

A Pilot Plant Investigation of

THE RECOVERY OF LEAD AND ZINC

from Grum Deposit Samples

submitted by

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NOTE:

This report refers to the samples as received.

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REPORT COMPOSITION

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

VOLUME 2 - Tests PP-7 to PP-23

VOLUME 3 - Tests PP-24 to PP-38

VOLUME 4 - Tests PP-39 to PP-53
Appendix No. 3

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Test No. PP39

1. Grinding

1.1. Purpose: To repeat conditions of test PP38.

1.2. Method: As for test PP31 to PP38. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 698 pounds per hour. Samples were taken every 20 minutes during the last two hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Goodwin Cyclone:

1 1/2 inch diameter
1/2 inch vortex
3/16 inch apex

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PP1.

1.4. Results: The operation of the grinding circuit was satisfactory. Net power consumption in the Hendy mill was 18.26 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 91.0 % minus 200 mesh.

Test No. PP39 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 0.4 percent moisture content	
Feed Rate:	698 dry pounds per hour	
Mill Speed:	32 r.p.m., 80.5 percent of critical speed	
Mill Load:	3 inch balls	1000 pounds
	1 ½ inch balls	961 pounds
	1 inch balls	400 pounds
	<hr/>	
	Total	2361 pounds
Operating Time:	Total 7.75 hours, test period 2.0 hours	
Mill Feed:	Total 5410 pounds, test period 1396 pounds	
Circulating Load:	Cyclone underflow 490 percent	
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2138 71
	Cyclone Overflow	1316 32
	Cyclone Underflow	2368 76
Average Power:	Gross	8.31 kilowatts
	No Load	1.92 kilowatts
	Net	6.39 kilowatts
Net Power Consumption:	18.26 kilowatt-hours per ton of ½ inch feed.	
Work Index:	13.49	

Test No. PP39 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc., Zinc 2nd Cl. Tail. and Zinc 1st Cl. Scav. Conc.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	
Mill Load:	1 inch balls	660 pounds
	½ inch balls	220 pounds
	<hr/>	
	Total	880 pounds
Operating Time:	Total 7.75 hours, test period 2.0 hours	
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2504 75
	Cyclone Overflow	1080 9.5
	Cyclone Underflow	2504 75
Average Power:	Gross	2.26 kilowatts
	No Load	0.92 kilowatts
	Net	1.34 kilowatts
Net Power Consumption:	3.83 kilowatt-hours per ton of feed.	

Test No. PP39 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	6.1	6.1	93.9
3	18.1	24.2	75.8
4	12.7	36.9	63.1
6	11.4	48.3	51.7
8	9.0	57.3	42.7
10	7.3	64.6	35.4
14	5.7	70.3	29.7
20	3.9	74.2	25.8
28	3.2	77.4	22.6
35	2.4	79.8	20.2
48	2.9	82.7	17.3
65	2.5	85.2	14.8
100	2.1	87.3	12.7
150	2.1	89.4	10.6
200	2.2	91.6	8.4
- 200	8.4	100.0	-
Total	100.0	-	-

Mill Discharge

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.4	1.1	98.9
48	1.4	2.5	97.5
65	2.5	5.0	95.0
100	4.3	9.3	90.7
150	8.1	17.4	82.6
200	15.8	33.2	66.8
270	13.4	46.6	53.4
400	19.2	65.8	34.2
- 400	34.2	100.0	-
Total	100.0	-	-

Test No. PP39 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.3	0.5	99.5
28	0.4	0.9	99.1
35	0.6	1.5	98.5
48	1.8	3.3	96.7
65	3.2	6.5	93.5
100	5.1	11.6	88.4
150	9.4	21.0	79.0
200	17.7	38.7	61.3
270	14.5	53.2	46.8
400	20.3	73.5	26.5
- 400	26.5	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.3	0.3	99.7
100	0.7	1.0	99.0
150	2.1	3.1	96.9
200	5.9	9.0	91.0
270	6.9	15.9	84.1
400	14.8	30.7	69.3
- 400	69.3	100.0	-
Total	100.0	-	-

Test No. PP39 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	1.8	1.8	98.2
270	2.9	4.7	95.3
29.8 μm	9.0	13.7	86.3
23.1	5.8	19.5	80.5
16.2	16.8	36.3	63.7
11.1	17.4	53.7	46.3
8.6	10.5	64.2	35.8
- 8.6	35.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.78

Pb Regrind Cyclone Underflow

+ 200 mesh	2.4	2.4	97.6
270	4.8	7.2	92.8
28.9 μm	9.0	16.2	83.8
22.4	29.2	45.4	54.6
15.7	39.8	85.2	14.8
10.8	5.9	91.1	8.9
8.3	1.9	93.0	7.0
- 8.3	7.0	100.0	-
Total	100.0	-	-

Specific Gravity 5.00

Pb Regrind Mill Discharge

+ 200 mesh	1.9	1.9	98.1
270	2.8	4.7	95.3
29.4 μm	8.2	12.9	87.1
22.8	6.6	19.5	80.5
15.9	38.5	58.0	42.0
10.9	8.2	66.2	33.8
8.5	3.1	69.3	30.7
- 8.5	30.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.97

Test No. PP39 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 30.6 μ m	1.0	1.0	99.0
23.7	2.6	3.6	96.4
16.5	21.2	24.8	75.2
11.4	22.9	47.7	52.3
8.8	12.9	60.6	39.4
- 8.8	39.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.50

Pb 4th Cleaner Concentrate

+ 25.6 μ m	2.4	2.4	97.6
19.8	4.9	7.3	92.7
13.8	20.4	27.7	72.3
9.5	22.8	50.5	49.5
7.4	13.2	63.7	36.3
- 7.4	36.3	100.0	-
Total	100.0	-	-

Specific Gravity 5.87

Zn Regrind Cyclone Underflow

+ 200 mesh	5.8	5.8	94.2
270	9.2	15.0	85.0
31.2 μ m	7.8	22.8	77.2
24.2	40.8	63.6	36.4
16.9	29.9	93.5	6.5
11.6	2.7	96.2	3.8
9.0	0.4	96.6	3.4
- 9.0	3.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.48

Test No. PP39 - Continued

1.4.3. Screen Analyses

Zn Regrind Mill Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	4.6	4.6	95.4
270	9.6	14.2	85.8
30.8 μ m	8.4	22.6	77.4
23.9	41.6	64.2	35.8
16.6	27.6	91.8	8.2
11.4	2.6	94.4	5.6
8.9	0.8	95.2	4.8
- 8.9	4.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.54

Zn Regrind Cyclone Overflow

+ 32.4 μ m	3.7	3.7	96.3
25.1	7.0	10.7	89.3
17.5	21.3	32.0	68.0
12.1	17.8	49.8	50.2
9.3	9.5	59.3	40.7
- 9.3	40.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.16

Test No. PP39 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.3 μ m	2.0	2.0	98.0
24.9	5.5	7.5	92.5
17.4	19.6	27.1	72.9
12.0	18.0	45.1	54.9
9.2	11.0	56.1	43.9
- 9.2	43.9	100.0	-
Total	100.0	-	--

Specific Gravity 4.06

Zn Scavenger Tailing

+ 150 mesh	2.8	2.8	97.2
200	6.1	8.9	91.1
37.1 μ m	14.5	23.4	76.6
28.7	9.8	33.2	66.8
20.0	15.2	48.4	51.6
13.8	11.6	60.0	40.0
10.7	7.0	67.0	33.0
- 10.7	33.0	100.0	-
Total	100.0	-	-

Specific Gravity 3.48

Test No. PP39 - Continued

2. Flotation

2.1. Purpose: To repeat conditions of test PP38.

2.2. Method: No changes were made in the circuit. The circuit was operated for 7.5 hours, and samples were taken every 20 minutes during the last hour of the operation.

2.2.1. Flotation Equipment

As for test PP26.

2.2.2. Flotation Reagent

See following page.

2.3. Flowsheet: As for test PP26.

2.4. Results: Lower circulation loads in the lead 2nd, 3rd and 4th cleaner stages resulted in a lower lead concentrate grade (56.9 %) and low lead recovery. The zinc 4th cleaner concentrate assayed 50.0 % Zn at 76.6 % Zn recovery.

Test No. PP39 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	4.50	Ball Mill Feed
NaCN	0.20	Ball Mill Feed
ZnSO ₄	1.00	Ball Mill Feed
Z-11	0.08	Ball Mill Feed
R-242	0.03	Pb Rougher Conditioner
MIBC	0.105	Pb Rougher Feed Pump
MIBC	0.073	Pb Rougher 3rd Cell
Z-11	0.04	Pb Scavenger Feed
MIBC	0.003	Pb Scavenger Feed
Na ₂ CO ₃	0.30	Pb Regrind Mill
ZnSO ₄	0.50	Pb Regrind Mill
NaCN	0.30	Pb Regrind Mill
R-242	0.01	Pb Cyclone Feed Pump
MIBC	0.004	Pb 1st Cleaner Feed
NaCN	0.10	Pb 2nd Cleaner Feed
NaCN	0.07	Pb 3rd Cleaner Feed
Ca(OH) ₂	2.74	Zn Rougher Cond. No. 1
CuSO ₄	2.04	Zn Rougher Cond. No. 1
Z-200	0.093	Zn Rougher Cond. No. 2
Z-11	0.15	Zn Rougher Feed Pump
DF-250	0.075	Zn Rougher Feed Pump
DF-250	0.053	Zn Rougher Feed
DF-250	0.029	Zn Scavenger Feed
Z-11	0.03	Zn Scavenger Feed
Z-200	0.050	Zn Scavenger Feed
CuSO ₄	0.30	Zn Regrind Mill
Z-200	0.031	Zn Regrind Mill
Ca(OH) ₂	1.28	Zn Regrind Mill
Z-200	0.028	Zn 1st Cleaner Scavenger
Z-11	0.03	ZN 1st Cleaner Scavenger
Ca(OH) ₂	0.34	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.14	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.21	Zn 4th Cleaner Feed

Test No. PP39 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	8.9
Pb Rougher Feed	9.0
Pb Scavenger Tailing	8.8
Pb Regrinding Mill Discharge	9.8
Pb 1st Cleaner Feed	9.3
Pb 2nd Cleaner Feed	9.2
Pb 3rd Cleaner Feed	9.1
Pb 4th Cleaner Feed	9.0
Zn Rougher Feed	10.0
Zn Scavenger Tailing	9.3
Zn 1st Cl. Scav. Feed	10.6
Zn 1st Cleaner Feed	10.9
Zn 2nd Cleaner Feed	11.0
Zn 3rd Cleaner Feed	11.1
Zn 4th Cleaner Feed	11.1

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Pb Rougher Feed	1188
Pb Scavenger Tailing	1150
Pb 1st Cleaner Feed	1145
Pb Rougher Concentrate	1238
Zn Rougher Feed	1153
Zn 1st Cleaner Feed	1080
Zn Rougher Concentrate	1173
Zn Comb. Tail. Cyclone O/F	1025
Zn Comb. Tail. Cyclone U/F	1518

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	20
Pb Regrinding Mill Discharge	22
Zn Rougher Feed	22
Zn Regrinding Mill Discharge	25

Test No. PP39 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.79	10.0
Pb Rougher Feed	6.50	11.8
Pb Rougher Concentrate	23.0	17.0
Pb Rougher Tailing	2.23	16.4
Pb Scavenger Concentrate	8.05	17.2
Pb Scavenger Tailing	1.79	9.79
Pb 1st Cleaner Concentrate	24.7	20.7
Pb 1st Cleaner Tailing	10.0	18.9
Pb Regrind Cyclone Overflow	20.0	20.6
Pb Regrind Cyclone Underflow	21.8	14.1
Pb Cleaner Concentrate	56.9	12.5
Zn Rougher Feed	1.54	9.01
Zn Rougher Concentrate	2.48	25.3
Zn Rougher Tailing	1.13	2.23
Zn Scavenger Concentrate	1.38	4.66
Zn Scavenger Tailing	1.13	1.71
Zn 1st Cleaner Tailing	2.40	6.95
Zn 1st Cleaner Concentrate	3.26	40.5
Zn Regrinding Cyclone Overflow	1.69	22.5
Zn Regrinding Cyclone Underflow	2.95	14.0
Zn 1st Cleaner Scavenger Concentrate	3.29	13.2
Zn 1st Cleaner Scavenger Tailing	1.84	2.24
Zn Combined Tailing	1.28	1.80
Zn Cleaner Concentrate	2.90	50.0

Test No. PP39 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	17.14	23.0	17.0	68.1	25.3
Pb Rougher Tailing	82.86	2.23	10.4	31.9	74.7
Cyclone Overflow (meas)	100.00	5.79	10.0	100.0	100.0
(Calc.)	-	5.79	11.5	-	-
Pb Scavenger Concentrate	5.82	8.05	17.2	8.1	8.7
Pb Scavenger Tailing	77.04	1.79	9.79	23.8	65.4
Pb Rougher Tailing (meas)	82.86	2.23	10.4	31.9	86.2
(Calc.)	-	2.23	10.3	31.9	74.1
Pb 1st Cleaner Conc.	15.16	24.7	20.7	64.7	27.2
Pb 1st Cleaner Tail.	1.98	10.0	18.9	3.4	3.2
Pb Rougher Conc. (meas)	17.14	23.0	17.0	68.1	29.1
(Calc.)	-	23.0	20.5	68.1	30.4
Zn Rougher Concentrate	25.25	2.48	25.3	10.8	55.4
Zn Rougher Tailing	51.79	1.13	2.23	10.1	10.0
Pb Scavenger Tail. (meas)	77.04	1.79	9.79	23.8	75.4
(Calc.)	-	1.57	9.79	20.9	65.4
Zn Scavenger Conc.	9.13	1.38	4.66	2.2	3.7
Zn Scavenger Tail.	42.66	1.13	1.71	8.3	6.3
Zn Rougher Tailing (meas)	51.79	1.13	2.23	10.1	11.5
(Calc.)	-	1.17	2.23	10.5	10.0
Zn 1st Cleaner Conc.	13.81	3.26	40.5	7.8	48.5
Zn 1st Cleaner Tail.	11.44	2.40	6.95	4.7	6.9
Zn Rougher Conc. (meas)	25.25	2.48	25.3	10.8	63.9
(Calc.)	-	2.87	25.3	12.5	55.4
Zn 1st Cl. Scav. Conc.	4.92	3.29	13.2	2.8	5.6
Zn 1st Cl. Scav. Tail.	6.52	1.84	2.24	2.1	1.3
Zn 1st Cl. Tail. (meas)	11.44	2.40	6.95	4.7	8.0
(Calc.)	-	2.46	6.95	4.9	6.9

Three-Product Formula

Pb 4th Cleaner Conc.	7.66	56.9	12.5	75.3	9.6
Zn 4th Cleaner Conc.	15.31	2.90	50.0	7.7	76.6
Zn Combined Tailing	77.03	1.28	1.80	17.0	13.8
Cyclone Overflow	100.00	5.79	10.0	100.0	100.0

Test No. PP40

1. Grinding

1.1. Purpose: To repeat conditions of test PP39.

1.2. Method: As for test PP31 to PP38. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 70⁴ pounds per hour. Samples were taken every 20 minutes during the last two hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PP1.

1.4. Results: The operation of the grinding circuit was satisfactory. Net power consumption in the Hendy mill was 18.60 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 91.5 % minus 200 mesh.

Test No. PP40 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 0.4 percent moisture content		
Feed Rate:	704 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
	Total	2361 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Mill Feed:	Total 5456 pounds, test period 1408 pounds		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2140	71
	Cyclone Overflow	1314	32
	Cyclone Underflow	2392	78
Average Power:	Gross	8.43 kilowatts	
	No Load	1.92 kilowatts	
	Net	6.51 kilowatts	
Net Power Consumption:	18.60 kilowatt-hours per ton of ½ inch feed.		
Work Index:	13.74		

Test No. PP40 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc., Zinc 2nd Cl. Tail. and Zinc 1st Cl. Scav. Conc.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	
Mill Load:	1 inch balls	660 pounds
	$\frac{1}{2}$ inch balls	220 pounds
	<hr/>	
	Total	880 pounds
Operating Time:	Total 7.75 hours, test period 2.0 hours	
Pulp Densities:		<u>gpl</u> <u>% Solids</u>
	Mill Discharge	2436 75
	Cyclone Overflow	1070 8.5
	Cyclone Underflow	2436 75
Average Power:	Gross	2.49 kilowatts
	No Load	0.92 kilowatts
	Net	1.57 kilowatts
Net Power Consumption:	4.49 kilowatt-hours per ton of feed.	

Test No. PP40 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	5.0	5.0	95.0
3	11.8	16.8	83.2
4	13.2	30.0	70.0
6	11.7	41.7	58.3
8	9.6	51.3	48.7
10	7.7	59.0	41.0
14	6.2	65.2	34.8
20	4.5	69.7	30.3
28	3.7	73.4	26.6
35	2.8	76.2	23.8
48	3.4	79.6	20.4
65	3.1	82.7	17.3
100	2.5	85.2	14.8
150	2.5	87.7	12.3
200	2.6	90.3	9.7
- 200	9.7	100.0	-
Total	100.0	-	-

Mill Discharge

+ 14	0.2	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.5	1.2	98.8
48	1.3	2.5	97.5
65	2.4	4.9	95.1
100	4.3	9.2	90.8
150	8.2	17.4	82.6
200	16.2	33.6	66.4
270	13.5	47.1	52.9
400	20.1	67.2	32.8
- 400	32.8	100.0	-
Total	100.0	-	-

Test No. PP40 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.4	0.8	99.2
35	0.6	1.4	98.6
48	1.7	3.1	96.9
65	3.1	6.2	93.8
100	5.3	11.5	88.5
150	9.7	21.2	78.8
200	18.1	39.3	60.7
270	14.8	54.1	45.9
400	20.4	74.5	25.5
- 400	25.2	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.2	0.2	99.8
100	0.6	0.8	99.2
150	2.0	2.8	97.2
200	5.7	8.5	91.5
270	6.6	15.1	84.9
400	13.9	29.0	71.0
- 400	71.0	100.0	-
Total	100.0	-	-

Test No. PP40 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	3.1	3.1	96.9
270	4.2	7.3	92.7
31.1 μm	9.8	17.1	82.9
24.1	6.2	23.3	76.7
16.8	14.8	38.1	61.9
11.6	16.3	54.4	45.6
8.9	10.6	65.0	35.0
- 8.9	35.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.62

Pb Regrind Cyclone Underflow

+ 200 mesh	2.2	2.2	97.8
270	5.5	7.7	92.3
29.4 μm	9.6	17.3	82.7
22.8	28.0	45.3	54.7
15.9	40.2	85.5	14.5
10.9	7.5	93.0	7.0
8.5	1.8	94.8	5.2
- 8.5	5.2	100.0	-
Total	100.0	-	-

Specific Gravity 5.03

Pb Regrind Discharge

+ 150 mesh	0.7	0.7	99.3
200	1.0	1.7	98.3
270	3.5	5.2	94.8
29.9 μm	7.4	12.6	87.4
23.2	28.4	41.0	59.0
16.2	37.6	78.6	21.4
11.1	9.0	87.6	12.4
8.6	3.0	90.6	9.4
- 8.6	9.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.95

Test No. PP40 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 30.0 μ m	1.0	1.0	99.0
23.2	2.4	3.4	96.6
16.2	16.6	20.0	80.0
11.1	22.2	42.2	57.8
8.6	13.7	55.9	44.1
- 8.6	44.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.55

Pb 4th Cleaner Concentrate

+ 25.7 μ m	1.0	1.0	99.0
19.9	1.8	2.8	97.2
13.9	16.1	18.9	81.1
9.6	23.4	42.3	57.7
7.4	14.3	56.6	43.4
- 7.4	43.4	100.0	-
Total	100.0	-	-

Specific Gravity 5.96

Zn Regrind Cyclone Underflow

+ 200 mesh	4.8	4.8	95.2
270	8.9	13.7	86.3
31.7 μ m	6.6	20.3	79.7
24.6	36.6	56.9	43.0
17.2	34.0	90.9	9.1
11.8	5.0	95.9	4.1
9.1	0.9	96.8	3.2
- 9.1	3.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.49

Test No. PP40 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.6 μm	5.7	5.7	94.3
25.3	9.8	15.5	84.5
17.7	28.4	43.9	56.1
12.1	16.5	60.4	39.6
9.4	8.0	68.4	31.6
- 9.4	31.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.22

Zn 4th Cleaner Concentrate

+ 31.9 μm	0.8	0.8	99.2
24.7	1.7	2.5	97.5
17.2	13.7	16.2	83.8
11.9	19.4	35.6	64.4
9.2	13.2	48.8	51.2
- 9.2	51.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.19

Test No. PP40 - Continued

1.4.3. Screen Analyses

Zn Scavenger Tailing

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	1.1	1.1	98.9
150	2.4	3.5	96.5
200	6.6	10.1	89.9
34.9 μ m	12.8	22.9	77.1
27.1	9.0	31.9	68.1
18.9	14.5	46.4	53.6
13.0	11.3	57.7	42.3
10.0	7.1	64.8	35.2
- 10.0	35.2	100.0	-
Total	100.0	-	-

Specific Gravity 3.87

Zn Regrind Discharge

+ 200 mesh	3.8	3.8	96.2
270	8.8	12.6	87.4
31.7 μ m	7.2	19.8	80.2
24.6	38.3	58.1	41.9
17.2	33.2	91.3	8.7
11.8	2.9	94.2	5.8
9.1	1.0	95.2	4.8
- 9.1	4.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.45

Test No. PP40 - Continued

2. Flotation

2.1. Purpose: To repeat conditions of test PP39 at a finer lead concentrate regrinding.

2.2. Method: The 1 ½ inch Goodwin cyclone was replaced with a 1 inch Krebs cyclone. At 10:30 A.M. collector Z-11 addition to the Zn rougher feed was increased from 0.15 lb/ton to 0.2 lb/ton due to poor frothing conditions. At 12:30 P.M. lime was removed from Zn conditioner No. 1 and added to Zn conditioner No. 2.

2.2.1. Flotation Equipment

As for test PP26.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP26.

2.4. Results: Lead grade and recovery were similar to that of the previous test (Test PP39). Zinc concentrate grade increased with a decrease in zinc recovery. The zinc 4th cleaner concentrate assayed 56.0 % Zn at 72.9 % recovery.

Test No. PP40 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	5.24	Ball Mill Feed
NaCN	0.20	Ball Mill Feed
ZnSO ₄	0.95	Ball Mill Feed
Z-11	0.10	Ball Mill Feed
R-242	0.025	Pb Rougher Conditioner
MIBC	0.105	Pb Rougher Feed Pump
MIBC	0.075	Pb Rougher 3rd Cell
Z-11	0.04	Pb Scavenger Feed
MIBC	0.003	Pb Scavenger Feed
Na ₂ CO ₃	0.50	Pb Regrind Mill
ZnSO ₄	0.52	Pb Regrind Mill
NaCN	0.30	PB Regrind Mill
R-242	0.01	Pb Cyclone Feed Pump
NaCN	0.09	Pb 2nd Cleaner Feed
MIBC	0.003	Pb 2nd Cleaner Feed
NaCN	0.08	Pb 3rd Cleaner Feed
CuSO ₄	2.04	Zn Rougher Cond. No. 2
Ca(OH) ₂	2.44	Zn Rougher Cond. No. 1
Z-200	0.095	Zn Rougher Feed Pump
DF-250	0.076	Zn Rougher Feed Pump
Z-11	0.20	Zn Rougher Feed Pump
Z-11	0.03	Zn Scavenger Feed
DF-250	0.030	Zn Scavenger Feed
Z-200	0.052	Zn Scavenger Feed
Ca(OH) ₂	1.05	Zn Regrind Mill
CuSO ₄	0.30	Zn Regrind Mill
Z-200	0.054	Zn Regrind Mill
Z-11	0.03	Zn 1st Cleaner Scavenger
Z-200	0.020	Zn 1st Cleaner Scavenger
Ca(OH) ₂	0.33	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.15	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.20	Zn 4th Cleaner Feed

Test No. PP40 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	9.0
Pb Rougher Feed	9.1
Pb Scavenger Tailing	8.9
Pb Regrinding Mill Discharge	9.8
Pb 1st Cleaner Feed	9.3
Pb 2nd Cleaner Feed	9.2
Pb 3rd Cleaner Feed	9.2
Pb 4th Cleaner Feed	9.0
Zn Rougher Feed	9.8
Zn Scavenger Tailing	9.1
Zn 1st Cl. Scav. Feed	10.5
Zn 1st Cleaner Feed	10.8
Zn 2nd Cleaner Feed	11.0
Zn 3rd Cleaner Feed	11.2
Zn 4th Cleaner Feed	11.3

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Pb Regrinding Mill Discharge	2422
Pb Rougher Feed	1188
Pb Scavenger Tailing	1142
Pb 1st Cleaner Feed	1113
Pb Rougher Concentrate	1330
Zn Rougher Feed	1163
Zn Cyclone Feed	1317
Zn 1st Cleaner Feed	1070
Zn Concentrate	1270
Zn Comb. Tail. Cyclone O/F	1017
Zn Comb. Tail. Cyclone U/F	1565

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	20
Pb Regrinding Mill Discharge	23
Zn Rougher Feed	22
Zn Regrinding Mill Discharge	25

Test No. PP40 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.90	10.1
Pb Rougher Feed	6.23	11.8
Pb Rougher Concentrate	23.4	16.9
Pb Rougher Tailing	2.18	10.6
Pb Scavenger Concentrate	6.16	15.8
Pb Scavenger Tailing	1.49	9.76
Pb 1st Cleaner Concentrate	33.9	18.9
Pb 1st Cleaner Tailing	9.35	18.8
Pb Regrind Cyclone Overflow	21.8	19.2
Pb Regrind Cyclone Underflow	21.0	12.5
Pb Cleaner Concentrate	57.2	12.8
Zn Rougher Feed	1.50	8.36
Zn Rougher Concentrate	2.16	26.9
Zn Rougher Tailing	1.37	2.89
Zn Scavenger Concentrate	1.33	4.51
Zn Scavenger Tailing	1.39	1.88
Zn 1st Cleaner Tailing	2.56	9.44
Zn 1st Cleaner Concentrate	3.16	44.7
Zn Regrind Cyclone Overflow	2.71	26.4
Zn Regrind Cyclone Underflow	1.95	18.3
Zn Combined Tailing	1.47	2.20
Zn 1st Cleaner Scavenger Concentrate	3.35	19.7
Zn 1st Cleaner Scavenger Tailing	2.26	3.97
Zn Cleaner Concentrate	2.26	56.0

Test No. PP40 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	17.53	23.4	16.9	69.5	25.3
Pb Rougher Tailing	82.47	2.18	10.6	30.5	74.7
Cyclone Overflow (meas)	100.00	5.90	10.1	100.0	100.0
(Calc.)	-	5.90	11.7	-	-
Pb Scavenger Concentrate	12.19	6.16	15.8	12.7	16.5
Pb Scavenger Tailing	70.28	1.49	9.76	17.7	58.6
Pb Rougher Tailing (meas)	82.47	2.18	10.6	30.4	86.6
(Calc.)	-	2.18	10.7	30.4	75.1
Pb 1st Cleaner Conc.	10.03	33.9	18.9	57.6	16.2
Pb 1st Cleaner Tail.	7.50	9.35	18.8	11.9	12.1
Pb Rougher Conc. (meas)	17.53	23.4	16.9	69.5	29.3
(Calc.)	-	23.4	18.9	69.5	38.3
Zn Rougher Concentrate	20.11	2.16	26.9	7.4	46.2
Zn Rougher Tailing	50.17	1.37	2.89	11.6	12.4
Pb Scavenger Tailing (meas)	70.28	1.49	9.76	17.7	67.9
(Calc.)	-	1.60	9.76	19.0	58.6
Zn Scavenger Concentrate	19.27	1.33	4.51	4.3	7.4
Zn Scavenger Tailing	30.90	1.39	1.88	7.3	5.0
Zn Rougher Tailing (meas)	50.17	1.37	2.89	11.6	14.4
(Calc.)	-	1.37	2.89	11.6	12.4
Zn 1st Cleaner Conc.	9.95	3.16	44.7	5.3	38.0
Zn 1st Cleaner Tail.	10.16	2.56	9.44	4.4	8.2
Zn Rougher Conc. (meas)	20.11	2.16	26.9	7.4	53.6
(Calc.)	-	2.86	26.9	9.7	46.2
Zn 1st Cl. Scav. Conc.	3.53	3.35	19.7	2.0	5.9
Zn 1st Cl. Scav. Tail.	6.63	2.26	3.97	2.5	2.2
Zn 1st Cl. Tail. (meas)	10.16	2.56	9.44	4.4	9.5
(Calc.)	-	2.64	9.44	4.5	8.1

Three-Product Formula

Pb 4th Cleaner Conc.	7.76	57.2	12.8	75.2	9.8
Zn 4th Cleaner Conc.	13.15	2.26	56.0	5.0	72.9
Zn Combined Tailing	79.09	1.47	2.20	19.8	17.3
Zn Cyclone Overflow	100.00	5.90	10.1	100.0	100.0

Test No. PP41

1. Grinding

1.1. Purpose: To repeat conditions of test PP40.

1.2. Method: As for test PP31 to 40. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 694 pounds per hour. Samples were taken every 20 minutes during the last 2 hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PP1.

1.4. Results: The grinding circuit was stable during the test run. Net power consumption in the Hendy mill was 18.6 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 91.1 % minus 200 mesh. Power in the Denver mill was not calculated.

