A Pilot Plant Investigation of

THE RECOVERY OF LEAD AND ZINC

from Cyprus Anvil samples

submitted by

CYPRUS ANVIL MINING CORPORATION

Progress Report No. 6 (Volume III)

Project No. L.R. 2202

NOTE:

This report refers to the samples as received.

LAKEFIELD RESEARCH OF CANADA LIMITED
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I N D E X

Index - Continued

Test No. PP15

1. Grinding

1.1. Purpose: To repeat conditions of tests PP13 and PP14 at coarser primary grinding.

1.2. Method: The feed rate to the Hendy mill was increased from 508.5 kilograms per hour to 646 kilograms per hour. The circuit was operated for a period of 7.5 hours. 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. PP15 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.9 percent moisture content		
Feed Rate:	646.0 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 4845 kilograms, test period 1292 kilograms		
Circulating Load:	Cyclone underflow 79.2 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2236	72.5
	Cyclone Overflow	1420	39.0
	Cyclone Underflow	2880	85.5
Average Power:	Gross	6.18 kilowatts	
	No Load	1.93 kilowatts	
	Net	4.25 kilowatts	
Net Power Consumtpion:	6.58 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	8.90		
Cyclone Overflow K_{80}:	132.5 micrometers		

Test No. PP15 - 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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	1157.8	12.1	25.7	2252	74	-
Cyclone Overflow	646.0	37.6	56.9	1420	39	-
Cyclone Underflow	511.8	7.5	19.9	2880	85.5	79.2

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical Mill

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

Feed Rate: 32.75 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: 1.47 kilowatt-hours per tonne of flotation feed

Test No. PP15 - 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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	60.7	43.5	-	-
Mill Discharge	248.21	51.5	24.5	-	-
Cyclone O'Flow	32.75	83.5	66.5	1145	17
Cyclone U'Flow	215.46	45.8	20.0	1685	57

1.4.3. Zinc Regrind Mill Report

Regrind Mill: Denver Mill
Regrind Feed: Zn rougher concentrate + Zn 1st cleaner scavenger concentrate
Feed Rate: 110 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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	22.8	9.4	-	-
Mill Discharge	239	37.8	21	-	-
Cyclone O'Flow	110	47.0	27	1330	33
Cyclone U'Flow	129	24.3	14	1695	54

Test No. PP15 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	3.9	3.9	96.1
3	13.6	17.5	82.5
4	10.2	27.7	72.3
6	5.9	33.6	66.4
8	5.8	39.4	60.6
10	5.5	44.9	55.1
14	5.3	50.2	49.8
20	5.3	55.5	44.5
28	6.8	62.3	37.7
35	6.0	68.3	31.7
48	6.4	74.7	25.3
65	5.3	80.0	20.0
100	3.3	83.3	16.7
- 100	16.7	100.0	-
Total	100.0	-	-

Hendy Discharge

+ 8	0.1	0.1	99.9
10	0.2	0.3	99.7
14	0.4	0.7	99.3
20	0.6	1.3	98.7
28	1.4	2.7	97.3
35	2.2	4.9	95.1
48	6.2	11.1	88.9
65	13.5	24.6	75.4
100	17.5	42.1	57.9
150	17.9	60.0	40.0
200	14.3	74.3	25.7
270	9.2	83.5	16.5
400	4.4	87.9	12.1
- 400	12.1	100.0	--
Total	100.0	-	-

Test No. PP15 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 8	0.2	0.2	99.8
10	0.3	0.5	99.5
14	0.3	0.8	99.2
20	0.6	1.4	98.6
28	1.3	2.7	97.3
35	2.4	5.1	94.9
48	6.9	12.0	88.0
65	14.9	26.9	73.1
100	19.5	46.4	53.6
150	19.2	65.6	34.4
200	14.5	80.1	19.9
270	8.6	88.7	11.3
400	3.8	92.5	7.5
- 400	7.5	100.0	--
Total	100.0	-	-

Hendy Cyclone Overflow

+ 48	4.4	4.4	95.6
65	4.0	8.4	91.6
100	8.0	16.4	83.6
150	11.5	27.9	72.1
200	13.2	41.1	58.9
270	12.2	53.3	46.7
400	8.5	61.8	38.2
- 400	38.2	100.0	-
Total	100.0	-	-

Test No. PP15 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 48	2.9	2.9	97.1
65	4.0	6.9	93.1
100	8.5	15.4	84.6
150	11.8	27.2	72.8
200	15.9	43.1	56.9
270	8.7	51.8	48.2
400	10.6	62.4	37.6
- 400	37.6	100.0	-
Total	100.0	-	-

Test No. PP15 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	10.6	10.6	89.4
100	2.3	12.9	87.1
150	5.8	18.7	81.3
200	7.0	25.7	74.3
270	6.0	31.7	68.3
400	7.6	39.3	60.7
28.6 µm	8.0	47.3	52.7
22.2	7.0	54.3	45.7
15.5	9.1	63.4	36.6
10.6	8.8	72.2	27.8
8.2	5.2	77.4	22.6
- 8.2	22.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.15

Pb Regrind Discharge

+ 65 mesh	0.2	0.2	99.8
100	0.2	0.4	99.6
150	1.4	1.8	98.2
200	7.6	9.4	90.6
270	15.6	25.0	75.0
400	23.5	48.5	51.5
26.2 µm	15.1	63.6	36.4
20.3	11.9	75.5	24.5
14.2	9.1	84.6	15.4
9.7	4.2	88.8	11.2
7.5	1.9	90.7	9.3
- 7.5	9.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.83

Test No. PP15 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.6	0.6	99.4
100	0.3	0.9	99.1
150	3.0	3.9	96.1
200	9.8	13.7	86.3
270	16.1	29.8	70.2
400	24.4	54.2	45.8
26.7 µm	13.8	68.0	32.0
20.8	11.5	79.5	20.5
14.5	8.2	87.7	12.3
10.0	3.4	91.1	8.9
7.7	1.5	92.6	7.4
- 7.7	7.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.83

Pb Regrind Cyclone Overflow

+ 100 mesh	0.2	0.2	99.8
150	0.2	0.4	99.6
200	1.4	1.8	98.2
270	3.4	5.2	94.8
400	11.3	16.5	83.5
28.1 µm	10.5	27.0	73.0
21.8	10.0	37.0	63.0
15.2	13.2	50.2	49.8
10.5	13.2	63.4	36.6
8.1	7.9	71.3	28.7
- 8.1	28.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.18

Test No. PP15 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	20.8	20.8	79.2
100	6.3	27.1	72.9
150	11.2	38.3	61.7
200	11.8	50.1	49.9
270	18.7	68.8	31.2
400	8.4	77.2	22.8
27.4 µm	4.5	81.7	18.3
21.3	6.2	87.9	12.1
14.8	5.8	93.7	6.3
10.2	3.7	97.4	2.6
7.9	1.6	99.0	1.0
- 7.9	1.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.39

Zn Regrind Discharge

+ 65 mesh	0.4	0.4	99.6
100	1.2	1.6	98.4
150	6.5	8.1	91.9
200	17.4	25.5	74.5
270	17.7	43.2	56.8
400	19.0	62.2	37.8
28.2 µm	6.2	68.4	31.6
21.9	7.9	76.3	23.7
15.3	7.4	83.7	16.3
10.5	5.0	88.7	11.3
8.1	2.5	91.2	8.8
- 8.1	8.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.13

Test No. PP15 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	3.4	3.4	96.6
100	4.4	7.8	92.2
150	13.5	21.3	78.7
200	21.7	43.0	57.0
270	17.1	60.1	39.9
400	15.6	75.7	24.3
27.4 µm	4.2	79.9	20.1
21.3	4.8	84.7	15.3
14.8	4.2	88.9	11.1
10.2	2.9	91.8	8.2
7.9	1.5	93.3	6.7
- 7.9	6.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.46

Zn Regrind Cyclone Overflow

+ 65 mesh	0.2	0.2	99.8
100	1.0	1.2	98.8
150	4.3	5.5	94.5
200	12.7	18.2	81.8
270	15.5	33.7	66.3
400	19.3	53.0	47.0
27.7 µm	7.4	60.4	39.6
21.4	9.8	70.2	29.8
15.0	9.4	79.6	20.4
10.3	6.2	85.8	14.2
8.0	3.2	89.0	11.0
- 8.0	11.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.29

Test No. PP15 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of tests PP13 and PP14 using a coarser primary grind and coarser concentrate regrinds.

2.2. Method: As for tests PP13 and PP14, except that the feed rate in the primary grind was increased. 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. PP15 - Continued

2. Flotation

2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	8651.8	Lead	Hendy Mill Feed
NaCN	204.9	Lead	Hendy Mill Feed
A-343	9.33	Lead	Hendy Mill Feed
A-343	27.86	Lead	Pb Conditioner
MIBC	51.64	Lead	Pb Rougher Feed
A-343	34.97	Lead	Pb Scavenger Feed
MIBC	18.08	Lead	Pb Scavenger Feed
Na_2CO_3	609.5	Lead	Pb Regrind Mill
NaCN	56.19	Lead	Pb Regrind Mill
A-343	7.38	Lead	Pb Regrind Mill
NaCN	13.47	Lead	Pb 1st Cl. Scav. Feed
A-343	9.26	Lead	Pb 1st Cl. Scav. Feed
MIBC	2.45	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	186.7	Lead	Pb 2nd Cl. Feed
$Ca(OH)_2$	3009.3	Zinc	Zn Conditioner Feed
$CuSO_4$	557.3	Zinc	Zn Conditioner Feed
A-343	55.73	Zinc	Zn Rougher Feed
R-208	26.01	Zinc	Zn Rougher Feed
MIBC	94.40	Zinc	Zn Rougher Feed
D-1012	12.26	Zinc	Zn Rougher Feed
A-343	13.75	Zinc	Zn Scavenger Feed
R-208	52.01	Zinc	Zn Scavenger Feed
D-1012	24.52	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	1476.8	Zinc	Zn Regrind Mill
$CuSO_4$	141.2	Zinc	Zn Regrind Mill
Z-200	9.75	Zinc	Zn 1st Cl. Feed
A-343	18.67	Zinc	Zn 1st Cl. Scav. Feed
MIBC	24.52	Zinc	Zn 1st Cl. Scav. Feed
D-1902	19.13	Zinc	Zn 3rd Cl. Feed
D-1902	10.59	Zinc	Zn 4th Cl. Feed

Test No. PP15 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The lead and zinc flotation circuits were very stable during the test run. It was observed that large quantities of coarse pyrite were floated in the lead and zinc rougher stages. However, the rejection of pyrite during cleaning was satisfactory.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.8	1345
Pb Scavenger Tail.	9.7	1310
Pb 1st Cl. Feed	10.1	1145
Pb 1st Cl. Scav.	10.0	-
Pb 2nd Cl. Feed	9.9	-
Pb 3rd Cl. Feed	10.3	-
Zn Rougher Feed	10.4	1240
Zn Scav. Tail.	10.3	1190
Zn 1st Cl. Feed	11.9	1330
Zn 1st Cl. Scav. Tail.	11.8	1080
Zn Combined Tail.	-	1165
Zn 2nd Cl. Feed	11.3	-
Zn 3rd Cl. Feed	9.7	-
Zn 4th Cl. Feed	9.0	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher Feed	24
Zn Rougher Feed	24.5

Test No. PP15 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne		
	Pb	Zn	Ag
Hendy Cyclone O'Flow	2.36	3.85	21.09
Pb Rougher Conc.	32.7	7.11	-
Pb Rougher Tail.	1.29	3.99	-
Pb Scavenger Conc.	1.54	3.48	-
Pb Scavenger Tail.	0.74	3.91	-
Pb 1st Cl. Conc.	34.3	8.45	-
Pb 1st Cl. Tail.	9.26	9.95	-
Pb 1st Cl. Scav. Conc.	11.2	10.1	-
Pb 1st Cl. Scav. Tail.	5.39	9.59	-
Pb 2nd Cl. Conc.	49.6	6.51	-
Pb 3rd Cl. Conc.	63.0	4.01	454.48
Zn Rougher Feed	0.91	4.58	-
Zn Rougher Conc.	1.54	19.9	-
Zn Scavenger Conc.	1.54	3.48	-
Zn Scavenger Tail.	0.61	0.51	-
Zn 1st Cl. Conc.	1.70	42.1	-
Zn 1st Cl. Tail.	1.56	8.46	-
Zn 1st Cl. Scav. Conc.	2.23	17.5	-
Zn 1st Cl. Scav. Tail.	0.94	0.59	-
Zn 2nd Cl. Conc.	1.70	47.9	-
Zn 3rd Cl. Conc.	1.45	49.7	-
Zn 4th Cl. Conc.	1.22	50.0	44.75
Zn Comb. Tail.	0.61	0.51	-

Test No. PP15 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight	Assays, %, g/tonne			% Distribution		
	%	Pb	Zn	Ag	Pb	Zn	Ag
Pb 3rd Cl. Conc.	2.74	63.0	4.01	454.48	73.2	2.9	59.1
Zn 4th Cl. Conc.	6.56	1.22	50.0	44.75	3.4	85.1	13.9
Zn Combined Tail.	90.70	0.61	0.51	6.29	23.4	12.0	27.0
Kason Undersize	100.00	2.36	3.85	21.09	100.0	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.07	32.7	7.11	-	70.2	8.9	-
Pb Scav. Tail.	94.93	0.74	3.91	-	29.8	91.1	-
Kason Undersize (Meas.)	100.00	2.36	3.85	-	100.0	100.0	-
(Calc.)	-	2.36	4.07	-	-	-	-
Zn Rougher Conc.	17.05	1.54	19.9	-	9.4	86.6	-
Zn Comb. Tail.	80.21	0.61	0.51	-	17.4	10.5	-
Pb Scav. Tail. (Meas.)	97.26	0.74	3.91	-	26.8	97.1	-
(Calc.)	-	0.77	3.91	-	31.8	98.7	-

Test No. PP16

1. Grinding

1.1. Purpose: To repeat conditions of test PP15.

1.2. Method: As for test PP15. The circuit was operated for a period of 7.5 hours. 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 circuit operation was stable during the test run.

Test No. PP16 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.9 percent moisture content		
Feed Rate:	615.1 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 4613 kilograms, test period 1230 kilograms		
Circulating Load:	Cyclone underflow 83.2 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2358	76
	Cyclone Overflow	1430	39
	Cyclone Underflow	2874	85.5
Average Power:	Gross	6.29 kilowatts	
	No Load	1.93 kilowatts	
	Net	4.36 kilowatts	
Net Power Consumption:	7.09 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	9.44		
Cyclone Overflow K_{80}:	128.0 micrometers		

Test No. PP16 - 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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	1126.9	12.9	26.3	2256	73	-
Cyclone Overflow	615.1	41.7	60.3	1430	39	-
Cyclone Underflow	511.8	7.8	19.6	2874	85.5	83.2

1.4.2. Lead Regrind Mill Report

Regrind Mill:	Hardinge Conical Mill	
Regrind Feed:	Pb rougher concentrate + Pb 1st cleaner scav. concentrate	
Feed Rate:	31.7 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	1.90 kilowatts
	No Load	0.95 kilowatts
	Net	0.95 kilowatts
Net Power Consumption:	1.54 kilowatt-hours per tonne of flotation feed	

Test No. PP16 - 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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	57.8	41.5	-	-
Mill Discharge	317.2	53.5	26.0	-	-
Cyclone O'Flow	31.7	98.3	96.0	1055	6.7
Cyclone U'Flow	285.5	49.8	22.5	2565	77

Test No. PP16 - 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: 71.2 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

1.4.3.1. Classification Data

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

Product	Rate	% Passing		Density	
	kg/h	400 mesh	20 µm	g.p.l.	% Solids
Regrind Feed	-	40.1	24	-	-
Mill Discharge	317.4	34.9	15	-	-
Cyclone O'Flow	71.2	62.3	37	1155	17.5
Cyclone U'Flow	246.2	25.3	10	2195	72

Test No. PP16 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	8.1	8.1	91.9
3	10.3	18.4	81.6
4	9.0	27.4	72.6
6	7.4	34.8	65.2
8	4.9	39.7	60.3
10	5.3	45.0	55.0
14	5.2	50.2	49.8
20	5.2	55.4	44.6
28	7.1	62.5	37.5
35	7.0	69.5	30.5
48	6.5	76.0	24.0
65	5.0	81.0	19.0
100	3.4	84.4	15.6
- 100	15.6	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.4	0.7	99.3
28	1.2	1.9	98.1
35	2.5	4.4	95.6
48	6.4	10.8	89.2
65	12.3	23.1	76.9
100	18.1	41.2	58.8
150	18.1	59.3	40.7
200	14.4	73.7	26.3
270	8.9	82.6	17.4
400	4.5	87.1	12.9
- 400	12.9	100.0	-
Total	100.0	-	-

Test No. PP16 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 8	0.1	0.1	99.9
10	0.3	0.4	99.6
14	0.3	0.7	99.3
20	0.5	1.2	98.8
28	1.3	2.5	97.5
35	2.7	5.2	94.8
48	6.9	12.1	87.9
65	12.4	24.5	75.5
100	20.0	44.5	55.5
150	19.2	63.7	36.3
200	16.7	80.4	19.6
270	6.5	86.9	13.1
400	5.3	92.2	7.8
- 400	7.8	100.0	-
Total	100.0	-	-

Hendy Cyclone Overflow

+ 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	0.5	1.5	98.5
35	0.8	2.3	97.7
48	1.8	4.1	95.9
65	4.4	8.5	91.5
100	8.1	16.6	83.4
150	11.2	27.8	72.7
200	12.4	40.2	59.8
270	11.7	51.9	48.1
400	8.4	60.3	39.7
- 400	39.7	100.0	-
Total	100.0	-	-

Test No. PP16 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 48	2.2	2.2	97.8
65	4.3	6.5	93.5
100	8.6	15.1	84.9
150	10.4	25.5	74.5
200	14.2	39.7	60.3
270	8.4	48.1	51.9
400	10.2	58.3	41.7
- 400	41.7	100.0	-
Total	100.0	-	-

Test No. PP16 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	1.4	1.4	98.6
100	4.3	5.7	94.3
150	6.9	12.6	87.4
200	10.9	23.5	76.5
270	8.7	32.2	66.8
400	10.0	42.2	57.8
27.0 µm	8.0	50.2	49.8
20.9	6.7	56.9	43.1
14.6	8.0	64.9	35.1
10.0	7.4	72.3	27.7
7.8	5.0	77.3	22.7
- 7.8	22.7	100.0	-
Total	100.0	-	-

Pb Regrind Discharge

Specific Gravity 4.79

+ 65 mesh	0.4	0.4	99.6
100	0.6	1.0	99.0
150	3.2	4.2	95.8
200	7.8	12.0	88.0
270	13.5	25.5	74.5
400	21.0	46.5	53.5
25.4 µm	15.2	61.7	38.3
19.7	12.4	74.1	25.9
13.8	11.7	85.8	14.2
9.5	6.4	92.2	7.8
7.3	1.4	93.6	6.4
- 7.3	6.4	100.0	-
Total	100.0	-	-

Specific Gravity 5.01

Test No. PP16 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.9	0.9	99.1
100	0.8	1.7	98.3
150	3.7	5.4	94.6
200	9.4	14.8	85.2
270	14.6	29.4	70.6
400	20.8	50.2	49.8
25.0 µm	15.4	65.6	34.4
19.4	12.4	78.0	22.0
13.6	11.0	89.0	11.0
9.3	5.2	94.2	5.8
7.2	1.0	95.2	4.8
- 7.2	4.8	100.0	-
Total	100.0	-	-

Specific Gravity 5.08

Pb Regrind Cyclone Overflow

+ 150 mesh	0.2	0.2	99.8
200	0.2	0.4	99.6
270	0.3	0.7	99.3
400	1.0	1.7	98.3
28.5 µm	0.8	2.5	97.5
22.1	0.9	3.4	96.6
15.4	2.4	5.8	94.2
10.6	14.8	20.6	79.4
8.2	17.6	38.2	61.8
- 8.2	61.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.15

Test No. PP16 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	3.0	3.0	97.0
100	7.0	10.0	90.0
150	8.4	18.4	81.6
200	14.8	33.2	66.8
270	12.3	45.5	54.5
400	14.4	59.9	40.1
29.4 µm	5.0	64.9	35.1
22.8	7.8	72.7	27.3
15.9	7.6	80.3	19.7
10.9	5.2	85.5	14.5
8.5	2.8	88.3	11.7
- 8.5	11.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.24

Zn Regrind Discharge

+ 100 mesh	0.8	0.8	99.2
150	5.5	6.3	93.7
200	15.2	21.5	78.5
270	21.2	42.7	57.3
400	22.4	65.1	34.9
27.4 µm	8.1	73.2	26.8
21.3	9.2	82.4	17.6
14.8	6.2	88.6	11.4
10.2	3.2	91.8	8.2
7.9	1.4	93.2	6.8
- 7.9	6.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.40

Test No. PP16 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	2.0	2.0	98.0
100	2.5	4.5	95.5
150	10.1	14.6	85.4
200	18.4	33.0	67.0
270	21.0	54.0	46.0
400	20.7	74.7	25.3
27.4 µm	7.0	81.7	18.3
21.3	7.0	88.7	11.3
14.8	4.2	92.9	7.1
10.2	1.8	94.7	5.3
7.9	0.7	95.4	4.6
- 7.9	4.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.41

Zn Regrind Cyclone Overflow

+ 100 mesh	0.4	0.4	99.6
150	0.8	1.2	98.8
200	5.0	6.2	93.8
270	11.0	17.2	82.8
400	20.5	37.7	62.3
27.7 µm	9.0	46.7	53.3
21.4	13.0	59.7	40.3
15.0	12.6	72.3	27.7
10.3	8.4	80.7	19.3
8.0	4.4	85.1	14.9
- 8.0	14.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.28

Test No. PP16 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of test PP15 using finer lead and zinc rougher concentrate regrinds.

