Test No. PP10 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %, g/tonne			% Distribution		
		Pb	Zn	Ag	Pb	Zn	Ag
Pb Cleaner Conc.	2.61	68.2	2.82	486.38	76.7	1.9	58.2
Zn Cleaner Conc.	6.24	0.34	52.0	34.86	0.9	85.6	10.0
Zn Combined Tail.	91.15	0.57	0.52	7.62	22.4	12.5	31.8
Kason Undersize	100.00	2.32	3.79	21.82	100.0	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.10	25.1	6.75	-	77.2	8.7	-
Pb Scavenger Tail.	94.90	0.56	3.82	-	22.8	91.3	-
Cyclone Overflow (Meas.)	100.0	2.32	3.79	--	-	-	-
(Calc.)	-	2.32	3.97	-	100.0	100.0	-
Zn Rougher Conc.	8.39	0.85	39.6	-	3.0	83.8	-
Zn Comb. Tail.	89.00	0.56	0.45	-	17.2	10.0	-
Zn Flot. Feed (Meas.)	97.39	0.56	3.82	-	22.8	91.3	-
(Calc.)	-	0.58	3.82	-	20.2	93.8	-

Test No. PP11

1. Grinding

- 1.1. Purpose: To repeat conditions of test No. PP10, with a finer primary grind.
- 1.2. Method: Similar to test PP10 except that the mill discharge was classified in two stages. The primary and secondary cyclone underflow products were returned to the mill feed. The circuit was operated for a period of 7.5 hours at a feed rate of 366.0 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.
- 1.3. Flowsheet: See following page.
- 1.4. Results:

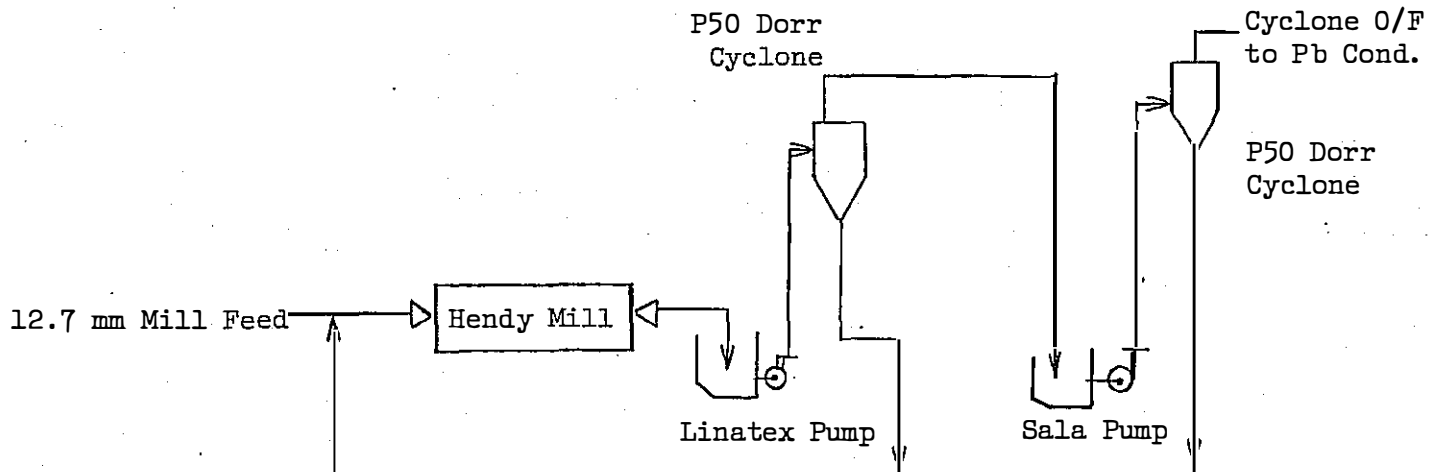
1.4.1. Observations

Stable grinding circuit was not obtained during the test run due to unstable operation of the secondary cyclone.

Test No. PP11 - Continued

1. Grinding

1.3. Flowsheet



Test No. PP11 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.4 percent moisture content		
Feed Rate:	366.0 dry kilograms per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	76.2 mm balls	365.5 kilograms	
	50.8 mm balls	362.8 kilograms	
	25.4 mm balls	181.3 kilograms	
	Total	909.6 kilograms	
Operating Time:	Total 7.5 hours, test period 2.0 hours		
Mill Feed:	Total 2745 kilograms, test period 732.0 kilograms		
Circulating Load:	Primary Cyclone underflow 827.2 percent		
	Secondary Cyclone Underflow 158.5 percent		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2178	71.6
	Primary Cyclone Overflow	1400	38.0
	Primary Cyclone Underflow	2828	84.3
Average Power:	Gross	10.33 kilowatts	
	No Load	1.93 kilowatts	
	Net	8.40 kilowatts	
Net Power Consumption:	22.95 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	13.79		
Cyclone Overflow K ₈₀ :	31.4 micrometers		

Test No. PP11 - Continued

1. Grinding

1.4.1.2. Classification Data

	<u>Primary</u>	<u>Secondary</u>
Grinding Mill: Hendy	50.8 mm dia.	50.8 mm dia
Primary Cyclone: P50 Dorr	15.9 mm vortex	15.9 mm vortex
Secondary Cyclone: P50 Dorr	12.7 mm apex	6.35 mm apex

Product	Rate kg/h	% Passing		Density		Recircu- lating Load %
		400 mesh	200 mesh	g.p.l.	% Solids	
Primary Cyclone Feed	3974.6	24.1	30.5	2052	67.8	-
Primary Cyclone Overflow	946.0	49.2	82.0	1400	38.0	-
Primary Cyclone Underflow	3028.6	18.9	55.1	2828	84.3	827.2
Secondary Cyclone Feed	946.0	49.2	82.0	1400	38.0	-
Secondary Cyclone Overflow	366.0	84.0	96.7	1170	19.4	-
Secondary Cyclone Underflow	580.0	32.2	77.8	2484	78.0	158.5

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical Mill

Regrind Feed: Pb rougher concentrate + Pb 1st Cl. Scav. Conc.

Feed Rate: 24.12 calculated kilograms per hour of concentrate

Mill Speed: 30 r.p.m., 65 percent of critical speed

Mill Load: 50 mm balls 90.7 kilograms
25 mm balls 90.7 kilograms
Total 181.4 kilograms

Average Power: Gross 1.90 kilowatts
No Load 0.95 kilowatts
Net 0.95 kilowatts

Net Power Consumption: 2.59 kilowatt-hours per tonne of flotation feed

Test No. PP11 - Continued

1. Grinding

1.4.2.1. Classification Data

Cyclone Krebs 2.5 mm diameter
 12.7 mm vortex
 3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	g.p.l.	% Solids
Regrind Feed	-	89.1	64	-	-
Mill Discharge	-	72.1	27	-	-
Cyclone O/F	24.12	98.9	85	1080	9.4
Cyclone U/F	-	73.1	24	2580	75.0

1.4.3. Zinc Regrind Mill Report

Regrind Mill: Denver Mill
 Regrind Feed: Zn rougher concentrate + Zn 1st cleaner scavenger concentrate
 Feed Rate: 32.94 calculated kilograms per hour of concentrate
 Mill Speed: 58 r.p.m., 70 percent of critical speed
 Mill Load: 25 mm balls 113.4 kg.