Test No. PP41 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus $\frac{1}{2}$ inch ore at 0.5 percent moisture content		
Feed Rate:	694 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	$1\frac{1}{2}$ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
	Total	2361 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Mill Feed:	Total 5379 pounds, test period 1388 pounds		
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>	
	Mill Discharge	2142	71
	Cyclone Overflow	1314	32
	Cyclone Underflow	2336	76
Average Power:	Gross	8.42 kilowatts	
	No Load	1.92 kilowatts	
	Net	6.51 kilowatts	
Net Power Consumption:	18.60 kilowatt-hours per ton of $\frac{1}{2}$ inch feed.		
Work Index:	13.72		

Test NO. PP41 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill		
Feed:	Zinc Ro. Conc., Zn 2nd Cl. Tail. and Zn 1st Cl. Scav. Conc.		
Mill Speed:	32 r.p.m., 75 per cent of critical speed		
Mill Load:	1 inch balls	660 pounds	
	$\frac{1}{2}$ inch balls	220 pounds	
	<hr/>		
	Total	880 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>	
	Mill Discharge	2482	75
	Cyclone Overflow	1153	17.5
	Cyclone Underflow	2482	75
Average Power:	Gross	2.73 kilowatts	
	No Load	0.92 kilowatts	
	Net	1.81 kilowatts	
Net Power Consumption:	5.17 kilowatt-hours per ton of feed.		

Test No. PP41 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	5.6	5.6	94.4
3	17.8	23.4	76.6
4	13.7	37.1	62.9
6	9.1	46.2	53.8
8	8.7	54.9	45.1
10	7.4	62.3	37.7
14	5.9	68.2	31.8
20	4.2	72.4	27.6
28	3.4	75.8	24.2
35	2.1	77.9	22.1
48	3.1	81.0	19.0
65	2.8	83.8	16.2
100	2.3	86.1	13.9
150	2.3	88.4	11.6
200	2.3	90.7	9.3
- 200	9.3	100.0	-
Total	100.0	-	-

Cyclone Underflow

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.4	0.8	99.2
35	0.6	1.4	98.6
48	2.0	3.4	96.6
65	3.3	6.7	93.3
100	5.3	12.0	88.0
150	9.9	21.9	78.1
200	18.3	40.2	59.8
270	14.7	54.9	45.1
400	18.3	73.2	26.8
- 400	26.8	100.0	-
Total	100.0	-	-

Test No. PP41 - Continued

1.4.3. Screen Analyses

Mill Discharge

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.1	0.3	99.7
28	0.3	0.6	99.4
35	0.4	1.0	99.0
48	1.4	2.4	97.6
65	2.8	5.2	94.8
100	4.6	9.8	90.2
150	8.7	18.5	81.5
200	16.6	35.1	64.9
270	13.8	48.9	51.1
400	18.0	66.9	33.1
- 400	33.1	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.2	0.2	99.8
100	0.7	0.9	99.1
150	2.0	2.9	97.1
200	6.0	8.9	91.1
270	6.9	15.8	84.2
400	14.2	30.0	70.0
- 400	70.0	100.0	-
Total	100.0	-	-

Test No. PP41 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	3.7	3.7	96.3
270	4.2	7.9	92.1
31.7 μ m	9.0	16.9	83.1
24.6	6.0	22.9	77.1
17.2	13.7	36.6	63.4
11.8	15.8	52.4	47.6
9.1	11.0	63.4	36.6
- 9.1	36.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.50

Pb Regrind Cyclone Underflow

+ 200 mesh	2.7	2.7	97.3
270	5.6	8.3	91.7
29.9 μ m	8.3	16.6	83.4
23.2	26.7	43.3	56.7
16.2	38.0	81.3	18.7
11.1	9.5	90.8	9.2
8.6	2.6	93.4	6.6
- 8.6	6.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.94

Pb Regrind Discharge

+ 200 mesh	1.6	1.6	98.4
270	3.8	5.4	94.6
29.9 μ m	7.4	12.8	87.2
23.2	33.6	46.4	53.6
16.2	28.5	74.9	25.1
11.1	11.3	86.2	13.8
8.6	3.8	90.0	10.0
- 8.6	10.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.88

Test No. PP41 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 30.6 μ m	0.6	0.6	99.4
23.7	1.3	1.9	98.1
16.5	11.6	13.5	86.5
11.4	21.0	34.5	65.5
8.8	15.0	49.5	50.5
- 8.8	50.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.46

Pb 4th Cleaner Concentrate

+ 25.2 μ m	0.9	0.9	99.1
19.5	1.4	2.3	97.7
13.6	14.1	16.4	83.6
9.4	23.2	39.6	60.4
7.2	14.8	54.4	45.6
- 7.2	45.6	100.0	-
Total	100.0	-	-

Specific Gravity 6.03

Zn Regrind Discharge

+ 200 mesh	5.2	5.2	94.8
270	11.4	16.6	83.4
31.1 μ m	3.5	23.8	76.2
24.1	41.2	65.0	35.0
16.8	26.0	91.0	9.0
11.6	3.3	94.3	5.7
8.9	1.2	95.5	4.5
- 8.9	4.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.55

Test No. PP41 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	5.8	5.8	94.2
270	11.4	17.2	82.8
31.3 μm	7.1	24.3	75.7
24.2	42.4	66.7	33.3
16.9	26.0	92.7	7.3
11.6	2.7	95.4	4.6
9.0	0.8	96.2	3.8
- 9.0	3.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.54

Zn Regrind Cyclone Overflow

+ 32.6 μm	6.2	6.2	93.8
25.3	12.2	18.4	81.6
17.7	28.4	46.8	53.2
12.1	17.5	64.3	35.7
9.4	8.2	72.5	27.5
- 9.4	27.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.26

Test No. PP41 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.7 µm	0.8	0.8	99.2
25.4	1.8	1.8	98.2
17.7	7.7	9.5	90.5
12.2	14.7	24.2	75.8
9.4	12.2	36.4	63.6
- 9.4	63.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.06

Zn Combined Tailing

+ 100 mesh	1.2	1.2	98.8
150	2.4	3.6	96.4
200	6.2	9.8	90.2
37.7 µm	10.9	20.7	79.3
29.2	9.4	30.1	69.9
20.4	15.8	45.9	54.1
14.0	12.4	58.3	41.7
10.8	7.4	65.7	34.3
- 10.8	34.3	100.0	-
Total	100.0	-	-

Specific Gravity 3.45

Test NO. PP41 - Continued

2. Flotation

2.1. Purpose: To repeat conditions of test PP40 for lead circuit, and attempt to decrease the zinc content in the zinc combined tailing.

2.2. Method: No changes in the lead circuit were made. The following changes in the zinc circuit were carried out:
1) Collector Z-11 was added to the zinc 1st cleaner feed at a rate of 0.03 lb/ton, and collector Z-200 additions to the Zn regrinding mill was decreased slightly.
2) The pH of the zinc 3rd and 4th cleaner stages was increased from 11.1 to 11.4.

2.2.1. Flotation Equipment

As for test PP26.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP26.

2.4. Results: Higher circulation load in the lead cleaning stages improved lead grade with no losses in recovery. Changes in the zinc circuit significantly improved zinc concentrate grade and recovery. The Zn 4th cleaner concentrate assayed 57.4 % at 79.5 % Zn recovery.

Test No. PP41 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	4.90	Ball Mill Feed
NaCN	0.22	Ball Mill Feed
ZnSO ₄	0.95	Ball Mill Feed
Z-11	0.09	Ball Mill Feed
R-242	0.03	Pb Rougher Conditioner
MIBC	0.105	Pb Rougher Feed Pump
MIBC	0.075	Pb Rougher 3rd Cell
Z-11	0.04	Pb Scavenger Feed
MIBC	0.004	Pb Scavenger Feed
Na ₂ CO ₃	0.50	Pb Regrind Mill
ZnSO ₄	0.55	Pb Regrind Mill
NaCN	0.32	Pb Regrind Mill
R-242	0.01	Pb Cyclone Feed Pump
MIBC	0.005	Pb 1st Cleaner Feed
NaCN	0.09	Pb 2nd Cleaner Feed
MIBC	0.003	Pb 2nd Cleaner Feed
NaCN	0.07	Pb 3rd Cleaner Feed
Ca(OH) ₂	2.60	Zn Rougher Cond. No. 1
CuSO ₄	2.05	Zn Rougher Cond. No. 2
Z-11	0.18	Zn Rougher Feed Pump
Z-200	0.096	Zn Rougher Feed Pump
DF-250	0.076	Zn Rougher Feed Pump
DF-250	0.081	Zn Rougher Feed
Z-11	0.04	Zn Scavenger Feed
DF-250	0.030	Zn Scavenger Feed
Z-200	0.051	Zn Scavenger Feed
CuSO ₄	0.30	Zn Regrind Mill
Ca(OH) ₂	1.30	Zn Regrind Mill
Z-200	0.038	Zn Regrind Mill
Z-11	0.06	Zn 1st Cleaner Scavenger
Z-200	0.028	Zn 1st Cleaner Scavenger
Z-11	0.03	Zn 1st Cleaner Feed
Ca(OH) ₂	0.30	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.18	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.18	Zn 4th Cleaner Feed

Test No. PP41 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	9.0
Pb Rougher Feed	9.1
Pb Scavenger Tailing	8.9
Pb Regrinding Mill Discharge	9.7
Pb 1st Cleaner Feed	9.3
Pb 2nd Cleaner Feed	9.3
Pb 3rd Cleaner Feed	9.2
Pb 4th Cleaner Feed	9.1
Zn Rougher Feed	9.8
Zn Scavenger Tailing	9.3
Zn 1st Cl. Scav. Feed	10.8
Zn 1st Cleaner Feed	11.0
Zn 2nd Cleaner Feed	11.2
Zn 3rd Cleaner Feed	11.3
Zn 4th Cleaner Feed	11.5

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1816
Pb Rougher Feed	1180
Pb Scavenger Tailing	1157
Pb 1st Cleaner Feed	1108
Pb Rougher Concentrate	1258
Zn Rougher Feed	1155
Zn Cyclone Feed	1367
Zn 1st Cleaner Feed	1153
Zn Rougher Concentrate	1412
Zn Comb. Tail. Cyclone O/F	1005
Zn Comb. Tail. Cyclone U/F	1437

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	20
Pb Regrinding Mill Discharge	23
Zn Rougher Feed	22
Zn Regrinding Mill Discharge	29

Test No. PP41 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.74	9.95
Pb Rougher Feed	6.01	12.1
Pb Rougher Concentrate	20.1	17.2
Pb Rougher Tailing	2.07	10.6
Pb Scavenger Concentrate	5.17	15.3
Pb Scavenger Tailing	1.46	9.33
Pb 1st Cleaner Concentrate	32.8	23.6
Pb 1st Cleaner Tailing	7.88	19.7
Pb Re grind Cyclone Overflow	22.7	23.0
Pb Re grind Cyclone Underflow	22.1	15.2
Pb Cleaner Concentrate	62.7	10.4
Zn Rougher Feed	1.19	6.82
Zn Rougher Concentrate	1.49	22.2
Zn Rougher Tailing	1.14	2.17
Zn Scavenger Concentrate	1.18	3.16
Zn Scavenger Tailing	1.31	1.73
Zn 1st Cleaner Tailing	2.17	5.39
Zn 1st Cleaner Concentrate	2.91	38.6
Zn Re grinding Cyclone Overflow	2.46	20.4
Zn Re grinding Cyclone Underflow	1.77	16.5
Zn 1st Cleaner Scavenger Concentrate	2.79	9.11
Zn 1st Cleaner Scavenger Tailing	1.14	0.91
Zn Combined Tailing	1.24	1.65
Zn Cleaner Concentrate	2.37	57.4

Test No. PP41 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	20.36	20.1	17.2	71.3	29.3
Pb Rougher Tailing	79.64	2.07	10.6	28.7	70.7
Cyclone Overflow (meas)	100.00	5.74	9.95	100.0	100.0
(Calc.)	-	5.74	11.9	-	-
Pb Scavenger Concentrate	13.09	5.17	15.3	11.8	16.8
Pb Scavenger Tailing	66.55	1.46	9.33	16.9	52.0
Pb Rougher Tail. (meas)	79.64	2.07	10.6	28.7	84.8
(Calc.)	-	2.07	10.3	28.7	68.8
Pb 1st Cleaner Conc.	9.98	32.8	23.6	57.0	19.7
Pb 1st Cleaner Tail.	10.38	7.88	19.7	14.2	17.1
Pb Rougher Conc. (meas)	20.36	20.1	17.2	71.3	35.2
(Calc.)	-	20.1	21.6	71.2	36.8
Zn Rougher Concentrate	23.79	1.49	22.2	6.2	44.2
Zn Rougher Tailing	42.76	1.14	2.17	8.5	7.8
Pb Scavenger Tail. (meas)	66.55	1.46	9.33	16.9	62.4
(Calc.)	-	1.27	9.33	14.7	52.0
Zn Scavenger Concentrate	13.16	1.18	3.16	2.7	3.5
Zn Scavenger Tailing	29.60	1.31	1.73	6.8	4.3
Zn Rougher Tailing (meas)	42.76	1.14	2.17	8.5	9.3
(Calc.)	-	1.27	2.17	9.5	7.8
Zn 1st Cleaner Conc.	12.04	2.91	38.6	6.1	38.9
Zn 1st Cleaner Tail.	11.75	2.17	5.39	4.4	5.3
Zn Rougher Conc. (meas)	23.79	1.49	22.2	6.2	53.1
(Calc.)	-	2.54	22.2	10.5	44.2
Zn 1st Cl. Scav. Conc.	6.42	2.79	9.11	3.1	4.9
Zn 1st Cl. Scav. Tail.	5.33	1.14	0.91	1.1	0.4
Zn 1st Cl. Tail. (meas)	11.75	2.17	5.39	4.4	6.4
(Calc.)	-	-	5.39	4.2	5.3

Three-Product Formula

Pb Cleaner Concentrate	7.07	62.7	10.4	77.2	7.3
Zn Cleaner Concentrate	13.78	2.37	57.4	5.7	79.6
Zn Combined Tailing	79.15	1.24	1.65	17.1	13.1
Cyclone Overflow	100.00	5.74	9.95	100.0	100.0

Test No. PP42

1. Grinding

1.1. Purpose:

The first of three continuous tests to determine the stability of the grinding circuit over an extended time period.

1.2. Method:

As for test PP31 to 41. The circuit was operated for a period of 11.5 hours at a feed rate of 691 pounds per hour. Samples were taken every hour during 6 hours of the operation. (3:00 P.M. to 8:00 P.M.)

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Re grind

Denver Mill; Krebs Cyclone:

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

Zn Re grind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet:

As for test PP1.

1.4. Results:

The grinding circuit was stable during the test period. Net power consumption in the Hendy mill was 17.6 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 91.0 % minus 200 mesh.

Test No. PP42 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus $\frac{1}{2}$ inch ore at 0.5 percent moisture content		
Feed Rate:	691 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	$1\frac{1}{2}$ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
	Total	2361 pounds	
Operating Time:	Total 11.0 hours, test period 5.0 hours		
Mill Feed:	Total 7601 pounds, test period 3455 pounds		
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>	
	Mill Discharge	2159	72
	Cyclone Overflow	1322	32
	Cyclone Underflow	2364	77
Average Power:	Gross	8.12 kilowatts	
	No Load	1.92 kilowatts	
	Net	6.20 kilowatts	
Net Power Consumption:	17.71 kilowatt-hours per ton of $\frac{1}{2}$ inch feed.		
Work Index:	13.10		

Test No. PP42 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc., Zn 2nd Cl. Tail. and Zn 1st Cl. Scav. Conc.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	
Mill Load:	1 inch balls	660 pounds
	$\frac{1}{2}$ inch balls	220 pounds
	<hr/>	
	Total	880 pounds
Operating Time:	Total 11.0 hours, test period 5.0 hours	
Pulp Densities:		<u>gpl</u> <u>% Solids</u>
	Mill Discharge	1256 26
	Cyclone Overflow	1163 18
	Cyclone Underflow	1256 26
Average Power:	Gross	2.76 kilowatts
	No Load	0.92 kilowatts
	Net	1.84 kilowatts
Net Power Consumption:	5.26 kilowatt-hours per ton of feed.	

Test No. PP42 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	5.0	5.0	95.0
3	15.6	20.6	79.4
4	13.7	34.3	65.7
6	10.4	44.7	55.3
8	8.5	53.2	46.8
10	7.5	60.7	39.3
14	5.7	66.4	33.6
20	4.1	70.5	29.5
28	3.3	73.8	26.2
35	2.6	76.4	23.6
48	3.3	79.7	20.3
65	3.0	82.7	17.3
100	2.5	85.2	14.8
150	2.5	87.7	12.3
200	2.7	90.4	9.6
- 200	9.6	100.0	-
Total	100.0	-	-

Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.2	0.5	99.5
28	0.4	0.9	99.1
35	0.6	1.5	98.5
48	1.5	3.0	97.0
65	2.7	5.7	94.3
100	4.5	10.2	89.8
150	8.6	18.8	81.2
200	16.5	35.3	64.7
270	13.7	49.0	51.0
400	19.8	68.8	31.2
- 400	31.2	100.0	-
Total	100.0	-	-

Test No. PP42 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.3	0.5	99.5
28	0.4	0.9	99.1
35	0.7	1.6	98.4
48	1.8	3.4	96.6
65	3.1	6.5	93.5
100	5.4	11.9	88.1
150	10.0	21.9	78.1
200	18.4	40.3	59.7
270	14.9	55.2	44.8
400	20.2	75.4	24.6
- 400	24.6	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.3	0.3	99.7
100	0.6	0.9	99.1
150	2.1	3.0	97.0
200	6.0	9.0	91.0
270	7.0	16.0	84.0
400	14.9	30.9	69.1
- 400	69.1	100.0	-
Total	100.0	-	-

Test No. PP42 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	2.2	2.2	97.8
270	3.2	5.4	94.6
31.3 μ m	8.4	13.8	86.2
24.2	6.9	20.7	79.3
16.9	18.4	39.1	60.9
11.6	17.4	56.5	43.5
9.0	10.4	66.9	33.1
- 9.0	33.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.53

Pb Regrind Discharge

+ 200 mesh	1.1	1.1	98.9
270	3.8	4.9	95.1
29.9 μ m	11.4	16.3	83.7
23.2	35.7	52.0	48.0
16.2	25.2	77.2	22.8
11.1	9.4	86.6	13.4
8.6	3.4	90.0	10.0
- 8.6	10.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.90

Pb Regrind Cyclone Underflow

+ 200 mesh	2.4	2.4	97.6
270	4.9	7.3	92.7
29.9 μ m	8.8	16.1	83.9
23.2	27.8	43.9	56.1
16.2	37.0	80.9	19.1
11.1	8.8	89.7	10.3
8.6	2.8	92.5	7.5
- 8.6	7.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.93

Test No. PP42 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	7.1	7.1	92.9
270	8.6	15.7	84.3
32.6 μ m	6.0	21.7	78.3
25.3	31.6	53.3	46.7
17.7	23.0	76.3	23.7
12.1	7.8	84.1	15.9
9.4	3.4	87.5	12.5
- 9.4	12.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.24

Pb Regrind Cyclone Overflow

+ 30.1 μ m	2.4	2.4	97.6
23.3	4.5	6.9	93.1
16.3	18.9	25.8	74.2
11.2	21.4	47.2	52.8
8.7	12.8	60.0	40.0
- 8.7	40.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.54

Pb 4th Cleaner Concentrate

+ 25.2 μ m	1.6	1.6	98.4
19.5	2.8	4.4	95.6
13.6	16.4	20.8	79.2
9.4	21.8	42.6	57.4
7.2	13.6	56.2	43.8
- 7.2	43.8	100.0	-
Total	100.0	-	-

Specific Gravity 6.03

Test No. PP42 - Continued

1.4.3. Screen Analyses

Zn Tailing Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100 mesh	1.4	1.4	98.6
150	2.6	4.0	96.0
200	5.0	9.0	91.0
36.3 μm	8.2	17.2	82.8
28.2	28.0	45.2	54.8
19.6	23.3	68.5	31.5
13.5	16.0	84.5	15.5
10.4	6.2	90.7	9.3
- 10.4	9.3	100.0	-
Total	100.0	-	-

Specific Gravity 3.61

Zn Regrind Discharge

+ 200 mesh	3.8	3.8	96.2
270	7.3	11.1	88.9
32.6 μm	6.6	17.7	82.3
25.3	36.5	54.2	45.8
17.7	18.7	72.9	27.1
12.1	8.9	81.8	18.2
9.4	4.0	85.8	14.2
- 9.4	14.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.23

Zn Regrind Cyclone Overflow

+ 200 mesh	3.2	3.2	96.8
270	4.8	8.0	92.0
32.6 μm	5.5	13.5	86.5
25.3	29.0	42.5	57.5
17.7	20.5	63.0	37.0
12.1	11.6	74.6	25.4
9.4	5.6	80.2	19.8
- 9.4	19.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.23

Test No. PP42 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.3 µm	12.3	12.3	87.7
25.0	8.6	20.9	79.1
17.5	17.4	38.3	61.7
12.0	14.9	53.2	46.8
9.3	9.2	62.4	37.6
- 9.3	37.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.14

Zn Combined Tailing

+ 100 mesh	1.0	1.0	99.0
150	1.8	2.8	97.2
200	5.2	8.0	92.0
37.7 µm	14.4	22.4	77.6
29.2	9.9	32.3	67.7
20.4	16.0	48.3	51.7
14.0	12.0	60.3	39.7
10.8	7.2	67.5	32.5
- 10.8	32.5	100.0	-
Total	100.0	-	-

Specific Gravity 3.40

Zn Tailing Cyclone Overflow

+ 36.8 µm	0.6	0.6	99.4
28.5	0.4	1.0	99.0
19.9	1.4	2.4	97.6
13.7	5.0	7.4	92.6
10.6	9.8	17.2	82.8
- 10.6	82.8	100.0	-
Total	100.0	-	-

Specific Gravity 3.60

Test No. PP42 - Continued

2. Flotation

- 2.1. Purpose: The first of three continuous tests to study the flotation response over an extended period of time.
- 2.2. Method: The lead and zinc circuits were similar to those used in Tests PP40 and 41. Samples were taken every hour from 3:00 P.M. to 8:00 P.M. At 11:00 A.M., collector Z-11 additions to the Zn 1st cleaner were increased from 0.03 lb/ton to 0.09 lb /ton and collector Z-11 addition to the Zn 1st cleaner scavenger feed was omitted.
- 2.2.1. Flotation Equipment
- As for test PP36.
- 2.2.2. Flotation Reagents
- See following page.
- 2.3. Flowsheet: As for test PP36.
- 2.4. Results: The lead flotation circuit was stable during the test period. The lead cleaner concentrate assayed 60.7 % Pb at 75.6 % Pb recovery. High Z-11 additions in the zinc 1st cleaner produced a low grade zinc concentrate and a high circulation load was observed in the zinc 1st cleaner and regrinding circuit.

Test No. PP42 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	5.20	Ball Mill Feed
NaCN	0.20	Ball Mill Feed
ZnSO ₄	1.00	Ball Mill Feed
Z-11	0.09	Ball Mill Feed
R-242	0.03	Pb Rougher Conditioner
MIBC	0.100	Pb Rougher Feed Pump
MIBC	0.075	Pb Rougher 3rd Cell
Z-11	0.04	Pb Scavenger Feed
MIBC	0.003	Pb Scavenger Feed
Na ₂ CO ₃	0.40	Pb Regrind Mill
ZnSO ₄	0.50	Pb Regrind Mill
NaCN	0.31	Pb Regrind Mill
R-242	0.01	Pb Cyclone Feed Pump
MIBC	0.001	Pb 1st Cleaner Feed
NaCN	0.08	Pb 2nd Cleaner Feed
MIBC	0.003	Pb 2nd Cleaner Feed
NaCN	0.07	Pb 3rd Cleaner Feed
CuSO ₄	2.05	Zn Rougher Cond. No. 2
Ca(OH) ₂	2.70	Zn Rougher Cond. No. 1
Z-200	0.089	Zn Rougher Feed Pump
DF-250	0.073	Zn Rougher Feed Pump
Z-11	0.20	Zn Rougher Feed Pump
DF-250	0.066	Zn Rougher Feed
Z-11	0.04	Zn Scavenger Feed
DF-250	0.028	Zn Scavenger Feed
Z-200	0.048	Zn Scavenger Feed
CuSO ₄	0.30	Zn Regrind Mill
Z-200	0.036	Zn Regrind Mill
Ca(OH) ₂	1.07	Zn Regrind Mill
Z-11	0.03	Zn 1st Cleaner Feed
Z-11	0.06	Zn 1st Cleaner 5th Cell
Z-200	0.028	Zn 1st Cleaner Scavenger
Ca(OH) ₂	0.31	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.18	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.29	Zn 4th Cleaner Feed

Test No. PP42 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	9.0
Pb Rougher Feed	9.0
Pb Scavenger Tailing	8.8
Pb Regrinding Mill Discharge	9.6
Pb 1st Cleaner Feed	9.3
Pb 2nd Cleaner Feed	9.3
Pb 3rd Cleaner Feed	9.2
Pb 4th Cleaner Feed	9.1
Zn Rougher Feed	10.0
Zn Scavenger Tailing	9.4
Zn 1st Cl. Scav. Feed	10.8
Zn 1st Cleaner Feed	11.0
Zn 2nd Cleaner Feed	11.0
Zn 3rd Cleaner Feed	11.3
Zn 4th Cleaner Feed	11.4

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1865
Pb Rougher Feed	1217
Pb Scavenger Tailing	1149
Pb 1st Cleaner Feed	1188
Pb Rougher Concentrate	1284
Zn Rougher Feed	1165
Zn Cyclone Feed	1192
Zn 1st Cleaner Feed	1163
Zn Rougher Concentrate	1331
Zn Comb. Tail. Cyclone U/F	1497
Zn Comb. Tail. Cyclone O/F	1014

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	20.5
Pb Regrinding Mill Discharge	22
Zn Rougher Feed	21
Zn Regrinding Mill Discharge	22

Test No. PP42 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.78	10.1
Pb Rougher Feed	5.99	12.2
Pb Rougher Concentrate	18.7	18.0
Pb Rougher Tailing	2.20	10.8
Pb Scavenger Concentrate	6.12	16.5
Pb Scavenger Tailing	1.54	9.72
Pb 1st Cleaner Concentrate	2.58	19.4
Pb 1st Cleaner Tailing	1.93	2.86
Pb Regrind Cyclone Overflow	18.3	20.6
Pb Regrind Cyclone Underflow	18.7	13.5
Pb Cleaner Concentrate	60.9	10.8
Zn Rougher Feed	1.40	7.18
Zn Rougher Concentrate	2.09	25.9
Zn Rougher Tailing	1.22	2.48
Zn Scavenger Concentrate	1.24	3.54
Zn Scavenger Tailing	1.22	1.76
Zn 1st Cleaner Tailing	1.93	2.86
Zn 1st Cleaner Concentrate	2.58	19.4
Zn Regrinding Cyclone Overflow	2.31	13.6
Zn Regrinding Cyclone Underflow	2.22	12.6
Zn 1st Cleaner Scavenger Concentrate	1.94	3.33
Zn 1st Cleaner Scavenger Tailing	1.46	1.27
Zn Combined Tailing	1.27	1.65
Zn Cleaner Concentrate	2.65	48.4

Test No. PP42 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	21.70	18.7	18.0	70.2	31.6
Pb Rougher Tailing	78.30	2.20	10.8	29.8	68.4
Cyclone Overflow (meas)	100.00	5.78	10.1	100.0	100.0
(Calc.)	-	5.78	12.4	-	-
Pb Scavenger Concentrate	11.28	6.12	16.5	11.9	15.1
Pb Scavenger Tailing	67.02	1.54	9.72	17.9	52.7
Pb Rougher Tailing (meas)	78.30	2.20	10.8	29.8	83.7
(Calc.)	-	2.20	12.9	29.8	67.8
Pb 1st Cleaner Conc.	12.95	26.3	21.0	58.9	22.0
Pb 1st Cleaner Tail.	8.75	7.45	19.4	11.3	13.7
Pb Rougher Conc. (meas)	21.70	18.7	18.0	70.2	38.7
(Calc.)	-	18.7	20.4	70.2	35.7
Zn Rougher Concentrate	20.71	2.09	25.9	7.5	43.4
Zn Rougher Tailing	46.31	1.22	2.48	9.8	9.3
Pb Scavenger Tail. (meas)	67.02	1.54	9.72	17.9	69.5
(Calc.)	-	1.48	9.72	17.3	52.7
Zn Scavenger Concentrate	18.73	1.24	3.54	4.0	5.4
Zn Scavenger Tailing	27.58	1.22	1.76	5.8	3.9
Zn Rougher Tail. (meas)	46.31	1.22	2.48	9.8	11.4
(Calc.)	-	1.23	2.48	9.8	9.3

Three-Product Formula

Pb Cleaner Concentrate	7.18	60.9	10.8	75.6	7.7
Zn Cleaner Concentrate	16.66	2.65	48.4	7.6	79.9
Zn Combined Tailing	76.16	1.27	1.65	16.8	12.4
Cyclone Overflow	100.00	5.78	10.1	100.0	100.0

Test No. PP43

1. Grinding

1.1. Purpose: The second test of three continuous tests.

1.2. Method: No changes from test PP42. The circuit was sampled every hour from 1:00 A.M. to 8:00 A.M.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PP1.

1.4. Results: The grinding circuit was stable during the test period. Net power consumption in the Hendy mill was 17.49 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 90.9 % minus 200 mesh.

