

An Investigation of

THE RECOVERY OF LEAD AND ZINC

from Vangorda ore samples

sampled by

CURRAGH RESOURCES LTD.

Trip Report No. 6

006508

Project No. L.R. 3683

NOTE:

This report refers to the samples as received.

The practice of this Company in issuing reports of this nature is to require the recipient not to publish the report or any part thereof without the written consent of Lakefield Research.

LAKEFIELD RESEARCH
A DIVISION OF FALCONBRIDGE LIMITED
January 18,1991

TABLE OF CONTENTS

	<u>Page No.</u>
ABSTRACT.....	3
INTRODUCTION.....	4
SUMMARY AND CONCLUSIONS.....	5
1. Description of ore samples used in the Laboratory Testwork..	5
1.1 Stockpile ore V-90-PL-03 and 08	5
1.2 Drill core sample V-90-PL-09	6
2. Laboratory Testwork	6
2.1 Bench testwork on sample V-90-PL-03.....	6
2.2 Bench Testwork on sample V-90-PL-08	7
2.2.1 Rougher Flotation	7
2.2.2 Cleaner Flotation.....	9
2.3 Testwork on sample V-90-PL-08 blended with Faro ore.....	10
2.3.1 Ore sample.....	10
2.3.2 Rougher Flotation.....	10
2.3.3 Cleaner Flotation.....	11
2.4 Testwork on ore sample V-90-PL-09	13
3. Plant Reagent Addition Survey	15
4. Conclusions and Recommendations.....	16
DISCUSSION	17
1. Comparison of the samples average calculated head grades..	17
2. Bench testwork on sample V-90-PL-03	18
3. Bench testwork on sample V-90-PL-08	19
3.1 Rougher Flotation.....	19
3.2 Cleaner Flotation	20
4. Bench testwork on the composite sample PL-08 : Faro ore ...	22
4.1 Rougher Flotation	22
4.2 Cleaner Circuit	25
4.2.1 Effect of a different flowsheet configuration..	26
4.2.1.1 Recommendations	28
5. Bench testwork on sample PL-09.....	28
6. Plant Reagent Addition Survey.....	29
CALCULATIONS.....	35
LABORATORY TEST DETAILS	36
PLANT FLOTATION REAGENT ADDITION DETAILS	67

ABSTRACT

This study outlines the preliminary scoping tests of the heavily oxidized Vangorda ore, sampled from the surface stockpile. These results are:

1. The standard Vangorda ore reagent scheme and flowsheet gives no selectivity on this heavily oxidized ore, a bulk Pb, Zn flotation concentrate results.
2. The effect of high zinc depressant dosages give a marginal improvement in selectivity.
3. The bulk flotation of the lead and zinc followed by a lead depression and reverse zinc flotation indicates promising results.

A sample of drill core from below the heavily oxidized ore cap was tested using the standard Vangorda flowsheet and reagent scheme and good results confirm this ore type is amenable to processing by the standard Vangorda procedure.

This study prepared a historical record of the concentrator flotation reagent additions and resultant metallurgy during the week of October 19 to 25.

INTRODUCTION

It was requested that flotation tests be performed on site on new Vangorda ore samples. These were preliminary scoping tests to establish the responsiveness of this new ore to the standard Vangorda ore treatment procedure and to modify the reagent scheme or flowsheet as necessary. The reserve portion of the new Vangorda sample was forwarded to S. Bulatovic at Lakefield to continue concurrent examination of alternatives compatible with the current mill flowsheet.

A second request was that a historical record of the plant reagent additions be prepared prior to the Vangorda ore trial. Operator and shift metallurgist report data were compared to discuss these operating parameters.

The laboratory testwork and plant measurements were carried out on site in October 1990 with the assistance of and in discussion with the laboratory and plant technical staff of Curragh Resources.

LAKEFIELD RESEARCH



K.W. Sarbutt
Manager - Mineral Processing



R.H.O. Wagner, P.Eng.
Project Engineer

SUMMARY AND CONCLUSIONS

1. Description of Ore Samples used in the Laboratory Testwork

1.1 Stockpile ore V-90-PL-03 and -08

Samples V-90-PL-03 and -08 are grab samples from the perimeter and center of the stockpile respectively. The variation in the head grade of the two grab samples tested is significant.

Table No. 1 : Flotation test calculated head grade

Test No.	Sample Description	% Pb	% Zn	% Fe	% Cu
1	V-90-PL-03	5.92	7.09	11.9	-
2	"	6.20	7.77	11.4	0.48
3	"	5.57	7.97	15.8	-
4	"	5.80	8.06	15.4	-
5	"	5.54	7.85	15.3	-
6	"	5.50	7.83	15.7	-
7	"	5.44	7.99	14.8	-
8	"	5.48	7.93	15.7	-
9	"	5.49	7.87	16.0	-
V-90-PL-03 Average (calc)		5.66	7.82	14.7	0.48
10	V-90-PL-08	4.88	4.67	22.7	0.61
11	"	4.81	4.67	22.8	0.62
25	"	4.49	4.45	23.6	-
26	"	5.10	4.93	22.8	-
27	"	5.09	4.90	26.7	-
V-90-PL-08 Average (calc)		4.87	4.72	23.7	0.62

The enormous variation in head assay indicates the grab samples of this stockpile did not provide a representative sample of the oxidized ore stockpile.

1.2 Drill Core Sample V-90-PL-09

The V-90-PL-09 sample is an interval of drill core approximately 100 feet below surface and beneath the refractory ore cap. This sample is not heavily oxidized and the flotation test calculated head assay is 6.11% Pb, 6.20% Zn, 22.6% Fe and 0.13% Cu.

2. Laboratory Testwork

2.1 Bench Testwork on Sample V-90-PL-03

Increasing the NaCN dosage in the standard Vangorda flowsheet was examined:

Table No. 2 : Effect of Increased NaCN dosage

a) CONDITIONS

Test No.	Reagent additions, g/t		pH
	Depressant	Collector	
2	Na ₂ CO ₃ = 1300 NaCN = 200	1:1, 343/3418A = 12.5	9.6
4	Na ₂ CO ₃ = 1300 NaCN = 300	1:1, 343/3418A = 12.5	10.6

b) METALLURGICAL RESULTS

Test No.	Product	Wt. %	Grade, %			% Distribution		
			Pb	Zn	Fe	Pb	Zn	Fe
2	Rougher Conc	16.4	26.3	31.8	4.07	69.4	66.9	5.8
4	Rougher Conc	2.0	15.2	20.5	5.81	5.3	5.1	0.8

Increasing the cyanide dosage in the primary grind from 200 g/t to 300 g/t causes the bulk Pb, Zn flotation to become no flotation (Table No. 2).

Testwork on this stockpile perimeter grab sample V-90-PL-03 proves a bulk flotation of Pb and Zn minerals is obtainable but increasing the NaCN dosage does not improve Pb selectivity in the Vangorda flowsheet.

2.2 Bench Testwork on Sample V-90-PL-08

2.2.1 Rougher Flotation

For this ore type the following parameters were investigated:

- (1) Increasing the collector dosage
- (2) The pH modifier
- (3) Alternative zinc depressant combinations.

From the metallurgical results obtained in Table No. 4, the following observations can be made:

- 1) Increasing the collector 9:1 350/3418A from 10.5 g/t to 40 g/t gave improved bulk flotation recovery.
- 2) Changing the pH modifier from Na_2CO_3 to lime did not improve the selectivity for lead.
- 3) Increasing the zinc depressant dosages (Test 27) did not improve the selectivity of the lead minerals.

Table No. 4 : Effect of Increasing Collector, Changing pH modifier and Increasing Zinc Depressants In Roughing

a) CONDITIONS

TEST NO.	REAGENT ADDITIONS, g/t		pH
	DEPRESSANT	COLLECTOR	
10	Na ₂ CO ₃ =1725 NaCN/SD200=200	9:1 , 350/3418A=10.5	9.4
11	Na ₂ CO ₃ =1725 NaCN/SD200=240	9:1 , 350/3418A=34.5	9.4
25	Lime=800 NaCN/SD200=200	9:1 , 350/3418A=37	10
27	Na ₂ CO ₃ =2750 NaCN/SD200=350 NaCN=200 ZnSO ₄ =1900	9:1 , 350/3418A=40	9.7

Note: Test 27 was conditioned 10 minutes and aerated 4 minutes.

b) METALLURGICAL RESULTS

TEST NO.	PRODUCT	WT. %	GRADE, %			% DISTRIBUTION		
			Pb	Zn	Fe	Pb	Zn	Fe
10	Rougher Conc	2.1	21.6	20.7	10.8	9.4	9.3	1.0
11	Rougher Conc	14.4	21.8	28.1	10.0	65.1	86.4	6.3
25	Rougher Conc	16.4	20.7	25.0	12.2	75.8	92.5	8.5
27	Rougher Conc	19.4	21.3	23.1	14.4	81.2	91.6	10.5

2.2.2 Cleaner Flotation

For this ore type, increasing the zinc depressant dosage in regrinding and cleaning was examined. From the results the following observations can be drawn:

- (1) The standard Vangorda reagent scheme in cleaning shows no selectivity (Test 11, Table No. 5).
- (2) Increasing zinc depressant dosages of NaCN/SD200 and adding NaCN with ZnSO₄ and Na₂CO₃ improves the lead to zinc ratio; however, a saleable product is not possible (Test 25, Table No. 5).

Table No. 5 : Effect of Zinc Depressants in Pb Cleaning

a) CONDITIONS

Test No.	Reagent additions, g/t		pH
	Depressant	Collector	
11	NaCN/SD200 = 270	9 A350 = 29 1 3418A	9.5
25	NaCN/SD200 = 320 NaCN = 750 ZnSO ₄ = 1,000 Na ₂ CO ₃ = 1,000	9 A350 = 26 1 3418A	10.0

b) METALLURGICAL RESULTS

Test No.	Product	Wt. %	Pb	Grade, %		% Distribution		
				Zn	Fe	Pb	Zn	Fe
11	2nd Cl. Conc	3.9	5.82	51.6	5.66	4.7	42.8	1.0
	1st Cl. Conc	9.53	18.8	40.2	5.36	37.3	81.9	2.2
	1st Cl. Tailing	4.83	27.7	4.40	19.3	27.8	4.5	4.1
	Ro Conc	14.35	21.8	28.1	10.0	65.1	86.4	6.3
25	3rd Cl. Conc	3.5	50.4	17.0	5.11	39.2	13.3	0.8
	2nd Cl. Conc	4.9	43.1	21.5	5.85	47.3	23.8	1.2
	1st Cl. Conc	8.9	27.8	31.5	6.93	55.4	63.3	2.6
	1st Cl. Tailing	7.5	12.2	17.3	18.4	20.4	29.2	5.9
	Ro Conc	16.4	20.7	25.0	12.2	75.8	92.5	8.5

2.3 Testwork on Sample V-90-PL-08 Blended with Faro Ore

2.3.1 Ore Sample

A sample of V-90-PL-08 was blended with an equal weight of Faro ore to obtain a composite. The calculated head grades of the flotation test sample composites are listed below (Table No. 6).

Table No. 6 Composite Calculated Head Grades

Test No.	% Pb	%Zn	%Fe	%Cu
12	4.85	4.73	22.8	0.55
13	4.04	4.80	26.1	0.33
14	3.74	4.61	26.9	0.37
15	3.96	4.76	26.5	0.42
16	3.88	4.81	26.5	0.41
18	3.71	4.56	23.1	-
19	4.16	5.17	24.9	-
20	4.00	5.09	26.4	0.40
21	3.65	4.46	26.3	-
22	3.94	5.01	26.2	-
23	2.86	4.81	26.6	0.28
Average (calc)	3.89	4.80	25.7	0.39

2.3.2 Rougher Flotation

For the blended ore sample the following rougher flotation test variables were examined:

- 1) The standard Vangorda ore test reagent scheme.
- 2) Effect of the pH modifier.
- 3) The effect of increasing the zinc depressant dosage.

From the metallurgical results obtained (Table No. 7) the following observations can be made:

- 1) The standard Vangorda ore test conditions result in a non-selective lead flotation (Test 14).

- 2) Changing the pH modifier from 1750 g/t Na₂CO₃ (at pH = 9.8) to 800 g/t lime (at pH = 10) improves iron mineral rejection but does not improve the lead minerals selectivity against zinc (Test 15).
- 3) Increasing the zinc depressant dosage to 800 g/t NaCN/SD200, 750 g/t NaCN and 800 g/t ZnSO₄ improves the rougher lead mineral selectivity significantly (Test 13).

Table No. 7 : Effect of pH Modifier and High Zinc Depressant Dosages in Roughing

a) CONDITIONS

TEST NO.	REAGENT ADDITIONS, g/t		pH
	DEPRESSANT	COLLECTOR	
14	Na ₂ CO ₃ =1750 NaCN/SD200=200	9:1 , 350/3418A=32	9.8
15	Lime=800 NaCN/SD200=200	9:1 , 350/3418A=32	10.1
13	Na ₂ CO ₃ =1750 NaCN/SD200=800 NaCN=750 ZnSO ₄ =800	9:1 , 350/3418A=37	9.8

b) METALLURGICAL RESULTS

TEST NO.	PRODUCT	WT. %	GRADE, %			% DISTRIBUTION		
			Pb	Zn	Fe	Pb	Zn	Fe
14	Rougher Conc	21.8	14.8	20.3	21.9	86.0	96.1	17.7
15	Rougher Conc	16.3	19.8	27.6	12.9	81.4	94.2	7.9
13	Rougher Conc	8.7	35.0	13.4	14.5	75.7	24.4	4.8

2.3.3 Cleaner Flotation

For this composite, alternate rougher concentrate cleaning schemes were examined:

- 1) Using 320 to 420 g/t NaCN/SD200.
- 2) Trying 420 g/t of NaCN Complex.
- 3) Using NaCN complex with ZnSO₄ and/or NaCN.
- 4) Lead depression and reverse zinc flotation.

From the results in Table No. 8, the following observations can be made:

- 1) Increasing the NaCN SD200 in the range 320 to 420 g/t or using 420 g/t NaCN complex, did not improve the selective flotation of lead minerals (Tests 14 to 16).
- 2) Adding zinc sulphate and NaCN in conjunction with NaCN complex improves lead selectivity marginally (Test 21).
- 3) The best results (Test 23) are by Pb depression using dichromate followed by a zinc reverse flotation. The reverse flotation produces a 46.1% Zn concentrate (without regrind), and the lead flotation produces a 64.2% Pb concentrate grade with 5.9% Zn grade, a very acceptable lead concentrate grade (without regrind or cleaning).