1.4.3. Classification Data

Cyclone P25 Dorr 25 mm diameter
 6.35 mm vortex
 3.25 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	g.p.l.	% Solids
Cyclone Overflow	32.9	95.0	68	1100	12.1
Cyclone Underflow	-	75.4	31	1660	52.0
Regrind Feed	-	81.8	54	-	-
Mill Discharge	-	71.3	36	-	-

Test No. PP11 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	5.2	5.2	94.8
3	16.8	22.0	78.0
4	7.7	29.7	70.3
6	7.3	37.0	63.0
8	6.1	43.1	56.9
10	6.4	49.5	50.5
14	5.2	54.7	45.3
20	4.9	59.6	40.4
28	6.6	66.2	33.8
35	6.0	72.2	27.8
48	5.5	77.7	22.3
65	3.7	81.4	18.6
100	3.1	84.5	15.5
- 100	15.5	100.0	-
Total	100.0	-	-

Hendy Discharge

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.1	0.3	99.7
28	0.2	0.5	99.5
35	0.4	0.9	99.1
48	1.0	1.9	98.1
65	18.7	20.6	79.4
100	22.9	43.5	56.5
150	15.1	58.6	41.4
200	10.9	69.5	30.5
270	5.0	74.5	25.5
400	1.4	75.9	24.1
- 400	24.1	100.0	-
Total	100.0	-	-

Test No. PP11 - Continued

1. Grinding

1.5. Screen Analysis

Cyclone 1 Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.1	0.1	99.9
10	0.1	0.2	99.8
14	0.1	0.3	99.7
20	0.1	0.4	99.6
28	0.3	0.7	99.3
35	0.7	1.4	98.6
48	1.0	2.9	97.1
65	2.8	5.7	94.3
100	6.3	12.0	88.0
150	11.1	23.1	76.9
200	21.8	44.9	55.1
270	15.7	60.6	39.4
400	20.5	81.1	18.9
- 400	18.9	100.0	-
Total	100.0	-	-

Cyclone 1 Overflow

+ 48	0.4	0.4	99.6
65	0.5	0.9	99.1
100	1.7	2.6	97.4
150	4.1	6.7	93.3
200	11.3	18.0	82.0
270	11.5	29.5	70.5
400	21.3	50.8	49.2
- 400	49.2	100.0	-
Total	100.0	-	-

Test No. PP11 - Continued

1. Grinding

1.5. Screen Analysis

Cyclone 2 Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 35	0.2	0.2	99.8
48	0.2	0.4	99.6
65	0.6	1.0	99.0
100	2.1	3.1	96.9
150	5.7	8.8	91.2
200	13.4	22.2	77.8
270	23.9	46.1	53.9
400	21.7	67.8	32.2
- 400	32.2	100.0	-
Total	100.0	-	-

Cyclone 2 Overflow

+ 65	0.2	0.2	99.8
100	0.3	0.5	99.5
150	0.8	1.3	98.7
200	2.0	3.3	96.7
270	4.5	7.8	92.2
400	8.2	16.0	84.0
- 400	84.0	100.0	-
Total	100.0	-	-

Test No. PP11 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.3	0.3	99.7
100	0.1	0.4	99.6
150	0.4	0.8	99.2
200	1.2	2.0	98.0
270	2.2	4.2	95.8
400	6.7	10.9	89.1
28.1 μ m	8.0	18.9	81.1
21.8	9.6	28.5	71.5
15.2	13.6	42.1	57.9
10.5	14.0	56.1	43.9
8.1	8.7	64.8	35.2
- 8.1	35.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.21

Pb Regrind Discharge

+ 65 mesh	0.1	0.1	99.9
100	0.2	0.3	99.7
150	0.4	0.7	99.3
200	1.5	2.2	97.8
270	5.3	7.5	92.5
400	20.4	27.9	72.1
24.6 μ m	24.8	52.7	47.3
19.0	22.6	75.3	24.7
13.3	13.4	88.7	11.3
9.1	4.4	93.1	6.9
7.1	1.3	94.4	5.6
- 7.1	5.6	100.0	-
Total	100.0	-	-

Specific Gravity 5.14

Test No. PP11 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	0.2	0.2	99.8
150	0.3	0.5	99.5
200	1.6	2.1	97.9
270	5.5	7.6	92.4
400	19.3	26.9	73.1
24.6 μ m	27.7	54.6	45.4
19.0	23.5	78.1	21.9
13.3	13.0	91.1	8.9
9.1	3.6	94.7	5.3
7.1	1.0	95.7	4.3
- 7.1	4.3	100.0	-
Total	100.0	-	-

Specific Gravity 5.13

Pb Regrind Cyclone Overflow

+ 150 mesh	0.2	0.2	99.8
200	0.1	0.3	99.7
270	0.2	0.5	99.5
400	0.6	1.1	98.9
27.7 μ m	3.4	4.5	95.5
21.4	7.0	11.5	88.5
15.0	11.0	22.5	77.5
10.3	11.7	34.2	65.8
8.0	13.2	47.4	52.6
- 8.0	52.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.30

Test No. PP11 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	0.2	0.2	99.8
150	0.6	0.8	99.2
200	2.0	2.8	97.2
270	3.9	6.7	93.3
400	11.5	18.2	81.8
28.5 μ m	8.6	26.8	73.2
22.1	13.8	40.6	59.4
15.4	16.4	57.0	43.0
10.6	12.4	69.4	30.6
8.2	6.6	76.0	24.0
- 8.2	24.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.12

Zn Regrind Discharge

+ 100 mesh	0.4	0.4	99.6
150	0.4	0.8	99.2
200	3.8	4.6	95.4
270	5.6	10.2	89.8
400	18.5	28.7	71.3
28.1 μ m	7.2	35.9	64.1
21.8	19.5	55.4	44.6
15.2	22.8	78.2	21.8
10.5	9.1	87.3	12.7
8.1	2.6	89.9	10.1
- 8.1	10.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.22

Test No. PP11 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	0.2	0.2	99.8
150	1.2	1.4	98.6
200	2.4	3.8	96.2
270	4.4	8.2	91.8
400	16.4	24.6	75.4
27.7 μ m	11.6	36.2	63.8
21.4	23.8	60.0	40.0
15.0	23.8	83.8	16.2
10.3	7.2	91.0	9.0
8.0	1.8	92.8	7.2
- 8.0	7.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.26

Zn Regrind Cyclone Overflow

+ 200 mesh	0.4	0.4	99.6
270	1.2	1.6	98.4
400	3.4	5.0	95.0
28.5 μ m	2.2	7.2	92.8
22.1	18.4	25.6	74.4
15.4	20.2	45.8	54.2
10.6	17.4	63.2	36.8
8.2	8.5	71.7	28.3
- 8.2	28.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.04

Test No. PP11 - Continued

2. Flotation

2.1. Purpose: To repeat conditions of test PP10 using finer primary grind.

2.2. Method: Similar to test PP10 except that fineness of primary grind was slightly increased. The circuit was operated for a period of 7 hours and sampled every 30 minutes in the last two hours of operation.

2.2.1. Flotation Equipment

As for test PP8.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test No. PP6.

Test No. PP11 - Continued

2. Flotation

2.2. Flotation Reagents

Type	Rate	Circuit	Point of Additions
	g/tonne		
Na ₂ CO ₃	9740.48	Lead	Hendy Mill Feed
NaCN	291.92	Lead	Hendy Mill Feed
A-343	16.47	Lead	Hendy Mill Feed
A-343	72.85	Lead	Pb Conditioner
MIBC	92.32	Lead	Pb Rougher Feed
A-343	59.88	Lead	Pb Scavenger Feed
NaCN	97.31	Lead	Pb Regrind Cyclone O/F
Na ₂ CO ₃	1087.30	Lead	Pb Regrind Mill Feed
A-343	12.97	Lead	Pb Regrind Cyclone Feed Pump
NaCN	22.95	Lead	Pb 1st Cl. Scav. Feed
Na ₂ CO ₃	349.30	Lead	Pb 2nd Cleaner Feed
A-343	15.97	Lead	Pb 1st Cl. Scav. Feed
MIBC	2.50	Lead	Pb 1st Cl. Scav. Feed
Lime	3248.49	Zinc	Zn Conditioner Feed
CuSO ₄	973.05	Zinc	Zn Conditioner
A-343	97.31	Zinc	Zn Rougher Feed
R-208	42.42	Zinc	Zn Rougher Feed
MIBC	167.66	Zinc	Zn Rougher Feed
D-1012	25.45	Zinc	Zn Rougher Feed
A-343	24.45	Zinc	Zn Scavenger Feed
D-1012	24.95	Zinc	Zn Scavenger Feed
R-208	86.83	Zinc	Zn Scavenger Feed
Lime	2415.16	Zinc	Zn Regrind Mill Feed
CuSO ₄	227.04	Zinc	Zn Regrind Mill Feed
A-343	32.44	Zinc	Zn 1st Cl. Scav. Feed
MIBC	43.41	Zinc	Zn 1st Cl. Scav. Feed
Z-200	37.92	Zinc	Zn 1st Cl. Feed
D-1902	32.44	Zinc	Zn 3rd Cl. Feed
D-1902	17.96	Zinc	Zn 4th Cl. Feed
D-1902	62.24	Zinc	Zn 2nd Cl. Feed

