File B-7-501

006205

COPPER FLOTATION TEST WORK AT CYPRUS ANVIL - AN UPDATE

Submitted by -
R. Murarka

April, 1984

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

COPPER FLOTATION TEST WORK

1.0 SUMMARY

Some potential exists for recovering copper from 2EF and 2H ore types. The best rougher metallurgy for the two ore types was 5.4/76.1 and 7.8/67.3 grade/recovery respectively. The best first cleaner metallurgy was 14.7/61.8 and 17.5/58.5 respectively. However, the results should be viewed with caution since a serious problem exists with the reproducibility of results.

2.0 INTRODUCTION:

This report summarizes all laboratory test work carried out to date on copper flotation from Anvil ore. Many previous memoranda and reports have been included in the Appendices where results have been discussed. Nevertheless, a general discussion of all results is also included in this report.

3.0 HISTORICAL:

Copper recovery from Anvil ore was attempted a few times in the past 12 years. A review of best metallurgical results is included in Appendix I. The results obtained in 1979 by Lakefield Research Labs are the best so far but there was no ore-type classification at that time. The best metallurgy obtained recently for 2H ore (17.5/58.5 grade/recovery) is comparable to the above results.

4.0 RECENT RESULTS BY ORE TYPE:

4.1 2BCD ORE:

4.11 ROUGHER/CLEANER TESTS:

The initial test work is described and analyzed in the report included in Appendix II

4.12 REAGENT TESTING:

Appendix III describes the work done on 2BCD ore using combination of different promoters with the potassium amyl xanthate collector.

4.13 LOCKED CYCLE TESTS:

Locked cycle test results are reported and discussed in Appendix IV.

4.2 2EF ORE:

4.21 GROUP 'A' TEST-WORK (ROUGHER/CLEANER & REAGENT TESTS):

Test A-1: This test is the same as test #1, table I of Appendix II.
A-2: Same as test #2 in the above table
A-3: Table I of this report
A-4: Table I of this report
A-5: Table I of this report
A-6: Table I of this report
A-7: Table I of this report
A-8: Table I of this report
A-9: Table I of this report
A-10: Table I of this report
A-11: Table I of this report
A-12: Table I of this report

4.21 (Continued)

Test A-13: Results listed in table II
A-14: Results listed in table II
A-15: Results listed in table III
A-16 to A-22: Results listed in table IV
A-23: Results listed in table V
A-24: Results listed in table VI
A-25 to A-28: Results listed in table VII

4.22 LOCKED CYCLE TESTS:

Test C-1: Results reported and discussed in Appendix IV
Test C-2: See table VIII

4.23 DUPLICATES OF 1972 & 1977 TESTS:

These tests were carried out to duplicate the 1972 and 1977 tests reported in Appendix I. Since the collector Z-200 was not available, a replacement Minerec 1661 was used and various combinations of Z-11/Minerec 1661 were tried. The results are listed in Table IX

4.3 2H ORE:

Table X lists the results of all tests carried out for 2H ore. The test conditions were similar to the corresponding tests of 2EF ore.

The irregular numbering of the tests in table X is purely accidental and there is no particular reason for the missing test number A-3.

5.0 DISCUSSION:

As can be seen from the massive amount of data obtained, analysis of results becomes a difficult task. Nevertheless, an attempt will be made here to discuss the results in the best possible way without a complicated analysis.

5.1 2BCD ORE:

The historical work described in Appendix I was not carried out on specific ore types since the ore classification system did not exist until recently. However, it is thought that the ore types were more similar to 2EF than 2BCD because of the predominance of 2EF ore type in the ore body. Thus the present test work cannot be directly compared with historical.

Generally speaking the production of a Pb/Cu bulk conc. was favourable over Cu pre-flotation. The best pre-flotation test is test #9, table VII, Appendix II. The best bulk flotation test was test #7, table VI, Appendix II.

Three locked cycle tests (F-1, F-2, F-3) were carried out using the pre-flotation scheme (Appendix IV). Grade/recovery of the concentrates were acceptably low (best 10.6/40.3).

The separation of Cu from the bulk concentrate has not been successful, although some promising schemes are yet to be tried. The reason for the difficulty in Cu/Pb separation is unknown at present.

Various combinations of different promoters with potassium amyl xanthate did not improve the metallurgy as can be clearly seen from the results (Appendix III). The main problem was that there was a lack of selectivity between Pb and Zn. This may be due to the non-selective nature of potassium amyl xanthate.

5.2 2EF ORE:

Much greater success was achieved in selectively floating Cu from 2EF ore than from 2BCD ore.

Most tests were repetition of the 2BCD tests. The best test turned out to be a pre-flotation test similar to the best pre-flotation test for 2BCD ore. The results are listed in table I, test A-8. The final first cleaner metallurgy was 14.7/61.8 grade/recovery. The final third cleaner metallurgy obtained in a duplicate test (test A-24. table VI) was 20.0/33.2 grade/recovery.

If it is assumed that the ore type used in historical work was 2EF then the best Cu metallurgy obtained was in a cleaner test carried out by Lakefield Research Laboratories in 1979 (results in Appendix I). The third cleaner concentrate had a grade of 20.5% with a recovery of 53.8%.

Similar to 2BCD ore, a number of test were carried out with potassium amyl xanthate in combination with various promoters. As can be seen from the results in table IV, they were all worse than the results of the best test A-8. Here again the problem was lack of selectivity between Pb and Cu.

The first cleaner test A-8 and the third cleaner test A-24 were taken one step further to carry out a locked cycle test C-1 (Appendix IV) which produced a fourth cleaner conc. The test was carried through to six cycles. The metallurgy was worse than test A-8 or A-24 for unknown reasons.

Another locked cycle test with some changes in the flow scheme did not show improvement (test C-2, table VIII)

5.2 2EF ORE - (Cont'd)

A few rougher tests were carried out to duplicate the tests carried out in 1972 and 1977. The results of the duplicate tests of the 1972 tests are shown in table IX. If rougher metallurgy is considered alone, the results of test E-3 are superior to A-8. The reagent Minerec 1661 or the equivalent Z-200 is known to be Cu-selective. However, drawing any positive conclusions without further cleaner tests may be premature.

The results of the 1977 - duplicate test were not as good (table IX) and will not be discussed further.

5.3 2H ORE

Test work similar to 2EF ore was carried out for 2H ore as well (table X). The best test (test A-6) was similar to the best 2EF test A-8 (table I) except that more collector was required (120 g/t) probably because of higher Cu content of 2H ore.

The copper content of 2H ore was higher than 0.4% which is common in many Cu producing mines. Thus 2H ore has the highest potential for copper extraction. Unfortunately this ore type is not predominant in the Anvil ore body.

5.4 GENERAL:

Certain features were common to the best tests with 2BCD, 2EF and 2H ore types. There was no NaCN added and 1 kg/t Na_2SO_3 was used at the grinding stage. The reason for not adding NaCN is obvious (to prevent depression of Cu). Na_2SO_3 is normally used to depress Pb and it was used here for the same purpose. However, it only seems to be effective at low collector additions (test 9,

5.4 GENERAL - (Cont'd)

2BCD ore, table VII, Appendix II; test A-8, 2EF ore, table I; test A-6, 2H ore, table X).

Another general observation made was that there was little or no agreement between the open cycle cleaner tests and the corresponding locked cycle tests for both 2BCD and 2EF ores. Lack of stability was a common problem during the locked cycle test work. Unreasonably high circulating loads found during these tests could also be partially responsible for worse-than-expected metallurgical results.

The most serious problem with the entire Cu test work and with flotation tests in general was a low degree of reproducibility of results. Figure 1 shows the grade-recovery plots of seven identical rougher/cleaner tests. Although the single points for tests A-25 to A-28 show exceptionally good reproducibility and fall on the extrapolated curve for test A-8, tests A-15 and A-24 show very different behaviour.

A similar discrepancy between identical tests is pictured in figure 2.

From figure 1 and 2 it becomes clear that conclusions should be drawn with caution. A detailed study has to be undertaken in order to understand the causes of lack of reproducibility. Many factors e.g. human error, procedural differences, reagent qualities, slurry temperatures may have to be investigated.

6.0 CONCLUSIONS:

It is very difficult to draw firm conclusions without quantitatively

6.0 CONCLUSIONS - (Cont'd)

knowing the accuracy of the test-work since the differences between test-results may be due to chance. For unknown reasons large differences were detected between the results of identical tests.

Certain general conclusions can, however, be drawn. For 2BCD ore, copper pre-flotation does not seem to produce a copper concentrate with sufficiently high grade. Bulk Cu/Pb flotation seems to give superior results. However, Cu/Pb separation is still a problem.

For 2EF and 2H ores, potential of pre-floating the copper does exist. Many more tests are, however, required to be carried out to get a better understanding.

7.0 RECOMMENDATIONS:

A pre-requisite to more test-work should be the undertaking of a project for quantitatively estimating the experimental error in Cu flotation test results. Reasons for low reproducibility should be investigated and minimized. This will be beneficial for flotation test work in general.

Subsequently, many more tests have to be carried out before making a decision for pilot plant tests or full plant scale tests. In particular, new reagents should be tried to separate Cu from Pb in 2BCD ore; Minerec 1661 should be further investigated for all ore types. However, in light of the low Cu prices at present, further research may not be beneficial at this time.

Figure 1

Cyprus Anvil Mining Corporation

METALLURGICAL TEST REPORT

Grade-Recovery Curve

Test No.: 2EF ore Cu flotation Date: April 02/84

Objective: Identical tests Key:

Reagents: 1 kg/t Na_2SO_3, 70 g/t Z-11 to 1st Cleaner

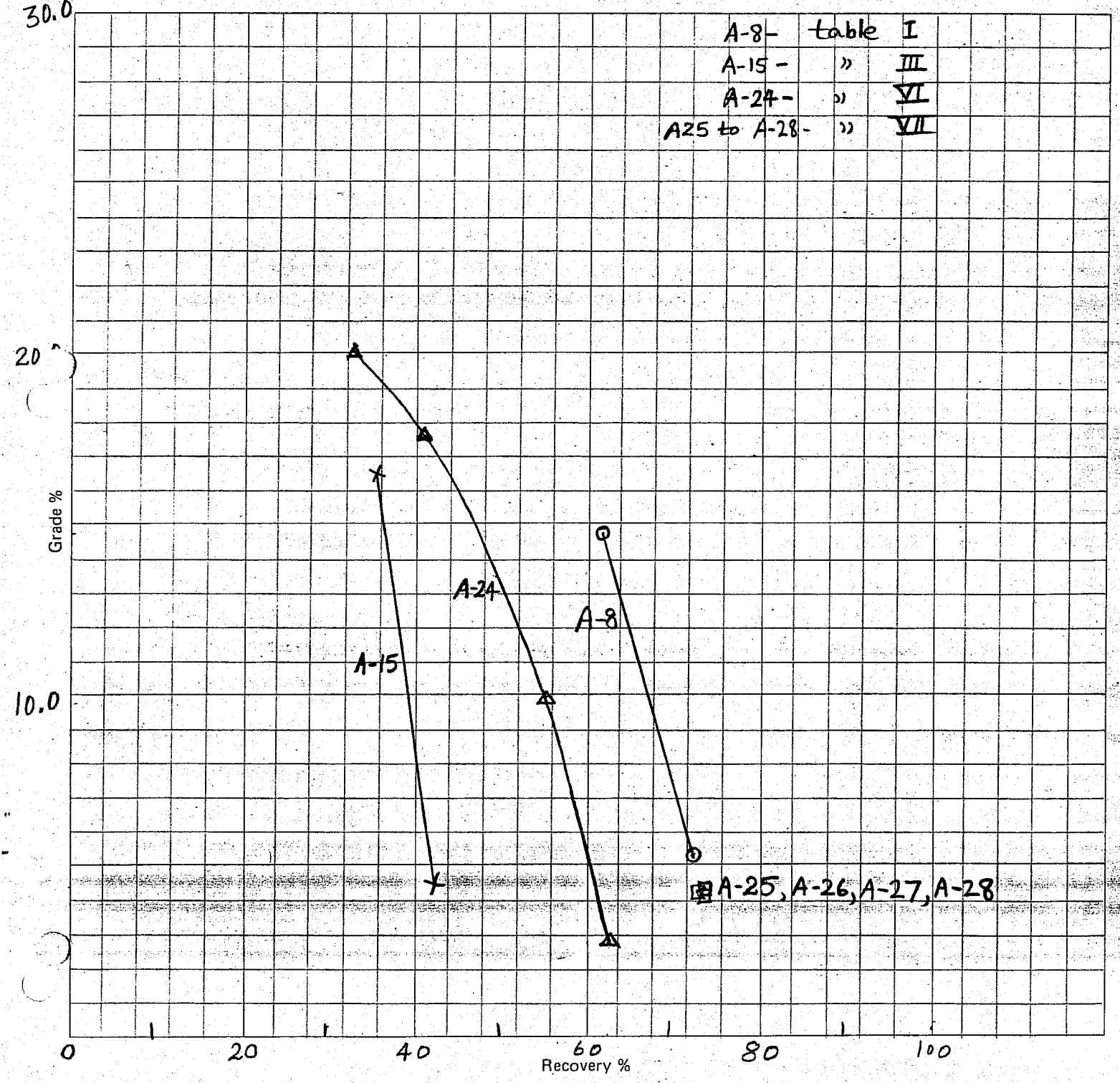


Figure 2

Cyprus Anvil Mining Corporation

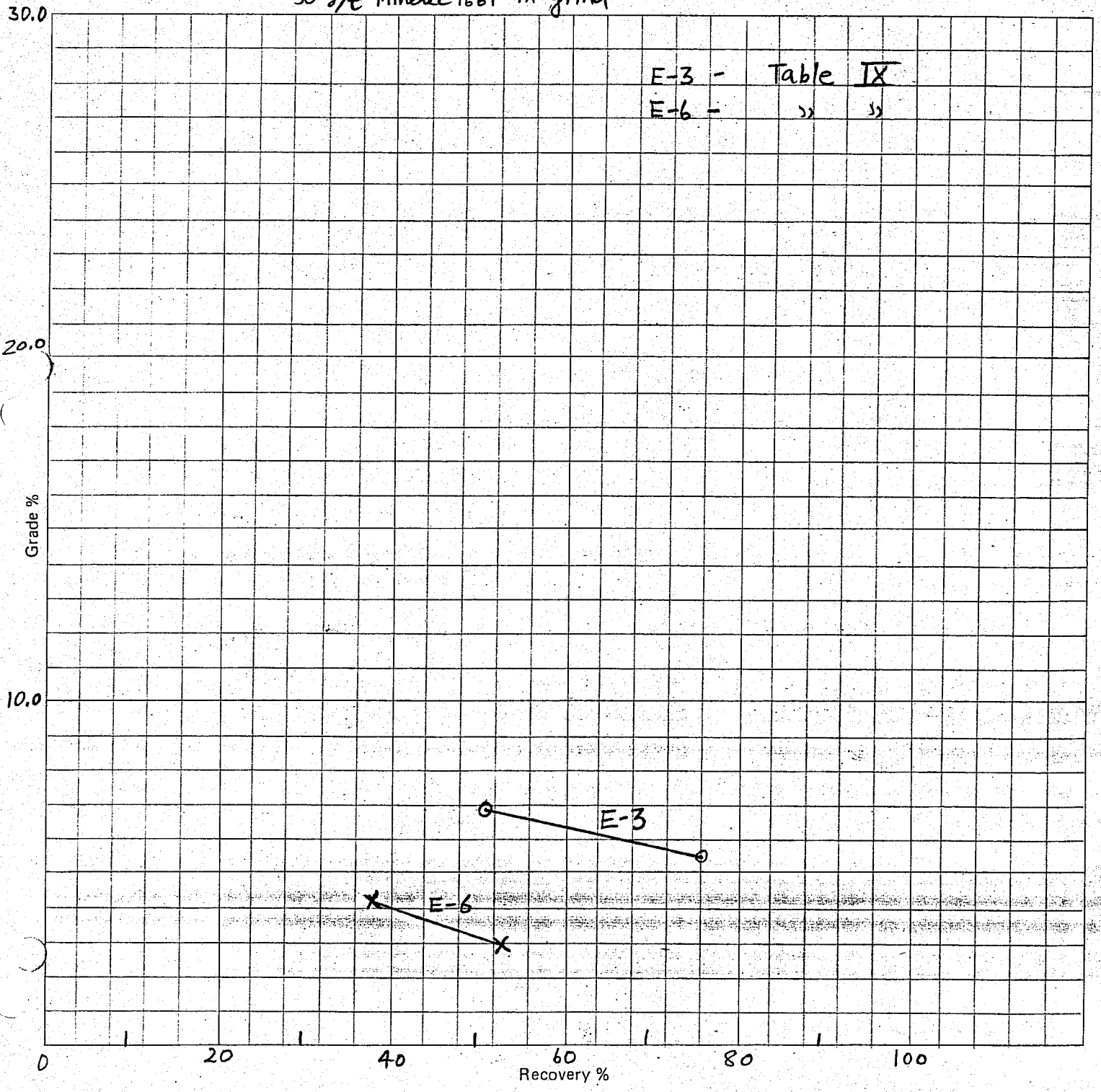
METALLURGICAL TEST REPORT

Grade-Recovery Curve

Test No.: 2EF ore Cu Flotation Date: April 02/84

Objective: identical tests Key:

Reagents: 2 Kg ore, 1.25 kg/t Na_2CO_3, 1.25 kg/t Na_2SO_3, 50 g/t Minerec 1661 in grind



-2EF Cu PREFLOAT TEST - GROUP A

	ORE TYPE AND TEST DESCRIPTION	SAMPLE	WTS.	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
Repeat of 2BCD test #1 Table V Appendix II	1kg/T Na_2SO_3 A-3 30g/T Z-11 to grind 30g/T Z-11 to rougher	CuRo conc.	36.1	33.00	7.68	18.0	4.36	8.87	31.29	5.22	2.11	73.10	25.10
		Tails	965.2	2.71	5.22	31.3	0.06	0.99	68.71	94.87	97.89	26.90	74.90
		Heads	1001.3	3.80	5.31	30.8	0.22	1.27	100.00	100.00	100.00	100.00	100.00
Repeat of 2BCD test #3 Table V Appendix II	1kg/T Na_2SO_3 A-4 30g/T Z-11 to grind 30g/T Z-11 to Ro. 20g/T Z-11 to 1st clnr	CuCC1	20.2	46.50	5.23	12.5	6.69	12.31	23.55	1.96	0.82	65.87	21.18
		CuCt1	15.5	14.00	10.52	24.8	0.75	3.82	5.44	3.03	1.26	5.67	5.04
		Rougher Conc.	35.7	32.39	7.53	17.8	4.11	8.62	28.99	4.99	2.08	71.54	26.22
		Tails	973.5	2.91	5.25	30.8	0.06	0.89	71.01	95.01	97.92	28.47	73.78
		Heads	1009.2	3.95	5.33	30.3	0.20	1.16	100.00	100.00	100.00	100.00	100.00
Repeat of 2BCD test #4 Table VI Appendix II	1kg/T Na_2SO_3 A-5 50g/T Z-11 to grind 30g/T Z-11 to Ro. 20g/T Z-11 to 1st clnr	CuCC1	15.7	38.10	6.18	14.3	8.75	10.17	15.56	1.79	0.73	69.37	15.18
		CuCt1	13.0	10.22	11.54	26.0	0.90	3.08	3.46	2.76	1.10	5.91	3.81
		Rougher Conc.	28.7	25.47	8.61	19.6	5.20	6.96	19.02	4.55	1.83	75.28	18.99
		Tails	979.2	3.18	5.29	30.8	0.05	0.87	80.99	95.45	98.17	24.72	81.01
		Heads	1007.9	3.81	5.38	30.5	0.20	1.04	100.00	100.00	100.00	100.00	100.00
Repeat of 2BCD test #6 Table VI Appendix II	1kg/T Na_2SO_3 A-6 70g/T Z-11 to grind 30g/T Z-11 to Ro 20g/T Z-11 to 1st clnr	CuCC1	13.0	36.00	5.90	14.9	10.11	9.59	11.65	1.35	0.63	63.97	9.33
		CuCt1	13.8	9.89	10.96	25.2	1.10	3.24	3.40	2.67	1.13	7.39	3.35
		Rougher Conc.	26.8	22.56	8.51	20.2	5.47	6.32	15.05	4.02	1.76	71.36	12.68
		Tails	980.8	3.48	5.54	30.7	0.06	1.19	84.95	95.97	98.23	28.64	87.33
		Heads	1007.6	3.99	5.62	30.4	0.20	1.33	100.00	100.00	100.00	100.00	100.00
Repeat of 2BCD test #7 Table VI Appendix II	1kg/T Na_2SO_3 A-7 100g/T Z-11 to grind 50g/T Z-11 to Ro. 30g/T Z-11 to 1st clnr (Repeat of 2BCD-B-7)	CuCC1	44.3	57.90	3.53	9.6	3.29	14.69	67.71	3.03	1.40	68.50	53.55
		CuCt1	18.4	8.10	10.82	27.0	0.57	2.51	3.93	3.86	1.63	4.93	3.80
		Rougher Conc.	62.7	43.28	5.67	14.7	2.49	11.12	71.64	6.89	3.03	73.43	57.35
		Tails	942.2	1.14	5.10	31.3	0.06	0.55	28.35	93.11	96.97	26.57	42.65
		Heads	1004.9	3.77	5.14	30.3	0.21	1.21	100.00	100.00	100.00	100.00	100.00