Table No. 8 : Composite Sample Cleaning Test Conditions and Results

a) CONDITIONS

TEST NO.	REAGENT ADDITIONS, g/t		pH
	DEPRESSANT	COLLECTOR	
15	NaCN/SD200=320	9:1 , 350/3418A=27	9.6
14	NaCN/SD200=420	9:1 , 350/3418A=27	9.9
16	NaCN Complex=420 (1-ZNO mixed with 3-NaCN ,4-SD200)	9:1 , 350/3418A=28	9.6
21	NaCN Complex=420 ZnSO4=400 NaCN=650	9:1 , 350/3418A=30	10.6
23 Zn Flot.	Ca(OH)2=1550 K2Cr2O7=1500 CuSO4=50	350=30	12.1
23 Pb Flot.	FeSO4=1500 NaCN/SD200=25	9:1 , 350/3418A=20	11.9

Table No. 8. cont'd**b) METALLURGICAL RESULTS**

TEST NO.	PRODUCT	WT. %	GRADE, %			% DISTRIBUTION		
			Pb	Zn	Fe	Pb	Zn	Fe
15	3rd Cleaner Conc	8.0	16	44.7	6.6	32.1	74.8	2.0
15	Rougher Conc	16.3	19.8	27.6	12.9	81.4	94.2	7.9
14	3rd Cleaner Conc	12.0	23.7	34.9	8.4	75.9	90.6	3.7
14	Rougher Conc	21.8	14.8	20.3	21.9	86.0	96.1	17.7
16	3rd Cleaner Conc	8.6	21.4	40.9	6.6	47.5	73.3	2.1
16	Rougher Conc	16.3	19.7	27.8	13.3	82.6	94.4	8.1
21	3rd Cleaner Conc	4.9	39.8	24.3	6.2	53.3	26.6	1.2
21	Rougher Conc	14.0	19.8	30.0	12.1	76.2	94.2	6.4
23	Zn Conc	6.8	12.1	46.1	7.5	28.8	65.2	1.9
23	Pb Conc	1.5	64.2	5.9	6.1	33.4	1.8	0.3
23	Rougher Conc	8.3	21.4	38.9	7.8	62.2	67.0	2.2

Test 23 rougher concentrate was lower recovery than the other tests because the rougher flotation was at a higher pH (pH = 11 using lime).

2.4 Testwork on Ore Sample V-90-PL-09

For this ore type the standard Vangorda ore flotation test procedure was examined:

The results of this test are favourable as shown in Table No. 9.

Table No. 9 : Effect of Vangorda Ore Reagent Scheme and Flowsheet on Sample V-90-PL-09

a) CONDITIONS

Stage	REAGENT ADDITIONS, g/t		pH
	DEPRESSANT	COLLECTOR	
Pb Rougher	NaCN/SD200=200 Na ₂ CO ₃ =1500	9:1 , 350/3418A=37	10
Pb Regrind	NaCN/SD200=75	9:1 , 350/3418A=18.0	9.7
Pb Cleaners	NaCN/SD200=120	9:1 , 350/3418A=1	9.7 to 9
Zn Rougher	Ca(OH) ₂ =750 CuSO ₄ =800	9:1 , 350/3418A=35	11.3

b) METALLURGICAL RESULTS

TEST NO.	PRODUCT	WT. %	GRADE, %			% DISTRIBUTION		
			Pb	Zn	Fe	Pb	Zn	Fe
17	Pb 4th Cleaner Conc	7.5	64.9	7.1	6.2	79.5	8.6	2.0
	Pb 1st Cleaner Conc	11.4	47.8	10.5	12.1	89.6	19.4	6.1
	Pb Rougher Tl. (calc)	76.3	0.6	4.4	23.1	7.0	54.6	78.2
	Zn Rougher Conc	13.1	0.8	22.9	20.0	1.7	48.5	11.6
	Zn Rougher Tl.	63.2	0.5	0.6	23.8	5.3	6.1	66.5
	Head(calc)	100.0	6.1	6.2	22.6	100.0	100.0	100.0
	Head(assay)		6.1	6.5	24.1			

The results obtained with Sample V-90-PL-09 indicate that the standard Vangorda treatment procedure is applicable for this ore type.

3. Plant Reagent Addition Survey

The plant operators and shift metallurgists routinely measure and record the flotation reagent additions and the following records were examined:

- 1) Grinding and Flotation Operators daily reports.
- 2) Daily Shift Metallurgist check list

and compared for the week of October 19 to 25. From comparisons of the two records, the following observations can be made:

- 1) Close reagent addition measurements occur with all reagent addition points except for the xanthate addition in the zinc circuit where the shift metallurgist check list report was 10% lower than the operators, indicating decreasing flow problems may exist in the xanthate system in the zinc circuit (decreasing dosage in Table No. 10).

Table No. 10 : Reagent Dosages for the week October 19-25

	NaCN/ SD200	Lead Circuit, g/t			Zinc Circuit, g/t		
		R342	343 Xanthate	MIBC	CuSO ₄	Xanthate	DF250
Operator	172	2	60	17	437	102	22
Shift Met.	170	2	61	16	436	92	25

The metallurgical results for the corresponding week October 19 to 25 were examined. The lead circuit and zinc concentrate grades are saleable (Table No. 11) and the respective recoveries are good; 77.3% for Pb and 81.9% for Zn to concentrate.

Table No. 11 : Metallurgical Results October 19 - 25

Product	Assays			% Distribution		
	%Pb	%Zn	Ag, g/t	Pb	Zn	Ag
Lead Concentrate	61.7	5.45	514	77.3	3.9	51.5
Zinc Concentrate	2.13	50.4	49.9	6.1	81.9	11.4

The metallurgical results in Table No. 11 were achieved on Faro ore with the reagent dosages of Table No. 10, and with stable circuit operation (pH and good mechanical operation).

4. Conclusions and Recommendations

- 1) Examining the Vangorda flowsheet and reagent scheme on PL-03, PL-08 and PL-08/Faro samples, good bulk lead and zinc flotation was achieved, indicating that this may be incorporated into a bulk flotation flowsheet, with subsequent separation of the bulk concentrate after regrind using the lead depression and reverse zinc flotation method.
- 2) Additional laboratory testwork is recommended to examine the bulk flotation and subsequent separation of the bulk concentrate after regrind using the lead depression method.

DISCUSSION

1. Comparison of the Samples Average Calculated Head Grades

Table No. 1 : Average Calculated Head Grades

Sample Description		Assay %			
		Pb	Zn	Fe	Cu
Stockpile Perimeter	PL-03	5.66	7.82	14.7	0.48
Stockpile Center	PL-08	4.87	4.72	23.7	0.62
Blended Ore 50/50	Faro PL-08	3.89	4.80	25.7	0.39
Drill Core	PL-09	6.11	6.20	22.6	0.13

Four samples were examined: the stockpile perimeter, stockpile center, blended ore and drill core. From the results above the following observations can be made:

- 1) Each sample's ore head grades is significantly different
- 2) The lead to zinc metal ratios are approximately equal in two of the four samples, in the Stockpile center and Drill Core.
- 3) The iron and copper grades are extremely variable.

In order to resolve the variation and enhance each sample's reproducibility, a new sampling technique is encouraged from finer particle size sources (like drill cuttings) to obtain representative samples for metallurgical testwork.

In spite of the sampling difficulties the stockpile centre sample was believed to be the most typical of anticipated mill feed so the majority of the tests were done on this V-90-PL-08 sample.

2. Bench Testwork on Sample V-90-PL-03

In this testwork the level of NaCN additions were examined.

From the results obtained, the following observations can be made: increasing the level of NaCN from 200 g/t into a range of 300 to 400 g/t gave no flotation (Table No. 2).

Table No. 2 : Effect of Increased NaCN Additions

a) CONDITIONS

Test No.	Grind		Reagent Additions, g/t		pH
	Time	Media	Depressant	Collector	
2	20	RM	Na ₂ CO ₃ = 1300 NaCN = 200	1 = 343 = 12.5 1 3418A	9.6
3	20	RM	Na ₂ CO ₃ = 1300 NaCN = 400	1 = 343 = 12.5 1 3418A	10.5
4	20	RM	Na ₂ CO ₃ = 1300 NaCN = 300	1 = 343 = 12.5 1 3418A	10.6

b) METALLURGICAL RESULTS

Test No.	Product	Wt. %	Grade, %				% Distribution			
			Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
2	Rougher Conc	16.4	26.3	31.8	4.07	2.22	69.4	66.9	5.8	75.2
2	Rougher Tail	83.6	2.3	3.1	12.9	0.14	30.6	33.1	94.2	24.8
2	Head (calc)	100.0	6.20	7.77	11.4	0.48	100.0	100.0	100.0	100.0
3	Rougher Conc	1.7	14.9	21.6	5.42	-	4.5	4.6	0.6	-
3	Rougher Tail	98.3	5.41	7.73	16.0	-	95.5	95.4	99.4	-
3	Head (calc)	100.0	5.57	7.97	15.8	-	100.0	100.0	100.0	-
4	Rougher Conc	2.0	15.2	20.5	5.81	-	5.3	5.1	0.8	-
4	Rougher TL	98.0	5.61	7.80	15.6	-	94.7	94.9	99.2	-
4	Head (calc)	100.0	5.80	8.06	15.4	-	100.0	100.0	100.0	-

3. Bench Testwork on Sample V-90-PL-08

3.1 Rougher Flotation

In these scoping tests the following variables were examined:

- 1) Level of collector additions
- 2) Alternative zinc depressant combinations

From the results obtained (Table No. 3) the following observations can be made:

- 1) Increasing the dosage of collector improves the collection of lead and zinc minerals into bulk concentrate
- 2) Alternative zinc depressants improve the lead selectivity to rougher concentrate.

The greatest Pb selectivity improvement occurred in the conditions of Test 26 when the zinc depressants (Na_2CO_3 , NaCN and ZnSO_4) are added to the primary grind followed by 2 minutes of aeration (to ensure oxygenated pulp), followed by the stage addition of 675 g/t and 300 g/t NaCN in the rougher flotation. The collectors are 242 and 9:1 A350/3418A and the 242 dosage is high at 20 g/t. The dosage of 242 is high to promote the Pb flotation selectivity and recovery. The total NaCN dosage of 1,175 g/t indicates the pulp is a high cyanide consumer and this requires follow-up mineralogical work to isolate these NaCN consumer minerals and to determine if a replacement for NaCN is possible to accomplish the same improved lead selectivity.

Table No. 3 : The effect of collector additions and alternative zinc depressant combinations

a) CONDITIONS

TEST NO.	REAGENT ADDITIONS, g/t		pH
	DEPRESSANT	COLLECTOR	
10	$\text{Na}_2\text{CO}_3=1725$ $\text{NaCN}/\text{SD}200=200$	9:1 , 350/3418A=10.5	9.4
11	$\text{Na}_2\text{CO}_3=1725$ $\text{NaCN}/\text{SD}200=240$	9:1 , 350/3418A=34.5	9.4
25	Lime=800 $\text{NaCN}/\text{SD}200=200$	9:1 , 350/3418A=37	10
26	$\text{Na}_2\text{CO}_3=2000$ $\text{NaCN}/\text{SD}200=0$ $\text{NaCN}=1175$ $\text{ZnSO}_4=600$	9:1 , 350/3418A=25 242=20 (2 min. aeration)	9.7
27	$\text{Na}_2\text{CO}_3=2750$ $\text{NaCN}/\text{SD}200=350$ $\text{NaCN}=200$ $\text{ZnSO}_4=1900$	9:1 , 350/3418A=40 (10 minutes conditioning) (4 min. aeration)	9.7

Table No. 3. cont.**b) METALLURGICAL RESULTS**

TEST NO.	PRODUCT	WT. %	GRADE, %			% DISTRIBUTION		
			Pb	Zn	Fe	Pb	Zn	Fe
10	Rougher Conc	2.1	21.6	20.7	10.8	9.4	9.3	1.0
11	Rougher Conc	14.4	21.8	28.1	10.0	65.1	86.4	6.3
25	Rougher Conc	16.4	20.7	25.0	12.2	75.8	92.5	8.5
26	Rougher Conc	12.8	28.6	16.8	15.9	72.0	43.8	9.0
27	Rougher Conc	19.4	21.3	23.1	14.4	81.2	91.6	10.5

3.2 Cleaner Flotation

The effect of alternative zinc depressants was examined:

- 1) Using only NaCN/SD200
- 2) Combining NaCN/SD200, NaCN, Na₂CO₃ and ZnSO₄

From the results in Table No. 4 the following observations can be made:

- 1) The use of 270 g/t NaCN/SD200 in regrinding and stage addition does not give satisfactory selective Pb cleaning conditions.
- 2) Using 320 g/t NaCN/SD200 in combination with 750 g/t NaCN, 1000 g/t Na₂CO₃ and 1000 g/t ZnSO₄ improves the zinc rejection but an undesirable grade bulk Pb, Zn flotation concentrate results. Therefore the depression of Zn to provide selective Pb cleaning is not possible in this flowsheet.