2.2. Method: As for test PP15 except that a different arrangements of the cyclones in the regrind was used. 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. PP16 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	8822.9	Lead	Hendy Mill Feed
NaCN	216.5	Lead	Hendy Mill Feed
A-343	9.49	Lead	Hendy Mill Feed
A-343	29.26	Lead	Pb Conditioner
MIBC	53.44	Lead	Pb Rougher Feed
A-343	36.87	Lead	Pb Scavenger Feed
Na_2CO_3	653.55	Lead	Pb Regrind Mill
NaCN	59.50	Lead	Pb Regrind Mill
A-343	7.90	Lead	Pb Regrind Mill
NaCN	13.75	Lead	Pb 1st Cl. Scav. Feed
A-343	9.54	Lead	Pb 1st Cl. Scav. Feed
MIBC	2.58	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	200.5	Lead	Pb 2nd Cl. Feed
$Ca(OH)_2$	3243.4	Zinc	Zn Conditioner Feed
$CuSO_4$	585.3	Zinc	Zn Conditioner Feed
A-343	58.53	Zinc	Zn Rougher Feed
R-208	39.02	Zinc	Zn Rougher Feed
MIBC	99.14	Zinc	Zn Rougher Feed
D-1012	12.88	Zinc	Zn Rougher Feed
A-343	14.63	Zinc	Zn Scavenger Feed
R-208	54.63	Zinc	Zn Scavenger Feed
D-1012	25.75	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	1463.2	Zinc	Zn Regrind Mill
$CuSO_4$	146.3	Zinc	Zn Regrind Mill
Z-200	10.24	Zinc	Zn 1st Cleaner Feed
A-343	19.41	Zinc	Zn 1st Cl. Scav. Feed
MIBC	25.75	Zinc	Zn 1st Cl. Scav. Feed
D-1902	19.31	Zinc	Zn 3rd Cl. Feed
D-1902	11.32	Zinc	Zn 4th Cl. Feed

Test No. PP16 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The operation of the circuit was not stable during the test run. The increased fineness of the concentrate regrinds resulted in improved cleaning performance.

Several pumps were sanded during the test run which resulted in unstable conditions.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.7	1320
Pb Scavenger Tail.	9.6	1295
Pb 1st Cl. Feed	10.1	1055
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.	10.3	1195
Zn 1st Cl. Feed	12.1	1155
Zn 1st Cl. Scav. Tail.	11.9	1060
Zn Combined Tail.	-	1165
Zn 2nd Cl. Feed	11.5	-
Zn 3rd Cl. Feed	10.0	-
Zn 4th Cl. Feed	9.3	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher Feed	23.5
Zn Rougher Feed	24

Test No. PP16 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne	
	Pb	Zn
Hendy Cyclone O'Flow	2.46	3.94
Pb Rougher Conc.	34.3	7.27
Pb Rougher Tail.	1.24	3.92
Pb Scavenger Conc.	7.76	9.08
Pb Scavenger Tail.	0.73	3.82
Pb 1st Cl. Conc.	38.4	6.09
Pb 1st Cl. Tail.	12.2	10.0
Pb 1st Cl. Scav. Conc.	14.4	10.1
Pb 1st Cl. Scav. Tail.	8.78	10.6
Pb 2nd Cl. Conc.	53.5	3.95
Pb 3rd Cl. Conc.	63.6	2.40
Zn Rougher Feed	0.90	4.52
Zn Rougher Conc.	1.72	27.9
Zn Scav. Conc.	1.84	4.50
Zn Scav. Tail.	0.62	0.55
Zn 1st Cl. Conc.	1.66	48.2
Zn 1st Cl. Tail.	1.83	9.52
Zn 1st Cl. Scav. Conc.	2.36	26.4
Zn 1st Cl. Scav. Tail.	2.64	1.33
Zn 2nd Cl. Conc.	1.46	49.5
Zn 3rd Cl. Conc.	1.38	50.2
Zn 4th Cl. Conc.	1.10	51.4
Zn Comb. Tail.	0.64	0.56

Test No. PP16 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb 3rd Cleaner Conc.	2.84	63.6	2.40	73.5	1.7
Zn 4th Cl. Conc.	6.55	1.10	51.4	2.9	85.4
Zn Comb. Tail.	90.61	0.64	0.56	23.6	12.9
Kason Undersize	100.00	2.46	3.94	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.15	34.3	7.27	71.8	9.4
Pb Scav. Tail.	94.85	0.73	3.82	28.2	90.6
Kason Undersize (Meas.)	100.00	2.46	3.94	100.0	100.0
(Calc.)	-	2.46	4.00	-	-
Zn Rougher Conc.	11.58	1.72	27.9	7.1	85.6
Zn Comb. Tail.	85.58	0.64	0.56	19.4	12.7
Pb Scav. Tail. (Meas.)	97.16	0.73	3.82	26.5	98.3
(Calc.)	-	0.77	3.82	30.4	97.1

Test No. PP17

1. Grinding

1.1. Purpose: To repeat the conditions of test No. 15.

1.2. Method: As for test PP15. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 623.0 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.

1.3. Flowsheet: As for test No. PP1.

1.4. Results:

1.4.1. Observations

The circuit was very stable during the test run.

Test No. PP17 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.7 percent moisture content		
Feed Rate:	623.0 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 4673 kilograms, test period 1246 kilograms		
Circulating Load:	Cyclone underflow 82.7 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2337	76
	Cyclone Overflow	1440	40
	Cyclone Underflow	2898	86
Average Power:	Gross	6.77 kilowatts	
	No Load	1.93 kilowatts	
	Net	4.84 kilowatts	
Net Power Consumption:	7.76 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	10.10		
Cyclone Overflow K_{80}:	119.4 micrometers.		

Test NO. PP17 - 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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	1138	15.8	29.0	2198	66	-
Cyclone Overflow	623	37.0	59.4	1440	40	-
Cyclone Underflow	515	7.5	20.8	2898	86	82.7

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical Mill

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

Feed Rate: 32.96 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 ballls	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:
1.52 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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	64.8	48.5	-	-
Mill Discahrge	364.84	45.1	13.0	-	-
Cyclone O'Flow	32.96	98.5	79.0	1120	13
Cyclone U'Flow	331.88	40.0	11.5	2790	84

Test No. PP17 - 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: 73.3 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 P-25 Dorr 25 mm diameter
6.35 mm vortex
3.25 mm apex

Product	Rate kg/h	% Passing 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	44.7	28	-	-
Mill Discharge	372.0	33.0	13.5	-	-
Cyclone O'Flow	73.3	71.6	45	1165	18
Cyclone U'Flow	298.7	25.3	8.5	2170	68

Test No. PP17 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	0.9	0.9	99.1
3	8.9	9.8	90.2
4	10.0	19.8	80.2
6	6.5	26.3	73.7
8	6.2	32.5	67.5
10	6.0	38.5	61.5
14	5.9	44.4	55.6
20	5.5	49.9	50.1
28	8.1	58.0	42.0
35	7.5	65.5	34.5
48	7.4	72.9	27.1
65	5.5	78.4	21.6
100	3.7	82.1	17.9
- 100	17.9	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.3	0.5	99.5
28	1.0	1.5	98.5
35	2.4	3.9	96.1
48	6.3	7.2	92.8
65	11.4	18.6	81.4
100	18.3	36.9	63.1
150	17.5	54.4	45.6
200	16.6	71.0	29.0
270	6.9	77.9	22.1
400	6.3	84.2	15.8
- 400	15.8	100.0	-
Total	100.0	-	-

Test No. PP17 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 8	0.1	0.1	99.9
10	0.2	0.3	99.7
14	0.3	0.6	99.4
20	0.5	1.1	98.9
28	1.2	2.3	97.7
35	2.3	4.6	95.4
48	6.6	11.2	88.8
65	14.1	25.3	74.7
100	19.3	44.6	55.4
150	19.6	64.2	35.8
200	15.0	79.1	20.8
270	9.0	88.2	11.8
400	4.3	92.5	7.5
- 400	7.5	100.0	-
Total	100.0	-	-

Hendy Cyclone Overflow

+ 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	0.3	0.8	99.2
35	0.6	1.4	98.6
48	1.7	3.1	96.9
65	3.7	6.8	93.2
100	8.5	15.3	84.7
150	10.6	25.9	74.1
200	14.5	40.4	59.6
270	8.3	48.7	51.3
400	11.5	60.2	39.8
- 400	39.8	100.0	-
Total	100.0	-	-

Test No. PP17 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 48	3.1	3.1	96.9
65	4.3	7.4	92.6
100	8.1	15.5	94.5
150	11.5	27.0	73.0
200	13.6	40.6	59.4
270	12.8	53.4	46.6
400	9.6	63.0	37.0
- 400	37.0	100.0	-
Total	100.0	-	-

Test No. PP17 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	1.0	1.0	99.0
100	3.2	4.2	95.8
150	5.3	9.5	90.5
200	7.9	17.4	82.6
270	7.6	25.0	75.0
400	10.2	35.2	64.8
28.5 µm	6.9	42.1	57.9
22.1	6.4	48.5	51.5
15.4	9.2	57.7	42.3
10.6	9.3	67.0	33.0
8.2	5.9	72.9	27.1
- 8.2	27.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.35

Pb Regrind Discharge

+ 65 mesh	0.38	0.38	99.62
100	1.44	1.82	98.18
150	4.30	6.12	93.88
200	10.12	16.24	83.76
270	15.64	31.88	68.12
400	22.98	54.86	45.14
25.5 µm	20.18	75.04	24.96
19.7	12.06	87.10	12.90
13.8	6.10	93.20	6.80
9.5	2.00	95.20	4.80
7.3	0.78	95.98	4.02
- 7.3	4.02	100.00	-
Total	100.0	-	-

Specific Gravity 5.19

Test No. PP17 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	1.7	1.7	98.3
100	4.7	6.4	93.6
150	10.1	16.5	83.5
200	9.8	26.3	73.7
270	13.6	39.9	60.1
400	20.1	60.0	40.0
25.3 µm	17.5	77.5	22.5
19.6	11.1	88.6	11.4
13.7	4.9	93.5	6.5
9.4	1.3	94.8	5.2
7.3	0.6	95.4	4.6
- 7.3	4.6	100.0	-
Total	100.0	-	-

Specific Gravity 5.21

Pb Regrind Cyclone Overflow

+ 100 mesh	0.2	0.2	99.8
150	0.2	0.4	99.6
200	0.3	0.7	99.3
270	0.2	0.9	99.1
400	0.6.	1.5	98.5
29.0 µm	3.0	4.5	95.5
22.5	9.8	14.3	85.7
15.7	20.4	34.7	65.3
10.8	18.2	52.9	47.1
8.3	10.1	63.0	37.0
- 8.3	37.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.04

Test No. PP17 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	2.3	2.3	97.7
100	6.9	9.2	90.8
150	10.1	19.3	80.7
200	13.2	32.5	67.5
270	10.6	43.1	56.9
400	12.2	55.3	44.7
28.9 µm	4.8	60.1	39.9
22.4	8.4	68.5	31.5
15.6	8.7	77.2	22.8
10.7	5.8	83.0	17.0
8.3	2.9	85.9	14.1
- 8.3	14.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.24

Zn Regrind Discharge

+ 65 mesh	0.4	0.4	99.6
100	1.0	1.4	98.6
150	4.0	5.4	94.6
200	14.0	19.4	80.6
270	22.4	41.8	58.2
400	25.2	67.0	33.0
28.1 µm	7.8	74.8	25.2
21.8	9.6	84.4	15.6
15.2	6.2	90.6	9.4
10.4	2.8	93.4	6.6
8.1	1.2	94.6	5.4
- 8.1	5.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.44

Test No. PP17 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	20.4	20.4	79.6
100	6.4	26.8	73.2
150	10.7	37.5	62.5
200	10.1	47.6	52.4
270	11.9	59.6	40.5
400	15.2	74.7	25.3
28.2 µm	7.9	82.6	17.4
21.9	7.4	90.0	10.0
15.3	4.2	94.2	5.8
10.5	1.5	95.7	4.3
8.1	0.6	96.3	3.7
- 8.1	3.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.49

Zn Regrind Cyclone Overflow

+ 100 mesh	0.2	0.2	99.8
150	0.4	0.6	99.4
200	3.1	3.7	96.3
270	6.8	10.5	89.5
400	17.9	28.4	71.6
28.6 µm	7.6	36.0	64.0
22.2	14.3	50.3	49.7
15.5	15.1	65.4	34.6
10.6	10.2	75.6	24.4
8.2	5.5	81.1	18.9
- 8.2	18.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.18

Test No. PP17 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of test PP15.

2.2. Method: As for test PP15. 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. PP17 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	8627.7	Lead	Hendy Mill Feed
NaCN	219.6	Lead	Hendy Mill Feed
A-343	9.48	Lead	Hendy Mill Feed
MIBC	53.89	Lead	Pb Rougher Feed
A-343	28.44	Lead	Pb Conditioner
A-343	34.43	Lead	Pb Scavenger Feed
Na_2CO_3	628.74	Lead	Pb Regrind Mill Feed
NaCN	54.89	Lead	Pb Regrind Mill Feed
A-343	7.48	Lead	Pb Regr. Cyclone Feed Pump
A-343	9.48	Lead	Pb 1st Cl. Scav.
NaCN	13.47	Lead	Pb 1st Cl. Scav.
MIBC	-	Lead	Pb 1st Cl. Scav.
Na_2CO_3	184.13	Lead	Pb 2nd Cleaner Feed
Lime	3293.4	Zinc	Zn Conditioner Feed
$CuSO_4$	570.36	Zinc	Zn Conditioner
A-343	57.38	Zinc	Zn Rougher Feed
R-208	28.44	Zinc	Zn Rougher Feed
MIBC	98.80	Zinc	Zn Rougher Feed
D-1012	14.97	Zinc	Zn Rougher Feed
A-343	14.47	Zinc	Zn Scavenger Feed
R-208	50.90	Zinc	Zn Scavenger Feed
D-1012	28.44	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	2370.25	Zinc	Zn Regrind Mill Feed
Z-200	9.48	Zinc	Zn 1st Cleaner Feed
A-343	18.96	Zinc	Zn 1st Cleaner Feed
MIBC	25.45	Zinc	Zn 1st Cleaner Feed
D-1902	20.46	Zinc	Zn 3rd Cleaner Feed
D-1902	7.49	Zinc	Zn 4th Cleaner Feed
$CuSO_4$	133.73	Zinc	Zn Regrind Mill Feed
MIBC	18.96	Lead	Pb Scavenger Feed

Test No. PP17 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The flotation circuit was very stable during the test run.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.9	1275
Pb Scavenger Tail.	9.9	1245
Pb 1st Cleaner Feed	10.1	1120
Pb 1st Cleaner Scav.	10.0	-
Pb 2nd Cleaner Feed	9.9	-
Pb 3rd Cleaner Feed	10.2	-
Zn Rougher Feed	10.4	1205
Zn Scavenger Tail.	10.3	1166
Zn 1st Cleaner Feed	12.2	1165
Zn 1st Cl. Scav. Tail.	12.3	1036
Zn Combined Tail.	-	-
Zn 2nd Cleaner Feed	11.7	-
Zn 3rd Cleaner Feed	10.6	-
Zn 4th Cleaner Feed	9.8	-
Zn Combined Tail.	-	1130

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher	22.5
Zn Rougher	23.5

Test No. PP17 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne	
	Pb	Zn
Hendy Cyclone O/F	2.41	3.82
Pb Rougher Conc.	31.6	6.96
Pb Rougher Tail.	1.33	4.19
Pb Scavenger Conc.	8.10	8.38
Pb Scavenger Tail.	0.78	3.90
Pb Comb. Tail.	0.95	4.52
Pb 1st Cl. Conc.	39.4	8.02
Pb 1st Cl. Tail.	11.7	10.4
Pb 1st Cl. Scav. Conc.	13.9	10.5
Pb 1st Cl. Scav. Tail.	6.93	9.82
Pb 2nd Cl. Conc.	55.0	5.83
Pb 3rd Cl. Conc.	67.6	3.17
Zn Rougher Conc.	1.52	26.9
Zn Scavenger Conc.	1.79	5.05
Zn Scavenger Tail.	0.65	0.60
Zn 1st Cl. Conc.	1.26	48.0
Zn 1st Cl. Tail.	1.70	11.1
Zn 1st Cl. Scav. Conc.	2.83	32.4
Zn 1st Cl. Scav. Tail.	1.61	3.30
Zn 2nd Cl. Conc.	1.23	49.9
Zn 3rd Cl. Conc.	1.15	50.6
Zn Comb. Tail.	0.67	0.74
Zn 4th Cl. Conc.	0.94	50.9

Test No. PP17 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Lead Concentrate	2.57	67.6	3.17	72.2	2.1
Zinc Concentrate	6.02	0.94	50.9	2.4	80.2
Tailings	91.41	0.67	0.74	25.4	17.7
Kason Undersize	100.00	2.41	3.82	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.29	31.6	6.96	69.4	9.1
Pb Scav. Tail.	94.71	0.78	3.90	30.6	90.9
Kason Undersize (Meas.)	100.00	2.41	3.82	100.0	100.0
(Calc.)	-	2.41	4.06	-	-
Zn Rougher Conc.	11.77	1.52	26.9	6.6	81.6
Zn Comb. Tail.	85.66	0.67	0.74	21.2	16.3
Pb Scav. Tail. (Meas.)	97.43	0.78	3.90	27.8	97.9
(Calc.)	-	0.77	3.90	31.2	99.5

Test No. PP18

1. Grinding

1.1. Purpose: To repeat conditions of test PP15.

1.2. Method: As for test PP15. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 627 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 circuit was stable during the test run.

