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Deadwood, South Dakota 57732

GILT EDGE SULFIDE PROJECT-FLOTATION, CYANIDATION, AND RELATED FLOWSHEET OPTIMIZATION STUDIES

(Roberts & Schaefer)

Hazen Research, Inc.

February 28, 1991

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Copy No. 26
HRI Project 7452 AND 7481

GILT EDGE SULFIDE PROJECT-FLOTATION, CYANIDATION, AND RELATED FLOWSHEET OPTIMIZATION STUDIES
(Roberts & Schaefer)

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INTRODUCTION

In August, 1990, Brohm Mining Corporation authorized Hazen Research, Inc. to conduct continuing metallurgical studies on gold ore samples from the Gilt Edge sulfide property in South Dakota. The project was directed by Roberts & Schaefer Company and was part of the updated feasibility study they are undertaking for Brohm.

Consistent with the objectives of the Roberts & Schaefer study, the primary purpose of the research at Hazen was to re-examine the use of froth flotation as a principal recovery method to attempt to reduce the projected capital and operating costs for Brohm's proposed commercial sulfide ore treatment facility. Consequently, the initial project (HRI 7452) studied the flotation response of gravity circuit tailings as an alternative to cyanidation. Having confirmed the positive flotation response of the tailings, the project was expanded in October, 1990 (HRI 7481), to include further optimization of the conditions for flotation of gravity tailings, as well as verification of the combined gravity plus flotation concentrate cyanide leaching conditions. The work included whole ore flotation and subsequent concentrate leaching as yet another process alternative.

Thus, the data compared the overall gold recoveries resulting from three different flowsheet options, namely:

Flowsheet 1:	Gravity/all leach (i.e., Bechtel study)
Flowsheet 2:	Gravity/flotation/combined concentrate leach
Flowsheet 3:	Flotation/concentrate leach

Various oxidative pre-treatment methods also were examined on the flotation concentrates, although it was recognized at the outset that some of these techniques would not likely be commercially viable. Confirming flotation tests also were performed using water samples from Homestake Mining's Lead, SD, operations, which was being considered as a possible water source for the Brohm sulfide operation.

This report summarizes, interprets, and presents all data generated for HRI Projects 7452 and 7481. Details of all test work are shown in the Appendix section of this report for reference.

SUMMARY

HEAD ASSAYS

Key head assays of the two test work ore samples were:

Sample	Assays Au oz/t	Ag oz/t	Fe, %	S_T, %
0.03 Sulfide Ore (HRI 44348)	0.045	0.05	4.4	4.0
Six-inch Core Composite (HRI 44671)	0.046	0.08	4.4	3.9

TEST WORK CONCLUSIONS

It was concluded that the flowsheet comprising gravity followed by flotation and cyanide leaching of the combined gravity/flotation concentrate, represented the best compromise between gold recoveries and our understanding of minimized capital and operating costs for a commercial operation. The other flowsheets studied included the original (i.e., Bechtel) gravity/all leach flowsheet and an all-flotation/concentrate leaching approach.

A comparison of salient overall metallurgical results for the three flowsheets is as follows:

Flowsheet	Combined NaCN Total Au Recovery, %	Tailings oz Au/t	Comsumption, lb/t ore
Gravity/All Leach	72.7	0.012	1.64
Gravity/Flotation/Leach	69.7	0.013	1.19
Flotation/Leach	66.2	0.014	1.26

The gravity all leach flowsheet represented the most extensive treatment, particularly in respect of cyanidation, carbon handling, and tailings detoxification.

The flotation/leach flowsheet is the simplest one, but the inclusion of a gravity

concentration step (Flowsheet 2) increased overall gold recoveries significantly, and also produced a direct-smelt gold product. Gold recoveries to the Gemeni concentrate ranged from approximately 8 to 12%.

It is important to remember, however, that gold recoveries were sensitive, i.e., perhaps two to three percentage points, to very small changes in assays due to normal experimental variations.

Overall silver recoveries were approximately 50%, although the recovery spread was larger than for gold due to larger normal analytical variations inherent with such low silver levels.

Laboratory tabling tests on the current samples confirmed prior Hazen tests. In addition to the gold recovered in the Gemeni concentrate, the gravity concentrate, i.e., Gemeni tailings, recovered typically another approximately 40 to 50% of the total gold. Jigging was less effective, due likely to fine gold losses, and recovered only 4.1 and 23.9% of the gold into the Gemeni concentrate and tailings, respectively.

Flotation of the gravity tailings recovered typically 65 to 70% of the gold in the tailings. The flotation tailings contained from 0.006 to 0.008 oz Au/ton, which were the same as obtained by cyanidation of the gravity tailings. Sulfur recoveries were approximatley 85% of that in the flotation feed, and rougher concentrates represented typically 4 to 5 weight %.

The optimum grind sizing was approximately 80% minus 100 mesh. Gold and sulfur flotation kinetics were rapid using a simple reagent scheme.

Similar flotation of whole ore was also effective, and the resultant rougher concentrates recovered approximately 83 to 85% of the gold and over 93% of the sulfur. The concentrates, which were typically 9 to 11 weight percent, contained 0.34 oz Au/ton and 39% S.

Carbon-in-leach tests on the separate gravity and whole ore concentrates dissolved 76% of the gold, and residues contained from approximately 0.066 to 0.080 oz Au/ton. Comparable results were obtained from CIL of the combined gravity plus flotation concentrate. The optimum concentrate regrinding size was approximately 90% minus 270 to 400 mesh.

The concentrate leach recovery clearly was a key factor limiting overall gold recoveries. Additional leaching tests showed that only with aggressive oxidation (i.e., roasting, nitric acid pre-leaching), was it possible to achieve gold dissolutions of over 90% from the concentrates.

Confirming whole ore and gravity tailings flotation tests were conducted using samples of untreated and biologically treated tailings impoundment water from the Homestake Lead operation. The flotation behavior was not affected with the Homestake water.

Hazen and Roberts & Schaefer presently are reviewing the cyanide detoxification requirements for permitting purposes. It would appear at this writing as though there are insufficient test work data in this regard. Brief prior Hazen testing for Brohm (per Bechtel) investigated ferrous sulfate with the objective only of reducing the free cyanide level to less than 20 mg/l. Although this was easily accomplished, that level is orders-of-magnitude higher than is indicated in the information available at present regarding the State of South Dakota surface water quality regulations. Hazen is preparing a scope of work to define more effective (SO_2/aeration, for example) detoxification methods. This work will be done in conjunction with analyses and possible testing of new source water samples expected from Brohm.

Material safety data sheets (MSDS) for the reagents used in the test work are presented in the appendix.

ORE SAMPLES

DESCRIPTION

Two Gilt Edge sulfide ore samples were used for this work. The first one (HRI Project 7452) was a 240-pound reject sample (HRI Sample No. 44348-1) with a Brohm identification of "0.03 sulfide ore". The sample was from prior Brohm work at Hazen and was selected primarily to expedite the test work.

The second sample was a 1000-pound minus 1/2-inch composite sample of Gilt Edge sulfide ore that was received at Hazen late in September from Dawson Metallurgical Labs in Salt Lake City. The sample was composited by Dawson from eight barrels of ore grade six-inch core rejects that had been prepared previously by Brohm.

A description of the individual samples comprising the composite follows in Table 1.

Table 1

List of Minus Six-Inch Core Samples

Barrel No.	Weight, lb	Assay, oz Au/t
1	411	0.039
2	699	0.034
3	624	0.057
4	616	0.032
5	661	0.049
6	600	0.029
7	623	0.038
8	265	0.131
Total	4,500	0.045

Upon receipt at Hazen, the 1,000-pound composite sample was assigned HRI Sample No. 44671.

PREPARATION

Each as-received minus 1/2-inch sample initially was blended thoroughly and a 50-pound head sample was split out and reserved. The remainder was stage crushed through minus six mesh, blended thoroughly, and split into either 1-, 2-, or 10-kg charges for various test work. Triplicate head pulps also were prepared from each ore sample.

HEAD ASSAYS

Table 2 shows the results of chemical assays of the head samples.

Table 2

Head Assays

HRI No.	Project No.	Head Split	Au oz/t	Ag oz/t	Fe %	S_T %
44348-1	7452	A	0.048	0.07	4.41	4.03
		B	0.042	0.02		
		C	0.044	0.05		
		Average	0.045	0.05		
44671	7481	A	0.035	0.08	4.44	3.73
		B	0.043	0.07	4.29	4.08
		C	0.059	0.09	4.34	3.73
		Average	0.046	0.08	4.36	3.85

All gold and silver assays were determined on one-assay ton lots using standard methods of fire assaying.

The average gold content of the samples of approximately 0.045-0.046 oz/ton checked very well with the Brohm values of 0.045 oz/ton.

The average direct gold fire assays also checked well with the average calculated value of 0.043 oz/ton for both ore samples based on all the test work performed on the samples.

The iron content of approximately 4.4% and the total sulfur content of approximately 3.9% agreed well with those of prior Gilt Edge sulfide composite samples tested at Hazen.

No other chemical characterization of the samples was made.

GRAVITY CONCENTRATION

TABLING/GEMENI

Initially, on each project, Wilfley table and Gemeni tests were conducted to generate gravity concentrates for leaching, along with gravity tailings for flotation testing. Sixty-kg of ore was processed for HRI Project 7452; whereas, 150-kg of ore were treated for HRI Project 7481.

The minus six-mesh ore samples were wet ball mill ground to 100% minus 10 mesh in 10-kg batches. The appropriate ground ore slurries were combined and passed over a Wilfley shaking table that was operated with continuous middlings recirculation. The table concentrates were then passed over a Gemeni deck to produce a free-gold or direct-smelt concentrate. This product was fire assayed directly in this work to enable metallurgical balances to be calculated.

The Gemeni tailings, which represented the gravity concentrate leach feed, were filtered, dried, weighed, and split into typically 500-gram test charges. A head sample also prepared for assays. The Wilfley table tailings, which represented flotation feed, were also filtered, dried, weighed, sampled, and then split into two-kg test charges.

Tabling test results are summarized in Table 3 and detailed metallurgical balances are appended. Overall, the results were consistent with prior Hazen tabling test on the Gilt Edge ores. The Gemeni concentrate gold recoveries were 12.3% from Sample 44348-1 and 8.3% from Sample 44671. The Gemeni tailings, i.e., gravity concentrate leach feed, represented 6.0 to 6.4 weight % and contained 0.344 oz Au/ton. Gold recoveries into this product were 43.8 and 47.3%, respectively, for samples 44671 and 44348-1. Wilfley table tailings; i.e., flotation feed, contained from 0.020 to 0.024 oz Au/ton and represented from 40.4 to 48.0% of the total gold in the ores.