Table No. 4 : Effect of Alternative Zinc Depressantsa) **CONDITIONS**

Test No.	Reagent Additions, g/t			
	Depressant		Collector	
	Rougher	Cleaners	Rougher	Cleaners
11	Na ₂ CO ₃ = 1725 NaCN/SD200 = 240	NaCN = 270 SD200	g 350 = 34.5 1 3418A	g = 350 = 29 1 3418A
25	Lime = 800 NaCN/SD200 = 200	Na ₂ CO ₃ = 1000 NaCN/SD200 = 320 ZnSO ₄ = 1000 NaCN = 750	g 350 = 37 1 3418A	g = 350 = 26 1 3418A

b) **RESULTS**

Test No.	Product	Wt. %	Grade, %				% Distribution			
			Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
11	Pb2nd Cl.Conc	3.88	5.82	51.6	5.7	3.45	4.7	42.8	1.0	21.4
	Pb 1st Cl.Conc	9.53	18.8	40.2	5.4	3.70	37.3	81.9	2.2	56.5
	Comb.Ro.Conc	14.35	21.8	28.1	10.0	3.21	65.1	86.4	6.3	73.9
	Pb. Ro Tailing	85.65	1.96	0.74	24.9	0.19	34.9	13.6	93.7	26.1
	Head (calc.)	100.0	4.81	4.67	22.8	0.62	100.0	100.0	100.0	100.0
25	Pb 3rd Cl.Conc	3.49	50.4	17.0	5.1	-	39.2	13.3	0.8	-
	Pb 3rd Cl.Tail	1.44	25.3	32.4	7.7	-	8.1	10.5	0.5	-
	Pb 2nd Cl. Tail	4.01	9.06	43.9	8.3	-	8.1	39.5	1.4	-
	Pb 1st Cl.Conc	8.93	27.8	31.5	6.9	-	55.4	63.3	2.6	-
	Comb.Ro Conc	16.43	20.7	25.0	12.2	-	75.8	92.5	8.5	-
	Pb Ro Tail	83.57	1.30	0.40	25.8	-	24.2	7.5	91.5	-
Head (calc.)	100.0	4.49	4.45	23.6	-	100.0	100.0	100.0	-	

4. Bench Testwork on the Composite Sample PL-08:Faro Ore. (50:50)

4.1 Rougher Flotation

In these scoping tests the following variables were examined:

- 1) pH modifier
- 2) Alternative zinc depressants and collectors

From the results of Table No. 5 the following observations can be made:

- 1) When changing the pH modifier from 1,750 g/t Na₂CO₃ to 800 g/t lime (with the pH in the range 9.8 to 10.1) a significant improvement in the Fe mineral depression occurred.

The effects of increasing lime addition to 1,250 g/t are:

- 1) The depression of the iron minerals is enhanced significantly
- 2) The Pb selectivity does not improve
- 3) The Pb recovery decreases (possibly due to the strong depression of some Fe and Pb middlings).
- 4) The Pb, Zn bulk recovery decreases

Table No. 5 : Effect of pH modifier

a) CONDITIONS

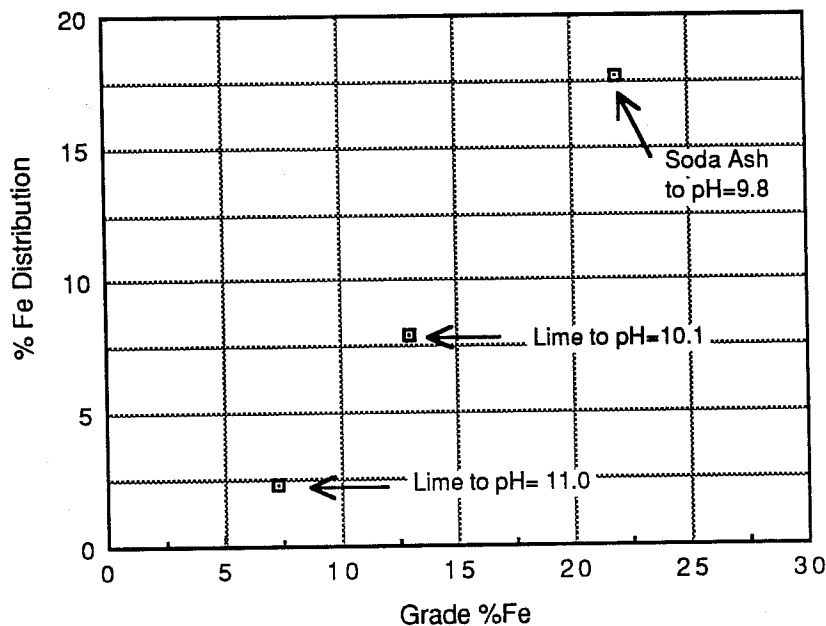
TEST NO.	REAGENT ADDITIONS, g/t		pH
	DEPRESSANT	COLLECTOR	
14	Na ₂ CO ₃ =1750 NaCN/SD200=200	9:1 , 350/3418A=32	9.8
15	Lime=800 NaCN/SD200=200	9:1 , 350/3418A=32	10.1
23	Lime=1250 NaCN/SD200=200 CuSO ₄ =100	9:1 , 350/3418A=60	11.0

b) METALLURGICAL RESULTS

TEST NO.	PRODUCT	WT. %	GRADE, %			% DISTRIBUTION		
			Pb	Zn	Fe	Pb	Zn	Fe
14	Rougher Conc	21.8	14.8	20.3	21.9	86.0	96.1	17.7
15	Rougher Conc	16.3	19.8	27.6	12.9	81.4	94.2	7.9
23	Rougher Conc	8.3	21.4	38.9	7.3	62.1	67.0	2.3

This effect of Na_2CO_3 or lime (in the presence of 200 g/t $\text{NaCN}/\text{SD200}$) on the Fe grade and distribution plot is Figure 1. Improved Fe mineral depression occurs as pH increases.

Figure 1 Effect of pH modifier



From the results obtained (Table No. 6) the following observations can be made:

- 1) With the higher dosages of ZnSO_4 and NaCN or $\text{NaCN}/\text{SD200}$ mixtures, the selectivity between lead and zinc minerals improved significantly (Tests 12 and 13).
- 2) Extended Pb rougher time (30% to 40%) with the higher dosages of ZnSO_4 and NaCN or $\text{NaCN}/\text{SD200}$ promotes Pb recovery (Tests 12 and 13).
- 3) The two collectors tested (343 or 350/3418A) are applicable with higher zinc depressant dosages (Tests 12 and 13).

Table No. 6 : Effect of Alternative Zinc Depressants and Collectors In the Pb Rougher

a) CONDITIONS

TEST NO.	DEPRESSANTS, g/t					ACTIVATORS, COLLECTORS, g/t				pH
	Na ₂ CO ₃	Ca(OH) ₂	NaCN SD200 (1:1)	NaCN	ZnSO ₄	CuSO ₄	343	350 3418A (9:1)	242	
12	1750			700	200		70			9.6
13	1750		800	750	800			42		9.8
14	1750		200					32		9.8
15		800	200					32		10.1
16		800		*200				32		10.2
18	2750				1500				89	9.5
19	1600			25	1100			15	60	9.5
20	1600		200	300	200			15	22	9.9
21		800		*200				37		10.0
22		800		*400	1000			37		9.4
23		1250	200			100		60		11.0

*NaCN Complex

b) METALLURGICAL RESULTS

TEST NO.	PRODUCT	WT. %	GRADE, %			% DISTRIBUTION		
			Pb	Zn	Fe	Pb	Zn	Fe
12	Rougher Conc**	12.8	28.8	20.1	12.5	75.9	54.3	7.0
13	Rougher Conc*	12.0	28.2	13.3	17.7	84.1	33.3	8.1
14	Rougher Conc	21.8	14.8	20.3	21.9	86.0	96.1	17.7
15	Rougher Conc	16.3	19.8	27.6	12.9	81.4	94.2	7.9
16	Rougher Conc*	18.4	18.1	25.1	15.6	85.9	95.9	10.8
18	Rougher Conc	21.5	14.9	18.7	22.4	86.1	88.3	20.8
19	Rougher Conc	23.8	15.3	20.7	20.7	87.4	95.1	19.8
20	Rougher Conc*	18.7	18.1	25.5	16.7	85.0	93.6	11.8
21	Rougher Conc	14.0	19.8	30.0	12.1	76.2	94.2	6.4
22	Rougher Conc	16.0	20.2	29.3	12.3	82.1	93.6	7.5
23	Rougher Conc	8.3	21.4	38.9	7.3	62.1	67.0	2.3

*Extended scavenger flotation 3 minutes.

**Extended scavenger flotation 4 minutes.

4.2 Cleaner Circuit

In the rougher concentrate cleaner circuit, the following variables were examined:

- 1) Alternative zinc depressant combinations.
- 2) Zinc reverse flotation.

From the results obtained (Table No. 7), the following observations can be made:

- 1) The effect of NaCN/SD200 or NaCN complex at 420 g/t promotes a bulk Pb, Zn concentrate.
- 2) The effect of high dosages of ZnSO₄ and NaCN with the NaCN complex is a bulk Pb, Zn concentrate.
- 3) The effect of a flowsheet change to lead depression followed by a reverse zinc flotation produces a marketable lead rougher concentrate (Test 23) and produces a good grade Zn rougher concentrate, the recovery of lead is low but a regrind of the zinc rougher concentrate has not been done which may permit Pb depression from the zinc to Pb concentrate.
- 4) Test 23 proves a marketable lead concentrate can be produced with a flowsheet change in cleaning.
- 5) The standard Vangorda ore cleaning flowsheet procedure produces bulk Pb, Zn concentrate.

Table No. 7 : Effect of Depressants in Bulk Concentrate Cleaning

a) CONDITIONS

TEST NO.	REAGENT ADDITIONS, g/t		pH
	DEPRESSANT	COLLECTOR	
14	NaCN/SD200=420	9:1 , 350/3418A=27	9.9
16	NaCN Complex=420 (1-ZNO mixed with 3-NaCN ,4-SD200)	9:1 , 350/3418A=28	9.6
21	NaCN Complex=420 ZnSO ₄ =400 NaCN=650	9:1 , 350/3418A=30	10.6
23 Reverse Zn Flot.	Ca(OH) ₂ =1550 K ₂ Cr ₂ O ₇ =1500 CuSO ₄ =50	350=30	12.1
23 Pb Flot.	FeSO ₄ =1500 NaCN/SD200=25	9:1 , 350/3418A=20	11.9

Table No. 7. cont'd**b) METALLURGICAL RESULTS**

TEST NO.	PRODUCT	WT. %	GRADE, %			% DISTRIBUTION		
			Pb	Zn	Fe	Pb	Zn	Fe
14	3rd Cleaner Conc	12.0	23.7	34.9	8.4	75.9	90.6	3.7
14	Rougher Conc	21.8	14.8	20.3	21.9	86.0	96.1	17.7
16	3rd Cleaner Conc	8.6	21.4	40.9	6.6	47.5	73.3	2.1
16	Rougher Conc	16.3	19.7	27.8	13.3	82.6	94.4	8.1
21	3rd Cleaner Conc	4.9	39.8	24.3	6.2	53.3	26.6	1.2
21	Rougher Conc	14.0	19.8	30.0	12.1	76.2	94.2	6.4
23	Zn Ro. Conc	6.8	12.1	46.1	7.5	28.8	65.2	1.9
23	Pb Ro. Conc	1.5	64.2	5.9	6.1	33.4	1.8	0.3
23	Comb. Ro. Conc	8.3	21.4	38.9	7.8	62.2	67.0	2.2

4.2.1 Effect of a Different Flowsheet Configuration

The effect of the bulk flotation of lead and zinc from the composite followed by a lead depression and reverse zinc flotation was examined (Test 23):

Table No. 8 : Test No. 23 using a Dichromate Depression to Separate the Pb and Zinc

a) **CONDITIONS**

Stage	Reagents Addition, g/t		pH
	Depressant/Activator	Collector	
Pb and Zn Flotation	Lime = 1250 NaCN/SD200 = 200 CuSO ₄ = 100	9 A350 = 60 1 3418A 10 minutes float time	11.0
Pb Depression Zn Flotation	Lime = 1550 No regrind K ₂ CR ₂ O ₇ = 1500 CuSO ₄ = 50	A350 = 30 7 minutes float time	12.1
Pb Activation Pb Flotation*	NaCN = 25 FeSO ₄ = 1500	9 A350 = 20 1 3418A 4 minutes float time	11.9

b) **METALLURGICAL RESULTS**

Product	Wt. %	Grade, %				% Distribution			
		Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
Zn Conc	6.80	12.1	46.1	7.5	1.21	28.8	65.2	1.9	29.3
Pb Ro Conc	1.49	64.2	5.89	6.1	1.64	33.4	1.8	0.3	8.7
Pb Comb. Conc	8.29	21.4	38.9	7.8	1.28	62.2	67.0	2.2	38.0
Pb Tail	91.7	1.18	1.73	28.3	0.19	37.8	33.0	97.8	62.0
Head (calc.)	100.0	2.86	4.81	26.6	0.28	100.0	100.0	100.0	100.0

* NOTE: The Pb flotation emptied the contents of the cell.

From the metallurgical results of this preliminary scoping test, a marketable Pb concentrate is produced (without regrinding). This scoping test is preliminary and requires optimization to increase Pb and Zn metal recoveries and reduce reagent consumption.

4.2.1.1 Recommendations

The new bulk flotation flowsheet with the lead depression and reverse zinc flotation configuration is recommended to be further developed as a possible technology to process the -3/4" Vangorda ore cap stockpile or Vangorda pit baritic sands as a blend with Faro ore. Therefore additional laboratory tests are recommended to confirm that this technology is applicable to these ore types. If laboratory tests are positive, then laboratory locked cycle tests and a confirmatory pilot plant are recommended.

5. Bench Testwork on Sample PL-09

Sample V-90-PL-09 was an interval of drill core approximately 100 feet below surface. This drill core was evaluated by the standard Vangorda flowsheet and reagent scheme.

Table No. 9 : Drill Core Sample Test Results (Test No. 17)

a) CONDITIONS

Stage	Lead Circuit		Zinc Circuit		Reagents Addition, g/t	
	Depressant	Collector	Depressant Activator	Collector	pH Pb	Zn
Rougher	Na ₂ CO ₃ = 1500 NaCN/SD200 = 200	9 A350 = 37 1 3418A	Ca(OH) ₂ = 750 CuSO ₄ = 800	9 A350 = 35 1 3418A	10.0	11.3
Regrind	NaCN/SD200 = 75	9 A350 = 18 1 3418A	-	-	9.7	-
Pb Cleaners	NaCN/SD200 = 120	9 A350 = 1 1 3418A	-	-	9.7 to 9.0	-

b) **METALLURGICAL RESULTS**

Product	Wt. %	Grade, %				% Distribution			
		Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
Pb 4th Cl. Conc	7.48	64.9	7.13	6.18	0.11	79.5	8.6	2.0	6.5
Pb 1st Conc	11.44	47.8	10.5	12.1	0.32	89.6	19.4	6.1	29.4
Pb Ro Tail (calc.)	76.3	0.56	4.44	23.1	0.06	7.0	54.6	78.2	33.5
Zn Ro. Conc	13.13	0.80	22.9	20.0	0.08	1.7	48.5	11.6	8.4
Zn Ro. Tail	63.17	0.51	0.60	23.8	0.05	5.3	6.1	66.5	25.1
Head (calc.)	100.0	6.11	6.20	22.6	0.13	100.0	100.0	100.0	100.0
Head (assay)		6.14	6.48	24.1	0.13				

The results obtained with sample V-90-PL-09 indicates that the standard Vangorda treatment procedure is applicable for this ore type.