Test No. PP18 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.8 percent moisture content		
Feed Rate:	627.3 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 4705 kilograms, test period 1255 kilograms		
Circulating Load:	Cyclone underflow 415.3 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2236	73
	Cyclone Overflow	1396	37
	Cyclone Underflow	2808	84
Average Power:	Gross	6.53 kilowatts	
	No Load	1.93 kilowatts	
	Net	4.60 kilowatts	
Net Power Consumption:	7.33 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	9.00		
Cyclone Overflow K_{80}:	115.4 micrometers		

Test No. PP18 - 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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	3232	11.0	25.2	2088	68	-
Cyclone Overflow	627	40.8	60.4	1396	37	-
Cyclone Underflow	2605	6.3	18.1	2808	84	415.3

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical mill

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

Feed Rate: 35.57 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 2.63 kilowatts
No Load 0.95 kilowatts
Net 1.68 kilowatts

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

Test No. PP18 - 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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	57.2	40.5	-	-
Mill Discharge	303.84	34.5	12.0	-	-
Cyclone O'Flow	35.57	80.7	52.5	1180	21
Cyclone U'Flow	268.27	30.2	9.8	2145	69

Test No. PP18 - 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: 125.1 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

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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	31.8	19	-	-
Mill Discharge	303.3	24.6	15	-	-
Cyclone Overflow	125.1	53.4	32	1190	21
Cyclone Underflow	178.2	12.9	7.5	2215	72

Test No. PP18 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	8.9	8.9	91.1
3	14.6	23.5	76.5
4	8.8	32.3	67.7
6	6.6	38.9	61.1
8	6.3	45.2	54.8
10	5.7	50.9	49.1
14	5.6	56.5	43.5
20	5.4	61.9	38.1
28	6.5	68.4	31.6
35	5.5	73.9	26.1
48	5.7	79.6	20.4
65	4.4	83.0	16.0
100	2.7	86.7	13.3
- 100	13.3	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.4	0.7	99.3
28	1.0	1.7	98.3
35	2.1	3.8	96.2
48	6.1	9.9	90.1
65	13.5	23.2	76.8
100	18.0	41.2	58.8
150	18.7	59.9	40.1
200	14.9	74.8	25.2
270	9.4	84.2	15.8
400	4.8	89.0	11.0
- 400	11.0	100.0	-
Total	100.00	-	-

Test No. PP18 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 8	0.2	0.2	99.8
10	0.3	0.5	99.5
14	0.3	0.8	99.2
20	0.4	1.2	98.8
28	1.4	2.6	97.4
35	3.2	5.8	94.2
48	7.0	12.8	87.2
65	12.6	25.4	74.6
100	20.1	45.5	54.5
150	19.1	64.6	35.4
200	17.3	81.9	18.1
270	6.6	88.5	11.5
400	5.2	93.7	6.3
- 400	6.3	100.0	-
Total	100.0	-	-

Hendy Cyclone Overflow

+ 8	0.2	0.2	99.8
10	0.3	0.5	99.5
14	0.3	0.8	99.2
20	0.2	1.0	99.0
28	0.4	1.4	98.6
35	0.6	2.0	98.0
48	1.6	3.6	96.4
65	3.7	7.3	92.7
100	7.7	15.0	85.0
150	10.2	25.2	74.8
200	13.9	39.1	60.9
270	8.6	47.7	52.3
400	11.5	59.2	40.8
- 400	40.8	100.0	-
Total	100.0	-	-

Test No. PP18 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 48	3.0	3.0	97.0
65	3.8	6.8	93.2
100	7.9	14.7	85.3
150	10.4	25.1	74.9
200	14.5	39.6	60.4
270	8.3	47.9	52.1
400	11.3	59.2	40.8
- 400	40.8	100.0	-
Total	100.0	-	-

Test No. PP18 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	1.4	1.4	98.6
100	5.2	6.6	93.4
150	8.1	14.7	85.3
200	9.6	24.3	75.7
270	8.0	32.3	67.7
400	10.5	42.8	57.2
27.7 µm	7.1	49.9	50.1
21.4	7.1	57.0	43.0
15.0	9.0	66.0	34.0
10.3	8.4	74.4	25.6
7.9	4.9	79.3	20.7
- 7.9	20.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.58

Pb Regrind Discharge

+ 65 mesh	0.2	0.2	99.8
100	0.8	1.0	99.0
150	2.6	3.6	96.4
200	14.0	17.6	82.4
270	21.9	39.5	60.5
400	26.0	65.5	34.5
25.6 µm	13.8	79.3	20.7
19.9	8.7	88.0	12.0
13.9	3.6	91.6	8.4
9.5	1.7	93.3	6.7
7.4	0.8	94.1	5.9
- 7.4	5.9	100.0	-
Total	100.0	-	-

Specific Gravity 5.17

Test No. PP18 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.4	0.4	99.6
100	1.6	2.0	98.0
150	5.3	7.3	92.7
200	16.7	24.0	76.0
270	24.4	48.4	51.6
400	21.4	69.8	30.2
25.4 µm	12.8	82.6	17.4
19.7	7.9	90.5	9.5
13.8	2.8	93.3	6.7
9.5	1.3	94.6	5.4
7.3	0.6	95.2	4.8
- 7.3	4.8	100.0	-
Totsl	100.0	-	-

Specific Gravity 5.02

Pb Regrind Cyclone Overflow

+ 100 mesh	0.2	0.2	99.8
150	0.3	0.5	99.5
200	2.2	2.7	97.3
270	4.8	7.5	92.5
400	11.8	19.3	80.7
28.2 µm	12.2	31.5	68.5
21.9	11.4	42.9	57.1
15.3	14.8	57.7	42.3
10.5	12.4	70.1	29.9
8.1	6.8	76.9	23.1
- 8.1	23.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.23

Test No. PP18 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	6.2	6.2	93.8
100	15.0	21.2	78.8
150	15.9	37.1	62.9
200	12.8	49.9	50.1
270	9.1	59.0	41.0
400	9.2	68.2	31.8
27.2 µm	4.2	72.4	22.6
21.1	6.4	78.8	21.2
14.7	6.8	85.6	14.4
10.1	4.6	90.2	9.8
7.8	2.3	92.5	7.5
- 7.8	7.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.70

Zn Regrind Discharge

+ 65 mesh	0.6	0.6	99.4
100	4.2	4.8	95.2
150	13.4	18.2	81.8
200	24.6	42.8	57.2
270	18.6	61.4	38.6
400	14.0	75.4	24.6
26.9 µm	4.2	79.6	20.4
20.8	4.9	84.5	15.5
14.5	4.4	88.9	11.1
10.0	2.8	91.7	8.3
7.7	1.4	93.1	6.9
- 7.7	6.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.74

Test NO. PP18 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	3.6	3.6	96.4
100	12.2	15.8	84.2
150	19.7	35.5	64.5
200	25.4	60.9	39.1
270	16.0	76.9	23.1
400	10.2	87.1	12.9
26.2 µm	2.6	89.7	10.3
20.4	2.6	92.3	7.7
14.7	2.0	94.3	5.7
9.8	1.2	95.5	4.5
7.5	0.6	96.1	3.9
- 7.5	3.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.74

Zn Regrind Cyclone Overflow

+ 100 mesh	1.2	1.2	98.8
150	3.6	4.8	95.2
200	11.2	16.0	84.0
270	14.0	30.0	70.0
400	16.6	46.6	53.4
27.4 µm	7.1	53.7	46.3
21.3	10.6	64.3	35.7
14.8	10.9	75.2	24.8
10.2	7.4	82.6	17.4
7.9	3.8	86.4	13.6
- 7.9	13.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.45

Test No. PP18 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of test PP17 using coarser lead and zinc regrinds.

2.2. Method: As for test PP17 except that the cyclones in the lead and zinc regrind circuits were changed. The 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 PP8.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP6.

Test No. PP18 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	8636.3	Lead	Hendy Mill Feed
NaCN	220.0	Lead	Hendy Mill Feed
A-343	9.47	Lead	Hendy Mill Feed
A-343	28.69	Lead	Lead Conditioner
MIBC	53.02	Lead	Pb Rougher Feed
A-343	34.86	Lead	Pb Scavenger Feed
MIBC	19.25	Lead	Pb Scavenger Feed
Na_2CO_3	636.0	Lead	Pb Regrind Mill
NaCN	56.67	Lead	Pb Regrind Mill
A-343	7.48	Lead	Pb Regrind Mill
NaCN	14.59	Lead	Pb 1st Cl. Scav. Feed
A-343	9.47	Lead	Pb 1st Cl. Scav. Feed
MIBC	2.52	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	172.15	Lead	Pb 2nd Cleaner Feed
$Ca(OH)_2$	2840.5	Zinc	Zn Conditioner Feed
$CuSO_4$	573.8	Zinc	Zn Conditioner Feed
A-343	57.38	Zinc	Zn Rougher Feed
R-208	26.78	Zinc	Zn Rougher Feed
MIBC	97.21	Zinc	Zn Rougher Feed
D-1012	12.62	Zinc	Zn Rougher Feed
A-343	14.35	Zinc	Zn Scavenger Feed
R-208	53.56	Zinc	Zn Scavenger Feed
D-1012	25.25	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	2501.0	Zinc	Zn Regrind Mill
$CuSO_4$	145.4	Zinc	Zn Regrind Mill
Z-200	10.04	Zinc	Zn 1st Cleaner Feed
A-343	19.41	Zinc	Zn 1st Cleaner Feed
MIBC	25.25	Zinc	Zn 1st Cleaner Feed
D-1902	19.13	Zinc	Zn 3rd Cleaner Feed
D-1902	10.33	Zinc	Zn 4th Cleaner Feed

Test No. PP18 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The flotation circuit was very stable during the test run.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.9	1250
Pb Scavenger Tail.	9.9	1230
Pb 1st Cleaner Feed	10.2	1180
Pb 1st Cleaner Scav.	10.0	-
Pb 2nd Cleaner Feed	10.0	-
Pb 3rd Cleaner Feed	10.2	-
Zn Rougher Feed	10.5	1210
Zn Scavenger Tail.	10.3	1145
Zn 1st Cl. Feed	12.4	1190
Zn 1st Cl. Scav. Tail.	12.3	1070
Zn Combined Tail.	-	1095
Zn 2nd Cleaner Feed	11.6	-
Zn 3rd Cleaner Feed	9.8	-
Zn 4th Cleaner Feed	9.1	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher	20
Zn Rougher	20

Test No. PP18 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne			
	Pb	Zn	Ag	Fe
Hendy Cyclone O'Flow	2.43	3.91	21.48	-
Pb Rougher Conc.	30.9	7.33	-	-
Pb Rougher Tail.	1.39	4.19	-	-
Pb Scavenger Conc.	7.17	8.14	-	-
Pb Scavenger Tail.	0.72	3.91	-	-
Pb 1st Cl. Conc.	29.5	11.2	-	-
Pb 1st Cl. Tail.	8.72	11.2	-	-
Pb 1st Cl. Scav. Conc.	10.1	11.9	-	-
Pb 1st Cl. Scav. Tail.	5.35	9.41	-	-
Pb 2nd Cl. Conc.	46.2	8.26	-	-
Pb 3rd Cl. Conc.	61.6	5.06	434.92	7.22
Zn Rougher Feed	0.68	3.84	-	-
Zn Rougher Conc.	0.71	16.5	-	-
Zn Scavenger Conc.	0.80	3.77	-	-
Zn Scavenger Tail.	0.75	0.64	-	-
Zn 1st Cl. Conc.	1.33	43.0	-	-
Zn 1st Cl. Tail.	0.58	3.33	-	-
Zn 1st Cl. Scav. Conc.	1.88	20.5	-	-
Zn 1st Cl. Scav. Tail.	0.45	0.80	-	-
Zn 2nd Cl. Conc.	1.65	47.0	-	-
Zn 3rd Cl. Conc.	1.26	48.4	-	-
Zn 4th Cl. Conc.	1.16	49.0	43.43	-
Zn Comb. Tail.	0.66	0.66	-	-

Test No. PP18 - 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.	2.85	61.6	5.06	434.92	72.3	3.7	57.7
Zn Cleaner Conc.	6.46	1.16	49.0	43.43	3.1	81.0	13.1
Zn Comb. Tail.	90.69	0.66	0.66	6.92	24.6	15.3	29.2
Kason Undersize	100.00	2.43	3.91	21.48	100.0	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.67	30.9	7.33	-	72.1	10.1	-
Pb Scav. Tail.	94.33	0.72	3.91	-	27.9	89.9	-
Kason Undersize (Meas.)	100.00	2.43	3.91	-	100.0	100.0	-
(Calc.)	-	2.43	4.10	-	-	-	-
Zn Rougher Conc.	19.94	0.71	16.5	-	6.0	83.4	-
Zn Comb. Tail.	77.21	0.66	0.66	-	21.7	12.9	-
Pb Scav. Tail. (Meas.)	97.15	0.72	3.91	-	27.7	96.3	-
(Calc.)	-	0.67	3.91	-	26.8	97.2	-

Test No. PP19

1. Grinding

1.1. Purpose: To repeat the conditions of test PP18.

1.2. Method: As for test PP18. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 627 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. PP19 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Muns 12.7 mm ore at 0.7 percent moisture content		
Feed Rate:	627.0 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 kilogrms	
	Total	675.7 kilograms	
Operating Time:	Total 7.5 hours, test period 2.0 hours		
Mill Feed:	Total 4703 kilograms, test period 1254 kilograms		
Circulating Load:	Cyclone underflow 415.6 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2234	73
	Cyclone Overflow	1400	38
	Cyclone Underflow	2810	84
Average Power:	Gross	6.41 kilowatts	
	No Load	1.93 kilowatts	
	Net	4.48 kilowatts	
Net Power Consumption:	7.15 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	9.48		
Cyclone Overflow K_{80}:	132.5 micrometers		

Test No. PP19 - 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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	3233	10.5	23.2	2118	70	-
Cyclone Overflow	627	35.7	55.3	1400	38	-
Cyclone Underflow	2606	6.3	19.3	2810	84	415.6

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical Mill

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

Feed Rate: 37.18 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:
1.90 kilowatt-hours per tonne of flotation feed

1.4.2.1. Classification Data

Product	Rate kg/h	% Passing 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	60.0	43.0	-	-
Mill Discharge	402.8	30.6	11.5	-	-
Cyclone O'Flow	37.2	74.8	53.5	1160	18
Cyclone U'Flow	365.6	29.0	10.5	2090	68

Test No. PP19 - 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: 74.9 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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	48.4	32	-	-
Mill Discharge	165.3	40.4	23	-	-
Cyclone O'Flow	74.9	67.2	42	1100	12
Cyclone U'Flow	90.4	23.1	10.5	1635	51

Test No. PP19 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 3/8 mesh	10.5	10.5	89.5
3	14.0	24.5	75.5
4	11.0	35.5	64.5
6	8.4	43.9	56.1
8	7.3	51.2	48.8
10	5.4	56.6	43.4
14	5.2	61.8	38.2
20	5.1	66.9	33.1
28	5.8	72.7	27.3
35	4.8	77.5	22.5
48	5.1	82.6	17.4
65	3.6	86.2	13.8
100	2.7	88.9	11.1
- 100	11.1	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.4	0.7	99.3
28	1.1	1.8	98.2
35	2.4	4.2	95.8
48	6.7	10.9	89.1
54	12.0	22.9	77.1
100	19.1	42.0	58.0
150	18.2	60.2	39.8
200	16.6	76.8	23.2
270	6.7	83.5	16.5
400	6.0	89.5	10.5
- 400	10.5	100.0	-
Total	100.0	-	-

Test No. PP19 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 8	0.1	0.1	99.9
10	0.2	0.3	99.7
14	0.4	0.7	99.3
20	0.6	1.3	98.7
28	1.3	2.6	97.4
35	2.5	5.1	94.9
48	7.0	12.1	87.9
65	14.2	26.3	73.7
100	19.6	45.9	54.1
150	19.8	65.7	34.3
200	15.0	80.7	19.3
270	8.6	89.3	10.7
400	9.4	93.7	6.3
- 400	6.3	100.0	-
Total	100.0	-	-

Hendy Cyclone Overflow

+ 8	0.2	0.2	99.8
10	0.4	0.6	99.4
14	0.5	1.1	98.9
20	0.5	1.6	98.4
28	0.7	2.3	97.7
35	1.1	3.4	96.6
48	2.7	6.1	93.9
65	6.5	12.6	87.4
100	10.7	22.3	76.7
150	13.1	36.4	63.6
200	12.9	49.3	50.7
270	2.2	51.5	48.5
400	7.9	59.4	40.6
- 400	40.6	100.0	-
Total	100.0	-	-

Test No. PP19 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 48	4.2	4.2	95.8
65	4.6	8.8	91.2
100	9.5	18.3	81.7
150	11.5	29.8	70.2
200	14.9	44.7	55.3
270	8.6	53.3	46.7
400	11.0	64.3	35.7
- 400	35.7	100.0	-
Total	100.0	-	-

Test No. PP19 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	2.3	2.3	97.7
100	2.1	4.4	95.6
150	6.4	10.8	89.2
200	9.2	20.0	80.0
270	8.4	28.4	71.6
400	11.6	40.0	60.0
28.4 µm	7.4	47.4	52.6
22.0	6.8	54.2	45.8
15.3	8.7	62.9	37.1
10.5	8.6	71.5	28.5
8.2	5.2	76.7	23.3
- 8.2	23.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.35

Pb Regrind Discharge

+ 65 mesh	0.6	0.6	99.4
100	0.6	1.2	98.8
150	6.3	7.5	92.5
200	16.6	24.1	75.9
270	23.9	48.0	52.0
400	21.4	69.4	30.6
26.4 µm	10.4	79.8	20.2
20.5	8.0	87.8	12.2
14.3	3.8	91.6	8.4
9.8	1.7	93.3	6.7
7.6	0.8	94.1	5.9
- 7.6	5.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.87

Test No. PP19 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.6	0.6	99.4
100	3.2	3.8	96.2
150	6.6	10.4	89.6
200	18.2	28.6	71.4
270	23.0	51.6	48.4
400	19.4	71.0	29.0
26.5 µm	10.2	81.2	18.8
20.6	7.7	88.9	11.1
14.4	3.7	92.6	7.4
9.9	1.6	94.2	5.8
7.6	0.6	94.8	5.2
- 7.6	5.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.88

Pb Regrind Cyclone Overflow

+ 100 mesh	0.2	0.2	99.8
150	0.7	0.9	99.1
200	3.6	4.5	95.5
270	7.4	11.9	88.1
400	13.3	25.2	74.8
29.3 µm	8.2	33.4	66.6
22.7	8.6	42.0	58.0
15.8	12.7	54.7	45.3
10.9	12.8	67.5	32.5
8.4	7.5	75.0	25.0
- 8.4	25.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.14

Test No. PP19 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	3.0	3.0	97.0
100	4.8	7.8	92.2
150	8.8	16.6	83.4
200	11.5	28.1	71.9
270	10.2	38.3	61.7
400	13.3	51.6	48.4
28.6 µm	5.2	56.8	43.2
22.2	8.8	65.6	34.4
15.5	8.5	74.1	25.9
10.6	6.6	80.7	19.3
8.2	3.4	84.1	15.9
- 8.2	15.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.20

Zn Regrind Discharge

+ 65 mesh	0.8	0.8	99.2
100	0.5	1.3	98.7
150	5.6	6.9	93.1
200	12.5	19.4	80.6
270	17.8	37.2	62.8
400	22.4	59.6	40.4
28.8 µm	6.0	65.6	34.4
22.3	9.2	74.8	25.2
15.6	7.7	82.5	17.5
10.7	4.8	87.3	12.7
8.3	2.4	89.7	10.3
- 8.3	10.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.31

Test No. PP19 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	3.8	3.8	96.2
100	6.3	10.1	89.9
150	10.8	20.9	79.1
200	18.0	38.9	61.1
270	18.2	57.1	42.9
400	19.8	76.9	23.1
28.5 µm	5.2	82.1	17.9
22.1	6.0	88.1	11.9
15.4	3.7	91.8	8.2
10.6	2.0	93.8	6.2
8.2	0.9	94.7	5.3
- 8.2	5.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.36

Zn Regrind Cyclone Overflow

+ 65 mesh	0.2	0.2	99.8
100	0.5	0.7	99.3
150	1.4	2.1	97.9
200	5.8	7.9	92.1
270	9.4	17.3	82.7
400	15.5	32.8	67.2
29.3 µm	6.8	39.6	60.4
22.7	12.4	52.0	48.0
15.8	14.5	66.5	33.5
10.4	10.2	76.7	23.3
8.4	5.3	82.0	18.0
- 8.4	18.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.16

Test No. PP19 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of test PP18.