Table 3

Tabling/Gemeni Results

Ore Sample	Product	Weight %	Assays, oz/Au/t	Distribution Au, %
44348-1	Gemeni Concentrate	<0.1	189.97	12.3
	Gemeni Tailings	6.4	0.344	47.3
	Wilfley Table Tailings	93.6	0.020	40.4
	Head (Calc'd)	100.0	0.046	100.0
	(Direct)	--	0.046	--
44671	Gemeni Concentrate	<0.1	63.45	8.3
	Gemeni Tailings	6.0	0.344	43.8
	Wilfley Table Tailings	94.0	0.024	48.0
	Head (Calc'd)	100.0	0.047	100.0
	(Direct)	--	0.046	--

JIG TEST

One test was performed in the present work to evaluate gravity recovery using a Denver jig, in contrast to the Reichert cone and spirals which were used previously (HRI Project 7161) in Hazen's pilot scale gravity test for Brohm. The jig test was conducted on an approximately 360-pound ore sample (HRI sample 44671) stage crushed to minus 10 mesh. This particle size was thought to be close to that from a "water flush" crushing system that was being considered by Roberts & Schaefer for the commercial project.

The sample was fed to a four-inch x six-inch Denver jig at the rate equivalent to 465 lb/hour. The water flowrate was 2.42 gpm, and the stroke was set at 7/8 inch. The hutch and bed concentrates were upgraded on a Deister table. The Deister table concentrate was screened on 20 mesh, and the resultant minus 20-mesh fraction was passed over the Gemeni table. The total Gemeni concentrate was fired analyzed. The tailings from the jig, Deister, and Gemeni tables were fire assayed along with the Deister concentrate plus 20-mesh fraction. Jig test results are shown in Table 4.

The jig test results showed that the gold recovery in the combined hutch and bed Gemeni concentrates was only 4.1%, or less than half of the approximately 8 to 12% recovered by laboratory scale tabling and in Hazen's prior pilot scale Reichert cone/spiral tests. The total

gold recovered into gravity concentrates by jigging was 23.9%, or again about one-half of that obtained in prior tabling tests. Although it is possible that somewhat better results might be achieved with further refinement of the jig conditions, it was speculated that the lower jig recoveries were due to fine-sized gold losses. An IHC type jig might be more effective for finer-grained gold recovery, but a large-scale pilot test would be required to confirm this.

Based on the results, however, a cone/spiral gravity circuit would be preferred commercially to maximize gold recoveries. Test details and screen analyses are appended.

GEMENI CONCENTRATE ANALYSES

Prior to being fired the Gemeni concentrate from the above laboratory tests, sample 44671 was submitted for a semi-quantitative emmission spectrographic analysis to give an idea of its suitability for direct smelting. The results (Table 5) showed that silica and iron (i.e., pyrite) were the principal constituents, but also present were minor or trace amounts of elements such as arsenic, bismuth, copper, and tungsten. Some of the trace metal constituents, tungsten for example, could have been due to metallic contamination during prior handling of ore sample.

Table 4

Metallurgical Balance - Minus 10-Mesh Jig Test

Product	g	%	Analyses mg	Analyses oz/ton	Analyses oz/ton	% Distribution Au	% Distribution Ag
Feed (Analyzed)				0.039	0.05		
Feed (Computed)	164,146.3	100.0		0.045	0.08	100.0	100.0
Jig Hutch Concentrate	(7,470.5)	(4.6)		(0.216)	(0.30)	(21.9)	(17.1)
Deister Table Concentrate	(2,949.5)	(1.8)		(0.405)	(0.45)	(16.3)	(9.9)
Concentrate +20 mesh	503.1	0.3		0.270	0.65	1.9	2.5
Gemini Concentrate	0.1	<0.01	8.946	1,808	244.5	3.6	0.3
Gemini Tailings	2,446.3	1.5		0.326	0.39	10.9	7.2
Deister Table Tailings	4,521.0	2.8		0.092	0.21	5.7	7.2
Jig Bed Concentrate	(1,677.7)	(1.0)		(0.087)	(0.092)	(2.0)	(1.2)
Deister Table Concentrate	(297.7)	(0.2)		(0.292)	(0.24)	(1.2)	(0.5)
Concentrate +20 mesh	135.3	0.1		0.142	0.31	0.3	0.3
Gemeni Concentrate	0.1	<0.01	1.36	294	0.00	0.5	0.0
Gemini Tailings	162.3	0.1		0.173	0.16	0.4	0.2
Deister Table Tailings	1,380.0	0.8		0.043	0.06	0.8	0.6
Jig.Tailings	154,998.0	94.4		0.036	0.07	76.1	81.8

Notes: 1. Combined free gold concentrate (i.e., Gemeni concentrate from bed and hutch = 4.1% Au recovery.
2. total Au recovery in gravity concentrates = 23.9% in 5.6 weight %.

Table 5

Semi-Quantitative Emission Spectrographic Analysis of Gemeni Concentrate

Element	Detection Limit	Units	Found
Al	0.01	%	0.8
Si	0.01	%	G(50)
Na	0.1	%	N
K	0.1	%	N
Fe	0.05	%	20
Mg	0.02	%	N
Ca	0.05	%	0.2
Ti	0.002	%	0.2
Mn	10	ppm	800
Ag	0.5	ppm	1200
As	200	ppm	2800
Au	10	ppm	2000
B	10	ppm	N
Ba	20	ppm	N
Be	1	ppm	N
Bi	10	ppm	800
Cd	20	ppm	N
Co	5	ppm	600
Cr	10	ppm	800
Cu	5	ppm	4000
La	20	ppm	N
Li	100	ppm	N
Mo	5	ppm	400
Nb	20	ppm	N
Ni	5	ppm	280
Pb	10	ppm	800
Sb	100	ppm	N
Sc	5	ppm	N
Sn	10	ppm	60
Sr	100	ppm	N
Th	100	ppm	N
V	10	ppm	N
W	50	ppm	8000
Y	10	ppm	N
Zn	200	ppm	1200
Zr	10	ppm	400

G = Greater than value shown
N = Not detected

INITIAL FLOTATION TESTS

(HRI PROJECT 7452)

GRAVITY TAILINGS

This first test work segment had as its objective of confirming the response of the gravity circuit tailings (i.e., Wilfley tabling tailings) to froth flotation recovery of the contained gold values. Flotation would serve in place of cyanidation of the gravity tailings and the flotation concentrate would need to be cyanide leached together with the gravity concentrate. This work followed up on preliminary tests performed at Hazen previously (HRI Projects 7161 and 7245) for Brohm, in which the resultant flotation tailings assays were essentially the same as with cyanidation of the tailings. Flotation treatment was conceived as being a viable alternative due to the suspected ease of flotation of the remaining gold-bearing pyrite and the almost complete absence of floatable siliceous or other gangue constituents which could be deleterious to flotation.

In the current work, most of the flotation tests included the key rougher stage only, in which several incremental concentrates or froth products were removed separately. This allowed a reliable determination of gold grades and recoveries on the basis of the important kinetics of flotation. Two cleaner flotation tests were performed to evaluate upgrading by reflotation methods. Fineness of grind of the gravity tailings or flotation feed was the principal variable.

Flotation was performed on 2,000-gram test charges using a Denver D-1 mechanism operated at 1900 rpm and a slurry pulp density of 34% solids. No adjustment was made to the starting ground ore slurry pH of about approximately 6-6.5. Reagent use was very simple, consisting of Aeroxanthate 350 (potassium amyl xanthate) and Aeropromoter 242 (sodium diisopropyl di-cresyl dithiophosphate) as sulfide mineral-gold collectors, and MIBC (methyl isobutyl carbinol, also known as methyl amyl alcohol) was used as frother. A small addition of anhydrous copper sulfate also was made in the last flotation step to enhance the recovery of any remaining sluggish or less floatable pyrite. Based on the metallurgical results which follow, there did not appear to be any great value to copper sulfate use.

Except where noted hereafter, this same procedure was used for all of the flotation test work in this report.

The rougher tailings in these and all other flotation tests were assayed on triplicate splits using one assay-ton fires. The average assay was used for metallurgical balance calculations. This more extensive analytical procedure was adopted to minimize analytical variations due to possible segregation of gold during blending. Generally, the triplicate assays agreed well and typically varied by no more than 0.001 or, at the most, 0.002 oz Au/ton.

Initial flotation test results are summarized in Table 6 and reagent and metallurgical balance details are shown in Appendix of this report.

Flotation of the gravity tailings recovered approximately 67% of the gold into a rougher concentrate representing 5.3 to 5.7 weight % of the tailings feed and containing typically 0.24 to 0.26 oz Au/ton. These results were obtained with a reasonable grind of 79% minus 100 mesh. Grinding to as fine as 93.8% minus 200 mesh increased the gold recovery to 72.5%, but the difference was due to a 0.001 oz Au/ton reduction in the tailings assay which is not analytically significant. These results confirmed Hazen's prior flotation tests, and demonstrated that the same tailings assays could be achieved with flotation as with direct cyanidation of the gravity tailings.

Due to the favorable mineralogical character of the tailings, the gold flotation rates were rapid and froths were mineralized intensely with pyrite. As shown in Figure 1, gold recovery was essentially levelled off after typically 10 minutes of rougher flotation, laboratory basis.

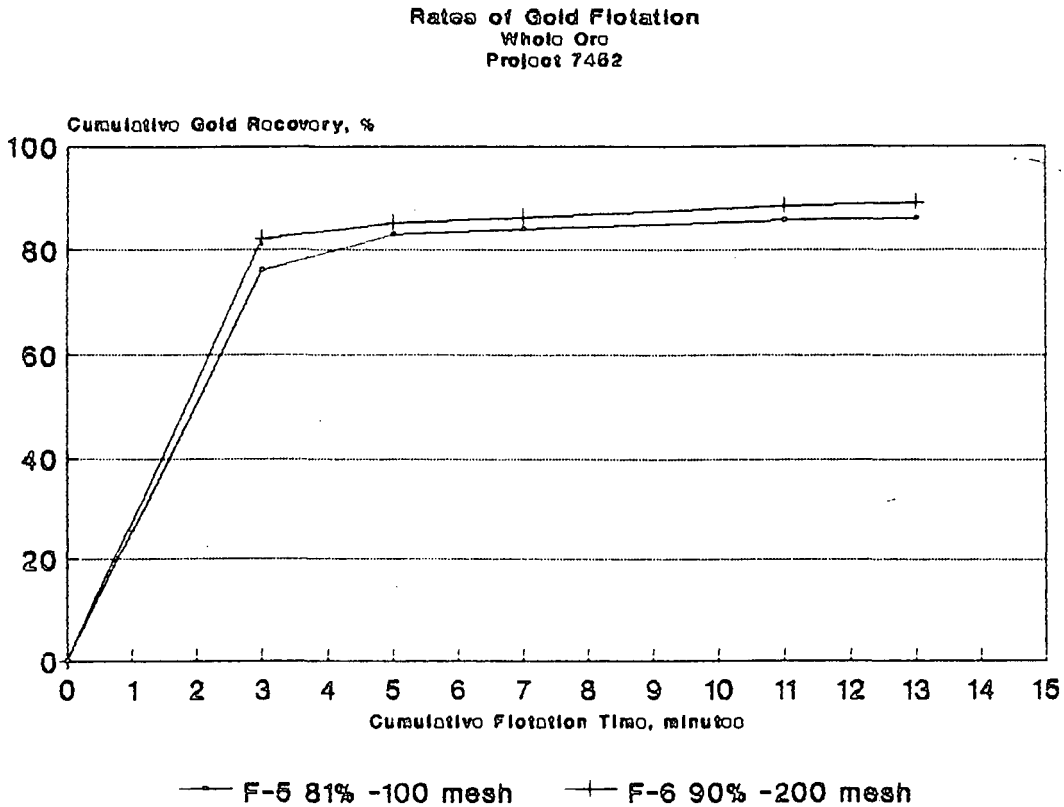
Cleaning of the rougher concentrate by reflotation, Test 3 and 4, resulted in good gold upgrading and weight rejection, but gold recovery losses were excessive. This is fairly typical of low grade rougher concentrates of this nature, and reflects the unavoidable loss of some of the pyrite which, of course, is gold-bearing, in the cleaner tailings. It is possible that recoveries would be increased due to recirculation effects in a steady state continuous operation.