TABLE I - (Cont'd)

-2EF Cu PREFLOAT TEST - GROUP A

	ORE TYPE AND TEST DESCRIPTION	SAMPLE	WTS.	ASSAYS					DISTRIBUTION				
				Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
Repeat of 2BCD test #9 Table VII Appendix II	1kg/T Na_2SO_3 A-8 50g/T Z-11 to grind 15g/T Z-11 to Ro 5g/T Z-11 to 1st clnr (Repeat of 2BCD-B-9)	CuCC1	7.7	16.40	7.86	19.3	14.70	5.31	3.20	1.08	0.48	61.75	3.63
		CuCt1	18.0	13.60	9.86	25.0	1.15	3.78	6.20	3.18	1.45	11.29	6.04
		Rougher Conc.	25.7	14.44	9.26	23.3	5.21	4.24	9.40	4.26	1.93	73.04	9.67
		Tails	988.1	3.62	5.41	30.9	0.05	1.03	90.60	95.74	98.08	26.95	90.33
		Heads	1013.8	3.89	5.51	30.7	0.18	1.11	100.00	100.00	100.00	100.00	100.00
Repeat of 2BCD test #10 Table VII Appendix II	2kg/T Na_2SO_3 A-9 100g/T Z-11 to grind 50g/T Z-11 to Ro 30g/T Z-11 to 1st clnr (Repeat of 2BCD-B-10)	CuCC1	10.4	19.20	7.89	19.6	11.40	5.75	5.45	1.59	0.66	59.62	5.53
		CuCt1	17.9	5.21	10.20	27.5	1.20	1.80	2.54	3.53	1.59	10.80	2.98
		Rougher Conc.	28.3	10.35	9.35	24.6	4.95	3.25	7.99	5.12	2.25	70.42	8.51
		Tails	980.5	3.44	5.01	30.8	0.06	1.01	92.01	94.89	97.75	29.58	91.50
		Heads	1008.8	3.63	5.13	30.6	0.20	1.07	100.00	100.00	100.00	100.00	100.00
	1kg/T Na_2SO_3 A-10 150g/T Z-11 to grind 75g/T Z-11 to Ro (Repeat of 2BCD #12)	CuRo Conc.	78.4	41.30	5.41	16.4	2.03	10.66	81.91	7.90	4.18	77.41	62.06
		Tails	928.9	0.77	5.32	31.7	0.05	0.55	18.09	92.10	95.82	22.59	37.94
		Heads	1007.3	3.92	5.33	30.5	0.20	1.34	100.00	100.00	100.00	100.00	100.00
	2kg/T Na_2SO_3 A-11 50g/T Z-11 to grind 15g/T Z-11 to Ro 5g/T Z-11 to 1st clnr (Repeat of 2BCD #13)	CuCC1	8.4	11.60	9.83	20.1	14.30	4.01	2.57	1.58	0.55	63.68	3.30
		CuCt1	19.8	14.90	10.46	24.6	0.99	3.97	7.77	3.96	1.58	10.39	7.69
		Rougher Conc.	28.2	13.92	10.27	23.2	4.95	3.98	10.34	5.54	2.13	74.07	10.99
		Tails 1	978.2	3.58	5.05	30.9	0.05	0.93	89.66	94.46	97.88	25.93	89.01
		Heads	1006.4	3.77	5.20	30.7	0.19	1.02	100.00	100.00	100.00	100.00	100.00
	No Sulphite A-12 20g/T Z-11 to Ro (Repeat of 2BCD #14)	CuRo Conc.	25.6	10.76	7.80	25.6	4.69	3.43	7.26	3.93	2.11	63.59	6.67
		Tails	982.2	3.58	4.97	30.9	0.07	1.25	92.74	96.07	97.89	36.41	93.33
		Heads	1007.8	3.76	5.04	30.77	0.19	1.31	100.00	100.00	100.00	100.00	100.00

(12,13)

TABLE II

2EF Cu PRE-FLOAT TESTS

	ORE TYPE AND TEST DESCRIPTION	SAMPLE	WTS.	ASSAYS					DISTRIBUTION				
				Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
A-13	2kg ore at 66% solids Grind: 3kg/T Na_2SO_3 1kg/T Na_2SO_3 100g/T Z-11 Rougher: 50g/T Z-11 pH = 9.9 1st cleaner: 30g/T Z-11 pH = 9.6	CuCC1	63.4	60.90	2.22	9.6	4.18	15.29	50.51	1.34	0.82	61.82	37.56
		CuCt1	26.8	14.32	10.55	28.4	1.09	4.23	5.02	2.70	1.03	6.81	4.39
		Calc. Cu Ro Conc.	90.2	47.06	4.70	15.2	3.26	12.00	55.53	4.04	1.85	68.63	41.95
		CuRo Tls	1920.5	1.77	5.23	37.8	0.07	0.78	44.47	95.95	98.15	31.36	58.04
		CALCHEAD	2010.7	3.80	5.21	36.8	0.21	1.28	100.00	100.00	100.00	100.00	100.00
A-14	as A-13 with KAX in place of Z-11	CuCC1	106.8	51.70	3.04	13.4	2.70	13.44	72.20	3.05	1.94	68.13	56.90
		CuCT1	45.9	14.27	8.64	29.7	0.91	4.22	8.56	3.73	1.85	9.87	7.68
		Calc CuRo Conc	152.7	40.45	4.72	18.3	2.16	10.67	80.76	6.78	3.79	78.00	64.58
		CuRoTls	1861.8	0.79	5.33	38.1	0.05	0.48	19.23	93.22	96.21	22.00	35.42
		CALCHEAD	2014.5	3.80	5.28	36.6	0.21	1.25	100.00	100.00	100.00	100.00	100.00

TABLE III

TEST - A-15 (TEST CONDITIONS IDENTICAL TO A-8)

PRODUCT	WEIGHT g	ASSAYS					DISTRIBUTION				
		Pb	Cu	Ag	Zn	Fe	Pb	Cu	Ag	Zn	Fe
$CuCC_1$	5.8	16.20	16.50	4.85	6.66	23.6	2.27	35.34	2.12	0.66	0.37
CT_1	20.3	11.25	0.96	3.22	9.91	31.0	5.51	7.20	4.92	3.46	1.70
Ro. Tls.	972.4	3.93	0.16	1.27	5.73	37.2	92.22	57.46	92.96	95.88	97.93
Calc. Hds.	998.5	4.15	0.27	1.33	5.82	36.99	100.00	100.00	100.00	100.00	100.00

Pb Cum. Grade	Cum. Rec.	Cu Cum. Grade	Cum. Rec.
16.20	2.27	16.50	35.34
12.35	7.78	4.41	42.54

TABLE IV

2EF Cu Prefloat — A-16 — KAX/N-30

PROD.	WEIGHTS GM.	%	ASSAYS PB	Cu	Ag	UNITS PB	Cu	Ag	DISTRIBUTION PB	Cu	Ag
Cu Ro	10.60	.01	12.65	9.35	4.16	.13	.10	.04	3.34	40.08	3.12
Cu Sc1	6.50	.01	21.50	3.29	6.12	.14	.02	.04	3.48	8.65	2.81
Cu Sc2	5.20	.01	23.10	1.89	6.45	.12	.01	.03	2.99	3.97	2.37
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tls	974.90	.98	3.72	.12	1.33	3.64	.12	1.30	90.20	47.30	91.70
HEADS			4.03	.25	1.42						

PB CUMULATIVE GRADES	CUMULATIVE RECOVERIES
12.65	3.34
16.01	6.81
17.67	9.80
17.67	9.80
17.67	9.80

Cu CUMULATIVE GRADES	CUMULATIVE RECOVERIES
9.35	40.08
7.05	48.72
5.84	52.70
5.84	52.70
5.84	52.70

2EF Cu Prefloat — A-17 — KAX/1334

PROD.	WEIGHTS GM.	%	ASSAYS PB	Cu	Ag	UNITS PB	Cu	Ag	DISTRIBUTION PB	Cu	Ag
Cu Ro	67.50	.07	47.80	1.74	12.09	3.23	.12	.82	81.89	53.45	61.54
Sc1	18.40	.02	14.36	.81	4.17	.26	.01	.08	6.71	6.78	5.79
Sc2	10.30	.01	7.65	.59	2.60	.08	.01	.03	2.00	2.77	2.02
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tls	903.50	.90	.41	.09	.45	.37	.08	.41	9.40	37.00	30.66
HEADS			3.94	.22	1.33						

PB CUMULATIVE GRADES	CUMULATIVE RECOVERIES
47.80	81.89
40.64	88.60
37.11	90.60
37.11	90.60
37.11	90.60

Cu CUMULATIVE GRADES	CUMULATIVE RECOVERIES
1.74	53.45
1.54	60.23
1.44	63.00
1.44	63.00
1.44	63.00

2EF Cu Pre-float — A-18 — KAX/1335

PROD.	WEIGHTS GM.	%	ASSAYS PB	Cu	Ag	UNITS PB	Cu	Ag	DISTRIBUTION PB	Cu	Ag
Cu Ro	46.80	.05	58.80	2.56	14.93	2.79	.12	.68	71.74	55.46	54.22
Sc1	14.20	.01	29.70	1.12	7.76	.43	.02	.11	10.99	7.37	8.91
Sc2	11.10	.01	13.47	.62	3.95	.15	.01	.04	3.90	3.19	3.54
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tls	915.90	.93	.56	.08	.45	.52	.07	.42	13.37	33.97	33.32
HEADS			3.88	.22	1.25						

PB CUMULATIVE GRADES	CUMULATIVE RECOVERIES
58.80	71.74
52.03	82.73
46.09	86.63
46.09	86.63
46.09	86.63

Cu CUMULATIVE GRADES	CUMULATIVE RECOVERIES
2.56	55.46
2.22	62.84
1.98	66.03
1.98	66.03
1.98	66.03

TABLE IV (cont'd)

2EF Cu Pre-float A-19 KAX/3459

PROD.	WEIGHTS GM.	%	ASSAYS PB	Cu	Ag	UNITS PB	Cu	Ag	DISTRIBUTION PB	Cu	Ag
CuRo	7.30	.01	12.92	11.92	4.46	.09	.09	.03	2.32	34.55	2.29
Sc1	7.60	.01	23.00	4.47	6.41	.17	.03	.05	4.30	13.49	3.42
Sc2	7.30	.01	25.90	1.85	6.99	.19	.01	.05	4.65	5.36	3.58
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ts	978.30	.98	3.69	.12	1.32	3.61	.12	1.29	88.74	46.61	90.71
HEADS			4.07	.25	1.42						

PB CUMULATIVE GRADES	CUMULATIVE RECOVERIES
12.92	2.32
18.06	6.62
20.64	11.26
20.64	11.26
20.64	11.26

Cu CUMULATIVE GRADES	CUMULATIVE RECOVERIES
11.92	34.55
8.12	48.03
6.06	53.39
6.06	53.39
6.06	53.39

2EF Cu Pre-float A-20 KAX/3700

PROD.	WEIGHTS GM.	%	ASSAYS PB	Cu	Ag	UNITS PB	Cu	Ag	DISTRIBUTION PB	Cu	Ag
CuRo	8.40	.01	22.10	9.62	6.37	.19	.08	.05	4.64	31.84	3.95
Sc1	19.40	.02	37.80	2.31	9.69	.73	.04	.19	18.33	17.66	13.87
Sc2	14.80	.01	37.10	.91	9.36	.55	.01	.14	13.72	5.31	10.22
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ts	955.80	.96	2.65	.12	1.02	2.54	.11	.98	63.31	45.19	71.95
HEADS			4.01	.25	1.36						

PB CUMULATIVE GRADES	CUMULATIVE RECOVERIES
22.10	4.64
33.06	22.97
34.46	36.69
34.46	36.69
34.46	36.69

Cu CUMULATIVE GRADES	CUMULATIVE RECOVERIES
9.62	31.84
4.52	49.50
3.27	54.81
3.27	54.81
3.27	54.81

TABLE IV (cont'd)

2EF Cu Pre-float A-21 KAX/3710

PROD.	WEIGHTS GM.	%	ASSAYS PB	Cu	Ag	UNITS PB	Cu	Ag	DISTRIBUTION PB	Cu	Ag
Cu Ro	7.20	.01	13.14	10.16	4.30	.10	.07	.03	2.41	29.13	2.36
Sc1	7.50	.01	22.30	4.48	6.25	.17	.03	.05	4.26	13.38	3.57
Sc2	8.30	.01	26.70	2.19	7.14	.22	.02	.06	5.64	7.24	4.52
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ts	970.90	.98	3.55	.13	1.21	3.47	.13	1.18	87.70	50.26	89.55
HEADS			3.95	.25	1.32						

PB CUMULATIVE GRADES	CUMULATIVE RECOVERIES
13.14	2.41
17.81	6.66
21.02	12.30
21.02	12.30
21.02	12.30

Cu CUMULATIVE GRADES	CUMULATIVE RECOVERIES
10.16	29.13
7.26	42.51
5.43	49.74
5.43	49.74
5.43	49.74

2EF Cu Pre-float A-22 KAX/3730

PROD.	WEIGHTS GM.	%	ASSAYS PB	Cu	Ag	UNITS PB	Cu	Ag	DISTRIBUTION PB	Cu	Ag
Cu Ro	5.90	.01	6.90	12.41	2.87	.04	.07	.02	1.04	29.57	1.20
Sc1	3.90	.00	9.35	7.11	3.44	.04	.03	.01	.93	11.20	.95
Sc2	4.40	.00	13.09	4.06	4.12	.06	.02	.02	1.47	7.22	1.29
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ts	990.50	.99	3.83	.13	1.37	3.78	.13	1.35	96.57	52.01	96.55
HEADS			3.91	.25	1.40						

PB CUMULATIVE GRADES	CUMULATIVE RECOVERIES
6.90	1.04
7.88	1.96
9.49	3.43
9.49	3.43
9.49	3.43

Cu CUMULATIVE GRADES	CUMULATIVE RECOVERIES
12.41	29.57
10.30	40.77
8.37	47.99
8.37	47.99
8.37	47.99

METALLURGICAL BALANCE

TABLE V

Cu PRE-FLOAT - MEGGEN SCHEME (VS LAKEFIELD 1980)

	ORE TYPE AND TEST DESCRIPTION	SAMPLE	WTS.	ASSAYS (%)					DISTRIBUTION (%)				
				Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
A-23	2EF ore - 2kg Grind: 1kg/T lime 1kg/T $ZnSO_4$ 150g/T Z-11 Cu Rougher: pH=9.5 (lime) Pb Rougher: pH=11.8 (lime) Ro1: 2min, 0 Z-11 Ro2: 2min, 5g/T Z-11 Ro3: 2min 15g/T Z-11 Ro4: 2min 50g/T Z-11 Ro5: 2min 100g/T Z-11	Cu Conc.	100.7	45.60	3.71	17.9	1.65	11.05	56.89	3.51	2.45	37.32	41.12
		Pb RO1	26.5	4.36	8.89	34.9	0.23	1.52	1.43	2.21	1.25	1.37	1.49
		Pb RO2	19.0	3.52	8.47	35.6	0.20	1.25	0.83	1.51	0.92	0.86	0.88
		Pb Ro3	16.4	3.90	9.40	35.0	0.21	1.40	0.79	1.45	0.78	0.78	0.85
		Pb Ro4	36.4	37.10	6.65	21.1	0.17	9.05	16.73	2.27	1.04	1.39	12.17
		Pb Ro5	52.3	21.20	10.23	26.4	0.23	5.68	13.74	5.03	1.87	2.71	10.98
		Tails	1759.8	0.44	5.08	38.4	0.14	0.50	9.59	84.01	91.69	55.48	32.52
		CALCHEAD	2011.1	4.01	5.29	36.6	0.22	1.35					

TABLE VI

PROD.	WEIGHTS GM.	%	ASSAYS PB	ZN	FE	UNITS			DISTRIBUTION PB	ZN	FE
$CuCC_3$	2.60	.00	15.60	4.33	22.10	.04	.01	.06	1.05	.21	.16
$CuCT_3$	1.04	.00	19.60	9.99	20.80	.02	.01	.02	.53	.19	.06
$CuCT_2$	5.10	.01	23.50	10.91	20.20	.12	.06	.10	3.12	1.04	.28
$CuCT_1$	26.10	.03	6.95	9.05	33.00	.18	.24	.86	4.72	4.41	2.35
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$CuRoTls$	970.10	.97	3.59	5.20	36.70	3.47	5.02	35.43	90.58	94.15	97.15
HEADS			3.83	5.33	36.47						

2EFore Cu Fe-float

A-24 Cupeat of A-8 and on to third cleaner)

grind: 1kg/tonne Na_2SO_3, 50g/tonne Z-11

rougher: 15g/tonne Z-11, pH = 9.5

1st clnr: 5g/tonne Z-11, pH = 9.5

2nd clnr: no Z-11, pH = 9.8

3rd clnr: 2.5g/tonne Z-11, pH = 10.0

PB CUMULATIVE GRADES		CUMULATIVE RECOVERIES
CuC_3	15.60	1.05
CuC_2	16.74	1.59
CuC_1	20.69	4.70
	10.40	9.42
CuR_0	10.40	9.42

ZN CUMULATIVE GRADES	CUMULATIVE RECOVERIES
4.33	.21
5.95	.40
8.84	1.44
9.00	5.85
9.00	5.85

PROD.	WEIGHTS GM.	%	ASSAYS Cu	Ag		UNITS			DISTRIBUTION Cu	Ag	
$CuCC_3$	2.60	.00	20.00	4.88	.01	.05	.01	.00	33.19	.97	.26
$CuCT_3$	1.04	.00	11.60	5.65	.01	.01	.01	.00	7.70	.45	.10
$CuCT_2$	5.10	.01	4.39	6.57	.01	.02	.03	.00	14.29	2.56	.51
$CuCT_1$	26.10	.03	.46	2.38	.01	.01	.06	.00	7.66	4.75	2.60
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$CuRoTls$	970.10	.97	.06	1.23	.01	.06	1.19	.01	37.15	91.27	96.53
HEADS			.16	1.30	.01						

Cu CUMULATIVE GRADES		CUMULATIVE RECOVERIES
CuC_3	20.00	33.19
CuC_3	17.60	40.89
CuC_1	9.89	55.18
	2.83	62.85
CuR_0	2.83	62.85

Ag CUMULATIVE GRADES	CUMULATIVE RECOVERIES
4.88	.97
5.10	1.42
5.96	3.98
3.28	8.73
3.28	8.73

METALLURGICAL BALANCE TABLE VII Sept 20/

DUPLICATE Cu ROUGHERS of 2EF ORE – Scheme used like test A-8

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS (%)					DISTRIBUTION (%)				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
A-25	Cu Ro Conc	31.9	14.96	8.28	26.2	4.31	4.36	12.92	5.27	2.32	73.89	11.70
	Cu Ro Tls	971.9	3.31	4.89	36.2	0.05	1.08	87.08	94.73	97.68	26.11	88.30
	CALCHEAD	1003.8	3.68	5.00	35.9	0.19	1.18	100.0	100.0	100.0	100.0	100.0
A-26	Cu Ro Conc	31.0	12.23	8.10	27.6	4.34	3.66	10.18	4.95	2.41	73.46	9.29
	Cu Ro Tls	972.0	3.44	4.96	35.6	0.05	1.14	89.82	95.05	97.59	26.54	90.71
	CALCHEAD	1003.0	3.71	5.06	35.4	0.18	1.22	100.0	100.0	100.0	100.0	100.0
A-27	Cu Ro Conc	34.2	11.33	8.15	27.8	4.01	3.50	10.26	5.37	2.63	73.80	8.58
	Cu Ro Tls	973.5	3.48	5.05	36.2	0.05	1.31	89.74	94.63	97.37	26.20	91.42
	CALCHEAD	1007.7	3.75	5.16	35.9	0.18	1.38	100.0	100.0	100.0	100.0	100.0
A-28	Cu Ro Conc	34.1	9.99	8.11	28.7	4.09	3.17	9.30	5.41	2.81	74.22	8.08
	Cu Ro Tls	968.8	3.43	4.99	34.9	0.05	1.27	90.70	94.59	97.19	25.78	91.92
	CALCHEAD	1002.9	3.65	5.10	34.7	0.19	1.33	100.0	100.0	100.0	100.0	100.0