2.2. Method: As for test PP18. 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. PP19 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	8763.7	Lead	Hendy Mill Feed
NaCN	216.5	Lead	Hendy Mill Feed
A-343	9.43	Lead	Hendy Mill Feed
A-343	28.59	Lead	Pb Conditioner
MIBC	54.32	Lead	Pb Rougher Feed
A-343	36.17	Lead	Pb Scavenger Feed
MIBC	17.69	Lead	Pb Scavenger Feed
Na_2CO_3	649.6	Lead	Pb Regrind Mill
NaCN	57.90	Lead	Pb Regrind Mill
A-343	7.80	Lead	Pb Regrind Mill
NaCN	13.04	Lead	Pb 1st Cl. Scav. Feed
A-343	9.38	Lead	Pb 1st Cl. Scav. Feed
MIBC	2.53	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	180.9	Lead	Pb 2nd Cleaner Feed
$Ca(OH)_2$	3014.6	Zinc	Zn Conditioner Feed
$CuSO_4$	574.2	Zinc	Zn Conditioner Feed
A-343	57.42	Zinc	Zn Rougher Feed
R-208	26.80	Zinc	Zn Rougher Feed
MIBC	97.27	Zinc	Zn Rougher Feed
D-1012	12.63	Zinc	Zn Rougher Feed
A-343	14.26	Zinc	Zn Scavenger Feed
R-208	53.59	Zinc	Zn Scavenger Feed
D-1012	25.26	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	2265.7	Zinc	Zn Regrind Mill
$CuSO_4$	143.55	Zinc	Zn Regrind Mill
Z-200	10.05	Zinc	Zn 1st Cleaner Feed
A-343	19.33	Zinc	Zn 1st Cl. Scav. Feed
MIBC	25.26	Zinc	Zn 1st Cl. Scav. Feed
D-1902	18.57	Zinc	Zn 3rd Cleaner Feed
D-1902	10.14	Zinc	Zn 4th Cleaner Feed

Test No. PP19 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The zinc rougher concentrate improved for this test. The circuit was stable during the test run.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.8	1265
Pb Scavenger Tail.	9.7	1250
Pb 1st Cleaner Feed	10.1	1160
Pb 1st Cleaner Scav.	10.0	-
Pb 2nd Cleaner Feed	10.0	-
Pb 3rd Cleaner Feed	10.2	-
Zn Rougher Feed	10.3	1195
Zn Scavenger Tail.	10.1	1175
Zn 1st Cleaner Feed	12.2	1100
Zn 1st Cl. Scav. Tail.	12.0	1020
Zn Combined Tail.	-	1130
Zn 2nd Cleaner Feed	11.5	-
Zn 3rd Cleaner Feed	10.0	-
Zn 4th Cleaner Feed	9.4	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher	19
Zn Rougher	20

Test No. PP19 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne			
	Pb	Zn	Ag	Fe
Hendy Cyclone O'Flow	2.37	3.83	21.80	-
Pb Rougher Conc.	28.7	7.53	-	-
Pb Rougher Tail.	1.37	4.12	-	-
Pb Scavenger Conc.	6.74	8.72	-	-
Pb Scavenger Tail.	0.71	3.82	-	-
Pb 2nd Cl. Tail.	26.6	11.2	-	-
Pb 1st Cl. Conc.	33.0	10.1	-	-
Pb 1st Cl. Tail.	9.01	9.93	-	-
Pb 1st Cl. Scav. Conc.	10.4	10.4	-	-
Pb 1st Cl. Scav. Tail.	4.86	8.32	-	-
Pb 2nd Cl. Conc.	51.4	7.25	-	-
Pb 3rd Cl. Conc.	64.3	4.08	451.94	6.95
Pb 3rd Cl. Tail.	43.0	9.11	-	-
Zn Rougher Feed	0.79	4.66	-	-
Zn Rougher Conc.	1.55	25.6	-	-
Zn Scavenger Conc.	1.73	6.47	-	-
Zn Scavenger Tail.	0.62	0.74	-	-
Zn 1st Cl. Conc.	1.85	40.5	-	-
Zn 1st Cl. Tail.	1.38	6.55	-	-
Zn 1st Cl. Scav. Conc.	2.11	14.8	-	-
Zn 1st Cl. Scav. Tail.	1.17	1.68	-	-
Zn 2nd Cl. Conc.	1.84	43.8	-	-
Zn 3rd Cl. Conc.	1.75	45.0	-	-
Zn 3rd Cl. Tail.	2.38	18.0	-	-
Zn 4th Cl. Conc.	1.66	46.8	49.24	-
Zn 4th Cl. Tail.	1.98	33.5	-	-
Zn Comb. Tail.	0.61	0.77	-	-

Test No. PP19 - 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.	2.66	64.3	4.08	451.94	72.1	2.8	55.1
Zn Cleaner Conc.	6.46	1.66	46.8	49.24	4.5	78.9	14.6
Zn Comb. Tails.	90.88	0.61	0.77	7.26	23.4	18.3	30.3
Kason Undersize	100.00	2.37	3.83	21.80	100.0	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.93	28.7	7.53	-	71.8	11.1	-
Pb Scavenger Tail.	94.07	0.71	3.82	-	28.2	88.9	-
Kason Undersize (Meas.)	100.00	2.37	3.83	-	100.0	100.0	-
(Calc.)	-	2.37	4.04	-	-	-	-
Zn Rougher Conc.	11.95	1.55	25.6	-	7.3	80.0	-
Zn Comb. Tail.	85.39	0.61	0.77	-	20.6	17.2	-
Pb Scav. Tail. (Meas.)	97.34	0.71	3.82	-	27.9	97.2	
(Calc.)	-	0.73	3.82	-	29.8	97.0	-

Test No. PP20

1. Grinding

1.1. Purpose: To investigate the effect of a finer primary grind.

1.2. Method: The ball charge in the Hendy mill was increased and the mill feed rate was decreased. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 426 kilograms per hour. Samples were taken every 30 mintues in the last two hours of operation.

1.3. Flowsheet: As for test No. PP1.

1.4. Results:

1.4.1. Observations

The circuit was stable during the test run.

Test No. PP20 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.6 percent moisture content		
Feed Rate:	426.0 dry kilograms per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	76.2 mm balls	471.6 kilograms	
	50.8 mm balls	185.9 kilograms	
	25.4 mm balls	145.1 kilograms	
	Total	802.6 kilograms	
Operating Time:	Total 7.5 hours, test period 2.0 hours		
Mill Feed:	Total 3195 kilograms, test period 852 kilograms		
Circulating Load:	Cyclone underflow 617.1 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2172	71
	Cyclone Overflow	1266	28
	Cyclone Underflow	2766	83.5
Average Power:	Gross	7.13 kilowatts	
	No Load	1.93 kilowatts	
	Net	5.20 kilowatts	
Net Power Consumption:	12.21 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	12.22		
Cyclone Overflow K_{80}:	79.2 micrometers		

Test No. PP20 - 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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	3055	15.1	36.4	2034	67	-
Cyclone Overflow	426	49.9	77.2	1266	28	-
Cyclone Underflow	2629	5.3	26.9	2766	83.5	617.1

1.4.2. Lead Regrind Mill Report

Regrind Mill: Hardinge Conical Mill

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

Feed Rate: 23.9 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: 3.36 kilowatt-hours per tonne of flotation feed

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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	74.6	52.5	-	-
Mill Discharge	244.9	35.7	14.0	-	-
Cyclone O'Flow	23.9	74.3	52.2	1150	17
Cyclone U'Flow	221.0	31.2	11.0	1795	58

Test No. PP20 - 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: 47.4 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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	58.0	38	-	-
Mill Discharge	99.5	55.7	35	-	-
Cyclone O'Flow	47.4	65.3	42	1090	11
Cyclone U'Flow	52.1	34.7	19	1300	31

Test No. PP20 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	3.1	3.1	96.9
3	15.3	18.4	81.6
4	10.8	29.2	70.8
6	8.9	38.1	61.9
8	6.1	44.2	55.8
10	6.6	50.8	49.2
14	5.8	56.6	43.4
20	5.4	62.0	38.0
28	6.5	68.5	31.5
35	5.5	74.0	26.0
48	5.7	79.7	20.3
65	4.0	83.7	16.3
100	3.0	86.7	13.3
- 100	13.3	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 14	0.1	0.1	99.9
20	0.3	0.4	99.6
28	0.6	1.0	99.0
35	1.1	2.1	97.9
48	2.8	4.9	95.1
65	6.1	11.0	89.0
100	12.2	23.2	76.8
150	18.7	41.9	58.1
200	21.7	63.6	36.4
270	10.8	74.4	25.6
400	10.5	84.9	15.1
- 400	15.1	100.0	-
Total	100.0	-	-

Test No. PP20 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 8	0.1	0.1	99.9
10	0.1	0.2	99.8
14	0.2	0.4	99.6
20	0.4	0.6	99.4
28	0.7	1.3	98.7
35	1.5	2.8	97.2
48	7.0	9.8	91.2
65	7.2	17.0	83.0
100	13.7	30.7	69.3
150	19.1	49.8	50.2
200	23.3	73.1	26.9
270	11.4	84.5	15.5
400	10.2	94.7	5.3
- 400	5.3	100.0	-
Total	100.0	-	-

Hendy 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	0.4	0.9	99.1
65	1.2	2.1	97.9
100	3.2	5.3	94.7
150	6.5	11.8	88.2
200	11.0	22.8	77.2
270	14.6	37.4	62.6
400	12.7	50.1	49.9
- 400	49.9	100.0	-
Total	100.0	-	-

Test No. PP20 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 48	0.6	0.6	99.4
65	1.2	1.8	98.2
100	3.3	5.1	94.9
150	6.8	11.9	88.1
200	11.7	23.6	76.4
270	15.0	38.6	61.4
400	13.3	51.9	48.1
- 400	48.1	100.0	-
Total	100.0	-	-

Test No. PP20 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.6	0.6	99.4
100	0.7	1.3	98.7
150	1.8	3.1	96.9
200	4.1	7.2	92.8
270	6.2	13.4	86.6
400	12.0	25.4	74.6
28.1 µm	8.8	34.2	65.8
21.8	9.2	43.4	56.6
15.2	11.3	54.7	45.3
10.4	11.4	66.1	33.9
8.1	6.7	72.8	27.2
- 8.1	27.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.46

Pb Regrind Discharge

+ 100 mesh	0.4	0.4	99.6
150	2.4	2.8	97.2
200	13.7	16.5	83.5
270	22.4	38.9	61.1
400	25.4	64.3	35.7
26.7 µm	12.0	76.3	23.7
20.7	9.3	85.6	14.4
14.4	5.6	91.2	8.8
9.9	2.4	93.6	6.4
7.7	1.0	94.6	5.4
- 7.7	5.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.90

Test No. PP20 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	1.2	1.2	98.8
100	1.5	2.7	97.3
159	3.6	6.3	93.7
200	14.0	20.3	79.7
270	23.2	43.5	56.5
400	25.3	68.8	31.2
26.6 µm	11.0	79.8	20.2
20.6	8.7	88.5	11.5
14.4	4.6	93.1	6.9
9.9	1.6	94.7	5.3
7.6	0.6	95.3	4.7
- 7.6	4.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.94

Pb Regrind Cyclone Overflow

+ 100 mesh	0.2	0.2	99.8
150	0.8	1.0	99.0
200	2.9	3.9	96.1
270	7.0	10.9	89.1
400	14.8	25.7	74.3
28.1 µm	8.8	34.5	65.5
21.8	9.4	43.9	56.1
15.2	11.8	55.7	44.3
10.5	11.6	67.3	32.7
8.1	7.1	74.4	25.6
- 8.1	25.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.35

Test No. PP20 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	2.0	2.0	98.0
100	0.4	2.4	97.6
150	4.4	6.8	93.2
200	8.4	15.2	84.8
270	11.0	26.2	73.8
400	15.8	42.0	58.0
28.9 µm	5.6	47.6	52.4
22.4	11.0	58.6	41.4
15.6	11.8	70.4	29.6
10.7	8.3	78.7	21.3
8.3	4.2	82.9	17.1
- 8.3	17.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.14

Zn Regrind Discharge

+ 100 mesh	0.2	0.2	99.8
150	2.0	2.2	97.8
200	7.4	9.6	90.4
270	12.8	22.4	77.6
400	21.9	44.3	55.7
29.0 µm	5.5	49.8	50.2
22.5	10.8	60.6	39.4
15.7	11.0	71.6	28.4
10.8	7.1	78.7	21.3
8.3	4.2	82.9	17.1
- 8.3	17.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.12

Test No. PP20 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.5	0.5	99.5
100	1.9	2.4	97.6
150	6.2	8.6	91.4
200	14.2	22.8	77.2
270	20.0	42.8	57.2
400	22.5	65.3	34.7
29.0 µm	4.9	70.2	29.8
22.5	8.2	78.4	21.6
15.7	6.8	85.2	14.8
10.8	3.9	89.1	10.9
8.3	1.9	91.0	9.0
- 8.3	9.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.16

Zn Regrind Cyclone Overflow

+ 65 mesh	0.2	0.2	99.8
100	0.2	0.4	99.6
150	0.6	1.0	99.0
200	5.4	6.4	93.6
270	9.7	16.1	83.9
400	18.6	34.7	65.3
28.9 µm	4.8	39.5	60.5
22.4	11.8	51.3	48.7
15.6	14.6	65.9	34.1
10.7	10.3	76.2	23.8
8.3	5.2	81.4	18.6
- 8.3	18.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.22

Test No. PP20 - Continued

2. Flotation

2.1. Purpose: To repeat conditions of test PP19 using a finer primary grind.

2.2. Method: As for test PP19 except that the fineness of flotation feed was increased. The circuit was operated for a period of 7.5 hours and sampled eveyr 30 minutes in the last two hours of operation.

2.2.1. Flotation Equipment

As for test PP6.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP8.

Test No. PP20 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	12897.8	Lead	Hendy Mill Feed
NaCN	323.9	Lead	Hendy Mill Feed
A-343	14.15	Lead	Hendy Mill Feed
A-343	42.08	Lead	Pb Conditioner
MIBC	78.08	Lead	Pb Rougher Feed
A-343	51.97	Lead	Pb Scavenger Feed
MIBC	29.75	Lead	Pb Scavenger Feed
Na_2CO_3	954.2	Lead	Pb Regrind Mill
NaCN	85.91	Lead	Pb Regrind Mill
A-343	10.92	Lead	Pb Regrind Mill
NaCN	20.95	Lead	Pb 1st Cl. Scav. Feed
A-343	13.87	Lead	Pb 1st Cl. Scav. Feed
MIBC	3.72	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	274.6	Lead	Pb 2nd Cleaner Feed
$Ca(OH)_2$	4478.8	Zinc	Zn Conditioner Feed
$CuSO_4$	845.1	Zinc	Zn Conditioner Feed
A-343	84.51	Zinc	Zn Rougher Feed
R-208	39.93	Zinc	Zn Rougher Feed
MIBC	143.2	Zinc	Zn Rougher Feed
D-1012	18.59	Zinc	Zn Rougher Feed
A-343	20.84	Zinc	Zn Scavenger Feed
R-208	78.87	Zinc	Zn Scavenger Feed
D-1012	37.18	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	3232.4	Zinc	Zn Regrind Mill
$CuSO_4$	214.1	Zinc	Zn Regrind Mill
Z-200	14.79	Zinc	Zn 1st Cleaner Feed
A-343	28.31	Zinc	Zn 1st Cl. Scav. Feed
MIBC	37.18	Zinc	Zn 1st Cl. Scav. Feed
D-1902	29.30	Zinc	Zn 3rd Cleaner Feed
D-1902	14.93	Zinc	Zn 4th Cleaner Feed

Test No. PP20 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The circuit was stable during the test.

It was observed that a portion of the coarse pyrite was floated in the zinc cleaner concentrate.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	10.0	1175
Pb Scavenger Tail.	10.0	1165
Pb 1st Cleaner Feed	10.2	1150
Pb 1st Cleaner Scav.	10.1	-
Pb 2nd Cleaner Feed	10.0	-
Pb 3rd Cleaner Feed	10.3	-
Zn Rougher Feed	10.6	1120
Zn Scavenger Tail.	10.5	1110
Zn 1st Cleaner Feed	12.4	1090
Zn 1st Cl. Scav. Tail.	12.3	1025
Zn Combined Tail.	-	1085
Zn 2nd Cleaner Feed	11.5	-
Zn 3rd Cleaner Feed	9.6	-
Zn 4th Cleaner Feed	9.0	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher	19.5
Zn Rougher	19.5

Test No. PP20 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne		
	Pb	Zn	Fe
Hendy Cyclone O'Flow	2.30	3.74	-
Pb Rougher Conc.	30.0	7.78	-
Pb Rougher Tail.	1.10	4.23	-
Pb Scavenger Conc.	6.24	8.39	-
Pb Scavenger Tail.	0.65	3.94	-
Pb 1st Cl. Conc.	32.5	9.98	-
Pb 1st Cl. Tail.	9.59	10.4	-
Pb 1st Cl. Scav. Conc.	12.6	10.4	-
Pb 1st Cl. Scav. Tail.	5.78	9.47	-
Pb 2nd Cl. Conc.	54.0	6.19	-
Pb 3rd Cl. Conc.	66.2	3.88	5.99
Zn Rougher Feed	0.76	4.32	-
Zn Rougher Conc.	1.21	29.8	-
Zn Scavenger Conc.	1.30	5.24	-
Zn Scavenger Tail.	0.55	0.47	-
Zn 1st Cl. Conc.	1.39	40.7	-
Zn 1st Cl. Tail.	1.35	6.67	-
Zn 1st Cl. Scav. Conc.	2.00	14.2	-
Zn 1st Cl. Scav. Tail.	1.26	2.60	-
Zn 2nd Cl. Conc.	1.38	46.6	-
Zn 3rd Cl. Conc.	1.27	47.9	-
Zn 4th Cl. Conc.	1.16	48.3	-
Zn Comb. Tail.	0.63	0.61	-

Test No. PP20 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight	Assays, %		% Distribution	
	%	Pb	Zn	Pb	Zn
Pb Cleaner Conc.	2.50	66.2	3.88	71.9	2.6
Zn Cleaner Conc.	6.39	1.16	48.3	3.2	82.5
Zn Comb. Tail.	91.11	0.63	0.61	24.9	14.9
Kason Undersize	100.00	2.30	3.74	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.62	30.0	7.78	73.3	10.5
Pb Scavenger Tail.	94.38	0.65	3.94	26.7	89.5
Kason Undersize (Meas.)	100.00	2.30	3.74	100.0	100.0
(Calc.)	-	2.30	4.15	-	-
Zn Rougher Conc.	11.12	1.21	29.8	5.6	84.1
Zn Comb. Tail.	86.38	0.63	0.61	22.5	13.3
Zn Scav. Tail. (Meas.)	97.50	0.65	3.94	28.1	97.4
(Calc.)	-	0.70	3.94	29.5	102.7

Test No. PP21

1. Grinding

1.1. Purpose: To repeat the conditions of test No. 20.

1.2. Method: Similar to test PP20. The circuit was operated for a period of 7.5 hours at a feed rate of 405 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. PP21 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.7 percent moisute content		
Feed Rate:	405.4 dry kilograms per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	76.2 mm balls	471.6	kilograms
	50.8 mm balls	185.9	kilograms
	25.4 mm balls	145.1	kilograms
	Total	802.6	kilograms
Operating Time:	Total 7.5 hours, test period 2.0 hours		
Mill Feed:	Total 3040 kilograms, test period 811 kilograms		
Circulating Load:	Cyclone underflow 672.5 percent		

Pulp Densities:	gpl	% Solids
Mill Discharge	2228	73
Cyclone Overflow	1262	28
Cyclone Underflow	2746	83.5

Average Power:	Gross	7.36	kilowatts
	No Load	1.93	kilowatts
	Net	5.43	kilowatts
Net Power Consumption:	13.39 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	12.84		
Cyclone Overflow K_{80}:	74.0 micrometers		

1.4.1. . 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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	3131.9	14.6	39.0	2042	67	-
Cyclone Overflow	405.4	53.2	79.9	1262	28	-
Cyclone Underflow	2726.5	9.8	32.3	2746	83.5	672.5

Test No. PP21 - Continued

1. Grinding

1.4.2. Lead Regrind Mill Report

Regrind Mill:	Hardinge Conical Mill	
Regrind Feed:	Pb rougher concentrate + Pb 1st cleaner scavenger concentrate	
Feed Rate:	19.5 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	2.26 kilowatts
	No Load	0.95 kilowatts
	Net	1.31 kilowatts
Net Power Consumption:	3.23 kilowatt-hours per tonne of flotation feed	

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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	79.8	54	-	-
Mill Discharge	239.5	41.3	18	-	-
Cyclone O'Flow	19.5	78.2	56	1130	15
Cyclone U'Flow	220.0	39.3	16	1725	55

Test No. PP21 - 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: 61.8 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

1.4.3.1. Classification Data

Cyclone: Goodwin 38.1 mm diameter
19.1 mm vortex
6.35 mm apex

Product	Rate kg/h	% Passing 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	59.0	34	-	-
Mill Discharge	142.6	52.1	30	-	-
Cyclone O'Flow	61.8	70.1	45	1130	15
Cyclone U'Flow	80.8	36.2	16	1445	41