6. Plant Reagent Addition Survey

The reagent addition measurement records of the grinding operators, Pb flotation operations, Zn flotation operators and the shift metallurgists were examined.

The reagent additions (cc/min) were converted into reagent dosages (g/t), compared, averaged and the corresponding metallurgical results are shown (Table No. 10).

Table No. 10 : Effect of Reagent Dosages on Concentrator Metallurgical Results. October 19-25

a) **CONDITIONS**

	NaCN SD200	Lead Circuit, g/t			Zinc Circuit, g/t		
		R-342	343 Xanthate	MIBC	CuSO ₄	Xanthate	DF250
Operator Rpt.	172	2	60	17	437	102	22
Shift Met. Checklist	170	2	61	16	436	92	25
Average g/t	171	2	61	16	437	97	24

b) **METALLURGICAL RESULTS**

Product	%Pb	Assays		Ag, g/t	% Distribution		
		%Zn			Pb	Zn	Ag
Lead Concentrate	61.7	5.45	514	77.3	3.9	51.5	
Zinc Concentrate	2.13	50.4	49.9	6.1	81.9	11.4	

From the results in Table No. 10, the following observations may be drawn:

- 1) The reagent dosages in the lead circuit are steady, this indicates constant flowrates as the operator's and shift metallurgist's measurements compare closely.
- 2) The reagent dosages in the zinc circuit are steady except for the xanthate. This dosage is 10% lower on the shift metallurgists' checklist. This indicates the flow is decreasing during the time interval between the operator's and shift metallurgist's measurement.

Tables 11, 12, 13 and 14 detail the reagent dosages, metallurgical results and pH on a daily basis. From the results in these tables the following observations are of interest:

- 1) The daily operation includes some scheduled cyclone maintenance and other mechanical maintenance: (one Pb regrind was down (October 18-20) for cyclone maintenance, low rod mill feed tonnage through A circuit October 22-24 due to conveying problems. Therefore, due to these circuit instabilities daily metallurgical grade and recovery trends could not be confirmed.
- 2) The lead and zinc concentrate grades and recoveries for October 19 to 25 are close to target (target in brackets). The lead concentrate is 61.7% Pb (60) grade with 77.3% Pb (80) recovery and the zinc concentrate is 50.4% Zn (52) grade and 81.9% (80) recovery. As the circuit stability improves it is possible these targets can be achieved.
- 3) The good metallurgy in the week of October 19 to 25 may be attributed to the reagent dosages, pH and other circuit factors and further evaluation of these reagent dosages under stable circuit conditions is recommended.

Table No. 11: Reagent Dosage (g/l) - Lead Circuit - October 1990
 Calculated from operator report and concentrator daily production report data.

Date	Feed Interruptions	NaCN /SD200		Ro Cond.	SIX			MIBC		Assays, %			% Distribution		
		Rod Mills	Regrind Mill		Ro Scav.	1st Cleaner	R242 Ro	Ro	Scav.	Pb	Zn	Ag	Pb	Zn	Ag
Oct. 14/90	---	157	0.76	34	19	0	2	11	5	55.6	6.21	429.0	66.0	3.8	44.0
Oct. 15/90	RM4 down for 8 h.	115	0	28	17	0.06	1	10	4	64.1	5.03	560.0	75.6	3.8	53.0
Oct. 16/90	Mill down from 5-7 PM.	144	0	29	17	0.68	1	10	4	55.0	6.52	510.0	78.6	5.7	50.0
Oct. 17/90	---	161	8	28	18	0	2	12	4	56.1	5.75	510.0	74.1	4.6	52.9
Oct. 18/90	Pb regrind down 24 h.	158	0	33	16	0	2	12	3	49.5	7.23	440.0	79.5	7.3	52.1
Oct. 19/90	# 1 regrind mill down 12 h.	166	3	44	20	0	2	11	4	60.9	5.17	468.0	79.9	3.8	57.9
Oct. 20/90	# 2 regrind mill down 12 h.	175	2	50	22	0	2	11	4	58.6	5.42	460.0	80.4	4.3	55.4
Oct. 21/90	---	166	1.2	44	19	0.73	2	11	6	59.8	4.97	470.0	73.8	3.3	45.8
Oct. 22/90	1/2 tonnage night shift.	162	3	32	16	0	2	11	4	59.3	6.09	519.0	78.8	4.4	49.2
Oct. 23/90	RM1-3 down for 3 hours.	166	6	30	16	2	2	13	4	65.6	5.03	555.0	74.1	3.3	50.7
Oct. 24/90	RM1 down for 6 h.	161	7	40	17	1	2	13	5	64.8	5.20	550.0	75.5	3.6	48.4
Oct. 25/90	---	182	6	47	17	3	2	13	5	63.0	6.30	579.0	78.3	4.7	53.3
Avg. 14-25		159	3	37	18	1	2	12	4	59.3	5.74	504	76.2	4.4	51.1
Avg. 19-25		168	4	41	18	1	2	12	5	61.7	5.45	514	77.3	3.9	51.5

Discussion

Reagents	g/L
Xanthate	86
Depressant	190
R242	1130
MIBC	1000

Table No. 12: Reagent Dosage (g/t) - Zinc Circuit - October 1990
 Data from operator reports and concentrator daily production reports.

Date	CuSO4		Ro Cond.2	SIX			Dow 250		Pb	Assays, %		% Distribution		
	Ro Cond 1	Regrind Mill		Zn Scav. K+L	Zn 1st Cleaner	Zn 1st Cl Scav	Ro	Scav.		Zn	Ag	Pb	Zn	Ag
Oct. 14/90	480	0	47	38	7	2	21	0	1.24	51.5	38.0	3.8	81.8	10.1
Oct. 15/90	337	0	47	21	5	2	20	0	2.28	45.9	54.0	6.2	80.6	11.8
Oct. 16/90	310	0	34	23	8	1	22	0	1.71	47.4	42.0	4.6	77.5	7.7
Oct. 17/90	353	0	43	30	4	2	27	0	1.98	48.1	43.0	5.6	82.4	9.5
Oct. 18/90	298	0	40	27	4	3	23	0	2.02	50.0	48.0	5.0	78.8	8.8
Oct. 19/90	427	0	45	39	15	4	34	0	1.88	49.7	40.0	5.5	82.7	11.1
Oct. 20/90	408	0	54	37	20	2	15	0	1.94	51.1	48.0	5.1	78.0	11.1
Oct. 21/90	431	0	43	33	13	2	18	0	1.80	49.1	48.0	5.8	84.6	12.2
Oct. 22/90	410	0	41	34	19	7	33	0	1.52	49.8	48.0	4.7	83.5	10.5
Oct. 23/90	408	0	43	39	11	2	22	0	2.91	50.1	57.0	8.4	83.2	13.4
Oct. 24/90	462	0	44	41	17	2	15	0	2.83	51.1	54.0	7.8	82.0	11.2
Oct. 25/90	510	0	43	40	20	4	19	0	2.03	52.1	54.0	5.2	79.7	10.2
Avg. 14-25	403	0	44	33	12	3	23	0	2.01	49.6	47.8	5.6	81.2	10.6
Avg. 19-25	437	0	45	37	17	3	22	0	2.13	50.4	49.9	6.1	81.9	11.4

Reagents	g/L
Xanthate	86
CuSO4	205
DF250	1000

Discussion

Table NO. 13 : Reagent Consumption (g/t) - Lead & Zinc Circuit - October 1990
Data calculated from Daily Metallurgist Checklist

Date	Shift	Lead Circuit				Zinc Circuit		
		NaCN SD200	R-242	Xanthate	MIBC	Xanthate	Dow 250	CuSO4
Oct. 18/90	Day	163	2	53	15	80	22	308
	Night	144	2	50	14	85	31	338
	Daily Avg.	154	2	51	15	83	27	323
Oct. 19/90	Day	160	2	61	17	91	38	433
	Night	-	-	-	-	-	-	-
	Daily Avg.	160	2	61	17	91	38	433
Oct. 20/90	Day	171	2	70	15	95	30	431
	Night	167	2	71	16	108	8	420
	Daily Avg.	169	2	70	16	102	19	425
Oct. 21/90	Day	171	2	70	15	95	30	431
	Night	-	-	-	-	-	-	-
	Daily Avg.	171	2	70	15	95	30	431
Oct. 22/90	Day	175	2	56	14	82	20	431
	Night	-	-	-	-	-	-	-
	Daily Avg.	175	2	56	14	82	20	431
Oct. 23/90	Day	165	2	43	17	85	24	374
	Night	-	-	-	-	-	-	-
	Daily Avg.	165	2	43	17	85	24	374
Oct. 24/90	Day	153	2	55	18	101	14	451
	Night	181	2	65	18	91	15	472
	Daily Avg.	167	2	60	18	96	15	461
Oct. 25/90	Day	179	2	70	18	86	28	482
	Night	184	2	61	-	97	-	513
	Daily Avg.	181	2	65	18	92	28	497
Oct. 26/90	Day	175	2	78	27	107	26	543
	Night	-	-	-	-	138	12	584
	Daily Avg.	175	2	78	27	122	19	564
Oct. 27/90	Day	186	2	74	17	126	0.8	395
	Night	-	-	-	-	-	-	-
	Daily Avg.	186	2	74	17	126	0.8	395
Oct. 28/90	Day	188	3	98	14	96	-	499
	Night	-	-	-	-	-	-	-
	Daily Avg.	188	3	98	14	96	0	499
Oct 18-28	Avg. (g/t)	172	2	66	17	97	20	439
Oct 19-25	Avg. (g/t)	170	2	61	16	92	25	436

Reagents	g/L
Xanthate	86
NaCN/SD200 mixture	190
R242	1130
MIBC	1000
Dowfroth 250	1000
CuSO4	205

Table No. 14 : pH Readings from Operator Reports

Date	Grinding Circuit				Lead Circuit			Zinc Circuit		Column
	Rod Mill 1	Rod Mill 2	Rod Mill 3	Rod Mill 4	Ro	1st Cleaner	3rd Cleaner	Ro	1st Cleaner	
Oct. 14/90	10.0	10.2	-	10.1	9.7	-	11.2	10.5	10.9	11.0
Oct. 15/90	10.8	10.8	-	10.0	9.7	8.7	11.2	10.2	10.3	10.6
Oct. 16/90	10.0	10.0	-	10.0	9.9	-	11.3	10.3	10.2	11.0
Oct. 17/90	10.4	10.5	-	10.2	9.9	10.4	11.4	10.5	10.2	10.9
Oct. 18/90	10.1	10.1	-	10.3	10.0	-	11.8	10.5	10.4	11.0
Oct. 19/90	9.8	9.8	9.3	10.7	10.2	-	11.6	10.4	10.4	11.4
Oct. 20/90	9.9	10.0	8.9	9.8	9.8	-	11.4	10.1	10.5	11.2
Oct. 21/90	10.0	10.0	9.5	10.6	10.0	-	11.1	10.6	10.4	11.2
Oct. 22/90	10.2	10.2	9.4	10.3	9.6	-	11.4	10.3	10.3	11.3
Oct. 23/90	11.3	11.2	11.2	9.5	9.7	-	11.1	10.5	10.2	11.6
Oct. 24/90	11.2	11.4	11.4	10.7	9.8	-	10.9	10.7	10.5	11.4
Oct. 25/90	12.1	12.1	10.9	8.7	9.4	-	11.3	10.8	10.1	11.1
Avg. 14-25	10.5	10.5	10.1	10.1	9.8	-	11.3	10.5	10.4	11.1
Avg. 19-25	10.6	10.7	10.1	10.0	9.8	-	11.3	10.5	10.3	11.3

C A L C U L A T I O N S

$$\text{g/t} = \frac{[\text{Reagent strength g/L}] \times [\text{cc/min}]}{[1,000 \text{ cc/L}] \times [\text{t/min}]}$$

Assumptions: 1) Tonnage steady at 10 t/min

2) Reagent strength in g/L

343 Xanthate	=	86
1:1, NaCN/SD200 mixture	=	190
CuSO ₄	=	205
MIBC	=	1000
DF250	=	1000
R242	=	1130

Example
$$\text{g/t} = \frac{[\text{Reagent strength g/L}] \times [\text{cc/min}]}{[10,000]}$$

1) To determine the dosage of 8933 cc/min of NaCN/SD200 mixture

$$\begin{aligned} \therefore \text{NaCN/SD200 Dosage} &= \frac{[190] \times [8933]}{10,000} \\ &= 170 \text{ g/t} \end{aligned}$$

LABORATORY TEST DETAILS

TEST NO. 1

Purpose: To investigate the lead flotation on the Vangorda PL-3 Ore using new standard test conditions.

Procedure: As shown below.

Feed: 2000 grams of minus 10 mesh V-90-PL-3 Vangorda ore.

Grind: 20 minutes at 70 % solids in a lab rod mill with 16.5 kg of rods.