Test No. PP43 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minsu $\frac{1}{2}$ inch ore at 0.4 percent moisture content	
Feed Rate:	700 dry pounds per hour	
Mill Speed:	32 r.p.m., 80.5 percent of critical speed	
Mill Load:	3 inch balls	1000 pounds
	1 $\frac{1}{2}$ inch balls	961 pounds
	1 inch balls	400 pounds
	<hr/>	
	Total	2361 pounds
Operating Time:	Total 12.0 hours, test period 7.0 hours	
Mill Feed:	Total 8,400 pounds, test period 4900 pounds	
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	71
	Cyclone Overflow	33
	Cyclone Underflow	78
Average Power:	Gross	8.04 kilowatts
	No Load	1.92 kilowatts
	Net	6.12 kilowatts
Net Power Consumption:	17.49 kilowatt-hours per ton of $\frac{1}{2}$ inch feed.	
Work Index:	12.94	

Test No. PP43 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc., Zn 2nd Cl. Tail., and Zn 1st Cl. Scav. Conc.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	
Mill Load:	1 inch balls	660 pounds
	$\frac{1}{2}$ inch balls	220 pounds
	<hr/>	
	Total	880 pounds
Operating Time:	Total 12.0 hours, test period 7.0 hours	
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	1797 56
	Cyclone Overflow	1289 29
	Cyclone Underflow	1797 56
Average Power:	Gross	2.17 kilowatts
	No Load	0.92 kilowatts
	Net	1.25 kilowatts
Net Power Consumption:	3.49 kilowatt-hours per ton of feed.	

Test No. PP43 - Continued

1.4.3. Screen Analysis

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	3.8	3.8	96.2
3	14.4	18.2	81.8
4	11.9	30.1	69.9
6	10.1	40.2	59.8
8	8.2	48.4	51.6
10	7.8	56.2	43.8
14	6.4	62.6	37.4
20	4.8	67.4	32.6
28	3.8	71.2	28.8
35	2.9	74.1	25.9
48	3.6	77.7	22.3
65	3.1	80.8	19.2
100	2.7	83.5	16.5
150	2.6	86.1	13.9
200	2.6	88.7	11.3
- 200	11.3	100.0	-
Total	100.0	-	-

Cyclone Underflow

+ 10	0.2	0.2	99.8
14	0.2	0.4	99.6
20	0.3	0.7	99.3
28	0.6	1.3	98.7
35	1.0	2.3	97.7
48	2.0	4.3	95.9
65	3.3	7.6	92.4
100	5.4	13.0	87.0
150	10.0	23.0	77.0
200	19.4	42.4	57.6
270	16.1	58.5	41.5
400	16.2	74.7	25.3
- 400	25.3	100.0	-
Total	100.0	-	-

Test No. PP43 - Continued

1.4.3. Screen Analysis

Mill Discharge

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.3	0.5	99.5
28	0.4	0.9	99.1
35	0.6	1.5	98.5
48	1.5	3.0	97.0
65	2.8	5.8	94.2
100	4.7	10.5	89.5
150	8.8	19.3	80.7
200	16.6	35.9	44.8
270	13.8	49.7	50.3
400	18.8	68.5	31.5
- 400	31.5	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.3	0.3	99.7
100	0.8	1.1	98.9
150	2.1	3.2	96.8
200	5.9	9.1	90.9
270	7.3	16.4	83.6
400	13.1	29.5	70.5
- 400	70.5	100.0	-
Total	100.0	-	-

Test No. PP43 - Continued

1.4.3. Screen Analysis

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	2.6	2.6	97.4
270	3.8	6.4	93.6
31.3 μm	9.0	15.4	84.6
24.2	6.3	21.7	78.3
16.9	14.7	36.4	63.6
11.7	16.0	52.4	47.6
9.0	10.8	63.2	36.8
- 9.0	36.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.60

Pb Regrind Cyclone Underflow

+ 200 mesh	1.8	1.8	98.2
270	4.2	6.0	94.0
29.8 μm	7.2	13.2	86.8
23.1	34.8	48.0	52.0
16.1	30.1	78.1	21.9
11.1	11.0	89.1	10.9
8.6	3.0	92.1	7.9
- 8.6	7.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.93

Pb Regrind Discharge

+ 200 mesh	1.0	1.0	99.0
270	3.3	4.3	95.7
29.7 μm	7.3	11.6	88.4
23.0	32.4	44.0	56.0
16.0	28.5	72.5	27.5
11.0	12.0	84.5	15.5
8.5	4.0	88.5	11.5
- 8.5	11.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.95

Test No. PP43 - Continued

1.4.3. Screen Analysis

Pb 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 25.7 μ m	1.7	1.7	98.3
19.9	2.2	3.9	96.1
13.9	14.4	18.3	81.7
9.5	22.1	40.4	59.6
7.4	14.2	54.6	45.4
- 7.4	45.4	100.0	-
Total	100.0	-	-

Specific Gravity 5.99

Zn Regrind Discharge

+ 200 mesh	5.0	5.0	95.0
270	8.8	13.8	86.2
32.6 μ m	5.0	18.8	81.2
25.3	32.4	51.2	48.8
17.7	30.5	81.7	18.3
12.1	7.9	89.6	10.4
9.4	2.8	92.4	7.6
- 9.4	7.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.27

Test No. PP43 - Continued

1.4.3. Screen Analysis

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 150 mesh	1.3	1.3	98.7
200	5.4	6.7	93.3
270	9.5	16.2	83.8
32.5 µm	4.6	20.8	79.2
25.2	33.8	54.6	45.4
17.6	29.6	84.2	15.8
12.1	7.2	91.4	8.6
9.3	2.4	93.8	6.2
- 9.3	6.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.26

Zn Regrind Cyclone Overflow

+ 200 mesh	3.1	3.1	96.9
270	5.8	8.9	91.1
33.1 µm	5.3	14.2	85.8
25.6	35.6	49.8	50.2
17.9	22.6	72.4	27.6
12.3	9.7	82.1	17.9
9.5	4.1	86.2	13.8
- 9.5	13.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.21

Test No. PP43 - Continued

1.4.3. Screen Analysis

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.3 µm	0.7	0.7	99.3
25.1	1.4	2.1	97.9
17.5	9.4	11.5	88.5
12.0	17.0	28.5	71.5
9.2	13.2	41.7	58.3
- 9.2	58.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.10

Zn Combined Tailing

+ 100 mesh	0.7	0.7	99.3
150	1.9	2.6	97.4
200	6.0	8.6	91.4
35.6 µm	15.5	24.1	75.9
27.6	10.2	34.3	65.7
19.2	15.8	50.1	49.9
13.2	11.7	61.8	38.2
10.2	7.0	68.8	31.2
- 10.2	31.2	100.0	-
Total	100.0	-	-

Specific Gravity 3.69

Test No. PP43 - Continued

2. Flotation

2.1. Purpose: The second of three continuous tests.

2.2. Method: The circuit was similar to test PP42. The circuit was sampled every hour from 1:00 A.M. to 8:00 A.M.

2.2.1. Flotation Equipment

As for test PP26.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP26.

2.4. Results: The lead grade and recovery was very similar to that of the previous test. In the zinc circuit the zinc recovery was lower but the concentrate grade was improved.

Test No. PP43 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	5.00	Ball Mill Feed
NaCN	0.20	Ball Mill Feed
ZnSO ₄	1.00	Ball Mill Feed
Z-11	0.09	Ball Mill Feed
R-242	0.03	Pb Rougher Conditioner
MIBC	0.105	Pb Rougher Feed Pump
MIBC	0.070	Pb Rougher 3rd Cell
Z-11	0.04	Pb Scavenger Feed
MIBC	0.003	Pb Scavenger Feed
Na ₂ CO ₃	0.50	Pb Re grind Mill
ZnSO ₄	0.50	Pb Re grind Mill
NaCN	0.30	Pb Re grind Mill
R-242	0.01	Pb Cyclone Feed Pump
MIBC	0.001	Pb 1st Cleaner Feed
NaCN	0.10	Pb 2nd Cleaner Feed
MIBC	0.003	Pb 2nd Cleaner Feed
NaCN	0.08	Pb 3rd Cleaner Feed
CuSO ₄	2.06	Zn Rougher Cond. No. 1
Ca(OH) ₂	2.40	Zn Rougher Cond. No. 2
Z-200	0.095	Zn Rougher Feed Pump
DF-250	0.075	Zn Rougher Feed Pump
Z-11	0.20	Zn Rougher Feed Pump
DF-250	0.066	Zn Rougher Feed
Z-11	0.04	Zn Scavenger Feed
DF-250	0.029	Zn Scavenger Feed
Z-200	0.053	Zn Scavenger Feed
CuSO ₄	0.30	Zn Re grind Mill
Z-200	0.038	Zn Re grind Mill
Ca(OH) ₂	1.22	Zn Re grind Mill
Z-11	0.03	Zn 1st Cleaner Feed
Z-11	0.05	Zn 1st Cleaner Scav.
Z-200	0.029	Zn 1st Cleaner Scav.
Ca(OH) ₂	0.25	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.20	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.25	Zn 4th Cleaner Feed

Test No. PP43 - Continued

2.2.3. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1839
Pb Rougher Feed	1191
Pb Rougher Concentrate	1263
Pb Scavenger Tailing	1146
Pb 1st Cleaner Feed	1140
Pb 1st Cleaner Tailing	1061
Pb 1st Cleaner Concentrate	1064
Pb 2nd Cleaner Concentrate	1121
Pb 3rd Cleaner Concentrate	1132
Zn Rougher Feed	1130
Zn Rougher Concentrate	1371
Zn Cyclone Feed	1380
Zn 1st Cleaner Feed	1180
Zn 1st Cleaner Concentrate	1111
Zn 2nd Cleaner Concentrate	1081
Zn 3rd Cleaner Concentrate	1134
Zn 1st Cleaner Tailing	1076
Zn Combined Tailing	1079

Test No. PP43 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	9.0
Pb Rougher Feed	9.0
Pb Scavenger Tailing	8.9
Pb Regrinding Mill Discharge	9.7
Pb 1st Cleaner Feed	9.3
Pb 2nd Cleaner Feed	9.3
Pb 3rd Cleaner Feed	9.2
Pb 4th Cleaner Feed	9.1
Zn Rougher Feed	9.9
Zn Scavenger Tailing	9.5
Zn 1st Cl. Scav. Feed	10.8
Zn 1st Cleaner Feed	11.0
Zn 2nd Cleaner Feed	11.0
Zn 3rd Cleaner Feed	11.2
Zn 4th Cleaner Feed	11.4

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	20
Pb Regrinding Mill Discharge	21
Zn Rougher Feed	21
Zn Regrinding Mill Discharge	22

Test No. PP43 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.83	10.0
Pb Rougher Feed	6.02	11.9
Pb Rougher Concentrate	21.8	16.9
Pb Rougher Tailing	2.21	11.0
Pb Scavenger Concentrate	6.39	16.4
Pb Scavenger Tailing	1.55	9.88
Pb 1st Cleaner Concentrate	27.0	20.6
Pb 1st Cleaner Tailing	8.32	19.4
Pb Regrind Mill Discharge	21.0	14.6
Pb Regrind Cyclone Overflow	20.0	19.9
Pb Regrind Cyclone Underflow	20.4	14.7
Pb 2nd Cleaner Feed	27.6	21.3
Pb 2nd Cleaner Concentrate	33.5	20.4
Pb 2nd Cleaner Tailing	18.3	22.5
Pb 3rd Cleaner Feed	35.2	20.1
Pb 3rd Cleaner Concentrate	46.7	17.2
Pb 3rd Cleaner Tailing	28.7	21.7
Pb 4th Cleaner Concentrate	60.7	10.9
Pb 4th Cleaner Tailing	39.8	19.3
Zn Rougher Feed	1.43	7.57
Zn Rougher Concentrate	1.89	20.4
Zn Rougher Tailing	1.28	2.95
Zn Scavenger Concentrate	1.25	4.00
Zn Scavenger Tailing	1.37	2.21
Zn Regrind Mill Discharge	2.37	21.7
Zn Regrind Cyclone Overflow	2.63	21.0
Zn Regrind Cyclone Underflow	2.41	21.9
Zn 1st Cleaner Concentrate	2.80	33.1
Zn 1st Cleaner Tailing	2.13	9.53
Zn 1st Cleaner Scavenger Concentrate	2.38	11.9
Zn 1st Cleaner Scavenger Tailing	1.36	2.14
Zn 2nd Cleaner Feed	2.77	34.0
Zn 2nd Cleaner Concentrate	2.75	41.7
Zn 2nd Cleaner Tailing	2.80	28.2
Zn 3rd Cleaner Feed	2.65	43.8
Zn 3rd Cleaner Concentrate	2.52	49.0
Zn 3rd Cleaner Tailing	2.71	39.8
Zn 4th Cleaner Concentrate	2.64	52.1
Zn 4th Cleaner Tailing	2.50	48.2
Zn Combined Tailing	1.30	2.11

Test No. PP43 - Continued

2.4.5. Water Additions in the Grind and Flotation Circuit

Point of Addition	Water (l/min.)
Hendy Mill Feed	4.3
Linatex Feed Pump Feed	1.45
Pb Rougher Launder	1.24
Pb Rougher Feed	0.75
Pb Regrind Mill Feed	1.65
Pb 1st Cleaner Launder	1.46
Pb 2nd Cleaner Launder	0.93
Pb 3rd Cleaner Launder	2.2
Pb 4th Cleaner Launder	0.89
Zn Rougher Feed	0.66
Zn Rougher Launder	0.82
Zn Scavenger Feed	0.70
Zn 1st Cleaner Launder	4.2
Zn 2nd Cleaner Launder	0.84
Zn 3rd Cleaner Launder	1.55
Zn 4th Cleaner Launder	2.74

Test No. PP43 - Continued

2.4.6. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	18.48	21.8	16.9	69.1	26.0
Pb Rougher Tailing	81.52	2.21	11.0	30.9	74.0
Cyclone Overflow (meas)	100.00	5.83	10.0	100.0	100.0
(Calc.)	-	5.83	12.1	-	-
Pb Scavenger Concentrate	11.12	6.39	16.4	12.2	15.1
Pb Scavenger Tailing	70.40	1.55	9.88	18.7	57.5
Pb Rougher Tail. (meas)	81.52	2.21	11.0	30.9	98.7
(Calc.)	-	2.21	10.8	30.9	72.6
Pb 1st Cleaner Conc.	13.34	27.0	20.6	61.8	22.7
Pb 1st Cleaner Tail.	5.14	8.32	19.4	7.3	8.2
Pb Rougher Conc. (meas)	18.48	21.8	16.9	69.1	31.2
(Calc.)	-	21.8	20.3	69.1	30.9
Zn Rougher Concentrate	27.96	1.89	20.4	9.1	47.2
Zn Rougher Tailing	42.44	1.28	2.95	9.3	10.4
Pb Scavenger Tail. (meas)	70.40	1.55	9.88	18.7	69.6
(Calc.)	-	1.52	9.88	18.4	57.6
Zn Scavenger Concentrate	17.54	1.25	4.00	3.8	5.8
Zn Scavenger Tailing	24.90	1.37	2.21	5.9	4.6
Zn Rougher Tail. (meas)	42.44	1.28	2.95	9.3	12.5
(Calc.)	--	1.32	2.95	9.7	10.4
Zn 1st Cleaner Conc.	12.89	2.80	33.1	6.2	35.3
Zn 1st Cleaner Tail.	15.07	2.13	9.53	5.5	11.9
Zn Rougher Conc. (meas)	27.96	1.89	20.4	9.1	57.0
(Calc.)	-	2.43	20.4	11.7	47.2
Zn 1st Cl. Scav. Conc.	11.41	2.38	11.9	4.7	11.2
Zn 1st Cl. Scav. Tail.	3.66	1.36	2.14	0.9	0.6
Zn 1st Cl. Tail. (meas)	15.07	2.13	9.53	5.5	14.4
(Calc.)	-	2.13	9.53	5.6	11.8

Test No. PP43 - Continued

2.4.6. Metallurgical Results

Three-Product Formula

Product	Weight	Assays, %				% Distribution			
	%	Pb	Zn	Au*	Ag*	Pb	Zn	Au	Ag
1. Pb Cl. Conc.	7.30	60.7	10.9	0.100	25.13	75.9	8.0	57.7	69.2
2. Zn Cl. Conc.	14.50	2.64	52.1	0.010	2.67	6.6	75.5	11.8	14.6
3. Zn Comb. Tail.	78.20	1.30	2.11	0.005	0.55	17.5	16.5	30.5	16.2
4. Cyclone O/F	100.00	5.83	10.0	0.030	2.58	100.0	100.0	100.0	100.0

* oz/ton

Test No. PP44

1. Grinding

1.1. Purpose: The final test of three continuous tests.

1.2. Method: No circuit changes were made. The circuit was sampled every 30 minutes from 1:00 P.M. to 4:00 P.M.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PP1.

1.4. Results: The grinding circuit was stable during the test run. Net power consumption in the Hendy mill was 17.91 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow assayed 89.9 % minus 200 mesh.

Test No. PP44 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 0.4 percent moisture content		
Feed Rate:	701 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
	Total	2361 pounds	
Operating Time:	Total 8.0 hours, test period 2.0 hours		
Mill Feed:	Total 5608 pounds, test period 1402 pounds		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2126	71
	Cyclone Overflow	1323	32
	Cyclone Underflow	2342	75
Average Power:	Gross	8.19 kilowatts	
	No Load	1.92 kilowatts	
	Net	6.27 kilowatts	
Net Power Consumption:	17.91 kilowatt-hours per ton of ½ inch feed.		
Work Index:	13.26		

Test No. PP44 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc., Zn 2nd Cl. Tail. and Zn 1st Cl. Scav. Conc.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	
Mill Load:	1 inch balls	660 pounds
	$\frac{1}{2}$ inch balls	220 pounds
	<hr/>	
	Total	880 pounds
Operating Time:	Total 8.0 hours, test period 2.0 hours	
Pulp Densities:		<u>gpl</u> <u>% Solids</u>
	Mill Discharge	1790 58
	Cyclone Overflow	1308 31
	Cyclone Underflow	1790 58
Average Power:	Gross	1.90 kilowatts
	No Load	0.92 kilowatts
	Net	0.98 kilowatts
Net Power Consumption:	2.80 kilowatt-hours per ton of feed.	

Test No. PP44 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	4.5	4.5	95.5
3	15.3	19.8	80.2
4	11.3	31.1	68.9
6	11.8	42.9	57.1
8	9.5	52.4	47.6
10	8.0	60.4	39.6
14	6.0	66.4	33.6
20	4.5	70.9	29.1
28	3.5	74.4	25.6
35	2.6	77.0	23.0
48	3.4	80.4	19.6
65	3.0	83.4	16.6
100	2.4	85.8	14.2
150	2.4	88.2	11.8
200	2.6	90.8	9.2
- 200	9.2	100.0	-
Total	100.0	-	-

Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.2	0.5	99.5
28	0.4	0.9	99.1
35	0.5	1.4	98.6
48	1.5	2.9	97.1
65	2.7	5.6	94.4
100	4.8	10.4	89.6
150	8.9	19.3	80.7
200	16.7	36.0	64.0
270	13.6	49.6	50.4
400	18.2	67.8	32.2
- 400	32.2	100.0	-
Total	100.0	-	-

Test No. PP44 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.2	0.2	99.8
14	0.3	0.5	99.5
20	0.3	0.8	99.2
28	0.5	1.3	98.7
35	0.7	2.0	98.0
48	1.8	3.8	96.2
65	3.3	7.1	92.9
100	5.6	12.7	87.3
150	10.0	22.7	77.4
200	18.5	41.2	58.8
270	14.5	55.7	44.3
400	18.7	74.4	25.6
- 400	25.6	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.3	0.3	99.7
100	0.8	1.1	98.9
150	2.4	3.5	96.5
200	6.6	10.1	89.9
270	7.4	17.5	82.5
400	15.1	32.6	67.4
- 400	67.4	100.0	-
Total	100.0	-	-

Test No. PP44 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	3.2	3.2	96.8
270	4.8	8.0	92.0
31.3 μm	10.5	18.5	81.5
24.2	7.5	26.0	74.0
16.9	16.8	42.8	57.2
11.6	15.6	58.4	41.6
9.0	9.5	67.9	32.1
- 9.0	32.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.59

Pb Regrind Cyclone Underflow

+ 200 mesh	3.0	3.0	97.0
270	6.4	9.4	90.6
29.9 μm	8.0	17.4	82.6
22.2	31.2	48.6	51.4
16.2	36.5	85.1	14.9
11.1	6.7	91.8	8.2
8.6	1.9	93.7	6.3
- 8.6	6.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.90

Pb Regrind Discharge

+ 200 mesh	1.6	1.6	98.4
270	4.3	5.9	94.1
29.9 μm	7.9	13.8	86.2
23.2	27.6	41.4	58.6
16.2	36.0	77.4	22.6
11.1	9.0	86.4	13.6
8.6	3.2	89.6	10.4
- 8.6	10.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.89

Test No. PP44 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 30.6 μ m	2.0	2.0	98.0
23.7	4.4	6.4	93.6
16.5	19.2	25.6	74.4
11.4	21.0	46.6	53.4
8.8	12.8	59.4	40.6
- 8.8	40.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.45

Pb 4th Cleaner Concentrate

+ 26.1 μ m	2.2	2.2	97.8
20.3	4.1	6.3	93.7
14.1	18.8	25.1	74.9
9.7	21.8	46.9	53.1
7.5	13.0	59.9	40.1
- 7.5	40.1	100.0	-
Total	100.0	-	-

Specific Gravity 5.75

Zn Regrind Cyclone Underflow

+ 200 mesh	4.1	4.1	95.9
270	6.4	10.5	89.5
33.1 μ m	4.4	14.9	85.1
25.6	29.4	44.3	55.7
17.9	38.8	83.1	16.9
12.3	8.4	91.5	8.5
9.5	2.1	93.6	6.4
- 9.5	6.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.18

Test No. PP44 - Continued

1.4.3. Screen Analyses

Zn Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	3.2	3.2	96.8
270	6.2	9.4	90.6
33.1 μ m	4.5	13.9	86.1
25.6	28.6	42.5	57.5
17.9	38.8	81.3	18.7
12.3	9.2	90.5	9.5
9.5	2.4	93.0	7.0
- 9.5	7.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.18

Zn Regrind Cyclone Overflow

+ 200 mesh	1.8	1.8	98.2
270	3.8	5.6	94.4
33.1 μ m	4.8	10.4	89.6
25.6	32.2	42.6	57.4
17.9	29.4	72.0	28.0
12.3	11.0	83.0	17.0
9.5	3.8	86.8	13.2
- 9.5	13.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.16

Test No. PP44 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.7 µm	1.2	1.2	98.8
25.4	3.3	4.5	95.5
17.7	20.8	25.3	74.7
12.2	20.8	46.1	53.9
9.4	10.8	56.9	43.1
- 9.4	43.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.08

Zn Combined Tailing

+ 100 mesh	1.1	1.1	98.9
150	2.3	3.4	96.6
200	6.6	10.0	90.0
35.9 µm	15.7	25.7	74.3
27.8	10.8	36.5	63.5
19.4	16.0	52.5	47.5
13.3	11.4	63.9	36.1
10.3	6.3	70.3	29.7
- 10.3	29.7	100.0	-
Total	100.0	-	-

Specific Gravity 3.64

Test No. PP44 - Continued

2. Flotation

2.1. Purpose: The final test of three continuous tests.

2.2. Method: No circuit changes were made. The circuit was sampled every 30 minutes from 1:00 P.M. to 4:00 P.M.

2.2.1. Flotation Equipment

As for test PP26.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP26.

2.4. Results: The lead and zinc metallurgical results were poor. The lead cleaner concentrate assayed 54.1 % Pb at 77.1 % Pb recovery. The zinc cleaner concentrate assayed 52.4 % zinc at 64.1 % zinc recovery. High circulation load in the zinc regrinding circuit produced a coarse cyclone overflow product. This resulted in a high zinc loss in the zinc scavenger tailing.

Test No. PP44 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	5.20	Ball Mill Feed
NaCN	0.23	Ball Mill Feed
ZnSO ₄	1.10	Ball Mill Feed
Z-11	0.10	Ball Mill Feed
R-242	0.03	Pb Rougher Conditioner
MIBC	0.100	Pb Rougher Feed Pump
MIBC	0.069	Pb Rougher 3rd Cell
Z-11	0.04	Pb Scavenger Feed
MIBC	0.003	Pb Scavenger Feed
Na ₂ CO ₃	0.50	Pb Regrind Mill
ZnSO ₄	0.50	Pb Regrind Mill
NaCN	0.33	Pb Regrind Mill
R-242	0.01	Pb Cyclone Feed Pump
MIBC	0.001	Pb 1st Cleaner Feed
NaCN	0.09	Pb 2nd Cleaner Feed
MIBC	0.003	Pb 2nd Cleaner Feed
NaCN	0.08	Pb 3rd Cleaner Feed
CuSO ₄	2.05	Zn Rougher Cond. No. 2
Ca(OH) ₂	2.44	Zn Rougher Cond. No. 1
Z-200	0.096	Zn Rougher Feed Pump
DF-250	0.073	Zn Rougher Feed Pump
Z-11	0.20	Zn Rougher Feed Pump
DF-250	0.062	Zn Rougher Feed
Z-11	0.04	Zn Scavenger Feed
DF-250	0.030	Zn Scavenger Feed
Z-200	0.048	Zn Scavenger Feed
CuSO ₄	0.30	Zn Regrind Mill
Z-200	0.037	Zn Regrind Mill
Ca(OH) ₂	1.28	Zn Regrind Mill
Z-11	0.03	Zn 1st Cleaner Feed
Z-11	0.05	Zn 1st Cleaner Scavenger
Z-200	0.024	Zn 1st Cleaner Scavenger
Ca(OH) ₂	0.27	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.20	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.23	Zn 4th Cleaner Feed

Test No. PP44 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	9.0
Pb Rougher Feed	9.0
Pb Scavenger Tailing	8.8
Pb Regrinding Mill Discharge	9.8
Pb 1st Cleaner Feed	9.4
Pb 2nd Cleaner Feed	9.4
Pb 3rd Cleaner Feed	9.3
Pb 4th Cleaner Feed	9.2
Zn Rougher Feed	9.9
Zn Scavenger Tailing	9.4
Zn 1st Cl. Scav. Feed	10.9
Zn 1st Cleaner Feed	11.1
Zn 2nd Cleaner Feed	11.1
Zn 3rd Cleaner Feed	11.3
Zn 4th Cleaner Feed	11.5

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1852
Pb Rougher Feed	1217
Pb Scavenger Tailing	1160
Pb 1st Cleaner Feed	1163
Pb Rougher Concentrate	1330
Zn Rougher Feed	1173
Zn Cyclone Feed	1400
Zn 1st Cleaner Feed	1308
Zn Rougher Concentrate	1430
Zn Combined Tailing	1078

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	20
Pb Regrinding Mill Discharge	22.5
Zn Rougher Feed	22
Zn Regrinding Mill Discharge	23.5

Test No. PP44 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.80	9.95
Pb Rougher Feed	5.66	11.8
Pb Rougher Concentrate	21.9	16.5
Pb Rougher Tailing	2.27	10.5
Pb Scavenger Concentrate	5.81	15.2
Pb Scavenger Tailing	1.49	9.58
Pb 1st Cleaner Concentrate	25.8	19.6
Pb 1st Cleaner Tailing	5.81	17.6
Pb Regrind Cyclone Overflow	17.7	19.3
Pb Regrind Cyclone Underflow	18.1	12.4
Pb Cleaner Concentrate	54.1	13.2
Zn Rougher Feed	1.35	7.02
Zn Rougher Concentrate	1.70	20.1
Zn Rougher Tailing	1.24	2.47
Zn Scavenger Concentrate	1.18	3.17
Zn Scavenger Tailing	1.32	1.83
Zn 1st Cleaner Tailing	2.14	16.1
Zn 1st Cleaner Concentrate	2.46	37.6
Zn Regrinding Cyclone Overflow	2.31	31.5
Zn Regrinding Cyclone Underflow	2.23	32.4
Zn Combined Tailing	1.30	2.99
Zn 1st Cleaner Scavenger Concentrate	2.42	23.9
Zn 1st Cleaner Scavenger Tailing	1.57	6.14
Zn Cleaner Concentrate	2.64	52.1

Test No. PP44 - Continue

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	17.98	21.9	16.5	67.9	25.6
Pb Rougher Tailing	82.02	2.27	10.5	32.1	74.4
Cyclone Overflow (meas)	100.00	5.80	9.95	100.0	100.0
(Calc.)	-	5.80	11.58	-	-
Pb Scavenger Concentrate	14.81	5.81	15.2	14.8	19.4
Pb Scavenger Tailing	67.21	1.49	9.58	17.3	55.6
Pb Rougher Tail. (meas)	82.02	2.27	10.5	32.1	82.0
(Calc.)	-	2.27	10.6	32.1	75.0
Pb 1st Cleaner Conc.	14.47	25.8	19.6	64.4	24.5
Pb 1st Cleaner Tail.	3.51	5.81	17.6	3.5	5.3
Pb Rougher Conc. (meas)	17.98	21.9	16.5	67.9	29.8
(Calc.)	-	21.9	19.2	67.9	29.8
Zn Rougher Concentrate	27.11	1.70	20.1	7.9	47.1
Zn Rougher Tailing	40.10	1.24	2.47	8.6	8.6
Pb Scavenger Tail. (meas)	67.21	1.49	9.58	17.3	64.7
(Calc.)	-	1.43	9.58	16.5	55.7
Zn Scavenger Concentrate	32.10	1.18	3.17	6.5	8.8
Zn Scavenger Tailing	35.11	1.32	1.83	8.0	5.5
Zn Rougher Tail. (meas)	67.21	1.24	2.47	14.4	16.7
(Calc.)	-	1.25	2.47	14.5	14.3
Zn 1st Cleaner Conc.	5.04	2.46	37.6	2.1	16.4
Zn 1st Cleaner Tail.	22.07	2.14	16.1	8.1	30.7
Zn Rougher Conc. (meas)	27.11	1.70	20.1	7.9	54.8
(Calc.)	-	2.20	20.1	10.2	47.1
Zn 1st Cl. Scav. Conc.	12.38	2.42	23.9	5.2	25.6
Zn 1st Cl. Scav. Tail.	9.69	1.57	6.14	2.6	5.1
Zn 1st Cl. Tail. (meas)	22.07	2.14	16.1	8.1	35.7
(Calc.)	-	2.05	16.1	7.8	30.7

Three-Product Formula

Pb Cleaner Concentrate	8.30	54.1	13.2	77.4	11.0
Zn Cleaner Concentrate	12.37	2.26	52.4	4.8	65.1
Zn Combined Tailing	79.33	1.30	2.99	17.8	23.9
Cyclone Overflow	100.00	5.80	9.95	100.0	100.0

Test No. PP45

1. Grinding

1.1. Purpose: To repeat conditions of test PP41.

1.2. Method: As for test PP41. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 701 pounds per hour. Samples were taken every 20 minutes during the last two hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Sala Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PP1.