Test No. PP21 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	6.8	6.8	93.2
3	17.9	24.7	75.3
4	8.1	32.8	67.2
6	6.8	34.6	60.4
8	5.5	45.0	55.0
10	5.0	50.0	50.0
14	4.7	54.7	45.3
20	5.0	59.7	40.3
28	6.2	65.9	34.1
35	5.7	71.6	28.4
48	5.9	77.5	22.5
65	4.3	81.8	18.2
100	3.4	85.2	14.8
- 100	14.8	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 14	0.1	0.1	99.9
20	0.1	0.2	99.8
28	0.4	0.6	99.4
35	0.9	1.5	98.5
48	2.7	3.2	96.8
65	6.0	9.2	90.8
100	11.7	20.9	79.1
150	18.4	39.3	60.7
200	21.7	61.0	39.0
270	16.5	77.5	22.5
400	7.4	85.4	14.6
- 400	14.6	100.0	-
Total	100.0	-	-

Test No. PP21 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.3	0.5	99.5
28	0.5	1.0	99.0
35	1.0	2.0	98.0
48	2.8	4.8	95.2
65	5.9	10.7	89.3
100	12.9	23.6	76.4
150	18.7	42.3	57.7
200	25.4	67.7	32.3
270	12.0	79.7	20.3
400	10.5	90.2	9.8
- 400	9.8	100.0	-
Total	100.0	-	-

Hendy Cyclone Overflow

+ 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	0.1	0.5	99.5
35	0.2	0.7	99.3
48	0.5	1.2	98.8
65	1.2	2.4	97.6
100	3.0	5.4	94.6
150	6.4	11.8	88.2
200	11.1	22.9	77.1
270	14.3	37.2	62.8
400	11.9	49.1	50.9
- 400	50.9	100.0	-
Total	100.0	-	-

Test No. PP21 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 48	0.5	0.5	99.5
65	0.9	1.4	98.6
100	2.6	4.0	96.0
150	5.7	9.7	90.3
200	10.4	20.1	79.9
270	14.4	34.5	65.5
400	12.3	46.8	53.2
- 400	53.2	100.0	-
Total	100.0	-	-

Test No. PP21 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.6	0.6	99.4
100	0.7	1.3	98.7
150	1.2	2.5	97.5
200	4.4	6.9	93.1
270	6.6	13.5	86.5
400	6.7	20.2	79.8
27.8 µm	13.0	33.2	66.8
21.5	9.7	42.9	57.1
15.0	11.7	54.6	45.4
10.3	11.3	65.9	34.1
8.0	7.0	72.9	27.1
- 8.0	27.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.61

Pb Regrind Discharge

+ 100 mesh	0.2	0.2	99.8
150	1.0	1.2	98.8
200	10.1	11.3	88.7
270	22.8	34.1	65.9
400	24.6	58.7	41.3
27.0 µm	12.7	71.4	28.6
20.9	10.3	81.7	18.3
14.6	7.6	89.3	10.7
10.0	3.4	92.7	7.3
7.8	1.4	94.1	5.9
- 7.8	5.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.80

Test No. PP21 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.1	0.1	99.9
100	0.3	0.4	99.6
150	1.5	1.9	98.1
200	10.2	12.1	87.9
270	23.6	35.7	64.3
400	25.0	60.7	39.3
27.0 µm	11.6	72.3	27.7
20.9	10.3	82.6	17.4
14.6	7.3	89.9	10.1
10.0	3.1	93.0	7.0
7.8	1.2	94.2	5.8
- 7.8	5.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.77

Pb Regrind Cyclone Overflow

+ 100 mesh	0.1	0.1	99.9
150	0.2	0.3	99.7
200	1.8	2.1	97.9
270	5.1	7.2	92.8
400	14.6	21.8	78.2
28.2 µm	9.2	31.0	69.0
21.9	9.7	40.7	59.3
15.3	11.0	51.7	48.3
10.5	12.4	64.1	35.9
8.1	8.4	72.5	27.5
- 8.1	27.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.27

Test No. PP21 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	1.6	1.6	98.4
100	2.5	4.1	95.9
150	4.5	8.6	91.4
200	8.6	17.2	82.8
270	10.3	27.5	72.5
400	13.5	41.0	59.0
28.9 µm	8.1	49.1	50.9
22.4	11.4	60.5	39.5
15.6	12.2	72.7	27.3
10.8	8.3	81.0	19.0
8.3	4.0	85.0	15.0
- 8.3	15.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.27

Zn Regrind Discharge

+ 65 mesh	0.1	0.1	99.9
100	0.3	0.4	99.6
150	1.8	2.2	97.8
200	9.4	11.6	88.4
270	15.7	27.3	72.7
400	20.6	47.9	52.1
29.4 µm	7.1	55.0	45.0
22.8	10.8	65.8	34.2
15.9	10.6	76.4	23.6
10.9	7.0	83.4	16.6
8.5	3.6	87.0	13.0
- 8.5 µm	13.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.23

Test No. PP21 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.5	0.5	99.5
100	2.4	2.9	97.1
150	6.8	9.7	90.3
200	14.0	23.7	76.3
270	19.3	43.0	57.0
400	20.8	63.8	36.2
28.8 µm	6.2	70.0	30.0
22.3	10.1	80.1	19.9
15.6	6.7	86.8	13.2
10.7	3.8	90.6	9.4
8.3	1.9	92.5	7.5
- 8.3	7.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.32

Zn Regrind Cyclone Overflow

+ 100 mesh	0.3	0.3	99.7
150	0.7	1.0	99.0
200	4.3	5.3	94.7
270	8.4	13.7	86.3
400	16.2	29.9	70.1
29.0 µm	6.8	36.7	63.3
22.5	13.0	49.7	50.3
15.7	15.6	65.3	34.7
10.8	10.8	76.1	23.9
8.3	5.4	81.5	18.5
- 8.3	18.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.13

Test No. PP21 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of test PP20.

2.2. Method: As for test PP20 except taht the lime additions to the zinc rougher and cleaning were decreased 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 PP6.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP8.

Test No. PP21 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	13353.3	Lead	Hendy Mill Feed
NaCN	331.2	Lead	Hendy Mill Feed
A-343	14.80	Lead	Hendy Mill Feed
A-343	44.03	Lead	Pb Conditioner
MIBC	84.00	Lead	Pb Rougher Feed
A-343	56.31	Lead	Pb Scavenger Feed
MIBC	31.26	Lead	Pb Scavenger Feed
Na_2CO_3	984.2	Lead	Pb Regrind Mill
NaCN	91.02	Lead	Pb Regrind Mill
A-343	11.47	Lead	Pb Regrind Mill
NaCN	22.57	Lead	Pb 1st Cl. Scav. Feed
A-343	14.80	Lead	Pb 1st Cl. Scav. Feed
MIBC	3.91	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	279.7	Lead	Pb 2nd Cleaner Feed
$Ca(OH)_2$	4373.4	Zinc	Zn Conditioner Feed
$CuSO_4$	888.0	Zinc	Zn Conditioner Feed
A-343	88.8	Zinc	Zn Rougher Feed
R-208	41.44	Zinc	Zn Rougher Feed
MIBC	150.4	Zinc	Zn Rougher Feed
D-1012	19.54	Zinc	Zn Rougher Feed
A-343	22.20	Zinc	Zn Scavenger Feed
R-208	82.88	Zinc	Zn Scavenger Feed
MIBC	31.26	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	2641.8	Zinc	Zn Regrind Mill
$CuSO_4$	223.5	Zinc	Zn Regrind Mill
Z-200	15.54	Zinc	Zn 1st Cleaner Feed
A-343	37.00	Zinc	Zn 1st Cl. Scav. Feed
MIBC	39.07	Zinc	Zn 1st Cl. Scav. Feed
D-1902	45.14	Zinc	Zn 3rd Cleaner Feed
D-1902	29.60	Zinc	Zn 4th Cleaner Feed

Test No. PP21 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The flotation circuit was stable during the test run.

Coarse pyrite was floated in the zinc circuit and low concentrate grade could be expected.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	10.1	1175
Pb Scavenger Tail.	10.1	1095
Pb 1st Cl. Feed	10.3	1130
Pb 1st Cl. Scav.	10.1	-
Pb 2nd Cl. Feed	10.1	-
Pb 3rd Cl. Feed	10.4	-
Zn Rougher Feed	10.5	1135
Zn Scavenger Tail.	10.4	1095
Zn 1st Cl. Feed	12.0	1130
Zn 1st Cl. Scav. Tail.	11.6	1020
Zn Combined Tail.	-	1070
Zn 2nd Cl. Feed	9.9	-
Zn 3rd Cl. Feed	9.1	-
Zn 4th Cl. Feed	8.8	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher	19.5
Zn Rougher	19.5

Test No. PP21 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne		
	Pb	Zn	Fe
Hendy Cyclone O/F	2.38	3.79	-
Pb Rougher Conc.	37.0	6.67	-
Pb Rougher Tail.	1.31	4.18	-
Pb Scavenger Conc.	6.99	8.36	-
Pb Scavenger Tail.	0.63	3.87	-
Pb 1st Cl. Conc.	32.7	10.6	-
Pb 1st Cl. Tail.	11.7	10.2	-
Pb 1st Cl. Scav. Conc.	13.7	10.7	-
Pb 1st Cl. Scav. Tail.	6.39	8.33	-
Pb 2nd Cl. Conc.	52.5	6.85	-
Pb 3rd Cl. Conc.	67.3	3.68	5.60
Zn Rougher Feed	0.74	4.14	-
Zn Rougher Conc.	1.24	21.8	-
Zn Scavenger Conc.	1.11	3.96	-
Zn Scavenger Tail.	0.59	0.46	-
Zn 1st Cl. Conc.	1.29	41.0	-
Zn 1st Cl. Tail.	1.31	5.49	-
Zn 1st Cl. Scav. Conc.	1.82	13.6	-
Zn 1st Cl. Scav. Tail.	1.14	1.72	-
Zn 2nd Cl. Conc.	1.27	47.2	-
Zn 3rd Cl. Conc.	1.26	47.6	-
Zn 4th Cl. Conc.	1.18	48.8	-
Zn Comb. Tail.	0.59	0.54	-

Test No. PP21 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	2.63	67.3	3.68	74.3	2.6
2. Zn Cleaner Conc.	6.56	1.18	48.8	3.2	84.5
3. Zn Comb. Tail.	90.81	0.59	0.54	22.5	12.9
Kason Undersize	100.00	2.38	3.79	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	4.81	37.0	6.67	74.8	8.0
Pb Scav. Tail.	95.19	0.63	3.87	25.2	92.0
Kason Undersize (Meas.)	100.00	2.38	3.79	100.0	100.0
(Calc.)	-	2.38	4.00		
Zn Rougher Conc.	15.25	1.24	21.8	7.2	85.9
Zn Comb. Tail.	82.12	0.59	0.54	18.5	11.5
Pb Scav. Tail. (Meas.)	97.37	0.63	3.87	25.7	97.4
(Calc.)	-	0.69	3.87	28.3	97.4

Test No. PP22

1. Grinding

1.1. Purpose: To repeat the conditions of test PP20 and PP21.

1.2. Method: As for test PP20 and PP21. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 406 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 feed rate to the Hendy mill was not stable during the test run. This resulted in a coarser cyclone overflow product.

Test No. PP22 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.7 percent moisture content		
Feed Rate:	406.4 dry kilograms per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	76.2 mm balls	471.6 kilograms	
	50.8 mm balls	185.9 kilograms	
	25.4 mm balls	145.1 kilograms	
	Total	802.6 kilograms	
Operating Time:	Total 7.5 hours, test period 2.0 hours		
Mill Feed:	Total 3049 kilograms, test period 813 kilograms		
Circulating Load:	Cyclone underflow 670.8 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2208	72
	Cyclone Overflow	1262	27.5
	Cyclone Underflow	2766	83.5
Average Power:	Gross	6.89 kilowatts	
	No Load	1.93 kilowatts	
	Net	4.96 kilowatts	
Net Power Consumption:	12.20 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	11.93		
Cyclone Overflow K_{s_o}:	79.2 micrometers		

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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	3132	15.1	40.1	2062	68	-
Cyclone Overflow	406	49.4	77.4	1262	27.5	-
Cyclone Underflow	2726	11.1	34.9	2766	83.5	670.8

Test No. PP22 - Continued

1. Grinding

1.4.2. Lead Regrind Mill Report

Regrind Mill:	Hardinge Conical Mill	
Regrind Feed:	Pb rougher concentrate + Pb 1st cleaner scavenger concentrate	
Feed Rate:	20.81 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	2.26 kilowatts
	No Load	0.95 kilowatts
	Net	1.31 kilowatts
Net Power Consumption:	3.22 kilowatt-hours per tonne of flotation feed	

1.4.2.1. Classification Data

Cyclone: Krebs 25.4 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	67.8	50	-	-
Mill Discharge	255.4	53.7	26	-	-
Cyclone O'Flow	20.8	97.3	85	1090	10.8
Cyclone U'Flow	234.6	51.9	24	2365	76

Test No. PP22 - 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: 73.5 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

Average Power: Not calculated

1.4.3.1. Classification Data

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

Product	Rate	% Passing		Density	
		400	20		
	kg/h	mesh	µm	g.p.l.	% Solids
Regrind Feed	-	58.1	34	-	-
Mill Discharge	340.2	49.6	16	-	-
Cyclone O'Flow	73.5	82.7	54	1130	15.2
Cyclone U'Flow	266.7	42.4	10	2065	67.5

Test No. PP22 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	14.9	14.9	85.1
3	16.4	31.3	68.7
4	8.4	39.7	60.3
6	7.5	47.2	52.8
8	6.0	53.2	46.8
10	4.9	58.1	41.9
14	4.5	62.6	37.4
20	4.4	67.0	33.0
28	5.1	72.1	27.9
35	4.6	76.7	23.3
48	4.8	81.5	18.5
65	3.5	85.0	15.0
100	2.7	87.7	12.3
- 100	12.3	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 14	0.1	0.1	99.9
20	0.1	0.2	99.8
28	0.4	0.6	99.4
35	0.8	1.4	98.6
48	2.4	3.8	96.2
65	5.7	9.5	90.5
100	11.2	20.7	79.3
150	17.8	38.5	61.5
200	21.4	59.9	40.1
270	16.8	76.7	23.3
400	8.2	84.9	15.1
- 400	15.1	100.0	-
Total	100.0	-	-

Test No. PP22 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.4	0.8	99.2
35	0.9	1.7	98.3
48	2.5	4.2	95.8
65	5.6	9.8	90.2
100	12.1	21.9	78.1
150	18.4	40.3	59.7
200	24.8	65.1	34.9
270	12.4	77.5	22.5
400	11.4	88.9	11.1
- 400	11.1	100.0	-
Total	100.0	-	-

Hendy 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	0.4	0.9	99.1
65	1.1	2.0	98.0
100	3.0	5.0	95.0
150	6.3	11.3	88.7
200	11.3	22.6	77.4
270	15.0	37.6	62.4
400	13.0	50.6	49.4
- 400	49.4	100.0	-
Total	100.0	-	-

Test No. PP22 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 48	0.8	0.8	99.2
65	1.8	2.6	97.4
100	4.7	7.3	92.7
150	8.3	15.6	84.4
200	15.7	31.3	68.7
270	10.6	41.9	58.1
400	14.7	56.6	43.4
- 400	43.4	100.0	-
Total	100.0	-	-

Zn Scavenger Tailing

+ 48	0.6	0.6	99.4
65	0.9	1.5	98.5
100	2.8	4.3	95.7
150	5.6	9.9	90.1
200	12.5	22.4	77.6
270	9.7	32.1	67.9
400	15.1	47.2	52.8
- 400	52.8	100.0	-
Total	100.0	-	-

Test No. PP22 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.7	0.7	99.3
100	1.6	2.3	97.7
150	3.8	6.1	93.9
200	7.6	13.7	86.3
270	7.6	21.3	78.7
400	10.9	32.2	67.8
26.7 µm	9.1	41.3	58.7
20.7	8.4	49.7	50.3
14.4	9.8	59.5	40.5
9.9	8.7	68.2	31.8
7.7	5.7	73.9	26.1
- 7.7	26.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.87

Pb Regrind Discharge

+ 65 mesh	0.6	0.6	99.4
100	1.0	1.6	98.4
150	1.8	3.4	96.6
200	6.6	10.0	90.0
270	16.1	26.1	73.9
400	20.2	46.3	53.7
26.7 µm	14.4	60.7	39.3
20.7	13.3	74.0	26.0
14.4	11.5	85.5	14.5
9.9	5.8	91.3	8.7
7.8	1.3	92.6	7.4
- 7.8	7.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.92

Test No. PP22 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.8	0.8	99.2
100	1.2	2.0	98.0
150	2.2	4.2	95.8
200	7.4	11.6	88.4
270	16.4	28.0	72.0
400	20.1	48.1	51.9
27.1 µm	14.2	62.3	37.7
21.0	13.0	75.3	24.7
14.7	11.4	86.7	13.3
10.1	5.0	91.7	8.3
7.8	0.6	92.3	7.7
- 7.8	7.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.74

Pb Regrind Cyclone Overflow

+ 200 mesh	0.2	0.2	99.8
270	0.4	0.6	99.4
400	2.1	2.7	97.3
26.7 µm	6.1	8.8	91.2
20.7	5.6	14.4	85.6
14.5	8.0	22.4	77.6
9.9	15.0	37.4	62.6
7.7	13.8	51.2	48.8
- 7.7	48.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.77

Test No. PP22 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	1.0	1.0	99.0
100	2.0	3.0	97.0
150	4.0	7.0	93.0
200	9.1	16.1	83.9
270	10.2	26.3	73.7
400	15.6	41.9	58.1
27.9 µm	8.6	50.5	49.5
21.6	12.3	62.8	37.2
15.1	12.5	75.3	24.7
10.4	7.9	83.2	16.8
8.0	3.6	86.8	13.2
- 8.0	13.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.55

Zn Regrind Discharge

+ 65 mesh	3.5	3.5	96.5
100	1.2	4.7	95.3
150	2.2	6.9	93.1
200	6.0	12.9	87.1
270	13.7	26.6	73.4
400	23.8	50.4	49.6
29.6 µm	13.2	63.6	36.4
23.0	15.4	79.0	21.0
16.0	9.0	88.0	12.0
11.0	3.8	91.8	8.2
8.5	1.4	93.2	6.8
- 8.5	6.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.24

Test No. PP22 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	4.8	4.8	95.2
100	2.4	7.2	92.8
150	3.4	10.6	89.4
200	7.8	18.4	81.6
270	14.6	33.0	67.0
400	24.6	57.6	42.4
30.2 µm	11.7	69.3	30.7
23.4	14.6	83.9	16.1
16.4	7.9	91.8	8.2
11.2	2.4	94.2	5.8
8.7	0.8	95.0	5.0
- 8.7	5.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.70

Zn Regrind Cyclone Overflow

+ 65 mesh	0.1	0.1	99.9
100	0.1	0.2	99.8
150	0.1	0.3	99.7
200	1.7	2.0	98.0
270	3.3	5.3	94.7
400	12.0	17.3	82.7
27.5 µm	7.0	24.3	75.7
21.3	16.2	40.5	59.5
14.9	20.4	60.9	39.1
10.2	13.5	74.4	25.6
7.9	6.5	80.9	19.1
- 7.9	19.1	100.0	-
Total	100:0	-	-

Specific Gravity 4.57

Test No. PP22 - Continued

2. Flotation

2.1. Purpose: To repeat conditions of test PP20 and PP21, but using finer zinc and lead rougher concentrate regrinds.

2.2. Method: Similar to tests PP20 and PP21, except that the cyclones in the lead and zinc regrind circuits were changed. 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 PP6.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test No. PP8.