Table 6

Summary of Initial Rougher and Cleaner Flotation on Gravity Tailings

Test No.	Grind Product	Calc'd Head Assays oz Au/ton	Rougher Concentrate Weight %	Rougher Concentrate Assays, oz Au/ton	Rougher Concentrate Au Distribution, %	Tailings Assays, oz Au/ton
1	93.8% minus 200 mesh	0.020	6.75	0.22	72.5	0.006
2	97.8% minus 100 mesh	0.020	5.69	0.24	67.5	0.007
7	79% minus 100 mesh	0.020	5.29	0.26	67.2	0.007
3	97.8% minus 100 mesh	0.020	(1.88)	(0.44)	(40.8)	0.008
4	93.8% minus 100 mesh	0.022	(2.76)	(0.46)	(57.3)	0.006

Notes: 1. Values in parentheses refer to cleaner concentrate data.
2. Direct fire assay of gravity tailings flotation feed was 0.020 oz Au/ton.


Rates of Gold Flotation
Whole Ore
Project 7462
Cumulative Gold Recovery, %
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Cumulative Flotation Time, minutes
F-5 81% -100 mesh
F-6 90% -200 mesh

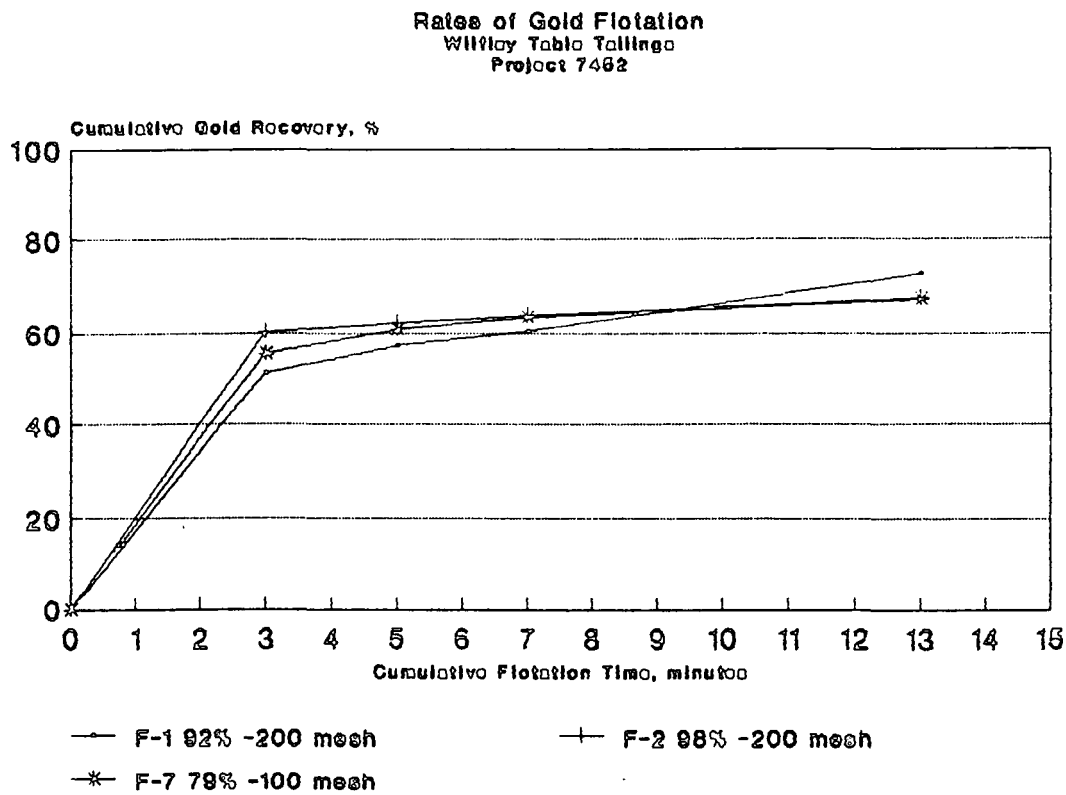

Rates of Gold Flotation
Wilfley Table Tailings
Project 7462
Cumulative Gold Recovery, %
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Cumulative Flotation Time, minutes
F-1 92% -200 mesh
F-2 98% -200 mesh
F-7 79% -100 mesh

Figure 1

In order to determine gold recovery by particle size, an important factor in assessing flotation response, the gravity tailings flotation feed and rougher tailings were sized and the fractions were analyzed for gold. The analysis, the details of which are appended, showed that gold recoveries were as high as approximately 70% from the finer sized fractions, and that the gold content in the flotation tailings was uniform according to particle size. Summary data were:

Table 7

Gold Recovery By Particle Size

Size Fraction Tyler Mesh	Weight, %	Assays, oz Au/t Feed	Assays, oz Au/t Tailings	Au Recovery, By Size, %
48 x 65	6.8	0.010	0.007	30.0
65 x 100	14.2	0.010	0.007	30.0
100 x 150	15.8	0.012	0.005	58.3
150 x 200	11.1	0.012	0.006	50.0
200 x 270	9.7	0.016	0.006	62.5
270 x 325	3.9	0.018	0.005	72.2
325 x 400	3.2	0.027	0.008	70.3
-400	35.3	0.027	0.008	70.3
Head (Calc'd)	100.0	0.018	0.007	--
Head (Direct)	--	0.020	0.007	--

The size uniformity of gold present in the flotation tailings indicated that it occurred probably as widespread and extremely fine (i.e., micron sized) disseminations or encapsulations in non-sulfide gangue or in pyrite encapsulated in gangue. Unreasonably fine grinding likely would be necessary to liberate and, hence, recover the gold by flotation or cyanidation.

Based on gravity concentration and flotation, the total gold recovery was 86.7%, as follows.

Table 8

Total Recovery by Gravity and Flotation

Gemeni Concentrate	Gravity Concentrate (i.e., Gemeni Table)	Rougher Flotation Concentrate	Total
12.3	47.3	27.1[1]	86.7

[1] Based on 67.2% of recovery of 40.4% overall distribution of gold in gravity tailings.

The recoveries, of course, do not reflect gold losses during cyanidation of the combined gravity and flotation concentrates, which subject is covered subsequently in this report.

WHOLE ORE FLOTATION

Flotation test results obtained on whole ore are summarized in Table 9. These tests were conducted to compare gold recoveries by direct flotation of the ore with those obtained with the gravity-flotation flowsheet.

Based on these brief tests, the total gold recoveries of 86 to 89.1% were essentially the same as obtained by gravity-plus-flotation. At the coarsest grind tested of 81.1% minus 100 mesh, the concentrate weight recovery was 12.5% of the ore and contained 0.30 oz Au/ton, which data were similar to those of the combined gravity + flotation concentrate.

Although the all-flotation results were generally comparable to the gravity + flotation circuit results, considerably more test work conducted with all-flotation schemes in the subsequent (HRI Project 7481) testing would show that this approach was less reliable in achieving high overall gold recoveries consistently.

The remainder of this report describes the test work performed on the minus 6-inch drill core sulfide composite sample.

Table 9

Initial Whole Ore Flotation Tests

Test No.	Grind Product	Calc'd Head Assays oz Au/ton	Rougher Concentrate Weight %	Rougher Concentrate Assays, oz Au/ton	Rougher Concentrate Au Distribution, %	Tailings Assays, oz Au/ton
5	81.1% minus 100 mesh	0.044	12.53	0.300	86.0	0.007
6	90.3% minus 200 mesh	0.047	15.37	0.270	89.1	0.006
8	81.1% minus 100 mesh	0.038	(7.05)	(0.442)	(82.1)	0.003

Notes: 1. Direct ore head assay = 0.046 oz Au/ton.
2. Values in parentheses refer to 2nd cleaner concentrate.

FINENESS OF GRIND

The effect on gold recoveries of varying the fineness of primary grind from approximate P80's of 48 to 325 mesh was evaluated in rougher flotation tests. Results are summarized in Table 10.

The results showed that a primary grind of approximately 80% minus 100 mesh was necessary to achieve a gold recovery of 85% or more in rougher flotation. This result was obtained in five out of the six tests conducted at 100 mesh or finer. At coarser grinds, with the exception of one test at approximately 80% minus 65 mesh, gold recoveries were reduced to approximately 80%. Thus, there appeared to be a trend towards slightly higher gold recoveries with finer grinding, as indicated in Figure 2. However, the data are subject to significant scatter as a result of significant variations in the tailings assays which made it somewhat difficult to generate reliable recovery trends. The variations were thought due to the slightly differing amounts of free gold in the feed sample and the slightly varying degree of recovery of any fine-grained free gold in the froth phase. Small analytical variations likely also contributed to significant gold recovery variations.

The rates of gold flotation are shown in Figure 3. Again, the data showed that gold recoveries essentially were levelled off after about 10 minutes of flotation, laboratory basis.

Based on these results, the primary grind size of 80% minus 100 mesh was selected as the coarsest grind at which reliable high gold recoveries could be achieved consistently. However, some of the test work, noted hereafter, was conducted at 80% minus 65 mesh since a complete grind/recovery profile was not available.

pH

The rougher flotation slurry pH was raised from approximately six, the unadjusted starting level, to 8.0 with lime (2.0 lb/ton) and to 11.0 with sodium hydroxide in another test. Sodium hydroxide was chosen over lime to achieve this high alkalinity to prevent any deleterious flotation effects from occurring due to the strong thixotropic nature of the slurry which might result from high lime use.