1.4. Results: The grinding circuit was stable during the test run. Net power consumption in the Hendy mill was 17.91 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 91.1 % minus 200 mesh.

Test No. PP45 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus $\frac{1}{2}$ inch ore at 0.4 percent moisture content		
Feed Rate:	701 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	$1\frac{1}{2}$ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
	Total	2361 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Mill Feed:	Total 5433 pounds, test period 1402 pounds		
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>	
	Mill Discharge	2130	71
	Cyclone Overflow	1316	32
	Cyclone Underflow	2294	75
Average Power:	Gross	8.19 kilowatts	
	No Load	1.92 kilowatts	
	Net	6.27 kilowatts	
Net Power Consumption:	17.91 kilowatt-hours per ton of $\frac{1}{2}$ inch feed.		
Work Index:	13.26		

Test No. PP45 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc., Zn 2nd Cl. Tail. and Zinc 1st Cl. Scav. Conc.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	
Mill Load:	1 inch balls	660 pounds
	½ inch balls	220 pounds
	<hr/>	
	Total	880 pounds
Operating Time:	Total 7.75 hours, test period 2.0 hours	
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	1432 46
	Cyclone Overflow	1178 20
	Cyclone Underflow	1432 40
Average Power:	Gross	2.26 kilowatts
	No Load	0.92 kilowatts
	Net	1.34 kilowatts
Net Power Consumption:	3.83 kilowatt-hours per ton of feed.	

Test No. PP45 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	6.3	6.3	93.7
3	19.2	25.5	74.5
4	16.5	42.0	58.0
6	9.7	51.7	48.3
8	8.6	60.3	39.7
10	6.6	66.9	33.1
14	5.3	72.2	27.8
20	3.7	75.9	24.1
28	3.0	78.9	21.1
35	2.2	81.1	18.9
48	2.6	83.7	16.3
65	2.4	86.1	13.9
100	1.9	88.0	12.0
150	1.9	89.9	10.1
200	2.1	92.0	8.0
- 200	8.0	100.0	-
Total	100.0	-	-

Mill Discharge

+ 14	0.2	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.5	1.2	98.8
48	1.4	2.6	97.4
65	2.4	5.0	95.0
100	4.4	9.4	90.6
150	8.3	17.8	82.2
200	16.5	34.3	65.7
270	14.0	48.3	51.7
400	19.0	67.3	32.7
- 400	32.7	100.0	-
Total	100.0	-	-

Test No. PP45 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 14	0.2	0.2	99.8
20	0.2	0.4	99.6
28	0.4	0.8	99.2
35	0.6	1.4	98.6
48	1.8	3.2	96.8
65	3.1	6.3	93.7
100	5.2	11.5	88.5
150	9.8	21.3	78.7
200	18.6	39.9	60.1
270	15.2	55.1	44.9
400	20.4	75.5	24.5
- 400	24.5	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.3	0.3	99.7
100	0.7	1.0	99.0
150	2.0	3.0	97.0
200	5.9	8.9	91.1
270	6.8	15.7	84.3
400	14.8	30.5	69.5
- 400	69.5	100.0	-
Total	100.0	-	-

Test No. PP45 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	4.6	4.6	95.4
270	5.8	10.4	89.6
30.6 μ m	13.0	23.4	76.6
23.7	8.4	31.8	68.2
16.5	15.9	47.7	52.3
11.4	14.0	61.7	38.3
8.8	8.7	70.4	29.6
- 8.8	29.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.67

Pb Regrind Cyclone Underflow

+ 200 mesh	3.4	3.4	96.6
270	6.4	9.8	90.2
29.9 μ m	8.4	18.2	81.8
23.2	29.4	47.6	52.4
16.2	40.4	88.0	12.0
11.1	6.4	94.4	5.6
8.6	1.4	95.8	4.2
- 8.6	4.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.95

Pb Regrind Discharge

+ 200 mesh	2.4	2.4	97.6
270	4.8	7.2	92.8
29.8	7.0	14.2	85.8
23.1	27.5	41.7	58.3
16.1	39.8	81.5	18.5
11.1	7.6	89.1	10.9
8.6	2.2	91.3	8.7
- 8.6	8.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.92

Test No. PP45 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 29.6 μm	1.3	1.3	98.7
23.0	2.4	3.7	96.3
16.0	16.3	20.0	80.0
11.0	21.4	41.4	58.6
8.5	13.2	54.6	45.4
- 8.5	45.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.63

Pb 4th Cleaner Concentrate

+ 27.4 μm	1.6	1.6	98.4
21.2	3.2	4.8	95.2
14.8	19.8	24.6	75.4
10.2	24.2	48.8	51.2
7.9	13.5	62.3	37.7
- 7.9	37.7	100.0	-
Total	100.0	-	-

Specific Gravity 5.46

Zn Regrind Discharge

+ 200 mesh	1.7	1.7	98.3
270	6.2	7.9	92.1
33.1 μm	5.3	13.2	86.8
25.6	32.4	45.6	54.4
17.9	33.0	78.6	21.4
12.3	8.0	86.6	13.4
9.5	3.1	89.7	10.3
- 9.5	10.3	100.0	-
Total	100.0	-	-

Specific Gravity 5.50

Test No. PP45 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	3.6	3.6	96.4
270	7.6	11.2	88.8
32.2 μ m	4.8	16.0	84.0
24.9	33.7	49.7	50.3
17.4	32.0	81.7	18.3
12.0	7.2	88.9	11.1
9.2	2.6	91.5	8.5
- 9.2	8.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.40

Zn Regrind Cyclone Overflow

+ 200 mesh	1.2	1.2	98.8
270	3.9	5.1	94.9
32.5 μ m	5.0	10.1	89.9
25.2	34.6	44.7	55.3
17.6	24.6	69.3	30.7
12.1	10.2	79.5	20.5
9.3	4.2	83.7	16.3
- 9.3	16.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.24

Test No. PP45 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.7 μm	5.8	5.8	94.2
25.4	10.6	16.4	83.6
17.7	23.3	39.7	60.3
12.2	15.1	54.8	45.2
9.4	8.6	63.4	36.6
- 9.4	36.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.13

Zn Combined Tailing

+ 100 mesh	1.2	1.2	98.8
150	2.1	3.3	96.7
200	6.0	9.3	90.7
36.8 μm	13.3	22.6	77.4
28.5	9.5	32.1	67.9
19.9	15.6	47.7	52.3
13.7	12.0	59.7	40.3
10.6	17.0	66.7	33.3
- 10.6	33.3	100.0	-
Total	100.0	-	-

Specific Gravity 3.57

Test No. PP45 - Continued

2. Flotation

2.1. Purpose: To investigate the effect of using recycle water.

2.2. Method: The effluent from the tailing pond was pumped to a Sala thickener. The recycle water from the sala thickener was pumped to the grinding and flotation head tanks. Water from the head tanks was used in the primary grinding circuit, Pb and Zn regrinding and cleaning.

The following changes were made to reagent additions:

- 1) Omitted MIBC from the Pb rougher and cleaning circuit.
- 2) Decreased collector Z-11 to the primary grinding feed.
- 3) Collector R-242 addition to the Pb 1st cleaner was replaced with collector Z-11.
- 4) The DF-250 to the Zn rougher was reduced from 0.183 to 0.03 lb/ton.
- 5) The collector Z-11 additions to the Zn 1st cleaner and Zn 1st cleaner scavenger were reduced.

2.2.1. Flotation Equipment

As for test PP36.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP26.

2.4. Results: The lead and zinc metallurgical results were poor. The use of recycle water in the lead cleaning produced a voluminous unselective froth. This resulted in a poor lead concentrate grade and high losses of zinc in the lead concentrate. It appears that the use of recycle water in the zinc circuit was not detrimental.

Test No. PP45 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	4.64	Ball Mill Feed
NaCN	0.20	Ball Mill Feed
ZnSO ₄	0.95	Ball Mill Feed
Z-11	0.07	Ball Mill Feed
R-242	0.03	Pb Rougher Conditioner
Z-11	0.04	Pb Scavenger Feed
MIBC	0.003	Pb Scavenger Feed
Na ₂ CO ₃	0.50	Pb Regrind Mill
ZnSO ₄	0.50	Pb Regrind Mill
NaCN	0.30	Pb Regrind Mill
R-242	0.01	Pb Cyclone Feed Pump
NaCN	0.10	Pb 2nd Cleaner Feed
NaCN	0.08	Pb 3rd Cleaner Feed
Ca(OH) ₂	2.44	Zn Rougher Cond. No. 1
CuSO ₄	2.04	Zn Rougher Cond. No. 2
Z-11	0.20	Zn Rougher Feed Pump
Z-200	0.093	Zn Rougher Feed Pump
DF-250	0.004	Zn Rougher Feed
Z-11	0.04	Zn Scavenger Feed
DF-250	0.029	Zn Scavenger Feed
Z-200	0.053	Zn Scavenger Feed
CuSO ₄	0.30	Zn Regrind Mill
Ca(OH) ₂	0.82	Zn Regrind Mill
Z-200	0.038	Zn Regrind Mill
Z-11	0.01	Zn 1st Cleaner Feed
Z-200	0.041	Zn 1st Cleaner Scav. Feed
Z-11	0.02	Zn 1st Cleaner Scav. Feed
Ca(OH) ₂	0.22	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.20	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.20	Zn 4th Cleaner Feed

Test No. PP45 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	9.2
Pb Rougher Feed	9.3
Pb Scavenger Tailing	9.1
Pb Regrinding Mill Discharge	9.8
Pb 1st Cleaner Feed	9.5
Pb 2nd Cleaner Feed	9.6
Pb 3rd Cleaner Feed	9.6
Pb 4th Cleaner Feed	9.3
Zn Rougher Feed	10.0
Zn Scavenger Tailing	9.5
Zn 1st Cl. Scav. Feed	10.9
Zn 1st Cleaner Feed	11.2
Zn 2nd Cleaner Feed	11.2
Zn 3rd Cleaner Feed	11.4
Zn 4th Cleaner Feed	11.5

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1798
Pb Rougher Feed	1163
Pb Scavenger Tailing	1132
Pb 1st Cleaner Feed	1065
Pb Rougher Concentrate	1278
Zn Rougher Feed	1178
Zn Cyclone Feed	1237
Zn 1st Cleaner Feed	1178
Zn Rougher Concentrate	1298
Zn Combined Tailing	1053
Pb Regrind Mill Discharge	2366

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	18
Pb Regrinding Mill Discharge	20
Zn Rougher Feed	20
Zn Regrinding Mill Discharge	20

Test No. PP45 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.74	9.85
Pb Rougher Feed	5.63	10.6
Pb Rougher Concentrate	23.8	15.1
Pb Rougher Tailing	1.88	9.95
Pb Scavenger Concentrate	6.51	15.6
Pb Scavenger Tailing	1.36	9.21
Pb 1st Cleaner Concentrate	33.1	16.8
Pb 1st Cleaner Tailing	5.45	15.5
Pb Re grind Cyclone Overflow	21.1	16.5
Pb Re grind Cyclone Underflow	18.1	11.7
Pb Cleaner Concentrate	46.8	15.4
Zn Rougher Feed	1.29	6.68
Zn Rougher Concentrate	1.88	28.2
Zn Rougher Tailing	1.19	2.90
Zn Scavenger Concentrate	1.27	4.30
Zn Scavenger Tailing	1.21	1.75
Zn 1st Cleaner Tailing	2.66	10.8
Zn 1st Cleaner Concentrate	3.13	38.9
Zn Re grinding Cyclone Overflow	3.01	29.2
Zn Re grinding Cyclone Underflow	2.80	27.6
Zn 1st Cleaner Scavenger Concentrate	3.10	15.5
Zn 1st Cleaner Scavenger Tailing	1.81	1.66
Zn Combined Tailing	1.30	1.73
Zn Cleaner Concentrate	2.61	53.8

Test No. PP45 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

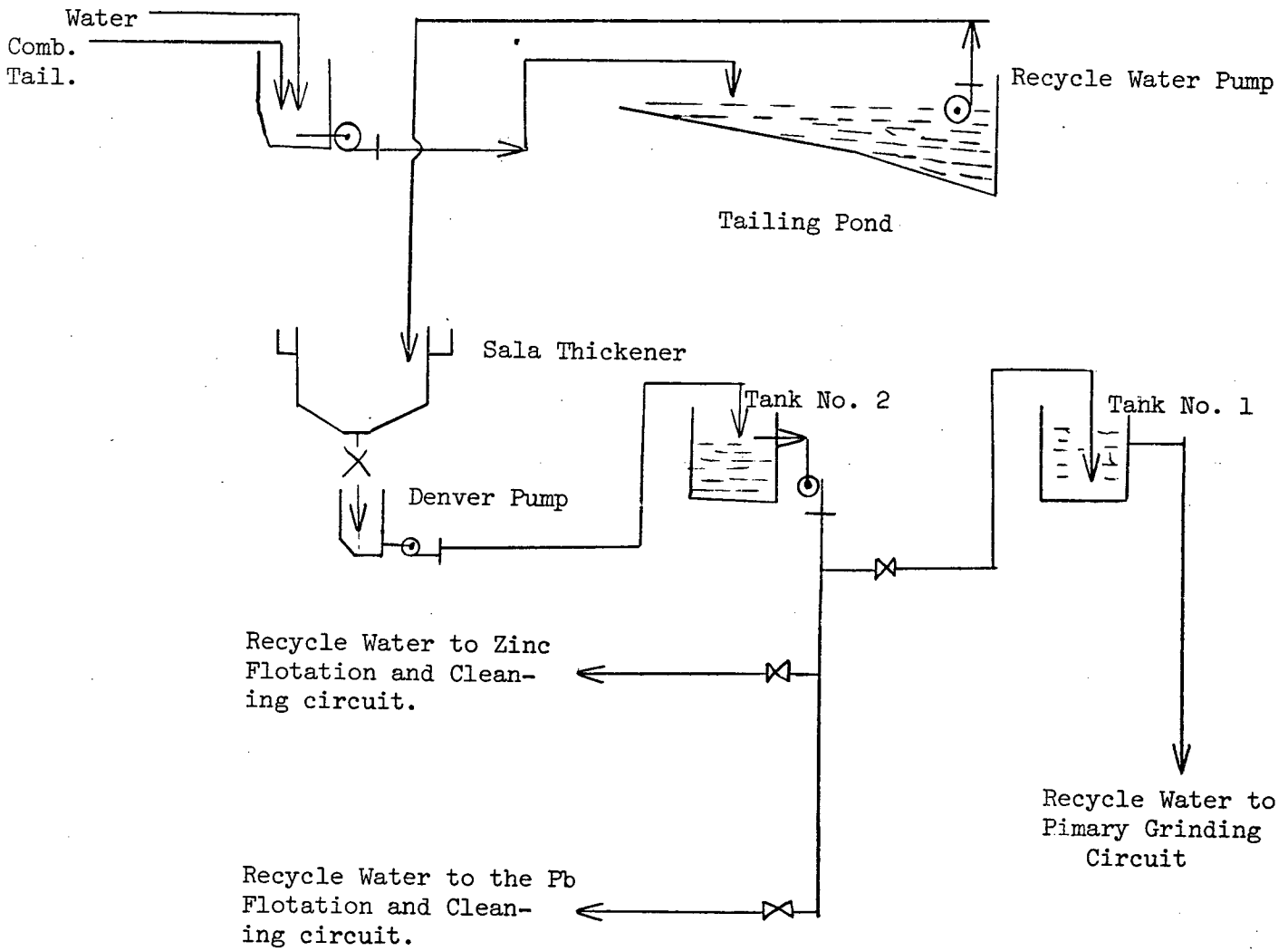
Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	17.61	23.8	15.1	73.0	24.5
Pb Rougher Tailing	82.39	1.88	9.95	27.0	75.5
Cyclone Overflow (meas)	100.00	5.74	9.85	100.0	100.0
(Calc.)	-	5.74	10.9	-	-
Pb Scavenger Concentrate	8.32	6.51	15.6	9.4	12.0
Pb Scavenger Tailing	74.07	1.36	9.21	17.6	62.8
Pb Rougher Tail. (meas)	82.39	1.88	9.95	27.0	83.2
(Calc.)	-	1.88	9.86	27.0	74.8
Pb 1st Cleaner Conc.	11.69	33.1	16.8	67.4	18.1
Pb 1st Cleaner Tail.	5.92	5.45	15.5	5.6	8.4
Pb Rougher Conc. (meas)	17.61	23.8	15.1	73.0	27.0
(Calc.)	-	23.8	16.4	73.0	26.5
Zn Rougher Concentrate	18.47	1.88	28.2	6.0	48.0
Zn Rougher Tailing	55.60	1.19	2.90	11.5	14.8
Pb Scavenger Tail. (meas)	74.07	1.36	9.21	17.5	69.3
(Calc.)	-	1.36	9.21	17.5	62.8
Zn Scavenger Concentrate	25.07	1.27	4.30	5.5	9.9
Zn Scavenger Tailing	30.53	1.21	1.75	6.4	4.9
Zn Rougher Tail. (meas)	55.60	1.19	2.90	11.5	16.4
(Calc.)	-	1.24	2.90	11.9	14.8
Zn 1st Cleaner Conc.	11.44	3.13	38.9	6.2	41.0
Zn 1st Cleaner Tail.	7.03	2.66	10.8	3.3	7.0
Zn Rougher Conc. (meas)	18.47	1.88	28.2	6.0	53.0
(Calc.)	-	2.95	28.2	9.5	48.0
Zn 1st Cl. Scav. Conc.	4.64	3.10	15.5	2.5	6.6
Zn 1st Cl. Scav. Tail.	2.39	1.81	1.66	0.8	0.4
Zn 1st Cl. Tail. (meas)	7.03	2.66	10.8	3.3	7.7
(Calc.)	-	-	10.8	3.3	7.0

Three-Product Formula

Pb 4th Cleaner Conc.	9.38	46.8	15.4	76.5	14.7
Zn 4th Cleaner Conc.	13.13	2.61	53.8	6.0	71.7
Zn Combined Tailing	77.49	1.30	1.73	17.5	13.6
Cyclone Overflow	100.00	5.74	9.85	100.0	100.0

Test No. PP45 - Continued

2.5. Recycle Water Flowsheet



Test No. PP46

1.1. Purpose: To repeat conditions of test PP45.

1.2. Method: As for test PP31 to 45. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 699 pounds per hour. Samples were taken every 20 minutes during the last two hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill (1' x 2') Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PP1.

1.4. Results: The grinding circuit was stable during the test run. Net power consumption in the Hendy mill was 16.91 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 90.3 % minus 200 mesh. Power in the Denver Mill was not calculated.

Test No. PP46 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 0.5 percent moisture content	
Feed Rate:	699 dry pounds per hour	
Mill Speed:	32 r.p.m., 80.5 percent of critical speed	
Mill Load:	3 inch balls	1000 pounds
	1½ inch balls	961 pounds
	1 inch balls	400 pounds
	<hr/>	
	Total	2361 pounds
Operating Time:	Total 7.75 hours, test period 2.0 hours	
Mill Feed:	Total 5417 pounds, test period 1398 pounds	
Circulating Load:	Cyclone underflow 530 percent	
Pulp Densities:		<u>gpl</u> <u>% Solids</u>
	Mill Discharge	2142 71
	Cyclone Overflow	1322 32
	Cyclone Underflow	2274 75
Average Power:	Gross	7.84 kilowatts
	No Load	1.92 kilowatts
	Net	5.92 kilowatts
Net Power Consumption:	16.91 kilowatt-hours per ton of ½ inch feed.	
Work Index:	12.80	

Test No. PP46 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc., Zinc 2nd Cl. Tail. and Zinc 1st Cl. Scav.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	Conc.
Mill Load:	1 inch balls	660 pounds
	$\frac{1}{2}$ inch balls	220 pounds
	<hr/>	
	Total	880 pounds
Operating Time:	Total 7.75 hours, test period 2.0 hours	
Pulp Densities:		<u>gpl</u> <u>% Solids</u>
	Mill Discharge	1182 20
	Cyclone Overflow	1113 13
	Cyclone Underflow	1182 20
Average Power:	Gross	2.49 kilowatts
	No Load	0.92 kilowatts
	Net	1.57 kilowatts
Net Power Consumption:	4.49 kilowatt-hours per ton of feed.	

Test No. PP46 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	4.3	4.3	95.7
3	15.8	20.1	79.9
4	12.6	32.7	67.3
6	11.2	43.9	56.1
8	8.7	52.6	47.4
10	7.2	59.8	40.2
14	5.9	65.7	34.3
20	4.3	70.0	30.0
28	3.6	73.6	26.4
35	2.8	76.4	23.6
48	3.4	79.8	20.2
65	3.0	82.8	17.2
100	2.5	85.3	14.7
150	2.5	87.6	12.2
200	2.6	90.4	9.6
- 200	9.6	100.0	-
Total	100.0	-	-

Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.2	0.5	99.5
28	0.3	0.8	99.2
35	0.5	1.3	98.7
48	1.5	2.8	97.2
65	2.7	5.5	94.5
100	4.6	10.1	89.9
150	8.6	18.7	81.3
200	16.6	35.3	64.7
270	13.8	49.1	50.9
400	18.7	67.8	32.2
- 400	32.2	100.0	-
Total	100.0	-	-

Test No. PP46 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	4.0	4.0	96.0
270	5.1	9.1	90.9
30.9 μ m	10.6	19.7	80.3
23.9	8.3	28.0	72.0
16.7	17.9	45.9	54.1
11.5	15.8	61.7	38.3
8.9	9.0	70.7	29.3
- 8.9	29.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.57

Pb Regrind Cyclone Underflow

+ 200 mesh	3.6	3.6	96.4
270	7.1	10.7	89.3
29.5 μ m	8.2	18.9	81.1
22.9	37.6	56.5	43.5
16.0	24.6	81.1	18.9
11.6	10.2	91.3	8.7
8.5	2.7	94.0	6.0
- 8.5	6.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.84

Pb Regrind Discharge

+ 200 mesh	2.5	2.5	97.5
270	6.7	9.2	90.8
29.6 μ m	9.0	18.2	81.8
23.0	31.3	49.5	50.5
16.0	31.4	80.9	19.1
11.0	7.3	88.2	11.8
8.5	2.6	90.8	9.2
- 8.5	9.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.92

Test No. PP46 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 14	0.2	0.2	99.8
20	0.2	0.4	99.6
28	0.5	0.9	99.1
35	0.7	1.6	98.4
48	1.8	3.4	96.6
65	3.3	6.7	93.3
100	5.5	12.2	87.8
150	9.9	22.1	77.9
200	18.5	40.6	59.4
270	14.8	55.4	44.6
400	19.8	75.2	24.8
- 400	24.8	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.4	0.4	99.6
100	0.8	1.2	98.8
150	2.2	3.4	96.6
200	6.3	9.7	90.3
270	7.2	16.9	83.1
400	14.8	31.7	68.3
- 400	68.3	100.0	-
Total	100.0	-	-

Test No. PP46 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 30.5 μ m	4.3	4.3	95.7
23.6	6.6	10.9	89.1
16.5	20.6	31.5	68.5
11.3	19.6	51.1	48.9
8.8	11.5	62.6	37.4
- 8.8	37.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.61

Pb 4th Cleaner Concentrate

+ 26.1 μ m	3.0	3.0	97.0
20.3	5.0	8.0	92.0
14.1	19.0	27.0	73.0
9.7	20.8	47.8	52.2
7.5	12.5	60.3	39.7
- 7.5	39.7	100.0	-
Total	100.0	-	-

Specific Gravity 5.88

Zn Regrind Discharge

+ 200 mesh	1.6	1.6	98.4
270	4.7	6.3	93.7
31.6 μ m	5.8	12.1	87.9
29.5	25.3	37.4	62.6
17.1	20.1	57.5	42.5
11.7	12.8	70.3	29.7
9.1	6.3	76.6	23.4
- 9.1	23.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.44

Test No. PP46 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	1.6	1.6	98.4
270	4.6	6.2	93.8
32.0 μm	11.5	17.7	82.3
24.9	10.9	28.6	71.4
17.3	19.5	48.1	51.9
11.9	14.5	62.6	37.4
9.2	7.7	70.3	29.7
- 9.2	29.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.42

Zn Regrind Cyclone Underflow

+ 200 mesh	4.4	4.4	95.6
270	6.9	11.3	88.7
31.5 μm	5.6	16.9	83.1
24.4	28.8	45.7	54.3
17.0	18.3	64.0	36.0
11.7	11.2	75.2	24.8
9.0	5.2	80.4	19.6
- 9.0	19.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.43

Test No. PP46 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.4 µm	12.0	12.0	88.0
25.1	8.4	20.4	79.6
17.5	17.2	37.6	62.4
12.1	15.0	52.6	47.4
9.3	9.2	61.8	38.2
- 9.3	38.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.15

Zn Combined Tailing

+ 100 mesh	1.4	1.4	98.6
150	2.3	3.7	96.3
200	6.4	10.1	89.9
36.5 µm	13.8	23.9	76.1
28.3	9.2	33.1	66.9
19.7	15.2	48.3	51.7
13.6	11.6	59.9	40.1
10.5	6.8	66.7	33.3
- 10.5	33.3	100.0	-
Total	100.0	-	-

Specific Gravity 3.57

Test No. PP46 - Continued

2. Flotation

- 2.1. Purpose:
- 1) To study the effect of omitting the recycle water from the lead cleaning.
 - 2) To repeat the conditions of test 39 for zinc circuit.

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

A) Pb Circuit

- 1) Fresh water was added to the lead rougher concentrate launder and lead cleaners.
- 2) MIBC was added to the Pb rougher cell No. 3 feed.

B) Zinc Circuit

- 1) Decreased pH in the Zn cleaners
- 2) Omitted Z-11 to the Zn 1st cleaner feed
- 3) Decreased Z-11 to the Zn 1st cleaner scavenger feed.

2.2.1. Flotation Equipment

As for test PP36

2.3. Flowsheet: As for test PP36.

2.4. Results: The omission of recycle water in the Pb cleaning improved lead concentrate grade with no losses in recovery. The zinc flotation results were very similar to that obtained in test PP39.