Test No. PP22 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	13287.6	Lead	Hendy Mill Feed
NaCN	334.0	Lead	Hendy Mill Feed
A-343	14.99	Lead	Hendy Mill Feed
A-343	43.92	Lead	Pb Conditioner
MIBC	81.85	Lead	Pb Rougher Feed
A-343	56.03	Lead	Pb Scavenger Feed
MIBC	29.72	Lead	Pb Scavenger Feed
Na_2CO_3	972.6	Lead	Pb Regrind Mill
NaCN	89.69	Lead	Pb Regrind Mill
A-343	11.52	Lead	Pb Regrind Mill
NaCN	20.67	Lead	Pb 1st Cl. Scav. Feed
A-343	15.21	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	292.3	Lead	Pb 2nd Cleaner Feed
$Ca(OH)_2$	3787.0	Zinc	Zn Conditioner Feed
$CuSO_4$	885.8	Zinc	Zn Conditioner Feed
A-343	88.6	Zinc	Zn Rougher Feed
R-208	41.34	Zinc	Zn Rougher Feed
MIBC	150.1	Zinc	Zn Rougher Feed
D-1012	19.49	Zinc	Zn Rougher Feed
A-343	21.56	Zinc	Zn Scavenger Feed
R-208	82.68	Zinc	Zn Scavenger Feed
D-1012	38.98	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	1823.4	Zinc	Zn Regrind Mill
$CuSO_4$	218.5	Zinc	Zn Regrind Mill
Z-200	15.50	Zinc	Zn 1st Cleaner Feed
A-343	37.21	Zinc	Zn 1st Cl. Scav. Feed
MIBC	38.98	Zinc	Zn 1st Cl. Scav. Feed
D-1902	29.86	Zinc	Zn 3rd Cleaner Feed
D-1902	31.89	Zinc	Zn 4th Cleaner Feed

Test No. PP22 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The circuit was stable during the test run. The cleaning of the Zn concentrate improved with the finer regrind of the zinc rougher concentrate.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	10.0	1190
Pb Scavenger Tail.	9.9	1180
Pb 1st Cl. Feed	10.1	1090
Pb 1st Cl. Scav.	9.9	-
Pb 2nd Cl. Feed	9.9	-
Pb 3rd Cl. Feed	10.2	-
Zn Rougher Feed	10.4	1155
Zn Scavenger Tail.	10.3	1145
Zn 1st Cl. Feed	12.1	1130
Zn 1st Cl. Scav. Tail.	12.0	1045
Zn Combined Tails.	-	1100
Zn 2nd Cl. Feed	11.4	-
Zn 3rd Cl. Feed	9.7	-
Zn 4th Cl. Feed	9.0	-

2.4.3. Pulp Temperature

Product	Temperature ^{o}C
Pb Rougher	20
Zn Rougher	20

Test No. PP22 - Continued

2. Flotation

2.4.4. Chemical Analyses

	Assays, %, g/tonne		
	Pb	Zn	Fe
Hendy Cyclone O/F	2.24	3.48	-
Pb Rougher Conc.	33.0	6.95	-
Pb Rougher Tail.*	1.15	4.02	-
Pb Scavenger Conc.	5.69	7.90	-
Pb Scavenger Tail.	0.58	3.67	-
Pb 1st Cl. Conc.	26.3	7.70	-
Pb 1st Cl. Tail.	6.82	11.4	-
Pb 1st Cl. Scav. Conc.	8.71	12.2	-
Pb 1st Cl. Scav. Tail.	5.23	10.4	-
Pb 2nd Cl. Conc.	46.6	5.93	-
Pb 3rd Cl. Conc.	66.7	2.79	5.14
Zn Rougher Feed	0.67	3.58	-
Zn Rougher Conc.	0.84	18.2	-
Zn Scavenger Conc.	0.87	2.64	-
Zn Scavenger Tail.	0.57	0.35	-
Zn 1st Cl. Conc.	1.18	40.1	-
Zn 1st Cl. Tail.	0.77	2.96	-
Zn 1st Cl. Scav. Conc.	1.95	9.42	-
Zn 1st Cl. Scav. Tail.	0.53	0.43	-
Zn 2nd Cl. Conc.	1.16	46.4	-
Zn 3rd Cl. Conc.	1.10	46.7	-
Zn 4th Cl. Conc.	1.07	49.0	-
Zn Comb. Tails.	0.58	0.36	-
Pb Ro. Tail. 1*	1.09	3.77	-
Pb Ro. Tail. 2	0.90	3.56	-
Pb Ro. Tail. 3	0.80	3.49	

Test No. PP22 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight	Assays, %		% Distribution	
	%	Pb	Zn	Pb	Zn
Pb Cleaner Conc.	2.46	66.7	2.79	73.3	2.0
Zn Cleaner Conc.	6.29	1.07	49.0	2.9	88.6
Zn Comb. Tail.	91.25	0.58	0.36	23.8	9.4
Kason Undersize	100.00	2.24	3.48	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.12	33.0	6.95	75.4	9.3
Pb Scav. Tail.	94.88	0.58	3.67	24.6	90.7
Kason Undersize (Meas.)	100.00	2.24	3.48	100.0	100.0
(Calc.)	-	2.24	3.84	-	-
Zn Rougher Conc.	18.09	0.84	18.2	6.6	90.2
Zn Comb. Tail.	79.45	0.58	0.36	20.1	7.8
Pb Scav. Tail. (Meas.)	97.54	0.58	3.67	26.7	98.0
(Calc.)	-	0.63	3.67	27.4	102.8

Test No. PP23

1. Grinding

1.1. Purpose: To repeat the conditions of test PP20 to 22.

1.2. Method: As for tests PP20 to PP22. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 404.5 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.

1.3. Flowsheet: As for test No. PP1.

1.4. Results:

1.4.1. Observations

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

Test No. PP23 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 µm ore at 0.6 percent moisture content		
Feed Rate:	404.5 dry kilograms per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	76.2 mm balls	471.6 kilograms	
	50.8 mm balls	185.9 kilograms	
	25.4 mm balls	145.1 kilograms	
	Total	802.6 kilograms	
Operating Time:	Total 7.5 hours, test period 2.0 hours		
Mill Feed:	Total 2852 kilograms, test period 809 kilograms		
Circulating Load:	Cyclone underflow 674 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2220	72
	Cyclone Overflow	1248	26
	Cyclone Underflow	2770	83.5
Average Power:	Gross	7.01 kilowatts	
	No Load	1.93 kilowatts	
	Net	5.08 kilowatts	
Net Power Consumption:	12.56 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	12.15		
Cyclone Overflow Kso:	76.6 micrometers		

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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	3130.8	15.2	36.9	2072	68	-
Cyclone Overflow	404.5	52.5	78.4	1248	26	-
Cyclone Underflow	2726.3	9.1	31.7	2766	83.5	674.0

Test No. PP23 - Continued

1. Grinding

1.4.2. Lead Regrind Mill Report

Regrind Mill:	Hardinge Conical mill	
Regrind Feed:	Pb rougher concentrate + Pb 1st cleaner scavenger concentrate	
Feed Rate:	25.4 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:	Gross	2.02 kilowatts
	No Load	0.95 kilowatts
	Net	1.07 kilowatts
Net Power Consumption:	2.65 kilowatt-hours per tonne of flotation feed	

1.4.2.1. Classification Data

Cyclone: Krebs 25.4 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	73.3	52.5	-	-
Mill Discharge	369.2	47.8	19.5	-	-
Cyclone O'Flow	25.4	98.3	93.5	1090	12
Cyclone U'Flow	343.8	45.7	16.0	2600	80

Test No. PP23 - Continued

1. Grinding

1.4.3. Zinc Regrind Mill Report

Regrind Mills: Denver Mill + Octagonal Mill

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

Feed Rate: 72.3 calculated kilograms per hour of concentrate

Mill Speed: 58 r.p.m., 70 percent of critical speed

Mill Load:

Denver		Octagonal	
25 mm balls	113.4 kg	25 mm balls	90.7 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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	60.6	36	-	-
Mill Discharge	454.8	60.1	28	-	-
Cyclone O'Flow	72.3	91.7	67	1145	17
Cyclone U'Flow	382.5	52.2	19	1875	61

Test No. PP23 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	16.1	16.1	83.9
3	15.3	31.4	68.6
4	7.9	39.3	60.7
6	4.7	44.0	56.0
8	5.9	49.9	50.1
10	4.7	54.6	45.4
14	4.5	59.1	40.9
20	4.7	63.8	36.2
28	5.9	69.7	30.3
35	5.2	74.9	25.1
48	5.4	80.3	19.7
65	4.3	84.6	15.4
100	2.9	87.5	12.5
- 100	12.5	100.0	--
Total	100.0	-	-

Hendy Mill Discharge

+ 14	0.1	0.1	99.9
20	0.1	0.2	99.8
28	0.4	0.6	99.4
35	0.9	1.5	98.5
48	2.6	4.1	95.9
65	5.4	9.5	90.5
100	12.1	21.6	78.4
150	17.5	39.1	60.9
200	24.0	63.1	36.9
270	11.3	74.4	25.6
400	10.4	84.8	15.2
- 400	15.2	100.0	-
Total	100.0	-	-

Test No. PP23 - Continued

1. Grinding

1.5. Screen Analysis

P-50 Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	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	0.5	1.2	98.8
35	1.0	2.2	97.8
48	2.7	4.9	95.1
65	5.8	10.7	89.3
100	13.0	23.7	76.3
150	18.6	42.3	57.7
200	26.0	68.3	31.7
270	12.1	80.4	19.6
400	10.5	90.9	9.1
- 400	9.1	100.0	-
Total	100.0	-	-

P-50 Cyclone Overflow

+ 48	0.6	0.6	99.4
65	0.8	1.4	98.6
100	2.2	3.6	96.4
150	4.9	8.5	91.5
200	9.1	17.6	82.4
270	13.2	30.8	69.2
400	11.5	42.3	57.7
- 400	57.7	100.0	-
Total	100.0	-	-

Test No. PP23 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 48	0.4	0.4	99.6
65	1.0	1.4	98.6
100	2.9	4.3	95.7
150	6.3	10.6	89.4
200	11.0	21.6	78.4
270	14.1	35.7	64.3
400	11.8	47.5	52.5
- 400	52.5	100.0	-
Total	100.0	-	-

Test No. PP23 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.8	0.8	99.2
100	1.0	1.8	98.2
150	2.2	4.0	96.0
200	5.3	9.3	90.7
270	6.4	15.7	84.3
400	11.0	26.7	73.3
28.6 µm	7.8	34.5	65.5
22.2	8.7	43.2	56.8
15.5	11.0	54.2	45.8
10.6	10.6	64.8	35.2
8.2	6.6	71.4	28.6
- 8.2	28.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.49

Pb Regrind Discharge

+ 65 mesh	0.2	0.2	99.8
100	0.4	0.6	99.4
150	1.7	2.3	97.7
200	7.9	10.2	89.8
200	7.9	10.2	89.8
270	16.8	27.0	73.0
400	25.2	52.2	47.8
27.0 µm	14.1	66.3	33.7
20.9	13.6	79.9	20.1
14.6	10.0	89.9	10.1
10.0	4.0	93.9	6.1
7.7	1.1	95.0	5.0
- 7.7	5.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.89

Test No. PP23 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.2	0.2	99.8
100	0.4	0.6	99.4
150	1.8	2.4	97.6
200	8.3	10.7	89.3
270	16.8	27.5	72.5
400	26.8	54.3	45.7
26.8 µm	14.9	69.2	30.8
20.8	14.2	83.4	16.6
14.5	8.7	92.1	7.9
10.0	3.0	95.1	4.9
7.7	0.8	95.9	4.1
- 7.7	4.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.95

Pb Regrind Cyclone Overflow

+ 200 mesh	0.2	0.2	99.8
270	0.3	0.5	99.5
400	1.2	1.7	98.3
28.2 µm	1.5	3.2	96.8
21.9	1.7	4.9	95.1
15.3	4.5	9.4	90.6
10.5	17.2	26.6	73.4
8.1	16.3	42.9	57.1
- 8.1	57.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.30

Test No. PP23 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.9	0.9	99.1
100	0.8	1.7	98.3
150	4.0	5.7	94.3
200	9.1	14.8	85.2
270	10.0	24.8	75.2
400	14.6	39.4	60.6
29.0 µm	6.2	45.6	54.4
22.5	11.9	57.5	42.5
15.7	13.4	70.9	29.1
10.8	8.2	79.1	20.9
8.3	4.0	83.1	16.9
- 8.3	16.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.38

Zn Regrind Discharge

+ 100 mesh	0.3	0.3	99.7
150	0.9	1.2	98.8
200	4.6	5.8	94.2
270	11.2	17.0	83.0
400	22.9	39.9	60.1
28.5 µm	8.6	48.5	51.5
22.1	18.2	66.7	33.3
15.4	15.1	81.8	18.2
10.6	6.8	88.6	11.4
8.2	2.6	91.2	8.8
- 8.2	8.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.45

Test No. PP23 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.4	0.4	99.6
100	0.8	1.2	98.8
150	2.6	3.8	96.2
200	8.2	12.0	88.0
270	12.1	24.1	75.9
400	23.7	47.8	52.2
28.6 µm	10.0	57.8	42.2
22.2	17.4	75.2	24.8
15.5	12.6	87.8	12.2
10.6	4.7	92.5	7.5
8.2	1.6	94.1	5.9
- 8.2	5.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.49

Zn Regrind Cyclone Overflow

+ 200 mesh	0.6	0.6	99.4
270	1.2	1.8	98.2
400	6.5	8.3	91.7
27.4 µm	5.2	13.5	86.5
21.3	13.9	27.4	72.6
14.8	21.2	48.6	51.4
10.2	16.0	64.6	35.4
7.9	8.0	72.6	27.4
- 7.9	27.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.38

Test No. PP23 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of test PP22, but with finer zinc concentrate regrinding.

2.2. Method: Similar to test PP22 except that the zinc rougher regrinding capacity was increased. An additional regrinding mill was added to the circuit. 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 PP6.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP8.

Test No. PP23 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	13449.8	Lead	Hendy Mill Feed
NaCN	333.7	Lead	Hendy Mill Feed
A-343	14.68	Lead	Hendy Mill Feed
A-343	44.50	Lead	Pb Conditioner
MIBC	82.72	Lead	Pb Rougher Feed
A-343	53.40	Lead	Pb Scavenger Feed
MIBC	29.37	Lead	Pb Scavenger Feed
Na_2CO_3	966.0	Lead	Pb Regrind Mill
NaCN	90.85	Lead	Pb Regrind Mill
A-343	11.72	Lead	Pb Regrind Mill
NaCN	20.02	Lead	Pb 1st Cl. Scav. Feed
A-343	14.83	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	271.4	Lead	Pb 2nd Cleaner Feed
$Ca(OH)_2$	4049.4	Zinc	Zn Conditioner Feed
$CuSO_4$	890.0	Zinc	Zn Conditoner Feed
A-343	89.0	Zinc	Zn Rougher Feed
R-208	41.53	Zinc	Zn Rougher Feed
MIBC	78.32	Zinc	Zn Rougher Feed
D-1012	19.58	Zinc	Zn Rougher Feed
A-343	21.66	Zinc	Zn Scavenger Feed
R-208	83.06	Zinc	Zn Scavenger Feed
D-1012	39.16	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	1713.2	Zinc	Zn Regrind Mill
$CuSO_4$	219.5	Zinc	Zn Regrind Mill
Z-200	15.57	Zinc	Zn 1st Cleaner Feed
A-343	37.23	Zinc	Zn 1st Cl. Scav. Feed
MIBC	39.16	Zinc	Zn 1st Cl. Scav. Feed
D-1902	44.80	Zinc	Zn 3rd Cl. Feed
D-1902	31.59	Zinc	Zn 4th Cl. Feed

Test No. PP23 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The operation of the circuit was stable during the test run. Zinc cleaning improved after increasing the regrind fineness.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.9	1185
Pb Scavenger Tail.	9.8	1175
Pb 1st Cleaner Feed	10.1	1090
Pb 1st Cleaner Scav.	10.0	-
Pb 2nd Cleaner Feed	9.9	-
Pb 3rd Cleaner Feed	10.1	-
Zn Rougher Feed	10.4	1140
Zn Scavenger Tail.	10.3	1110
Zn 1st Cleaner Feed	11.9	1145
Zn 1st Cl. Scav. Tail.	11.8	1050
Zn Combined Tails.	-	1095
Zn 2nd Cleaner Feed	11.2	-
Zn 3rd Cleaner Feed	9.7	-
Zn 4th Cleaner Feed	9.2	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher	20
Zn Rougher	20

Test No. PP23 - Continued

2. Flotation

2.4.4. Chemical Analysis

Product	Assays, %, g/tonne		
	Pb	Zn	Fe
Hendy Cyclone O'Flow	2.40	3.87	-
Pb Rougher Conc.	29.4	7.68	-
Pb Rougher Tail.	1.12	4.12	-
Pb Scavenger Conc.	5.93	8.31	-
Pb Scavenger Tail.	0.59	3.92	-
Pb 1st Cl. Conc.	27.1	8.92	-
Pb 1st Cl. Tail.	7.61	10.9	-
Pb 1st Cl. Scav. Conc.	9.66	11.1	-
Pb 1st Cl. Scav. Tail.	4.83	10.6	-
Pb 2nd Cl. Conc.	47.0	7.06	-
Pb 3rd Cl. Conc.	62.6	4.02	5.82
Zn Rougher Feed	0.65	3.72	-
Zn Rougher Conc.	0.83	19.3	-
Zn Scav. Conc.	0.76	2.65	-
Zn Scav. Tail.	0.59	0.47	-
Zn 1st Cl. Conc.	1.14	41.0	-
Zn 1st Cl. Tail.	1.13	3.37	-
Zn 1st Cl. Scav. Conc.	2.24	13.9	-
Zn 1st Cl. Scav. Tail.	0.82	0.60	-
Zn 2nd Cl. Conc.	1.02	45.4	-
Zn 3rd Cl. Conc.	0.99	46.0	-
Zn 4th Cl. Conc.	0.82	50.1	-
Zn Comb. Tails.	0.57	0.45	-

Test No. PP23 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Cleaner Conc.	2.92	62.6	4.20	76.2	3.2
Zn Cleaner Conc.	6.67	0.82	50.1	2.3	86.3
Zn Comb. Tail.	90.41	0.57	0.45	21.5	10.5
Kason Undersize	100.00	2.40	3.87	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	6.28	29.4	7.68	77.0	11.6
Pb Scav. Tail.	93.72	0.59	3.92	23.0	88.4
Kason Undersize (Meas.)	100.00	2.40	3.87	100.0	100.0
(Calc.)	-	2.40	4.16	-	-
Zn Rougher Conc.	17.87	0.83	19.3	5.9	87.7
Zn Comb. Tail.	79.21	0.57	0.45	17.9	9.1
Pb Scav. Tail. (Meas.)	97.08	0.59	3.92	23.8	96.8
(Calc.)	-	0.62	3.92	25.0	98.3

Test No. PP24

1. Grinding

1.1. Purpose: To repeat the conditions of test PP23, but with finer primary grind.

1.2. Method: Similar to test PP23 except that the Hendy mill ball charge was adjusted as follows:
1. Increased 50.8 mm ball charge from 186 kg to 281 kg.
2. Increased 25.4 mm ball charge from 145 kg to 197 kg.

The grinding circuit was operated for a period of 7.5 hours, and sampled every 20 minutes in the last two hours of operation.

1.3. Flowsheet: As for test PP2.

1.4. Results:

1.4.1. Observations

The grinding circuit was stable during the test run.