Test No. PP11 - Continued

2. Flotation

2.4. Results:

2.4.1. Observation

The froth conditions in the lead and zinc circuits were poor due to low pulp densities. In the lead rougher fine galena floated slowly and required extra collector addition in order to maintain recovery.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.7	1120
Pb Scavenger Feed	9.6	-
Pb 1st Cleaner Feed	10.1	1080
Pb 1st Cleaner Scavenger	10.1	-
Pb 2nd Cleaner Feed	9.9	-
Pb 3rd Cleaner Feed	10.1	-
Zn Rougher Feed	10.4	1100
Zn Scavenger Feed	10.3	1100
Zn 1st Cleaner Feed	11.9	1100
Zn 1st Cleaner Scav. Feed	11.7	-
Zn 2nd Cleaner Feed	10.5	-
Zn 3rd Cleaner Feed	9.3	-
Zn 4th Cleaner Feed	8.8	-
Pb Scavenger Tailing	-	1100
Zn 1st Cl. Scav. Tail.	-	1010
Zn Combined Tailing	-	1060

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher Feed	24.5
Zn Rougher Feed	24.0

Test No. PP11 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne		
	Pb	Zn	Fe
Hendy Cyclone Overflow	2.52	3.94	-
Pb Rougher Conc.	29.3	7.52	-
Pb Rougher Tail.	1.04	4.57	-
Pb Scavenger Conc.	5.48	8.38	-
Pb Scavenger Tail.	0.63	4.02	-
Pb 1st Cl. Conc.	49.2	6.04	-
Pb 1st Cl. Tail.	21.4	8.33	-
Pb 1st Cl. Scav. Conc.	23.9	8.26	-
Pb 1st Cl. Scav. Tail.	9.89	9.85	-
Pb 2nd Cl. Conc.	60.2	3.81	-
Pb 3rd Cl. Conc.	67.5	2.30	4.22
Zn Rougher Feed	0.68	4.24	-
Zn Rougher Conc.	0.86	37.1	-
Zn Scavenger Conc.	1.07	4.65	-
Zn Scavenger Tail.	0.59	0.56	-
Zn 1st Cl. Conc.	0.73	46.0	-
Zn 1st Cl. Tail.	1.53	8.32	-
Zn 1st Cl. Scav. Conc.	2.04	18.3	-
Zn 1st Cl. Scav. Tail.	1.53	2.87	-
Zn 2nd Cl. Conc.	0.53	50.9	-
Zn 3rd Cl. Conc.	0.52	51.3	-
Zn 4th Cl. Conc.	0.44	52.1	-
Zn Comb. Tail.	0.62	0.64	-

Test No. PP11 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	2.86	67.5	2.30	76.6	1.6
2. Zn Cleaner Conc..	6.33	0.44	52.1	1.1	83.8
3. Zn Comb. Tailing	90.81	0.62	0.64	22.3	14.6
4. Cyclone Overflow	100.0	2.52	3.94	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	6.59	29.3	7.52	76.6	11.7
Pb Scav. Tailing	93.41	0.63	4.02	23.4	88.3
Cyclone Overflow (Meas.)	100.00	2.52	3.94	-	-
(Calc.)	-	2.52	4.25	100.0	100.0
Zn Rougher Conc.	9.00	0.86	37.1	2.9	84.1
Zn Comb. Tailing	88.14	0.62	0.64	20.5	14.3
Zn Flot. Feed (Meas.)	97.14	0.63	4.02	23.4	98.4
(Calc.)	-	0.64	4.02	24.7	99.0

Test No. PP12

1. Grinding

1.1. Purpose: To repeat conditions of test No. PP11.

1.2. Method: As for test PP11. The grinding circuit was operated for a period of 7 hours at a feed rate of 369 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.

1.3. Flowsheet: As for test PP11.

1.4. Results:

1.4.1. Observations

The grinding circuit was very stable during the test run.

Test No. PP12 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.8 percent moisture content		
Feed Rate:	369.0 dry kilograms per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	76.2 mm balls	365.5 kilograms	
	50.8 mm balls	362.8 kilograms	
	25.4 mm balls	181.3 kilograms	
	Total	909.6 kilograms	
Operating Time:	Total 7.0 hours, test period 2.0 hours		
Mill Feed:	Total 2583 kilograms, test period 738 kilograms		
Circulating Load:	Primary Cyclone Underflow	856.9 percent	
	Secondary Cyclone Underflow	157.7 percent	
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>	
	Mill Discharge	2214	73
	Prim. Cyclone O/F	1412	38
	Prim. Cyclone U/F	2814	84
Average Power:	Gross	9.93 kilowatts	
	No Load	1.93 kilowatts	
	Net	8.00 kilowatts	
Net Power Consumption:	21.68 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	12.84		
Cyclone Overflow K_{80} :	30.4 micrometers		

Test No. PP12 - Continued

1. Grinding

1.4.1.2. Classification Data

	<u>Primary</u>	<u>Secondary</u>
Grinding Mill Hendy	50.8 mm diameter	50.8 mm diameter
Primary Cyclone P-50 Dorr	15.9 mm vortex	15.9 mm vortex
Secondary Cyclone P-50 Dorr	12.7 mm apex	6.35 mm apex

Product	Rate kg/h	% Passing		Density		Recircu- lating Load %
		400 mesh	200 mesh	g.p.l.	% Solids	
Prim. Cyclone Feed	4113	26.3	63.9	2036	66	-
Prim. Cyclone Overflow	951	44.3	82.3	1412	38	-
Prim. Cyclone Underflow	3162	16.8	57.5	2814	84	856.9
Sec. Cyclone Feed	951	44.3	82.3	1412	38	-
Sec. Cyclone Overflow	369	84.2	97.2	1158	18	-
Sec. Cyclone Underflow	582	28.8	77.0	2546	79	157.7

Test No. PP12 - Continued

1. Grinding

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical Mill

Regrind Feed: Pb rougher concentrate + Pb 1st Cl. Scav. Conc.

Feed Rate: 22.0 calculated kilograms per hour of concentrate

Mill Speed: 30 r.p.m., 65 percent of critical speed

Mill Load: 50 mm balls 90.7 kilograms
 25 mm balls 90.7 kilograms
 Total 181.4 kilograms

Average Power: Gross 2.02 kilowatts
 No Load 0.95 kilowatts
 Net 1.07 kilowatts

Net Power Consumption: 2.90 kilowatt-hours per tonne of flotation feed

1.4.2.1. Classification Data

Cyclone Krebs 25 mm diameter
 12.7 mm vortex
 3.2 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	g.p.l.	% Solids
Regrind Feed	-	87.5	66	-	-
Mill Discharge	290.6	74.0	27	-	-
Cyclone O'Flow	22.0	98.2	95	1065	7.7
Cyclone U'Flow	268.6	73.4	24	2560	74.5

Test No. PP12 - Continued

1. Grinding

1.4.3. Zinc Regrind Mill Report

Regrind Mill: Denver Mill
Regrind Feed: Zn rougher concentrate + Zn 1st cleaner scavenger concentrate
Feed Rate: 34.0 calculated kilograms per hour of concentrate
Mill Speed: 58 r.p.m., 70 percent of critical speed
Mill Load: 25 mm balls 113.4 kg

Average Power: Not calculated.

1.4.3.1. Classification Data

Cyclone P-25 Dorr 25 mm diameter
6.35 mm vortex
3.25 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	g.p.l.	% Solids
Cyclone O'flow	34.0	96.5	78	1070	8.6
Cyclone U'flow	160.2	76.0	33	1730	55.5
Mill Discharge	194.2	80.3	40	-	-
Regrind Feed	-	78.4	57	-	-

Test No. PP12 - Continued

1.5. Screen Analysis

Hendy Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	6.3	6.3	93.7
3	13.3	19.6	80.4
4	10.0	29.6	70.4
6	8.8	38.4	61.6
8	6.5	44.9	55.1
10	6.0	50.9	49.1
14	5.3	56.2	43.8
20	4.9	61.1	38.9
28	6.7	67.8	32.2
35	6.1	73.9	26.1
48	5.7	79.6	20.4
65	3.8	83.4	16.6
100	3.2	86.6	13.4
- 100	13.4	100.0	-
Total	100.0	-	-

Hendy Discharge

+ 14	0.1	0.1	99.9
20	0.1	0.2	99.8
28	0.2	0.4	99.6
35	0.3	0.7	99.3
48	0.9	1.6	98.4
65	2.3	3.9	96.1
100	4.8	8.7	91.3
150	8.6	17.3	82.7
200	18.8	36.1	63.9
270	15.2	51.3	48.7
400	22.4	73.7	26.3
- 400	26.3	100.0	-
Total	100.0	-	-