Regrind: 10 minutes with 18 kg of steel balls

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Na ₂ CO ₃	NaCN	343 3418A (1:1)	MIBC	Grind	Cond.	Froth	
Grind	1300	200	-	-	20	1	-	9.7
Pb Rougher	-	-	5	14	-	1	4	-
Pb Scavenger	-	-	5	10	-	1	3	-
	-	-	2.5	10	-	1	3	9.7
Pb Regrind	-	75	20	-	10	-	-	-
Pb 1st Cleaner	-	20	-	5	-	1	4	8.9
	-	-	1	5	-	1	6	-
Pb 1st Cl Scav	-	-	5	5	-	1	3	8.9
Pb 2nd Cleaner	-	50	-	2	-	1	5	8.7
Pb 3rd Cleaner	-	25	4	5	-	1	5	-
Pb 4th Cleaner	-	25	-	5	-	1	4	9.2
	-	25	2	5	-	1	3	-
Pb 5th Cleaner	-	25	-	5	-	1	3	9.0
	-	25	2	5	-	1	3	-

Stage:	Rougher	1st Cleaner	2nd - 5th Cleaners
Flotation Cell:	D1-5L	D1-2.5L	D1-1.5L
Speed rpm:	1650	1200	900

Test No.: 1

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Final Conc	276.53	13.87	24.2	40.3	2.98	56.7	78.8	3.5
2. Pb 5th Clnr Tail	3.27	0.16	19.6	28.4	7.20	0.5	0.7	0.1
3. Pb 4th Clnr Tail	2.69	0.13	16.8	24.1	8.85	0.4	0.5	0.1
4. Pb 3rd Clnr. Tail	5.96	0.30	19.2	22.7	7.29	1.0	1.0	0.2
5. Pb 2nd Clnr Tail	12.42	0.62	19.0	21.0	7.86	2.0	1.8	0.4
6. Pb 1st Clnr Tail	38.63	1.94	12.6	12.4	9.23	4.1	3.4	1.5
7. Pb 1st Scav Conc	9.07	0.46	22.9	31.0	6.81	1.8	2.0	0.3
8. Pb Final Scav Tail	1644.70	82.51	2.41	1.02	13.6	33.6	11.9	94.0
Head (calc.)	1993.27	100.00	5.92	7.09	11.9	100.0	100.0	100.0
Head (assay)			6.52	8.22	12.6			

CUMMULATIVE:

Pb 5th Clnr Conc	276.53	13.87	24.2	40.3	2.98	56.7	78.8	3.5
Pb 4th Clnr Conc	279.80	14.04	24.1	40.2	3.03	57.2	79.5	3.6
Pb 3rd Clnr Conc	282.49	14.17	24.1	40.0	3.08	57.6	80.0	3.7
Pb 2nd Clnr Conc	288.45	14.47	24.0	39.7	3.17	58.6	80.9	3.8
Pb 1st Clnr Conc	300.87	15.09	23.8	38.9	3.37	60.6	82.8	4.3
Pb Ro Conc	348.57	17.49	22.5	35.7	4.10	66.4	88.1	6.0

TEST NO. 2

Purpose: To duplicate test 1.

Procedure: Similar to Test 1.

Feed: 2000 grams of minus 10 mesh V-90-PL-3 Vangorda ore.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Regrind: 10 minutes using steel balls.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Na ₂ CO ₃	NaCN	343 3418A (1:1)	MIBC	Grind	Cond.	Froth	
Grind	1300	200	-	-	20	-	-	9.6
Pb Rougher	-	-	5	15	-	1	4	-
Pb Scavenger	-	-	5	10	-	1	3	-
	-	-	2.5	10	-	1	3	-
Pb Regrind	-	75	20	-	10	-	-	-
Pb 1st Cleaner	-	20	-	5	-	1	4	8.8
	-	-	1	5	-	1	6	-
Pb 1st Cl Scav	-	-	5	5	-	1	3	-
Pb 2nd Cleaner	-	50	-	2	-	1	5	9.2
Pb 3rd Cleaner	-	25	4	5	-	1	5	9.3
Pb 4th Cleaner	-	25	-	5	-	1	4	9.1
	-	-	2	5	-	1	3	-
Pb 5th Cleaner	-	25	-	5	-	1	3	9.0
	-	-	2	5	-	1	3	-

Stage:	Rougher	1st Cleaner	2nd - 5th Cleaners
Flotation Cell:	D1-5L	D1-2.5L	D1-1.5L
Speed rpm:	1650	1200	900

LR: 3683
Test No.: 2

Project: Vangorda

October 1990

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. Pb Final Conc	209.44	10.49	31.3	35.2	2.68	2.47	52.9	47.5	2.5	53.4
2. Pb 5th Clnr Tail	14.12	0.71	26.9	31.8	4.60	2.48	3.1	2.9	0.3	3.6
3. Pb 4th Clnr Tail	2.18	0.11	20.4	23.5	6.13	1.81	0.4	0.3	0.1	0.4
4. Pb 3rd Clnr. Tail	22.28	1.12	26.1	33.8	3.75	2.40	4.7	4.9	0.4	5.5
5. Pb 2nd Clnr Tail	39.08	1.96	17.1	34.4	5.67	2.11	5.4	8.7	1.0	8.5
6. Pb 1st Clnr Tail	40.10	2.01	9.28	10.5	9.61	0.88	3.0	2.7	1.7	3.6
7. Pb 1st Scav Conc	9.57	0.48	18.3	37.6	5.47	1.68	1.4	2.3	0.2	1.7
8. Pb 2nd Scav Conc	49.35	2.47	13.4	42.9	4.41	1.28	5.3	13.6	1.0	6.5
9. Pb Final Scav Tail	1611.15	80.67	1.83	1.65	13.2	0.10	23.8	17.1	93.0	16.6
Head (calc.)	1997.27	100.00	6.20	7.77	11.4	0.48	100.0	100.0	100.0	100.0
Head (assay)			6.52	8.22	12.6	0.61				

CUMMULATIVE:

Pb 5th Clnr Conc	209.44	10.49	31.3	35.2	2.68	2.47	52.9	47.5	2.5	53.4
Pb 4th Clnr Conc	223.56	11.19	31.0	35.0	2.80	2.47	56.0	50.4	2.7	57.1
Pb 3rd Clnr Conc	225.74	11.30	30.9	34.9	2.83	2.46	56.3	50.7	2.8	57.5
Pb 2nd Clnr Conc	248.02	12.42	30.5	34.8	2.92	2.46	61.0	55.6	3.2	63.0
Pb 1st Clnr Conc	287.10	14.37	28.7	34.7	3.29	2.41	66.4	64.2	4.1	71.5
Pb Ro Conc	327.20	16.38	26.3	31.8	4.07	2.22	69.4	66.9	5.8	75.2
Pb Ro. Tl.	1670.07	83.62	2.3	3.1	12.9	0.14	30.6	33.1	94.2	24.8
Pb Ro Conc + Scav 1&2	386.12	19.33	24.4	33.3	4.14	2.09	76.2	82.9	7.0	83.4

TEST NO. 3

Purpose: To evaluate the effect of increasing the cyanide addition to 400 g/t.

Procedure: Similar to Test 1, double the NaCN dosage.

Feed: 2000 grams of minus 10 mesh V-90-PL-3 Vangorda ore.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Na ₂ CO ₃	NaCN	343 3418A (1:1)	MIBC	Grind	Cond.	Froth	
Grind	1300	400	-	-	20	-	-	10.5
Pb Rougher	-	-	5	15	-	1	4	-
Pb Scavenger	-	-	5	10	-	1	3	-
	-	-	2.5	10	-	1	3	-

pH Water = 7.4

Stage: Rougher
Flotation Cell: D1-5L
Speed rpm: 1650

At the end of the Pb Scavenger, added 400 g/t FeSO₄, 2.5 g/t collector, no additional Pb flotation visible.

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Ro Conc	37.52	1.70	14.9	21.6	5.42	4.5	4.6	0.6
2. Pb Ro Tail	2169.90	98.30	5.41	7.73	16.0	95.5	95.4	99.4
Head (calc.)	2207.4	100.00	5.57	7.97	15.8	100.0	100.0	100.0

TEST NO. 4

Purpose: To evaluate the effect of 300 g/t NaCN.

Procedure: Similar to Test 2, but 300 g/t NaCN.

Feed: 2000 grams of minus 10 mesh V-90-PL-3 Vangorda ore.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Na ₂ CO ₃	NaCN	343 3418A (1:1)	MIBC	Grind	Cond.	Froth	
Grind	1300	300	-	-	20	-	-	10.6
Pb Rougher	-	-	5	15	-	1	4	-
Pb Scavenger	-	-	5	10	-	1	3	-
	-	-	2.5	10	-	1	3	-

Stage: Rougher
 Flotation Cell: D1-5L
 Speed rpm: 1650

Test No.: 4

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Ro Conc	41.50	2.02	15.2	20.5	5.81	5.3	5.1	0.8
2. Pb Ro Tail	2015.40	97.98	5.61	7.80	15.6	94.7	94.9	99.2
Head (calc.)	2056.9	100.00	5.80	8.06	15.4	100.0	100.0	100.0

TEST NO. 5

Purpose: To investigate the lead flotation on the Vangorda PL-3 ore using new standard test conditions.

Procedure: Use of depressant NaCN/SD200 replacing NaCN .
Use of collector A350/3418A (9/1)replacing 343/3418A(1/1)
and adding 242 as below.

Feed: 2000 grams of minus 10 mesh V-90-PL-3 Vangorda ore.

Grind: 25 minutes at 70 % solids in a lab rod mill.

Regrind : 10 minutes with steel balls.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH	Lime to pH
	Na ₂ CO ₃	NaCN SD200	A350 3418A (9:1)	MIBC	242	Grind	Cond.	Froth		
Grind	1000	200	-	-	-	20	-	-	-	-
	-	-	3	-	-	5	-	-	-	-
Pb Rougher	-	-	3	15	2	-	1	4	10.2	-
Pb Scavenger	-	-	3	10	-	-	1	3	-	-
	-	-	3	10	-	-	1	3	-	-
Pb Regrind	-	100	15	-	-	10	-	-	-	-
Pb 1st Cleaner	-	20	-	5	-	-	1	4	9.6	-
	-	-	1	5	-	-	1	6	-	-
Pb 1st Cl Scav	-	-	3	5	-	-	1	3	-	-
Pb 2nd Cleaner	-	50	-	2.5	-	-	1	4	9.4	-
	-	-	1	5	-	-	1	3	-	-
Pb 3rd Cleaner	-	25	-	5	-	-	1	4	9.3	-
	-	-	1	5	-	-	1	3	-	-

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. 3rd Cleaner Conc	28.69	1.4	10.5	47.7	4.56	2.6	8.4	0.4
2. 3rd Cleaner Tail	4.20	0.2	20.5	25.9	8.91	0.8	0.7	0.1
3. 2nd Cl Tail	9.01	0.4	20.4	20.3	9.68	1.6	1.1	0.3
4. 1st Cl Tail	45.16	2.2	18.1	14.9	11.3	7.1	4.1	1.6
5. Ro Tail	1979.40	95.8	5.08	7.02	15.6	87.9	85.6	97.6
Head (calc.)	2066.5	100.00	5.54	7.85	15.3	100.0	100.0	100.0

CUMMULATIVE:

2nd Cleaner Conc	32.89	1.6	11.8	44.9	5.12	3.4	9.1	0.5
1st Cleaner Conc	41.90	2.0	13.6	39.6	6.10	5.0	10.2	0.8
Rougher Conc	87.06	4.2	15.9	26.8	8.80	12.1	14.4	2.4

TEST NO. 6

Purpose: To evaluate the use of ZnSO₄.

Procedure: Similar to Test 5, but with ZnSO₄ mixed together with the NaCN/SD200.

Feed: 2000 grams of minus 10 mesh V-90-PL-3 Vangorda ore.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Na ₂ CO ₃	NaCN SD200 ZnSO ₄ (2/1/1)	A350 3418A (9/1)	MIBC	242	Grind	Cond.	Froth	
Grind	750	200	-	-	-	15	-	-	-
Grind	-	-	3	-	-	5	-	-	-
Pb Rougher	-	-	3	15	2	-	1	4	9.9
Pb Scavenger	-	-	3	10	-	-	1	3	-
	-	-	3	10	-	-	1	3	-

Stage: Rougher
 Flotation Cell: D1-5L
 Speed, rpm: 1650

Test No.: 6

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Ro Conc	90.9	4.39	18.2	32.4	4.85	14.5	18.2	1.4
2. Pb Ro Tail	1982.0	95.61	4.92	6.70	16.2	85.5	81.8	98.6
Head (calc.)	2072.9	100.00	5.50	7.83	15.7	100.0	100.0	100.0

TEST NO. 7

Purpose: To evaluate the effect of a coarser grind.
 Procedure: Similar to Test 5, but a 10 minute primary grind.
 Feed: 2000 grams of minus 10 mesh V-90-PL-3 Vangorda ore.
 Grind: 10 minutes at 70 % solids in a lab rod mill.
 Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Na ₂ CO ₃	NaCN SD200	A350 3418A (9:1)	MIBC	242	Grind	Cond.	Froth	
Grind	1000	200	-	-	-	8	-	-	-
	-	-	2	-	-	2	-	-	-
Pb Rougher	-	-	2	15	2	-	1	4	10.3
Pb Scavenger	-	-	2	10	-	-	1	3	-
	-	-	2	10	-	-	1	3	-

Stage: Rougher
 Flotation Cell: D1-5L
 Speed, rpm: 1650

Test No.: 7

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Ro Conc	40.0	1.92	15.8	29.0	4.76	5.6	7.0	0.6
2. Pb Ro Tail	2044.6	98.08	5.24	7.58	15.0	94.4	93.0	99.4
Head (calc.)	2084.6	100.00	5.44	7.99	14.8	100.0	100.0	100.0

TEST NO. 8

Purpose: To evaluate the effect of a coarse grind.

Procedure: Similar to Test 5, but a 7 minute primary grind.

Feed: 2000 grams of minus 10 mesh V-90-PL-3 Vangorda ore.

Grind: 7 minutes at 70 % solids in a lab rod mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Na ₂ CO ₃	NaCN SD200	A350 3418A (9:1)	MIBC	242	Grind	Cond.	Froth	
Grind	1000	200	-	-	-	5	-	-	-
	-	-	2	-	-	2	-	-	-
Pb Rougher	-	-	2	15	2	-	1	4	10.4
Pb Scavenger	-	-	2	10	-	-	1	3	-
	-	-	2	10	-	-	1	3	-

Stage: Rougher
 Flotation Cell: D1-5L
 Speed, rpm: 1650

Test No.: 8

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Ro Conc	20.8	0.92	16.8	24.4	3.57	2.8	2.8	0.2
2. Pb Ro Tail	2233.4	99.08	5.37	7.78	15.8	97.2	97.2	99.8
Head (calc.)	2254.2	100.00	5.48	7.93	15.7	100.0	100.0	100.0

TEST NO. 9

Purpose: To evaluate the effect of increasing the NaCN and ZnSO₄ dosages.

Procedure: Similar to Test 6, but mix ZnSO₄ with Na₂CO₃, and a 40 minute primary grind.

Feed: 2000 grams of minus 10 mesh V-90-PL-3 Vangorda ore.

Grind: 40 minutes at 70 % solids in a lab rod mill.