Test No. PP24 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.7 percent moisture content		
Feed Rate:	394.9 dry kilograms per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	76.2 mm balls	471.6 kilograms	
	50.8 mm balls	281.1 kilograms	
	25.4 mm balls	197.3 kilograms	
	Total	950.0 kilograms	
Operating Time:	Total 7.5 hours, test period 2.0 hours		
Mill Feed:	Total 2962 kilograms, test period 790 kilograms		
Circulating Load:	Cyclone underflow 691.8 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2126	70
	Cyclone Overflow	1242	26
	Cyclone Underflow	2756	83.5
Average Power:	Gross	7.96 kilowatts	
	No Load	1.93 kilowatts	
	Net	6.03 kilowatts	
Net Power Consumption:	15.27 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	11.80		
Cyclone Overflow K_{80}:	50.3 micrometers		

1.4.1.2. Classification Data

Grind Mill: Hendy
Cyclone: P-50 Dorr — 50.8 mm diameter, 15.9 mm vortex, 12.7 mm apex

Product	Rate kg/h	% Passing 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	3127.0	21.0	52.7	2022	67	-
Cyclone Overflow	394.9	67.7	89.5	1242	26	-
Cyclone Underflow	2732.1	14.6	48.4	2756	83.5	691.8

Test No. PP24 - Continued

1. Grinding

1.4.2. Lead Regrind Mill Report

Regrind Mill:	Hardinge Conical Mill	
Regrind Feed:	Pb rougher concentrate + Pb 1st cleaner scavenger concentrate	
Feed Rate:	23.0 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	1.90 kilowatts
	No Load	0.95 kilowatts
	Net	0.95 kilowatts
Net Power Consumption:	2.41 kilowatt-hours per tonne of flotation feed	

1.4.2.1. Classification Data

Cyclone: Krebs 25.4 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	81.7	61.5	-	-
Mill Discharge	325.4	59.5	21.0	-	-
Cyclone O'Flow	23.0	97.2	84.2	1135	15.5
Cyclone U'Flow	302.4	61.2	22.0	2595	80

Test No. PP24 - Continued

1. Grinding

1.4.3. Zinc Regrind Mill Report

Regrind Mill: Denver Mill + Octagonal Mill

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

Feed Rate: 51.5 calculated kilograms per hour of concentrate

Mill Speed: 58 r.p.m., 70 percent of critical speed

Mill Loads:

Denver		Octagonal	
25 mm balls	113.4 kg	25 mm balls	90.7 kg
Total	204.1 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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	69.3	46	-	-
Mill Discharge	211.8	71.3	34	-	-
Cyclone O'Flow	51.5	96.9	79	1100	12
Cyclone U'Flow	160.3	62.0	25	1565	47

Test No. PP24 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	10.4	10.4	89.6
3	14.4	24.8	75.2
4	7.4	32.2	67.8
6	6.0	38.2	61.8
8	5.8	44.0	56.0
10	5.2	49.2	50.8
14	4.8	54.0	46.0
20	4.6	58.6	41.4
28	6.6	65.2	34.8
35	6.4	71.6	28.4
48	6.1	77.7	22.3
65	4.6	82.3	17.7
100	3.2	85.5	14.5
- 100	14.5	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 14	0.1	0.1	99.9
20	0.1	0.2	99.8
28	0.2	0.4	99.6
35	0.5	0.9	99.1
48	1.4	2.3	97.7
65	3.2	5.5	94.5
100	7.3	12.8	87.2
150	11.9	24.7	75.3
200	22.6	47.3	52.7
270	14.8	62.1	37.9
400	16.9	79.0	21.0
- 400	21.0	100.0	-
Total	100.0	-	-

Test No. PP24 - Continued

1. Grinding

1.5. Screen Analysis

P-50 Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.5	1.2	98.8
48	1.6	2.8	97.2
65	3.8	6.6	93.4
100	8.1	14.7	85.3
150	14.8	29.5	70.5
200	22.1	51.6	48.4
270	21.5	73.1	26.9
400	12.3	85.4	14.6
- 400	14.6	100.0	-
Total	100.0	-	-

P-50 Cyclone Overflow

+ 48	0.2	0.2	99.8
65	0.2	0.4	99.6
100	0.9	1.3	98.7
150	2.0	3.3	96.7
200	7.1	10.4	89.6
270	7.2	17.6	82.4
400	14.0	31.6	68.4
- 400	68.4	100.0	-
Total	100.0	-	-

Test No. PP24 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 48	0.1	0.1	99.9
65	0.2	0.3	99.7
100	0.9	1.2	98.8
150	2.3	3.5	96.5
200	7.0	10.5	89.5
270	7.2	17.7	82.3
400	14.6	32.3	67.7
- 400	67.7	100.0	-
Total	100.0	-	-

Test No. PP24 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.2	0.2	99.8
100	0.3	0.5	99.5
150	1.0	1.5	98.5
200	3.0	4.5	95.5
270	4.8	9.3	90.7
400	9.0	18.3	81.7
29.3 µm	6.8	25.1	74.9
22.7	8.2	33.3	66.7
15.8	11.7	45.0	55.0
10.9	13.0	58.0	42.0
8.4	8.3	66.3	33.7
- 8.4	33.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.28

Pb Regrind Discharge

+ 150 mesh	0.5	0.5	99.5
200	3.8	4.3	95.7
270	11.6	15.9	84.1
400	24.6	40.5	59.5
26.6 µm	19.8	60.3	39.7
20.6	18.4	78.7	21.3
14.4	10.8	89.5	10.5
9.9	3.8	93.3	6.7
7.7	1.3	94.6	5.4
- 7.7	5.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.98

Test No. PP24 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.1	0.1	99.9
100	0.2	0.3	99.7
150	0.6	0.9	99.1
200	3.6	4.5	95.5
270	10.8	15.3	84.7
400	23.5	38.8	61.2
26.8 µm	20.3	59.1	40.9
20.8	18.5	77.6	22.4
14.5	11.4	89.0	11.0
10.0	4.8	93.8	6.2
7.7	1.4	95.2	4.8
- 7.7	4.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.91

Pb Regrind Cyclone Overflow

+ 200 mesh	0.4	0.4	99.6
270	0.4	0.8	99.2
400	2.0	2.8	97.2
28.6 µm	1.6	4.4	95.6
22.2	6.2	10.6	89.4
15.5	15.7	26.3	73.7
10.6	16.4	42.7	57.3
8.2	11.9	54.6	45.4
- 8.2	45.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.22

Test No. PP24 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.3	0.3	99.7
100	0.7	1.0	99.0
150	2.6	3.6	96.4
200	6.4	10.0	90.0
270	7.9	17.9	82.1
400	12.8	30.7	69.3
29.7 µm	5.2	35.9	64.1
23.0	11.0	46.9	53.1
16.1	14.4	61.3	38.7
11.0	10.8	72.1	27.9
8.5	5.4	77.5	22.5
- 8.5	22.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.15

Zn Regrind Discharge

+ 150 mesh	0.6	0.6	99.4
200	3.4	4.0	96.0
270	6.5	10.5	89.5
400	18.2	28.7	71.3
29.7 µm	7.6	36.3	63.7
23.0	19.6	55.9	44.1
16.1	19.2	75.1	24.9
11.0	9.3	84.4	15.6
8.5	3.7	88.1	11.9
- 8.5	11.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.17

Test No. PP24 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.2	0.2	99.8
100	0.4	0.6	99.4
150	2.9	3.5	96.5
200	5.4	8.9	91.1
270	10.9	19.8	80.2
400	18.2	38.0	62.0
29.7 µm	8.6	46.6	53.4
23.0	19.6	66.2	33.8
16.1	17.1	83.3	16.7
11.0	7.0	90.3	9.7
8.5	2.2	92.5	7.5
- 8.5	7.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.18

Zn Regrind Cyclone Overflow

+ 270 mesh	0.5	0.5	99.5
400	2.6	3.1	96.9
29.0 µm	2.4	5.5	94.5
22.5	8.8	14.3	85.7
15.7	19.6	33.9	66.1
10.8	18.8	52.7	47.3
8.3	10.6	63.3	36.7
- 8.3	36.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.10

Test No. PP24 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of test PP23, but with finer primary grinding.

2.2. Method: As for test PP23 except for a finer primary grind of 89 % minus 200 mesh. 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. PP24 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	13703.1	Lead	Hendy Mill Feed
NaCN	339.6	Lead	Hendy Mill Feed
A-343	14.66	Lead	Hendy Mill Feed
A-343	45.58	Lead	Pb Conditioner
MIBC	87.24	Lead	Pb Rougher Feed
A-343	57.74	Lead	Pb Scavenger Feed
MIBC	26.57	Lead	Pb Scavenger Feed
Na_2CO_3	934.4	Lead	Pb Regrind Mill
NaCN	87.37	Lead	Pb Regrind Mill
A-343	12.31	Lead	Pb Regrind Mill
NaCN	22.03	Lead	Pb 1st Cl. Scav. Feed
A-343	15.42	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	274.3	Lead	Pb 2nd Cleaner Feed
$Ca(OH)_2$	3988.4	Zinc	Zn Conditioner Feed
$CuSO_4$	911.6	Zinc	Zn Conditioner Feed
A-343	91.16	Zinc	Zn Rougher Feed
R-208	42.54	Zinc	Zn Rougher Feed
MIBC	80.22	Zinc	Zn Rougher Feed
D-1012	20.06	Zinc	Zn Rougher Feed
A-343	22.49	Zinc	Zn Scavenger Feed
R-208	85.09	Zinc	Zn Scavenger Feed
D-1012	40.11	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	1823.3	Zinc	Zn Regrind Mill
$CuSO_4$	227.9	Zinc	Zn Regrind Mill
Z-200	15.95	Zinc	Zn 1st Cleaner Feed
A-343	38.36	Zinc	Zn 1st Cl. Scav. Feed
MIBC	40.11	Zinc	Zn 1st Cl. Scav. Feed
D-1902	43.30	Zinc	Zn 3rd Cleaner Feed
D-1902	30.69	Zinc	Zn 4th Cleaner Feed

Test No. PP24 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The circuit was very stable during the test run.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.1	1160
Pb Scavenger Tail.	9.8	1155
Pb 1st Cl. Feed	10.0	1135
Pb 1st Cl. Scav.	9.9	-
Pb 2nd Cl. Feed	9.9	-
Pb 3rd Cl. Feed	10.1	-
Zn Rougher Feed	10.4	1120
Zn Scavenger Tail.	10.2	1090
Zn 1st Cl. Feed	11.7	1100
Zn 1st Cl. Scav. Tail.	11.6	1030
Zn Combined Tails.	-	1070
Zn 2nd Cl. Feed	10.9	-
Zn 3rd Cl. Feed	9.5	-
Zn 4th Cl. Feed	9.0	-

2.4.3. Pulp Temperature

Product	Temperature ^{o}C
Pb Rougher	21
Zn Rougher	21.5

Test No. PP24 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne		
	Pb	Zn	Fe
Hendy Cyclone O'Flow	2.32	3.82	-
Pb Rougher Conc.	30.1	7.39	-
Pb Rougher Tail.	0.95	4.17	-
Pb Scav. Conc.	5.84	8.96	-
Pb Scav. Tail.	0.60	4.07	-
Pb 1st Cl. Conc.	39.9	7.51	-
Pb 1st Cl. Tail.	12.3	10.0	-
Pb 1st Cl. Scav. Conc.	15.8	9.98	-
Pb 1st Cl. Scav. Tail.	5.99	9.64	-
Pb 2nd Cl. Conc.	57.3	5.64	-
Pb 3rd Cl. Conc.	67.9	3.52	4.51
Zn Rougher Feed	0.70	4.26	-
Zn Rougher Conc.	1.07	26.9	-
Zn Scavenger Conc.	1.00	3.83	-
Zn Scavenger Tail.	0.59	0.46	-
Zn 1st Cl. Conc.	1.05	43.6	-
Zn 1st Cl. Tail.	1.58	8.61	-
Zn 1st Cl. Scav. Conc.	2.09	21.4	-
Zn 1st Cl. Scav. Tail.	1.62	2.70	-
Zn 2nd Cl. Conc.	0.77	48.2	-
Zn 3rd Cl. Conc.	0.76	48.7	-
Zn 4th Cl. Conc.	0.61	51.8	-
Zn Comb. Tail.	0.60	0.54	-

Test No. PP24 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Cleaner Conc.	2.56	67.9	3.52	74.8	2.4
Zn Cleaner Conc.	6.25	0.61	51.8	1.6	84.8
Zn Comb. Tails.	91.19	0.60	0.54	23.6	12.8
Kason Undersize	100.00	2.32	3.82	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	5.83	30.1	7.39	75.6	10.1
Pb Scav. Tail.	94.17	0.60	4.07	24.4	89.9
Kason Undersize (Meas.)	100.00	2.32	3.82	100.0	100.0
(Calc.)	-	2.32	4.26	-	-
Zn Rougher Conc.	13.05	1.07	26.9	5.4	86.4
Zn Comb. Tail.	84.39	0.60	0.54	19.8	11.2
Pb Scav. Tail. (Meas.)	97.44	0.60	4.07	25.2	97.6
(Calc.)	-	0.66	4.07	27.8	103.8

Test No. PP25

1. Grinding

1.1. Purpose: To repeat the conditions of test PP24.

1.2. Method: As for test PP24. The circuit was operated for a period of 7 hours at a feed rate of 424 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 circuit was stable during the test run.

Test No. PP25 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.6 percent moisture content		
Feed Rate:	424.1 dry kilograms per hour		
Mill Speed:	32 r.;.m., 80.5 percent of critical speed		
Mill Load:	76.2 mm balls	471.6 kilograms	
	50.8 mm balls	281.1 kilograms	
	25.4 mm balls	197.3 kilograms	
	Total	950.0 kilograms	
Operating Time:	Total 7.0 hours, test period 2.0 hours		
Mill Feed:	Total 2969 kilograms, test period 848 kilograms		
Circulating Load:	Cyclone underflow 677.3 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2192	72
	Cyclone Overflow	1254	27
	Cyclone Underflow	2692	83
Average Power:	Gross	7.96 kilowatts	
	No Load	1.93 kilowatts	
	Net	6.03 kilowatts	
Net Power Consumption:	14.22 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	12.21		
Cyclone Overflow K_{80}:	59.9 micrometers		

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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	3296.7	20.0	47.0	2076	68	-
Cyclone Overflow	424.1	62.5	85.9	1254	27	-
Cyclone Underflow	2872.6	13.4	43.7	2692	83	677.3

Test No. PP25 - Continued

1. Grinding

1.4.2. Lead Regrind Mill Report

Regrind Mill:	Hardinge Conical Mill	
Regrind Feed:	Pb rougher concentrate + Pb 1st cleaner scavenger concentrate	
Feed Rate:	25.7 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:	2.81 kilowatt-hours per tonne of flotation feed	

1.4.2.1. Classification Data

Cyclone: Krebs 25.4 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	74.9	55.6	-	-
Mill Discharge	361.9	70.3	26.0	-	-
Cyclone O'Flow	25.7	97.4	87.5	1140	16
Cyclone U'Flow	336.2	67.5	24.0	2600	80

Test No. PP25 - Continued

1. Grinding

1.4.3. Zinc Regrind Mill Report

Regrind Mill: Denver Mill + Octagonal Mill

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

Feed Rate: 74.0 calculated kilograms per hour of concentrate

Mill Speed: 58 r.p.m., 70 percent of critical speed

Mill Load

Denver		Octagonal	
25 mm balls	113.4 kg	25 mm balls	90.7 kg
Total	204.1 kg		

Average Power: Not calculated

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 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	71.1	47	-	-
Mill Discharge	310.9	70.8	36	-	-
Cyclone O'Flow	74.0	95.7	75	1130	15
Cyclone U'Flow	236.9	55.6	23	1760	56

Test No. PP25 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	4.3	4.3	95.7
3	14.0	18.3	81.7
4	8.7	27.0	73.0
6	9.6	36.6	63.4
8	6.5	43.1	56.9
10	5.7	48.8	51.2
14	5.6	54.4	45.6
20	5.3	59.7	40.3
28	6.5	66.2	33.8
35	5.8	72.0	28.0
48	6.0	78.0	22.0
65	4.8	82.8	17.2
100	3.1	85.9	14.1
- 100	14.1	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 14	0.1	0.1	99.9
20	0.1	0.2	99.8
28	0.4	0.6	99.4
28	0.8	1.4	98.6
48	1.9	3.3	96.7
65	4.0	7.3	92.7
100	8.9	16.2	83.8
100	14.2	30.4	69.6
200	22.6	53.0	47.0
270	12.9	65.9	34.1
400	14.1	80.0	20.0
- 400	20.0	100.0	-
Total	100.0	-	-

Test No. PP25 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.4	0.8	99.2
35	0.7	1.5	98.5
48	1.9	3.4	96.6
65	4.6	8.0	92.0
100	9.8	17.8	82.2
150	16.6	34.4	65.6
200	21.9	56.3	43.7
270	19.6	75.9	24.1
400	10.7	86.6	13.4
- 400	13.4	100.0	-
Total	100.0	-	-

Hendy Cyclone Overflow

+ 48	0.3	0.3	99.7
65	0.4	0.7	99.3
100	1.6	2.3	97.7
150	3.2	5.5	94.5
200	10.0	15.5	84.5
270	8.6	24.1	75.9
400	14.9	39.0	61.0
- 400	61.0	100.0	-
Total	100.0	-	-

Test No. PP25 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 48	0.2	0.2	99.8
65	0.4	0.6	99.4
100	1.5	2.1	97.9
150	3.2	5.3	94.7
200	8.8	14.0	85.9
270	8.3	22.4	77.6
400	15.1	37.5	62.5
- 400	62.5	100.0	-
Total	100.0	-	-

Test No. PP25 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.4	0.4	99.6
100	0.6	1.0	99.0
150	2.0	3.0	97.0
200	4.9	7.9	92.1
270	6.4	14.3	85.7
400	10.8	25.1	74.9
29.1 µm	7.0	32.1	67.9
22.5	8.1	40.2	59.8
15.7	11.0	51.2	48.8
10.8	11.7	62.9	37.1
8.4	7.4	70.3	29.7
- 8.4	29.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.32

Pb Regrind Discharge

+ 150 mesh	0.6	0.6	99.4
200	1.9	2.5	97.5
270	6.5	9.0	91.0
400	20.7	29.7	70.3
26.4 µm	21.7	51.4	48.6
20.5	22.4	73.8	26.2
14.3	14.4	88.2	11.8
9.8	4.6	92.8	7.2
7.6	1.4	94.2	5.8
- 7.6	5.8	100.0	-
Total	100.0	-	-

Specific Gravity 5.08

Test No. PP25 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 100 mesh	0.2	0.2	99.8
150	0.6	0.8	99.2
200	2.3	3.1	96.9
270	7.1	10.2	89.8
400	22.3	32.5	67.5
26.4 µm	21.6	54.1	45.9
20.5	21.8	75.9	24.1
14.3	13.1	89.0	11.0
9.8	3.8	92.8	7.2
7.6	1.0	93.8	6.2
- 7.6	6.2	100.0	-
Total	100.0	-	-

Specific Gravity 5.11

Pb Regrind Cyclone Overflow

+ 200 mesh	0.4	0.4	99.6
270	0.4	0.8	99.2
400	1.8	2.6	97.4
28.9 µm	1.0	3.6	96.4
22.4	4.8	8.4	91.6
15.6	15.8	24.2	75.8
10.7	18.8	43.0	57.0
8.3	12.7	55.7	44.3
- 8.3	44.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.26

Test No. PP25 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.2	0.2	99.8
100	0.8	1.0	99.0
150	2.6	3.6	96.4
200	6.0	9.6	90.4
270	7.3	16.9	83.1
400	12.0	28.9	71.1
28.9 µm	6.8	35.7	64.3
22.4	12.0	47.7	52.3
15.6	14.6	62.3	37.7
10.7	10.6	72.9	27.1
8.3	4.8	77.7	22.3
- 8.3	22.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.35

Zn Regrind Cyclone Underflow

+ 65 mesh	0.4	0.4	99.6
100	0.4	0.8	99.2
150	2.2	3.0	97.0
200	7.3	10.3	89.7
270	11.9	22.2	77.8
400	22.2	44.4	55.6
28.9 µm	9.2	53.6	46.4
22.4	18.4	72.0	28.0
15.6	14.4	86.4	13.6
10.7	5.7	92.1	7.9
8.3	1.8	93.9	6.1
- 8.3	6.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.41

Test No. PP25 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Discharge

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 150 mesh	0.8	0.8	99.2
200	3.2	4.0	96.0
270	6.8	10.8	89.2
400	18.4	29.2	70.8
28.9 µm	9.8	39.0	61.0
22.4	19.6	58.6	41.4
15.6	17.8	76.4	23.6
10.7	8.6	85.0	15.0
8.3	3.5	88.5	11.5
- 8.3	11.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.37

Zn Regrind Cyclone Overflow

+ 200 mesh	0.2	0.2	99.8
270	0.5	0.7	99.3
400	3.6	4.3	95.7
28.5 µm	3.7	8.0	92.0
22.1	10.9	18.9	81.1
15.4	20.3	39.2	60.8
10.6	17.8	57.0	43.0
8.2	9.6	66.6	33.4
- 8.2	33.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.33

Test No. PP25 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of test PP24.