Test No. PP12 - Continued

1. Grinding

1.5. Screen Analysis

Cyclone Underflow (P50-1)

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.1	0.1	99.9
10	0.1	0.2	99.8
14	0.2	0.4	99.6
20	0.2	0.6	99.4
28	0.4	1.0	99.0
35	0.6	1.6	98.4
48	1.4	3.0	97.0
65	3.0	6.0	94.0
100	6.2	12.2	87.8
150	11.4	23.6	76.4
200	18.9	42.5	57.5
270	24.0	66.5	33.5
400	16.7	83.2	16.8
- 400	16.8	100.0	-
Total	100.0	-	-

Cyclone Overflow (P50-1)

+ 48	0.4	0.4	99.6
65	0.6	1.0	99.0
100	1.7	2.7	97.3
150	4.5	7.2	92.8
200	10.5	17.7	82.3
270	19.0	36.7	63.3
400	19.0	55.7	44.3
- 400	44.3	100.0	-
Total	100.0	-	-

Test No. PP12 - Continued

1. Grinding

1.5. Screen Analysis

P-50 2 Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 28	0.2	0.2	99.8
35	0.1	0.3	99.7
48	0.3	0.6	99.4
65	0.7	1.3	98.7
100	2.2	3.5	96.5
150	5.8	9.3	90.7
200	13.7	23.0	77.0
270	24.9	47.9	52.1
400	23.3	71.2	28.8
- 400	28.8	100.0	-
Total	100.0	-	-

P-50 2 Cyclone Overflow

+ 65	0.1	0.1	99.9
100	0.1	0.2	99.8
150	0.6	0.8	99.2
200	2.0	2.8	97.2
270	4.5	7.3	92.7
400	8.5	15.8	84.2
- 400	84.2	100.0	-
Total	100.0	-	-

Test No. PP12 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.2	0.2	99.8
100	0.2	0.4	99.6
150	0.4	0.8	99.2
200	1.4	2.2	97.8
270	2.6	4.9	95.1
400	7.6	12.5	87.5
27.8 μ m	6.7	19.2	80.8
21.6	10.1	29.3	70.7
15.1	14.2	43.5	56.5
10.3	14.5	58.0	42.0
8.0	9.0	67.0	33.0
- 8.0	33.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.34

Pb Regrind Discharge

+ 100 mesh	0.2	0.2	99.8
150	0.2	0.4	99.6
200	1.1	1.5	98.5
270	4.6	6.1	93.9
400	19.9	26.0	74.0
25.1 μ m	22.7	48.7	51.3
19.5	24.6	73.3	26.7
13.6	16.0	89.3	10.7
9.3	5.0	94.3	5.7
7.2	1.2	95.5	4.5
- 7.2	4.5	100.0	-
Total	100.0	-	-

Specific Gravity 5.09

Test No. PP12 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.1	0.1	99.9
100	0.2	0.3	99.7
150	0.4	0.7	99.3
200	1.3	2.0	98.0
270	4.2	6.2	93.8
400	20.4	26.6	73.4
24.9 μ m	24.6	51.2	48.8
19.3	25.3	76.5	23.5
13.5	14.9	91.4	8.6
9.3	3.5	94.9	5.1
7.2	0.8	95.7	4.3
- 7.2	4.3	100.0	-
Total	100.0	-	-

Specific Gravity 5.17

Pb Regrind Cyclone Overflow

+ 150 mesh	0.2	0.2	99.8
200	0.2	0.4	99.6
270	0.4	0.8	99.2
400	1.0	1.8	98.2
29.0 μ m	0.4	2.2	97.8
22.5	0.7	2.9	97.1
15.7	5.1	8.0	92.0
10.8	16.6	24.6	75.4
8.3	16.4	41.0	59.0
- 8.3	59.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.04

Test No. PP12 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.2	0.2	99.8
100	0.5	0.7	99.3
150	1.0	1.7	98.3
200	2.4	4.1	95.9
270	4.4	8.5	91.5
400	13.1	21.6	78.4
25.8 μ m	7.1	28.7	71.3
20.0	14.6	43.3	56.7
14.0	17.0	60.3	39.7
9.6	12.4	72.7	27.3
7.4	6.4	79.1	20.9
- 7.4	20.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.96

Zn Regrind Discharge

+ 150 mesh	0.1	0.1	99.9
200	2.0	2.1	97.9
270	3.9	6.0	94.0
400	13.7	19.7	80.3
28.2 μ m	8.2	27.9	72.1
21.9	22.7	50.6	49.4
15.3	25.5	76.1	23.9
10.5	10.0	86.1	13.9
8.1	3.0	89.1	10.9
- 8.1	10.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.32

Test No. PP12 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	0.1	0.1	99.9
150	0.3	0.4	99.6
200	1.9	2.3	97.7
270	4.2	6.5	93.5
400	17.5	24.0	76.0
28.1 μ m	9.1	33.1	66.9
21.8	23.7	56.8	43.2
15.2	24.5	81.3	18.7
10.4	8.6	89.9	10.0
8.1	2.3	92.2	7.8
- 8.1	7.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.28

Zn Regrind Cyclone Overflow

+ 65 mesh	0.2	0.2	99.8
100	0.2	0.4	99.6
150	0.2	0.6	99.4
200	0.2	0.8	99.2
270	0.4	1.2	98.8
400	2.3	3.5	96.5
29.8 μ m	3.4	6.9	93.1
23.1	7.4	14.3	85.7
16.1	19.4	33.7	66.3
11.1	20.1	53.8	46.2
8.6	10.8	64.6	35.4
- 8.6	35.4	100.0	-
Total	100.0	-	-

Specific Gravity 3.95

Test No. PP12 - Continued

2. Flotation

2.1. Purpose: To repeat conditions of test PP11 with slightly adjusted reagent additions in the circuit.

2.2. Method: As for test PP11 except that the reagents were adjusted as follows:

- 1) Increased collector to the lead rougher feed
- 2) Added frother MIBC to the lead scavenger feed
- 3) Slightly increased lime and CuSO_4 additions to the zinc rougher feed

The circuit was operated for a period of 7 hours and sampled every 30 minutes in the last two hours of operation.

2.2.1. Flotation Equipment

As for test PP8.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP6.

Test No. PP12 - Continued

2. Flotation

2.2. Flotation Reagents

Type	Rate	Circuit	Point of Additions
	g/tonne		
Na ₂ CO ₃	9863	Lead	Hendy Mill Feed
NaCN	279.7	Lead	Hendy Mill Feed
A-343	16.68	Lead	Hendy Mill Feed
A-343	97.72	Lead	Pb Conditioner
MIBC	92.94	Lead	Pb Rougher Feed
A-343	60.49	Lead	Pb Scavenger Feed
MIBC	32.19	Lead	Pb Scavenger Feed
Na ₂ CO ₃	1053.6	Lead	Pb Regrind Mill Feed
NaCN	96.91	Lead	Pb Regrind Mill Feed
A-343	12.68	Lead	Pb Regrind Mill Feed
NaCN	24.23	Lead	Pb 1st Cl. Scav. Feed
A-343	16.36	Lead	Pb 1st Cl. Scav. Feed
MIBC	4.29	Lead	Pb 1st Cl. Scav. Feed
Na ₂ CO ₃	312.2	Lead	Pb 2nd Cleaner Feed
Ca(OH) ₂	4731.7	Zinc	Zn Conditioner Feed
CuSO ₄	1300.8	Zinc	Zn Conditioner Feed
A-343	97.56	Zinc	Zn Rougher Feed
R-208	84.55	Zinc	Zn Rougher Feed
D-1012	22.76	Zinc	Zn Rougher Feed
MIBC	165.27	Zinc	Zn Rougher Feed
A-343	24.06	Zinc	Zn Scav. Feed
R-208	84.55	Zinc	Zn Scav. Feed
D-1012	36.42	Zinc	Zn Scav. Feed
Ca(OH) ₂	2829.2	Zinc	Zn Regrind Mill Feed
CuSO ₄	240.6	Zinc	Zn Regrind Mill Feed
Z-200	34.15	Zinc	Zn 1st Cleaner Feed
A-343	32.52	Zinc	Zn 1st Cl. Scav. Feed
MIBC	42.93	Zinc	Zn 1st Cl. Scav. Feed
D-1902	32.19	Zinc	Zn 3rd Cleaner Feed
D-1902	18.86	Zinc	Zn 4th Cleaner Feed