Test No. PP46 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	4.90	Ball Mill Feed
NaCN	0.20	Ball Mill Feed
ZnSO ₄	1.00	Ball Mill Feed
Z-11	0.10	Ball Mill Feed
Z-11	0.03	Pb Rougher Conditioner
Z-11	0.04	Pb Scavenger Feed
Na ₂ CO ₃	0.50	Pb Regrind Mill
ZnSO ₄	0.51	Pb Regrind Mill
NaCN	0.32	Pb Regrind Mill
Z-11	0.01	Pb Cyclone Feed Pump
NaCN	0.10	Pb 2nd Cleaner Feed
NaCN	0.07	Pb 3rd Cleaner Feed
Ca(OH) ₂	2.74	Zn Rougher Cond. No. 1
CuSO ₄	2.05	Zn Rougher Cond. No. 2
Z-11	0.20	Zn Rougher Feed Pump
Z-200	0.095	Zn Rougher Feed Pump
DF-250	0.023	Zn Rougher Feed
Z-11	0.04	Zn Scavenger Feed
Z-200	0.053	Zn Scavenger Feed
Ca(OH) ₂	0.95	Zn Regrind Mill
CuSO ₄	0.30	Zn Regrind Mill
Z-200	0.039	Zn Regrind Mill
Z-11	0.03	Zn 1st Cleaner Scavenger Feed
Ca(OH) ₂	0.25	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.15	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.10	Zn 4th Cleaner Feed

Test No. PP46 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	9.0
Pb Rougher Feed	9.0
Pb Scavenger Tailing	8.8
Pb Regrinding Mill Discharge	9.7
Pb 1st Cleaner Feed	9.2
Pb 2nd Cleaner Feed	9.3
Pb 3rd Cleaner Feed	9.2
Pb 4th Cleaner Feed	9.0
Zn Rougher Feed	10.0
Zn Scavenger Tailing	9.4
Zn Regrinding Mill Feed	10.6
Zn 1st Cleaner Feed	11.0
Zn 2nd Cleaner Feed	11.0
Zn 3rd Cleaner Feed	11.2
Zn 4th Cleaner Feed	11.2

2.4.2. Pulp Densities

	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1834
Pb Rougher Feed	1210
Pb Scavenger Tailing	1158
Pb 1st Cleaner Feed	1107
Pb Rougher Concentrate	1348
Zn Rougher Feed	1177
Zn Cyclone Feed	1142
Zn 1st Cleaner Feed	1113
Zn Rougher Concentrate	1202
Zn Combined Tailing	1065
Pb Regrind Mill Discharge	2500

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	19
Pb Regrinding Mill Discharge	22
Zn Rougher Feed	20
Zn Regrinding Mill Discharge	21

Test No. PP46 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.84	10.2
Pb Rougher Feed	5.87	11.7
Pb Rougher Concentrate	17.9	17.2
Pb Rougher Tailing	2.07	10.4
Pb Scavenger Concentrate	5.05	14.9
Pb Scavenger Tailing	1.35	9.60
Pb 1st Cleaner Concentrate	35.4	17.2
Pb 1st Cleaner Tailing	7.81	18.6
Pb Regrind Cyclone Overflow	17.5	17.8
Pb Regrind Cyclone Underflow	15.2	12.8
Pb Cleaner Concentrate	55.2	12.9
Zn Rougher Feed	1.36	8.26
Zn Rougher Concentrate	1.58	30.4
Zn Rougher Tailing	1.25	3.09
Zn Scavenger Concentrate	1.16	5.31
Zn Scavenger Tailing	1.31	2.13
Zn 1st Cleaner Tailing	1.57	2.50
Zn 1st Cleaner Concentrate	2.43	32.5
Zn Regrind Cyclone Overflow	2.13	20.9
Zn Regrind Cyclone Underflow	2.03	16.9
Zn 1st Cleaner Scavenger Concentrate	1.91	4.33
Zn 1st Cleaner Scavenger Tailing	1.38	1.40
Zn Combined Tailing	1.33	2.14
Zn Cleaner Concentrate	2.25	50.8

Test No. PP46 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	23.82	17.9	17.2	73.0	34.1
Pb Rougher Tailing	76.18	2.07	10.4	27.0	65.9
Cyclone Overflow (meas)	100.00	5.84	10.2	100.0	100.0
(Calc.)	-	5.84	12.0	-	-
Pb Scavenger Concentrate	14.82	5.05	14.9	12.8	18.4
Pb Scavenger Tailing	61.36	1.35	9.60	14.2	49.0
Pb Rougher Tail. (meas)	76.18	2.07	10.4	27.0	76.2
(Calc.)	-	2.07	10.6	27.0	67.4
Pb 1st Cleaner Conc.	8.71	35.4	17.2	52.8	12.5
Pb 1st Cleaner Tail.	15.11	7.81	18.6	20.2	23.4
Pb Rougher Conc. (meas)	23.82	17.9	17.2	73.0	40.2
(Calc.)	-	17.9	18.1	73.0	35.9
Zn Rougher Concentrate	14.63	1.58	30.4	4.0	37.0
Zn Rougher Tailing	46.73	1.25	3.09	10.0	12.0
Pb Scavenger Tail. (meas)	61.36	1.35	9.60	14.2	57.8
(Calc.)	-	1.33	9.60	14.0	49.0
Zn Scavenger Concentrate	14.11	1.16	5.31	2.8	6.2
Zn Scavenger Tailing	32.62	1.31	2.13	7.3	5.8
Zn Rougher Tail. (meas)	46.73	1.25	3.09	10.0	14.2
(Calc.)	-	1.26	3.09	10.1	12.0
Zn 1st Cleaner Conc.	13.61	2.43	32.5	5.7	36.8
Zn 1st Cleaner Tail.	1.02	1.57	2.50	0.3	0.2
Zn Rougher Conc. (meas)	14.63	1.58	30.4	4.0	43.6
(Calc.)	-	2.37	30.4	6.0	37.0
Zn 1st Cl. Scav. Conc.	0.38	1.91	4.33	0.1	0.1
Zn 1st Cl. Scav. Tail.	0.64	1.38	1.40	0.2	0.1
Zn 1st Cl. Tail. (meas)	1.02	1.57	2.50	0.3	0.4
(Calc.)	-	1.61	2.55	0.3	0.2

Three-Product Formula

Pb 4th Cleaner Conc.	8.12	55.2	12.9	76.8	10.3
Zn 4th Cleaner Conc.	14.77	2.25	50.8	5.7	73.6
Zn Combined Tailing	77.11	1.33	2.14	17.5	16.1
Cyclone Overflow	100.00	5.84	10.2	100.0	100.0

Test No. PP47

1. Grinding

1.1. Purpose: To repeat conditions of test PP46.

1.2. Method: As for test PP31 to 46. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 697 pounds per hour. Samples were taken every 20 minutes during the last two hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Re grind

Denver Mill (1' x 2') Krebs Cyclone:

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

Zn Re grind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PPl.

1.4. Results: The grinding circuit was very stable throughout the test run. Net power consumption in the Hendy mill was 17.91 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 89.6 % minus 200 mesh. Power in the Denver mill was not calculated.

Test No. PP47 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 0.4 percent moisture content		
Feed Rate:	697 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
	Total	2361 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Mill Feed:	Total 5402 pounds, test period 1394 pounds		
Circulating Load:	Cyclone underflow 530. percent		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2130	71
	Cyclone Overflow	1323	32
	Cyclone Underflow	2246	75
Average Power:	Gross	8.19 kilowatts	
	No Load	1.92 kilowatts	
	Net	6.27 kilowatts	
Net Power Consumption:	17.91 kilowatt-hours per ton of ½ inch feed.		
Work Index:	13.44		

Test No. PP47 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill		
Feed:	Zinc Ro. Conc., Zinc 2nd Cl. Tail. and Zinc 1st Cl. Scav. Conc.		
Mill speed:	32 r.p.m., 75 percent of critical speed		
Mill Load:	1 inch balls	860 pounds	
	½ inch balls	220 pounds	
	<hr/>		
	Total	1080 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2194	70
	Cyclone Overflow	1112	13
	Cyclone Underflow	2194	70
Average Power:	Gross	3.68 kilowatts	
	No Load	0.92 kilowatts	
	Net	2.76 kilowatts	
Net Power Consumption:	7.89 kilowatt-hours per ton of feed.		

Test No. PP47 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	6.1	6.1	93.9
3	18.3	24.4	75.6
4	13.3	37.7	62.3
6	10.2	47.9	52.1
8	8.7	56.6	43.4
10	6.9	63.5	36.5
14	5.4	68.9	31.1
20	3.8	72.7	27.3
28	3.2	75.9	24.1
35	2.5	78.4	21.6
48	3.0	81.4	18.6
65	2.7	84.1	15.9
100	2.2	86.3	13.7
150	2.2	88.5	11.5
200	2.4	90.9	9.1
- 200	9.1	100.0	-
Total	100.0	-	-

Cyclone Underflow

+ 10	0.2	0.2	99.8
14	0.2	0.4	99.6
20	0.3	0.7	99.3
28	0.5	1.2	98.8
35	0.6	1.8	98.2
48	1.8	3.6	96.4
65	3.2	6.8	93.2
100	5.4	12.2	87.8
150	9.9	22.1	77.9
200	18.3	40.4	59.6
270	14.4	54.8	45.2
400	19.1	73.9	26.1
- 400	26.1	100.0	-
Total	100.0	-	-

Test No. PP47 - Continued

1.4.3. Screen Analyses

Mill Discharge

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.2	0.5	99.5
28	0.4	0.9	99.1
35	0.5	1.4	98.6
48	1.5	2.9	97.1
65	2.6	5.5	94.5
100	4.6	10.1	89.9
150	8.6	18.7	81.3
200	16.2	34.9	65.1
270	13.3	48.2	51.8
400	18.2	66.4	33.6
- 400	33.6	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.4	0.4	99.6
100	0.9	1.3	98.7
150	2.5	3.8	96.2
200	6.6	10.4	89.6
270	7.3	17.7	82.3
400	14.4	32.1	67.9
- 400	67.9	100.0	-
Total	100.0	-	-

Test No. PP47 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	2.2	2.2	97.8
270	3.3	5.5	94.5
31.1 μ m	8.5	14.0	86.0
24.1	6.7	20.7	79.3
16.8	17.9	38.6	61.4
11.6	17.8	56.4	43.6
8.9	10.8	67.2	32.8
- 8.9	32.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.55

Pb Regrind Cyclone Underflow

+ 200 mesh	3.0	3.0	97.0
270	7.4	10.4	89.6
29.8 μ m	9.0	19.4	80.6
23.1	28.2	47.6	52.4
16.1	34.4	82.0	18.0
11.1	8.6	90.6	9.4
8.6	2.6	93.2	6.8
- 8.6	6.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.90

Pb Regrind Discharge

+ 200 mesh	1.9	1.9	98.1
270	5.2	7.1	92.9
29.8 μ m	8.4	15.5	84.5
23.1	28.8	44.3	55.7
16.1	32.3	76.6	23.4
11.1	9.6	86.2	13.8
8.6	3.4	89.6	10.4
- 8.6	10.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.95

Test No. PP47 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 30.7 μ m	3.2	3.2	96.8
23.8	4.2	7.4	92.6
16.6	17.6	25.0	75.0
11.4	20.8	45.8	54.2
8.8	13.0	58.8	41.2
- 8.8	41.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.64

Pb 4th Cleaner Concentrate

+ 26.2 μ m	2.7	2.7	97.3
20.3	3.4	6.1	93.9
14.2	16.5	22.6	77.4
9.7	21.7	44.3	55.7
7.5	13.9	58.2	41.8
- 7.5	41.8	100.0	-
Total	100.0	-	-

Specific Gravity 6.16

Zn Regrind Discharge

+ 200 mesh	1.8	1.8	98.2
270	3.2	5.0	95.0
31.1 μ m	5.3	10.3	89.7
24.1	30.6	40.9	59.1
16.8	36.9	77.8	22.2
11.6	11.0	88.8	11.2
8.9	2.7	91.5	8.5
- 8.9	8.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.54

Test No. PP47 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.4 µm	1.2	1.2	98.8
25.1	1.8	3.0	97.0
17.5	15.4	18.4	81.6
12.0	22.7	41.1	58.9
9.3	12.9	54.0	46.0
- 9.3	46.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.26

Zn Regrind Cyclone Overflow

+ 200 mesh	3.2	3.2	96.8
270	4.3	7.5	92.5
31.6 µm	5.2	12.7	87.3
24.5	24.8	37.5	62.5
17.1	47.8	85.3	14.7
11.8	8.8	94.1	5.9
9.1	1.5	95.6	4.4
- 9.1	4.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.50

Test No. PP47 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 34.0 µm	0.8	0.8	99.2
26.4	0.9	1.7	98.3
18.4	7.0	8.7	91.3
12.7	18.6	27.3	72.7
9.8	13.2	40.5	59.5
- 9.8	59.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.06

Zn Combined Tailing

+ 100 mesh	1.2	1.2	98.8
150	2.1	3.3	96.7
200	5.4	8.7	91.3
36.6 µm	10.5	19.2	80.8
28.4	7.2	26.4	73.6
19.8	15.3	41.7	58.3
13.6	14.9	56.6	43.4
10.5	8.4	65.0	35.0
- 10.5	35.0	100.0	-
Total	100.0	-	-

Specific Gravity 3.58

Test NO. PP47 - Continued

2. Flotation

2.1. Purpose: 1) To improve Pb concentrate grade.
 2) To repeat conditions of test PP41 for zinc circuit.

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

A) Pb Circuit

- 1) Increased water flow to the Pb 3rd cleaner concentrate launder from 2.3 l/min. to 3.3 l/min.
- 2) Decreased collector Z-11 to the Hendy mill feed from 0.09 lb/ton to 0.07 lb/ton.

B) Zinc Circuit

- 1) Increased pH in the Zn cleaning.
- 2) Added collector Z-11 to the Zn 1st cleaner at a rate of 0.02 lb/ton.
- 3) Increased collector Z-11 to the Zn 1st cleaner scavenger from 0.02 to 0.03 lb/ton.

2.2.1. Flotation Equipment

As for test PP36.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP36.

2.4. Results: A significant improvement in the Pb and zinc metallurgical results was achieved from the above changes. Lead cleaner concentrate assayed 64.6 % Pb at 77.9 % Pb recovery. The zinc cleaner concentrate assayed 55.5 % Zn at 81.5 % Zn recovery..

Test No. PP47 - Continued

2.2.2. Reagent Additions

Type	Pound of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	4.90	Ball Mill Feed
NaCN	0.20	Ball Mill Feed
ZnSO ₄	0.95	Ball Mill Feed
Z-11	0.07	Ball Mill Feed
Z-11	0.03	Pb Rougher Conditioner
Z-11	0.03	Pb Scavenger Feed
Na ₂ CO ₃	0.50	Pb Regrind Mill
ZnSO ₄	0.51	Pb Regrind Mill
NaCN	0.30	Pb Regrind Mill
Z-11	0.01	Pb Cyclone Feed Pump
NaCN	0.08	Pb 2nd Cleaner Feed
NaCN	0.07	Pb 3rd Cleaner Feed
Ca(OH) ₂	2.56	Zn Rougher Cond. No. 1
CuSO ₄	2.08	Zn Rougher Cond. No. 2
Z-11	0.20	Zn Rougher Feed Pump
Z-200	0.093	Zn Rougher Feed Pump
DF-250	0.048	Zn Rougher Feed
Z-11	0.04	Zn Scavenger Feed
Z-200	0.051	Zn Scavenger Feed
CuSO ₄	0.30	Zn Regrind Mill
Z-200	0.051	Zn Regrind Mill
Ca(OH) ₂	1.22	Zn Regrind Mill
Z-11	0.01	Zn 1st Cleaner Feed
Z-11	0.04	Zn 1st Cleaner Scav. Feed
Z-200	0.018	Zn 1st Cleaner Scav. Feed
Ca(OH) ₂	0.20	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.21	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.20	Zn 4th Cleaner Feed

Test No. PP47 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	9.2
Pb Rougher Feed	9.2
Pb Scavenger Tailing	9.0
Pb Regrinding Mill Discharge	9.8
Pb 1st Cleaner Feed	9.3
Pb 2nd Cleaner Feed	9.3
Pb 3rd Cleaner Feed	9.2
Pb 4th Cleaner Feed	9.0
Zn Rougher Feed	10.0
Zn Scavenger Tailing	9.6
Zn 1st Cl. Scav. Feed	10.3
Zn 1st Cleaner Feed	10.8
Zn 2nd Cleaner Feed	10.9
Zn 3rd Cleaner Feed	11.3
Zn 4th Cleaner Feed	11.5

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1818
Pb Rougher Feed	1218
Pb Scavenger Tailing	1150
Pb 1st Cleaner Feed	1180
Pb Rougher Concentrate	1383
Zn Rougher Feed	1155
Zn Cyclone Feed	1308
Zn 1st Cleaner Feed	1112
Zn Rougher Concentrate	1248
Zn Combined Tailing	1067
Pb Regrind Mill Discharge	2476

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	20
Pb Regrinding Mill Discharge	23
Zn Rougher Feed	21
Zn Regrinding Mill Discharge	28

Test No. PP47 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.72	10.0
Pb Rougher Feed	6.74	12.7
Pb Rougher Concentrate	19.0	19.4
Pb Rougher Tailing	2.20	10.8
Pb Scavenger Concentrate	5.78	15.6
Pb Scavenger Tailing	1.30	9.17
Pb 1st Cleaner Concentrate	32.1	20.1
Pb 1st Cleaner Tailing	1.80	4.73
Pb Re grind Cyclone Overflow	21.9	20.7
Pb Re grind Cyclone Underflow	18.3	14.2
Pb Cleaner Concentrate	32.1	20.1
Zn Rougher Feed	1.22	6.23
Zn Rougher Concentrate	1.50	18.4
Zn Rougher Tailing	1.11	2.24
Zn Scavenger Concentrate	1.12	2.94
Zn Scavenger Tailing	1.17	1.54
Zn 1st Cleaner Tailing	1.80	4.73
Zn 1st Cleaner Concentrate	3.12	41.4
Zn Re grind Cyclone Overflow	2.48	21.6
Zn Re grind Cyclone Underflow	1.25	14.0
Zn 1st Cleaner Scavenger Concentrate	2.90	11.3
Zn 1st Cleaner Scavenger Tailing	1.27	1.53
Zn Combined Tailing	1.19	1.54
Zn Cleaner Concentrate	2.23	55.5

Test No. PP47 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	20.95	19.0	19.4	69.6	32.3
PB Rougher Tailing	79.05	2.20	10.8	30.4	67.7
Cyclone Overflow (meas)	100.00	5.72	10.0	100.0	100.0
(Calc.)	-	5.72	12.6	-	-
Pb Scavenger Concentrate	15.88	5.78	15.6	16.1	19.7
Pb Scavenger Tailing	63.17	1.30	9.17	14.4	46.0
Pb Rougher Tail. (meas)	79.05	2.20	10.8	30.5	85.4
(Calc.)	-	2.20	10.5	30.5	65.7
Pb 1st Cleaner Conc.	8.36	32.1	20.1	46.9	13.3
Pb 1st Cleaner Tail.	12.59	10.3	20.2	22.7	20.2
Pb Rougher Conc. (meas)	20.95	19.0	19.4	69.6	40.6
(Calc.)	-	19.0	21.2	69.6	33.5
Zn Rougher Concentrate	27.09	1.50	18.4	7.1	39.6
Zn Rougher Tailing	36.08	1.11	2.24	7.0	6.4
Pb Scavenger Tail. (meas)	63.17	1.30	9.17	14.4	57.9
(Calc.)	-	1.28	9.17	14.1	46.0
Zn Scavenger Concentrate	18.04	1.12	2.94	3.5	4.2
Zn Scavenger Tailing	18.04	1.17	1.54	3.7	2.2
Zn Rougher Tail. (meas)	36.08	1.11	2.24	7.0	8.1
(Calc.)	-	1.15	2.24	7.2	6.4
Zn 1st Cleaner Conc.	10.10	3.12	41.4	5.5	33.2
Zn 1st Cleaner Tail.	16.99	1.80	4.73	5.3	6.4
Zn Rougher Conc. (meas)	27.09	1.50	18.4	7.2	49.8
(Calc.)	-	2.29	18.4	10.8	39.6
Zn 1st Cl. Scav. Conc.	5.56	2.90	11.3	2.8	5.0
Zn 1st Cl. Scav. Tail.	11.43	1.27	1.53	2.5	1.4
Zn 1st Cl. Tail. (meas)	16.99	1.80	4.73	5.3	8.0
(Calc.)	-	1.80	4.73	5.3	6.4

Three-Product Formula

Pb 4th Cleaner Conc.	6.90	64.6	9.25	77.9	6.4
Zn 4th Cleaner Conc.	14.69	2.23	55.5	5.7	81.5
Zn Combined Tailing	78.41	1.19	1.54	16.4	12.1
Cyclone Overflow	100.00	5.72	10.0	100.0	100.0

Test No. PP48

1. Grinding

- 1.1. Purpose: To repeat conditions of test PP47.
- 1.2. Method: As for test PP31 to PP47. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 697 pounds per hour. Samples were taken every 20 minutes in the last two hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

- 1.3. Flowsheet: As for test PP1.
- 1.4. Results: The grinding circuit was very stable during the test run. Net power consumption in the Hendy mill was 17.6 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 89.4 % minus 200 mesh. Power in the Denver mill was not calculated.

Test No. PP48 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 0.4 percent moisture content		
Feed Rate:	697 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
Total	2361 pounds		
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Mill Feed:	Total 5402 pounds, test period 1394 pounds		
Circulating Load:	Cyclone underflow 540 percent		
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>	
	Mill Discharge	2140	71
	Cyclone Overflow	1320	32
	Cyclone Underflow	2336	76
Average Power:	Gross	8.08 kilowatts	
	No Load	1.92 kilowatts	
	Net	6.16 kilowatts	
Net Power Consumption:	17.60 kilowatt-hours per ton of ½ inch feed.		
Work Index:	13.48		

Test No. PP48 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc. Zinc 2nd Cl. Tail. and Zinc 1st Cl. Scav. Conc.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	
Mill Load:	1 inch balls	860 pounds
	½ inch balls	220 pounds
	<hr/>	
	Total	1080 pounds
Operating Time:	Total 7.75 hours, test period 2.0 hours	
Pulp Densities:		<u>gpl</u> <u>% Solids</u>
	Mill Discharge	2274 75
	Cyclone Overflow	1150 17
	Cyclone Underflpw	2274 75
Average Power:	Gross	3.33 kilowatts
	No Load	0.92 kilowatts
	Net	2.41 kilowatts
Net Power Consumption:	6.89 kilowatt-hours per ton of feed.	

Test No. PP48 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	5.5	5.5	94.5
3	17.4	22.9	77.1
4	12.0	34.9	65.1
6	11.5	46.4	53.6
8	8.3	54.7	45.3
10	6.5	61.2	38.8
14	5.5	66.7	33.3
20	4.1	70.8	29.2
28	3.4	74.2	25.8
35	2.5	76.7	23.3
48	3.3	80.0	20.0
65	2.9	82.9	17.1
100	2.5	85.4	14.6
150	2.5	87.9	12.1
200	2.6	90.5	9.5
- 200	9.5	100.0	-
Total	100.0	-	-

Mill Discharge

+ 10	0.2	0.2	99.8
14	0.2	0.4	99.6
20	0.2	0.6	99.4
28	0.4	1.0	99.0
35	0.6	1.6	98.4
48	1.5	3.1	96.9
65	2.8	5.9	94.1
100	4.9	10.8	89.2
150	9.1	19.9	80.1
200	17.0	36.9	63.1
270	13.8	50.7	49.3
400	18.4	69.1	30.9
- 400	30.9	100.0	-
Total	100.0	-	-

Test No. PP48 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.2	0.2	99.8
14	0.2	0.4	99.6
20	0.3	0.7	99.3
28	0.5	1.2	98.8
35	0.7	1.9	98.1
48	2.0	3.9	96.1
65	3.4	7.3	92.7
100	5.8	13.1	86.9
150	10.4	23.5	76.5
200	19.0	42.5	57.5
270	14.8	57.3	42.7
400	18.9	76.2	23.8
- 400	23.8	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.4	0.4	99.6
100	0.9	1.3	98.7
150	2.5	3.8	96.2
200	6.8	10.6	89.4
270	7.5	18.1	81.9
400	16.0	34.1	65.9
- 400	65.9	100.0	-
Total	100.0	-	-

Test No. PP48 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	1.4	1.4	98.6
270	2.5	3.9	96.1
30.6 μm	7.0	10.9	89.1
23.7	4.8	15.7	84.3
16.5	13.8	29.5	70.5
11.4	17.0	46.5	53.5
8.8	11.7	58.2	41.8
- 8.8	41.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.63

Pb Re grind Cyclone Underflow

+ 200 mesh	1.8	1.8	98.2
270	4.4	6.2	93.8
29.2 μm	7.6	13.8	86.2
22.6	26.6	40.4	59.6
15.8	39.9	80.3	19.7
10.9	9.8	90.1	9.9
8.4	2.6	92.7	7.3
- 8.4	7.3	100.0	-
Total	100.0	-	-

Specific Gravity 5.03

Pb Re grind Discharge

+ 200 mesh	0.8	0.8	99.2
270	3.4	4.2	95.8
29.5 μm	9.4	13.6	86.4
22.9	35.0	48.6	51.4
16.0	27.6	76.2	23.8
10.9	10.2	86.4	13.6
8.5	3.4	89.8	10.2
- 8.5	10.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.96

Test No. PP48 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 34.2 μm	0.6	0.6	99.4
26.5	1.0	1.6	98.4
18.5	10.4	12.0	88.0
12.7	18.6	30.6	69.4
9.8	14.2	44.8	55.2
- 9.8	55.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.75

Pb 4th Cleaner Concentrate

+ 26.9 μm	0.7	0.7	99.3
20.8	1.4	2.1	97.9
14.5	14.5	16.6	83.4
10.0	25.5	42.1	57.9
7.7	17.2	59.3	40.7
- 7.7	40.7	100.0	-
Total	100.0	-	-

Specific Gravity 5.83

Zn Regrind Discharge

+ 200 mesh	1.4	1.4	98.6
270	3.2	4.6	95.4
30.6 μm	6.2	10.8	89.2
23.7	26.0	36.8	63.2
16.5	44.6	81.4	18.6
11.4	8.0	89.4	10.6
8.8	2.4	91.8	8.2
- 8.8	8.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.63

Test No. PP48 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	3.1	3.1	96.9
270	4.7	7.8	92.2
30.6 μm	5.4	13.2	86.8
23.7	26.2	39.4	60.6
16.5	47.4	86.8	13.2
11.4	6.3	93.1	6.9
8.8	1.4	94.5	5.5
- 8.8	5.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.67

Zn Regrind Cyclone Overflow

+ 29.5 μm	1.3	1.3	98.7
22.9	2.4	3.7	96.3
16.0	23.9	27.6	72.4
10.9	24.6	52.2	47.8
8.5	11.5	63.7	36.3
- 8.5	36.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.33

Test No. PP48 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 17.9 μ m	3.4	3.4	96.6
12.3	10.9	14.3	85.7
9.5	12.2	26.5	73.5
- 9.5	73.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.13

Zn Combined Tailing

+ 100 mesh	1.1	1.1	98.9
150	2.0	3.1	96.9
200	5.4	8.5	91.5
36.0 μ m	11.1	19.6	80.4
27.9	7.9	27.5	72.5
19.5	16.8	44.3	55.7
13.4	14.1	58.4	41.6
10.4	8.0	66.4	33.6
- 10.4	33.6	100.0	-
Total	100.0	-	-

Specific Gravity 3.65

Test No. PP48 - Continued

2. Flotation

- 2.1. Purpose:
- 1) To improve selectivity between Pb and Zn in the lead rougher circuit.
 - 2) To repeat conditions of test PP47 for the zinc circuit.

- 2.2. Method:
- The following reagent changes in the Pb circuit were made:
- 1) Reduced Z-11 additions to the Hendy mill feed from 0.07 to 0.05 lb/ton.
 - 2) Replaced Z-11 to the Pb conditioner with R-242 at the same rate.
 - 3) Replaced Z-11 to the Pb regrinding with R-242 at a slightly increased rate.

No changes in the zinc circuit were made.

2.2.1. Flotation Equipment

As for test PP36.

2.2.2. Flotation Reagents

See following page.

- 2.3. Flowsheet: As for test PP36.

- 2.4. Results: Lower collector additions to the Pb circuit resulted in poor lead metallurgical results. The lead cleaner concentrate assayed 57.7 % Pb at 68.5 % recovery. The zinc concentrate assayed 53.0 % Zn at 78.7 % Zinc recovery.

Test No. PP48 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	5.00	Ball Mill Feed
NaCN	0.20	Ball Mill Feed
ZnSO ₄	1.00	Ball Mill Feed
Z-11	0.05	Ball Mill Feed
R-242	0.63	Pb Rougher Conditioner
Z-11	0.04	Pb Scavenger Feed
Na ₂ CO ₃	0.50	Pb Regrind Mill
ZnSO ₄	0.56	Pb Regrind Mill
NaCN	0.32	Pb Regrind Mill
R-242	0.01	Pb Cyclone Feed Pump
NaCN	0.10	Pb 2nd Cleaner Feed
NaCN	0.08	Pb 3rd Cleaner Feed
Ca(OH) ₂	2.30	Zn Rougher Cond. No. 1
CuSO ₄	2.05	Zn Rougher Cond. No. 2
Z-11	0.20	Zn Rougher Feed Pump
Z-200	0.093	Zn Rougher Feed Pump
DF-250	0.032	Zn Rougher Feed
Z-11	0.04	Zn Scavenger Feed
Z-200	0.052	Zn Scavenger Feed
Ca(OH) ₂	1.10	Zn Regrind Mill
CuSO ₄	0.30	Zn Regrind Mill
Z-200	0.053	Zn Regrind Mill
Z-11	0.02	Zn 1st Cleaner Feed
Z-11	0.04	Zn 1st Cleaner Scavenger Feed
Z-200	0.022	Zn 1st Cleaner Scavenger Feed
Ca(OH) ₂	0.16	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.50	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.35	Zn 4th Cleaner Feed

Test No. PP48 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	9.1
Pb Rougher Feed	9.1
Pb Scavenger Tailing	8.9
Pb Regrinding Mill Discharge	9.7
Pb 1st Cleaner Feed	9.3
Pb 2nd Cleaner Feed	9.4
Pb 3rd Cleaner Feed	9.4
Pb 4th Cleaner Feed	9.1
Zn Rougher Feed	9.7
Zn Scavenger Tailing	9.3
Zn 1st Cl. Scav. Feed	10.5
Zn 1st Cleaner Feed	10.8
Zn 2nd Cleaner Feed	11.0
Zn 3rd Cleaner Feed	11.3
Zn 4th Cleaner Feed	11.4

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1832
Pb Rougher Feed	1228
Pb Scavenger Tailing	1180
Pb 1st Cleaner Feed	1188
Pb Rougher Concentrate	1323
Zn Rougher Feed	1167
Zn Cyclone Feed	1375
Zn 1st Cleaner Feed	1150
Zn Rougher Concentrate	1342
Zn Combined Tailing	1077
Pb Regrind Mill Discharge	2590

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	21
Pb Regrinding Mill Discharge	25
Zn Rougher Feed	22
Zn Regrinding Mill Discharge	25

Test No. PP48 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.69	9.85
Pb Rougher Feed	8.11	12.7
Pb Rougher Concentrate	24.0	16.9
Pb Rougher Tailing	3.60	11.5
Pb Scavenger Concentrate	8.74	16.3
Pb Scavenger Tailing	1.84	9.89
Pb Regrind Cyclone Overflow	27.8	17.8
Pb Regrind Cyclone Underflow	19.8	12.8
Pb 1st Cleaner Concentrate	38.3	16.6
Pb 1st Cleaner Tailing	16.3	18.0
Pb Cleaner Concentrate	57.7	12.1
Zn Rougher Feed	1.72	7.00
Zn Rougher Concentrate	2.59	25.1
Zn Rougher Tailing	1.50	2.76
Zn Scavenger Tailing	1.47	1.75
Zn Scavenger Concentrate	1.70	3.78
Zn Regrind Cyclone Overflow	3.60	23.5
Zn Regrind Cyclone Underflow	1.64	16.4
Zn 1st Cleaner Concentrate	4.38	40.5
Zn 1st Cleaner Tailing	2.50	5.28
Zn 1st Cleaner Scavenger Concentrate	4.29	12.1
Zn 1st Cleaner Scavenger Tailing	1.42	1.21
Zn 2nd Cleaner Feed	4.18	42.9
Zn 2nd Cleaner Concentrate	3.92	51.0
Zn 2nd Cleaner Tailing	4.59	34.2
Zn 3rd Cleaner Feed	3.80	49.2
Zn 3rd Cleaner Concentrate	4.18	50.8
Zn 3rd Cleaner Tailing	3.52	46.5
Zn 4th Cleaner Tailing	4.10	47.8
Zn Cleaner Concentrate	4.41	53.0
Zn Combined Tailing	1.46	1.63

Test No. PP48 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	10.25	24.0	16.9	43.2	14.4
Pb Rougher Tailing	89.75	3.60	11.5	56.8	85.6
Cyclone Overflow (meas)	100.00	5.69	9.85	100.0	100.0
(Calc.)	-	5.69	12.1	-	-
Pb Scavenger Concentrate	22.89	8.74	16.3	35.2	31.0
Pb Scavenger Tailing	66.86	1.84	9.89	21.6	54.9
Pb Rougher Tail. (meas)	89.75	3.60	11.5	56.8	104.8
(Calc.)	-	3.60	11.5	56.8	85.9
Pb 1st Cleaner Conc.	3.59	38.3	16.6	24.2	5.0
Pb 1st Cleaner Tail.	6.66	16.3	18.0	19.1	9.9
Pb Rougher Conc. (meas)	10.25	24.0	16.9	43.2	17.6
(Calc.)	-	24.0	17.5	43.3	14.9
Zn Rougher Concentrate	19.16	2.59	25.1	8.7	39.9
Zn Rougher Tailing	47.70	1.70	3.78	14.3	15.0
Pb Scavenger Tail. (meas)	66.86	1.84	9.89	21.6	67.1
(Calc.)	-	1.95	9.89	23.0	54.9
Zn Scavenger Concentrate	23.73	1.70	3.78	7.1	7.4
Zn Scavenger Tailing	23.97	1.47	1.75	6.2	3.5
Zn Rougher Tail. (meas)	47.70	1.50	2.76	12.6	10.9
(Calc.)	-	1.58	2.76	13.3	10.9
Zn 1st Cleaner Conc.	10.78	4.38	40.5	8.3	36.2
Zn 1st Cleaner Tail.	8.38	2.50	5.28	3.7	3.7
Zn Rougher Conc. (meas)	19.16	2.59	25.1	8.7	48.8
(Calc.)	-	3.56	25.1	12.0	39.9
Zn 1st Cl. Scav. Conc.	3.13	4.29	12.1	2.4	3.1
Zn 1st Cl. Scav. Tail.	5.25	1.42	1.21	1.3	0.5
Zn 1st Cl. Tail. (meas)	8.38	2.50	5.28	3.7	4.5
(Calc.)	-	2.50	5.28	3.7	3.6

Three-Product Formula

Pb 4th Cleaner Conc.	6.75	57.7	12.1	68.5	8.3
Zn 4th Cleaner Conc.	14.63	4.41	53.0	11.3	78.7
Zn Combined Tailing	78.62	1.46	1.63	20.2	13.0
Cyclone Overflow	100.00	5.69	9.85	100.0	100.0

Test No. PP49

1. Grinding

1.1. Purpose: To repeat conditions of test PP48.

1.2. Method: As for test PP31 to PP48. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 700 pounds per hour. Samples were taken every 20 minutes in the last 2 hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PP1.