NOTE ON P_{80}'s of tests A-8, A-15 and A-24

P_{80} = 33.1 μ for A-8

= 31.6 μ for A-15

= 32.5 μ for A-24

(N)

METALLURGICAL BALANCE

TABLE VIII

2-F Cu Locked Cycle Test C-2

- bulk grind and rougher - first cleaner open

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS (%) Pb	Zn	Fe	Cu	Ag	DISTRIBUTION (%) Pb	Zn	Fe	Cu	Ag
2EF locked cycle test	$Cu\,CC_3$ I	3.01	5.60	1.05	33.3	6.55	1.62	0.08	0.01	0.05	2.27	0.07
	II	4.64	7.43	0.96	32.9	6.74	2.28	0.17	0.02	0.08	3.60	0.14
-6 cycles	III	8.87	4.22	0.79	33.8	6.63	1.56	0.18	0.02	0.16	6.77	0.19
BULK GRIND:	IV	7.68	4.43	0.90	33.9	7.47	2.10	0.16	0.02	0.14	6.60	0.22
8 kg ore	V	9.13	4.66	0.98	33.4	7.19	2.09	0.20	0.03	0.16	7.56	0.26
66% solids	VI	7.89	6.95	1.23	31.7	8.34	2.86	0.26	0.03	0.13	7.57	0.30
1 kg/tonne Na_2SO_3												
3 kg/tonne Na_2CO_3	$Cu\,CT_1$ I	18.76	4.91	8.04	31.6	1.96	1.81	0.44	0.53	0.31	4.23	0.46
100 g/tonne Z-11	II	16.92	3.98	8.84	31.2	1.71	1.54	0.32	0.52	0.28	3.33	0.35
75 min grind	III	9.98	2.75	13.54	29.3	1.51	1.30	0.13	0.47	0.15	1.73	0.17
BULK ROUGHER:	IV	12.47	4.09	10.29	30.6	0.99	1.65	0.24	0.45	0.20	1.42	0.28
50 g/tonne Z-11	V	16.77	4.01	10.12	30.2	0.98	1.55	0.32	0.59	0.26	1.89	0.35
pH = 9.5	VI	16.32	4.43	8.84	31.4	0.77	1.63	0.35	0.50	0.27	1.45	0.36
85.4 g of bulk conc sent to assay, rest used in 6 parts for locked cycle test												
1st clnr: 23 g/tonne Z-11 pH = 9.8	$Cu\,RoTs$ (Total)	5093.5	3.99	5.48	37.0	0.08	1.42	96.47	96.61	97.31	46.44	96.20
	$Cu\,CT_2$	15.76	5.20	2.34	34.4	0.90	1.77	0.39	0.13	0.28	1.63	0.37
2nd clnr: 6 g/tonne Z-11 pH = 9.8	$Cu\,CT_3$	12.60	4.54	1.15	35.2	2.42	1.73	0.31	0.05	0.23	3.51	0.29
3rd clnr: no Z-11 pH = 9.8	CALCHEAD	5204.3	4.01	5.50	36.8	0.17	1.43	100.0	100.0	100.0	100.0	100.0
*calculated weight												
average of last two cycles	$Cu\,CC_3$	8.51	5.72	1.10	32.6	7.72	2.45	1.40	0.20	0.87	44.54	1.68
	$Cu\,CT_1$	16.55	4.22	9.49	30.8	0.88	1.59	2.01	3.29	1.60	9.87	2.12
	$Cu\,RoTs$	840.6	3.99	5.48	37.0	0.08	1.42	96.59	96.51	97.53	45.59	96.20
	CALCHEAD	865.7	4.01	5.51	36.8	0.17	1.43	100.0	100.0	100.0	100.0	100.0

METALLURGICAL BALANCE

TABLE VIII (cont'd)

C-2

2EF Cu Locked Cycle Test - Average by Cycle

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS (%)					DISTRIBUTION (%)				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
cycle I	$CuCC_3$	3.01	5.60	1.05	33.3	6.55	1.62	0.49	0.07	0.32	15.93	0.40
	$CuCT_1$	18.76	4.91	8.04	31.6	1.96	1.81	2.66	3.17	1.86	29.72	2.76
	CuRoTls	840.6*	3.99	5.48	37.0	0.08	1.42	96.85	96.77	97.82	54.35	96.85
	CALCHEAD	862.4	4.02	5.52	36.9	0.14	1.43	100.0	100.0	100.0	100.0	100.0
cycle II	$CuCC_3$	4.64	7.43	0.96	32.9	6.74	2.28	1.00	0.09	0.48	24.54	0.86
	$CuCT_1$	16.92	3.98	8.84	31.2	1.71	1.54	1.95	3.14	1.66	22.70	2.12
	CuRoTls	840.6*	3.99	5.48	37.0	0.08	1.42	97.05	96.76	97.86	52.76	97.02
	CALCHEAD	862.2	4.01	5.52	36.9	0.15	1.43	100.0	100.0	100.0	100.0	100.0
cycle III	$CuCC_3$	8.87	4.22	0.79	33.8	6.63	1.56	1.09	0.15	0.95	41.67	1.13
	$CuCT_1$	9.98	2.75	13.54	29.3	1.51	1.30	0.80	2.85	0.92	10.68	1.06
	CuRoTls	840.6*	3.99	5.48	37.0	0.08	1.42	98.10	97.01	98.13	47.65	97.80
	CALCHEAD	859.5	3.98	5.53	36.9	0.16	1.42	100.0	100.0	100.0	100.0	100.0
cycle IV	$CuCC_3$	7.68	4.43	0.90	33.9	7.17	2.10	0.99	0.15	0.82	41.89	1.31
	$CuCT_1$	12.47	4.09	10.29	30.6	0.99	1.65	1.48	2.71	1.20	9.01	1.67
	CuRoTls	840.6*	3.99	5.48	37.0	0.08	1.42	97.53	97.15	97.98	49.10	97.02
	CALCHEAD	860.8	4.00	5.51	36.9	0.16	1.43	100.0	100.0	100.0	100.0	100.0
cycle V	$CuCC_3$	9.13	4.66	0.98	33.4	7.19	2.09	1.23	0.19	0.96	43.96	1.54
	$CuCT_1$	16.77	4.01	10.12	30.2	0.98	1.55	1.94	3.55	1.59	11.01	2.10
	CuRoTls	840.6*	3.99	5.48	37.0	0.08	1.42	96.83	96.27	97.46	45.03	96.36
	CALCHEAD	866.5	4.00	5.52	36.9	0.17	1.43	100.0	100.0	100.0	100.0	100.0

* ½ of calc. CuRoTls weight

(23)

METALLURGICAL BALANCE — Table VIII (cont'd)

C-2

2EF Cu Locked Cycle Test - Last Cycle Met. Balance and Bulk Rougher Met. Balance

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS (%) Pb	Zn	Fe	Cu	Ag	DISTRIBUTION (%) Pb	Zn	Fe	Cu	Ag
cycle VI	$CuCC_3$	7.89	6.95	1.23	31.7	8.34	2.86	1.58	0.20	0.78	45.19	1.82
	CuCT$_1$	16.32	4.43	8.84	31.4	0.77	1.63	2.08	3.03	1.61	8.63	2.14
	CuRoTls	840.6*	3.99	5.48	37.0	0.08	1.42	96.35	96.77	97.61	46.18	96.04
* 1/6 of calc. CuRoTls weight	CALCHEAD	864.8	4.03	5.50	36.8	0.17	1.44	100.0	100.0	100.0	100.0	100.0
BULK test B-4: 8kg 2EF ore Bulk grind Bulk rougher for test C-2 above	CuRoConc	246.2*	4.74	5.94	34.8	3.16	2.00	3.65	3.34	2.91	55.74	4.30
	CuRoTls	7722.0	3.99	5.48	37.0	0.08	1.42	96.35	96.66	97.09	44.26	95.70
* calculated weight	CALCHEAD	7968.2	4.01	5.49	36.9	0.18	1.44	100.0	100.0	100.0	100.0	100.0

NOTE: calculated weights

8.0 kg ore ground

7722.0g collected as CuRoTls

246.2g collected as CuRoConc

-85.4g of this conc → assay

-160.8g (remainder) used in 6 parts for the C-2 locked cycle test

AND $\frac{160.8}{246.2}$ = ratio used to calculate CuRoTls weight

TABLE IX

2EF Cu TESTS TO "DUPLICATE" 1972 AND 1977

	ORE TYPE AND TEST DESCRIPTION	SAMPLE	WTS.	ASSAYS					DISTRIBUTION				
				Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
E-1	2kg ore Grind: 1250g/T Na_2SO_3 1250g/T Na_2SO_3 50g/T Z-11 Cu Ro Conc: 1 min at pH = 9.5 Cu Sc Conc: 4 min Pb Ro Conc: 75g/T Na_2SO_3 175g/T Z-11 4.5 min Pb Sc Conc: 12.5g/T Z-11 5 min.	Cu Ro Conc.	23.3	8.88	7.94	33.4	1.19	2.62	2.67	1.79	1.01	7.37	2.45
		Cu Sc Conc.	48.5	14.98	7.09	30.1	3.57	4.25	9.39	3.34	1.89	46.04	8.26
		Pb Ro Conc.	102.9	45.20	4.23	19.1	0.18	11.32	60.09	4.22	2.54	4.93	46.69
		Pb Sc Conc.	38.3	29.10	6.77	24.8	0.34	8.05	14.40	2.51	1.23	3.46	12.36
"1972"		Tls	1795.8	0.58	5.06	40.2	0.08	0.42	13.46	88.13	93.34	38.20	30.24
		CALCHEAD		3.85	5.13	38.5	0.19	1.24	100.00	100.00	100.00	100.00	100.00
E-2	as E-1 with Minerec 1661 in place of Z-11 throughout	Cu Ro Conc.	32.8	8.63	7.04	31.8	6.23	3.01	3.74	2.23	1.35	47.77	4.13
		Cu Sc Conc.	31.0	25.10	8.28	24.7	3.39	6.82	10.29	2.48	0.99	24.57	8.85
		Pb Ro Conc.	29.8	28.30	6.50	26.0	0.10	7.16	11.16	1.87	1.00	0.70	8.93
"1972"		Pb Sc Conc.	27.5	26.70	6.49	26.7	0.08	6.80	9.71	1.72	0.95	0.51	7.83
		Tails	1885.4	2.61	5.04	39.3	0.06	0.89	65.09	91.70	95.71	26.45	70.25
		CALCHEAD		3.77	5.16	38.6	0.21	1.19	100.00	100.00	100.00	100.00	100.00
E-3	as E-1 with Minerec 1661 in place of Z-11 in grind only	Cu Ro/Sc Comb.	59.2	16.50	7.70	28.2	5.40	4.80	12.27	4.15	2.17	76.13	10.53
		Cu Ro Conc.	31.0	8.32	7.06	32.0	6.87	2.85	3.25	1.98	1.29	51.05	3.26
		Cu Sc Conc.	28.2	25.40	8.50	24.0	3.71	6.99	9.02	2.17	0.88	25.08	7.27
"1972"		Pb Ro Conc.	85.9	61.00	3.34	11.3	0.06	15.34	65.95	2.60	1.26	1.24	48.63
		Pb Sc Conc.	26.8	22.80	8.41	28.0	0.10	6.35	7.69	2.04	0.97	0.64	6.28
		Tails	1835.7	0.61	5.49	40.2	0.05	0.51	14.09	91.21	95.61	22.00	34.55
		CALCHEAD		3.96	5.50	38.5	0.21	1.35	100.00	100.00	100.00	100.00	100.00
E-4	2kg ore Grind: 1.75kg/T Na_2SO_3 1.0kg/T Na_2SO_3 35g/T Z-11 PbR1: 1 min at pH=10.1 PbR2: 4 min PbSc1: 20g/T Na_2SO_3 10g/T Z-11	PbR1	21.2	18.60	6.51	29.5	2.02	4.98	4.90	1.34	0.82	11.27	3.83
		PbR2	56.6	33.90	5.44	22.9	2.47	8.82	23.86	2.98	1.70	36.80	18.12
		PbSc1	24.4	45.20	4.44	18.2	0.39	11.70	13.72	1.05	0.58	2.51	10.36
		PbSc2	34.7	30.70	6.06	25.1	0.46	8.04	13.25	2.04	1.14	4.20	10.13
		PbSc3	33.8	27.00	6.56	25.9	0.76	7.47	11.35	2.15	1.15	6.76	9.17
		PbSc Tls	1825.9	1.45	5.11	39.5	0.08	0.73	32.92	90.44	94.61	38.45	48.39

TABLE IX _ (Cont'd)

2EF Cu TEST TO "DUPLICATE" 1972 AND 1977

	ORE TYPE AND TEST DESCRIPTION	SAMPLE	WTS.	ASSAYS					DISTRIBUITION				
				Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
E-4 (Cont'd) "1977"	PbSc1: 1 min PbSc2: 3 min PbSc3: 10g/T Z-11 3 min	CALHEAD		4.03	5.17	38.2	0.19	1.38	100.00	100.00	100.00	100.00	100.00

TABLE IX (cont'd)

PROD.	WEIGHTS GM.	%	ASSAYS PB	Cu	Ag	UNITS			DISTRIBUTION PB	Cu	Ag
Cu Ro Conc	45.90	.02	8.50	4.16	2.81	.19	.10	.06	4.64	38.06	3.95
Sc Conc	43.00	.02	17.70	1.79	4.85	.38	.04	.10	9.04	15.34	6.39
Pb Ro Conc	110.70	.06	54.60	.13	13.22	3.02	.01	.73	71.82	2.87	44.84
Sc Conc	58.40	.03	7.75	.17	2.33	.23	.00	.07	5.38	1.98	4.17
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sc Tls	1746.00	.87	.44	.12	.76	.38	.10	.66	9.13	41.76	40.65
HEADS			4.20	.25	1.63						

PB CUMULATIVE GRADES
8.50
12.95
36.05
29.64
29.64

CUMULATIVE RECOVERIES
4.64
13.68
85.49
90.87
90.87

Cu CUMULATIVE GRADES
4.16
3.01
1.41
1.13
1.13

CUMULATIVE RECOVERIES
38.06
53.40
56.26
58.24
58.24

2EF Cu test

E-6
duplicate of E-3
Mmrec 1661/2-11

TABLE X

2H Cu Pre-Float Tests

Ju[illegible]2-H/83

*calculated

	ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
A-1	2Hore - 1kg charge grind: NO Na_2SO_3 30g/t Z-11 rougher: 30g/t Z-11 pH=9.5	Cu Ro Conc	40.4	13.00	7.38	28.1	6.10	5.38	13.29	4.36	3.18	54.93	9.88
		Cu Ro Tls	962.9	3.56	6.79	35.9	0.21	2.06	86.71	95.64	96.82	45.07	90.12
		CALCHEAD	1003.3	3.94	6.81	35.6	0.45	2.19	100.0	100.0	100.0	100.0	100.0
A-2	2Hore - 1kg charge grind: 1kg/t Na_2SO_3 30g/t Z-11 rougher: 30g/t Z-11 pH=9.5	Cu Ro Conc	33.9	22.10	6.89	22.4	7.97	8.49	18.76	3.54	2.14	58.18	13.56
		Cu Ro Tls	971.1	3.34	6.56	35.7	0.20	1.89	81.24	96.46	97.86	41.82	86.44
		CALCHEAD	1005.0	3.97	6.57	35.3	0.46	2.11	100.0	100.0	100.0	100.0	100.0
A-4	2Hore - 1kg charge grind: 1kg/t Na_2SO_3 30g/t Z-11 rougher: 30g/t Z-11 pH=9.5 1st cleaner: 20g/t Z-11 pH=8.9	Cu CC$_1$	13.9	22.60	4.44	17.6	15.70	882	7.83	0.93	0.67	52.65	5.74
		Cu CT$_1$	19.6	19.20	8.70	27.1	1.09	7.00	9.38	2.56	1.45	5.15	6.43
		* Cu Ro Conc*	33.5	20.61	6.93	23.2	7.15	7.76	17.21	3.49	2.12	57.80	12.17
		Cu Ro Tls	971.7	3.42	6.61	37.0	0.18	1.93	82.80	96.51	97.89	42.20	87.83
		CALCHEAD	1005.2	3.99	6.62	36.5	0.41	2.12	100.0	100.0	100.0	100.0	100.0
A-5	2Hore - 1kg charge grind: 1kg/t Na_2SO_3 50g/t Z-11 rougher: 30g/t Z-11 pH=9.5 1st cleaner: 20g/t Z-11 pH=9.0	Cu CC$_1$	13.5	19.10	4.47	19.5	17.10	7.61	6.43	0.88	0.75	54.63	4.41
		Cu CT$_1$	21.7	20.80	8.94	25.4	1.21	7.46	11.26	2.84	1.58	6.21	6.95
		* Cu Ro Conc*	35.2	20.15	7.23	23.1	7.30	7.52	17.69	3.72	2.33	60.84	11.37
		Cu Ro Tls	973.4	3.39	6.76	35.1	0.17	2.12	82.31	96.28	97.67	39.16	88.63
		CALCHEAD	1008.6	3.97	6.78	34.7	0.42	2.31	100.0	100.0	100.0	100.0	100.0

2H Cu, Pre-Float Tests

TABLE X (cont'd)

12-14-83

* calculated

	ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
A-6	2Hore-1kg charge grind: 1kg/t Na_2SO_3 70g/t Z-11 rougher: 30g/t Z-11 pH = 9.5 1st cleaner: 20g/t Z-11 pH = 9.0	CuCC1	13.9	18.60	4.67	19.1	17.50	7.77	6.42	0.92	0.75	58.53	4.95
		CuCT1	22.1	22.80	8.93	24.2	1.64	8.45	12.51	2.80	1.52	8.72	8.56
		Cu RoConc	36.0	21.18	7.29	22.2	7.76	8.19	18.92	3.73	2.27	67.25	13.51
		Cu RoTls	972.3	3.36	6.97	35.4	0.14	1.94	81.08	96.27	97.73	32.75	86.49
		CALCHEAD	1008.3	4.00	6.98	34.9	0.41	2.16	100.0	100.0	100.0	100.0	100.0
A-7	2Hore-1kg charge grind: 1kg/t Na_2SO_3 100g/t Z-11 rougher: 50g/t Z-11 pH = 9.5 1st cleaner: 30g/t Z-11 pH = 9.1	CuCC1	27.1	32.10	3.93	17.9	10.47	11.78	21.87	1.65	1.35	67.90	14.40
		CuCT1	25.1	13.30	10.11	27.4	1.15	5.45	8.39	3.94	1.92	6.91	6.17
		Cu RoConc	52.2	23.06	6.90	22.5	5.99	8.74	30.26	5.60	3.27	74.81	20.57
		Cu RoTls	956.8	2.90	6.35	36.3	0.11	1.84	69.74	94.40	96.73	25.19	79.43
		CALCHEAD	1009.0	3.94	6.38	35.6	0.41	2.20	100.0	100.0	100.0	100.0	100.0
A-8	2Hore-1kg charge grind: 1kg/t Na_2SO_3 50g/t Z-11 rougher: 15g/t Z-11 pH = 9.5 1st cleaner: 5g/t Z-11 pH = 8.9	CuCC1	7.0	18.00	3.42	19.9	18.80	7.25	3.15	0.37	0.38	31.66	2.37
		CuCT1	20.2	22.90	7.02	25.6	2.48	8.38	11.56	2.17	1.40	12.05	7.91
		Cu RoConc	27.2	21.64	6.09	24.1	6.68	8.09	14.71	2.53	1.78	43.71	10.28
		Cu RoTls	975.1	3.50	6.54	37.2	0.24	1.97	85.29	97.47	98.22	56.29	89.72
		CALCHEAD	1002.3	3.99	6.53	36.8	0.41	2.14	100.0	100.0	100.0	100.0	100.0
A-9	2Hore-1kg charge grind: 2kg/t Na_2SO_3 100g/t Z-11 rougher: 50g/t Z-11 pH = 9.5 1st cleaner: 30g/t Z-11 pH = 9.1	CuCC1	15.6	38.30	3.99	14.2	10.30	13.70	16.07	0.90	0.61	53.75	10.29
		CuCT1	22.3	12.30	10.99	27.1	1.39	4.87	7.38	3.56	1.67	10.37	5.23
		Cu RoConc	37.9	23.00	8.11	21.8	5.06	8.50	23.44	4.47	2.29	64.12	15.52
		Cu RoTls	974.9	2.92	6.74	36.2	0.11	1.80	76.56	95.53	97.71	35.88	84.48
		CALCHEAD	1012.8	3.71	6.86	36.0	0.30	2.07					

2H Cu Pre-Float Tests

TABLE X (cont'd)

12-14/83

*calculated

	ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
A-10	2Hore - 1kg charge grind: 1 kg/t Na_2SO_3 150 g/t Z-11 rougher: 75 g/t Z-11 pH = 9.6	Cu RoConc	112.9	25.50	5.40	23.0	3.08	9.59	68.55	8.73	7.10	77.99	50.07
		Cu RoTls	892.4	1.48	7.14	38.1	0.11	1.21	31.45	91.27	92.90	22.01	49.93
		CALCHEAD	1005.3	4.18	6.94	36.4	0.44	2.15	100.0	100.0	100.0	100.0	100.0
A-11	2Hore - 1kg charge grind: 2 kg/t Na_2SO_3 50 g/t Z-11 rougher: 15 g/t Z-11 pH = 9.5 1st cleaner: 5 g/t Z-11 pH = 9.0	Cu CC1	10.7	19.60	4.58	19.4	17.60	7.80	5.35	0.77	0.57	42.78	3.94
		Cu CT1	21.6	20.50	7.93	27.0	1.25	7.31	11.30	2.71	1.60	6.13	7.45
		Cu RoConc	32.3	20.20	6.82	24.5	6.67	7.47	16.66	3.48	2.17	48.91	11.39
		Cu RoTls	977.6	3.34	6.25	36.5	0.23	1.92	83.34	96.52	97.83	51.08	88.61
		CALCHEAD	1009.9	3.88	6.27	36.1	0.44	2.10	100.0	100.0	100.0	100.0	100.0
A-12	2Hore - 1kg charge LOW pH grind: no Na_2CO_3 no Na_2SO_3 no Z-11 Ro: 20 g/t Z-11 pH = 5.1	Cu RoConc	34.8	6.18	7.30	32.9	0.71	2.73	5.43	3.90	3.23	5.86	4.27
		Cu RoTls	968.7	3.87	6.47	35.4	0.41	2.20	94.57	96.10	96.77	94.14	95.73
		CALCHEAD	1003.5	3.95	6.50	35.3	0.42	2.22	100.0	100.0	100.0	100.0	100.0

APPENDIX I

HISTORICAL RESULTS ON COPPER FLOTATION

Cyprus Anvil Mining Corporation — Interoffice Correspondence

To: J. Levanaho

Date: July 10, 1983

From: R. Murarka

Subject: Cu/Au/Ag metallurgical response of Anvil ore: a review of best results.