Test No. PP12 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The flotation circuit was very stable during the test run. Higher lime additions to the zinc rougher feed improved froth conditions.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.8	1115
Pb Scavenger Tailing	9.7	1120
Pb 1st Cleaner Feed	10.4	1065
Pb 1st Cl. Scav.	10.2	-
Pb 2nd Cleaner Feed	10.1	-
Pb 3rd Cleaner Feed	10.4	-
Zn Rougher Feed	10.5	1105
Zn Scavenger Tail.	10.4	1090
Zn 1st Cl. Feed	12.1	-
Zn 1st Cl. Scav. Tail.	11.9	1025
Zn Combined Tail.	-	1080
Zn 2nd Cleaner Feed	11.5	-
Zn 3rd Cleaner Feed	9.7	-
Zn 4th Cleaner Feed	9.0	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher Feed	23.5
Zn Rougher Feed	23.0

Test No. PP12 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, % g/tonne		
	Pb	Zn	Fe
Hendy Cyclone O/F.	2.47	3.96	-
Pb Rougher Conc.	31.9	7.09	-
Pb Rougher Tail.	0.98	4.29	-
Pb Scavenger Conc.	4.02	7.53	-
Pb Scavenger Tail.	0.60	3.96	-
Pb 1st Cl. Conc.	46.7	5.68	-
Pb 1st Cl. Tail.	17.0	9.29	-
Pb 1st Cl. Scav. Conc.	21.8	8.98	-
Pb 1st Cl. Scav. Tail.	8.61	9.64	-
Pb 2nd Cl. Conc.	57.7	4.25	-
Pb 3rd Cl. Conc.	65.1	2.68	5.35
Zn Rougher Feed	0.65	4.19	-
Zn Rougher Conc.	0.80	36.1	-
Zn Scavenger Conc.	4.02	7.53	-
Zn Scavenger Tail.	0.62	0.58	-
Zn 1st Cl. Conc.	0.82	48.1	-
Zn 1st Cl. Tail.	1.19	4.23	-
Zn 1st Cl. Scav. Conc.	2.18	11.5	-
Zn 1st Cl. Scav. Tail.	0.89	1.76	-
Zn 2nd Cl. Conc.	0.63	50.0	-
Zn 3rd Cl. Conc.	0.55	50.3	-
Zn 4th Cl. Conc.	0.54	51.6	-
Zn Comb. Tail.	0.62	0.59	-

Test No. PP12 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Cleaner Conc.	2.88	65.1	2.68	75.9	1.9
Zn Cleaner Conc.	6.49	0.54	51.6	1.4	84.6
Zn Comb. Tailings	90.63	0.62	0.59	22.7	13.5
Cyclone Overflow	100.00	2.47	3.96	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.97	31.9	7.09	77.1	10.2
Pb Scav. Tail.	94.02	0.60	3.96	22.9	89.8
Cyclone Overflow (Meas.)	100.00	2.47	3.96	-	-
(Calc.)	-	2.47	4.15	100.0	100.0
Zn Rougher Conc.	9.22	0.80	36.1	2.9	84.9
Zn Comb. Tail.	87.90	0.62	0.59	21.2	13.2
Zn Flot. Feed (Meas.)	97.12	0.60	3.96	24.1	98.1
(Calc.)	-	0.64	3.96	25.1	97.2

Test No. PP13

1. Grinding

1.1. Purpose: To repeat conditions of test No. PP2.

1.2. Method: As for test No. PP2. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 473 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.

1.3. Flowsheet: As for test PP1.

1.4. Results:

1.4.1. Observations

The grinding circuit was stable during the test run.

Test No. PP13 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.8 percent moisture content	
Feed Rate:	473.8 dry kilograms per hour	
Mill Speed:	32 r.p.m., 80.5 percent of critical speed	
Mill Load:	76.2 mm balls	399.1 kilograms
	50.8 mm balls	185.9 kilograms
	25.4 mm balls	90.7 kilograms
	Total	675.7 kilograms
Operating Time:	Total 7.5 hours, test period 2.0 hours	
Mill Feed:	Total 3554 kilograms, test period 948 kilograms	
Circulating Load:	Cyclone underflow 102.3 percent	
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2158 71
	Cyclone Overflow	1340 33
	Cyclone Underflow	2846 85
Average Power:	Gross	7.13 kilowatts
	No Load	1.93 kilowatts
	Net	5.20 kilowatts
Net Power Consumption:	10.97 kilowatt-hours per tonne of 12.7 mm feed	
Work Index:	12.20	
Cyclone Overflow K_{80} :	93.9 micrometers	

Test No. PP13 - Continued

1. Grinding

1.4.1.2. Classification Data

Grinding Mill Hendy 50.8 mm diameter
Cyclone P-50 Dorr 15.9 mm vortex
 12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recircu- lating Load
		400 mesh	200 mesh	g.p.l.	% Solids	
Cyclone Feed	958.3	12.5	30.5	2132	70	-
Cyclone Overflow	473.8	49.0	71.3	1340	33	-
Cyclone Underflow	484.5	8.5	24.8	2846	85	102.3

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical Mill
Regrind Feed: Pb rougher concentrate + Pb 1st Cl. Scav. Conc.
Feed Rate: 37.38 calculated kilograms per hour of concentrate
Mill Speed: 30 r.p.m., 65 percent of critical speed
Mill Load: 50 mm balls 90.7 kilograms
 25 mm balls 90.7 kilograms
 Total 181.4 kilograms
Average Power: Gross 2.38 kilowatts
 No Load 0.95 kilowatts
 Net 1.43 kilowatts
Net Power Consumption: 3.02 kilowatt-hours per tonne of flotation feed

Test No. PP13 - Continued

1. Grinding

1.4.2.1. Classification Data

Cyclone Krebs 38.1 mm diameter
 12.7 mm vortex
 6.35 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	g.p.l.	% Solids
Regrind Feed	-	72.6	50.0	-	-
Mill Discharge	219.25	64.3	27.5	-	-
Cyclone O'Flow	37.38	84.0	51.5	1165	18
Cyclone U'Flow	181.78	59.4	25.2	1665	51

1.4.3. Zinc Regrind Mill Report

Regrind Mill: Denver Mill
 Regrind Feed: Zn rougher concentrate + Zn 1st cleaner scavenger concentrate
 Feed Rate: 181.6 calculated kilograms per hour of concentrate
 Mill Speed: 58 r.p.m., 70 percent of critical speed
 Mill Load: 25 mm balls 113.4 kg
 Average Power: Not calculated.

1.4.3.1. Classification Data

Cyclone Goodwin 38.1 mm diameter
 19.1 mm vortex
 6.35 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	g.p.l.	% Solids
Regrind Feed	-	50.3	30	-	-
Mill Discharge	345.7	39.7	23	-	-
Cyclone Overflow	181.6	56.0	32	1330	33
Cyclone Underflow	164.1	27.3	15	1720	55

Test No. PP13 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	2.0	2.0	98.0
3	12.1	14.1	85.9
4	11.9	26.0	74.0
6	8.9	34.9	65.1
8	6.3	41.2	58.8
10	5.7	46.9	53.1
14	5.6	52.5	47.5
20	4.9	57.4	42.6
28	7.0	64.4	35.6
35	6.5	70.9	29.1
48	6.2	77.1	22.9
65	4.3	81.4	18.6
100	3.4	84.8	15.2
- 100	15.2	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.2	0.5	99.5
28	0.6	1.1	98.9
35	1.4	2.5	97.5
48	3.7	6.2	93.8
65	9.0	15.2	84.8
100	15.7	30.9	69.1
150	20.0	50.9	49.1
200	18.6	69.5	30.5
270	12.3	81.8	18.2
400	5.7	87.5	12.5
- 400	12.5	100.0	-
Total	100.0	-	-

Test No. PP13 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.1	0.1	99.9
10	0.1	0.2	99.8
14	0.2	0.4	99.6
20	0.3	0.7	99.3
28	0.7	1.4	98.6
35	1.4	2.8	97.2
48	4.0	6.8	93.2
65	8.9	15.7	84.3
100	16.8	32.5	67.5
150	20.6	53.1	46.9
200	22.1	75.2	24.8
270	8.9	84.1	15.9
400	7.4	91.5	8.5
- 400	8.5	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 48	1.9	1.9	98.1
65	1.8	3.7	96.3
100	4.2	7.9	92.1
150	7.3	15.2	84.8
200	13.5	28.7	71.3
270	9.1	37.8	62.2
400	13.2	51.0	49.0
- 400	49.0	100.0	-
Total	100.0	-	-