Table 10

Summary of Rougher Flotation Results

Flotation Test No.	Feed: Grind Size	Feed: Variable/ Condition	Feed: Au %/t[1]	Rougher Concentrate: Wt %	Rougher Concentrate: Au oz/t	Rougher Concentrate: % Dist. Au	Rougher Tailing Au, oz/t
F-6	79.6% -48 mesh	Grind series	0.042	9.11	0.371	80.5	0.009
F-3	81.7% -65 mesh	Grind series	0.039	10.03	0.348	88.6	0.005
F-23	81.7% -65 mesh	Repeat of #3	0.041	10.29	0.324	80.5	0.009
F-2	82.5% -100 mesh	Grind series	0.043	10.84	0.342	85.6	0.007
F-22	82.5% -100 mesh	Repeat of #2	0.042	11.44	0.301	81.2	0.009
F-5	92.4% -150 mesh	Grind series	0.041	12.26	0.288	85.2	0.007
F-1	82.9% -200 mesh	Grind series	0.041	11.49	0.314	87.2	0.006
F-4	79.2% -325 mesh	Grind series	0.041	16.14	0.218	85.7	0.007
F-7	82.5% -100 mesh	NaOH, pH 11.0	0.044	15.32	0.250	87.4	0.007
F-8	82.5% -100 mesh	$Ca(OH)_2$, pH 8.0	0.043	11.78	0.325	89.7	0.005
F-12	82.5% -100 mesh	Ap-3477	0.048	12.04	0.318	79.8	0.011
F-13	82.5% -100 mesh	Ap-404	0.044	10.12	0.305	69.6	0.015
F-19	80% -65 mesh	Ro Conc. for leach	0.040	9.04	0.322	72.7	0.012

[1] Calculated from test product analyses.

Note: Average direct fire assays of head samples = 0.046 oz/t
Average Calculated feed 0.042 oz/t

Relationship Between Grind Particle Size
and Gold Recovery, Whole Ore Flotation

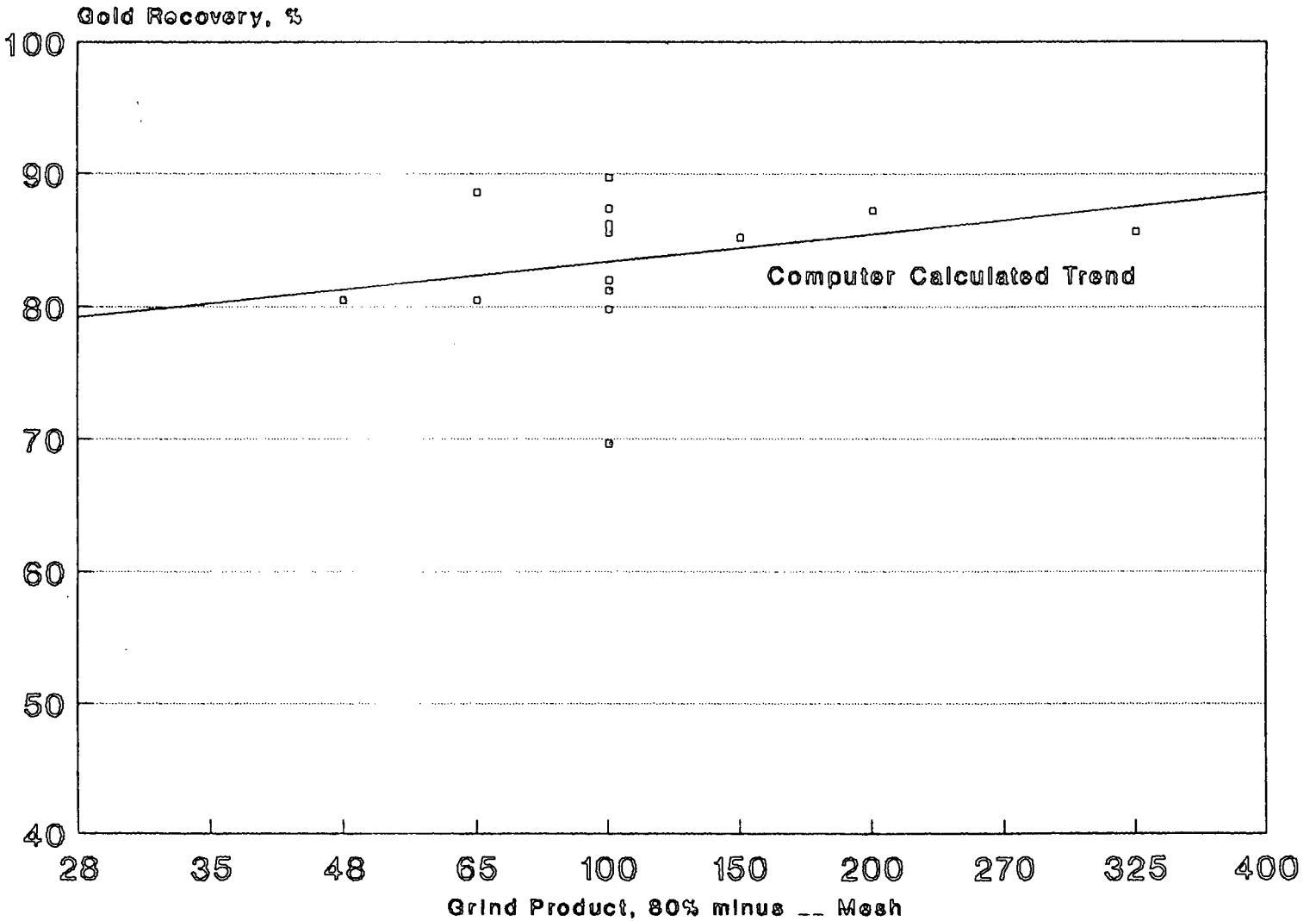


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Figure 2

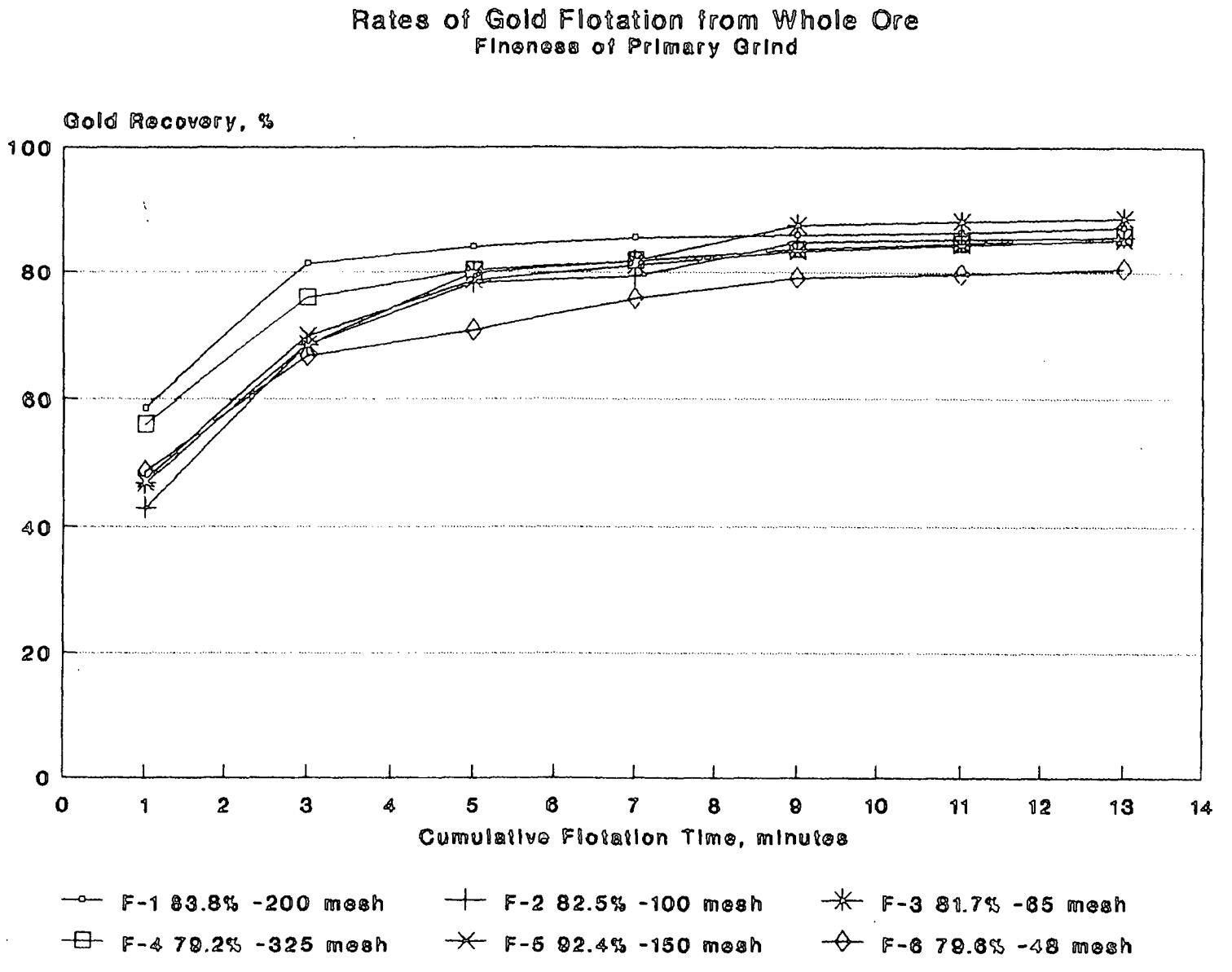

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Figure 3

The best results were obtained in the test with $Ca(OH)_2$ at pH 8. The gold recovery was a high 89.7% and the rougher concentrate weight recovery was 11.8%. Although it would be necessary to confirm any possible benefits of lime use with additional testing, it was decided to proceed with the test work without pH adjustment to minimize operating costs.