2.2. Method: As for test PP24. 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. PP25 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	12758.1	Lead	Hendy Mill Feed
NaCN	318.3	Lead	Hendy Mill Feed
A-343	14.20	Lead	Hendy Mill Feed
A-343	42.30	Lead	Pb Conditioner
MIBC	79.23	Lead	Pb Rougher Feed
A-343	53.65	Lead	Pb Scavenger Feed
MIBC	27.59	Lead	Pb Scavenger Feed
Na_2CO_3	904.0	Lead	Pb Regrind Mill
NaCN	83.33	Lead	Pb Regrind Mill
A-343	11.20	Lead	Pb Regrind Mill
NaCN	19.52	Lead	Pb 1st Cl. Scav. Feed
A-343	14.09	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	263.1	Lead	Pb 2nd Cleaner Feed
$Ca(OH)_2$	3925.9	Zinc	Zn Conditioner Feed
$CuSO_4$	848.8	Zinc	Zn Conditioner Feed
A-343	84.88	Zinc	Zn Rougher Feed
R-208	39.61	Zinc	Zn Rougher Feed
MIBC	74.70	Zinc	Zn Rougher Feed
D-1012	19.81	Zinc	Zn Rougher Feed
A-343	21.50	Zinc	Zn Scavenger Feed
R-208	79.23	Zinc	Zn Scavenger Feed
DF-250	39.61	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	1718.9	Zinc	Zn Regrind Mill
$CuSO_4$	212.2	Zinc	Zn Regrind Mill
Z-200	14.85	Zinc	Zn 1st Cleaner Feed
A-343	35.36	Zinc	Zn 1st Cl. Scav. Feed
MIBC	37.35	Zinc	Zn 1st Cl. Scav. Feed
D-1902	37.63	Zinc	Zn 3rd Cleaner Feed
D-1902	29.43	Zinc	Zn 4th Cleaner Feed

Test No. PP25 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

The flotation circuit was stable during the test run.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	10.1	1175
Pb Scavenger Tail.	10.1	1170
Pb 1st Cl. Feed	10.1	1140
Pb 1st Cl. Scav.	10.0	-
Pb 2nd Cl. Feed	9.9	-
Pb 3rd Cl. Feed	10.1	-
Zn Rougher Feed	10.3	1155
Zn Scavenger Tail.	10.2	1130
Zn 1st Cl. Feed	11.7	1130
Zn 1st Cl. Scav. Tail.	11.6	1040
Zn Combined Tails.	-	1100
Zn 2nd Cl. Feed	10.9	-
Zn 3rd Cl. Feed	9.4	-
Zn 4th Cl. Feed	8.9	-

2.4.3. Pulp Temperature

Product	Temperature ^{o}C
Pb Rougher	21.5
Zn Rougher	21.5

Test No. PP25 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne		
	Pb	Zn	Fe
Hendy Cyclone O'Flow	2.41	3.84	-
Pb Rougher Conc.	30.8	7.12	-
Pb Rougher Tail.	1.09	4.26	-
Pb Scavenger Conc.	5.39	8.19	-
Pb Scavenger Tail.	0.58	3.93	-
Pb 1st Cl. Conc.	37.9	7.18	-
Pb 1st Cl. Tail.	12.1	9.67	-
Pb 1st Cl. Scav. Conc.	15.8	9.47	-
Pb 1st Cl. Scav. Tail.	6.84	9.30	-
Pb 2nd Cl. Conc.	55.2	5.36	-
Pb 3rd Cl. Conc.	67.3	3.22	4.45
Zn Rougher Feed	0.66	4.27	-
Zn Rougher Conc.	0.79	19.9	-
Zn Scavenger Conc.	0.90	3.39	-
Zn Scavenger Tail.	0.58	0.41	-
Zn 1st Cl. Conc.	0.99	44.4	-
Zn 1st Cl. Tail.	1.15	4.60	-
Zn 1st Cl. Scav. Conc.	2.16	14.7	-
Zn 1st Cl. Scav. Tail.	0.77	1.19	-
Zn 2nd Cl. Conc.	0.84	49.1	-
Zn 3rd Cl. Conc.	0.78	49.9	-
Zn 4th Cl. Conc.	0.66	50.9	-
Zn Comb. Tails.	0.56	0.44	-

Test No. PP25 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight	Assays, %		% Distribution	
	%	Pb	Zn	Pb	Zn
Pb Cleaner Conc.	2.76	67.3	3.22	77.1	2.3
Zn Cleaner Conc.	6.59	0.66	50.9	1.8	87.3
Zn Comb. Tail.	90.65	0.56	0.44	21.1	10.4
Kason Undersize	100.00	2.41	3.84	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	6.06	30.8	7.12	77.4	10.5
Pb Scav. Tail.	93.94	0.58	3.93	22.6	89.5
Kason Undersize (Meas.)	100.00	2.41	3.84	100.0	100.0
(Calc.)	-	2.41	4.12	-	-
Zn Rougher Conc.	17.44	0.79	19.9	5.4	88.7
Zn Comb. Tail.	79.80	0.56	0.44	17.5	9.0
Pb Scav. Tail. (Meas.)	97.24	0.58	3.93	22.9	97.7
(Calc.)	-	0.60	3.93	24.3	99.5

Test No. PP26

1. Grinding

1.1. Purpose: To repeat the conditions of test No. PP16.

1.2. Method: The grinding circuit was adjusted as for test PP16. The circuit was operated for a period of 7.5 hours at a feed rate of 640 kilograms per hour. Samples were taken every 30 minutes in the last two hours of operation.

1.3. Flowsheet: As for test No. PP1.

1.4. Results:

1.4.1. Observations

The circuit was stable during the test run.

Test No. PP26 - Continued

1. Grinding

1.4.1.1. Ball Mill Report

Feed:	Minus 12.7 mm ore at 0.8 percent moisture content		
Feed Rate:	640.4 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 4803 kilograms, test period 1281 kilograms		
Circulating Load:	Cyclone underflow 471.1 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2262	74
	Cyclone Overflow	1418	38
	Cyclone Underflow	2824	84
Average Power:	Gross	6.41 kilowatts	
	No Load	1.93 kilowatts	
	Net	4.48 kilowatts	
Net Power Consumption:	7.00 kilowatt-hours per tonne of 12.7 mm feed		
Work Index:	10.00		
Cyclone Overflow K_{80}:	147 micrometers		

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 400 mesh	% Passing 200 mesh	Density g.p.l.	Density % Solids	Recirculating Load %
Cyclone Feed	3657.5	9.8	23.2	2140	70	-
Cyclone Overflow	640.4	33.8	54.1	1418	38	-
Cyclone Underflow	3017.1	6.3	17.5	2824	84	471.1

Test No. PP26 - Continued

1. Grinding

1.4.2. Lead Regrind Mill Report

Regrind Mill:	Hardinge Conical Mill	
Regrind Feed:	Pb rougher concentrate + Pb 1st cleaner scavenger concentrate	
Feed Rate:	49.1 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:	Gross	2.14 kilowatts
	No Load	0.95 kilowatts
	Net	1.19 kilowatts
Net Power Consumption:	1.86 kilowatt-hours per tonne of flotation feed	

1.4.2.1. Classification Data

Cyclone: Krebs 25.4 mm diameter
12.7 mm vortex
3.2 mm apex

Product	Rate kg/h	% Passing 400 mesh	% Passing 20 µm	Density g.p.l.	Density % Solids
Regrind Feed	-	63.6	45.5	-	-
Mill Discharge	293.5	53.1	22	-	-
Cyclone O'Flow	49.1	80.4	58	1210	23
Cyclone U'Flow	244.4	49.1	19	1915	63

Test No. PP26 - Continued

1. Grinding

1.4.3. Zinc Regrind Mill Report

Regrind Mills: Denver Mill + Octagonal Mill

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

Feed Rate: 126 calculated kilograms per hours of concentrate

Mill Speed: 58 r.p.m., 70 percent of critical speed

Mill Load:

Denver		Octagonal	
25 mm balls	113.4 kg	25 mm balls	90.7 kg
Total	204.1 kg		

Average Power: Not calculated

1.4.3.1. Classification Data

Product	Rate	% Passing		Density	
	kg/h	400 mesh	20 µm	g.p.l.	% Solids
Regrind Feed	-	45.8	29	-	-
Mill Discharge	359	43.9	23	-	-
Cyclone O'Flow	126	64.8	42	1200	22
Cyclone U'Flow	233	25.8	11	1800	58

Test No. PP26 - Continued

1. Grinding

1.5. Screen Analysis

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	2.1	2.1	97.9
3	16.7	18.8	81.2
4	7.2	26.0	74.0
6	6.8	32.8	67.2
8	5.3	38.1	61.9
10	5.5	43.6	56.4
14	5.8	49.4	50.6
20	6.0	55.4	44.6
28	7.3	62.7	37.3
35	6.5	69.2	30.8
48	6.7	75.9	24.1
65	5.4	81.3	18.7
100	3.6	84.9	15.1
- 100	15.1	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.4	0.7	99.3
28	1.0	1.7	98.3
35	2.0	3.7	96.3
48	6.7	10.4	89.6
65	14.5	24.9	75.1
100	19.0	43.9	56.1
150	18.6	62.5	37.5
200	14.3	76.8	23.2
270	8.8	85.6	14.4
400	4.6	90.2	9.8
- 400	9.8	100.0	-
Total	100.0	-	-

Test No. PP26 - Continued

1. Grinding

1.5. Screen Analysis

P50 Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 8	0.1	0.1	99.9
10	0.1	0.2	99.8
14	0.4	0.6	99.4
20	0.4	1.0	99.0
28	1.3	2.3	97.7
35	2.7	5.0	95.0
48	7.7	12.7	87.3
65	12.9	25.6	74.4
100	21.1	46.7	53.3
150	19.2	65.9	34.1
200	16.6	82.5	17.5
270	6.1	88.6	11.4
400	5.1	93.7	6.3
- 400	6.3	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 48	9.8	9.8	90.2
65	5.8	15.6	84.4
100	9.6	25.2	74.8
150	12.4	37.6	62.4
200	12.8	50.4	49.6
270	11.0	61.4	38.6
400	7.8	69.2	30.8
- 400	30.8	100.0	-
Total	100.0	-	-

Test No. PP26 - Continued

1. Grinding

1.5. Screen Analysis

Kason Undersize

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 48	3.8	3.8	96.2
65	6.1	9.9	90.1
100	10.2	20.1	79.9
150	12.6	32.7	67.3
200	13.2	45.9	54.1
270	11.8	57.7	42.3
400	8.5	66.2	33.8
- 400	33.8	100.0	-
Total	100.0	-	-

Test No. PP26 - Continued

1. Grinding

1.5. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	1.3	1.3	98.7
100	2.8	4.1	95.9
150	5.8	9.9	90.1
200	8.4	18.3	81.7
270	7.5	25.8	74.2
400	10.6	36.4	63.6
29.3 µm	6.7	43.1	56.9
22.7	7.6	50.7	49.3
15.8	9.8	60.5	39.5
10.9	10.5	71.0	29.0
8.4	6.2	77.2	22.8
- 8.4	22.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.29

Pb Regrind Discharge

+ 65 mesh	0.1	0.1	99.9
100	0.2	0.3	99.7
150	2.0	2.3	97.7
200	7.4	9.7	90.3
270	13.0	22.7	77.3
400	24.2	46.9	53.1
27.2 µm	15.0	61.9	38.1
21.1	15.0	76.9	23.1
14.7	9.3	86.2	13.8
10.1	3.8	90.0	10.0
7.8	1.7	91.7	8.3
- 7.8	8.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.82

Test No. PP26 - Continued

1. Grinding

1.5. Screen Analysis

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.6	0.6	99.4
100	0.8	1.4	98.6
150	3.6	5.0	95.0
200	8.2	13.2	86.8
270	13.6	26.8	73.2
400	24.1	50.9	49.1
27.2 µm	15.2	66.1	33.9
21.1	14.2	80.3	19.7
14.7	8.4	88.7	11.3
10.1	3.2	91.9	8.1
7.8	1.4	93.3	6.7
- 7.8	6.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.83

Pb Regrind Cyclone Overflow

+ 100 mesh	0.2	0.2	99.8
150	0.4	0.6	99.4
200	2.0	2.6	97.4
270	4.4	7.0	93.0
400	12.6	19.6	80.4
28.2 µm	8.0	27.6	72.4
21.9	10.4	38.0	62.0
15.3	13.4	51.4	48.6
10.5	13.6	65.0	35.0
8.1	8.1	73.1	26.9
- 8.1	26.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.24

Test No. PP26 - Continued

1. Grinding

1.5. Screen Analysis

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	4.0	4.0	96.0
100	6.0	10.0	90.0
150	9.8	19.8	80.2
200	11.8	31.6	68.4
270	10.3	41.9	58.1
400	12.8	54.7	45.8
28.9 µm	5.8	60.5	39.5
22.4	9.0	69.5	30.5
15.6	9.4	78.9	21.1
10.7	6.4	85.3	14.7
8.3	2.9	88.2	11.8
- 8.3	11.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.42

Zn Regrind Cyclone Underflow

+ 65 mesh	3.8	3.8	96.2
100	3.8	7.6	92.4
150	10.6	18.2	81.8
200	17.6	35.8	64.2
270	17.2	53.0	47.0
400	21.2	74.2	25.8
28.1 µm	7.0	81.2	18.8
21.8	7.2	88.4	11.6
15.2	4.2	92.6	7.4
10.4	1.8	94.4	5.6
8.1	0.8	95.2	4.8
- 8.1	4.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.55

Test No. PP26 - Continued

1. Grinding

1.5. Screen Analysis

Zn Regrind Discharge

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65 mesh	0.2	0.2	99.8
100	0.8	1.0	99.0
150	5.2	6.2	93.8
200	12.2	18.4	81.6
270	15.9	34.3	65.7
400	22.0	56.3	43.7
28.1 µm	8.2	64.5	35.5
21.8	10.4	74.9	25.1
15.2	8.2	83.1	16.9
10.4	4.8	87.9	12.1
8.1	2.4	90.3	9.7
- 8.1	9.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.56

Zn Regrind Cyclone Overflow

+ 100 mesh	0.4	0.4	99.6
150	2.0	2.4	97.6
200	5.2	7.6	92.4
270	9.4	17.0	83.0
400	18.2	35.2	64.8
27.8 µm	5.6	40.8	59.2
21.6	12.2	53.0	47.0
15.1	14.8	67.8	32.2
10.3	10.4	78.2	21.8
8.0	5.2	83.4	16.6
- 8.0	16.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.33

Test No. PP26 - Continued

2. Flotation

2.1. Purpose: To repeat the conditions of test PP16 but produce a portion of Pb-Zn bulk concentrate.

2.2. Method: As for test PP16 except that a portion of the zinc 3rd cleaner concentrate (Cell No. 2) and lead 2nd cleaner concentrate (Cell No. 4) were removed during the sampling period. 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 PP8.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP6.

Test No. PP26 - Continued

2. Flotation

2.2.2. Flotation Reagents

Type	Rate g/tonne	Circuit	Point of Additions
Na_2CO_3	8326.7	Lead	Hendy Mill Feed
NaCN	208.5	Lead	Hendy Mill Feed
A-343	10.73	Lead	Hendy Mill Feed
A-343	28.34	Lead	Pb Conditioner
MIBC	51.32	Lead	Pb Rougher Feed
A-343	36.91	Lead	Pb Scavenger Feed
MIBC	19.48	Lead	Pb Scavenger Feed
Na_2CO_3	599.6	Lead	Pb Regrind Mill
NaCN	55.28	Lead	Pb Regrind Mill
A-343	7.50	Lead	Pb Regrind Mill
NaCN	13.35	Lead	Pb 1st Cl. Scav. Feed
A-343	9.09	Lead	Pb 1st Cl. Scav. Feed
Na_2CO_3	183.6	Lead	Pb 2nd Cleaner Feed
$Ca(OH)_2$	2136.1	Zinc	Zn Conditioner Feed
$CuSO_4$	562.1	Zinc	Zn Conditioner Feed
A-343	56.21	Zinc	Zn Rougher Feed
R-208	26.23	Zinc	Zn Rougher Feed
MIBC	49.47	Zinc	Zn Rougher Feed
D-1012	12.37	Zinc	Zn Rougher Feed
A-343	14.05	Zinc	Zn Scavenger Feed
DF-250	26.23	Zinc	Zn Scavenger Feed
R-208	52.47	Zinc	Zn Scavenger Feed
$Ca(OH)_2$	2172.3	Zinc	Zn Regrind Mill
$CuSO_4$	138.7	Zinc	Zn Regrind Mill
Z-200	9.84	Zinc	Zn 1st Cleaner Feed
A-343	23.42	Zinc	Zn 1st Cl. Scav. Feed
MIBC	24.73	Zinc	Zn 1st Cl. Scav. Feed
D-1902	30.07	Zinc	Zn 3rd Cleaner Feed
D-1902	21.36	Zinc	Zn 4th Cleaner Feed

Test No. PP26 - Continued

2. Flotation

2.4. Results:

2.4.1. Observations

Strong pyrite flotation was observed in the zinc rougher stage. At 11:30 A.M., the lime addition was increased to the zinc rougher and to the Zn 1st cleaner. The concentrate grades improved only slightly.

2.4.2. pH and Pulp Density

Product	pH	Pulp Density gpl
Pb Rougher Feed	9.7	1275
Pb Scavenger Tail.	9.7	1240
Pb 1st Cl. Feed	10.1	1210
Pb 1st Cl. Scav.	9.9	-
Pb 2nd Cl. Feed	9.9	-
Pb 3rd Cl. Feed	10.2	-
Zn Rougher Feed	10.2	1175
Zn Scavenger Tail.	10.1	1165
Zn 1st Cl. Feed	12.1	1200
Zn 1st Cl. Scav. Tail.	12.0	1085
Zn Combined Tails.	-	1155
Zn 2nd Cl. Feed	11.2	-
Zn 3rd Cl. Feed	9.8	-
Zn 4th Cl. Feed	9.2	-

2.4.3. Pulp Temperature

Product	Temperature °C
Pb Rougher	20
Zn Rougher	20.5

Test No. PP26 - Continued

2. Flotation

2.4.4. Chemical Analyses

Product	Assays, %, g/tonne		
	Pb	Zn	Fe
Hendy Cyclone O'Flow	2.38	3.76	-
Pb Rougher Conc.	23.1	7.78	-
Pb Rougher Tail.	1.41	4.22	-
Pb Scav. Conc.	6.14	7.93	-
Pb Scav. Tail.	0.66	3.58	-
Pb 1st Cl. Conc.	38.3	8.68	-
Pb 1st Cl. Tail.	11.8	9.82	-
Pb 1st Cl. Scav. Conc.	14.9	10.1	-
Pb 1st Cl. Scav. Tail.	6.76	9.48	-
Pb 2nd Cl. Conc.	54.1	6.35	-
Pb 3rd Cl. Conc.	67.2	3.78	6.35
Zn Rougher Feed	0.82	3.97	-
Zn Rougher Conc.	1.19	15.0	-
Zn Scavenger Conc.	1.04	4.26	-
Zn Scavenger Tail.	0.54	0.73	-
Zn 1st Cl. Conc.	1.87	39.3	-
Zn 1st Cl. Tail.	1.00	2.86	-
Zn 1st Cl. Scav. Conc.	2.32	10.3	-
Zn 1st Cl. Scav. Tail.	0.73	0.53	-
Zn 2nd Cl. Conc.	1.97	46.6	-
Zn 3rd Cl. Conc.	1.70	48.3	-
Zn 4th Cl. Conc.	1.55	49.8	-
Zn Comb. Tails.	0.58	0.69	-
Pb Middlings	47.3	7.84	13.1
Zn Middlings	1.95	47.8	12.3

Test No. PP26 - Continued

2. Flotation

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Cleaner Conc.	2.62	67.2	3.78	73.8	2.6
Zn Cleaner Conc.	6.09	1.55	49.8	4.0	80.6
Zn Comb. Tails.	91.29	0.58	0.69	22.2	16.8
Kason Undersize	100.00	2.38	3.76	100.0	100.0
Lead Conc.	2.31	67.2	3.78	65.3	2.6
Zinc Conc.	5.45	1.55	49.8	4.0	72.2
Bulk Conc.	0.99	20.6	31.4	8.6	8.3
Comb. Tailings	91.25	0.58	0.69	22.1	16.9
Head (Calc.)	100.00	2.38	3.76	100.0	100.0

2.4.6. Metallurgical Results

Two-Product Formula

Pb Rougher Conc.	7.66	23.1	7.78	74.4	15.3
Pb Scav. Tail.	92.34	0.66	3.58	25.6	84.7
Kason Undersize (Meas.)	100.00	2.38	3.76	100.0	100.0
(Calc.)	-	2.38	3.90	-	-
Zn Rougher Conc.	19.67	1.19	15.0	9.0	82.4
Zn Comb. Tail.	77.71	0.58	0.69	17.2	15.0
Pb Scav. Tail. (Meas.)	97.38	0.66	3.58	26.2	97.4
(Calc.)	-	0.70	3.58	28.8	92.7