Test No. PP13 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	1.4	1.4	98.6
100	0.8	2.2	97.8
150	2.4	4.6	95.4
200	5.2	9.8	90.2
270	6.4	16.2	83.8
400	11.2	27.4	72.6
28.8 μ m	8.6	36.0	64.0
22.3	9.6	45.6	54.4
15.6	12.4	58.0	42.0
10.7	11.9	69.9	30.1
8.3	6.4	76.3	23.7
- 8.3	23.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.20

Pb Regrind Discharge

+ 65 mesh	0.2	0.2	99.8
100	0.2	0.4	99.6
150	0.8	1.2	98.8
200	4.2	5.4	94.6
270	8.5	13.9	86.1
400	21.8	35.7	64.3
26.9 μ m	18.8	54.5	45.5
20.8	17.4	71.9	28.1
14.5	11.9	83.8	16.2
10.0	4.2	88.0	12.0
7.7	1.5	89.5	10.5
- 7.7	10.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.69

Test No. PP13 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.4	0.4	99.6
100	0.4	0.8	99.2
150	2.2	3.0	97.0
200	6.0	9.0	91.0
270	10.2	19.2	80.8
400	21.4	40.6	59.4
26.9 μ m	17.5	58.1	41.9
20.8	16.2	74.3	25.7
14.5	11.0	85.3	14.7
10.0	3.8	89.1	10.9
7.7	1.4	90.5	9.5
- 7.7	9.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.67

Pb Regrind Cyclone Overflow

+ 150 mesh	0.3	0.3	99.7
200	1.0	1.3	98.7
270	3.0	4.4	95.7
400	11.7	16.0	84.0
28.1 μ m	13.8	29.8	70.2
21.8	14.0	43.8	56.2
15.2	15.3	59.1	40.9
10.5	12.4	71.5	28.5
8.1	6.3	77.8	22.2
- 8.1	22.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.19

Test No. PP13 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	1.4	1.4	98.6
100	2.4	3.8	96.2
150	6.3	10.1	89.9
200	12.0	22.1	77.9
270	12.0	34.1	65.9
400	15.6	49.7	50.3
26.7 μ m	9.8	59.5	40.5
20.7	10.5	70.0	30.0
14.5	10.1	80.1	19.9
9.9	6.5	86.6	13.4
7.7	3.0	89.6	10.4
- 7.7	10.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.63

Zn Regrind Discharge

+ 65 mesh	0.4	0.4	99.6
100	1.1	1.5	98.5
150	4.9	6.4	93.6
200	17.1	23.5	76.5
270	17.6	41.1	58.9
400	19.2	60.3	39.7
26.9 μ m	8.3	68.6	31.4
20.8	8.4	77.0	23.0
14.5	2.6	84.6	15.4
10.0	4.9	89.5	10.5
7.7	2.4	91.9	8.1
- 7.7	8.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.68

Test No. PP13 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	5.6	5.6	94.4
100	1.2	6.8	93.2
150	12.4	19.2	80.8
200	21.0	40.2	59.8
270	17.2	57.4	42.6
400	15.3	72.7	27.3
26.9 μ m	5.9	78.6	21.4
20.8	5.9	84.5	15.5
14.5	5.2	89.7	10.3
10.0	3.0	92.7	7.3
7.7	1.3	94.0	6.0
- 7.7	6.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.62

Zn Regrind Cyclone Overflow

+ 100 mesh	0.6	0.6	99.4
150	2.6	3.2	96.8
200	9.0	12.2	87.8
270	12.8	25.0	75.0
400	19.0	44.0	56.0
26.5 μ m	11.7	55.7	44.3
20.5	12.2	67.9	32.1
14.3	11.3	79.2	20.8
9.9	7.3	86.5	13.5
7.6	3.4	89.9	10.1
- 7.6	10.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.56

Test No. PP13 - Continued

2. Flotation

2.1. Purpose: To repeat conditions of test No. PP10 at a coarse primary grind.

2.2. Method: The circuit was similar to test PP10 except that the collector additions to the lead rougher were reduced slightly. The circuit was operated for a period of 7.5 hours, and sampled every 30 minutes in the last two hours of operation.

2.2.1. Flotation Equipment

As for test PP8.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP6.

Test No. PP13 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate	Circuit	Point of Additions
	g/tonne		
Na ₂ CO ₃	7653.0	Lead	Hendy Mill Feed
NaCN	234.2	Lead	Hendy Mill Feed
A-343	12.66	Lead	Hendy Mill Feed
A-343	38.11	Lead	Pb Conditioner
MIBC	70.0	Lead	Pb Rougher Feed
A-343	46.72	Lead	Pb Scav. Feed
MIBC	25.07	Lead	Pb Scav. Feed
Na ₂ CO ₃	811.8	Lead	Pb Regr. Mill Feed
NaCN	75.33	Lead	Pb Regr. Mill Feed
A-343	10.00	Lead	Pb Regr. Mill Feed
NaCN	18.67	Lead	Pb 1st Cl. Scav. Feed
A-343	12.60	Lead	Pb 1st Cl. Scav. Feed
MIBC	11.25	Lead	Pb 1st Cl. Scav. Feed
Na ₂ CO ₃	250.7	Lead	Pb 2nd Cleaner Feed
Ca(OH) ₂	4120.8	Zinc	Zn Conditioner Feed
CuSO ₄	1012.8	Zinc	Zn Conditioner Feed
A-343	75.96	Zinc	Zn Rougher Feed
R-208	66.84	Zinc	Zn Rougher Feed
D-1012	17.72	Zinc	Zn Rougher Feed
MIBC	128.6	Zinc	Zn Rougher Feed
A-343	18.74	Zinc	Zn Scav. Feed
R-208	66.84	Zinc	Zn Scav. Feed
D-1012	33.93	Zinc	Zn Scav. Feed
Ca(OH) ₂	1880.0	Zinc	Zn Regr. Mill Feed
CuSO ₄	188.6	Zinc	Zn Regr. Mill Feed
Z-200	13.29	Zinc	Zn 1st Cleaner Feed
A-343	25.32	Zinc	Zn 1st Cl. Scav. Feed
MIBC	33.42	Zinc	Zn 1st Cl. Scav. Feed
D-1902	8.74	Zinc	Zn 3rd Cleaner Feed
D-1902	4.52	Zinc	Zn 4th Cleaner Feed

Test No. PP13 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

Strong pyrite flotation was observed in the lead, zinc, rougher and cleaners. Adjustments in the reagent additions would be required to improve concentrate grades.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.7	1190
Pb Scavenger Tail.	9.6	1190
Pb 1st Cl. Feed	10.4	1165
Pb 1st Cl. Scav.	10.3	-
Pb 2nd Cl. Feed	10.2	-
Pb 3rd Cl. Feed	10.5	-
Zn Rougher Feed	10.4	1220
Zn Scavenger Tail.	10.3	1130
Zn 1st Cl. Feed	11.6	1330
Zn 1st Cl. Scav. Tail.	11.5	1130
Zn Comb. Tail.	-	1110
Zn 2nd Cl. Feed	10.5	-
Zn 3rd Cl. Feed	9.1	-
Zn 4th Cl. Feed	8.7	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher Feed	23.5
Zn Rougher Feed	23.5

Test No. PP13 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, % _A , g/tonne		
	Pb	Zn	Fe
Hendy Cyclone 0/F	2.42	3.87	-
Pb Rougher Conc.	23.9	8.29	-
Pb Rougher Tail.	1.19	4.56	-
Pb Scavenger Conc.	5.08	7.73	-
Pb Scavenger Tail.	0.58	3.79	-
Pb 1st Cl. Conc.	32.2	9.55	-
Pb 1st Cl. Tail.	9.17	10.1	-
Pb 1st Cl. Scav. Conc.	12.9	10.5	-
Pb 1st Cl. Scav. Tail.	5.68	9.93	-
Pb 3rd Cl. Conc.	63.4	4.56	6.89
Zn Rougher Feed	0.62	3.39	-
Zn Rougher Conc.	0.54	8.89	-
Zn Scavenger Conc.	0.60	2.53	-
Zn Scavenger Tail.	0.69	0.54	-
Zn 1st Cl. Conc.	1.00	39.1	-
Zn 1st Cl. Tail.	0.52	1.53	-
Zn 1st Cl. Scav. Conc.	1.37	5.81	-
Zn 1st Cl. Scav. Tail.	0.45	0.31	-
Zn 2nd Cl. Conc.	0.97	46.8	-
Zn 3rd Cl. Conc.	0.82	48.5	-
Zn 4th Cl. Conc.	0.78	50.6	-
Zn Comb. Tailing	0.66	0.47	-