COLLECTORS

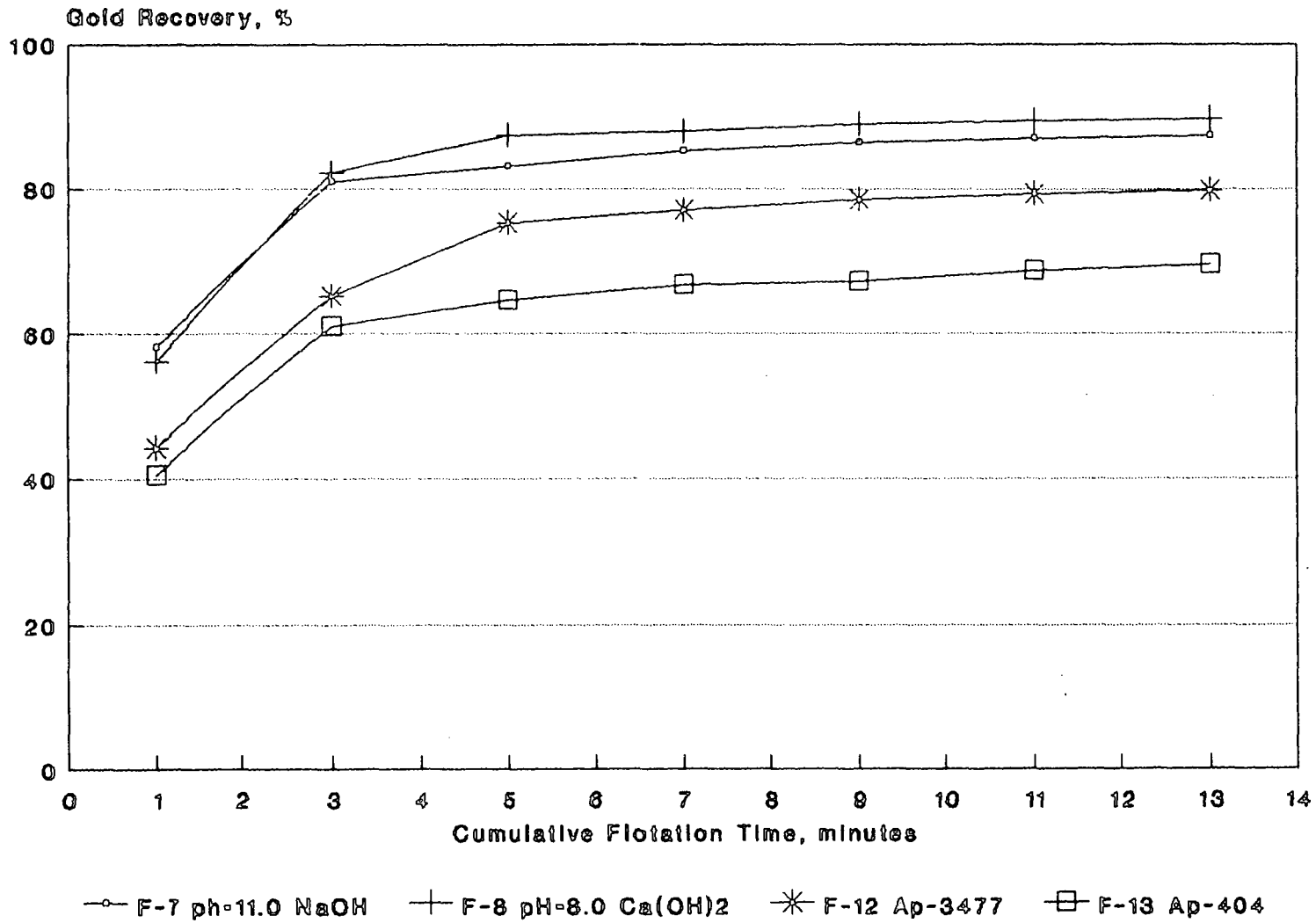
The collectors Aeropromoter 3477 (sodium diisobutyl dithiocarbamate) and Aeropromoter 404 (mercapto benzothiazole) were evaluated in place of Aeropromoter 242 selected previously. Gold recoveries were significantly lower with those two collectors; consequently, AP-242 was used for all subsequent tests. The rates of flotation for the pH and reagent tests are shown in Figure 4.

To some degree, the gold recoveries obtained in rougher flotation were dependent on the weight recovery of the concentrate, as shown in Figure 5. Although there again is considerable data scatter, the relationship is fairly typical of the flotation of low grade gold ores, in which small incremental recovery increases result due to the less selective flotation of middling and locked sulfide/gangue particles.

CLEANER FLOTATION

Three cleaner flotation tests, summarized in Table 11, were performed to upgrade rougher concentrates by two stages of reflotation. Although, as before, there was significant weight rejection and gold upgrading, the recoveries to the cleaner concentrates were reduced to 57.8 and 64.8% from over 80% in the rougher concentrates. The best results were obtained in test F-9 which used the 80% minus 100 mesh primary grind and regrinding of the rougher concentrate prior to cleaning.

Rates of Au Flotation from Whole Ore
Auxiliary Collectors and pH Modification



All tests were conducted at 82.5 % -100 mesh.

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Figure 4

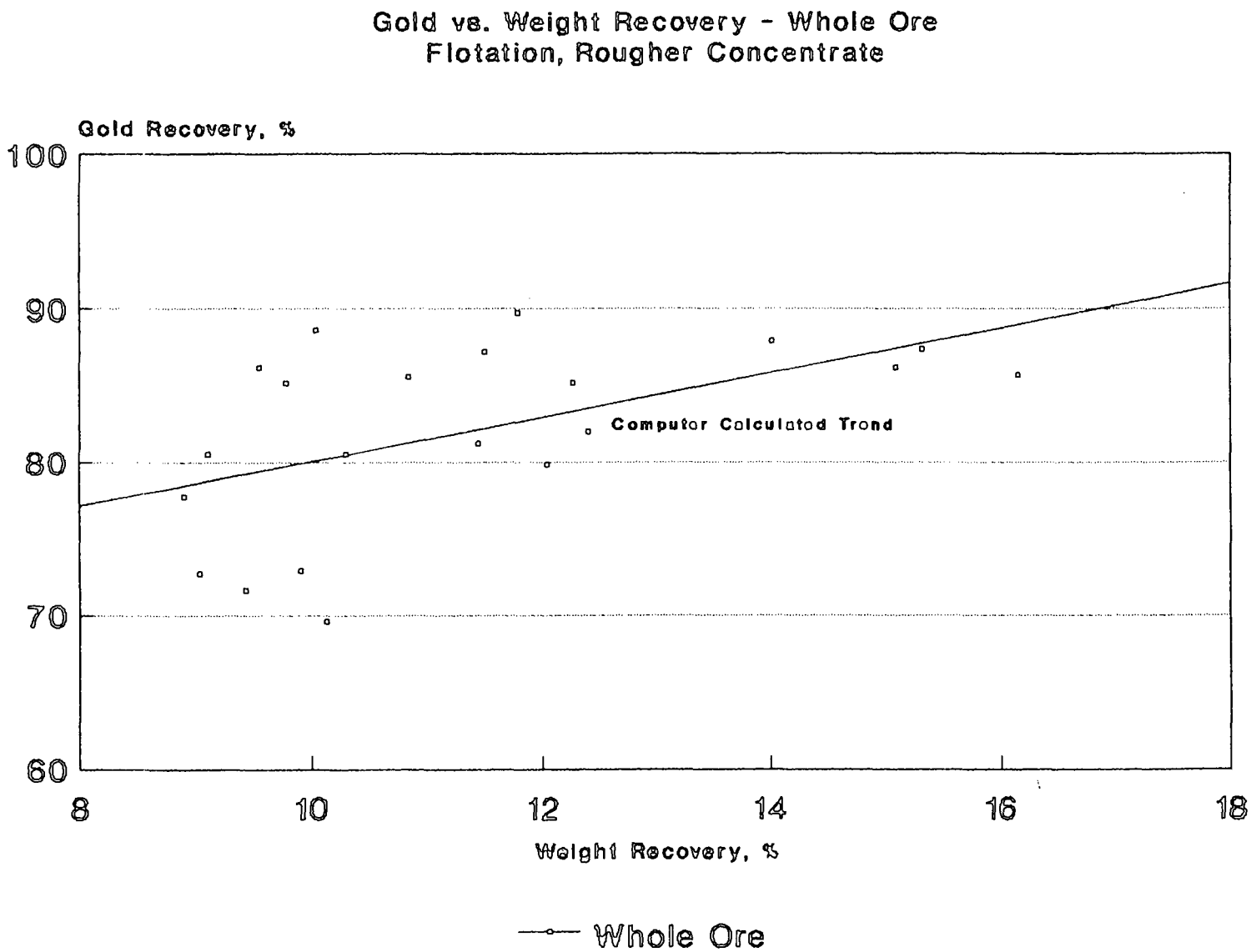
Gold vs. Weight Recovery - Whole Ore
Flotation, Rougher Concentrate
Gold Recovery, %
100
90
80
70
60
8
10
12
14
16
18
Weight Recovery, %
Computer Calculated Trend
Whole Ore

Figure 5

Table 11

Summary of Whole Ore Cleaner Flotation Results

Flotation Test No.	Feed			Concentrate Products					Rougher Tailing, oz/t
	Grind Size	Variable/ Condition	Head, oz. Au/t[1]	Rougher		Cleaner		% Dist., Au	
				Wt. %	oz Au/t	Wt. %	Au oz/t		
F-20	81.7% -65 mesh	Cleaner test	0.047	9.91	0.342	6.54	0.382	53.7	0.014
F-21	81.7% -65 mesh	Cleaner test	0.045	9.44	0.339	6.27	0.412	57.8	0.014
F-9	82.5% -100 mesh	Cleaner test	0.035	8.89	0.303	5.92	0.380	64.8	0.009

Note: Average direct fire assay of head samples: = .046 oz Au/t
Average calculated feed = .042 oz Au/t

However, because of the importance to the commercial project economics, Hazen was requested to conduct a locked cycle test, a laboratory simulation of a continuous flotation circuit, to determine reliably the projected gold recovery under recirculation conditions.

CYCLE TEST

An eight-stage locked cycle test was conducted using a typical counter-current arrangement. It was decided to route the first cleaner tailings to the head of rougher flotation in order to maximize overall gold recoveries, rather than to scavenger the first cleaner tailings which would directly contribute to higher gold losses. The first three cycles used a primary grind of 81.7% minus 65 mesh; whereas, the grind sizing was increased to 82.5% passing 100 mesh when it had become apparent during the test that excessive, very coarse grained pyrite was building up in the cleaner tailings.

Overall, the test was successful in that the projected gold recovery increased from that in the batch test to as high as 83.4%. However, the concentrate represented 9.34 weight % of the ore and contained 0.365 oz Au/ton, which indicated that gold upgrading and weight rejection were only marginally better than the rougher concentrate qualities of some of the better batch tests. The test recovered over 94% of the sulfur, and the final concentrate grade was 39% S.

The rougher tailings assay was 0.008 oz Au/ton, which was slightly higher than in many of the preceding batch tests.

Despite the low degree of upgrading, the reliability of the reagent balance and the test flowsheet was demonstrated, and the test came into equilibrium or steady state as would be expected by the third or fourth cycle.

The cycle test metallurgical balance is shown in Table 12.