Regrind: 20 minutes in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne							Time, minutes			pH
	Na ₂ CO ₃	ZnSO ₄	NaCN	SD200	A350 3418A (9:1)	242	MIBC	Grind	Cond.	Froth	
Grind	750	750	400	100	-	-	-	35	-	-	-
Pb Rougher	-	-	-	-	2	-	-	5	-	-	-
Pb Scavenger	-	-	-	-	2	2	15	-	1	4	9.1
	-	-	-	-	1	-	10	-	1	3	-
Pb Scavenger 2	-	-	-	-	1	-	10	-	1	3	-
	-	-	-	-	1	-	10	-	1	3	8.9
Pb Regrind	125	125	200	100	-	-	-	15	-	-	-
	-	-	-	-	5	-	-	5	-	-	-
Pb 1st Cleaner	-	-	-	-	10	-	20	-	1	4	10.1
	-	-	-	-	1	-	5	-	1	6	-
	-	-	-	-	2	-	5	-	1	3	-

Stage: Rougher 1st Cleaner
 Flotation Cell: D1-5L D1-2.5L
 Speed, rpm: 1650 1200

Test No.: 9**Metallurgical Results**

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. 1st Cleaner Conc	2.76	0.13	39.4	17.7	4.47	1.0	0.3	0.0
2. 1st Cleaner Tail	19.85	0.96	14.9	16.4	9.02	2.6	2.0	0.5
3. Scav Conc	10.15	0.49	21.9	26.4	5.42	2.0	1.6	0.2
4. Scav Tail	2041.70	98.42	5.27	7.68	16.1	94.5	96.1	99.3
Head (calc.)	2074.5	100.00	5.49	7.87	16.0	100.0	100.0	100.0

CUMMULATIVE:

1+2		1.09	17.9	16.6	8.46	3.6	2.3	0.6
1+2+3		1.58	19.1	19.6	7.52	5.5	3.9	0.7

TEST NO. 10

Purpose: To investigate the lead flotation on the PL-08 Vangorda ore using the standard test conditions.

Procedure: Similar to Test 5.

Feed: 2000 grams of minus 10 mesh V-90-PL-08 Vangorda ore.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Regrind: 10 minutes in the lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH	pH Increased with lime
	Na ₂ CO ₃	NaCN SD200	A350 3418A (9:1)	MIBC	Grind	Cond.	Froth		
Grind	1725	200	-	-	15	-	-	-	
Pb Rougher	-	-	2	-	5	-	-	-	
Pb Scavenger	-	-	3	14	-	1	4	9.4	
Pb Regrind	-	-	3	10	-	1	3	-	
Pb 1st Cleaner	-	-	2.5	10	-	1	3	-	
Pb 1st CI Scav	-	75	5	-	10	-	-	-	
Pb 2nd Cleaner	-	20	-	4	-	1	4	9.4	
	-	-	1	4	-	1	6	-	
	-	-	2	4	-	1	3	-	
	-	50	-	2	-	1	4	-	10.7
	-	-	1	4	-	1	3	-	

Water pH = 7

Stage:	Rougher	1st Cleaner	2nd Cleaner
Flotation Cell:	D1-5L	D1-2.5L	D1-1.5L
Speed, rpm:	1650	1200	900

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. 2nd Cleaner Conc	11.13	0.56	8.48	49.8	6.15	2.83	1.0	5.9	0.2	2.6
2. 2nd Cleaner Tail	14.69	0.74	40.4	16.9	6.51	4.66	6.1	2.7	0.2	5.6
3. 1st CI Tail	16.38	0.82	13.7	4.22	17.7	1.85	2.3	0.7	0.6	2.5
4. Ro Tail	1955.83	97.89	4.52	4.33	23.0	0.56	90.6	90.7	99.0	89.4
Head (calc.)	1998.0	100.00	4.88	4.67	22.7	0.61	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

1st Cleaner Conc	1.29	26.6	31.1	6.35	3.87	7.1	8.6	0.4	8.2
Pb Rougher Conc	2.11	21.6	20.7	10.8	3.09	9.4	9.3	1.0	10.6

TEST NO. 11

Purpose: To evaluate the effect of increasing collector in the pb float and increasing the depressant to the regrind.

Procedure: Similar to Test 10, increased collector and depressants.

Feed: 2000 grams of minus 10 mesh V-90-PL-08 Vangorda ore.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Regrind: 10 minutes in the lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Na ₂ CO ₃	NaCN SD200	A350 3418A (9:1)	MIBC	Grind	Cond.	Froth	
Grind	1725	200	-	-	15	-	-	-
	-	-	2	-	5	-	-	9.4
Pb Rougher	-	-	5	14	-	1	4	-
Pb Scavenger	-	40	5	10	-	1	3	-
	-	-	22.5	20	-	1	12	-
Pb Regrind	-	200	20	-	10	-	-	-
Pb 1st Cleaner	-	20	-	4	-	1	4	9.5
	-	-	-	4	-	1	6	-
Pb 1st Cl Scav	-	-	5	4	-	1	8	9.4
Pb 2nd Cleaner	-	50	-	2	-	1	4	-
	-	-	4	4	-	1	4	-

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. 2nd Cleaner Conc	80.16	3.88	5.82	51.6	5.66	3.45	4.7	42.8	1.0	21.4
2. 2nd Cleaner Tail	46.38	2.24	18.0	39.3	5.39	4.02	8.4	18.9	0.5	14.4
3. 1st Cl Tail	99.81	4.83	27.7	4.40	19.3	2.25	27.8	4.5	4.1	17.4
4. 1st Cl Scav. Conc	70.46	3.41	34.2	27.7	5.00	3.78	24.2	20.2	0.7	20.6
5. Ro Tail	1771.19	85.65	1.96	0.74	24.9	0.19	34.9	13.6	93.7	26.1
Head (calc.)	2068.0	100.00	4.81	4.67	22.8	0.62	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

1st Cleaner Ro. Conc	6.12	10.3	47.1	5.56	3.66	13.1	61.7	1.5	35.9
1st Cleaner Ro. + Scav. Conc	9.53	18.8	40.2	5.36	3.70	37.3	81.9	2.2	56.5
Rougher Conc	14.35	21.8	28.1	10.0	3.21	65.1	86.4	6.3	73.9

TEST NO. 12

Purpose: To investigate the lead flotation on the 1:1 blended PL-08 Vangorda and Faro ore using new standard test conditions.

Procedure: As below.

Feed: 2000 grams of minus 10 mesh 1:1 blended V-90-PL-08 Vangorda : Faro ore.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Na ₂ CO ₃	NaCN	343	MIBC	ZnSO ₄	Grind	Cond.	Froth	
Grind	1750	200	-	-	200	20	-	-	9.0
Pb Rougher	-	500	40	12	-	-	5	4	9.6
Pb Scavenger	-	-	20	6	-	-	1	3	-
	-	-	10	4	-	-	1	4	-

Stage: Rougher
 Flotation Cell: D1-5L
 Speed, rpm: 1600

Test No.: 12

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. Pb Ro Conc	135.79	7.25	39.1	14.7	10.8	2.96	58.5	22.5	3.4	38.8
2. Pb Scav. Conc	103.31	5.51	15.3	27.3	14.7	3.30	17.4	31.8	3.6	32.9
3. Pb Scav Tail	1634.91	87.24	1.34	2.48	24.3	0.18	24.1	45.7	93.0	28.4
Head (calc.)	1874.0	100.00	4.85	4.73	22.8	0.55	100.0	100.0	100.0	100.0
Head(assay)	144.01	-	4.94	4.93	22.2	0.63				

Calculated Grades and Recoveries

1+2	239.1	12.8	28.8	20.1	12.5	3.11	75.9	54.3	7.0	71.6
-----	-------	------	------	------	------	------	------	------	-----	------

TEST NO. 13

Purpose: To investigate the lead flotation on the 1:1 blended PL-08 Vangorda and Faro ore using new standard test conditions.

Procedure: As indicated below.

Feed: 2000 grams of minus 10 mesh 1:1 blended V-90-PL-08 Vangorda and Faro ore.

Grind: 22 minutes at 70 % solids in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	Na ₂ CO ₃	NaCN SD200	A350 3418A (9:1)	ZnSO ₄	MIBC	NaCN	Grind	Cond.	Froth	
Grind	1750	200	-	-	-	-	17	-	-	-
	-	-	2	-	-	-	5	-	-	-
Pb Rougher	-	300	15	800	14	750	-	1	4	9.8
Pb Scavenger	-	300	10	-	10	-	-	1	3	-
	-	-	10	-	10	-	-	1	3	-
Pb Scav Conc	-	-	5	-	10	-	-	1	3	-

Stage: Rougher
Flotation Cell: D1-5L
Speed, rpm: 1600

Test No.: 13

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. Pb Ro Conc	153.80	8.73	35.0	13.4	14.5	2.13	75.7	24.4	4.8	56.6
2. Pb Scav. Conc	58.30	3.31	10.2	13.0	26.1	1.39	8.4	9.0	3.3	14.0
3. Pb Scav Tail	1548.86	87.96	0.73	3.64	27.3	0.11	15.9	66.7	91.9	29.4
Head (calc.)	1760.96	100.00	4.04	4.80	26.1	0.33	100.0	100.0	100.0	100.0
Head (assay)			3.94	5.03	26.2	0.34				

Calculated Grades and Recoveries

1+2		12.04	28.2	13.3	17.7	1.93	84.1	33.3	8.1	70.6
-----	--	-------	------	------	------	------	------	------	-----	------

TEST NO. 14

Purpose: To investigate the lead flotation on the Vangorda ore and Faro ore using new standard test conditions.

Procedure: Similar to Test 10, but increased collector.

Feed: 2000 grams of minus 10 mesh 1:1 blended V-90-PL-08 Vangorda and Faro ore.

Grind: 22 minutes at 70 % solids in a lab rod mill.

Regrind: 15 minutes in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Na ₂ CO ₃	NaCN SD200	A350 3418A (9:1)	MIBC	Grind	Cond.	Froth	
Grind	1750	200	-	-	17	-	-	-
	-	-	2	-	5	-	-	-
Pb Rougher	-	-	10	14	-	1	4	9.8
Pb Scavenger	-	-	10	10	-	1	3	-
	-	-	10	10	-	1	3	-
Pb Regrind	-	300	15	-	15	-	-	-
Pb 1st Cleaner	-	20	-	4	-	1	4	9.9
	-	-	1	4	-	1	6	-
Pb 1st Cl Scav	-	-	5	4	-	1	3	-
Pb 2nd Cleaner	-	50	-	2	-	1	4	9.4
	-	-	4	4	-	1	4	-
Pb 3rd Cleaner	-	50	-	4	-	1	4	9.4
	-	-	2	4	-	1	3	-

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. 3rd Clnr Conc	237.04	11.96	23.7	34.9	8.38	2.23	75.9	90.6	3.7	73.0
2. 3rd Clnr Tail	20.20	1.02	17.7	12.0	25.2	2.81	4.8	2.7	1.0	7.8
3. 2nd Clnr Tail	20.42	1.03	6.31	5.72	34.5	0.95	1.7	1.3	1.3	2.7
4. 1st Clnr Tail	153.64	7.75	1.70	0.91	40.7	0.27	3.5	1.5	11.7	5.7
5. Ro Tail	1550.88	78.24	0.67	0.23	28.3	0.05	14.0	3.9	82.3	10.7
Head (calc.)	1982.2	100.00	3.74	4.61	26.9	0.37	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

2nd Cleaner Conc		12.98	23.2	33.1	9.7	2.28	80.7	93.3	4.7	80.9
1st Cleaner Conc		14.01	22.0	31.1	11.5	2.18	82.4	94.6	6.0	83.6
Rougher Conc		21.76	14.8	20.3	21.9	1.50	86.0	96.1	17.7	89.3

TEST NO. 15

Purpose: To evaluate the use of lime.

Procedure: Similar to Test 14.

Feed: 2000 grams of minus 10 mesh 1:1 blended V-90-PL-08 Vangorda and Faro ore.

Grind: 22 minutes at 70 % solids in a lab rod mill.

Regrind: 15 minutes in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Lime	NaCN SD200	A350 3418A (9:1)	MIBC	Grind	Cond.	Froth	
Grind	800	200	-	-	17	-	-	-
	-	-	2	-	5	-	-	-
Pb Rougher	-	-	10	14	-	1	4	10.1
Pb Scavenger	-	-	10	10	-	1	3	-
	-	-	10	10	-	1	3	-
Pb Regrind	-	200	15	-	15	-	-	-
Pb 1st Cleaner	-	20	-	4	-	1	4	9.6
	-	-	1	4	-	1	6	-
Pb 1st Cl Scav	-	-	5	4	-	1	3	-
Pb 2nd Cleaner	-	50	-	2	-	1	4	9.4
	-	-	4	4	-	1	4	-
Pb 3rd Cleaner	-	50	-	4	-	1	4	9.4
	-	-	2	4	-	1	3	-

Stage:	Rougher	1st Cleaner	2nd Cleaner
Flotation Cell:	D1-5L	D1-2.5L	D1-1.5L
Speed, rpm:	1600	1200	900

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. 3rd Clnr Conc	158.06	7.97	16.0	44.7	6.64	1.39	32.1	74.8	2.0	26.3
2. 3rd Clnr Tail	7.93	0.40	19.5	29.6	10.1	3.20	2.0	2.5	0.2	3.0
3. 2nd Clnr Tail	19.26	0.97	18.5	19.1	14.7	3.00	4.5	3.9	0.5	6.9
4. 1st Clnr Tail	137.90	6.95	24.4	8.96	19.9	2.29	42.8	13.1	5.2	37.8
5. Ro Tail	1661.20	83.72	0.88	0.33	29.1	0.13	18.6	5.8	92.1	25.9
Head (calc.)	1984.35	100.00	3.96	4.76	26.5	0.42	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

2nd Cleaner Conc		8.36	16.2	44.0	6.81	1.48	34.1	77.2	2.2	29.4
1st Cleaner Conc		9.34	16.4	41.4	7.63	1.63	38.6	81.1	2.7	36.3
Rougher Conc		16.28	19.8	27.6	12.9	1.91	81.4	94.2	7.9	74.1

TEST NO. 16

Purpose: To evaluate the use of NaCN complex (1-ZNO mixed with 3-NaCN and 4-SD200).

Procedure: Similar to Test 15 but with NaCN complex.