Test No. PPl3 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb 3rd Cl. Conc.	2.79	63.4	4.56	73.2	3.3
Zn 4th Cl. Conc.	6.56	0.78	50.6	2.1	85.7
Zn Combined Tails.	90.65	0.66	0.47	24.7	11.0
Cyclone Overflow	100.00	2.42	3.87	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	7.89	23.9	8.29	77.9	15.8
Pb Scav. Tail.	92.11	0.58	3.79	22.1	84.2
Cyclone Overflow (Meas.)	100.00	2.42	3.87	100.0	100.0
(Calc.)	-	2.42	4.14	-	-
Zn Rougher Conc.	38.33	0.54	8.89	9.3	89.5
Zn Comb. Tail.	58.88	0.66	0.47	17.5	7.2
Pb Scav. Tail. (Meas.)	97.21	0.58	3.79	26.8	96.7
(Calc.)	-	0.61	3.79	24.6	95.2

Test No. PP14

1. Grinding

- 1.1. Purpose: Tp produce a coarser primary grinding product.
- 1.2. Method: Similar to test PP14, except that the mill feed rate was increased from 473 kg per hours to 509 kilograms per hour. The circuit was operated for a period of 7.5 hours and sampled every 30 minutes in the last two hours of operation.
- 1.3. Flowsheet: As for test PP11.
- 1.4. Results:

1.4.1. Observations

The circuit was stable during the test run.

Test No. PP14 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.9 percent moisture content		
Feed Rate:	508.5 dry kilograms per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	76.2 mm balls	399.1 kilograms	
	50.8 mm balls	185.9 kilograms	
	25.4 mm balls	90.7 kilograms	
	Total	675.7 kilograms	
Operating Time:	Total 7.5 hours, test period 2.0 hours		
Mill Feed:	Total 3814 kilograms, test period 1017 kilograms		
Circulating Load:	Cyclone underflow 100.3 percent		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2282	74
	Cyclone Overflow	1412	38
	Cyclone Underflow	2862	85
Average Power:	Gross	6.53 kilowatts	
	No Load	1.93 kilowatts	
	Net	4.60 kilowatts	
Net Power Consumption:	9.05 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	10.09		
Cyclone Overflow K_{80} :	97.2 micrometers		

Test No. PP14 - Continued

1. Grinding

1.4.1.2. Classification Data

Grinding mill Hendy
Cyclone P-50 Dorr 50.8 mm diameter
 15.9 mm vortex
 12.7 mm apex

Product	Rate kg/h	% Passing		Density		Recircu- lating Load %
		400 mesh	200 mesh	g.p.l.	% Solids	
Cyclone Feed	1019	13.3	30.0	2194	71	-
Cyclone Overflow	509	46.4	69.5	1412	38	-
Cyclone Underflow	510	8.8	23.4	2862	85	100.3

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical Mill

Regrind Feed: Pb rougher concentrate + Pb 1st cleaner scav. concentrate

Feed Rate: 26.7 calculated kilograms per hour of concentrate

Mill Speed: 30 r.p.m., 65 percent of critical speed

Mill Load: 50 mm balls 90.7 kilograms
 25 mm balls 90.7 kilograms
 Total 181.4 kilograms

Average Power: Gross 2.14 kilowatts
 No Load 0.95 kilowatts
 Net 1.19 kilowatts

Net Power Consumption: 2.34 kilowatt-hours per tonne of flotation feed

Test No. PP14 - Continued

1. Grinding

1.4.2.1. Classification Data

Cyclone Krebs 38.1 mm diameter
 12.7 mm vortex
 6.35 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	g.p.l.	% Solids
Regrind Feed	-	66.1	49	-	-
Mill Discharge	159.2	52.6	26	-	-
Cyclone Overflow	26.7	86.8	58	1105	13
Cyclone Underflow	132.5	52.9	26	1435	40

Test No. PP14 - Continued

1. Grinding

1.4.3. Zinc Regrind Mill Report

Regrind Mill: Denver mill
Regrind Feed: Zn rougher concentrate + Zn 1st cleaner scav. concentrate
Feed Rate: 42.5 calculated kilograms per hour of concentrate
Mill Speed: 58 r.p.m., 70 percent of critical speed
Mill Load: 25 mm balls 113.4 kg

1.4.3.1. Classification Data

Cyclone Goodwin 38.1 mm diameter
19.1 mm vortex
6.35 mm apex

Product	Rate kg/h	% Passing		Density	
		400 mesh	20 µm	g.p.l.	% Solids
Regrind Feed	-	50.3	31	-	-
Mill Discharge	102.9	56.9	37	-	-
Cyclone Overflow	42.5	69.6	43	1095	11.3
Cyclone Underflow	60.4	45.8	27	1245	26

Test No. PP14 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	6.9	6.9	93.1
3	15.2	22.1	77.9
4	13.8	35.9	64.1
6	6.9	42.8	57.2
8	5.8	48.6	51.4
10	5.1	53.7	46.3
14	4.8	58.5	41.5
20	4.3	62.8	37.2
28	6.2	69.0	31.0
35	5.9	74.9	25.1
48	5.5	80.4	19.6
65	4.1	84.5	15.5
100	2.8	87.3	12.7
- 100	12.7	100.0	-
Total	100.0	-	-

Hendy Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.3	0.6	99.4
28	0.8	1.4	98.6
35	1.6	3.0	97.0
48	4.3	7.3	92.7
65	9.6	16.9	83.1
100	16.0	32.9	67.1
150	19.5	52.4	47.6
200	17.6	70.0	30.0
270	11.4	81.4	18.6
400	5.3	86.7	13.3
- 400	13.3	100.0	-
Total	100.0	-	-

Test No. PP14 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 8	0.2	0.2	99.8
10	0.3	0.5	99.5
14	0.4	0.9	99.1
20	0.5	1.4	98.6
28	1.1	2.5	97.5
35	1.8	4.3	95.7
48	4.5	8.8	91.2
65	9.8	18.6	81.4
100	17.5	36.1	63.9
150	19.6	55.7	44.3
200	20.9	76.6	23.4
270	7.9	84.5	15.5
400	6.7	91.2	8.8
- 400	8.8	100.0	-
Total	100.0	-	-

Hendy Cyclone Overflow

+ 48	1.9	1.9	98.1
65	2.2	4.1	95.9
100	5.1	9.1	90.9
150	8.5	17.6	82.4
200	12.3	29.9	70.1
270	13.6	43.5	56.5
400	10.2	53.7	46.3
- 400	46.3	100.0	-
Total	100.0	-	-

Test No. PP14 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 48	1.6	1.6	98.4
65	2.2	3.8	96.2
100	4.9	8.7	91.3
150	7.2	15.9	84.1
200	14.6	30.5	69.5
270	9.6	40.1	59.9
400	13.5	53.6	46.4
- 400	46.4	100.0	-
Total	100.0	-	-

Test No. PP14 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.9	0.9	99.1
100	1.8	2.7	97.3
150	3.5	6.2	93.8
200	7.5	13.7	86.3
270	8.3	22.0	78.0
400	11.9	33.9	66.1
26.7 μ m	8.3	42.2	57.8
20.7	8.1	50.3	49.7
14.5	10.1	60.4	39.6
9.9	9.4	69.8	30.2
7.7	5.7	75.5	24.5
- 7.7	24.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.78

Pb Regrind Discharge

+ 65 mesh	0.1	0.1	99.9
100	0.1	0.2	99.8
150	0.8	1.0	99.0
200	6.6	7.6	92.4
270	14.2	21.8	78.2
400	25.6	47.4	52.6
27.1 μ m	12.5	59.9	40.1
21.0	13.2	73.1	2.69
14.7	11.1	84.2	15.8
10.1	5.2	89.4	10.6
7.8	2.2	91.6	8.4
- 7.8	8.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.69