Table 12

Cycle Test Metallurgical Results

Product	Weight %	Assays, oz/ton, % Au	Ag	S	Distribution, % Au	Ag	S
1. 2nd Cleaner Concentrate A	0.79	0.378	0.76	41.00	7.3	7.5	8.7
2. 2nd Cleaner Concentrate B	0.85	0.360	0.73	42.30	7.5	7.8	9.8
3. 2nd Cleaner Concentrate C	1.07	0.394	0.65	40.30	10.3	8.7	11.6
4. 2nd Cleaner Concentrate D	1.06	0.320	0.64	35.40	8.3	8.5	10.1
5. 2nd Cleaner Concentrate E	1.16	0.412	0.75	37.00	11.7	10.9	11.6
6. 2nd Cleaner Concentrate F	1.21	0.320	0.72	37.00	9.4	10.9	12.1
7. 2nd Cleaner Concentrate G	1.13	0.390	0.71	38.80	10.8	10.1	11.9
8. 2nd Cleaner Concentrate H	1.26	0.324	0.70	38.90	10.0	11.1	13.3
9. 2nd Cleaner Tailings H	0.44	0.222	0.43	16.30	2.4	2.4	1.9
10. 1st Cleaner Tailings H	0.63	0.344	0.26	14.00	5.3	2.0	2.4
11. Rougher Tailings A	11.20	0.008	0.02	0.36	2.2	2.8	1.1
12. Rougher Tailings B	11.27	0.008	0.01	0.33	2.2	1.4	1.0
13. Rougher Tailings C	11.49	0.009	0.03	0.33	2.5	4.3	1.0
14. Rougher Tailings D	11.35	0.008	0.03	0.25	2.2	4.3	0.8
15. Rougher Tailings E	11.48	0.007	0.01	0.30	2.0	1.4	0.9
16. Rougher Tailings F	11.15	0.007	0.02	0.16	1.9	2.8	0.5
17. Rougher Tailings G	11.17	0.007	0.01	0.20	1.9	1.4	0.6
18. Rougher Tailings H	11.31	0.008	0.01	0.24	2.2	1.4	0.7
Head, Calc'd	100.00	0.041	0.08	3.70	100.0	100.0	100.0
Head, Direct		0.046	0.08	3.82			
Calculated Products							
Weighted Average, Cycles G & H Concentrates		0.365	0.73	38.9			
Weighted Average, Cycles G & H Ro Tailings		0.008	0.01	0.22			
Two-product formula projected recoveries (for combined cycles G & H)	9.34				83.4	88.6	94.8

UNIT CELL FLOTATION

Two tests, No. 10 and 11, were conducted to evaluate unit cell flotation. In a broad sense, unit cell flotation, which is usually conducted on a grinding mill discharge or cyclone underflow, is somewhat comparable to gravity recovery in that it seeks to recover coarsely-liberated gold particles early in the circuit and to avoid prolonged, recirculation of such values in closed-circuit grinding mills. A contemporary example of one type of unit flotation is the Outokumpu "Flash" cell.

The unit cell tests were conducted on feeds carefully ground to P90's of 20 and 35 mesh. The products were partially deslimed by sedimentation (i.e., Outokumpu lab practice), to simulate a cyclone underflow, and floated in a Denver cell for two minutes. The froth product was assayed, and the unit cell tailings were further ground to approximately 80% minus 100 mesh and floated in the usual manner as if they were new feed.

Test results are shown in Table 13. As much as from 37.2 to 51.8% of the total gold was recovered into the unit cell concentrates from the 35- and 20-mesh grinds, respectively. The concentrate were relatively high grade at between approximately 0.5 and 0.6 oz Au/ton, and represented between three and four weight percent of the ore.

Flotation of the reground unit cell tailings resulted in total test gold recoveries of 83.2 to 84.5, which were no better than without unit cell flotation.

Although, in terms of coarse free gold removal, the unit cell tests were promising as a possible alternative to gravity methods, it was decided not to pursue unit cell flotation on the assumption that, commercially, coarse native gold would be more likely to escape a unit cell than it might from a gravity circuit. Moreover, the unit cell concentrate would not be capable of being upgraded much further by flotation, therefore, some form of gravity "finishing" step would be required.

Table 13

Unit Cell Flotation Comparison

Test No.	Product	Weight %	Assays, oz Au/ton	Au Distributions, % Total	Au Distributions, % Recoverable
10	P90 = 35 mesh				
	Unit Cell Conc	3.05	0.505	37.2	44.0
	Tailings	92.51	0.029	59.5	
	Slimes	4.44	0.031	3.3	
	P80 = 100 mesh				
	Rougher Conc	6.51	0.300	47.3	
	Rougher Tailings	90.44	0.006	15.5	
	Head, Calc'd	100.00	0.041	100.0	
	Unit Cell Conc + Rougher Conc	9.56	0.366	84.5	
11	P90 = 20 mesh				
	Unit Cell Conc	3.82	0.590	51.8	62.7
	Tailings	92.37	0.024	45.2	
	Slimes	3.81	0.034	3.0	
	P80 = 100 mesh				
	Rougher Conc	7.47	0.182	31.4	
	Rougher Tailings	88.71	0.008	16.8	
	Head, Calc'd	100.00	0.043	100.0	
	Unit Cell Conc + Rougher Conc	11.29	0.321	83.2	

CONCENTRATE PRODUCTION TEST

Two 20-kg each, large-scale tests were run on the sulfide core composite sample to generate sufficient concentrate for the leaching studies. The tests used an Agitair 1.7-ft^3 cell and conditions developed in the prior two-kg bench tests.

The total gold recovery in this test was only 72.7%, based on a rougher tailings assays of 0.012 oz Au/ton. This assay was exceptionally high and was thought due possibly to the 65 mesh grind which may have been too coarse. It may also have reflected the differences in the ability to recover free gold due to the different efficiencies involved with the flotation machines used, i.e., the Denver bench cell vs the Agitair pilot-scale mechanism.

The combined test rougher concentrate contained 0.322 oz Au/ton and represented 9.04 weight %, which data were comparable to those of prior smaller-scale tests. A total of approximately 3,500 grams of rougher concentrate was made for subsequent leaching tests.

FLOTATION OF GRAVITY TAILINGS

The following describes the flotation testwork performed on the gravity (i.e., Gemeni) tailings, which test was described earlier in this report.

FINENESS OF GRIND

Table 15 shows the results of tests varying the fineness of grind of the gravity tailing on flotation recoveries. The results showed that a grind of approximately 80% minus 100 mesh was as coarse as was possible to obtain gold recoveries of from 66 to 77.4%. At 48- and 65-mesh grinds, gold recoveries decreased markedly. At the 100 mesh grind, the rougher concentrates contained typically 0.25 to 0.3 oz Au/ton and represented 5.2 weight %. Rates of gold flotation are shown in Figure 6.

Overall, these results confirmed prior gravity tailings flotation results. Total gold recoveries from this composite ore sample were as shown in Table 14.

Table 14

Total Recovery by Gravity and Flotation

Gemeni Concentrate	Gravity Concentrate	Flotation Concentrate	Total
8.3	43.8	33.6	85.7

The 100 mesh P80 grind was repeated on a four-kg feed basis to generate concentrate for leaching tests. The rougher concentrates recovered 67% of the gold, represented 5.2 weight percent, and contained 0.27 oz Au/ton. Tailings contained 0.008 oz Au/ton.

No other reagent or pH-related variations were evaluated on the gravity tailings flotation.

REAGENT BALANCE

A summarized reagent balance, including various retention times, is shown in Table 16. Note that all the froth removal or retention times are laboratory based and do not reflect any commercial equipment scale up factors.

Table 15

Gravity Tailings Flotation Results

Test No.	Grind Size	Variable /Condition	Calculated Head oz Au/ton	Rougher Concentrate Weight %	Rougher Concentrate Assay oz Au/ton	Rougher Concentrate Au Distribution, % Feed	Rougher Concentrate Au Distribution, % Ore	Tailings oz Au/ton
F-17	71.7% - 48 mesh	Gemeni	0.019	3.65	0.295	55.4	85.0	0.009
F-16	75.1% - 65 mesh	Gemeni	0.020	3.72	0.280	52.0	86.4	0.010
F-15	81.9% -100 mesh	Gemeni	0.017	5.25	0.247	77.4	72.2	0.004
F-14	83.9% -200 mesh	Gemeni	0.018	8.84	0.166	80.1	74.2	0.004
F-24	81.9% -100 mesh	Concentrate for leach	0.021	5.23	0.268	66.4	80.2	0.008
F-25	81.9% -100 mesh	Concentrate for leach	0.022	5.17	0.280	67.1	79.9	0.008

Note: Average Direct Fire Assays of Head Samples: Ore: 0.046
Feed: 0.024
Calc'd: 0.020

Rates of Au Flotation from Gravity Tails
Fineness of Primary Grind

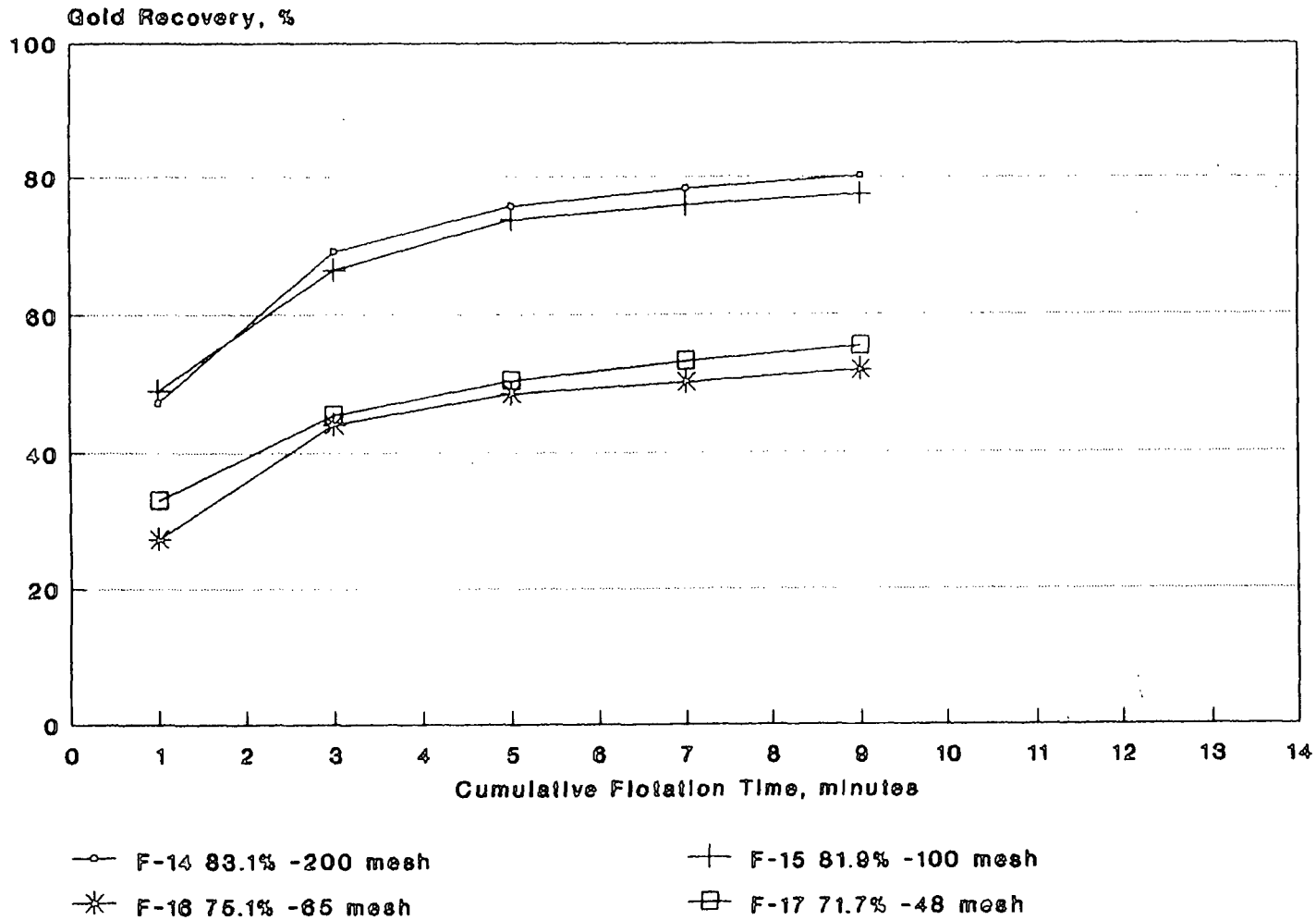

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Figure 6

Table 16

Summary reagent Balance and Conditions
for Flotation of Gravity Tailings

Stage	Reagents Added, lb/ton of ore					Time, Minutes		Pulp pH
	AX-350	AP-242	$CuSO_4$ $5H_2O$	MIBC		Condition	Froth	
Rougher 1	0.05	0.05	-	0.02		1	3	5.7
Rougher 2	0.05	0.05	-	0.01		1	4	5.6
Rougher 3	0.03	0.02	-	0.01		1	4	5.5
Rougher 4	0.02	0.02	0.25	0.01		1	4	5.3
Totals	0.15	0.14	0.25	0.05		4	15	-