1.4. Results: The operation of the grinding circuit was satisfactory. Net power consumption in the Hendy mill was 17.91 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 90.0 % minus 200 mesh. Power in the Denver mill was not calculated.

Test No. PP49 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 0.4 percent moisture content		
Feed Rate:	700 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
	Total	2361 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Mill Feed:	Total 5425 pounds, test period 1400 pounds		
Circulating Load:	Cyclone underflow 496 percent		
Pulp Densities:		<u>gpl</u> <u>% Solids</u>	
	Mill Discharge	2150	71
	Cyclone Overflow	1328	33
	Cyclone Underflow	2310	76
Average Power:	Gross	8.19 kilowatts	
	No Load	1.92 kilowatts	
	Net	6.27 kilowatts	
Net Power Consumption:	17.91 kilowatt-hours per ton of ½ inch feed.		
Work Index:	13.47		

Test No. PP49 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc., Zinc 2nd Cl. Tail. and Zinc 1st Cl. Scav. Conc.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	
Mill Load:	1 inch balls	860 pounds
	$\frac{1}{2}$ inch balls	220 pounds
	<hr/>	
	Total	1080 pounds
Operating Time:	Total 7.75 hours, test period 2.0 hours	
Pulp Densities:		<u>gpl</u> <u>% Solids</u>
	Mill Discharge	2110 67
	Cyclone Overflow	1103 12
	Cyclone Underflow	2110 67
Average Power:	Gross	3.56 kilowatts
	No Load	0.92 kilowatts
	Net	2.64 kilowatts
Net Power Consumption:	7.54 kilowatt-hours per ton of feed.	

Test No. PP49 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	6.4	6.4	93.6
3	17.7	24.1	75.9
4	14.3	38.4	61.6
6	10.9	49.3	50.7
8	8.6	57.9	42.1
10	7.5	65.4	34.6
14	5.2	70.6	29.4
20	3.7	74.3	25.7
28	3.1	77.4	22.6
35	2.3	79.7	20.3
48	2.9	82.6	17.4
65	2.6	85.2	14.8
100	2.2	87.4	12.6
150	2.2	89.6	10.4
200	2.2	91.8	8.2
- 200	8.2	100.0	-
Total	100.0	-	-

Mill Discharge

+ 14	0.2	0.2	99.8
20	0.3	0.5	99.5
28	0.3	0.8	99.2
35	0.6	1.4	98.6
38	1.6	3.0	97.0
65	2.7	5.7	94.3
100	4.9	10.6	89.4
150	9.0	19.6	80.4
200	16.7	36.3	63.7
270	13.5	49.8	50.2
400	18.9	68.7	31.3
- 400	31.3	100.0	-
Total	100.0	-	-

Test No. PP49 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.2	0.2	99.8
14	0.2	0.4	99.6
20	0.3	0.7	99.3
28	0.5	1.2	98.8
35	0.7	1.9	98.1
48	1.9	3.8	96.2
65	3.4	7.2	92.8
100	5.6	12.8	87.2
150	10.3	23.1	76.9
200	18.7	41.8	58.2
270	14.8	56.6	43.4
400	19.4	76.0	24.0
- 400	24.0	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.4	0.4	99.6
100	0.8	1.2	98.8
150	2.4	3.6	96.4
200	6.4	10.0	90.0
270	7.2	17.2	82.8
400	15.2	32.4	67.6
- 400	67.6	100.0	-
Total	100.0	-	-

Test No. PP49 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	4.0	4.0	96.0
270	5.0	9.0	91.0
32.2 μ m	10.4	19.4	80.6
24.9	8.3	27.7	72.3
17.4	17.2	44.9	55.1
12.0	15.3	60.2	39.8
9.2	9.5	69.7	30.3
- 9.2	30.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.40

Pb Regrind Cyclone Underflow

+ 200 mesh	3.8	3.8	96.2
270	7.8	11.6	88.4
30.2 μ m	8.4	20.0	80.0
23.4	29.1	49.1	50.9
16.3	32.4	81.5	18.5
11.2	8.4	89.9	10.1
8.7	2.7	92.6	7.4
- 8.7	7.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.82

Pb Regrind Dishcharge

+ 200 mesh	2.1	2.1	97.9
270	5.5	7.6	92.4
29.6 μ m	8.2	15.8	84.2
23.1	28.7	44.5	55.5
16.1	30.8	75.3	24.7
11.1	9.7	85.0	15.0
8.6	3.6	88.6	11.4
- 8.6	11.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.88

Test No. PP49 - Continued

1.4.3. Screen Analyses

Zn Regrind Discharge

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	1.2	1.2	98.8
270	2.4	3.6	96.4
31.6 μ m	9.9	13.5	86.5
24.5	13.8	27.3	72.7
17.1	37.4	64.7	35.3
11.7	18.6	83.3	16.7
9.1	4.5	87.8	12.2
- 9.1	12.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.43

Zn Regrind Cyclone Overflow

+ 32.5 μ m	0.6	0.6	99.4
25.2	0.8	1.4	98.6
17.6	8.2	9.6	90.4
12.1	24.6	34.2	65.8
9.3	17.2	51.4	48.6
- 9.3	48.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.23

Test No. PP49 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 31.3 μm	7.3	7.3	92.7
24.2	6.0	13.3	86.7
16.9	18.0	31.3	68.7
11.6	18.8	50.1	49.9
9.0	11.8	61.9	38.1
- 9.0	38.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.59

Pb 4th Cleaner Concentrate

+ 26.2 μm	3.3	3.3	96.7
20.3	4.9	8.2	91.8
14.2	18.4	26.6	73.4
9.7	19.4	46.0	54.0
7.5	13.0	59.0	41.0
- 7.5	41.0	100.0	-
Total	100.0	-	-

Specific Gravity 6.08

Zn Regrind Cyclone Underflow

+ 150 μm	0.8	0.8	99.2
200	2.3	3.1	96.9
270	3.1	7.2	92.8
32.2 μm	12.3	19.5	80.5
24.9	15.5	35.0	65.0
17.4	39.6	74.6	25.4
12.0	17.2	91.8	8.2
9.2	2.7	94.5	5.5
- 9.2	5.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.41

Test No. PP49 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 18.4	2.3	2.3	97.7
12.7	10.6	12.9	87.1
9.8	13.0	25.9	74.1
- 9.8	74.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.05

Zn Combined Tailing

+ 100 mesh	1.2	1.2	98.8
150	2.1	3.3	96.7
200	5.6	8.9	91.1
270	5.6	14.5	85.5
36.1 μ m	6.9	21.4	78.6
28.0	8.4	29.8	70.2
19.5	14.7	44.5	55.5
13.4	13.2	57.7	42.3
10.4	8.0	65.7	34.3
- 10.4	34.3	100.0	-
Total	100.0	-	-

Specific Gravity 3.63

Test No. PP49 - Continued

2. Flotation

2.1. Purpose: 1) To repeat conditions of test PP47 for Pb circuit.
2) To investigate the effect of the Z-200 and DF-250 omission from the zinc circuit.

2.2. Method: The level and type of collectors in the lead circuit were similar to that of test PP47.

In the zinc circuit collector Z-200 additions to the zinc rougher, Zn scavenger, Zn regrinding and Zn 1st cleaner scavenger stages were replaced with collector Z-11, at a reduced rate. Frother DF-250 additions to the Zn rougher were replaced with MIBC and MIBC was added to the Zn 1st cleaner.

2.2.1. Flotation Equipment

As for test PP36.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP36.

2.4. Results: The lead metallurgical results were similar to that of test PP47.

The omission of Z-200 from zinc circuit appeared to improve selectivity between Zn and pyrite minerals. The zinc cleaner concentrate assayed, 56.5 % Zn at 78.3 % Zn recovery.

Test No. PP49 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	4.90	Ball Mill Feed
NaCN	0.20	Ball Mill Feed
ZnSO ₄	0.95	Ball Mill Feed
Z-11	0.07	Ball Mill Feed
Z-11	0.03	Pb Rougher Conditioner
Z-11	0.03	Pb Scavenger Feed
Na ₂ CO ₃	0.50	Pb Regrind Mill
ZnSO ₄	0.56	Pb Regrind Mill
NaCN	0.30	Pb Regrind Mill
Z-11	0.01	Pb Cyclone Feed Pump
NaCN	0.09	Pb 2nd Cleaner Feed
NaCN	0.08	Pb 3rd Cleaner Feed
Ca(OH) ₂	2.24	Zn Rougher Cond. No. 1
CuSO ₄	2.06	Zn Rougher Cond. No. 2
Z-11	0.23	Zn Rougher Feed Pump
MIBC	0.078	Zn Rougher Feed Pump
MIBC	0.075	Zn Rougher Feed
Z-11	0.10	Zn Scavenger Feed
MIBC	0.044	Zn Scavenger Feed
CuSO ₄	0.30	Zn Regrind Mill
Z-11	0.09	Zn Regrind Mill
Ca(OH) ₂	0.95	Zn Regrind Mill
Z-11	0.02	Zn 1st Cleaner Feed
MIBC	0.04	Zn 1st Cleaner Feed
Z-11	0.05	Zn 1st Cleaner Scav. Feed
Ca(OH) ₂	0.18	Zn 2nd Cleaner Feed
MIBC	0.015	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.55	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.33	Zn 4th Cleaner Feed

Test No. PP49 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	9.1
Pb Rougher Feed	9.1
Pb Scavenger Tailing	8.8
Pb Regrinding Mill Discharge	9.9
Pb 1st Cleaner Feed	9.3
Pb 2nd Cleaner Feed	9.4
Pb 3rd Cleaner Feed	9.4
Pb 4th Cleaner Feed	9.2
Zn Rougher Feed	9.7
Zn Scavenger Tailing	9.3
Zn 1st Cl. Scav. Feed	10.8
Zn 1st Cleaner Feed	11.0
Zn 2nd Cleaner Feed	11.2
Zn 3rd Cleaner Feed	11.5
Zn 4th Cleaner Feed	11.6

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1838
Pb Rougher Feed	1233
Pb Scavenger Tailing	1172
Pb 1st Cleaner Feed	1240
Pb Rougher Concentrate	1420
Zn Rougher Feed	1193
Zn Cyclone Feed	1260
Zn 1st Cleaner Feed	1103
Zn Rougher Concentrate	1272
Zn Combined Tailing	1075

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	22
Pb Regrinding Mill Discharge	26
Zn Rougher Feed	23
Zn Regrinding Mill Discharge	28

Test No. PP49 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.77	10.1
Pb Rougher Feed	5.65	12.2
Pb Rougher Concentrate	15.8	16.6
Pb Rougher Tailing	1.92	10.5
Pb Scavenger Concentrate	4.88	14.3
Pb Scavenger Tailing	1.35	9.46
Pb 1st Cleaner Concentrate	23.4	20.2
Pb 1st Cleaner Tailing	6.52	18.2
Pb Regrind Cyclone Overflow	17.8	19.1
Pb Regrind Cyclone Underflow	15.8	13.6
Pb Cleaner Concentrate	62.7	9.67
Zn Rougher Feed	1.31	7.59
Zn Rougher Concentrate	1.81	33.6
Zn Rougher Tailing	1.29	3.35
Zn Scavenger Concentrate	1.32	5.32
Zn Scavenger Tailing	1.25	1.84
Zn 1st Cleaner Tailing	3.95	14.4
Zn 1st Cleaner Concentrate	3.24	51.0
Zn Regrinding Cyclone Overflow	3.39	36.5
Zn Regrinding Cyclone Underflow	1.79	26.7
Zn 1st Cleaner Scavenger Concentrate	5.41	24.9
Zn 1st Cleaner Scavenger Tailing	2.31	2.72
Zn Combined Tailing	1.41	1.92
Zn Cleaner Concentrate	1.97	56.5

Test No. PP49 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight	Assays, %		% Distribution	
	%	Pb	Zn	Pb	Zn
Pb Rougher Concentrate	27.74	15.8	16.6	76.0	37.8
Pb Rougher Tailing	72.26	1.92	10.5	24.0	62.2
Cyclone Overflow (meas)	100.00	5.77	10.1	100.0	100.0
(Calc.)	-	5.77	12.19	-	-
Pb Scavenger Concentrate	11.67	4.88	14.3	9.9	13.7
Pb Scavenger Tailing	60.59	1.35	9.46	14.2	47.0
Pb Rougher Tail. (meas)	72.26	1.92	10.5	24.0	75.1
(Calc.)	-	1.92	10.2	24.1	60.7
Pb 1st Cleaner Conc.	15.25	23.4	20.2	61.8	25.3
Pb 1st Cleaner Tail.	12.49	6.52	18.2	14.1	18.6
Pb Rougher Conc. (meas)	27.74	15.8	16.6	75.9	45.6
(Calc.)	-	15.8	19.3	75.9	43.9
Zn Rougher Concentrate	12.24	1.81	33.6	3.8	33.7
Zn Rougher Tailing	48.35	1.29	3.35	10.8	13.3
Pb Scavenger Tail. (meas)	60.59	1.35	9.46	14.2	56.8
(Calc.)	-	1.40	9.46	14.6	47.0
Zn Scavenger Concentrate	20.98	1.32	5.32	4.8	9.2
Zn Scavenger Tailing	27.37	1.25	1.84	5.9	4.1
Zn Rougher Tail. (meas)	48.35	1.29	3.35	10.8	16.0
(Calc.)	-	1.28	3.35	10.7	13.3
Zn 1st Cleaner Conc.	6.42	3.24	51.0	3.6	26.9
Zn 1st Cleaner Tail.	5.82	3.95	14.4	4.0	6.9
Zn Rougher Conc. (meas)	12.24	1.81	33.6	3.8	40.7
(Calc.)	-	3.6	33.6	7.6	33.8
Zn 1st Cl. Scav. Conc.	3.06	5.41	24.9	2.9	6.3
Zn 1st Cl. Scav. Tail.	2.76	2.31	2.72	1.1	0.6
Zn 1st Cl. Tail. (meas)	5.82	3.95	14.4	4.0	8.3
(Calc.)	-	3.94	14.4	4.0	6.9

Three-Product Formula

Pb 4th Cleaner Conc.	6.99	62.7	9.67	76.0	6.7
Zn 4th Cleaner Conc.	14.00	1.97	56.5	4.7	78.3
Zn Combined Tailing	79.01	1.41	1.92	19.3	15.0
Cyclone Overflow	100.00	5.77	10.1	100.0	100.0

Test No. PP50

1. Grinding

1.1. Purpose:

To repeat conditions of test PP49.

1.2. Method:

As for test PP31 to 49. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 694 pounds per hour. Samples were taken every 20 minutes during the last two hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet:

As for test PP1.

1.4. Results:

The grinding circuit was stable during the test run. Net power consumption in the Hendy mill was 17.26 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 88.5 % minus 200 mesh. Power in the Denver mill was not calculated.

Test No. PP50 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus $\frac{1}{2}$ inch ore at 0.4 percent moisture content		
Feed Rate:	694 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	$1\frac{1}{2}$ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
	Total	2361 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Mill Feed:	Total 5379 pounds, test period 1388 pounds		
Circulating Load:	Cyclone underflow 525 percent		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2144	71
	Cyclone Overflow	1332	33
	Cyclone Underflow	2334	76
Average Power:	Gross	7.96 kilowatts	
	No Load	1.92 kilowatts	
	Net	6.04 kilowatts	
Net Power Consumption:	17.26 kilowatt-hours per ton of $\frac{1}{2}$ inch feed.		
Work Index:	13.23		

Test No. PP50 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill		
Feed:	Zinc Ro. Conc., Zn 2nd Cl. Tail., and Zinc 1st Cl. Scav. Conc.		
Mill Speed:	32 r.p.m., 75 percent of critical speed		
Mill Load:	1 inch balls	860 pounds	
	½ inch balls	220 pounds	
	<hr/>		
	Total	1080 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2464	76
	Cyclone Overflow	1392	37
	Cyclone Underflow	2464	76
Average Power:	Gross	3.56 kilowatts	
	No Load	0.92 kilowatts	
	Net	2.64 kilowatts	
Net Power Consumption:	7.54 kilowatt-hours per ton of feed.		

Test No. PP50 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	5.0	5.0	95.0
3	14.8	19.8	80.2
4	13.0	32.8	67.2
6	11.0	43.8	56.2
8	8.7	52.5	47.5
10	7.4	59.9	40.1
14	6.1	66.0	34.0
20	4.3	70.3	29.7
28	3.6	73.9	26.1
35	2.6	76.5	23.5
48	3.4	79.9	20.1
65	3.0	82.9	17.1
100	2.5	85.4	14.6
150	2.5	87.9	12.1
200	2.6	90.5	9.5
- 200	9.5	100.0	-
Total	100.0	-	-

Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.3	0.6	99.4
28	0.4	1.0	99.0
35	0.6	1.6	98.4
48	1.6	3.2	96.8
65	2.9	6.1	93.9
100	5.0	11.1	88.9
150	9.4	20.5	79.5
200	17.4	37.9	62.1
270	13.8	51.7	48.3
400	18.8	70.5	29.5
- 400	29.5	100.0	-
Total	100.0	-	-

Test No. PP50 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.2	0.2	99.8
14	0.2	0.4	99.6
20	0.3	0.7	99.3
28	0.5	1.2	98.8
35	0.8	2.0	98.0
48	2.1	4.1	95.9
65	3.6	7.7	92.3
100	5.9	13.6	86.4
150	10.7	24.3	75.7
200	19.2	43.5	56.5
270	14.7	58.2	41.8
400	18.9	77.1	22.9
- 400	22.9	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.5	0.5	99.5
100	1.0	1.5	98.5
150	2.8	4.3	95.7
200	7.2	11.5	88.5
270	7.8	19.3	80.7
400	15.1	34.4	65.6
- 400	65.6	100.0	-
Total	100.0	-	-

Test No. PP50 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 150 mesh	1.2	1.2	98.8
200	2.8	4.0	96.0
270	4.8	8.8	91.2
31.7 μ m	10.3	19.1	80.9
24.6	8.3	27.4	72.6
17.1	18.2	45.6	54.4
11.8	14.7	60.3	39.7
9.1	9.4	69.7	30.3
- 9.1	30.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.50

Pb Regrind Cyclone Underflow

+ 150 mesh	0.8	0.8	99.2
200 mesh	3.2	4.0	96.0
270	8.1	12.1	87.9
30.2 μ m	8.5	20.6	79.4
23.4	30.2	50.8	49.2
16.3	31.3	82.1	17.9
11.2	8.4	90.5	9.5
8.7	2.9	96.3	3.7
- 8.7	3.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.86

Pb Regrind Discharge

+ 200 mesh	2.6	2.6	97.4
270	6.2	8.8	91.2
30.1 μ m	8.3	17.1	82.9
23.2	28.3	45.4	54.6
16.3	31.2	76.6	23.4
11.2	9.6	86.2	13.8
8.6	3.7	89.9	10.1
- 8.6	10.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.86

Test No. PP50 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 31.6 μ m	3.9	3.9	96.1
24.5	5.4	9.3	90.7
17.1	19.0	28.3	71.7
11.8	20.4	48.7	51.3
9.1	12.4	61.1	38.9
- 9.1	38.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.48

Pb 4th Cleaner Concentrate

+ 26.5 μ m	2.8	2.8	97.2
20.6	3.8	6.6	93.4
14.4	17.1	23.7	76.3
9.9	21.5	45.2	54.8
7.6	13.6	58.8	41.2
- 7.6	41.2	100.0	-
Total	100.0	-	-

Specific Gravity 6.02

Zn Regrind Discharge

+ 200 mesh	1.5	1.5	98.5
270	3.5	5.0	95.0
30.8 μ m	6.2	11.2	88.8
23.9	25.2	36.4	63.6
16.7	45.8	82.2	17.8
11.5	7.1	89.3	10.7
8.8	2.4	91.7	8.3
- 8.8	8.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.69

Test No. PP50 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 150 mesh	0.9	0.9	99.1
200	2.6	3.5	96.5
270	5.3	8.8	91.2
30.7 μm	6.2	15.0	85.0
23.8	29.4	44.4	55.6
16.6	47.0	91.4	8.6
11.4	4.4	95.8	4.2
8.8	1.0	96.8	3.2
- 8.8	3.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.69

Zn Regrind Cyclone Overflow

+ 32.4 μm	1.3	1.3	98.7
25.1	2.3	3.6	96.4
17.5	19.7	23.3	76.7
12.1	22.5	45.8	54.2
9.3	11.9	57.7	42.3
- 9.3	42.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.32

Test No. PP50 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 33.5 µm	1.4	1.4	98.6
26.0	2.8	4.2	95.8
18.1	17.4	21.6	78.4
12.5	19.4	41.0	59.0
9.6	11.5	52.5	47.5
- 9.6	47.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.10

Zn Combined Tailing

+ 100 mesh	1.0	1.0	99.0
150	1.8	2.8	97.2
200	4.5	7.3	92.7
36.7 µm	5.9	13.2	86.8
28.5	6.1	19.3	80.7
19.9	17.0	36.3	63.7
13.7	16.6	52.9	47.1
10.5	9.6	62.5	37.5
- 10.5	37.5	100.0	-
Total	100.0	-	-

Specific Gravity 3.60

Test No. PP50 - Continued

2. Flotation

- 2.1. Purpose:
- 1) To study the effect of omitting the $ZnSO_4$ from the lead circuit.
 - 2) To improve zinc recovery.

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

A) Pb Circuit

- 1) Omitted $ZnSO_4$ from the Pb primary grind mill feed and Pb concentrate regrind mill feed.
- 2) Added MIBC to the Pb rougher and scavenger feed.

B) Zn Circuit

- 1) Frother MIBC additions to the Zn circuit were replaced with frother DF-250.
- 2) Collector Z-200 was added to the zinc rougher feed pump at a rate of 0.05 lb/ton.

2.2.1. Flotation Equipment

As for test PP36.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP36.

2.4. Results: Omission of $ZnSO_4$ from the lead rougher and cleaning circuit resulted in an increased zinc content of the lead rougher and 1st cleaner concentrate. However, the zinc was rejected well in the further cleaning (i.e. 2nd, 3rd and 4th cleaner). The lead cleaner concentrate assayed 60.7 % Pb at 78.1 % Pb recovery. The addition of collector Z-11 to the Zn cleaning slightly reduced Zn concentrate grade. The zinc 4th cleaner concentrate assayed 53.6 % Zn at 80.6 % Zn recovery.

Test No. PP50 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagents Per Ton of Feed	Point of Addition
Na ₂ CO ₃	4.48	Ball Mill Feed
NaCN	0.20	Ball Mill Feed
Z-11	0.08	Ball Mill Feed
Z-11	0.03	Pb Rougher Conditioner
Z-11	0.03	Pb Scavenger Feed
Na ₂ CO ₃	0.50	Pb Regrind Mill
NaCN	0.30	Pb Regrind Mill
Z-11	0.01	Pb Cyclone Feed Pump
NaCN	0.08	Pb 2nd Cleaner Feed
NaCN	0.08	Pb 3rd Cleaner Feed
Ca(OH) ₂	2.24	Zn Rougher Cond. No. 2
CuSO ₄	2.05	Zn Rougher Cond. No. 1
Z-11	0.23	Zn Rougher Feed Pump
DF-250	0.096	Zn Rougher Feed Pump
Z-200	0.052	Zn Rougher Feed Pump
DF-250	0.003	Zn Rougher Feed
Z-11	0.09	Zn Scavenger Feed
DF-250	0.012	Zn Scavenger Feed
Ca(OH) ₂	1.20	Zn Regrind Mill
CuSO ₄	0.30	Zn Regrind Mill
Z-11	0.09	Zn Regrind Mill
DF-250	0.066	Zn 1st Cleaner Feed
Z-11	0.02	Zn 1st Cleaner Feed
DF-250	0.028	Zn 1st Cleaner Scavenger Feed
Z-11	0.05	Zn 1st Cleaner Scavenger Feed
DF-250	0.010	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.17	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.55	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.30	Zn 4th Cleaner Feed

Test No. PP50 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	8.7
Pb Rougher Feed	8.9
Pb Scavenger Tailing	8.7
Pb Regrinding Mill Discharge	10.1
Pb 1st Cleaner Feed	9.4
Pb 2nd Cleaner Feed	9.4
Pb 3rd Cleaner Feed	9.4
Pb 4th Cleaner Feed	9.1
Zn Rougher Feed	9.8
Zn Scavenger Tailing	9.3
Zn 1st Cl. Scav. Feed	10.3
Zn 1st Cleaner Feed	10.7
Zn 2nd Cleaner Feed	10.9
Zn 3rd Cleaner Feed	11.4
Zn 4th Cleaner Feed	11.5

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone	1822
Pb Rougher Feed	1232
Pb Scavenger Tailing	1187
Pb 1st Cleaner Feed	1270
Pb Rougher Concentrate	1443
Zn Rougher Feed	1157
Zn Cyclone Feed	1317
Zn 1st Cleaner Feed	1100
Zn Rougher Concentrate	1292
Zn Combined Tailing	1068
Pb Regrind Mill Discharge	2522

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	20
Pb Regrinding Mill Discharge	26
Zn Rougher Feed	21
Zn Regrinding Mill Discharge	29

Test No. PP50 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.81	10.2
Pb Rougher Feed	5.61	12.1
Pb Rougher Concentrate	15.5	16.9
Pb Rougher Tailing	1.76	9.91
Pb Scavenger Concentrate	4.80	15.4
Pb Scavenger Tailing	1.40	9.18
Pb 1st Cleaner Concentrate	21.1	21.6
Pb 1st Cleaner Tailing	1.16	1.74
Pb Re grind Cyclone Overflow	1.66	13.3
Pb Re grind Cyclone Underflow	0.76	6.48
Pb Cleaner Concentrate	60.8	10.9
Zn Rougher Feed	1.30	7.80
Zn Rougher Concentrate	1.25	15.2
Zn Rougher Tailing	1.39	2.55
Zn Scavenger Concentrate	1.38	3.64
Zn Scavenger Tailing	1.36	1.86
Zn 1st Cleaner Tailing	1.16	1.74
Zn 1st Cleaner Concentrate	2.72	34.2
Zn Re grinding Cyclone Overflow	1.66	13.3
Zn Re grinding Cyclone Underflow	0.76	6.48
Zn 1st Cleaner Scavenger Concentrate	1.95	4.48
Zn 1st Cleaner Scavenger Tailing	0.95	0.99
Zn Combined Tailing	1.16	1.51
Zn Cleaner Concentrate	2.46	53.6

Test No. PP50 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	29.48	15.5	16.9	78.6	41.6
Pb Rougher Tailing	70.52	1.76	9.91	21.4	58.4
Cyclone Overflow (meas)	100.00	5.81	10.2	100.0	100.0
(Calc.)	-	5.81	11.97	-	-
Pb Scavenger Concentrate	7.47	4.80	15.4	6.2	9.6
Pb Scavenger Tailing	63.05	1.40	9.18	15.2	48.4
Pb Rougher Tail. (meas)	70.52	1.76	9.91	21.4	68.5
(Calc.)	-	1.76	9.84	21.4	58.0
Pb 1st Cleaner Conc.	18.70	21.1	21.6	67.9	33.7
Pb 1st Cleaner Tail.	10.78	5.78	18.0	10.7	16.2
Pb Rougher Conc. (meas)	29.48	15.5	16.9	78.6	48.8
(Calc.)	-	15.5	20.3	78.6	49.9
Zn Rougher Concentrate	33.05	1.25	15.2	7.1	42.0
Zn Rougher Tailing	30.00	1.39	2.55	7.2	6.4
Pb Scavenger Tail. (meas)	63.05	1.40	9.18	15.2	56.7
(Calc.)	-	1.32	9.18	14.3	48.4
Zn Scavenger Concentrate	11.63	1.38	3.64	2.8	3.5
Zn Scavenger Tailing	18.37	1.36	1.86	4.5	2.9
Zn Rougher Tail. (meas)	30.00	1.39	2.55	7.2	7.5
(Calc.)	-	1.41	2.55	7.3	6.4
Zn 1st Cleaner Conc.	13.70	2.72	34.2	6.4	39.1
Zn 1st Cleaner Tail.	19.35	1.16	1.74	3.9	2.8
Zn Rougher Conc. (meas)	33.05	1.25	15.2	7.1	49.3
(Calc.)	-	1.81	15.2	10.3	41.9
Zn 1st Cl. Scav. Conc.	4.16	1.95	4.48	1.4	1.6
Zn 1st Cl. Scav. Tail.	15.19	0.95	0.99	2.5	1.3
Zn 1st Cl. Tail. (meas)	19.35	1.16	1.74	3.9	2.9
(Calc.)	-	1.16	1.73	3.9	2.9

Three-Product Formula

Pb 4th Cleaner Conc.	7.46	60.8	10.9	78.1	8.0
Zn 4th Cleaner Conc.	15.34	2.46	53.6	6.5	80.6
Zn Combined Tailing	77.20	1.16	1.51	15.4	11.4
Cyclone Overflow	100.00	5.81	10.2	100.0	100.0

Test No. PP51

1. Grinding

1.1. Purpose: To repeat conditions of test PP50.

1.2. Method: As for test PP31 - 50. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 700 pounds per hour. Samples were taken every 20 minutes during the last two hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PPl.