This review includes work done on Anvil ore for recovering Cu. The period covered is 1972 to 1979. Very little work has been done on Au, Ag recoveries. The work done recently in the CAMC lab is not included here because the metallurgy obtained so far has not been as good as past work.

I. April 1972, CAMC Lab. Table I shows the technical details of the test. This was truly a Cu pre-float test. The flotation feed grind was 57% - 74 um. Flotation feed density was 28% solids by weight.

Table II shows the metallurgical balance of the whole circuit.

The main conclusion drawn by this study was that by using stronger collectors eg. Z-200
(a) Pb recoveries can be improved
(b) a Cu conc. can be produced

II. August 1977, CAMC Lab. Table III shows technical details of this test. Table IV is the cumulative metallurgical balance of Pb and Cu in the Pb circuit only. Pb R1 and R2 represent Cu pre-flotation while Pb S_1, S_2 and S_3 represent Pb flotation.

The head Cu grade in this work was very high (0.38% Cu). In spite of this, the metallurgy was poorer than the work in 1972. Ag recoveries were also determined in this work but were less than 50% in the overall Pb circuit.

III. February 1979, Lakefield Lab. These are the best results to date. Table V gives the technical details. Table VI lists the metallurgy. Although Cu metallurgy was good, only 59.4% of Zn left the circuit which means contamination of Cu and Pb with Zn. The principal conclusions drawn were: (a) Cu pre-flotation causes the Pb grade in the Pb conc. to drop and (b) it causes the recoveries of Pb and Zn in their respective concentrates to drop.

R. Murarka
Metallurgist

CYPRUS ANVIL

TABLE I

Grind	Na_2CO_3	2.5#/ton		
	Na_2SO_3	2.5#/ton	17 mins.)	
	Z-200	0.10#/ton	3 mins.)	20 mins
Cu.R.C.			pH 9.5	1 min.
Cu.Sc.C.				4 mins
NaCN Cond.	NaCN	0.15 #/ton		10 mins
	Z-11	0.025#/ton		
Pb.Sc.C.				5 mins
Zn. Cond.	CaO	1.25#/ton		
	$CuSO_4$	0.75#/ton		
	Z-11	0.075#/ton		2 mins
Zn.R.C.	Df1012		pH 10.6	5 mins
	Z-11	0.025#/ton		
Zn.Sc.C.	Df1012			6 mins

TABLE II

		ASSAY %			DISTRIBUTION %		
Product	%Wt.	Pb	Zn	Cu	Pb	Zn	Cu
Cu.R.C.	0.4	8.4	10.2	16.5	0.6	0.6	41.3
Cu.Sc.C.	0.9	12.8	13.2	2.2	2.6	1.7	13.0
Pb.R.C.	7.9	48.3	8.0	0.08	81.1	8.9	4.0
Pb.Sc.C.	3.8	6.7	10.9	0.11	5.6	5.8	2.6
Zn.R.C.	10.6	1.0	47.7	0.20	2.4	71.4	13.2
Zn.Sc.C.	2.5	2.2	15.2	0.17	1.3	5.4	2.7
Zn.Sc.T.	73.9	0.4	0.6	0.05	6.4	6.2	23.2
Heads		4.7	7.1	0.16			

TABLE III

Reagents lb/ton		Addition Point
NaCN	0.06	Grind 11 min.
Na_2CO_3	3.5	
Na_2SO_3	2.0	
Z-11	0.07	Grind 2 min.
pH	10.1	Pb R1
NaCN		
Z-11		Pb R2
NaCN	0.04	
Z-11	0.02*	Pb S1
Z-11		Pb S2
Z-11	0.02	Pb S3

* Reagents added and conditioned for three minutes.

TABLE IV

	Grade		Recovery	
	Pb	Cu	Pb	Cu
Pb R1	21.0	10.5	21.0	63.6
R2	21.9	8.2	32.3	72.7
Pb S1	31.0	5.5	70.8	75.8
S2	31.7	5.1	72.3	75.8
S3	38.3	4.1	87.7	75.8

TABLE V

Purpose: A preliminary test to investigate the flotation of copper and lead but use a 1:1 mixture of Z-6 and 3501 in the copper rougher and add $ZnSO_4$ to the copper regrind.

Procedure: Grind and float a copper concentrate and a lead concentrate. Regrind the copper concentrate and clean three times.

Feed: 2000 grams minus 10 mesh Mill Feed Sample

Grind: 20 minutes at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, grams per tonne							Time, minutes			pH
	Na_2CO_3	Na_2SO_3	Z-6/ 3501	MIBC	NaCN	R-242	$ZnSO_4$	Grind	Cond.	Froth	
Grind	2000	1000	15	–	–	–	–	20	–	–	–
Cu Rougher	–	–	10	20	–	–	–	–	2	3	9.
	–	–	10	5	–	–	–	–	1	2	–
	–	–	5	5	–	–	–	–	1	2	–
Condition	–	–	–	–	150	–	500	–	2	–	9.
Pb Rougher	–	–	5	–	–	15	–	–	1	3	–
	–	–	5	–	–	5	–	–	1	3	–
	–	–	–	–	–	5	–	–	1	3	–
		H-31	Z200		A.C.**	SO_2		** ACTIVATED CARBON			
Cu Conc. Regr. *	–	–	–	–	–	–	300	20'	–	–	–
Condition	100	125	–	–	40	–	–	–	5	–	9.
	–	–	–	–	–	250	–	–	5	–	5.
Cu 1st Cl.	–	–	20	–	–	–	–	–	5	2	6.
	–	–	5	–	–	20	–	–	1	2	–
Cu 2nd Cl.	–	50	–	2.5	–	15	–	–	2	1	5.
	–	–	5	–	–	–	–	–	1	2	–
Cu 3rd Cl.	–	25	–	2.5	–	10	–	–	2	1	5.
	–	–	2.5	–	–	–	–	–	1	1	–

	ROUGHER	1st. Cu. Cl.	2nd & 3rd
machine	D - 1	D - 1	D - 1
rpm.	1900	1300	1000
% solids	33	-	-

* Cu regrind mill - pebble mill

TABLE VI

Product	Weight	Assays, %			% Distribution		
	%	Cu	Pb	Zn	Cu	Pb	Zn
1. Cu Cleaner Conc.	0.52	20.5	5.98	14.0	53.8	0.5	0.
2. Cu 3rd Cleaner Tail.	0.27	4.96	21.3	21.9	6.8	1.0	0.
3. Cu 2nd Cleaner Tail.	0.82	1.43	31.3	19.5	5.9	4.4	2.
4. Cu 1st Cleaner Tail.	9.16	0.17	38.8	13.4	7.9	60.4	15.
5. Pb Rougher Conc.	14.99	0.091	11.5	11.2	6.9	29.3	21.
6. Pb Rougher Tail.	74.24	0.050	0.35	6.29	18.7	4.4	59.
Head (Calculated)	100.00	0.20	5.88	7.87	100.0	100.0	100.

Calculated Grades and Recoveries

Products 1 and 2	0.79	15.2	11.2	16.7	60.6	1.5	1.7
Products 1 to 3	1.61	8.18	21.4	18.1	66.5	5.9	3.7
Products 1 to 4	10.77	1.37	36.2	14.1	74.4	66.3	19.3
Products 5 and 6	89.23	0.057	2.22	7.11	25.6	33.7	80.7

APPENDIX II

INITIAL TEST WORK ON 2BCD AND 2EF ORES

To J. Levanaho

Date July 11, 1983

From R. Murarka

cc: M. Nicholson

Subject Copper test work: an up-date

SUMMARY:

Test work was carried out using three different approaches: Cu seperation from a Pb 3rd Cleaner conc., Cu pre-flotation and Cu/Pb bulk flotation-separation. It appears that the best route to follow is the last one. With ores similar to ours, this route is most common in the industry. The success in producing a Cu concentrate so far has been limited but further test work with a different set of Pb depressants used in the industry may prove beneficial.

INTRODUCTION:

Cu test work was conducted mainly on 2BCD ore (head Cu assay varying from 0.18 to 0.30%). Minor work was done on 2EF ore because of its lower head grade (0.15% Cu) but more work can be planned depending on the success with 2BCD ore. The success with these ore types will determine the feasibility of Cu concentrate production. Other ore-types occur in minor proportions in the Faro ore body.

2EF ORE:

Only 2 tests were carried out trying to pre-float the Cu. Very little NaCN and Z-11 were used. It was hoped that the amount of NaCN would be just sufficient to depress the iron in the ore but not Cu. Small amount of Z-11 was added in order to float Cu only. In the second test Na_2SO_3 was also added to further retard flotation of Pb.

The results are presented in Table 1. It can be seen that Cu/Pb separation is very poor.

2BCD ORE:

(a) Cu/Pb separation from Pb final concentrate: It was noticed in earlier work with 2BCD ore that much Cu was found in the final Pb concentrate. Thus the obvious route to go was to produce a large scale final Pb concentrate and extract the Cu from it.

In the first three tests (table II), no collector was added.

TABLE 1

	ORE TYPE & TEST DESCRIPTION	SAMPLE	WTS.	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
1.	2 EF-no Na_2SO_3												
	-10g/t NaCN	Cu/Pb conc.	87.4	28.7	5.97	22.6	.66	8.83	74.6	12.5	5.8	57.5	47.5
	-30g/t Z-11 to grind	Cu/Pb Tls.	916.5	.93	4.00	35.1	.10	.93	25.4	87.5	94.2	42.5	52.5
	-50g/t Z-11 to flot.	Heads	1003.9	3.35	4.17	34.0	.15	1.62	100.0	100.0	100.0	100.0	100.0
2.	2 EF-with Na_2SO_3												
	-10g/t NaCN	Cu/Pb conc	56.1	9.31	7.55	29.1	.99	3.12	15.4	9.4	4.8	37.1	12.2
	-30g/t Z-11 to grind	Cu/Pb tls.	942.0	3.06	4.33	34.2	.10	1.34	84.6	90.6	95.2	62.9	87.8
	-30g/t Z-11 to flot.	Heads	998.1	3.41	4.51	33.9	.15	1.44	100.0	100.0	100.0	100.0	100.0

Cu/Pb Separation from $PbCl_3$

TABLE II

ORE TYPE and TEST DESCRIPTION	SAMPLE	WTS.	Assays					Distribution				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
2BCD - Assayed Heads ($PbCC_3$)	$PbCC_3$	—	59.3	4.13	6.3	2.51	20.72	—	—	—	—	—
	$PbCT_3$	—	3.25	9.43	18.8	.64	2.08	—	—	—	—	—
1. 2BCD - 1200g/T $K_2Cr_2O_7$ - no 2-11 - 2 drops MIBC	Cu Conc	16.4	46.6	4.97	8.5	5.64	17.44	32.3	21.5	27.7	63.9	33.8
	Cu Tls	35.5	45.2	8.36	10.2	1.45	15.78	67.7	78.5	72.3	36.1	66.2
	Heads	51.9	45.6	7.29	9.7	2.74	16.36	100.0	100.0	100.0	100.0	100.0
2. 2BCD - 1800g/T $K_2Cr_2O_7$ - no 2-11 - no MIBC	Cu Conc	9.5	50.0	3.97	8.1	6.01	18.69	14.4	12.0	17.4	38.5	15.4
	Cu Tls	49.6	57.2	5.56	7.4	1.84	19.60	85.6	88.0	82.6	61.5	84.6
	Heads	59.1	56.0	5.30	7.5	2.51	19.45	100.0	100.0	100.0	100.0	100.0
3. 2BCD - Rougher - 1800g/T $K_2Cr_2O_7$ + 1 drop MIBC	Rougher Conc	13.3	55.3	4.47	7.11	4.75	19.36	21.1	19.4	21.4	39.1	21.5
- Cleaner - 500g/T $K_2Cr_2O_7$ + 1 dr. MIBC	Cu Conc	3.5	46.2	4.18	9.1	7.73	17.03	4.6	4.8	7.2	16.7	5.0
	Cu 1st Tls	9.8	58.5	4.58	6.4	3.68	20.19	16.5	14.7	14.2	22.3	16.5
	Cu RO Tls	47.2	58.1	5.21	7.4	2.08	19.91	78.9	80.5	78.6	61.0	78.5
	Heads	60.5	57.5	5.05	7.3	2.67	19.79	100.0	100.0	100.0	100.0	100.0

2BCD ORE cont"d:

$K_2Cr_2O_7$ was used for depressing the Pb but it can be seen that increasing quantities of $K_2Cr_2O_7$ depress more Cu along with Pb. Increasing the amount of frother floats more Pb and Cu.

In tests 4 to 8, (table 111) effect of varying Z-11, M1BC (frother) and $K_2Cr_2O_7$ was studied. It can be concluded here that adding more Z-11 enhances flotation of both Pb and Cu.

So far, in all but one tests, no cleaning of the "Cu conc" was attempted. At this point it was decided to clean this "Cu conc". Variation in the amounts of $K_2Cr_2O_7$ and M1BC was again tried and three tests were conducted (table 1V, tests 9 to 11). Although a "Cu conc" grading 14% Cu was produced, the overall Cu recovery was very poor and the Pb grade of this "Cu conc" was too high.

(b) Cu Pre-flotation:

Similar strategy was used here as for 2EF ore. Since NaCN depressed some Cu (test 1, table V), no NaCN was used in tests 2 and 3. As can be seen, no improvement in Cu recovery resulted. In test 3, depression of Pb that accompanied Cu in preflotation was attempted. This resulted in a concentrate grading 6% Cu with 55% recovery.

(c) Cu/Pb bulk flotation-separation - I :-

Although pre-flotation of Cu was the objective, the result in tests 4 to 8 turned out to be Cu/Pb bulk flotation (table VI). No NaCN and 1 kg/t of Na_2SO_3 was used in order to encourage Cu flotation and discourage Pb flotation. The bulk conc. was subsequently treated with $K_2Cr_2O_7$ to depress the Pb.

The first cleaner grade/recovery of Cu were the best so far in this series of tests. However, it was thought that $K_2Cr_2O_7$ usage to depress Pb may have an adverse effect in the Pb circuit. As a result another test was carried out without $K_2Cr_2O_7$. Also very little Z-11 was added to discourage Pb flotation. Strickly speaking this was an attempt to pre-float the Cu (table V11, test 9). The first cleaner conc. had grade/recovery of 9.5% Cu/41% recovery but contamination with Pb, Zn, Fe was high. Pb and Ag recoveries to the rougher conc. are very poor in comparison with Cu. This strengthens the belief that Ag is not associated with Cu.

Another test was carried out to discourage Pb flotation by adding twice as much Na_2SO_3 as in previous tests. Results are shown in table V11, test 10. Clearly the extra Na_2SO_3 was not helpful.

Cu / Pb Separation from $PbCO_3$ TABLE III

	ORETYPE and Test Description	SAMPLE	WTS	ASSAYS (%)					DISTRIBUTION (%)				
				Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
4.	2BCD - 1200 g/t $K_2Cr_2O_7$ - no Z-11 - 4 drops MIBC	Cu Ro. Conc	23.5	57.2	4.17	6.1	4.27	20.42	35.82	32.04	33.15	64.58	36.78
		Cu Ro. Tls	39.6	60.8	5.25	7.3	1.39	20.83	64.17	67.96	66.85	35.42	63.22
		Calc. Head	63.1	59.5	4.85	6.9	2.46	20.68	100	100	100	100	100
5.	2BCD - 1800 g/t $K_2Cr_2O_7$ - 20 g/t Z-11 - 2 drops MIBC	Cu Ro. Conc.	25.4	50.5	6.53	7.7	4.40	17.71	48.54	49.92	43.24	78.91	48.99
		Cu Ro. Tls.	26.2	51.9	6.35	9.8	1.14	17.88	51.46	50.08	56.76	21.09	51.01
		Calc. Head	51.6	51.2	6.44	8.8	2.74	17.80	100	100	100	100	100
6.	2BCD - 1800 g/t $K_2Cr_2O_7$ - 50 g/t Z-11 - 2 drops MIBC	Cu Ro. Conc	48.9	55.8	5.22	6.9	3.97	19.72	68.25	58.19	54.67	94.93	69.34
		Cu Ro. Tls.	25.9	49.0	7.08	10.8	0.40	16.46	31.75	41.81	45.33	5.07	30.66
		Calc. Head	74.8	53.4	5.86	8.3	2.73	18.59	100	100	100	100	100
7.	2BCD - 1800 g/t $K_2Cr_2O_7$ - 80 g/t Z-11 - 2 drops MIBC	Cu Ro. Conc.	32.6	50.5	7.09	8.1	4.08	17.57	59.47	60.04	49.72	85.24	59.84
		Cu Ro. Tls.	24.5	45.8	6.28	10.9	0.94	15.69	40.53	39.96	50.28	14.76	40.16
		Calc. Head	57.1	48.5	6.74	9.3	2.73	16.73	100	100	100	100	100
8.	2BCD - 1800 g/t $K_2Cr_2O_7$ - 100 g/t Z-11 - 2 drops MIBC	Cu Ro. Conc.	47.6	56.9	5.04	6.7	3.64	19.99	69.20	57.07	52.66	91.24	69.66
		Cu Ro. Tls	25.6	47.1	7.05	11.2	0.65	16.19	30.80	42.93	47.34	8.76	30.34
		Calc. Head	73.2	53.5	5.74	8.3	2.59	18.66	100	100	100	100	100