Feed: 2000 grams of minus 10 mesh 1:1 blended V-90-PL-08 Vangorda and Faro ore.

Grind: 22 minutes at 70 % solids in a lab rod mill.

Regrind: 10 minutes in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Lime	NaCN Complex	A350 3418A (9:1)	MIBC	Grind	Cond.	Froth	
Grind	800	200	-	-	17	-	-	-
Pb Rougher	-	-	2	-	5	-	-	10.2
Pb Scavenger	-	-	10	14	-	1	4	-
Pb Scav. Conc	-	-	10	10	-	1	3	-
Pb Regrind	-	-	10	10	-	1	3	-
Pb 1st Cleaner	-	300	-	-	10	-	3	-
Pb 1st Cl Scav	-	20	-	4	-	1	4	9.6
Pb 2nd Cleaner	-	-	1	4	-	1	6	-
Pb 3rd Cleaner	-	-	5	4	-	1	3	-
	-	50	-	2	-	1	4	9.4
	-	-	4	4	-	1	4	-
	-	50	-	4	-	1	4	9.4
	-	-	2	4	-	1	3	-

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. 3rd Clnr Conc	176.96	8.62	21.4	40.9	6.55	1.50	47.5	73.3	2.1	31.7
2. 3rd Clnr Tail	26.84	1.31	22.2	33.4	8.57	3.13	7.5	9.1	0.4	10.0
3. 2nd Clnr Tail	21.35	1.04	22.8	20.9	14.3	3.31	6.1	4.5	0.6	8.4
4. 1st Clnr Tail	109.77	5.34	15.6	6.75	25.0	1.88	21.5	7.5	5.0	24.7
5. Scav. Conc	42.61	2.07	6.15	3.43	34.0	1.01	3.3	1.5	2.7	5.1
6. Ro Scav. Tail	1676.46	81.62	0.67	0.24	29.0	0.10	14.1	4.1	89.2	20.0
Head (calc.)	2053.99	100.00	3.88	4.81	26.5	0.41	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

2nd Cleaner Conc		9.92	21.5	39.9	6.82	1.71	55.0	82.4	2.5	41.7
1st Cleaner Conc		10.96	21.6	38.1	7.53	1.87	61.1	86.9	3.1	50.2
Rougher Conc		16.31	19.7	27.8	13.3	1.87	82.6	94.4	8.1	74.8
Rougher Tailing		83.69	0.8	0.3	29.1	0.12	17.4	5.6	91.9	25.2
Rougher & Scav. Conc		18.38	18.1	25.1	15.6	1.77	85.9	95.9	10.8	80.0

TEST NO. 17

Purpose: To investigate the lead and zinc flotation on the PL-09 drill core using the standard Vangorda ore test conditions.

Procedure: Similar to Test 15 but with increased collector , aeration and a 10 minute regrind.

Feed: 2000 grams of minus 10 mesh V-90-PL-09 Vangorda drill core.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Regrind: 10 minutes in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Na ₂ CO ₃	NaCN SD200	A350 3418A (9:1)	MIBC	Grind	Cond / Aeration	Froth	
Grind	1500	200	-	-	15	-	-	-
Pb Rougher	-	-	2	-	5	-	-	10.0
Pb Scavenger	-	-	20	14	-	1/4	4	-
	-	-	10	10	-	1	3	-
	-	-	5	10	-	1	6	-
Pb Regrind	-	75	18	-	10	-	-	9.7
Pb 1st Cleaner	-	20	1	4	-	1	4	-
Pb 1st Cl Scav	-	-	1	4	-	1	6	-
Pb 2nd Cleaner	-	50	-	2	-	1	4	9.7
Pb 3rd Cleaner	-	25	-	4	-	1	5	9.4
Pb 4th Cleaner	-	25	-	4	-	1	6	9.0

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Ca(OH) ₂	CuSO ₄	A350 3418A (9:1)	DF250	Grind	Cond.	Froth	
Zinc Circuit: Condition	750	-	-	-	-	5	-	11.3
	-	700	-	-	-	5	-	-
Zn Rougher	-	100	20	8	-	2	4	-
	-	-	15	4	-	1	3	-

Stage:	Rougher	1st Cleaner	2nd Cleaner
Flotation Cell:	D1-5L	D1-2.5L	D1-1.5L
Speed, rpm:	1600	1200	900

Test No.: 17

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. 4th Clnr Conc	142.85	7.48	64.9	7.13	6.18	0.11	79.5	8.6	2.0	6.5
2. 4th Clnr Tail	11.88	0.62	30.0	15.8	17.8	0.41	3.1	1.6	0.5	2.0
3. 3rd Clnr Tail	27.06	1.42	18.0	17.7	22.2	0.56	4.2	4.0	1.4	6.3
4. 2nd Clnr Tail	36.71	1.92	9.14	16.6	26.0	0.95	2.9	5.2	2.2	14.5
5. 1st Clnr Tail	205.61	10.77	1.13	12.4	29.1	0.28	2.0	21.6	13.9	24.0
6. 1st Clnr Scav. Conc	28.41	1.49	5.96	18.4	27.6	1.11	1.5	4.4	1.8	13.1
7. Zn Ro Conc	250.65	13.13	0.80	22.9	20.0	0.08	1.7	48.5	11.6	8.4
8. Zn Ro Tail	1206.00	63.17	0.51	0.60	23.8	0.05	5.3	6.1	66.5	25.1
Head (calc.)	1909.17	100.00	6.11	6.20	22.6	0.13	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

Product	WT.	Assays, %				% Distribution			
	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1+2 (3rd Cl. Conc)	8.10	62.2	7.80	7.07	0.13	82.5	10.2	2.5	8.6
1+2+3 (2nd Cl. Conc)	9.52	55.6	9.3	9.32	0.20	86.7	14.2	3.9	14.9
1+2+3+4 (1st Cl. Conc)	11.44	47.8	10.5	12.1	0.32	89.6	19.4	6.1	29.4
Pb Ro. Tail	76.30	0.56	4.44	23.1	0.06	7.0	54.6	78.2	33.5
Pb Ro. Tail (assay)		0.54	4.54	24.1	0.03				

Calculated Rod Mill Feed Assay

Head (calc. flot. test)	1909.17	93.85	6.11	6.20	22.6	0.13
Pb Ro. Tailing	125.12	6.15	0.54	4.54	24.1	0.03
Total	2034.29	100.00	6.14	6.48	24.1	0.13

TEST NO. 18

Purpose: To evaluate ZnSO₄ and 242 on the blended Faro:Vangorda ore (1:1) using new test conditions.

Procedure: As indicated below.

Feed: 2000 grams of minus 10 mesh blended Faro and V-90-PL-08 Vangorda ore, 1:1.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Na ₂ CO ₃	242	MIBC	ZnSO ₄	Grind	Cond.	Froth	
Grind	2750	-	-	1500	20	-	-	9.5
Pb Rougher	-	80	8	-	-	1	4	-
Pb Scavenger	-	6	2	-	-	1	3	-
	-	3	10	-	-	1	3	-

Stage: Rougher
 Flotation Cell: D1-5L
 Speed, rpm: 1600

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Ro Conc	342.0	16.50	18.5	16.7	21.8	82.2	60.5	15.6
2. Pb Scav 1 Conc	65.5	3.16	3.31	24.5	24.8	2.8	17.0	3.4
3. Pb Scav 2 Conc	38.0	1.83	2.14	26.9	23.3	1.1	10.8	1.8
4. Pb Ro Tail	1627.0	78.50	0.66	0.68	23.3	13.9	11.7	79.2
Head (calc.)	2072.5	100.00	3.71	4.56	23.1	100.0	100.0	100.0

Calculated Grades and Recoveries

1+2		19.66	16.1	18.0	22.3	85.0	77.5	19.0
1+2+3		21.50	14.9	18.7	22.4	86.1	88.3	20.8

TEST NO. 19

Purpose: To evaluate the use of ZnSO₄ and 242.

Procedure: Similar to test 18 but using lower dosages.

Feed: 2000 grams of minus 10 mesh blended Faroand V-90-PL-08 Vangorda ore, 1:1.

Grind: 22 minutes at 70 % solids in a lab rod mill.

Conditions:

	Reagents Added, grams per tonne						Time, minutes			pH
	Na ₂ CO ₃	NaCN	242	9:A350 1:3418A	MIBC	ZnSO ₄	Grind	Cond.	Froth	
Grind	1600	25	-	-	-	1100	22	-	-	-
Pb Rougher	-	-	60	-	6	-	-	1	4	9.5
Pb Scavenger	-	-	-	10	2	-	-	1	3	-
	-	-	-	5	10	-	-	1	3	-

Stage: Rougher
 Flotation Cell: D1-5L
 Speed, rpm: 1600

LR: 3683

Project: Vangorda

October 19/90

Test No.: 19

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Ro Conc	456.10	23.78	15.3	20.7	20.7	87.4	95.1	19.8
2. Pb Ro Tail	1462.30	76.22	0.69	0.33	26.2	12.6	4.9	80.2
Head (calc.)	1918.4	100.00	4.16	5.17	24.9	100.0	100.0	100.0

TEST NO. 20

Purpose: To evaluate the use of ZnSO₄ and 242.

Procedure: As indicated below.

Feed: 2000 grams of minus 10 mesh blended Faro and V-90-PL-08 Vangorda ore, 1:1.

Grind: 22 minutes at 70 % solids in a lab rod mill.

Regrind: 10 minutes in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne							Time, minutes			pH
	Na ₂ CO ₃	NaCN SD200	A350 3418A (9:1)	ZnSO ₄	MIBC	242	NaCN	Grind	Cond.	Froth	
Grind	1600	200	-	200	-	-	-	17	-	-	-
	-	-	-	-	-	2	-	5	-	-	9.9
Aeration	-	-	-	-	-	20	-	-	-	4	-
Pb Rougher	-	-	-	-	8	-	300	-	5	4	-
Pb Scavenger	-	-	10	-	10	-	-	-	1	3	-
	-	-	5	-	10	-	-	-	1	3	-
Pb Regrind	125	200	18	100	-	-	-	10	-	4	-
Pb 1st Cleaner	-	20	-	100	4	-	-	-	1	-	9.5
	-	-	1	-	4	-	-	-	1	6	-
Pb 1st Cl Scav	-	-	5	-	4	-	-	-	1	3	-

Stage:	Rougher	1st Cleaner
Flotation Cell:	D1-5L	D1-2.5 L
Speed, rpm:	1600	1200

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. 1st Cleaner Conc	282.5	14.13	23.5	32.5	10.4	2.05	83.0	90.2	5.6	72.4
2. 1st Cl Tail	91.7	4.59	1.66	3.75	36.0	0.28	1.9	3.4	6.3	3.2
3. Ro Tail	1625.8	81.29	0.74	0.40	28.6	0.12	15.0	6.4	88.2	24.4
Head (calc.)	2000.0	100.00	4.00	5.09	26.4	0.40	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

1+2		18.71	18.1	25.5	16.7	1.62	85.0	93.6	11.8	75.6
-----	--	-------	------	------	------	------	------	------	------	------

TEST NO. 21

Purpose: To evaluate the use of lime and NaCN complex.

Procedure: Similar to L16 but with NaCN and ZnSO₄ in cleaning.

Feed: 2000 grams of minus 10 mesh blended Faro and V-90-PL-08 Vangorda ore, 1:1.

Grind: 22 minutes at 70 % solids in a lab rod mill.

Regrind: 10 minutes in a lab rod mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Lime	NaCN Complex	A350 3418A (9:1)	MIBC	NaCN	Grind	Cond.	Froth	
Grind	800	200	-	-	-	17	-	-	-
	-	-	2	-	-	5	-	-	-
Aeration	-	-	20	-	-	-	-	15	10.0
Pb Rougher	-	-	-	14	-	-	1	4	-
Pb Scavenger	-	-	10	10	-	-	1	3	-
	-	-	5	10	-	-	1	3	-
Pb Regrind	-	200	18	-	-	10	-	-	-
Pb 1st Cleaner	-	20	-	4	400	-	2	4	10.6
	-	-	1	4	-	-	1	6	-
Pb 1st Cl Scav	-	-	5	4	-	-	1	3	-
		ZnSO ₄							
Pb 2nd Cleaner	400	50	-	2	200	-	5	4	10.0
	-	-	4	4	-	-	1	4	-
Pb 3rd Cleaner	-	25	-	4	50	-	1	4	9.6
	-	-	2	4	-	-	1	3	-

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. 3rd Cleaner Conc	102.1	4.88	39.8	24.3	6.24	53.3	26.6	1.2
2. 3rd Cleaner Tail	21.1	1.01	15.0	40.3	8.86	4.1	9.1	0.3
3. 2nd Cl Tail	85.2	4.07	7.34	45.1	10.6	8.2	41.2	1.6
4. 1st Cl Tail	84.5	4.04	9.54	19.0	21.4	10.6	17.2	3.3
5. Ro Tail	1798.0	85.99	1.01	0.30	28.6	23.8	5.8	93.6
Head (calc.)	2090.9	100.00	3.65	4.46	26.3	100.0	100.0	100.0

Calculated Grades and Recoveries

2nd Cleaner Conc		5.89	35.6	27.0	6.69	57.4	35.7	1.5
1st Cleaner Conc		9.97	24.0	34.4	8.29	65.6	77.0	3.1
Rougher Conc		14.01	19.8	30.0	12.07	76.2	94.2	6.4

TEST NO. 22

Purpose: To evaluate the use of NaCN complex and ZnSO₄.

Procedure: As indicated below.

Feed: 2000 grams of minus 10 mesh blended Faro and V-90-PL-08 Vangorda ore, 1:1.

Grind: 22 minutes at 70 % solids in a lab rod mill.

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Lime	NaCN Complex	A350 3418A (9:1)	MIBC	ZnSO ₄	Grind	Cond.	Froth	
Grind	800	400	-	-	1000	17	-	-	-
	-	-	2	-	-	5	-	-	9.4
Aeration	-	-	20	-	-	-	-	4	-
Pb Rougher	-	-	-	14	-	-	1	4	-
Pb Scavenger	-	-	10	10	-	-	1	3	-
	-	-	5	10	-	-	1	3	-

Stage:	Rougher	1st Cleaner
Flotation Cell:	D1-5L	D1-2.5 L
Speed, rpm:	1600	1200

Test No.: 22

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Ro Conc	336.20	16.02	20.2	29.3	12.3	82.1	93.6	7.5
2. Pb Ro Tail	1762.30	83.98	0.84	0.38	28.8	17.9	6.4	92.5
Head (calc.)	2098.5	100.00	3.94	5.01	26.2	100.0	100.0	100.0

TEST NO. 23

Purpose: To investigate a lead and zinc bulk flotation on the blended Faro and PL-8 Vangorda (1:1) and use a dichromate depression to separate the lead and zinc.