1.4. Results: The grinding circuit was stable during the test run. Net power consumption in the Hendy mill was 15.89 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 89.0 % passing 200 mesh. Power in the Denver mill was not calculated.

Test No. PP51 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus $\frac{1}{2}$ inch ore at 0.4 percent moisture content		
Feed Rate:	700 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	$1\frac{1}{2}$ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
Total	2361 pounds		
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Mill Feed:	Total 5425 pounds, test period 1400 pounds		
Circulating Load:	Cyclone underflow 545 percent		
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>	
	Mill Discharge	2144	71
	Cyclone Overflow	1324	33
	Cyclone Underflow	2300	76
Average Power:	Gross	7.48 kilowatts	
	No Load	1.92 kilowatts	
	Net	5.56 kilowatts	
Net Power Consumption:	15.89 kilowatt-hours per ton of $\frac{1}{2}$ inch feed.		
Work Index:	11.95		

Test No. PP51 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc., Zinc 2nd Cl. Tail. and Zinc 1st Cl. Scav. Conc.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	
Mill Load:	1 inch balls	860 pounds
	$\frac{1}{2}$ inch balls	220 pounds
	<hr/>	
	Total	1080 pounds
Operating Time:	Total 7.75 hours, test period 2.0 hours	
Pulp Densities:	<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2440 75
	Cyclone Overflow	1100 10
	Cyclone Underflow	2440 75
Average Power:	Gross	3.80 kilowatts
	No Load	0.92 kilowatts
	Net	2.88 kilowatts
Net Power Consumption:	8.23 kilowatt-hours per ton of feed.	

Test No. PP51 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	5.2	5.2	94.8
3	12.7	17.9	82.1
4	14.5	32.4	67.6
6	9.9	42.3	57.7
8	8.9	51.2	48.8
10	7.7	58.9	41.1
14	6.2	65.1	34.9
20	4.5	69.6	30.4
28	3.7	73.3	26.7
35	2.8	76.1	23.9
48	3.4	79.5	20.5
65	3.1	82.6	17.4
100	2.5	85.1	14.9
150	2.5	87.6	12.4
200	2.7	90.3	9.7
- 200	9.7	100.0	-
Total	100.0	-	-

Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.3	0.6	99.4
28	0.5	1.1	98.9
35	0.6	1.7	98.3
48	1.7	3.4	96.6
65	3.3	6.7	93.3
100	5.4	12.1	87.9
150	9.8	21.9	78.1
200	17.3	39.2	60.8
270	13.1	52.3	47.7
400	17.7	70.0	30.0
- 400	30.0	100.0	-
Total	100.0	-	-

Test No. PP51 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.3	0.3	99.7
14	0.3	0.6	99.4
20	0.3	0.9	99.1
28	0.6	1.5	98.5
35	0.8	2.3	97.7
48	2.1	4.4	95.6
65	3.8	8.2	91.8
100	6.2	14.4	85.6
150	11.0	25.4	74.6
200	19.0	44.4	55.6
270	14.3	58.7	41.3
400	17.5	76.2	23.8
- 400	23.8	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.4	0.4	99.6
100	1.0	1.4	98.6
150	2.7	4.1	95.9
200	6.9	11.0	89.0
270	7.4	18.4	81.6
400	15.1	33.5	66.5
- 400	66.5	100.0	-
Total	100.0	-	-

Test No. PP51 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	4.2	4.2	95.8
270	5.0	9.2	90.8
31.7 μ m	10.2	19.4	80.6
24.6	9.0	28.4	71.6
17.2	17.0	45.4	54.6
11.8	15.8	61.2	38.8
9.1	9.2	70.4	29.6
- 9.1	29.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.48

Pb Re grind Cyclone Underflow

+ 150 mesh	1.6	1.6	98.4
200	4.8	6.4	93.6
270	9.5	15.9	84.1
30.1 μ m	8.5	24.4	75.6
23.3	29.7	54.1	45.9
16.3	28.2	82.3	17.7
11.2	7.9	90.2	9.8
8.6	2.9	93.1	6.9
- 8.6	6.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.87

Zn Re grind Cyclone Overflow

+ 32.1 μ m	1.3	1.3	98.7
24.9	2.1	3.4	96.6
17.4	20.3	23.7	76.3
11.9	22.4	46.1	53.9
9.2	12.0	58.1	41.9
- 9.2	41.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.41

Test No. PP51 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 31.0 µm	7.1	7.1	92.9
24.0	7.0	7.0	85.9
16.8	19.9	34.0	66.0
11.5	18.8	52.8	47.2
8.9	11.2	64.0	36.0
- 8.9	36.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.61

Pb 4th Cleaner Concentrate

+ 26.2 µm	3.5	3.5	96.5
20.3	7.0	10.5	89.5
14.2	17.3	27.8	72.2
9.7	18.6	46.4	53.6
7.5	13.0	59.4	40.6
- 7.5	40.6	100.0	-
Total	100.0	-	-

Specific Gravity 6.16

Zn Regrind Discharge

+ 200 mesh	1.7	1.7	98.3
270	3.6	5.3	94.7
30.8 µm	6.3	11.6	88.4
23.9	25.0	36.6	63.4
16.7	46.4	83.0	17.0
11.5	7.2	90.2	9.8
8.8	2.4	92.6	7.4
- 8.8	7.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.71

Test No. PP51 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 150 mesh	1.0	1.0	99.0
200	2.8	3.8	96.2
270	5.5	9.3	90.7
30.7 μm	5.8	15.1	84.9
23.8	28.7	43.8	56.2
16.6	47.6	91.4	8.6
11.4	4.5	95.9	4.1
8.8	1.0	96.9	3.1
- 8.8	3.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.72

Pb Regrind Discharge

+ 200 mesh	2.8	2.8	97.2
270	7.7	10.5	89.5
30.1 μm	8.9	19.4	80.6
23.3	30.9	50.3	49.7
16.3	26.1	76.4	23.6
11.2	9.5	85.9	14.1
8.6	3.8	89.7	10.3
- 8.6	10.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.87

Test No. PP51 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 33.5 µm	1.4	1.4	98.6
26.0	2.2	3.6	96.4
18.1	16.3	19.9	80.1
12.5	19.5	39.4	60.6
9.6	19.5	58.9	41.1
- 9.6	41.1	100.0	-
Total	100.0	-	-

Specific Gravity 4.09

Zn Combined Tailing

+ 100 mesh	1.0	1.0	99.0
150	1.8	2.8	97.2
200	4.2	7.0	93.0
36.5 µm	5.2	12.2	87.8
28.3	6.0	18.2	81.8
19.7	16.8	35.0	65.0
13.6	16.6	51.6	48.4
10.5	9.4	61.0	39.0
- 10.5	39.0	100.0	-
Total	100.0	-	-

Specific Gravity 3.59

Test No. PP51 - Continued

2. Flotation

2.1. Purpose: To repeat conditions of test PP50.

2.2. Method: The circuit was similar to test PP50 except that collector additions to the Zn regrind mill decreased slightly.

2.2.1. Flotation Equipment

As for test PP26.

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP26.

2.4. Results: The lead and zinc metallurgical results were similar to that of test PP50. The lead cleaner concentrate assayed 65.8 % Pb at 74.4 % Pb recovery. The zinc cleaner concentrate assayed 52.6 % Zn at 82.6 % Zn recovery.

Test No. PP51 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	4.90	Ball Mill Feed
NaCN	0.18	Ball Mill Feed
Z-11	0.07	Ball Mill Feed
Z-11	0.03	Pb Rougher Conditioner
MIBC	0.018	Pb Rougher Feed Pump
Z-11	0.03	Pb Scavenger Feed
Na ₂ CO ₃	0.40	Pb Regrind Mill
NaCN	0.32	Pb Regrind Mill
Z-11	0.01	Pb Cyclone Feed Pump
NaCN	0.08	Pb 2nd Cleaner Feed
NaCN	0.07	Pb 3rd Cleaner Feed
CuSO ₄	2.05	Zn Rougher Cond. No. 1
Ca(OH) ₂	2.80	Zn Rougher Cond. No. 2
Z-11	0.23	Zn Rougher Feed Pump
DF-250	0.105	Zn Rougher Feed Pump
Z-200	0.053	Zn Rougher Feed Pump
Z-11	0.09	Zn Scavenger Feed
DF-250	0.013	Zn Scavenger Feed
CuSO ₄	0.30	Zn Regrind Mill
Z-11	0.08	Zn Regrind Mill
Ca(OH) ₂	1.60	Zn Regrind Mill
DF-250	0.088	Zn 1st Cleaner Feed
Z-11	0.02	Zn 1st Cleaner Feed
Z-11	0.05	Zn 1st Cleaner Scavenger
MIBC	0.030	Zn 1st Cleaner Scavenger
MIBC	0.009	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.18	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.46	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.27	Zn 4th Cleaner Feed

Test No. PP51 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	8.8
Pb Rougher Feed	8.8
Pb Scavenger Tailing	8.6
Pb Regrinding Mill Discharge	10.0
Pb 1st Cleaner Feed	9.2
Pb 2nd Cleaner Feed	9.2
Pb 3rd Cleaner Feed	9.2
Pb 4th Cleaner Feed	9.0
Zn Rougher Feed	9.7
Zn Scavenger Tailing	9.3
Zn 1st Cl. Scav. Feed	10.1
Zn 1st Cleaner Feed	10.4
Zn 2nd Cleaner Feed	10.7
Zn 3rd Cleaner Feed	11.2
Zn 4th Cleaner Feed	11.3

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1850
Pb Rougher Feed	1233
Pb Scavenger Tailing	1188
Pb 1st Cleaner Feed	1288
Pb Rougher Concentrate	1497
Zn Rougher Feed	1150
Zn Cyclone Feed	1375
Zn 1st Cleaner Feed	1100
Zn Rougher Concentrate	1402
Zn Combined Tailing	1062
Pb Regrind Mill Discharge	2518

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	20
Pb Regrinding Mill Discharge	24
Zn Rougher Feed	21
Zn Regrinding Mill Discharge	28

Test No. PP51 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	6.07	10.5
Pb Rougher Feed	6.04	12.8
Pb Rougher Concentrate	15.2	17.5
Pb Rougher Tailing	1.76	2.86
Pb Scavenger Concentrate	4.63	15.5
Pb Scavenger Tailing	1.55	9.88
Pb 1st Cleaner Concentrate	24.9	21.0
Pb 1st Cleaner Tailing	7.19	18.9
Pb Regrind Cyclone Overflow	18.8	19.7
Pb Regrind Cyclone Underflow	16.7	13.6
Pb Cleaner Concentrate	65.8	8.86
Zn Rougher Feed	1.66	7.89
Zn Rougher Concentrate	1.43	15.0
Zn Rougher Tailing	1.76	2.86
Zn Scavenger Concentrate	1.78	3.80
Zn Scavenger Tailing	1.83	2.09
Zn 1st Cleaner Tailing	1.27	1.59
Zn 1st Cleaner Concentrate	2.46	32.6
Zn Regrinding Cyclone Overflow	1.61	13.2
Zn Regrinding Cyclone Underflow	0.74	6.34
Zn 1st Cleaner Scavenger Concentrate	1.70	3.26
Zn 1st Cleaner Scavenger Tailing	1.10	0.99
Zn Combined Tailing	1.52	1.60
Zn Cleaner Concentrate	2.39	52.6

Test No. PP51 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	30.36	15.2	17.5	76.0	41.6
Pb Rougher Tailing	69.64	2.09	10.7	24.0	58.4
Cyclone Overflow (meas)	100.00	6.07	10.5	100.0	100.0
(Calc.)	-	6.07	12.8	-	-
Pb Scavenger Concentrate	12.21	4.63	15.5	9.3	14.8
Pb Scavenger Tailing	57.43	1.55	9.88	14.7	44.5
Pb Rougher Tail. (meas)	69.64	2.09	10.7	24.0	71.0
(Calc.)	-	2.09	10.9	24.0	59.3
Pb 1st Cleaner Conc.	13.73	24.9	21.0	56.3	22.6
Pb 1st Cleaner Tail.	16.63	7.19	18.9	19.7	24.6
Pb Rougher Conc. (meas)	30.36	15.2	17.5	76.0	50.6
(Calc.)	-	15.2	19.8	76.0	47.2
Zn Rougher Concentrate	33.21	1.43	15.0	7.8	39.0
Zn Rougher Tailing	24.22	1.76	2.86	7.0	5.4
Pb Scavenger Tail. (meas)	57.43	1.55	9.88	14.7	54.0
(Calc.)	-	1.57	9.88	14.8	44.4
Zn Scavenger Concentrate	10.91	1.78	3.80	3.2	3.2
Zn Scavenger Tailing	13.31	1.83	2.09	4.0	2.2
Zn Rougher Tail. (meas)	24.22	1.76	2.86	7.0	6.6
(Calc.)	-	1.81	2.86	7.2	5.4
Zn 1st Cleaner Conc.	14.36	2.46	32.6	5.8	36.6
Zn 1st Cleaner Tail.	18.85	1.27	1.59	3.9	2.3
Zn Rougher Conc. (meas)	33.21	1.43	15.0	7.8	47.4
(Calc.)	-	1.78	15.0	9.7	38.9
Zn 1st Cl. Scav. Conc.	4.98	1.70	3.26	1.4	1.3
Zn 1st Cl. Scav. Tail.	13.87	1.10	0.99	2.5	1.1
Zn 1st Cl. Tail. (meas)	18.85	1.27	1.59	3.9	2.9
(Calc.)	-	1.26	1.59	3.9	2.4

Three-Product Formula

Pb 4th Cleaner Conc.	6.86	65.8	8.86	74.4	5.8
Zn 4th Cleaner Conc.	16.48	2.39	52.6	6.5	82.6
Zn Combined Tailing	76.66	1.52	1.60	19.1	11.6
Cyclone Overflow	100.00	6.07	10.5	100.0	100.0

Test No. PP52

1. Grinding

1.1. Purpose: To repeat conditions of test PP51.

1.2. Method: As for test PP31 - 51. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 705 pounds per hour. Samples were taken every 20 minutes during the last two hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PP1.

1.4. Results: The grinding circuit was stable during the test run. Net power consumption in the Hendy mill was 16.91 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow was 88.3 % minus 200 mesh. Power in the Denver mill was not calculated.

Test No. PP52 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 0.4 percent moisture content		
Feed Rate:	705 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
	Total	2361 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Mill Feed:	Total 5464 pounds, test period 1410 pounds		
Circulating Load:	Cyclone underflow 533 percent		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2134	70
	Cyclone Overflow	1326	33
	Cyclone Underflow	2402	78
Average Power:	Gross	7.84 kilowatts	
	No Load	1.92 kilowatts	
	Net	5.92 kilowatts	
Net Power Consumption:	16.91 kilowatt-hours per ton of ½ inch feed.		
Work Index:	12.96		

Test No. PP52 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill		
Feed:	Zinc Ro. Conc., Zinc 2nd Cl. Tail. and Zinc 1st Cl. Scav.		
Mill Speed:	32 r.p.m., 75 percent of critical speed	Conc.	
Mill Load:	1 inch balls	860 pounds	
	½ inch balls	220 pounds	
	<hr/>		
	Total	1080 pounds	
Operating Time:	Total 7.75 hours, test period 2.0 hours		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2466	78.3
	Cyclone Overflow	1078	9.6
	Cyclone Underflow	2466	78.3
Average Power:	Gross	3.56 kilowatts	
	No Load	0.92 kilowatts	
	Net	2.64 kilowatts	
Net Power Consumption:	7.54 kilowatt-hours per ton of feed.		

Test No. PP52 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	5.7	5.7	94.3
3	18.4	24.1	75.9
4	14.3	38.4	61.6
6	10.1	48.5	51.5
8	9.1	57.6	42.4
10	6.7	64.3	35.7
14	5.2	69.5	30.5
20	3.8	73.3	26.7
28	3.1	76.4	23.6
35	2.4	78.8	21.2
48	3.0	81.8	18.2
65	2.7	84.5	15.5
100	2.3	86.8	13.2
150	2.3	89.1	10.9
200	2.4	91.5	8.5
- 200	8.5	100.0	-
Total	100.0	-	-

Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.3	0.6	99.4
28	0.4	1.0	99.0
35	0.6	1.6	98.4
48	1.7	3.3	96.7
65	3.2	6.5	93.5
100	5.4	11.9	88.1
150	10.0	21.9	78.1
200	18.1	40.0	60.0
270	13.8	53.8	46.2
400	18.1	71.9	28.1
- 400	28.1	100.0	-
Total	100.0	-	-

Test No. PP52 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.3	0.3	99.7
14	0.3	0.6	99.4
20	0.3	0.9	99.1
28	0.6	1.5	98.5
35	0.8	2.3	97.7
48	2.1	4.4	95.6
65	3.7	8.1	91.9
100	6.3	14.4	85.6
150	11.4	25.8	74.2
200	20.0	45.8	54.2
270	14.9	60.7	39.3
400	19.1	79.8	20.2
- 400	20.2	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.5	0.5	99.5
100	1.0	1.5	98.5
150	2.8	4.3	95.7
200	7.4	11.7	88.3
270	7.8	19.5	80.5
400	15.5	35.0	65.0
- 400	65.0	100.0	-
Total	100.0	-	-

Test No. PP52 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 150 mesh	1.7	1.7	98.3
200	4.0	5.7	94.3
270	5.8	11.5	88.5
31.5 µm	10.4	21.9	78.1
24.4	9.0	30.9	69.1
17.0	17.2	48.1	51.9
11.7	14.3	62.4	37.6
9.0	8.7	71.1	28.9
- 9.0	28.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.53

Pb Regrind Discharge

+ 150 mesh	0.8	0.8	99.2
200	2.8	3.6	96.4
270	7.5	11.1	88.9
30.0 µm	8.8	19.9	80.1
23.2	29.7	49.6	50.4
16.2	28.5	78.1	21.9
11.1	8.6	86.7	13.3
8.6	3.3	90.0	10.0
- 8.6	10.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.86

Pb Regrind Cyclone Underflow

+ 150 mesh	1.0	1.0	99.0
200	3.6	4.6	95.4
270	8.1	12.7	87.3
30.3 µm	7.8	20.5	79.5
23.5	31.0	51.5	48.5
16.4	29.2	80.7	19.3
11.3	7.2	87.9	12.1
8.7	2.4	90.3	9.7
- 8.7	9.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.84

Test No. PP52 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 31.0 μm	5.6	5.6	94.4
24.0	6.6	12.6	87.8
16.8	19.4	31.6	68.4
11.5	18.9	50.5	49.5
8.91	11.6	62.1	37.9
- 8.91	37.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.56

Pb 4th Cleaner Concentrate

+ 26.5 μm	5.0	5.0	95.0
20.5	6.0	11.0	89.0
14.3	19.6	30.6	69.4
9.8	20.2	50.8	49.2
7.6	12.1	62.9	37.1
- 7.6	37.1	100.0	-
Total	100.0	-	-

Specific Gravity 5.93

Zn Regrind Discharge

+ 200 mesh	4.4	4.4	95.6
270	8.0	12.4	87.6
31.3 μm	6.4	18.8	81.2
24.2	36.2	55.0	45.0
16.9	34.7	89.7	10.3
11.6	3.8	93.5	6.5
9.0	1.2	94.7	5.3
- 9.0	5.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.61

Test No. PP52 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Underflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 150 mesh	1.4	1.4	98.6
200	5.1	6.5	93.5
270	9.9	16.4	83.6
31.3 μm	6.4	22.8	77.2
24.3	39.0	61.8	38.2
16.9	31.9	93.7	6.3
11.6	2.4	96.1	3.9
9.0	0.6	96.7	3.3
- 9.0	3.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.61

Zn Regrind Cyclone Overflow

+ 32.0 μm	3.4	3.4	96.6
24.8	9.3	12.7	87.3
17.3	30.7	43.4	56.6
11.9	19.0	62.4	37.6
9.2	8.8	71.2	28.8
- 9.2	28.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.38

Test No. PP52 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 33.4 μ m	2.2	2.2	97.8
25.9	5.3	7.5	92.5
18.1	19.7	27.2	72.8
12.4	17.3	44.5	55.5
9.6	10.9	55.4	44.6
- 9.6	44.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.12

Zn Combined Tailing

+ 100 mesh	1.6	1.6	98.4
150	2.9	4.5	95.5
200	7.0	11.5	88.5
37.6 μ m	12.0	23.5	76.5
29.1	9.0	32.5	67.5
20.3	15.5	48.0	52.0
14.0	11.5	59.5	40.5
10.8	7.1	66.6	33.4
- 10.8	33.4	100.0	-
Total	100.0	-	-

Specific Gravity 3.49

Test No. PP52 - Continued

2. Flotation

- 2.1. Purpose: To study the effect of open circuit lead flotation.
- 2.2. Method: The lead 1st cleaner tailing was refloated in a scavenger cleaner stage using small additions of Z-11 (0.02 lb/ton). The 1st cleaner scavenger concentrate was returned to the lead rougher feed and tailing was passed to the zinc flotation.

Reagent additions were similar to that of test PP47.

2.2.1. Flotation Equipment

As for test PP26 except that additional bank of 6 fagergren No. 12 cells was used in the lead cleaner scavenger stage.

2.2.2. Flotation Reagents

See following page.

- 2.4. Results: After the above changes, conditions in the lead rougher and cleaning improved slightly. The lead cleaner concentrate assayed 58.3 % Pb at 77.5 % Pb recovery.

Test No. PP52 - Continued

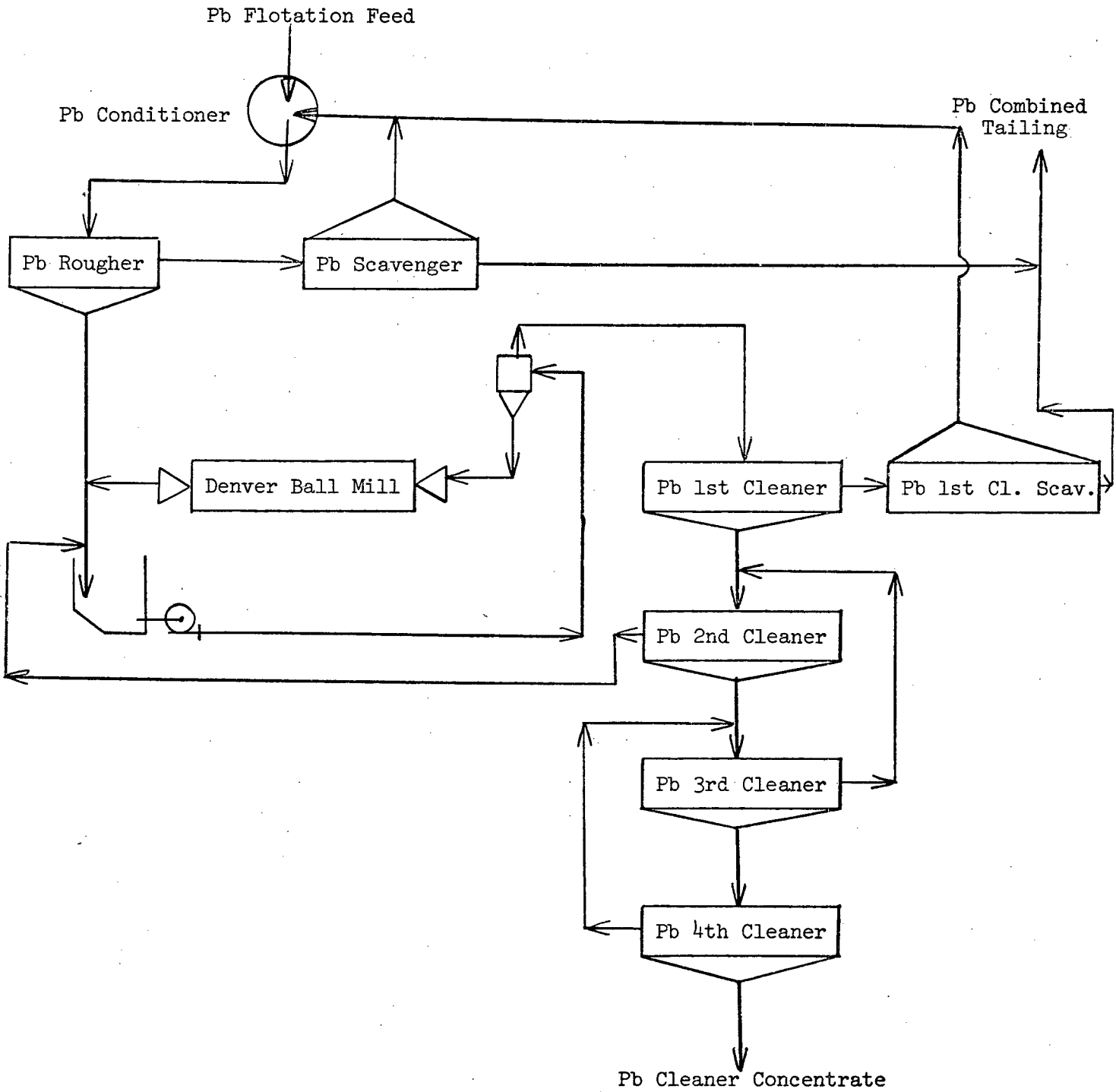
2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	5.60	Ball Mill Feed
NaCN	0.22	Ball Mill Feed
ZnSO ₄	0.95	Ball Mill Feed
Z-11	0.07	Ball Mill Feed
Z-11	0.03	Pb Rougher Conditioner
MIBC	0.019	Pb Rougher Feed Pump
Z-11	0.03	Pb Scavenger Feed
Na ₂ CO ₃	0.40	Pb Regrind Mill
ZnSO ₄	0.54	Pb Regrind Mill
NaCN	0.28	Pb Regrind Mill
Z-11	0.01	Pb Cyclone Feed Pump
Z-11	0.03	Pb 1st Cleaner Scav. Feed
MIBC	0.013	Pb 1st Cleaner Scav. Feed
NaCN	0.10	Pb 2nd Cleaner Feed
NaCN	0.07	Pb 3rd Cleaner Feed
Ca(OH) ₂	3.36	Zn Rougher Cond. No. 1
CuSO ₄	2.05	Zn Rougher Cond. No. 2
Z-11	0.24	Zn Rougher Feed Pump
DF-250	0.120	Zn Rougher Feed Pump
Z-200	0.053	Zn Rougher Feed Pump
Z-11	0.09	Zn Scavenger Feed
DF-250	0.015	Zn Scavenger Feed
Ca(OH) ₂	2.04	Zn Regrind Mill
CuSO ₄	0.30	Zn Regrind Mill
Z-11	0.08	Zn Regrind Mill
Z-11	0.05	Zn 1st Cleaner Feed
DF-250	0.053	Zn 1st Cleaner Feed
Z-11	0.08	Zn 1st Cleaner Scav. Feed
DF-250	0.028	Zn 1st Cleaner Scav. Feed
Ca(OH) ₂	0.25	Zn 2nd Cleaner Feed
DF-250	0.008	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.56	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.50	Zn 4th Cleaner Feed