Cu / Pb Separation TABLE IV
from $PbCl_3$

	ORETYPE and Test Description	SAMPLE	WTS	ASSAYS (%)					DISTRIBUTION (%)				
				Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
9.	2BCD R_o - 1200 g/t $K_2Cr_2O_7$ - 50 g/t Z-11 - 2 drops MIBC C_1 - 600 g/t $K_2Cr_2O_7$ - 25 g/t Z-11 - 1 drop MIBC C_2 - 180 g/t $K_2Cr_2O_7$ - 7.5 g/t Z-11 - 1 drop MIBC	$CuCC_2$	2.89	32.8	5.05	12.4	11.21	14.07	4.03	4.04	7.02	25.06	4.98
		$CuCT_2$	12.5	51.6	5.00	7.6	4.95	18.64	27.39	17.28	18.62	47.87	28.54
		Calc. $CuCC_1$	15.4	48.1	5.01	8.5	6.13	17.78	(31.42)	(21.32)	(25.64)	(72.93)	(33.52)
		$CuCT_1$	15.0	50.7	5.25	7.8	1.38	17.22	32.29	21.78	22.93	16.02	31.64
		Calc. Cu Ro. Conc	30.4	49.4	5.13	8.2	3.78	17.50	(63.71)	(43.10)	(48.57)	(88.95)	(65.16)
		Cu Ro. Tls.	21.6	40.7	9.80	12.5	0.68	13.54	36.29	56.91	51.44	11.05	34.83
		Calc. Head	51.4	45.8	7.04	9.9	2.52	15.88	100	100	100	100	100
10.	2BCD R_o - 3000 g/t $K_2Cr_2O_7$ - 50 g/t Z-11 - 2 drops MIBC C_1 - 1500 g/t $K_2Cr_2O_7$ - 25 g/t Z-11 - 1 drop MIBC C_2 - 450 g/t $K_2Cr_2O_7$ - 7.5 g/t Z-11 - 1 drop MIBC	$CuCC_2$	2.38	19.2	7.25	15.2	13.89	10.59	1.15	4.28	6.39	18.66	1.82
		$CuCT_2$	12.8	43.4	7.19	8.5	6.77	16.41	13.97	22.83	19.22	48.92	15.18
		Calc. $CuCC_1$	15.2	39.6	7.20	9.6	7.89	15.50	(15.12)	(27.11)	(25.61)	(67.58)	(17.00)
		$CuCT_1$	25.9	62.0	4.60	4.9	1.46	20.81	40.39	29.56	22.41	21.35	38.96
		Calc. Cu Ro. Conc.	41.1	53.7	5.56	6.6	3.83	18.85	(55.51)	(56.67)	(48.02)	(88.93)	(55.96)
		Cu Ro. Tls	32.7	54.1	5.34	9.0	0.60	18.63	44.49	43.32	51.98	11.08	44.04
		Calc. Head	73.8	53.9	5.46	7.7	2.40	18.75	100	100	100	100	100
11.	2BCD R_o - 1800 g/t $K_2Cr_2O_7$ - 50 g/t Z-11 - 4 drops MIBC C_1 - 900 g/t $K_2Cr_2O_7$ - 25 g/t Z-11 - 2 drops MIBC C_2 - 270 g/t $K_2Cr_2O_7$ - 7.5 g/t Z-11 - 1 drop MIBC	$CuCC_2$	3.56	29.7	6.98	11.9	9.73	12.58	5.24	6.29	7.91	28.11	6.23
		$CuCT_2$	11.2	42.8	7.08	8.7	5.05	15.84	23.74	20.08	18.20	45.90	24.67
		Calc. $CuCC_1$	14.8	39.6	7.06	9.5	6.18	15.05	(28.98)	(26.37)	(26.11)	(74.01)	(30.90)
		$CuCT_1$	16.5	48.8	6.89	7.7	1.45	17.03	39.87	28.79	23.73	19.42	39.07
		Calc. Cu Ro. Conc.	31.3	44.5	6.97	8.5	3.68	16.10	(68.85)	(55.16)	(49.84)	(93.43)	(69.97)
		Cu Ro. Tls	18.4	34.2	9.62	14.6	0.44	11.77	31.16	44.83	50.17	6.57	30.11
		Calc. Heado	49.7	40.7	7.95	10.8	2.48	14.48	100	100	100	100	100

Cu PRE-FLOAT TESTS

Table V

ORE - TYPE & TEST DESCRIPTION	SAMPLE	WTS.	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
1. 2BCD-with Na_2SO_3 -10g/t NaCN -30g/t Z-11 to grind -30g/t Z-11 to flot.	Cu/Pb conc.	134.2	19.4	9.03	11.9	1.04	7.05	83.3	18.4	12.5	61.4	63.0
	Cu/Pb Tls.	854.3	.61	6.30	13.1	.10	.65	16.7	81.6	87.5	38.6	37.0
	Heads	988.5	3.16	6.67	12.9	.23	1.52	100.0	100.0	100.0	100.0	100.0
2. 2BCD-with Na_2SO_3 -no NaCN -30g/t Z-11 to grind -30g/t Z-11 to float	Cu/Pb conc.	129.0	17.0	8.93	12.6	1.07	6.37	72.1	18.8	12.8	62.9	56.8
	Cu/Pb Tls.	868.3	.98	6.16	12.7	.09	.72	27.9	81.2	87.2	37.1	43.2
	Heads	997.3	3.05	6.52	12.7	.22	1.45	100.0	100.0	100.0	100.0	100.0
3. 2BCD-with Na_2SO_3 -no NaCN	Rougher	87.9	12.6	10.13	11.5	1.61	5.02	35.7	13.5	7.8	61.5	29.8
	Cu conc.	21.0	12.8	13.40	14.0	6.06	6.60	8.7	4.3	2.3	55.3	9.4
-30g/t Z-11 to grind	Cu Tls.	66.9	12.5	9.10	10.7	.21	4.53	27.0	9.3	5.5	6.1	20.5
-30g/t Z-11 to flot.	CuRO Tls.	912.8	2.19	6.24	13.0	.10	1.14	64.3	86.4	92.2	38.6	70.1
CLnr.-1000g/t $K_2Cr_2O_7$ -20 g/t Z-11	Heads	1000.7	3.10	6.58	12.9	.23	1.48	100.0	100.0	100.0	100.0	100.0

① No NaCN added
② 1 kg/t Na_2SO_3 added to grind

TABLE VI

	2BCD ORETYPE and Test Description				SAMPLE	WTS	ASSAYS					DISTRIBUTION				
	g/t Z-11			$K_2Cr_2O_7$			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
	Grind	Ro	Cln	to Clnr 1												
4.	50	30	20	2000	CuConc	15.7	16.20	10.71	15.10	6.75	7.76	8.85	2.83	1.74	59.23	9.96
					CuTls 1	68.7	25.80	7.20	11.00	.26	9.05	61.70	8.34	5.56	9.94	50.85
					CuRoMet	84.4	24.01	7.85	11.76	1.47	8.81	70.55	11.17	7.30	69.21	60.81
					CuRoTls	909.6	.93	5.80	13.80	.06	.53	29.45	88.83	92.70	30.79	39.19
					Heads	994.0	2.89	5.97	13.67	.18	1.23	100.00	100.00	100.00	100.00	100.00
5.	50	30	20	3000	CuConc	17.8	15.60	11.25	14.60	6.40	7.62	9.15	3.27	1.90	63.19	9.67
					CuTls 1	77.1	26.80	7.97	11.60	.26	9.47	68.09	10.02	6.55	11.12	57.07
					CuRoMet	94.9	24.70	8.59	12.16	1.41	9.12	77.24	13.29	8.46	74.31	61.74
					CuRoTls	906.7	.76	5.86	13.80	.05	.59	22.76	86.71	91.55	25.69	38.26
					Heads	1001.6	3.03	6.12	13.64	.18	1.40	100.00	100.00	100.00	100.00	100.00
6.	70	30	20	2000	CuConc	18.5	13.30	11.52	15.70	6.07	6.60	8.17	3.45	2.20	59.85	8.77
					CuTls 1	82.5	22.90	7.39	12.60	.16	8.42	62.73	9.88	7.87	7.04	49.89
					CuRoMet	101.0	21.14	8.15	13.17	1.24	8.09	70.90	13.33	10.07	66.89	58.66
					CuRoTls	886.5	.99	6.08	13.40	.07	.65	29.10	86.67	89.93	33.11	41.34
					Heads	987.5	3.05	6.25	13.38	.19	1.41	100.00	100.00	100.00	100.00	100.00
7.	100	50	30	2000	CuConc	29.1	13.10	8.67	19.90	4.14	6.12	12.86	4.36	4.27	67.04	14.87
					CuTls 1	131.4	16.90	5.26	21.00	.16	6.26	74.90	11.94	20.35	11.70	68.66
					CuRoMet	160.5	16.21	5.84	20.80	.88	6.23	87.76	16.30	24.62	78.74	83.53
					CuRoTls	837.8	.43	5.78	12.20	.05	.23	12.24	83.70	75.38	21.26	16.47
					Heads	998.3	2.97	5.80	13.58	.18	1.20	100.00	100.00	100.00	100.00	100.00
8.	100	50	30	3000	CuConc	22.4	13.80	9.21	19.40	5.04	6.77	10.14	3.34	3.34	59.86	11.89
					CuTls 1	150.4	15.80	5.10	23.30	.15	5.99	77.93	12.42	27.30	11.92	70.63
					CuRoMet	172.8	15.54	5.63	22.79	.79	6.09	88.07	15.76	30.69	61.78	82.52
					CuRoTls	823.7	.44	6.32	10.80	.04	.27	11.93	84.24	69.31	38.22	17.48
					Heads	996.5	3.06	6.20	12.88	.19	1.28	100.00	100.00	100.00	100.00	100.00

Table VII

	ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
9.	2BCD	$CuCC_1$	12.2	11.70	12.58	15.1	9.44	7.20	4.64	2.17	1.45	40.65	1.22
	- same as no. 7 (Table VI) but no $K_2Cr_2O_7$	$CuCT_1$	36.9	8.09	9.61	10.4	.46	3.16	9.80	5.07	3.01	5.96	3.64
		*CuRoCon	49.1	8.99	10.35	11.6	2.70	4.16	14.49	7.19	4.46	46.61	4.91
	- low 2-11 used (70 g/T in whole circuit)	CuRoTls	958.3	2.74	6.90	12.8	.16	1.50	85.51	92.81	95.54	53.39	95.09
		Heads	949.1	3.05	7.07	12.74	.28	1.63	100.00	100.00	100.00	100.00	100.00
10.	2BCD	$CuCC_1$	17.5	11.90	11.48	15.2	7.01	6.76	6.90	2.84	2.17	40.74	7.32
	- same as no. 7 (TABLE VI) but with 2kg/T Na_2SO_3	$CuCT_1$	112.1	19.60	8.15	13.4	.28	7.43	72.77	12.93	12.28	10.42	51.50
		* CuRoCon	129.6	18.56	8.60	13.6	1.19	7.34	79.67	15.77	14.45	51.16	58.82
		CuRoTls	864.9	.71	6.88	12.1	.17	.77	20.34	84.22	85.55	48.83	41.18
		Heads	944.5	3.04	7.10	12.3	.30	1.63	100.00	100.00	100.00	100.00	100.00

Table V111 lists the results of additional tests some of which are Cu-pre float tests but are presented in this section for chronological continuity. Test 11 was identical to test 7, (table V1) except that the primary grind was longer. 2BCD ore is harder than 2EF or 2H ore types and needs to be ground longer to attain similar fineness. The metallurgy was not better than test 7.

Test 12 was also same as test 7, (table V1) except for higher Z-11 usage. The results are similar to test 7. Test 13 uses conditions which are a combination of conditions used in tests 9 and 10, (table V11). There is no improvement in results.

In test 14 an attempt was made to pre-float Cu using an acid pH (<7) and very low Z-11. The results were satisfactory as compared to many previous tests. However, slightly higher Z-11 may improve Cu rougher recovery.

Another test that should be carried out involves $K_2Cr_2O_7$ addition to primary grind without Z-11. This may help in achieving a better separation of Pb in the rougher stage.

(d) Cu/Pb bulk flotation - separation -II:-

The accidental finding of Cu/Pb bulk flotation while attempting Cu pre-flotation in tests 4 to 8 (table V1), led to the use of test 7 as standard procedure for producing a Cu/Pb bulk rougher conc. Table 1X shows the metallurgy obtained when a Cu/Pb bulk conc. was produced on a large scale using a large grinding mill and flotation cell. Obviously the metallurgy differs from test 7 (table V1) very drastically. Many changes in procedure may be necessary in order to obtain comparable metallurgy in a large scale test.

The Cu/Pb rougher conc. produced as above was used for Pb/Cu separation tests. Table X lists results of six such tests. In test 1 to 5 an attempt was made to depress Cu using NaCN in the regrind mill. As the amount of NaCN increases so does Cu in the Pb first cleaner tails. Unfortunately much of the Pb is also depressed making Cu/Pb separation using this technique impractical.

Another cleaner test was carried out using a Finnish flow scheme called Vihanti process (test 6). The results are very poor.

Table X1 lists results of a test which was a repetition of test 4 (table X) except that the bulk rougher conc. was prepared without any Na_2SO_3 in the primary grind. This was done based on the hypothesis that Na_2SO_3 renders galena insensitive to flotation in presence of NaCN as found in tests 1 to 5 (table X).

TABLE V111

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
11. 2BCD Same as test 7 (Tab V1) but with a 20 minute primary grind.	CuCC1	36.8	13.00	8.16	17.0	3.18	5.71	15.93	4.41	5.53	48.29	15.15
	CuCT1	167.6	12.60	5.99	16.9	.18	4.80	70.34	14.75	25.05	12.45	67.99
	Cu/PbRo Conc.	204.4	12.67	6.38	16.9	.72	4.96	86.27	19.16	30.58	60.74	73.14
	Cu/PbScT1s	742.8	.52	6.94	9.9	.12	.47	13.73	80.84	69.42	39.26	26.86
	Heads	997.2	3.01	6.83	11.84	.24	1.39	100.00	100.00	100.00	100.00	100.00
12. 2BCD Same as test 7 (Tab V1) with high 2-11	Cu/PbRo Conc.	274.3	9.71	5.07	20.4	.57	3.84	88.88	14.91	51.07	64.27	83.37
	Cu/PbScT1s	724.5	.46	7.72	7.4	.12	.29	11.12	80.09	48.93	35.73	16.63
	Heads	998.8	3.00	6.99	10.97	.24	1.26	100.00	100.00	100.00	100.00	100.00
13. 2BCD -no NaCN -2kg/t Na_2SO_3 -70 g/t Z-11 (total) -no $K_2Cr_2O_7$	CuCC1	23.9	30.60	10.26	9.9	5.33	12.26	24.61	3.74	2.04	51.02	14.25
	CuCT1	34.2	9.74	9.67	10.2	.28	3.52	11.21	5.04	3.01	3.84	7.91
	Cu/PbRo Conc	58.1	18.32	9.91	10.1	2.36	7.12	35.82	8.78	5.06	54.86	27.16
	Cu/PbScT1s	939.4	2.03	6.37	11.7	.12	1.18	64.18	91.22	94.94	45.15	72.84
	Heads	997.5	2.98	6.58	11.61	.25	1.53	100.00	100.00	100.00	100.00	100.00
14. 2BCD Cu/Pb Ro Conc. Low pH with H_2SO_3 -20 g/t 2-11	Cu/PbRo Conc	24.0	18.30	10.00	12.5	4.99	7.69	14.82	3.63	2.48	46.02	12.97
	Cu/PbScT1s	974.9	2.59	6.54	12.1	.15	1.27	85.18	96.37	97.52	54.98	87.03
	Heads	998.9	2.97	6.62	12.11	.27	1.42	100.00	100.00	100.00	100.00	100.00

TABLE IX

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
Cu/Pb Ro. Conc. generation for group D1-5 Using test 7 (table VI) scheme	Cu/Pb Ro Conc	570.10	26.40	4.63	16.0	1.69	10.37	62.77	4.87	9.06	44.64	46.52
	Cu/Pb Ro Tls	7429.4	1.20	6.94	12.3	.16	.83	37.23	95.13	90.94	55.36	53.48
	Heads	8000.0	3.00	6.78	12.6	.27	1.59	100.00	100.00	100.00	100.00	100.00

Cu/Pb Separation from Cu/Pb Rougher Concentrate - Pb Cleaning

TABLE - X

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
2BCD												
1. Std Pb Cleaning circuit. -no NaCN to regrind	$PbCC_3$	7.7	57.70	4.17	6.6	4.83	22.09	16.50	7.17	3.11	21.62	16.87
	$PbCT_3$	8.3	44.10	6.91	9.8	4.87	16.91	13.59	12.81	4.97	23.49	13.92
	$PbCC_2$	16.0	50.65	5.59	8.3	4.85	19.40	30.09	19.98	8.08	45.11	30.74
	$PbCT_2$	13.3	31.10	5.90	14.1	2.40	11.78	15.36	17.52	11.47	18.55	15.54
	$PbCC_1$	29.3	41.77	5.73	10.9	3.74	15.94	45.45	37.50	19.55	63.66	46.33
	$PbCT_1$	72.7	20.20	3.85	18.1	.86	7.44	54.54	62.50	80.45	36.34	53.66
	* Heads	102.0	26.40	4.39	16.0	1.69	9.88	100.00	100.00	100.00	100.00	100.00
2. same as above - 50 g/T NaCN in regrind.	$PbCC_3$	6.6	71.70	1.03	2.9	1.47	26.11	17.74	1.55	1.19	5.59	17.55
	$PbCT_3$	7.2	55.60	2.09	7.2	2.80	20.58	15.01	3.44	3.23	11.62	15.09
	$PbCC_2$	13.8	63.30	1.58	5.1	2.16	23.22	32.75	4.99	4.42	17.21	32.64
	$PbCT_2$	9.2	31.80	4.11	14.5	2.56	11.77	10.97	8.64	8.31	13.57	11.03
	$PbCC_1$	23.0	50.70	2.59	8.9	2.32	18.64	43.72	13.63	12.73	30.78	43.67
	$PbCT_1$	77.0	14.50	4.91	18.2	1.56	7.18	56.29	86.37	87.27	69.22	56.32
	* Heads	100.0	26.68	4.38	16.1	1.74	9.82	100.00	100.00	100.00	100.00	100.00
3. Same as above -100 g/T NaCN in Regrind	$PbCC_3$	7.6	74.00	1.00	2.4	1.05	26.06	21.07	1.68	1.14	4.72	20.24
	$PbCT_3$	6.6	55.20	2.06	6.9	2.37	20.16	13.65	3.00	2.84	9.26	13.60
	$PbCC_2$	14.2	65.26	1.44	4.5	1.10	23.32	34.72	4.68	3.98	13.48	33.84
	$PbCT_2$	9.5	31.40	4.03	14.2	2.44	11.71	11.18	8.44	8.41	13.72	11.32
	$PbCC_1$	23.7	51.69	2.51	8.4	1.64	18.66	45.90	13.12	12.39	27.70	45.16
	$PbCT_1$	76.8	18.80	5.13	18.3	1.59	6.98	54.10	86.88	87.61	72.30	54.84
	* Heads	100.50	26.56	4.51	16.0	1.68	9.74	100.00	100.00	100.00	100.00	100.00

Table X (cont'd)

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
2BCD												
4. std Pb cleaning circuit - 200 g/t NaCN to Regrind	$PbCC_3$	6.4	75.50	1.09	2.0	.42	26.19	17.77	1.56	.80	1.55	16.72
	$PbCT_3$	7.3	61.90	1.87	4.9	1.13	22.18	16.62	3.06	2.25	4.75	16.15
	$PbCC_2$	13.7	68.25	1.50	3.5	.80	24.05	34.39	4.62	3.05	6.30	32.87
	$PbCT_2$	9.3	31.40	4.18	14.0	2.28	11.98	10.74	8.71	8.17	12.22	11.11
	$PbCC_1$	23.0	53.35	2.58	7.7	1.40	14.17	45.13	13.33	11.22	18.52	43.98
	$PbCT_1$	77.7	19.20	4.51	18.2	1.82	7.23	54.87	86.67	88.78	81.48	56.02
	* Heads	100.7	27.00	4.43	15.8	1.72	9.96	100.00	100.00	100.00	100.00	100.00
5. Std Pb cleaning circuit - 500 g/t NaCN to regrind.	$PbCC_3$	6.8	61.40	1.21	1.9	0.33	26.08	16.46	1.87	.81	1.33	17.97
	$PbCT_3$	5.1	58.60	3.01	5.5	.99	20.45	11.78	3.30	1.77	3.09	10.57
	$PbCC_2$	11.9	60.20	1.99	3.4	.61	23.67	28.24	5.37	2.58	4.33	28.54
	$PbCT_2$	10.2	33.40	6.04	12.7	1.88	12.50	13.43	14.01	8.16	11.40	12.92
	$PbCC_1$	22.1	47.83	3.86	7.7	1.20	18.51	41.66	19.39	10.74	15.73	41.46
	$PbCT_1$	77.9	19.00	4.55	18.2	1.82	7.42	58.34	80.61	82.26	84.27	58.55
	* Heads	100.0	25.37	4.40	15.9	1.68	9.87	100.00	100.00	100.00	100.00	100.00
6. 2BCD Vihanti process Bulk Flotation to Third cleaner conc and separate. - pH to 10.8 with lime - 240 g/t Z-11 (total) - Fourth cleaner 200 g/t $K_2Cr_2O_7$	Cu Conc.	2.3	31.40	22.00	7.7	3.13	12.00	1.27	3.54	.46	2.36	1.39
	Pb Conc	31.4	52.00	9.40	6.3	1.78	17.08	28.68	20.63	5.18	18.34	27.09
	Cu/Pb CT_3	28.3	34.70	10.05	10.5	2.42	12.64	17.25	19.88	7.79	22.47	18.07
	Cu/Pb CC_2	62.0	43.34	10.16	8.3	2.12	14.86	47.20	44.05	13.43	43.17	46.85
	Cu/Pb CT_2	21.9	21.60	5.81	16.3	1.39	8.03	12.15	8.89	9.36	9.99	8.88
	Cu/Pb CC_1	83.9	37.67	9.02	10.4	1.93	13.08	59.35	52.94	22.79	53.16	55.43
	Cu/Pb CT_1	150.3	15.40	4.48	19.6	.95	5.87	40.65	47.06	77.21	46.85	44.56
	* Heads	234.2	24.31	6.11	16.29	1.30	8.45	100.00	100.00	100.00	100.00	100.00

* HEADS WERE Cu/Pb rougher conc.