CONCENTRATE LEACHING STUDIES

WHOLE ORE CONCENTRATE

Cyanide leaching (i.e., CIL) tests were performed on the rougher concentrates generated from whole ore, with the principal variable being fineness of regrind.

Leaching conditions were based on those demonstrated in prior extensive work done at Hazen on Gilt Edge sulfide concentrates. These were:

% Solids:	40
Preaeration:	20 minutes a pH 12 with CaO
NaCN:	2.5 g/l
CaO:	1.0 g/l, equivalent to pH > 12
Carbon:	30 g/l of slurry; Calgon GRC-22, 6 x 14 mesh, pretreated.
Aeration:	continuous
Time:	24 hours

Leaching results, which are summarized in Table 17, showed that a regrind product sizing of 90% minus 270 mesh gave the lowest residue assays of 0.076 oz/ton, equivalent to a gold dissolution of 75.7% of that in the concentrate feed.

Sodium cyanide consumptions were typically approximately 10 to over 11 lb/ton of concentrate, or about one lb/ton of ore.

GEMENI TAILINGS

A similar suite of tests (AL-1 through AL-4) were performed on the Gemeni tailings to evaluate fineness of regrind (Table 18).

The results verified that the concentrate needed to be reground to approximately 90% minus 270 mesh for gold solubilities to level off. At this size, the gold dissolution was 77.6% based on residue assay of 0.076 oz Au/ton. The sodium cyanide consumption was 5.3 lb/ton of concentrate or 0.32 lb/ton of ore.

Figures 7 and 8 show the relationship between regrind fineness and gold solubilities for the whole ore and gravity tailings concentrate leaching tests.

Table 17

Summary of Whole Ore Flotation
Rougher Concentrate Leaching Results

Test No.	Feed: Regrind Size	Feed: Variable/ Condition	Feed: Calc'd Head, oz Au/t	24 Hr Au Dis., %[1]	Ore Basis Au Recovery %[2]	Leach Residue, oz Au/t	Reagent Consumption, lb/t: NaCN Feed[1]	NaCN Ore[2]	CaO Feed[1]	CaO Ore[2]
AL-6	90% -65 mesh	Grind series	0.340	57.9	42.1	0.143	10.48	0.95	14.4	1.30
AL-7	90% -150 mesh	Grind series	0.329	75.7	55.0	0.080	11.57	1.05	21.6	1.95
AL-8	90% -270 mesh	Grind series	0.315	75.8	55.1	0.076	11.46	1.04	17.4	1.57
AL-9	90% -400 mesh	Grind series	0.328	76.8	55.8	0.076	11.63	1.05	23.00	2.08

Note: Average direct fire assays of feed sample = 0.322 oz Au/ton
[1] Based on leach feed (Flotation Test #19, rougher concentrate).
[2] Based on whole ore.

Table 18

Summary of Gemeni Tailings
Leaching Results

Test No.	Feed: Regrind Size	Feed: Variable/ Condition	Feed: Calc'd Head, oz Au/t	24 Hr Au Dis., %[1]	Ore Basis Au Recovery, %[2]	Leach Residue, oz Au/t	Reagent Consumption, lb/t: NaCN Feed[1]	NaCN Ore[2]	CaO Feed[1]	CaO Ore[2]
AL-1	97% -65 mesh	Grind series	0.296	67.6	76.8	0.096	5.18	0.31	8.9	0.53
AL-2	98% -100 mesh	Grind series	0.345	64.6	78.2	0.122	4.09	0.25	13.4	0.80
AL-3	90% -200 mesh	Grind series	0.362	66.9	77.2	0.120	5.23	0.31	15.1	0.91
AL-4	86% -270 mesh	Grind series	0.336	77.4	72.2	0.076	5.26	0.32	14.4	0.86
AL-5	80% -400 mesh	Grind seried	0.325	78.8	71.5	0.069	6.89	0.41	9.7	0.58

Note: Average direct fire assays of feed sample = 0.322 oz Au/t.

[1] Based on leach feed (Flotation Test #19 Rougher Concentrate).

[2] Based on whole ore.

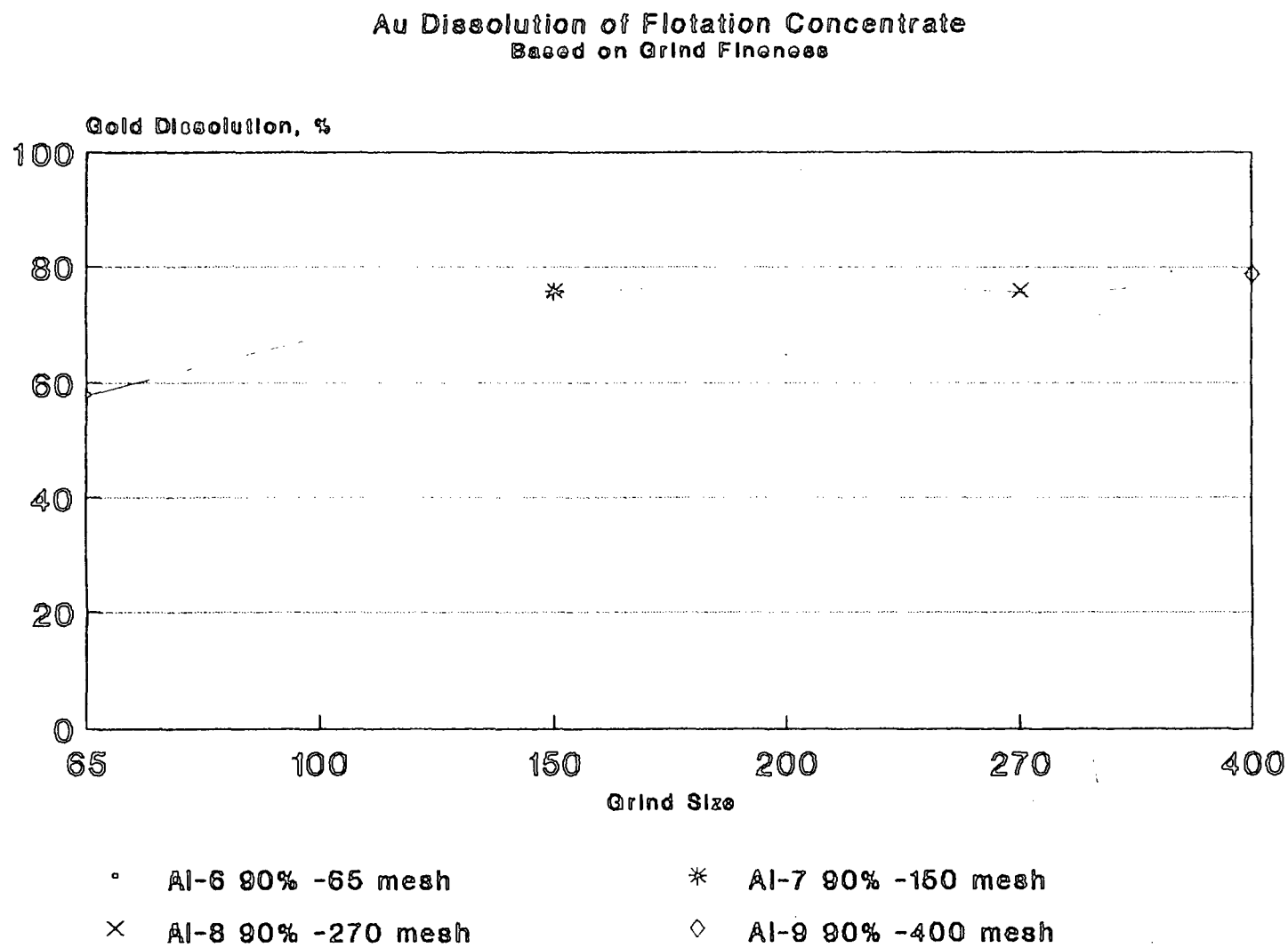
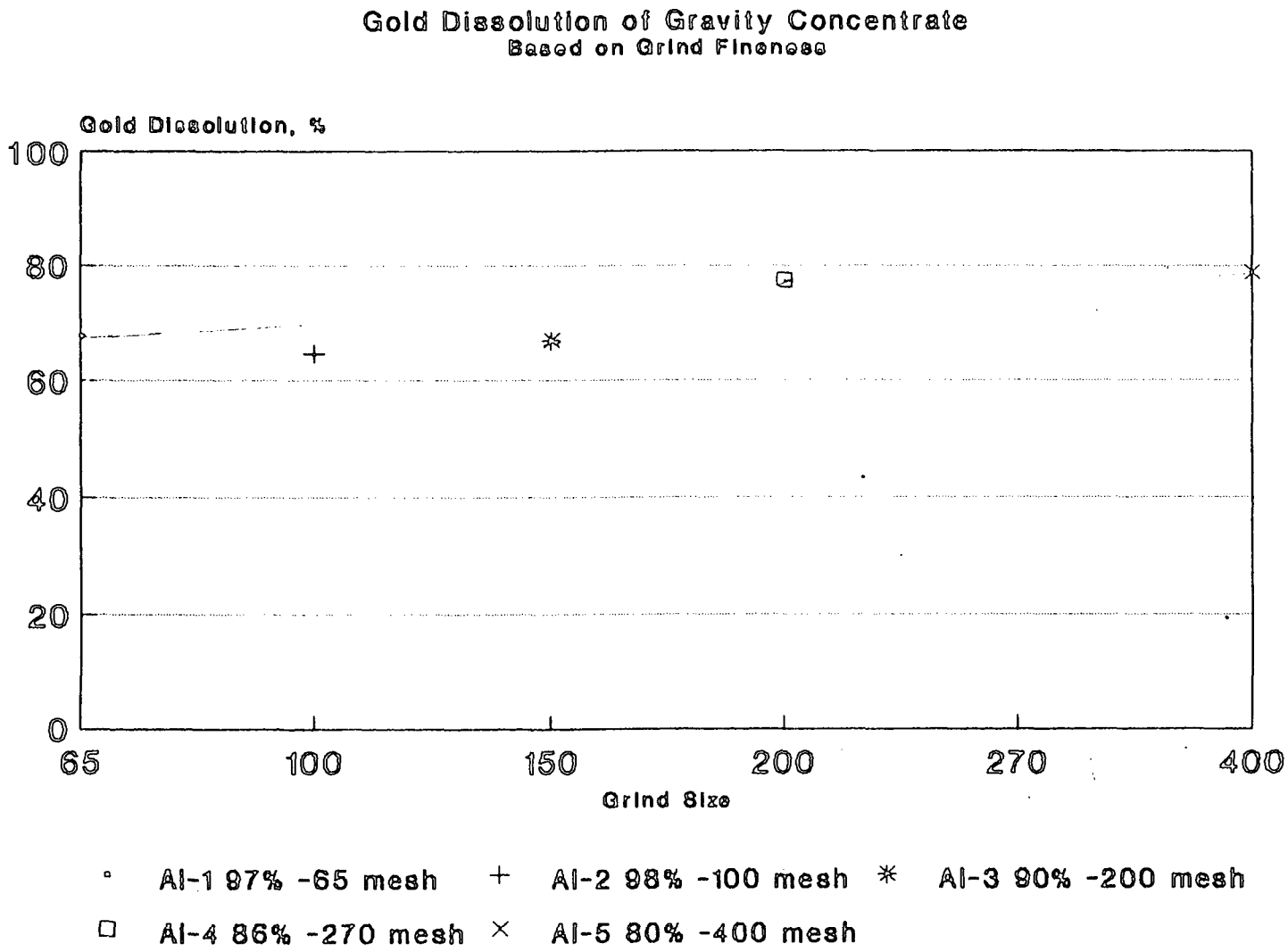