Procedure: As indicated below.

Feed: 2000 grams of minus 10 mesh blended Faro and V-90-PL-08 Vangorda ore, 1:1.

Grind: 22 minutes at 70 % solids in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne								Time, minutes			pH
	Lime	NaCN SD200	CuSO ₄	A350	MIBC	DF250	K ₂ Cr ₂ O ₇	9:A350 1:3418A	Grind	Cond.	Froth	
Grind	1250	150	-	-	-	-	-	-	17	-	-	-
	-	50	-	-	-	-	-	5	5	-	-	-
Pb Rougher	-	-	-	-	14	-	-	35	-	1	4	11.0
Pb Scavenger	-	-	100	-	10	-	-	15	-	1	3	-
	-	-	-	-	10	-	-	5	-	1	3	-
Condition	1550	-	-	-	-	-	1000	-	-	8	-	12.1
Zn Rougher	-	-	50	20	-	10	500	-	-	2	4	-
Zn Ro Scav	-	-	-	10	-	4	-	-	-	1	3	-
	-	-	FeSO ₄ 1500	-	10	-	-	20	-	5	-	12.3
Pb Activation	-	25	-	-	-	-	-	-	-	-	4	11.9
Pb Conc	-	-	-	-	-	-	-	-	-	-	-	-

Stage: Rougher
Flotation Cell: D1-5L
Speed, rpm: 1600

Metallurgical Results

Product	Weight		Assays, %				% Distribution			
	g	%	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
1. Zn Conc	136.0	6.80	12.1	46.1	7.52	1.21	28.8	65.2	1.9	29.3
2. Pb Ro Conc	29.7	1.49	64.2	5.89	6.11	1.64	33.4	1.8	0.3	8.7
3. Ro Tail	1834.3	91.72	1.18	1.73	28.3	0.19	37.9	33.0	97.7	62.0
Head (calc.)	2000.0	100.00	2.86	4.81	26.6	0.28	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

1+2		8.29	21.4	38.9	7.27	1.29	62.1	67.0	2.3	38.0
-----	--	------	------	------	------	------	------	------	-----	------

TEST NO. 24

Purpose: To evaluate the use of low dosages of NaCN and ZnSO₄.

Procedure: As indicated below.

Feed: 2000 grams of minus 10 mesh blended Faro and V-90-PL-08 Vangorda ore, 1:1.

Grind: 22 minutes at 70% solids in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	Na ₂ CO ₃	NaCN SD200	A350 3418A	ZnSO ₄	MIBC	NaCN	Grind	Cond.	Froth	
Grind	1500	200	-	200	-	100	17	-	-	-
	-	-	2	-	-	-	5	-	-	-
Condition	-	-	-	-	-	-	-	3	-	9.5
Pb Rougher	-	-	20	-	14	-	-	1	4	-
Pb Scavenger	-	-	10	-	10	-	-	1	3	-
	-	-	5	-	10	-	-	1	3	-

Stage: Rougher
 Flotation Cell: D1-5L
 Speed, rpm: 1600

Metallurgical Results:

This test produces a bulk Pb Zn rougher concentrate.

The Pb rougher tailing assayed 1.02%Pb, 0.31%Zn and 28.1%Fe.

TEST NO. 25

Purpose: To evaluate lime in the rougher and high depressant dosages in the regrind and cleaners on Vangorda V-90-PL-08 ore.

Procedure: As indicated below.

Feed: 2000 grams of minus 10 mesh V-90-PL-08 Vangorda ore.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Regrind: 10 minutes in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	Lime	NaCN SD200	A350 3418A (9:1)	NaCN	MIBC	ZnSO ₄	Grind	Cond.	Froth	
Grind	800	200	-	-	-	-	15	-	-	-
	-	-	2	-	-	-	5	-	-	-
Pb Rougher	-	-	20	-	14	-	-	1	4	10.0
Pb Scavenger	-	-	10	-	10	-	-	1	3	-
	-	-	5	-	10	-	-	1	3	-
	Na ₂ CO ₃ 1000	-	-	-	-	-	-	-	-	-
Pb Regrind	200	200	-	300	-	1000	10	-	-	-
Pb 1st Cleaner	-	20	18	150	4	-	-	1	4	10.0
	-	-	1	-	4	-	-	1	6	-
Pb 1st Cl Scav	-	-	5	-	4	-	-	1	3	-
Pb 2nd Cleaner	-	50	-	300	2	-	-	1	4	11.0
	-	-	1	-	4	-	-	1	3	-
Pb 3rd Cleaner	-	50	-	-	4	-	-	1	4	9.6
	-	-	1	-	4	-	-	1	3	-

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. 3rd Cleaner Conc	76.5	3.49	50.4	17.0	5.11	39.2	13.3	0.8
2. 3rd Cleaner Tail	31.5	1.44	25.3	32.4	7.65	8.1	10.5	0.5
3. 2nd Cl Tail	87.8	4.01	9.06	43.9	8.25	8.1	39.5	1.4
4. 1st Cl Tail	164.3	7.50	12.2	17.3	18.4	20.4	29.2	5.9
5. Ro Tail	1831.3	83.57	1.30	0.40	25.8	24.2	7.5	91.5
Head (calc.)	2191.4	100.00	4.49	4.45	23.6	100.0	100.0	100.0

Calculated Grades and Recoveries

2nd Cleaner Conc		4.93	43.1	21.5	5.85	47.3	23.8	1.2
1st Cleaner Conc		8.93	27.8	31.5	6.93	55.4	63.3	2.6
Rougher Conc		16.43	20.7	25.0	12.2	75.8	92.5	8.5

TEST NO. 26

Purpose: To increase the NaCN and ZnSO₄ to the rougher on the Vangorda PL-08 ore.

Procedure: As indicated below.

Feed: 2000 grams of minus 10 mesh V-90-PL-08 Vangorda ore.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	Na ₂ CO ₃	NaCN	A350 3418A (9:1)	242	MIBC	ZnSO ₄	Grind	Cond.	Froth	
Grind	2000	200	-	-	-	600	20	-	-	-
Aeration	-	-	-	-	-	-	-	-	2	9.7
Pb Rougher	-	675	10	20	6	-	-	1	4	-
Pb Scavenger	-	300	10	-	10	-	-	1	3	-
	-	-	5	-	10	-	-	1	3	-

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Ca(OH) ₂	CuSO ₄	A350	DF250	Grind	Cond.	Froth	
Zn Circuit: Condition	-	-	-	-	-	5	-	11.2
	-	800	-	-	-	5	-	-
Zn Rougher	-	-	20	6	-	2	5	-
	-	-	-	-	-	-	2	-

Stage: Rougher
Flotation Cell: D1-5L
Speed, rpm: 1600

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Ro Conc	241.0	12.84	28.6	16.8	15.9	72.0	43.8	9.0
2. Zn Ro Conc	129.9	6.92	7.07	35.6	13.2	9.6	50.0	4.0
3. Zn Ro Tail	1506.6	80.24	1.17	0.38	24.7	18.4	6.2	87.0
Head (calc.)	1877.5	100.00	5.10	4.93	22.8	100.0	100.0	100.0

Calculated Grades and Recoveries

Pb Ro. Tailing (calc)	1636.5	87.2	1.64	3.18	23.8	28.0	56.2	91.0
(assay)			1.61	3.20	24.0			

TEST NO. 27

Purpose: To evaluate the effect of NaCN and ZnSO₄ on the Vangorda V-90-PL-08 ore.

Procedure: As indicated below.

Feed: 2000 grams of minus 10 mesh V-90-PL-08 Vangorda ore.

Grind: 20 minutes at 70 % solids in a lab rod mill.

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	Na ₂ CO ₃	NaCN SD200	A350 3418A (9:1)	NaCN	MIBC	ZnSO ₄	Grind	Cond.	Froth	
Grind	2000	200	-	-	-	750	20	-	-	-
Aeration	750	-	-	-	-	1150	-	10	4	8.8
Pb Rougher	-	100	20	200	14	-	-	1	4	9.0
Pb Scavenger	-	-	10	-	10	-	-	1	3	-
	-	50	10	-	10	-	-	1	10	-

Stage: Rougher
 Flotation Cell: D1-5L
 Speed, rpm: 1600

Metallurgical Results

Product	Weight		Assays, %			% Distribution		
	g	%	Pb	Zn	Fe	Pb	Zn	Fe
1. Pb Ro Conc	388.3	19.42	21.3	23.1	14.4	81.2	91.6	10.5
2. Pb Ro Tail	1611.7	80.59	1.19	0.51	29.7	18.8	8.4	89.5
Head (calc.)	2000.0	100.00	5.09	4.90	26.7	100.0	100.0	100.0

PLANT FLOTATION REAGENT ADDITION DETAILS

Table NO. 1: Reagent Additions (cc/min) - Lead Circuit - October 1990
From operator reports

Date	NaCN /SD200		Ro Cond.	SIX Scav.	1st Cleaner	R242 Ro	MIBC	
	Rod Mills	Regrind Mill					Ro	Scav.
Oct. 14/90	8271	40	4008	2250	0	20	114	51
Oct. 15/90	6060	0	3221	2033	6.5	13	101	39
Oct. 16/90	7569	13	3425	1934	79	11	97	43
Oct. 17/90	8450	407	3267	2141	0	20	120	42
Oct. 18/90	8317	0	3850	1867	0	18	115	34
Oct. 19/90	8745	163	5163	2300	0	20	113	42
Oct. 20/90	9195	86	5800	2525	0	20	113	42
Oct. 21/90	8729	63	5150	2233	85	20	111	64
Oct. 22/90	8550	152	3750	1892	0	20	108	35
Oct. 23/90	8738	329	3517	1833	179	20	126	43
Oct. 24/90	8459	388	4617	2017	159	20	133	47
Oct. 25/90	9600	292	5450	1971	344	20	133	48
Avg. 14-25	8390	161	4268	2083	71	19	115	44
Avg. 19-25	8859	210	4778	2110	110	20	120	46

Table NO. 2: Reagent Additions (CC/min) - Zinc Circuit - October 1990
From operator reports

Date	CuSO ₄		SIX				Dow 250	
	Ro Cond 1	Regrind Mill	Ro Cond.2	Zn Scav. K+L	Zn 1st Cleaner	Zn 1st Cl Scav	Ro	Scav.
Oct. 14/90	23396	0	5492	4421	858	207	212	0
Oct. 15/90	16438	0	5500	2482	552	201	201	0
Oct. 16/90	15105	0	4009	2640	924	136	224	0
Oct. 17/90	17209	0	4954	3486	425	233	269	0
Oct. 18/90	14521	0	4642	3166	483	326	233	0
Oct. 19/90	20833	0	5232	4541	1800	512	344	0
Oct. 20/90	19920	0	6273	4250	2317	273	154	0
Oct. 21/90	21000	0	4971	3821	1533	265	183	0
Oct. 22/90	19990	0	4750	3900	2267	842	325	0
Oct. 23/90	19917	0	4971	4588	1263	281	217	0
Oct. 24/90	22542	0	5163	4713	2034	238	145	0
Oct. 25/90	24900	0	4996	4638	2360	413	193	0
Avg. 14-25	19648	0	5079	3887	1401	327	225	0
Avg. 19-25	21300	0	5194	4350	1939	403	223	0

Table NO. 3: Reagent Consumption (cc/min) - Lead & Zinc Circuit - October 1990
Data from Daily Metallurgist Checklist

Date	Shift	Lead Circuit				Zinc Circuit		
		NaCN SD200	R-242	Xanthate	MIBC	Xanthate	Dow 250	CuSO4
Oct. 18/90	Day	8600	20	6200	150	9300	220	15000
	Night	7600	20	5770	140	9900	310	16500
	Daily Avg.	8100	20	5985	145	9600	265	15750
Oct. 19/90	Day	8428	20	7122	165	10602	375	21125
	Night	-	-	-	-	-	-	-
	Daily Avg.	8428	20	7122	165	10602	375	21125
Oct. 20/90	Day	9000	20	8100	154	11050	298	21000
	Night	8800	20	8200	156	12600	84	20500
	Daily Avg.	8900	20	8150	155	11825	191	20750
Oct. 21/90	Day	9000	20	8100	154	11050	298	21000
	Night	-	-	-	-	-	-	-
	Daily Avg.	9000	20	8100	154	11050	298	21000
Oct. 22/90	Day	9200	20	6500	140	9550	200	21000
	Night	-	-	-	-	-	-	-
	Daily Avg.	9200	20	6500	140	9550	200	21000
Oct. 23/90	Day	8670	20	5000	167	9925	235	18250
	Night	-	-	-	-	-	-	-
	Daily Avg.	8670	20	5000	167	9925	235	18250
Oct. 24/90	Day	8060	20	6400	175	11700	140	22000
	Night	9500	20	7540	182	10600	150	23000
	Daily Avg.	8780	20	6970	179	11150	145	22500
Oct. 25/90	Day	9400	20	8180	182	9980	280	23500
	Night	9700	20	7050	-	11300	-	25000
	Daily Avg.	9550	20	7615	182	10640	280	24250
Oct. 26/90	Day	9200	20	9030	267	12450	255	26500
	Night	-	-	-	-	16000	120	28500
	Daily Avg.	9200	20	9030	267	14225	188	27500
Oct. 27/90	Day	9800	20	8560	172	14700	8	19250
	Night	-	-	-	-	-	-	-
	Daily Avg.	9800	20	8560	172	14700	8	19250
Oct. 28/90	Day	9900	25	11400	142	11170	-	24333
	Night	-	-	-	-	-	-	-
	Daily Avg.	9900	25	11400	142	11170	0	24333
Oct 18-28	Avg. (cc/min)	9048	20	7676	170	11312	199	21428
Oct 19-25	Avg. (cc/min)	8933	20	7065	163	10677	246	21268

LAKEFIELD RESEARCH
A Division of Falconbridge Limited
Lakefield, Ontario
January 18, 1991/mo