Table XI

Cu/Pb Separation from Cu/Pb Rougher Concentrate - Pb Cleaning

ORETYPE and Test Description: 2BCD

1 kg test

Cu/Pb Rougher Conc to Pb first cleaner

- no sulphite + no cyanide in primary grind
- 200 g/T NaCN in regrind
- 240 g/T 2-11 (total)
- 20 Min. grind

SAMPLE	ASSAYS						DISTRIBUTION				
	WTS	Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
Pb CC1	39.5	55.70	2.97	9.1	1.25	19.33	72.71	1.72	2.96	19.79	56.44
Pb CT1	166.1	2.77	5.87	27.0	.63	1.68	15.20	14.28	36.88	41.95	20.63
Cu/Pb Ro	205.6	12.94	5.31	23.6	.75	5.07	8791	16.00	39.84	61.74	77.07
Cu/Pb Sc Tls	795.4	.46	7.21	9.2	.12	.39	12.09	84.00	60.17	38.26	22.93
Heads	1001.0	3.02	6.82	12.15	.25	1.35	100.00	100.00	100.00	100.00	100.00

The results of this test show that Cu/Pb separation in the first Pb cleaning stage has improved but grade/recovery of Cu in Pb first cleaner tails is hopelessly low.

CONCLUSIONS:

So far we have had only a limited success with Cu separation. It has been discovered that the main problem is Cu/Pb separation.

A look at the flow sheet of other mines presently producing a Cu conc. from Cu/Pb bulk conc. suggests that the best route to go may be to depress Pb instead of Cu. Since the volume of Cu mineral is much smaller that that of Pb mineral, it is logical to try to float Cu from the bulk conc. The use of $K_2Cr_2O_7$ to depress Pb is quite rare in the industry. Since we have carried out many tests with $K_2Cr_2O_7$ so far, further tests should be suspended.

Another depressant for Pb used extensively in the industry is SO_2 in the presence of starch. In test 14 (table V111) an acid pH (<7) was tried and the results were better than many other pre-float tests. More tests at lower pH with SO_2/starch may significantly improve Cu metallurgy.

RECOMMENDATIONS:

(a) Carry out a series of tests using the SO_2/starch reagent scheme similar to the one used at Magmont Concentrator, Missouri.

(b) Try to duplicate the results of test 7 (table V1) on a large scale.

R. Murarka
Metallurgist

APPENDIX III

2BCD ORE COLLECTOR/PROMOTER TESTS

Cyprus Anvil Mining Corporation — Interoffice Correspondence

To: Ron Murarka — Date: July 20, 1983

From: Sibyl Frei

Subject: Copper Pre-flotation Testing : 2BCD Collector/Promoter Tests.

CONCLUSIONS:

1. Potassium amyl xanthate (PAX) is a very strong, non-selective collector. For copper flotation, lower dosages of PAX are required (12 gm/tonne PAX addition produced the best results of these tests).

2. The addition of promoter as well as collector to the grind and to all rougher and scavanger stages provided for the best metallurgical performance in these tests.

3. Of the promoters tested in conjuction with PAX, SPELD 3730 was the best for copper flotation (see table 1) with SPELD N-30 and SPELD 3459 also showing significantly better metallurgy at low PAX addition than the bulk of these tests.

RECOMMENDATIONS:

1. A weaker collector than PAX be tried in copper pre-flotation.

2. These and other promoters be used in conjuction with weaker collectors in further Cu pre-flotation testwork.

DISCUSSION :

A series of Cu pre-float rougher tests were performed using PAX and various RESINEX Corporation promoters. For each test, 1 kg. of 2BCD ore was used as charge to the rod mill and ground to a P_{80} of approximately 50 microns using 1 kg/tonne Na_2SO_3 (with Na_2CO_3 as the pH modifier). After raising the pH to 9.5 with NA_2CO_3, one 2 minute rougher concentrate was collected and then two 1-minute scavenger concentrates were collected. M1BC frother was used as necessary.

The first tests (G-1 and G-2) established the necessary level of PAX addition to the grind and the start of the roughing stage only.

Next a series of tests (G-3 through G-9) were attempted with each of the promoters (separately) added in a 1:1 ratio to PAX with 50% of the promoter being added at the start of the roughing stage and 25% being added before each of the 2 scavengers.

DISCUSSION (cont'd):

Another series of tests (G-10 through G-16) were tried where only 30% of the PAX used in each stage of the preceeding tests was added. As well, the addition points for the promoters were changed to 50% added to the grind, 25% at the start of roughing and 25% prior to collection of the first scavenger concentrate (with dosages the same in the previous test series).

Finally, the three most promising tests of the G-10 to G-16 series were repeated with the same dosages of PAX and promoter added to the grind but no collector or promoter added to the rougher or scavanger stages (see tests G-17, G-18 and G-19).

As PAX is a very strong collector, throughout these tests quite a bit of Pb was recovered into the "copper concentrate" even though in grinding no NaCN was used and Na_2SO_3 was added in an attempt to depress Pb and float Cu.

On the following pages, the final results and metallurgical balances for the collector/promoter testwork has been summarized.

Table 2 summarizes the promoters that were tested in this series of copper pre-float testing..

S. Frei

Sibyl Frei
Senior Metallurgical Technician

TABLE 1: Results from the Three Most Promising Tests

TEST NO.	PAX Addition (gm/tonne)		PROMOTER Addition (gm/tonne)			ROUGHER CONCENTRATE METALLURGY				
						Copper (%)		Lead (%)		Silver(%)
	to grind	to rougher	name	to grind	to ro/sc	grade	recovery	grade	recovery	recovery
G-16	10	2	3730	20	20	3.83	76.2	44.8	37.1	2.7
G-10	10	2	N-30	20	20	3.54	80.8	41.2	35.8	27.8
G-13	10	2	3459	20	20	2.21	81.3	50.9	66.5	50.5

TABLE 2: PROMOTERS TESTED

PROMOTER	Metals Promoted	Metals not Selective Toward	Recommended Dosage
SPELD 1334	Cu, Pb, Ag	pyrite	20-100 gm/tonne
SPELD 1335	Pb, Ag, Cu, Au	iron sulphides	20-100 gm/tonne
SPELD 3459	Cu, Zn, Ag, Au, Ni, Co, Sb	iron ores	10-100 gm/tonne
SPELD 3700	Cu, Zn	pyrite & other iron ores	20-80 gm/tonne
SPELD 3710	Au, Ag, Cu, Zn	Pb	20-80 gm/tonne
SPELD 3730	Zn	Pb	20-80 gm/tonne
SPELD N-30	Pb, Cu (oxidized)	—	20-80 gm/tonne

TABLE I

G

2BCD Cu-Preflood : Collector/Promoter Testing

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
1. 315-P collector (Potassium Amyl Xanthate) 70 g/T	CuRo	54.00	46.10	8.22	8.80	1.66	22.79	74.74	7.65	3.84	77.10	57.48
	CuSc1	22.40	15.80	13.90	14.10	.61	9.05	10.63	5.37	2.56	11.75	9.47
	CuSc2	15.50	5.67	13.90	14.10	.25	4.05	2.64	3.71	1.77	3.33	2.93
	CuScTls	908.10	.44	5.32	12.50	.01	.71	12.00	83.27	91.83	7.81	30.12
	Heads	1000.00	3.33	5.80	12.36	.12	2.14					
2. 315-P 40 g/T	CuRo	39.10	51.50	7.29	6.70	2.21	25.75	65.68	4.94	2.18	77.38	51.68
	CuSc1	19.10	22.40	15.90	11.30	.65	11.31	13.96	5.27	1.80	11.12	11.09
	CuSc2	12.40	8.58	16.30	12.50	.29	4.81	3.47	3.51	1.29	3.22	3.06
	CuScTls	924.60	.56	5.38	12.30	.01	.72	16.89	86.28	94.73	8.28	34.17
	Heads	995.20	3.08	5.79	12.06	.11	1.96					
3. 315-P 40g/T (prom) N-30 40g/T	CuRo	48.00	45.00	8.76	7.90	1.72	22.32	72.20	7.63	3.15	77.22	54.56
	CuSc1	21.70	15.70	14.60	12.70	.56	8.53	11.39	5.75	2.29	11.37	9.43
	CuSc2	12.00	7.17	15.00	13.10	.25	4.46	2.88	3.27	1.31	2.81	2.73
	CuScTls	920.60	.44	4.99	12.20	.01	.71	13.54	83.36	93.26	8.61	33.29
	Heads	1002.30	2.98	5.50	12.02	.11	1.96					
4. 315-P 40g/T (prom) 1334 40g/T	CuRo	46.20	46.70	7.97	7.90	1.78	22.62	74.26	6.90	3.17	79.82	55.51
	CuSc1	14.20	18.10	13.60	12.70	.60	9.21	8.85	3.62	1.57	8.27	6.95
	CuSc2	10.90	8.25	13.90	13.10	.27	4.98	3.10	2.84	1.24	2.86	2.88
	CuScTls	932.30	.43	4.96	11.60	.01	.70	13.80	86.64	94.02	9.05	34.66
	Heads	1003.60	2.89	5.32	11.46	.10	1.88					

(58)

TABLE XI

G

2BCD Cu Re-float : Collector/Promoter Testing

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
5. 315-P 40g/T (prom) 1335 40g/T	CuRo	51.50	45.70	8.07	8.60	1.70	21.90	76.18	7.25	3.59	75.01	58.20
	$CuSc_1$	15.10	17.20	13.70	13.30	.54	8.93	8.41	3.61	1.63	6.99	6.96
	$CuSc_2$	8.90	8.78	13.20	14.00	.28	5.12	2.53	2.05	1.01	2.14	2.35
	CuScTls	926.10	.43	5.39	12.50	.02	.68	12.89	87.09	93.78	15.87	32.49
	Heads	1001.60	3.08	5.72	12.32	.12	1.93					
6. 315-P 40g/T (prom) 3459 40g/T	CuRo	44.60	50.80	7.74	7.20	1.92	25.22	73.17	5.98	2.64	72.46	55.72
	$CuSc_1$	15.80	20.20	14.90	12.40	.67	10.21	10.42	4.13	1.63	9.06	8.08
	$CuSc_2$	12.60	7.67	14.70	12.90	.25	4.65	3.16	3.25	1.35	2.70	2.94
	CuScTls	922.20	.44	5.36	12.30	.02	.72	13.25	86.64	94.38	15.78	33.26
	Heads	994.70	3.08	5.74	12.08	.12	2.01					
7. 315-P 40g/T (prom) 3700 40g/T	CuRo	49.30	46.80	8.31	8.60	1.69	23.16	75.71	7.06	3.44	78.35	57.98
	$CuSc_1$	17.40	17.20	14.20	13.40	.61	9.08	9.82	4.26	1.89	9.98	8.02
	$CuSc_2$	11.90	6.91	14.80	14.50	.27	4.49	2.70	3.03	1.40	3.02	2.71
	CuScTls	919.30	.39	5.41	12.50	.01	.67	11.77	85.66	93.27	8.65	31.28
	Heads	997.90	3.05	5.82	12.35	.11	1.97					
8 315-P 40g/T (prom) 3710 40g/T	CuRo	52.40	45.20	8.34	8.60	1.73	21.75	76.50	7.58	3.68	81.02	56.80
	$CuSc_1$	16.80	16.20	13.80	13.00	.53	8.59	8.79	4.05	1.78	7.96	7.19
	$CuSc_2$	12.80	7.04	14.20	14.30	.25	4.39	2.91	3.15	1.49	2.86	2.80
	CuScTls	912.80	.40	5.38	12.50	.01	.73	11.79	85.21	93.05	8.16	33.21
	Heads	994.8	3.11	5.79	12.33	.11	2.02					

TABLE IV

2BCD Cu Preflot: Collector/Promoter Testing

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
9. 315-P 40g/t (prom) 3730 40g/t	CuRoConc	47.60	49.40	7.66	7.50	1.97	24.61	71.36	6.31	2.91	74.86	55.09
	CuSc1	18.00	17.30	14.60	11.40	.56	9.60	9.45	4.55	1.67	8.05	8.13
	CuSc2	11.30	7.72	14.10	12.50	.26	4.65	2.65	2.76	1.15	2.35	2.47
	CuScTls	923.80	.54	5.40	12.50	.02	.77	16.54	86.38	94.26	14.75	34.32
	Heads	1000.70	3.29	5.77	12.24	.13	2.13					
10. 315-P 12g/t (prom) N-30 40g/t	CuRoConc	25.60	41.20	7.82	8.50	3.54	20.24	35.79	3.61	1.81	80.80	27.77
	CuSc1	19.20	35.40	10.64	8.50	.49	15.10	23.07	3.69	1.36	8.39	15.54
	CuSc2	10.00	18.40	12.60	10.60	.26	8.69	6.24	2.28	.88	2.32	4.66
	CuScTls	952.00	1.08	5.26	12.10	.01	1.02	34.89	90.42	95.95	8.49	52.04
	Heads	1006.80	2.93	5.50	11.92	.11	1.85					
11. 315-P 12g/t (prom) 1334 40g/t	CuRoConc.	46.90	49.90	7.94	7.40	1.87	23.64	75.43	6.58	2.80	79.92	57.35
	CuSc1	20.30	15.40	13.90	13.40	.49	7.95	10.08	4.98	2.19	9.06	8.35
	CuSc2	12.30	6.08	14.00	13.40	.24	4.12	2.41	3.04	1.33	2.69	2.62
	CuScTls	914.30	.41	5.29	12.70	.01	.67	12.08	85.40	93.68	8.33	31.68
	Heads	993.80	3.12	5.70	12.47	.11	1.95					
12. 315-P 12g/t (prom) 1335 40g/t	CuRoConc.	45.40	48.30	8.17	7.40	1.83	23.88	73.01	6.83	2.83	78.91	53.87
	CuSc1	19.90	17.00	14.40	12.30	.51	8.42	11.26	5.28	2.06	9.64	8.69
	CuSc2	12.40	6.93	14.40	12.80	.23	4.05	2.86	3.29	1.34	2.71	2.60
	CuScTls	920.00	.42	4.99	12.10	.01	.73	12.87	84.59	93.77	8.74	34.83
	Heads	997.70	3.01	5.44	11.90	.11	1.93					

(09)

LEE 5/03

TABLE IV

G

2BCD Cu Preflot + Collector/Promoter Testing

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
13. 315-P 12 g/T (prom) 3459 40 g/T	CuRoConc.	41.30	50.90	8.29	7.30	2.21	24.98	66.47	5.49	2.51	81.26	50.52
	CuSc1	17.60	26.00	13.40	10.60	.50	12.78	14.47	3.78	1.55	7.83	11.01
	CuSc2	12.00	11.71	14.40	11.70	.25	6.12	4.44	2.77	1.17	2.67	3.60
	CuSCTls.	924.90	.50	5.93	12.30	.01	.77	14.62	87.96	94.76	8.23	34.87
	Heads	995.80	3.18	6.26	12.06	.11	2.05					
14. 315-P 12 g/T (prom) 3700 40 g/T	CuRoConc.	55.80	44.50	9.47	8.10	1.66	22.34	78.26	8.33	3.70	80.75	58.77
	CuSc1	19.00	14.60	13.70	12.60	.55	7.88	8.74	4.11	1.96	9.11	7.06
	CuSc2	12.00	5.53	13.50	13.10	.21	3.48	2.09	2.55	1.29	2.20	1.97
	CuSCTls	910.50	.38	5.92	12.50	.01	.75	10.90	85.01	93.06	7.94	32.20
	Heads	997.30	3.18	6.36	12.26	.12	2.13					
15. 315-P 12 g/T (prom) 3710 40 g/T	CuRoConc.	55.00	44.40	10.16	8.20	1.72	21.75	76.90	9.31	3.70	81.56	56.27
	CuSc1	19.60	14.60	13.50	11.80	.50	7.95	9.01	4.41	1.90	8.45	7.33
	CuSc2	11.90	6.28	13.30	12.20	.21	3.90	2.35	2.64	1.19	2.15	2.18
	CuSCTls	909.10	.41	5.52	12.50	.01	.80	11.74	83.64	93.21	7.84	34.21
	Heads	995.60	3.19	6.03	12.25	.12	2.14					
16. 315-P 12 g/T (prom) 3730 40 g/T	CuRoConc.	26.30	44.80	7.41	7.60	3.83	21.72	37.05	3.18	1.63	76.20	2.65
	CuSc1	21.00	36.20	12.10	8.20	.46	14.92	23.91	4.14	1.40	7.31	2.11
	CuSc2	10.60	19.10	13.60	9.50	.29	8.72	6.37	2.35	.82	2.33	1.07
	CuSCTls	936.20	1.11	5.92	12.60	.02	1.18	32.68	90.33	96.15	14.16	94.18
	Heads	994.10	3.20	6.17	12.34	.13	2.09					

(61)

2 of 3 pages

Table IV

G

2BCD Cu Preflog : Collector/Promoter Testing

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
17. 315-P 10g/T (prom) N-30 20g/T (to grind only)	CuRoConc	26.70	37.50	8.85	9.00	3.43	19.78	31.41	3.98	1.87	53.35	23.04
	$CuSc_1$	15.50	32.60	11.66	8.20	.62	14.46	15.85	3.05	.99	5.60	9.78
	$CuSc_2$	11.60	19.40	12.51	9.80	.38	9.14	6.69	2.32	.84	2.44	4.39
	CuScTls	947.00	1.55	5.68	13.10	.07	1.52	46.05	90.65	96.31	38.62	62.80
	Heads	1002.20	3.19	5.93	12.88	.17	2.29					
18. 315-P 10g/T (prom) 3459 20g/T (to grind only)	CuRoConc	44.80	44.00	8.84	7.00	2.19	23.10	65.15	6.67	2.49	55.44	51.58
	$CuSc_1$	19.00	18.90	14.40	10.30	.51	9.08	11.87	4.61	1.56	5.48	8.60
	$CuSc_2$	14.60	8.14	14.30	11.70	.28	4.42	3.93	3.52	1.36	2.31	3.22
	CuScTls	929.80	.62	5.44	12.80	.07	.79	19.05	85.20	94.59	36.78	36.61
	Heads	1006.20	3.00	5.89	12.48	.18	1.99					
19. 315-P 10g/T (prom) 3730 20g/T (to grind only)	CuRoConc	29.20	41.30	8.91	8.40	3.14	20.86	38.51	4.43	1.96	53.57	27.40
	$CuSc_1$	16.60	29.00	11.84	8.70	.56	13.65	15.37	3.35	1.15	5.43	10.19
	$CuSc_2$	11.60	16.70	12.20	10.00	.33	7.68	6.19	2.41	.93	2.24	4.01
	CuScTls	947.60	1.32	5.56	12.70	.07	1.37	39.94	89.80	95.97	38.76	58.40
	Heads	1005.00	3.12	5.84	12.48	.17	2.21					

APPENDIX IV

LOCKED CYCLE TEST RESULTS

To Ron Murarka

Date July 20, 1983

From Sibyl Frei

Subject Copper Pre-float Testing: Locked Cycle Tests on 2BCD and 2EF Ores.

CONCLUSIONS:

1. A final copper concentrate grade of 10% was obtained for both 2BCD and 2EF ore best locked cycle tests.
2. Only 37% to 45% copper recovery was obtained in these locked cycle tests.
3. In the best 2BCD and 2EF locked cycle tests, 15% or less lead was recovered, 10% or less silver was recovered and less than 1% of the iron was recovered into the copper concentrate.
4. Stability was not achieved in these locked cycle tests even though 6 cycles were performed.

RECOMMENDATIONS:

1. A copper concentrate not be produced by pre-flotation.
2. Method development for rougher and cleaner tests be linked to any examination of locked cycle test methods for copper flotation.

DISCUSSION:

The locked cycle tests were performed for a copper pre-flotation circuit only. All grinds were done using 1 kg/tonne Na_2SO_3 but no NaCN. M1BC frother was used as necessary during the rougher and cleaning stages. A summary of the test conditions is presented in Table 1.

Stability was not achieved in these locked cycle tests even though 6 cycles were performed. In 2BCD test F-1, the last two cycles were close to stable which was the only test that showed signs of reaching stability. In contrast, the 2EF test C-1 had an initial copper grade of 19.6% which dropped steadily throughout the cycles to a 9.6 % Cu grade in the final cycle.

DISCUSSION (cont'd):

During the 2EF locked cycle test, it was noted that a large amount of sample was being recirculated from cycle to cycle. A calculation of circulating loads for this test (see table 2) shows a very large amount of sample mass being recirculated in the fourth cleaning stage particularly. The amount of copper metal being recirculated increased steadily from the first through the fourth cleaning stages which is opposite to the trend observed from the ore type lead and zinc locked cycle tests performed in January and February, 1983.