Test No. PP14 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.2	0.2	99.8
100	0.4	0.6	99.4
150	1.4	2.0	98.0
200	6.2	8.2	91.8
270	14.0	22.2	77.8
400	24.9	47.1	52.9
27.1 μ m	12.3	59.4	40.6
21.0	13.3	72.7	27.3
14.7	11.2	83.9	16.1
10.1	5.6	89.5	10.5
7.8	2.2	91.7	8.3
- 7.8	8.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.65

Pb Regrind Cyclone Overflow

+ 100 mesh	0.2	0.2	99.8
150	0.2	0.4	99.6
200	1.0	1.4	98.6
270	2.6	4.0	96.0
400	9.2	13.2	86.8
27.2 μ m	12.8	26.0	74.0
21.1	11.0	37.0	63.0
14.7	13.5	50.5	49.5
10.1	12.6	63.1	36.9
7.8	7.6	70.7	29.3
- 7.8	29.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.34

Test No. PP14 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	1.4	1.4	98.6
100	3.3	4.7	95.3
150	6.8	11.5	88.5
200	11.1	22.6	77.4
270	11.8	34.3	65.6
400	15.3	49.7	50.3
29.6 μ m	5.0	54.7	45.3
22.9	9.5	64.2	35.8
16.0	10.0	74.2	25.8
11.0	7.0	81.2	18.8
8.5	3.8	85.0	15.0
- 8.5	15.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.04

Zn Regrind Discharge

+ 100 mesh	0.4	0.4	99.6
150	1.8	2.2	97.8
200	8.4	10.6	89.4
270	12.6	23.2	76.8
400	19.9	43.1	56.9
29.6 μ m	4.4	47.5	52.5
22.9	10.2	57.7	42.3
16.0	11.9	69.6	30.4
11.0	8.7	78.3	21.7
8.5	4.8	83.1	16.9
- 8.5	16.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.11

Test No. PP14 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65 mesh	0.9	0.9	99.1
100	2.4	3.3	96.7
150	5.5	8.8	91.2
200	12.7	21.5	78.5
270	14.2	35.7	64.3
400	18.5	54.2	45.8
29.6 μ m	4.7	58.9	41.1
22.9	9.1	68.0	32.0
16.0	8.8	76.8	23.2
11.0	6.2	83.0	17.0
8.5	3.2	86.2	13.8
- 8.5	13.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.11

Zn Regrind Cyclone Overflow

+ 65 mesh	0.2	0.2	99.8
100	0.5	0.7	99.3
150	0.9	1.6	98.4
200	5.2	6.8	93.2
270	8.4	15.2	84.8
400	15.2	30.4	69.6
28.3 μ m	8.8	39.2	60.8
22.0	12.8	52.0	48.0
15.3	14.0	66.0	34.0
10.5	9.9	75.9	24.1
8.1	5.3	81.2	18.8
- 8.1	18.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.15

Test No. PP14 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of test PP13.

2.2. Method: As for test PP13 except that the reagent additions to the zinc circuit were adjusted as per test PP9. The flotation circuit was operated for a period of 7.5 hours and sampled every 20 minutes in the last two hours of operation.

2.2.1. Flotation Equipment

As for test PP8.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP6.

Test No. PP14 - Continued

2. Flotation

2.2. Flotation Reagents

Type	Rate	Circuit	Point of Additions
	g/tonne		
Na ₂ CO ₃	7009.2	Lead	Hendy Mill Feed
NaCN	222.7	Lead	Hendy Mill Feed
A-343	11.74	Lead	Hendy Mill Feed
A-343	35.25	Lead	Pb Conditioner
MIBC	66.97	Lead	Pb Rougher Feed
A-343	44.60	Lead	Pb Scav. Feed
MIBC	23.36	Lead	Pb Scav. Feed
Na ₂ CO ₃	787.7	Lead	Pb Regrind Mill
NaCN	70.8	Lead	Pb Regrind Mill
A-343	9.21	Lead	Pb Regrind Mill
NaCN	17.70	Lead	Pb 1st Cl. Scav. Feed
A-343	12.10	Lead	Pb 1st Cl. Scav. Feed
MIBC	3.12	Lead	Pb 1st Cl. Scav. Feed
Na ₂ CO ₃	226.6	Lead	Pb 2nd Cleaner Feed
Ca(OH) ₂	3522.3	Zinc	Zn Conditioner Feed
CuSO ₄	708.0	Zinc	Zn Conditioner Feed
A-343	70.8	Zinc	Zn Rougher Feed
R-208	33.04	Zinc	Zn Rougher Feed
D-1012	15.58	Zinc	Zn Rougher Feed
MIBC	119.9	Zinc	Zn Rougher Feed
A-343	17.46	Zinc	Zn Scavenger Feed
R-208	66.08	Zinc	Zn Scavenger Feed
D-1012	30.33	Zinc	Zn Scavenger Feed
Ca(OH) ₂	1823.1	Zinc	Zn Regrind Mill Feed
CuSO ₄	175.8	Zinc	Zn Regrind Mill Feed
Z-200	12.39	Zinc	Zn 1st Cleaner Feed
A-343	23.84	Zinc	Zn 1st Cl. Scav. Feed
MIBC	31.15	Zinc	Zn 1st Cl. Scav. Feed
D-1902	25.25	Zinc	Zn 3rd Cleaner Feed
D-1902	11.09	Zinc	Zn 4th Cleaner Feed

Test No. PP14 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations.

The operation of the zinc circuit was unstable during the test run due to sanding-up the zinc rougher pump.

Poor lead cleaning was observed due to coarse concentrate regrind.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.4	1235
Pb Scavenger Tail.	9.4	1240
Pb 1st Cl. Feed	10.1	1165
Pb 1st Cl. Scav.	10.0	-
Pb 2nd Cl. Feed	9.9	-
Pb 3rd Cl. Feed	10.3	-
Zn Rougher Feed	10.4	1250
Zn Scavenger Tail.	10.2	1135
Zn 1st Cl. Feed	11.9	1095
Zn 1st Cl. Scav. Tail.	11.8	1010
Zn Combined Tail.	-	1115
Zn 2nd Cl. Feed	11.3	-
Zn 3rd Cl. Feed	10.3	-
Zn 4th Cl. Feed	9.4	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher Feed	23.5
Zn Rougher Feed	23.5

Test No. PP14 - Continued

2. Flotation

2.4.4. Chemical Analysis

Product	Assays, %, g/t	
	Pb	Zn
Hendy Cyclone O/F	2.40	3.90
Pb Rougher Conc.	33.8	7.02
Pb Rougher Tail.	0.99	3.87
Pb Scavenger Conc.	7.80	8.26
Pb Scavenger Tail.	0.66	3.83
Pb Comb. Tail.	-	-
Pb 1st Cl. Conc.	32.9	8.44
Pb 1st Cl. Tail.	7.76	9.82
Pb 1st Cl. Scav. Conc.	10.7	10.4
Pb 1st Cl. Scav. Tail.	4.39	9.24
Pb 3rd Cl. Conc.	45.8	7.89
Zn Rougher Feed	1.10	4.80
Zn Rougher Conc.	1.37	37.0
Zn Scavenger Conc.	2.09	7.97
Zn Scavenger Tail.	0.57	0.59
Zn 1st Cl. Conc.	1.07	47.8
Zn 1st Cl. Scav. Conc.	1.85	28.9
Zn 1st Cl. Scav. Tail.	1.80	7.27
Zn 2nd Cl. Conc.	0.91	49.8
Zn 3rd Cl. Conc.	0.88	50.1
Zn Comb. Tail.	0.57	0.67
Zn 4th Cl. Conc.	0.66	51.7

Test No. PP14 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb 3rd Cleaner Conc.	4.04	45.8	7.89	77.0	8.2
Zn 4th Cleaner Conc.	5.76	0.66	51.7	1.6	76.3
Zn Combined Tails.	90.20	0.57	0.67	21.4	15.5
Kason Undersize	100.00	2.40	3.90	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.25	33.8	7.02	73.9	9.2
Pb Scav. Tail.	94.75	0.66	3.83	26.1	90.8
Kason Undersize (Meas.)	100.00	2.40	3.90	100.0	100.0
(Calc.)	-	2.40	4.00	-	-
Zn Rougher Conc.	8.35	1.37	37.0	4.3	77.1
Zn Comb. Tail.	87.61	0.57	0.67	18.7	14.7
Pb Scav. Tail. (Meas.)	95.96	0.66	3.83	23.0	91.8
(Calc.)	-	0.64	3.83	25.6	94.3