Test No. PP52 - Continued

2.3. Flowsheet

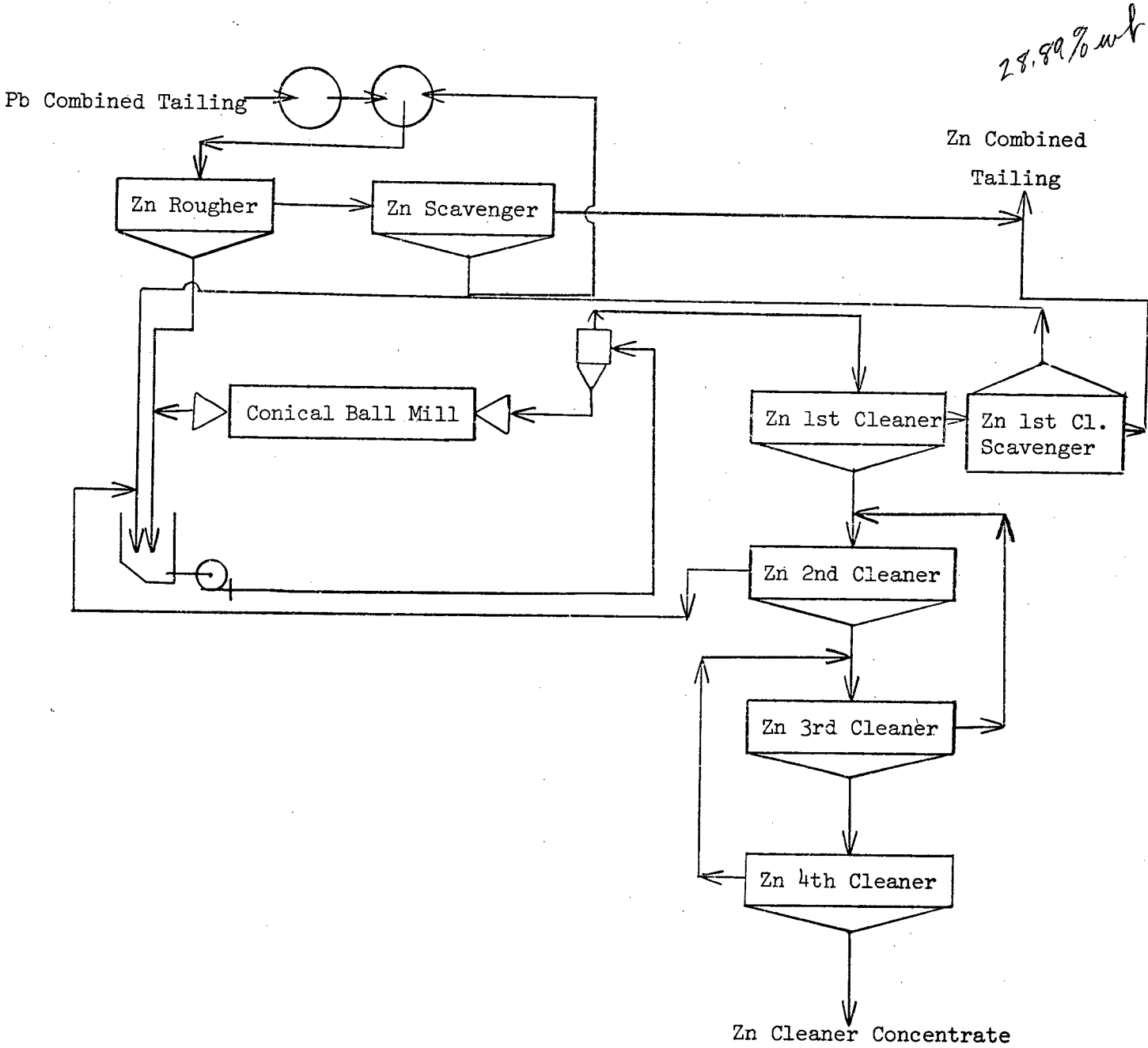
a) Pb Circuit



Test No. PP52 - Continued

2.3. Flowsheet

b) Zn Circuit



Test No. PP52 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	8.8
Pb Rougher Feed	8.7
Pb Scavenger Tailing	8.6
Pb Regrinding Mill Discharge	9.1
Pb 1st Cleaner Feed	8.9
Pb 2nd Cleaner Feed	9.1
Pb 3rd Cleaner Feed	9.1
Pb 4th Cleaner Feed	8.9
Zn Rougher Feed	9.8
Zn Scavenger Tailing	9.3
Zn 1st Cl. Scav. Feed	10.5
Zn 1st Cleaner Feed	10.6
Zn 2nd Cleaner Feed	10.9
Zn 3rd Cleaner Feed	11.3
Zn 4th Cleaner Feed	11.4
Pb 1st Cl. Scav. Feed	8.7

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Pb Rougher Feed	1268
Pb Scavenger Tailing	1228
Pb 1st Cleaner Feed	1272
Pb Rougher Concentrate	1453
Zn Rougher Feed	1203
Zn Cyclone Feed	1265
Zn 1st Cleaner Feed	1078
Zn Rougher Concentrate	1322
Zn Combined Tailing	1068
Pb Regrind Mill Discharge	2558

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	19
Pb Regrinding Mill Discharge	24
Zn Rougher Feed	22
Zn Regrinding Mill Discharge	32

Test No. PP52 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.62	9.75
Pb Rougher Feed	5.30	11.6
Pb Rougher Concentrate	15.7	16.5
Pb Rougher Tailing	1.74	10.2
Pb Scavenger Concentrate	4.13	14.4
Pb Scavenger Tailing	1.28	9.31
Pb 1st Cleaner Concentrate	20.6	20.5
Pb 1st Cleaner Tailing	5.06	17.8
Pb Regrind Cyclone Overflow	15.9	20.0
Pb Regrind Cyclone Underflow	13.6	12.9
Pb 1st Cleaner Scavenger Concentrate	5.68	18.6
Pb 1st Cleaner Scavenger Tailing	2.31	12.6
Pb Cleaner Concentrate	58.3	11.4
Zn Rougher Feed	1.18	6.92
Zn Rougher Concentrate	1.45	22.4
Zn Rougher Tailing	1.06	2.17
Zn Scavenger Concentrate	0.99	3.10
Zn Scavenger Tailing	1.26	1.68
Zn 1st Cleaner Tailing	1.30	2.20
Zn 1st Cleaner Concentrate	2.09	30.7
Zn Regrinding Cyclone Overflow	1.55	15.1
Zn Regrinding Cyclone Underflow	0.94	8.87
Zn 1st Cleaner Scavenger Concentrate	1.25	2.66
Zn 1st Cleaner Scavenger Tailing	1.33	1.57
Zn Combined Tailing	1.27	1.65
Zn Cleaner Concentrate	1.89	54.0

Test No. PP52 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	27.79	15.7	16.5	77.6	38.4
Pb Rougher Tailing	72.21	1.74	10.2	22.4	61.6
Cyclone Overflow (meas)	100.00	5.62	9.75	100.0	100.0
(Calc.)	-	5.62	12.0	-	-
Pb Scavenger Concentrate	11.65	4.13	14.4	8.6	14.0
Pb Scavenger Tailing	60.56	1.28	9.31	13.8	47.2
Pb Rougher Tail. (meas)	72.21	1.74	10.2	22.4	75.5
(Calc.)	-	1.73	10.1	22.4	61.2
Pb 1st Cleaner Conc.	19.03	20.6	20.5	69.8	32.6
Pb 1st Cleaner Tail.	8.76	5.06	17.8	7.9	13.0
Pb Rougher Conc. (meas)	27.79	15.7	16.5	77.6	47.0
(Calc.)	-	15.7	19.6	77.7	45.6
Pb 1st Cl. Scav. Conc.	7.15	5.68	18.6	7.2	11.1
Pb 1st Cl. Scav. Tail.	1.61	2.31	12.6	0.7	1.7
Pb 1st Cl. Tail. (meas)	8.76	5.06	17.8	7.9	16.0
(Calc.)	-	5.06	17.5	7.9	12.8
Zn Rougher Concentrate	22.22	1.45	22.4	5.7	41.7
Zn Rougher Tailing	39.95	1.06	2.17	7.5	7.3
Pb Comb. Tail. (meas)	62.17	1.31	9.40	14.5	59.9
(Calc.)	-	1.20	9.40	13.2	49.0
Zn Scavenger Concentrate	13.79	0.99	3.10	2.4	3.6
Zn Scavenger Tailing	26.16	1.26	1.68	5.9	3.7
Zn Rougher Tail. (meas)	39.95	1.06	2.17	7.5	8.9
(Calc.)	-	1.17	2.17	8.3	7.3
Zn 1st Cleaner Conc.	15.75	2.09	30.7	5.9	40.5
Zn 1st Cleaner Tail.	6.47	1.30	2.20	1.5	1.2
Zn Rougher Conc. (meas)	22.22	1.45	22.4	5.7	51.0
(Calc.)	-	1.86	22.4	7.4	41.7
Zn 1st Cl. Scav. Conc.	3.74	1.25	2.66	0.8	0.8
Zn 1st Cl. Scav. Tail.	2.73	1.33	1.57	0.6	0.4
Zn 1st Cl. Tail. (meas)	6.47	1.30	2.20	1.5	1.5
(Calc.)	-	1.28	2.20	1.4	1.2

Test No. PP52 - Continued

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb 4th Cleaner Conc.	7.47	58.3	11.4	77.5	8.7
Zn 4th Cleaner Conc.	14.08	1.89	54.0	4.7	78.0
Zn Combined Tailing	78.45	1.27	1.65	17.8	13.3
Cyclone Overflow	100.00	5.62	9.75	100.0	100.0

Test No. PP53

1. Grinding

1.1. Purpose: To repeat conditions of test PP52.

1.2. Method: As for test PP31 to 52. The circuit was operated for a period of 7.25 hours at a feed rate of 699 pounds per hour. Samples were taken every 20 minutes during the last $1\frac{1}{2}$ hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P50 Dorr Cyclone:

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

Pb Regrind

Denver Mill; Krebs Cyclone:

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

Zn Regrind

Conical Mill; Krebs Cyclone:

1 1/2 inch diameter
1/2 inch vortex
1/4 inch apex

1.3. Flowsheet: As for test PPl.

1.4. Results: The grinding circuit was stable during the test run. Net power consumption in the Hendy mill was 17.60 kilowatt-hours per ton of $\frac{1}{2}$ inch feed. The cyclone overflow was 87.7 % minus 200 mesh. Power in the Denver mill was not calculated.

Test No. PP53 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 0.4 percent moisture content		
Feed Rate:	699 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	961 pounds	
	1 inch balls	400 pounds	
	<hr/>		
	Total	2361 pounds	
Operating Time:	Total 7.25 hours, test period 1.5 hours		
Mill Feed:	Total 5068 pounds, test period 1049 pounds		
Circulating Load:	Cyclone underflow 530 percent		
Pulp Densities:		<u>gpl</u>	<u>% Solids</u>
	Mill Discharge	2138	71
	Cyclone Overflow	1340	34
	Cyclone Underflow	2373	77
Average Power:	Gross	8.09 kilowatts	
	No Load	1.92 kilowatts	
	Net	6.16 kilowatts	
Net Power Consumption:	17.60 kilowatt-hours per ton of ½ inch feed.		
Work Index:	13.48		

Test No. PP53 - Continued

1.4. Results:

1.4.2. Zinc Regrinding Mill Report

Regrinding Mill:	Conical Mill	
Feed:	Zinc Ro. Conc., Zinc 2nd Cl. Tail. and Zinc 1st Cl. Scav. Conc.	
Mill Speed:	32 r.p.m., 75 percent of critical speed	
Mill Load:	1 inch balls	860 pounds
	$\frac{1}{2}$ inch balls	220 pounds
	<hr/>	
	Total	1080 pounds
Operating Time:	Total 7.25 hours, test period 1.5 hours	
Pulp Densities:		<u>gpl</u> <u>% Solids</u>
	Mill Discharge	1928 68
	Cyclone Overflow	1158 18
	Cyclone Underflow	1928 68
Average Power:	Gross	3.48 kilowatts
	No Load	0.92 kilowatts
	Net	2.56 kilowatts
Net Power Consumption:	7.31 kilowatt-hours per ton of feed.	

Test No. PP53 - Continued

1.4.3. Screen Analyses

Mill Feed

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 3/8	3.2	3.2	96.8
3	13.4	16.6	83.4
4	14.7	31.3	68.7
6	10.5	41.8	58.2
8	8.7	50.5	49.5
10	7.8	58.3	41.7
14	6.2	64.5	35.5
20	4.7	69.2	30.8
28	3.8	73.0	27.0
35	2.8	75.8	24.2
48	3.5	79.3	20.7
65	3.2	82.5	17.5
100	2.6	85.1	14.9
150	2.6	87.7	12.3
200	2.7	90.4	9.6
- 200	9.6	100.0	-
Total	100.0	-	-

Mill Discharge

+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.2	0.5	99.5
28	0.4	0.9	99.1
35	0.6	1.5	98.5
48	1.6	3.1	96.9
65	3.0	6.1	93.9
100	5.2	11.3	88.7
150	9.7	21.0	79.0
200	17.7	38.7	61.3
270	13.5	52.2	47.8
400	18.2	70.4	29.6
- 400	29.6	100.0	-
Total	100.0	-	-

Test No. PP53 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	0.2	0.2	99.8
14	0.2	0.4	99.6
20	0.3	0.7	99.3
28	0.5	1.2	98.8
35	0.8	2.0	98.0
48	2.0	4.0	96.0
65	3.7	7.7	92.3
100	6.2	13.9	86.1
150	11.1	25.0	75.0
200	19.7	44.7	55.3
270	14.6	59.3	40.7
400	18.3	77.6	22.4
- 400	22.4	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.5	0.5	99.5
100	1.2	1.7	98.3
150	3.0	4.7	95.3
200	7.6	12.3	87.7
270	7.7	20.0	80.0
400	15.5	35.5	64.5
- 400	64.5	100.0	-
Total	100.0	-	-

Test No. PP53 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	5.2	5.2	94.8
270	5.0	10.2	89.8
31.4 μm	11.6	21.8	78.2
24.3	8.4	30.2	69.8
17.0	16.7	46.9	53.1
11.7	14.4	61.3	38.7
9.0	9.1	70.4	29.6
- 9.0	29.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.52

Pb Regrind Discharge

+ 200 mesh	3.1	3.1	96.9
270	8.0	11.1	88.9
30.2 μm	9.3	20.4	79.6
23.4	28.6	49.0	51.0
16.3	29.0	78.0	22.0
11.2	8.2	86.2	13.8
8.7	3.1	89.3	10.7
- 8.7	10.7	100.0	-
Total	100.0	-	-

Specific Gravity 4.82

Pb Regrind Cyclone Underflow

+ 200 mesh	7.4	7.4	92.6
270	10.9	18.3	81.7
30.3 μm	8.8	27.1	72.9
23.5	31.4	58.5	41.5
16.4	26.9	85.4	14.6
11.3	6.3	91.7	8.3
8.7	2.1	93.8	6.2
- 8.7	6.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.77

Test No. PP53 - Continued

1.4.3. Screen Analyses

Pb Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 30.4 μm	7.1	7.1	92.9
23.6	7.2	14.3	85.7
16.5	19.4	33.7	66.3
11.3	18.4	52.1	47.9
8.8	11.1	63.2	36.8
- 8.8	36.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.65

Pb 4th Cleaner Concentrate

+ 26.0 μm	6.7	6.7	93.3
20.2	8.2	14.9	85.1
14.1	18.8	33.7	66.3
9.7	18.8	52.5	47.5
7.5	11.6	64.1	35.9
- 7.5	35.9	100.0	-
Total	100.0	-	-

Specific Gravity 6.10

Zn Regrind Cyclone Underflow

+ 150 mesh	2.0	2.0	98.0
200	7.1	9.1	90.9
270	10.2	19.3	80.7
31.9 μm	7.9	27.2	72.8
24.7	33.2	60.4	39.6
17.3	25.8	86.2	13.8
11.9	7.1	93.3	6.7
9.2	2.2	95.5	4.5
- 9.2	4.5	100.0	-
Total	100.0	-	-

Specific Gravity 4.34

Test No. PP53 - Continued

1.4.3. Screen Analyses

Zn Regrind Cyclone Overflow

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	3.4	3.4	96.6
270	5.2	8.6	91.4
32.1 μ m	4.6	13.2	86.8
24.9	28.8	42.0	58.0
17.4	21.2	63.2	36.8
11.9	11.0	74.2	25.8
9.2	5.4	79.6	20.4
- 9.2	20.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.42

Zn Regrind Discharge

+ 150 mesh	1.5	1.5	98.5
200	5.9	7.4	92.6
270	10.1	17.5	82.5
32.7 μ m	5.9	23.4	76.6
25.4	31.0	54.4	45.6
17.7	27.3	81.7	18.3
12.1	8.4	90.1	9.9
9.4	3.0	93.1	6.9
- 9.4	6.9	100.0	-
Total	100.0	-	-

Specific Gravity 4.27

Test No. PP53 - Continued

1.4.3. Screen Analyses

Zn 4th Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.8 µm	2.0	2.0	98.0
25.5	2.9	4.9	95.1
17.8	11.6	16.5	83.5
12.2	15.3	31.8	68.2
9.4	12.0	43.8	56.2
- 9.4	56.2	100.0	-
Total	100.0	-	-

Specific Gravity 4.13

Zn Combined Tailing

+ 100 mesh	1.5	1.5	98.5
150	2.6	4.1	95.9
200	6.4	10.5	89.5
37.2 µm	14.2	24.7	75.3
28.9	9.8	34.5	65.5
20.1	15.5	50.0	50.0
13.8	11.7	61.7	38.3
10.7	7.0	68.7	31.3
- 10.7	31.3	100.0	-
Total	100.0	-	-

Specific Gravity 3.55

Test No. PP53 - Continued

2. Flotation

2.1. Purpose: To improve lead concentrate grade.

2.2. Method: The circuit was similar to test PP52; except that reagent additions in the lead circuit were modified as follows:

- 1) Decreased collector Z-11 additions to the lead rougher conditioner.
- 2) Increased MIBC to the lead rougher feed.

2.2.1. Flotation Equipment

As for test PP52

2.2.2. Flotation Reagents

See following page.

2.3. Flowsheet: As for test PP52

2.4. Results: The lead circuit was not stable during the test run. Uncontrollable froth in the lead 1st cleaner scavenger reduced lead rougher concentrate grade and increased recirculation load in the lead cleaning. The lead 4th cleaner concentrate assayed 60.9 % Pb at 75.5 % lead recovery.

Test No. PP53 - Continued

2.2.2. Reagent Additions

Type	Pounds of Reagent Per Ton of Feed	Point of Addition
Na ₂ CO ₃	6.00	Ball Mill Feed
NaCN	0.19	Ball Mill Feed
ZnSO ₄	1.00	Ball Mill Feed
Z-11	0.07	Ball Mill Feed
Z-11	0.01	Pb Rougher Conditioner
MIBC	0.025	Pb Rougher Feed Pump
Z-11	0.04	Pb Scavenger Feed
Na ₂ CO ₃	0.45	Pb Regrind Mill
ZnSO ₄	0.56	Pb Regrind Mill
NaCN	0.30	Pb Regrind Mill
Z-11	0.01	Pb Cyclone Feed Pump
MIBC	0.01	Pb 1st Cleaner Scav. Feed
Z-11	0.03	Pb 1st Cleaner Scav. Feed
NaCN	0.09	Pb 2nd Cleaner Feed
NaCN	0.07	Pb 3rd Cleaner Feed
Ca(OH) ₂	4.28	Zn Rougher Cond. No. 1
CuSO ₄	2.00	Zn Rougher Cond. No. 2
Z-11	0.24	Zn Rougher Feed Pump
DF-250	0.061	Zn Rougher Feed Pump
Z-200	0.053	Zn Rougher Feed Pump
Z-11	0.09	Zn Scavenger Feed
DF-250	0.013	Zn Scavenger Feed
CuSO ₄	0.30	Zn Regrind Mill
Z-11	0.09	Zn Regrind Mill
Ca(OH) ₂	2.40	Zn Regrind Mill
DF-250	0.047	Zn 1st Cleaner Feed
Z-11	0.01	Zn 1st Cleaner Feed
Z-11	0.05	Zn 1st Cleaner Scav. Feed
DF-250	0.029	Zn 1st Cleaner Scav. Feed
MIBC	0.010	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.33	Zn 2nd Cleaner Feed
Ca(OH) ₂	0.83	Zn 3rd Cleaner Feed
Ca(OH) ₂	0.75	Zn 4th Cleaner Feed

Test No. PP53 - Continued

2.4. Results:

2.4.1. pH

<u>Product</u>	<u>pH</u>
Cyclone Overflow	8.8
Pb Rougher Feed	8.7
Pb Scavenger Tailing	8.6
Pb Re grind Mill Discharge	9.4
Pb 1st Cleaner Feed	8.9
Pb 2nd Cleaner Feed	9.1
Pb 3rd Cleaner Feed	9.1
Pb 4th Cleaner Feed	8.9
Zn Rougher Feed	9.7
Zn Scavenger Tailing	9.3
Zn 1st Cl. Scav. Feed	10.6
Zn 1st Cleaner Feed	10.8
Zn 2nd Cleaner Feed	11.0
Zn 3rd Cleaner Feed	11.3
Zn 4th Cleaner Feed	11.5

2.4.2. Pulp Densities

<u>Product</u>	<u>Pulp Density gpl</u>
Primary Cyclone Feed	1900
Pb Rougher Feed	1273
Pb Scavenger Tailing	1242
Pb 1st Cleaner Feed	1248
Pb Rougher Concentrate	1400
Zn Rougher Feed	1178
Zn Cyclone Feed	1305
Zn 1st Cleaner Feed	1158
Zn Rougher Concentrate	1320
Zn Combined Tailing	1075
Pb Re grind Mill Discharge	2520

2.4.3. Pulp Temperature

<u>Product</u>	<u>°C</u>
Pb Rougher Feed	21
Pb Re grinding Mill Discharge	25
Zn Rougher Feed	23
Zn Re grinding Mill Discharge	26

Test No. PP53 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	5.78	9.80
Pb Rougher Feed	5.78	11.9
Pb Rougher Concentrate	16.5	16.5
Pb Rougher Tailing	2.05	10.4
Pb Scavenger Concentrate	4.95	14.7
Pb Scavenger Tailing	1.43	9.31
Pb 1st Cleaner Concentrate	25.2	20.5
Pb 1st Cleaner Tailing	6.49	18.2
Pb Regrind Cyclone Overflow	17.9	19.9
Pb Regrind Cyclone Underflow	15.4	12.9
Pb 1st Cleaner Scavenger Concentrate	7.06	12.9
Pb 1st Cleaner Scavenger Tailing	2.92	13.5
Pb Cleaner Concentrate	60.9	10.6
Zn Rougher Feed	1.38	7.93
Zn Rougher Concentrate	1.53	18.1
Zn Rougher Tailing	1.43	2.51
Zn Scavenger Concentrate	1.28	3.46
Zn Scavenger Tailing	1.58	1.98
Zn 1st Cleaner Tailing	1.51	3.05
Zn 1st Cleaner Concentrate	2.51	28.0
Zn Regrinding Cyclone Overflow	2.09	16.1
Zn Regrinding Cyclone Underflow	1.78	15.0
Zn 1st Cleaner Scavenger Concentrate	7.06	19.5
Zn 1st Cleaner Scavenger Tailing	2.92	13.5
Zn Combined Tailing	1.41	1.67
Zn Cleaner Concentrate	2.13	54.7

Test No. PP53 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	25.81	16.5	16.5	73.7	35.6
Pb Rougher Tailing	74.19	2.05	10.4	26.3	64.4
Cyclone Overflow (meas)	100.00	5.78	9.80	100.0	100.0
(Calc.)	-	5.78	11.97	-	-
Pb Scavenger Concentrate	13.07	4.95	14.7	11.2	16.1
Pb Scavenger Tailing	61.12	1.43	9.31	15.1	47.5
Pb Rougher Tail. (meas)	74.19	2.05	10.4	26.3	78.7
(Calc.)	-	2.05	12.9	26.3	63.6
Pb 1st Cleaner Conc.	13.81	25.2	20.5	60.2	23.7
Pb 1st Cleaner Tail.	12.00	6.49	18.2	13.5	18.2
Pb Rougher Conc. (meas)	25.81	16.5	16.5	73.7	43.5
(Calc.)	-	16.5	19.4	73.7	41.9
Pb 1st Cl. Scav. Conc.	10.35	7.06	19.5	12.6	16.9
Pb 1st Cl. Scav. Tail.	1.65	2.92	13.5	0.8	1.9
Pb 1st Cl. Tail. (meas)	12.00	6.49	18.2	13.5	22.3
(Calc.)	-	6.49	18.7	13.4	18.8
Zn Rougher Concentrate	27.82	1.53	18.1	7.4	42.1
Zn Rougher Tailing	34.95	1.43	2.51	8.6	7.3
Pb Combined Tail. (meas)	62.77	1.47	9.42	16.0	60.3
(Calc.)	-	1.47	9.42	16.0	49.4
Zn Scavenger Concentrate	12.52	1.28	3.46	2.8	3.6
Zn Scavenger Tailing	22.43	1.58	1.98	6.1	3.7
Zn Rougher Tail. (meas)	34.95	1.43	2.51	8.6	9.0
(Calc.)	-	1.47	2.51	8.9	7.3
Zn 1st Cleaner Conc.	16.78	2.51	28.0	7.3	39.3
Zn 1st Cleaner Tail.	11.04	1.51	3.05	2.9	2.8
Zn Rougher Conc. (meas)	27.82	1.53	18.1	7.4	51.4
(Calc.)	-	2.11	18.1	10.2	42.1
Zn 1st Cl. Scav. Conc.	5.24	1.95	5.31	1.8	2.3
Zn 1st Cl. Scav. Tail.	5.80	1.14	1.02	1.1	0.5
Zn 1st Cl. Tail. (meas)	11.04	1.51	3.05	2.9	3.4
(Calc.)	-	1.52	3.05	2.9	2.8

Test No. PP53 - Continued

2.4.5. Metallurgical Results

Three-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Zn	Pb
Pb 4th Cleaner Conc.	7.17	60.9	10.6	75.5	7.8
Zn 4th Cleaner Conc.	14.13	2.13	54.7	5.2	78.9
Zn Combined Tailing	78.70	1.41	1.67	19.3	13.3
Cyclone Overflow	100.00	5.78	9.80	100.0	100.0

APPENDIX NO. 3

Ore Sample Preparation Instruction

GRUM PILOT MILL COMPOSITE SAMPLE

I have informed Serge Bulatovic that the make-up of the pilot composite should be as follows:

A = 5 %	G = 10 %
B = 10 %	H = 10 %
C = 10 %	J = 15 %
D = 5 %	K-68 = 10 %
FV = 5 %	K-76 = 5 %
FQ = 5 %	K-80 = 10 %

Because the composite contains a higher percentage of "poor" material than originally intended, it is not expected to yield results as good as most previously-tested composites. Klaus Konigsmann suggested that only 75 tons be prepared initially and this instruction was relayed to Serge Bulatovic.

Composite Pilot Mill Sample

Sample	Ore Type	%	Ga/Sp	Ga/Sp/Py	Ga/Sp/Gm	Oxidation
A*	M	5	3-4	4	3	minor
B*	MV+Mpy	10	5-6	4-5	3	very strong
C*	MQ-P	10	3	3	3	-
D*	P	5	2-3	2-3	4	-
FV*	MV	5	3	2-3	3	very strong
FQ*	MQ	5	3	2	3	minor
G*	P	10	3	3	4	-
H*	P-MQ	10	2	3	3	-
J-76	Mpy	15	4	4	3	-
K-68	M	10	4	3-4	3	-
K-76	M+MV	5	5	4	2-3	mod-strong
+ K-80	M+MQ	10	3	3	3-4	-

* data based on polished sections of smaller bulk samples taken from the same sites, but previous to the collection in July of the pilot mill bulk samples.

Grum Pilot Mill Composite Sample - Continued

The pilot bulk sample has the following important "conservative" elements, based on my study of 182 polished sections in the "pit":

- 1) 20 % moderately to strongly oxidized ore versus calculated 15 %, much of which was only moderately to weakly oxidized.
- 2) Ga/Sp = 4, 5, 6 = 40 % versus 34 % as calculated from the 182 pit samples. Note that a majority of the 5 and 6 values yielding the 34 % figure are from the zone along the stratigraphic top of the orebody on section 72W, and that the density of sampling of this limited zone was greater than the average sample density, for the rest of the orebody.
- 3) As shown in the table below, fair and poor samples make up 45 % of the composite, but because these fair and poor samples are all high grade they probably contribute at least 60 % of the Pb and Zn to the composite.

The two most important ratings for Grum ores are the Ga/Sp and $\frac{Ga}{Sp/Py}$ ratings, and the former is more important than the latter because:

- 1) massive pyritic ores at Grum are subordinate to massive galena-sphalerite-rich ore,
- 2) massive pyritic ores at Grum are lower grade than the massive galena-sphalerite-rich ores.

It now appears that the $\frac{Ga}{Sp/Py}$ rating is of even less importance, probably because it could only be high in ores with a high percentage of silicate gangue (Gm), but at Grum such ores (P and MQ) usually have abundant relatively coarse galena and sphalerite grains.

Considering the Ga/Sp and $\frac{Ga}{Sp/Py}$ ratings in the table above, and neglecting the effects of oxidation, the samples could be rated for metallurgical response as follows:

Metallurgical Rating	Samples	% Of Composite
GOOD (ratings of 1-3)	C, D, FV, FQ, G, H, K-80	55
FAIR (Ratings of 4 are dominant)	A, J-76, K-68	30
POOR (Ratings include 5 or 6)	B, K-76	15

Grum Pilot Mill Composite Sample - Continued

Despite the poorer-than-planned composition of the composite, it is in one way more representative than the composite planned for in my July 4 memo because it contains a higher percentage of "fair" ores rather than simply good and bad ores. I am also pleased that we will now have tested more of the metallurgically "fair" ores (ratings of + 4 dominant). Further, with the addition of the "J" and "K" samples, we now have located sources of all classes of ores for any future requirements.

Grum ores have shown wide variability, even over a few meters. Therefore, mill feed during mining operations will contain a mixture of various types of ores. In recent tests, composites with up to 25 % of oxidized 4 to 6 ores, (A and B) have yielded fairly good results; therefore, mill feeds should be programmed to contain less than the allowable amounts (as determined from tests) of oxidized or 5 to 6 ores.

To sum up, I think that the composite is well worth testing since it contains a good mixture of ore-types, but that it is somewhat unevenly weighted with high-grade fair to poor (metallurgical ratings) ores and may not, therefore, yield really good results. If this sample does yield acceptable results, then I think that with proper programming of mill feed during mining, virtually all of the orebody could yield acceptable results.

David Carson