S. Frei

Sibyl Frei
Senior Metallurgical Technician

TABLE 1: Locked Cycle Test Conditions

Ore Type	Test No.	Charge per Cycle (kg)	pH Range	Condition of First Cleaner	Z-11 additions (gm/tonne)					
					to grind	to rougher	to first cleaner	to second cleaner	to third cleaner	to fourth cleaner
2BCD	F-1	1	normal	closed	40	10	none	none	none	none
2BCD	F-2	1	low	closed	100	50	10	15	10	not performed
2BCD	F-3	1	normal	open	40	10	none	none	none	none
2EF	C-1	2	normal	closed	50	15	5	2.5	none	none

TABLE 11: Circulating Loads in the 2EF Copper Locked Cycle Test

STAGE	COPPER CIRCUIT	
	Mass Balance (%)	Metal Balance (%)
1st Cleaner	128	10
2nd Cleaner	70	18
3rd Cleaner	77	38
4th Cleaner	216	95

TABLE I

June 30-83

LOCKED CYCLE CLEANER TEST "To upgrade copper"

ORETYPE and Test Description

No $K_2Cr_2O_7$
No NaCN
1 Kg/T Na_2SO_3
Low Z-11

- **Prim. Grind**
  Na_2CO_3 3 Kg/T
  Na_2SO_3 1 Kg/T
  Z-11 50 g/T
  25 min. grind
- **Rougher**
  pH to 9.5
- **1ST CLNR**
  pH to 9.5
- **2nd CLNR**
  pH to 9.6
- **3RD CLNR**
  pH to 9.8
- **4TH CLNR**
  pH to 10.0

	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
	Cu Conc I	56.3	64.90	4.79	6.1	2.64	27.90	10.74	0.41	0.26	5.50	6.57
	II	36.7	62.20	4.32	6.5	4.38	27.60	6.71	0.24	0.18	5.95	4.24
	III	11.3	32.80	6.95	12.7	11.60	22.15	1.09	0.12	0.11	4.85	1.05
	IV	5.8	23.30	6.47	15.3	16.10	19.93	0.40	0.06	0.07	3.45	0.48
	V	13.3	39.10	7.29	12.0	11.30	25.37	1.53	0.14	0.12	5.56	1.41
	VI	13.8	42.10	6.93	10.6	9.95	24.67	1.71	0.15	0.11	5.08	1.42
	Tails I	1835.8	0.74	5.25	11.5	0.19	0.90	3.99	14.81	15.70	12.90	6.91
	II	1937.8	1.52	5.73	11.6	0.17	1.36	8.66	17.06	16.72	12.19	11.03
	III	1934.2	1.82	5.69	11.8	0.11	1.62	10.35	16.91	16.98	7.87	13.11
	IV	1933.5	1.70	5.62	11.7	0.12	1.58	9.66	16.70	16.83	8.58	12.78
	V	1977.8	1.83	5.77	12.3	0.11	1.71	10.64	17.54	18.10	8.05	14.15
	VI	1578.0	1.57	5.34	11.7	0.13	1.55	7.28	12.95	13.73	7.59	10.24
	4TH clnr tls VI	30.4	58.50	8.65	5.5	2.19	22.29	5.23	0.40	0.12	2.46	2.84
	3rd clnr tls VI	60.1	53.70	9.55	6.3	1.20	23.05	9.49	0.88	0.28	2.67	5.80
	2nd clnr tls VI	88.6	41.50	10.68	8.9	0.68	17.61	10.81	1.45	0.59	2.23	6.53
	1ST clnr tls VI	13.8	42.10	6.93	10.6	9.95	24.67	1.71	0.15	0.11	5.08	1.42
	Heads	11,527.2	2.95	5.64	11.66	0.23	2.07	100.00	100.00	100.00	100.00	100.00

	wts	Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
Cu Conc	13.55	40.60	7.11	11.3	10.62	25.02	15.40	0.96	0.71	40.28	10.47
Tails	1777.9	1.70	5.56	12.0	0.12	1.63	84.60	99.03	99.29	59.72	89.53
Heads	1791.45	1.99	5.57	12.0	0.20	1.81	100.00	100.00	100.00	100.00	100.00

(49)

F-1

TABLE II

June 30.83

• METALLURGICAL RESPONSE OF INDIVIDUAL CYCLES •

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
CYCLE 1	Cu Conc	56.7	64.90	4.79	6.1	2.64	27.90	72.90	2.72	1.60	29.88	48.74
	TAILS	1835.8	0.74	5.25	11.5	0.19	0.90	27.10	97.28	98.40	70.12	51.26
	HEADS	1892.1	2.65	5.24	11.3	0.26	1.70	100.00	100.00	100.00	100.00	100.00
CYCLE 2	Cu Conc	36.7	62.20	4.32	6.5	4.38	27.60	43.66	1.41	1.05	32.79	27.76
	TAILS	1937.8	1.52	5.73	11.6	0.17	1.36	56.34	98.59	98.95	67.21	72.24
	HEADS	1974.5	2.65	5.70	11.5	0.25	1.85	100.00	100.00	100.00	100.00	100.00
CYCLE 3	Cu Conc	11.3	32.80	6.95	12.7	11.60	22.15	9.52	0.71	0.62	38.12	7.40
	TAILS	1934.2	1.82	5.69	11.8	0.11	1.62	90.47	99.29	99.38	61.88	92.60
	HEADS	1945.5	2.00	5.70	11.8	0.18	1.74	100.00	100.00	100.00	100.00	100.00
CYCLE 4	Cu Conc	5.8	23.30	6.47	15.3	16.10	19.93	3.95	0.34	0.39	28.70	3.64
	TAILS	1933.5	1.70	5.62	11.7	0.12	1.58	96.05	99.66	99.61	71.30	96.35
	HEADS	1939.3	1.76	5.62	11.7	0.17	1.63	100.00	100.00	100.00	100.00	100.00
CYCLE 5	Cu Conc	13.3	39.10	7.29	12.0	11.30	25.37	12.56	0.84	0.65	40.86	9.07
	TAILS	1977.8	1.83	5.77	12.3	0.11	1.71	87.44	99.16	99.35	59.14	90.93
	HEADS	1991.1	2.08	5.78	12.3	0.18	1.87	100.00	100.00	100.00	100.00	100.00
CYCLE 6	Cu Conc	13.8	42.10	6.93	10.6	9.95	24.67	19.00	1.12	0.79	40.10	12.22
	TAILS	1578.0	1.57	5.34	11.7	0.13	1.55	81.00	98.88	99.21	59.90	87.78
	HEADS	1591.8	1.92	5.35	11.7	0.22	1.75	100.00	100.00	100.00	100.00	100.00

SIZE ANALYSIS METALLURGICAL BALANCE
****

TEST= F-1
******
SAMPLE= 2BCD locked cy test Cu CONC
****

SIZE ANALYSIS
****

PLUS FRACTION	SIZE (U)	MASS RET.(G)	MASS % RET.	CUM. % PASS.
4	4199	0.00	0.00	100.00
6	3327	0.00	0.00	100.00
10	1651	0.00	0.00	100.00
14	1168	0.00	0.00	100.00
20	833	0.00	0.00	100.00
28	589	0.00	0.00	100.00
35	417	0.00	0.00	100.00
48	295	0.00	0.00	100.00
65	208	.06	.03	99.97
100	147	.06	.03	99.94
150	104	1.67	.84	99.11
200	74	6.72	3.36	95.75
270	53	7.87	3.94	91.81
CYCLONE				
1	36.7	3.41	6.26	85.55
2	26.3	3.69	6.78	78.77
3	18.1	6.41	11.77	67.00
4	12.2	7.50	13.77	53.23
5	8.9	5.87	10.78	42.45
OVERFLOW	-8.9	23.12	42.45	

S.G.= 3.58 P80= 30 µm

METAL= Pb
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	4.56	.0014	.01
100	147	4.56	.0014	.01
150	104	4.56	.0381	.22
200	74	4.72	.1586	.92
270	53	4.65	.1830	1.07
CYCLONE				
1	36.7	17.80	1.1145	6.49
2	26.3	14.13	.9574	5.57
3	18.1	19.80	2.3305	13.57
4	12.2	22.10	3.0435	17.72
5	8.9	24.10	2.5976	15.12
OVERFLOW	-8.9	15.90	6.7500	39.30

TOTAL METAL UNITS= 17.1759

* + 100 mesh

METAL= Zn
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	3.41	.0010	.01
100	147	3.41	.0010	.01
150	104	3.41	.0285	.32
200	74	7.13	.2396	2.71
270	53	11.76	.4628	5.24
CYCLONE				
1	36.7	15.28	.9567	10.84
2	26.3	14.23	.9642	10.93
3	18.1	12.79	1.5054	17.06
4	12.2	10.75	1.4804	16.78
5	8.9	8.71	.9388	10.64
OVERFLOW	-8.9	5.29	2.2458	25.45

TOTAL METAL UNITS= 8.8241

F-1 2BCD locked cycle Cu Ag

METAL= Fe
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	19.50	.0059	.05
100	147	19.50	.0059	.05
150	104	19.50	.1628	1.30
200	74	19.10	.6418	5.12
270	53	17.10	.6729	5.37
CYCLONE				
1	36.7	20.10	1.2585	10.05
2	26.3	14.00	.9486	7.57
3	18.1	11.90	1.4006	11.18
4	12.2	10.60	1.4598	11.65
5	8.9	10.10	1.0886	8.69
OVERFLOW	-8.9	11.50	4.8821	38.97

TOTAL METAL UNITS= 12.5274

METAL= Cu
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	1.69	.0005	.02
100	147	1.69	.0005	.02
150	104	1.69	.0141	.51
200	74	2.47	.0830	3.02
270	53	2.26	.0889	3.24
CYCLONE				
1	36.7	3.04	.1903	6.93
2	26.3	2.17	.1470	5.36
3	18.1	1.58	.1860	6.77
4	12.2	12.10	1.6664	60.69
5	8.9	.98	.1056	3.85
OVERFLOW	-8.9	.62	.2632	9.59

TOTAL METAL UNITS= 2.7456

METAL= Ag
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	3.96	.0012	.01
100	147	3.96	.0012	.01
150	104	3.96	.0331	.37
200	74	3.94	.1324	1.47
270	53	3.71	.1460	1.62
CYCLONE				
1	36.7	11.06	.6925	7.69
2	26.3	8.25	.5590	6.21
3	18.1	10.07	1.1852	13.16
4	12.2	10.36	1.4267	15.84
5	8.9	10.99	1.1846	13.16
OVERFLOW	-8.9	8.58	3.6425	40.45

TOTAL METAL UNITS= 9.0043

SIZE ANALYSIS METALLURGICAL BALANCE
****
****

TEST= F-1
*****
SAMPLE= 2BCD locked cyc test
****

Cu TLS

SIZE ANALYSIS
****

PLUS FRACTION	SIZE (U)	MASS RET.(G)	MASS % RET.	CUM. % PASS.
4	4199	0.00	0.00	100.00
6	3327	0.00	0.00	100.00
10	1651	0.00	0.00	100.00
14	1168	0.00	0.00	100.00
20	833	0.00	0.00	100.00
28	589	0.00	0.00	100.00
35	417	0.00	0.00	100.00
48	295	0.00	0.00	100.00
65	208	.04	.02	99.98
100	147	.71	.36	99.63
150	104	12.76	6.38	93.25
200	74	34.70	17.35	75.90
270	53	24.32	12.16	63.74
CYCLONE				
1	41.1	6.22	7.93	55.81
2	29.5	7.35	9.37	46.44
3	20.3	8.75	11.15	35.28
4	13.7	7.11	9.06	26.22
5	10.0	4.49	5.72	20.50
OVERFLOW	-10.0	16.08	20.50	

S.G.= 3.03 P80= 81 µm

METAL= Pb
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	1.09	.0002	.01
100	147	1.09	.0039	.24
150	104	.83	.0530	3.24
200	74	1.10	.1909	11.68
270	53	1.63	.1982	12.13
CYCLONE				
1	41.1	4.68	.3711	22.70
2	29.5	1.04	.0974	5.96
3	20.3	.76	.0848	5.19
4	13.7	.70	.0634	3.88
5	10.0	.93	.0532	3.26
OVERFLOW	-10.0	2.53	.5186	31.72

TOTAL METAL UNITS= 1.6346

* +100 mesh

METAL= Zn
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	1.25	.0003	.00
100	147	1.25	.0044	.08
150	104	1.19	.0759	1.40
200	74	2.24	.3886	7.14
270	53	3.68	.4475	8.23
CYCLONE				
1	41.1	10.23	.8111	14.91
2	29.5	5.79	.5425	9.97
3	20.3	6.51	.7261	13.35
4	13.7	7.76	.7033	12.93
5	10.0	8.23	.4710	8.66
OVERFLOW	-10.0	6.19	1.2688	23.33

TOTAL METAL UNITS= 5.4395

F-1 ZBCD locked cycle test TAILS

METAL= Fe
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	20.40	.0041	.03
100	147	20.40	.0724	.57
150	104	17.80	1.1356	8.93
200	74	14.50	2.5158	19.78
270	53	13.10	1.5930	12.52
CYCLONE				
1	41.1	23.70	1.8791	14.77
2	29.5	9.50	.8901	7.00
3	20.3	9.00	1.0038	7.89
4	13.7	9.40	.8519	6.70
5	10.0	9.80	.5609	4.41
OVERFLOW	-10.0	10.80	2.2137	17.40

TOTAL METAL UNITS= 12.7203

METAL= Cu
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	.11	.0000	.02
100	147	.11	.0004	.43
150	104	.11	.0070	7.79
200	74	.09	.0156	17.33
270	53	.09	.0109	12.14
CYCLONE				
1	41.1	.10	.0079	8.80
2	29.5	.08	.0075	8.32
3	20.3	.07	.0078	8.66
4	13.7	.07	.0063	7.04
5	10.0	.07	.0040	4.45
OVERFLOW	-10.0	.11	.0225	25.02

TOTAL METAL UNITS= .0901

METAL= Ag
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	2.21	.0004	.03
100	147	2.21	.0078	.52
150	104	1.78	.1136	7.59
200	74	1.54	.2672	17.85
270	53	1.56	.1897	12.67
CYCLONE				
1	41.1	3.74	.2965	19.81
2	29.5	.92	.0862	5.76
3	20.3	.71	.0792	5.29
4	13.7	.74	.0671	4.48
5	10.0	.89	.0509	3.40
OVERFLOW	-10.0	1.65	.3382	22.59

TOTAL METAL UNITS= 1.4969

F-2 2BCD Locked Cycle Test - Low pH - first Cleaner Open

TABLE I

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
F-2	$CuCC_3$ I	33.0	53.00	6.40	9.8	2.71	25.35	7.39	0.47	0.35	5.98	5.31
2BCD locked cycle test	II	5.1	42.30	3.82	12.9	8.85	23.70	0.91	0.04	0.07	3.02	0.77
-6 cycles	III	12.7	38.00	4.43	15.7	5.91	20.64	2.04	0.13	0.22	5.02	1.67
-prod. Cu conc. only	IV	22.7	46.60	3.98	13.4	3.57	23.27	4.47	0.20	0.33	5.42	3.36
- cleaning stages at pH = 5.5 using H_2SO_3 as the pH modifier.	V	16.4	36.00	4.65	16.3	5.54	19.70	2.50	0.17	0.29	6.07	2.05
	VI	32.2	38.30	3.90	16.3	2.91	19.62	5.21	0.28	0.57	6.27	4.01
	$CuCT_1$ I	65.5	13.40	3.97	23.4	0.34	6.43	3.71	0.58	1.67	1.49	2.68
	II	105.9	25.80	4.88	19.3	0.47	11.92	11.55	1.16	2.23	3.33	8.02
- open 1st cleaner	III	115.3	25.50	5.24	19.1	0.52	12.21	12.43	1.35	2.40	4.01	8.94
	IV	87.0	21.10	5.07	20.3	0.49	10.02	7.76	0.99	1.92	2.85	5.54
	V	114.0	25.50	5.16	19.1	0.43	12.01	12.29	1.32	2.37	3.28	8.70
	VI	77.1	22.00	5.38	19.7	0.44	10.42	7.17	0.93	1.65	2.27	5.10
	Fin. Tls. (total)	724.5.6	0.64	5.66	10.8	0.10	0.90	19.60	91.89	85.25	48.95	41.43
	$CuCT_2$ VI	25.8	20.90	6.39	19.0	0.98	11.20	2.28	0.37	0.53	1.69	1.84
	$CuCT_3$ VI	7.0	23.90	7.00	17.9	1.85	13.37	0.71	0.11	0.14	0.87	0.59
	Calc. HEAD	7965.3	2.97	5.60	11.5	0.19	1.97	100.0	100.0	100.0	100.0	100.0
F-2	$CuCC_3$	23.8	40.30	4.18	15.3	4.01	20.86	24.87	1.34	2.39	36.97	19.17
average of cycles 4, 5 and 6	$CuCT_1$	92.7	22.87	5.20	19.7	0.45	10.82	55.06	6.50	11.99	16.18	38.79
	Fin. Tls.	1207.6	0.64	5.66	10.8	0.10	0.90	20.07	92.16	85.62	46.85	42.03
	Calc. HEAD	1324.1	2.91	5.60	11.5	0.19	1.95	100.0	100.0	100.0	100.0	100.0

F-2 28CD Locked Cycle Test - Averages by Cycle

TABLE II

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
F-2 cycle 1 (28CD)	$CuCC_3$	33.0	53.00	6.40	9.8	2.71	25.35	51.45	2.89	2.17	38.47	35.68
	$CuCT_1$	65.5	13.40	3.97	23.4	0.34	6.43	25.82	3.56	10.29	9.58	17.96
	Fin. Tls.	1207.6	0.64	5.66	10.8	0.10	0.90	22.73	93.55	87.54	51.95	46.36
	CALC HEAD	1306.1	2.60	5.59	11.4	0.18	1.80	100.0	100.0	100.0	100.0	100.0
F-2 cycle 2 (28CD)	$CuCC_3$	5.1	42.30	3.82	12.9	8.85	23.70	5.80	0.26	0.43	20.93	4.89
	$CuCT_1$	105.9	25.80	4.88	19.3	0.47	11.92	73.43	7.01	13.49	23.08	51.11
	Fin. Tls.	1207.6	0.64	5.66	10.8	0.10	0.90	20.77	92.72	86.08	55.99	44.00
	CALC. HEAD	1318.6	2.82	5.59	11.5	0.16	1.87	100.0	100.0	100.0	100.0	100.0
F-2 cycle 3 (28CD)	$CuCC_3$	12.7	38.00	4.43	15.7	5.91	20.64	11.50	0.75	1.29	29.35	9.51
	$CuCT_1$	115.3	25.50	5.24	19.1	0.52	12.21	70.08	8.06	14.26	33.12	51.07
	Fin. Tls.	1207.6	0.64	5.66	10.8	0.10	0.90	18.42	91.19	84.45	66.71	39.42
	CALC. HEAD	1335.6	3.14	5.61	11.6	0.19	2.06	100.0	100.0	100.0	100.0	100.0
F-2 cycle 4 (28CD)	$CuCC_3$	22.7	46.60	3.98	13.4	3.57	23.27	28.85	1.23	2.01	33.15	21.24
	$CuCT_1$	87.0	21.10	5.07	20.3	0.99	10.02	50.07	5.99	11.69	17.44	35.05
	Fin. Tls.	1207.6	0.64	5.66	10.8	0.10	0.90	21.08	92.79	86.30	49.40	43.70
	CALC. HEAD	1317.3	2.78	5.59	11.5	0.19	1.89	100.0	100.0	100.0	100.0	100.0
F-2 cycle 5 (28CD)	$CuCC_3$	16.4	36.00	4.65	16.3	5.54	19.70	13.83	1.02	1.73	34.86	11.63
	$CuCT_1$	114.0	25.50	5.16	19.1	0.43	12.01	68.08	7.84	14.06	18.81	49.27
	Fin. Tls.	1207.6	0.64	5.66	10.8	0.10	0.90	18.10	91.14	84.21	46.33	39.11
	CALC. HEAD	1338.0	3.19	5.61	11.6	0.19	2.08	100.0	100.0	100.0	100.0	100.0
F-2 cycle 6 (28CD)	$CuCC_3$	32.2	38.30	3.90	16.3	2.91	19.62	33.31	1.70	3.48	37.72	25.05
	$CuCT_1$	77.1	22.00	5.38	19.7	0.44	10.42	45.81	5.62	10.07	13.66	31.86
	Fin. Tls.	1207.6	0.64	5.66	10.8	0.10	0.90	20.88	92.67	86.45	48.62	43.09
	CALC. HEAD	1316.9	2.81	5.60	11.5	0.19	1.92	100.0	100.0	100.0	100.0	100.0

F-3

2BCD LOCKED-CYCLE TEST (First Cleaner Open)

ORETYPE and Test Description

Reagents were identical to F-1

Grind: 2kg ore
66% sol.
1 kg/t Na_2SO_3
3 kg/t Na_2CO_3
10 g/t Z-11
30 min.

Rougher:
10 g/t Z-11
pH = 9.5

First Cleaner: (open)
no Z-11
pH = 9.5

Second Cleaner:
no Z-11
pH = 9.6

Third Cleaner:
no Z-11
pH = 9.8

Fourth Cleaner:
no Z-11
pH = 10.0

		ASSAYS					DISTRIBUTION				
SAMPLE	Wt%	Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
CuCC4 I	5.7	17.30	6.24	17.3	18.40	20.35	.3	.1	.1	4.6	.5
II	10.9	39.70	4.88	11.3	11.50	25.97	1.2	.1	.1	5.5	1.1
III	46.1	63.00	4.37	5.4	4.23	31.13	8.3	.3	.2	8.6	5.8
IV	22.5	56.00	4.29	7.2	6.67	29.74	3.6	.2	.1	6.6	2.7
V	29.3	48.70	4.46	6.4	5.57	30.42	4.1	.2	.1	7.2	3.6
VI	28.5	54.90	5.55	6.4	5.44	28.83	4.5	.2	.1	6.8	3.3
CuCT, I	56.9	10.20	8.64	10.6	.23	5.53	1.7	.7	.4	.6	1.3
II	57.0	6.71	7.09	10.8	.18	3.67	1.1	.6	.4	.5	.8
III	53.9	8.68	7.37	11.0	.22	4.24	1.3	.6	.4	.5	.9
IV	78.1	10.80	7.57	10.6	.25	5.39	2.4	.9	.6	.9	1.7
V	71.9	6.46	6.78	11.2	.20	3.68	1.3	.7	.6	.6	1.1
VI	68.9	6.62	6.92	10.9	.20	3.40	1.3	.7	.5	.6	.9
CuROT5 I	1833.6	1.31	5.64	11.9	.10	1.20	6.9	15.1	15.2	8.1	8.9
II	1884.4	1.42	5.77	11.9	.10	1.40	7.7	15.8	15.7	8.3	10.6
III	1891.0	1.43	5.49	12.3	.09	1.32	7.8	15.1	16.2	7.5	10.1
IV	1870.1	1.21	5.71	12.1	.10	1.17	6.5	15.6	15.8	8.2	8.8
V	1873.5	1.39	5.77	11.9	.09	1.29	7.5	15.7	15.6	7.4	9.7
VI	1865.1	1.40	5.58	12.8	.12	1.46	7.5	15.2	16.7	9.9	11.0
CuCT4 VI	58.2	63.00	7.23	4.1	1.19	27.65	10.5	.6	.2	3.1	6.5
CuCT3 VI	61.6	39.50	7.77	5.9	.82	23.78	7.0	.7	.3	2.2	5.9
CuCT2 VI	75.2	35.60	9.82	9.0	.60	15.85	7.7	1.1	.5	2.0	4.8
Heads	11,942.1	2.92	5.75	12.0	.19	2.08	100.0	100.0	100.0	100.0	100.0

(ST)

TAB 3

F-3

2BCD Cu Locked-Cycle Test - Metallurgy Calculated by Cycle.

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
VI	CuCC4	28.5	54.90	5.55	6.4	5.44	28.83	33.78	1.43	.74	39.50	21.69
	CuCT1	68.9	6.62	6.92	10.9	.20	3.40	9.85	4.32	3.04	3.51	6.18
	CuRoTs	1865.1	1.40	5.58	12.8	.12	1.46	56.38	94.19	96.55	57.02	71.89
	Heads	1962.5	2.36	5.63	12.6	.20	1.93					
Average of Cycles IV, V, and VI	CuCC4	26.8	53.20	4.77	6.7	5.89	29.66	31.75	1.14	.75	44.53	22.42
	CuCT1	73.0	7.96	7.09	10.9	.22	4.16	12.94	4.61	3.31	4.53	8.57
	CuROTIs	1869.6	1.33	5.69	12.3	.10	1.31	55.38	94.77	95.71	52.74	69.09
	Heads	1969.4	2.28	5.70	12.2	.18	1.80					

(77)

Dec 13/83

C-1 H-8 Schiavone July 14/83

2EF LOCKED CYCLE TEST (CLOSED CIRCUIT)

TABLE I : METALLURGICAL BALANCE AND AVERAGE OF FINAL CYCES

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS Pb	Zn	Fe	Cu	Ag	DISTRIBUTION Pb	Zn	Fe	Cu	Ag
2EF locked cycle test – 6 cycles grind: 2kg ore, 76% solids, 1 kg/t Na_2SO_3, 3 kg/t Na_2CO_3, 50 g/t Z-11, 30 min rougher: 15 g/t Z-11, pH = 9.5 first cleaner: (closed) 5 g/t Z-11, pH = 9.5 second cleaner: 2.5 g/t Z-11, pH = 9.6 third cleaner: no Z-11, pH = 9.8 fourth cleaner: no Z-11, pH = 10.0	$CuCC_4$ I	4.8	23.70	2.23	16.2	19.60	6.80	0.25	0.02	0.02	3.08	0.19
	II	8.3	37.50	2.36	12.8	14.20	9.84	0.68	0.03	0.03	3.86	0.47
	III	7.5	40.10	2.17	12.4	13.20	10.37	0.66	0.03	0.03	3.24	0.44
	IV	9.0	37.60	2.27	12.6	13.60	9.80	0.74	0.03	0.03	4.00	0.50
	V	14.6	46.10	2.06	10.1	10.63	11.61	1.47	0.05	0.04	5.08	0.97
	VI	17.9	47.80	2.13	10.7	9.60	12.42	1.87	0.06	0.06	5.62	1.27
	CuRoTls I	1881.9	3.25	4.96	28.3	0.23	1.34	13.36	15.66	15.50	14.16	14.39
	II	1935.9	3.14	4.76	28.7	0.17	1.45	13.28	15.46	16.17	10.77	16.02
	III	1968.1	3.28	5.02	28.9	0.16	1.29	14.10	16.58	16.55	10.30	14.49
	IV	1975.9	3.34	4.99	28.6	0.15	1.31	14.42	16.54	16.44	9.70	14.77
	V	1981.5	3.06	4.87	29.3	0.12	1.20	13.24	16.19	16.89	7.78	13.57
	VI	2000.4	2.93	5.15	29.4	0.16	1.23	12.80	17.29	17.11	10.47	14.04
	$CuCT_1$ VI	77.6	6.49	7.50	27.6	0.30	2.17	1.10	0.98	0.62	0.76	0.96
	$CuCT_2$ VI	42.7	25.00	7.21	20.3	1.26	6.88	2.33	0.52	0.25	1.76	1.68
	$CuCT_3$ VI	43.3	50.30	5.01	12.2	2.90	12.57	4.76	0.36	0.15	4.11	3.11
	$CuCT_4$ VI	38.6	58.70	3.06	8.3	4.21	14.33	4.95	0.20	0.09	5.32	3.16
	CALC HEAD	12000.0	3.81	4.96	28.6	0.25	1.46	100.0	100.0	100.0	100.0	100.0
average of cycles 5 & 6	CC4	16.25	47.04	2.10	10.4	10.06	12.06	11.38	0.34	0.29	36.97	7.47
	CuRoTls	1990.95	2.99	5.01	29.4	0.14	1.22	88.62	99.66	99.71	63.03	92.53
	CALCHEAD	2007.2	3.35	4.99	29.2	0.22	1.31	100.0	100.0	100.0	100.0	100.0

(7)

(C1) 2EF LOCKED CYCLE TEST

TABLE II: MET. BALANCE BY CYCLE

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
cycle 1	CuCC4	4.8	23.70	2.23	16.2	19.60	6.80	1.83	0.11	0.15	17.85	1.28
	CuRoTls	1881.9	3.25	4.96	28.3	0.23	1.34	98.17	99.89	99.85	82.15	98.72
	CALCHEAD	1886.7	3.30	4.95	28.3	0.28	1.35	100.0	100.0	100.0	100.0	100.0
cycle 2	CuCC4	8.3	37.50	2.36	12.8	14.20	9.84	4.87	0.21	0.19	26.37	2.83
	CuRoTls	1935.9	3.14	4.76	28.7	0.17	1.45	95.13	99.79	99.81	73.63	97.17
	CALCHEAD	1944.2	3.29	4.75	28.6	0.23	1.49	100.0	100.0	100.0	100.0	100.0
cycle 3	CuCC4	7.5	40.10	2.17	12.4	13.20	10.37	4.45	0.16	0.16	23.92	2.97
	CuRoTls	1968.1	3.28	5.02	28.9	0.16	1.29	95.55	99.84	99.84	76.08	97.03
	CALCHEAD	1975.6	3.42	5.01	28.8	0.21	1.32	100.0	100.0	100.0	100.0	100.0
cycle 4	CuCC4	9.0	37.60	2.27	12.6	13.60	9.80	4.88	0.21	0.20	29.23	3.30
	CuRoTls	1975.9	3.34	4.99	28.6	0.15	1.31	95.12	99.79	99.80	70.77	96.70
	CALCHEAD	1984.9	3.50	4.98	28.5	0.21	1.35	100.0	100.0	100.0	100.0	100.0
cycle 5	CuCC4	14.6	46.10	2.06	10.1	10.63	11.61	9.99	0.31	0.25	39.49	6.65
	CuRoTls	1981.5	3.06	4.87	29.3	0.12	1.20	90.01	99.69	99.75	60.51	93.35
	CALCHEAD	1996.1	3.37	4.85	29.2	0.20	1.28	100.0	100.0	100.0	100.0	100.0
cycle 6	CuCC4	17.9	47.80	2.13	10.7	9.60	12.42	12.74	0.37	0.32	34.93	8.29
	CuRoTls	2000.4	2.93	5.15	29.4	0.16	1.23	87.26	99.63	99.68	65.07	91.71
	CALCHEAD	2018.3	3.33	5.12	29.2	0.24	1.33	100.0	100.0	100.0	100.0	100.0

(79)

2EF Locked Cycle Test C-1

Calculated Head: Size Analysis and Metallurgical Balance for Copper Only

SIZE FRACTION	CuCC4 mass = 16.25gm		CuCC4 correction factor = 0.8475		CuRoTls mass = 1990.95gm		CuRoTls correction factor = 1.3462		CALC HEAD mass = 2007.2gm			DISTRIBUTION (%)
	% mass ret.				% mass ret.							
	CuCC4	Head	% Cu	metal units	Tails	Head	% Cu	metal units	% mass retained	total metal units	% Cu	Cu
+65					0.01	.0099	0.10	0	0.01	0	0	0
+100					0.15	.1488	0.10	.0002	0.15	.0002	0.13	6.09
+150					0.85	.8431	0.09	.0010	0.84	.0010	0.12	0.45
+200					3.25	3.2237	0.06	.0026	3.22	.0026	0.08	1.18
cyc 1	7.20	.0583	9.92	.0049	19.95	19.7885	0.06	.0160	19.85	.0209	0.11	9.48
cyc 2	7.50	.0607	14.82	.0076	31.33	31.0764	0.09	.0377	31.14	.0453	0.15	20.55
cyc 3	19.86	.1608	16.02	.0218	12.96	12.8551	0.09	.0156	13.02	.0374	0.29	16.97
cyc 4	26.72	.2163	14.45	.0265	9.40	9.3239	0.08	.0100	9.54	.0365	0.38	16.56
cyc 5	16.60	.1344	16.54	.0188	5.67	5.6241	0.10	.0076	5.76	.0264	0.46	11.98
cyc 5 %f	22.12	.1791	1.16	.0018	16.43	16.2970	0.22	.0483	16.48	.0501	0.30	22.73
									CALCHEAD % = 0.22			

Recovery by Size in Cu Concentrate of Copper

Size Fraction	Calc. Head Metal Units	CuCC4 Metal Units	% Recovery of Copper
+65	0	0	0
+100	0.0002	0	0
+150	0.0010	0	0
+200	0.0026	0	0
cyc1	0.0209	0.0049	23.4
cyc2	0.0453	0.0076	16.8
cyc3	0.0374	0.0218	58.3
cyc4	0.0365	0.0265	72.6
cyc5	0.0264	0.0188	71.2
cyc5 %f	0.0501	0.0018	3.6
Overall	0.2204	0.0814	36.9

@ SIZE ANALYSIS METALLURGICAL BALANCE

TEST= 2E F Cu

SAMPLE= Locked cycle test (Cu Concentrate

SIZE ANALYSIS

PLUS FRACTION	SIZE (U)	MASS RET.(G)	MASS % RET.	CUM. % PASS.
4	4199	0.00	0.00	100.00
6	3327	0.00	0.00	100.00
10	1651	0.00	0.00	100.00
14	1168	0.00	0.00	100.00
20	833	0.00	0.00	100.00
28	589	0.00	0.00	100.00
35	417	0.00	0.00	100.00
48	295	0.00	0.00	100.00
65	208	0.00	0.00	100.00
100	147	0.00	0.00	100.00
150	104	0.00	0.00	100.00
200	74	0.00	0.00	100.00
270	53	0.00	0.00	100.00
CYCLONE				
1	32.0	3.60	7.20	92.80
2	23.0	3.75	7.50	85.30
3	15.8	9.93	19.86	65.44
4	10.7	13.36	26.72	38.72
5	7.8	8.30	16.60	22.12
OVERFLOW	-7.8	11.06	22.12	

S.G.= 4.81 P80= 21.1 μ

METAL= Pb

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
65	208	0.00	0.0000	0.00
100	147	0.00	0.0000	0.00
150	104	0.00	0.0000	0.00
200	74	0.00	0.0000	0.00
270	53	0.00	0.0000	0.00
CYCLONE				
1	32.0	40.80	2.9376	9.72
2	23.0	35.50	2.6625	8.81
3	15.8	37.60	7.4674	24.71
4	10.7	40.50	10.8216	35.81
5	7.8	33.80	5.6108	18.57
OVERFLOW	-7.8	3.26	.7211	2.39

TOTAL METAL UNITS= 30.2210

METAL= Zn

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
65	208	0.00	0.0000	0.00
100	147	0.00	0.0000	0.00
150	104	0.00	0.0000	0.00
200	74	0.00	0.0000	0.00
270	53	0.00	0.0000	0.00
CYCLONE				
1	32.0	1.93	.1390	6.61
2	23.0	2.11	.1583	7.52
3	15.8	2.19	.4349	20.68
4	10.7	2.52	.6733	32.01
5	7.8	2.90	.4814	22.88
OVERFLOW	-7.8	.98	.2168	10.30

TOT. M.U. = 2.1037

2EFC-1 Cu CC4

METAL= Fe

******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
65	208	0.00	0.0000	0.00
100	147	0.00	0.0000	0.00
150	104	0.00	0.0000	0.00
200	74	0.00	0.0000	0.00
270	53	0.00	0.0000	0.00
CYCLONE				
1	32.0	14.00	1.0080	6.60
2	23.0	15.10	1.1325	7.42
3	15.8	15.50	3.0783	20.17
4	10.7	14.20	3.7942	24.86
5	7.8	15.80	2.6228	17.18
OVERFLOW	-7.8	16.40	3.6277	23.77

TOTAL METAL UNITS= 15.2635

METAL= Cu

******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
65	208	0.00	0.0000	0.00
100	147	0.00	0.0000	0.00
150	104	0.00	0.0000	0.00
200	74	0.00	0.0000	0.00
270	53	0.00	0.0000	0.00
CYCLONE				
1	32.0	9.92	.7142	6.02
2	23.0	14.82	1.1115	9.36
3	15.8	16.02	3.1816	26.80
4	10.7	14.45	3.8610	32.53
5	7.8	16.54	2.7456	23.13
OVERFLOW	-7.8	1.16	.2566	2.16

TOTAL METAL UNITS= 11.8706

METAL= Ag

******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
65	208	0.00	0.0000	0.00
100	147	0.00	0.0000	0.00
150	104	0.00	0.0000	0.00
200	74	0.00	0.0000	0.00
270	53	0.00	0.0000	0.00
CYCLONE				
1	32.0	10.01	.7207	9.35
2	23.0	8.92	.6690	8.68
3	15.8	9.35	1.8569	24.09
4	10.7	10.14	2.7094	35.15
5	7.8	9.14	1.5172	19.68
OVERFLOW	-7.8	1.06	.2345	3.04

TOTAL METAL UNITS= 7.7078

SIZE ANALYSIS METALLURGICAL BALANCE
****
****

TEST= 2EF Cu Locked Cycle test C-1
*****
SAMPLE= Cu Ro Tls
****

SIZE ANALYSIS
****

US FRACTION	SIZE (U)	MASS RET.(G)	MASS % RET.	CUM. % PASS.
4	4199	0.00	0.00	100.00
6	3327	0.00	0.00	100.00
10	1651	0.00	0.00	100.00
14	1168	0.00	0.00	100.00
20	833	0.00	0.00	100.00
28	589	0.00	0.00	100.00
35	417	0.00	0.00	100.00
48	295	0.00	0.00	100.00
65	208	.01	.01	100.00
100	147	.29	.15	99.85
150	104	1.70	.85	99.00
200	74	6.50	3.25	95.75
270	53	0.00	0.00	95.75
CYCLONE				
1	32.2	10.42	19.95	75.80
2	23.1	16.36	31.33	44.47
3	15.9	6.77	12.96	31.50
4	10.7	4.91	9.40	22.10
5	7.9	2.96	5.67	16.43
OVERFLOW	-7.9	8.58	16.43	

S.G.= 4.76 P80= 41.0μ

METAL= Pb
*****

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	4.52	.0002	.01
100	147	4.52	.0066	.21
150	104	4.47	.0380	1.19
200	74	1.71	.0556	1.75
270	53	0.00	0.0000	0.00
CYCLONE				
1	32.2	1.81	.3612	11.35
2	23.1	2.42	.7582	23.83
3	15.9	2.97	.3850	12.10
4	10.7	3.47	.3263	10.26
5	7.9	3.74	.2120	6.66
OVERFLOW	-7.9	6.32	1.0384	32.64

assay ave from +100 mesh sample TOTAL METAL UNITS= 3.1814

METAL= Zn
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
*65	208	6.85	.0003	.01
100	147	6.85	.0099	.18
150	104	5.91	.0502	.92
200	74	1.43	.0465	.85
270	53	0.00	0.0000	0.00
CYCLONE				
1	32.2	1.09	.2175	3.97
2	23.1	4.31	1.3503	24.66
3	15.9	6.95	.9010	16.46
4	10.7	8.19	.7701	14.07
5	7.9	9.35	.5300	9.68
OVERFLOW	-7.9	9.73	1.5987	29.20

TOTAL METAL UNITS= 5.4746

ZEF C-1 Tails

METAL= Fe
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
+65	208	32.20	.0016	.00
100	147	32.20	.0467	.14
150	104	32.70	.2780	.81
200	74	37.30	1.2123	3.51
270	53	0.00	0.0000	0.00
CYCLONE				
1	32.2	38.10	7.6026	22.04
2	23.1	35.90	11.2473	32.61
3	15.9	33.80	4.3820	12.70
4	10.7	32.70	3.0747	8.91
5	7.9	31.80	1.8026	5.23
OVERFLOW	-7.9	29.50	4.8471	14.05

assays are from +100 mesh sample TOTAL METAL UNITS= 34.4946

METAL= Cu
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
+65	208	.10	.0000	.00
100	147	.10	.0001	.14
150	104	.09	.0008	.74
200	74	.06	.0020	1.87
270	53	0.00	0.0000	0.00
CYCLONE				
1	32.2	.06	.0120	11.51
2	23.1	.09	.0282	27.10
3	15.9	.09	.0117	11.21
4	10.7	.08	.0075	7.23
5	7.9	.10	.0057	5.45
OVERFLOW	-7.9	.22	.0361	34.74

TOTAL METAL UNITS= .1040

METAL= Ag
******

PLUS FRACTION	SIZE (U)	% ASSAY	METAL UNITS	% DISTRIBUTION
4	4199	0.00	0.0000	0.00
6	3327	0.00	0.0000	0.00
10	1651	0.00	0.0000	0.00
14	1168	0.00	0.0000	0.00
20	833	0.00	0.0000	0.00
28	589	0.00	0.0000	0.00
35	417	0.00	0.0000	0.00
48	295	0.00	0.0000	0.00
+65	208	1.28	.0001	.01
100	147	1.28	.0019	.15
150	104	1.27	.0108	.87
200	74	.54	.0176	1.41
270	53	0.00	0.0000	0.00
CYCLONE				
1	32.2	.84	.1676	13.45
2	23.1	1.06	.3321	26.64
3	15.9	1.20	.1556	12.48
4	10.7	1.32	.1241	9.96
5	7.9	1.39	.0788	6.32
OVERFLOW	-7.9	2.18	.3582	28.73

TOTAL METAL UNITS= 1.2466