Figure 7

Project 7481



Project 7481

Figure 8

COMBINED GRAVITY AND FLOTATION CONCENTRATE

Leaching Tests

For confirmation, leaching tests were repeated on the combined gravity concentrate and flotation concentrate. Weight proportions (Table 19) were based on actual test metallurgical balances.

Table 19

Weight Proportion of Combined Concentrate

Concentrate	Weight %[1]	Weight Distribution, %
Gravity	6.0	55
Flotation	5.2	45
Total	11.2	100

[1] Ore basis.

Leaching results are shown in Table 20, and confirmed that the combined concentrate leaching behavior was no different than was that of the individual concentrate components. Gold dissolution was 76.2% based on a 0.072 oz Au/ton residue assay.

Concentrate Chemical Analyses

Chemical analyses are shown in Table 21 of a weighted composite of the gravity concentrate and flotation concentrate from the gravity tailings.

OXIDATIVE TREATMENTS

Different oxidative treatments were evaluated on the whole ore rougher flotation concentrate, largely as a diagnostic tool to see if it were possible to improve gold solubilities over typically 76% obtained without any such pretreatment.

The results (Table 22) showed that kiln roasting at 600°C and nitric acid preleaching were the only methods tested which resulted in significantly increased gold dissolutions of over 91%. The corresponding leach residues contained 0.034 oz Au/ton. Sodium cyanide consumptions were reasonable at about one lb/ton of ore equivalent for both oxidative methods.

Roasting at 750°C recovered only 65.2% of the gold. It was possible that an over-roasted condition occurred at this temperature, which would cause excessive impervious hematite to form, thereby impeding cyanide solution diffusion in the particles.

None of the other oxidative treatments, which were much less severe than thermal or HNO_3, resulted in any significant improvement in gold dissolution over that obtained without any pretreatment.

Although roasting and nitric acid leaching were effective in causing significant improvements in gold recoveries, experience would indicate that these methods might not be economically viable for treating such low grade ores.

Note that pressure oxidation tests were not conducted here, these tests apparently having been conducted previously by other investigators.

Table 20

Summary of Leaching Tests on Combined Gravity Tailings
and Rougher Flotation Concentrate

Test No.	Feed: Regrind Size	Feed: Variable/ Condition	Feed: Calcds Head, oz Au/t	24 Hr Au Dis., %[1]	Ore Basis Au Recovery, %[2]	Leach Residue, oz Au/t	Reagent Consumption, lb/t: NaCN Feed[1]	NaCN Ore[2]	CaO Feed[1]	CaO Ore[2]
AL-17	80% -200 mesh	F-24 Rou. conc.	0.263	77.9	51.7	0.058	14.97	0.78	11.9	0.62
AL-18	80% -200 mesh	F-25 Rou. conc.	0.262	77.1	51.7	0.060	15.90	0.82	12.4	0.65
AL-19	80% -200 mesh	55% Gemeni Tail 45% F-19 Ro conc.	0.303	76.2	--	0.072	10.80	--	7.5	--

[1] Based on leach feed.
[2] Based on whole ore.

Table 21

Concentrate Chemical Analyses[1]

Element	Assays
Au, oz/ton	0.30
Ag, oz/ton	0.75
$S_{(T)}$, %	41.2
Fe, %	35.3
C(T), %	0.21
Cu, %	0.177
Pb, %	0.072
Zn, %	0.037
Mn, %	0.024
Se, ppm	6.2
Hg, ppm	1.1
F, %	0.19
Bi, %	0.036
Co, %	0.021
Ni, %	0.011
Cd, %	<0.001
CaO, %	0.395
MgO, %	0.124
K_2O, %	1.75
Na_2O, %	0.388
Al_2O_3, %	3.08

[1] Weighted composite of gravity concentrate and flotation concentrate from gravity tailngs, i.e., CIL feed.

Table 22

Oxidative Treatment/Leaching Results

Test No.	Feed: Regrind Size	Feed: Variable/ Condition	Feed: Calc'd Head, oz Au/t	24 Hr Au Dis., %[1]	Ore Basis Au Recovery, %[2]	Leach Residue, oz Au/t	Reagent Consumption, lb/t: NaCN Feed[1]	NaCN Ore[2]	CaO Feed[1]	CaO Ore[2]
AL-10	80% -200 mesh	Roasted @ 600°C	0.392	91.3	66.4	0.034	13.14	1.19	35.2	3.18
AL-11	↓	Roasted @ 750°C	0.378	65.2	47.4	0.126	6.00	0.54	25.8	2.33
AL-12	↓	HNO_3 Preleach	0.433	92.1	67.0	0.034	22.34	2.02	43.8	3.96
AL-13	↓	Chlorination	0.265	74.3	54.0	0.068	7.82	0.71	28.8	2.60
AL-14	↓	$Pb(NO_3)_2$	0.289	76.5	55.6	0.068	10.38	0.94	14.7	1.33
AL-15	↓	O_2 Pre-aeration	0.313	78.9	57.4	0.066	13.33	11.21	29.1	2.63
AL-16	↓	NaOH	0.297	76.4	55.5	0.070	11.84	1.07	N/A	N/A

Note: Average direct fire assays of feed sample = 0.322 oz Au/t.

[1] Based on leach feed (Flotation Test #19 Rougher Concentrate).

[2] Based on whole ore.

HOMESTAKE WATER SAMPLES

Two water samples of Homestake (Lead) process tailings water were received at Hazen from Brohm. One sample was collected by Homestake from the floating barge in the treated impoundment area; whereas, the other sample was untreated water, i.e., prior to biological detoxification.

CHEMICAL ANALYSES

Hazen was requested to conduct confirming chemical analyses on both water samples for total and cyanide specification, various heavy metals, and other components such as pH, nitrate, sulfate, total dissolved solids, etc. Both treated and untreated water were used for flotation tests, in place of Hazen tap water, for whole ore flotation and flotation of gravity tailings. The filtrate from the rougher flotation tailings were then analyzed for the same components as noted above. The results of all chemical assays are shown in Table 23.

Note that analytical samples removed for various cyanide assays from both Homestake water samples were preserved at pH >12 with NaOH to prevent any further degradation. The samples as-received from Homestake did not appear to be preserved in any way, therefore, it was possible that some degradation of cyanide could have occurred from the time the samples were collected on-site. Hazen also was provided with copies of Homestake Grizzly Gulch barge impoundment (treated) water sample assays so that a real time profile of the chemical composition of the water could be made. Water analyses apparently can vary significantly seasonally. The as-received data are shown for reference in the Appendix.

FLOTATION TESTS

Rougher flotation tests were performed on whole ore and gravity tailings to determine if use of either the Homestake treated or untreated water would have any deleterious effects.

The results, summarized in Table 24, showed that gold grades and recoveries with either Homestake water sample were comparable to those obtained in earlier work with Hazen lab tap water.

Table 23

Homestake Water Assays

Determination	Untreated	Treated	F-27 Treated	F-28 Untreated	F-29 Treated	F-30 Untreated
As	(0.084)	0.028	0.003	0.003	0.004	0.004
Ba	3.45	0.05	0.01	0.01	0.13	0.11
Cd	0.002	<0.001	0.002	0.001	0.018	0.013
Cr	0.02	<0.01	N/A	N/A	0.03	0.07
Cu	1.04	0.01	0.04	0.01	0.03	0.07
Pb	(0.013)	0.001	0.008	0.005	<0.05	<0.05
Se	0.002	0.024	0.067	0.031	0.021	0.048
Ag	0.02	0.001	<0.01	0.02	<0.01	<0.01
Hg	<0.1	<0.1	0.8	0.1	<0.005	<0.005
SCN	311.0	<0.1	1.0	193.0	<0.1	1.52
CNO	<1.0	<1.0	<0.5	<0.5	<1.0	12.8
Free CN	1.19	<0.5	<0.5	<0.5	<0.10	<0.10
WAD CN	0.20	0.062	0.01	0.17	0.03	0.06
$CN_{(T)}$	0.24		0.01	0.17	0.0t	0.12
TDS	2,370	1,630	N/A	N/A	1,300	1,670
N	4.0	21.5	N/A	N/A	13.2	2.9

Note: All assays in mg/l.

Table 24

Summary of Flotation Results Using
Homestake Treated and Untreated Water

Flotation Test No.	Feed: Grind Size	Feed: Variable/ Condition	Feed: Calculated Head, oz Au/t	Rougher Concentrate: Wt. %	Rougher Concentrate: Assay, oz Au/t	Rougher Concentrate: % Dist. Au: Feed[1]	Rougher Concentrate: % Dist. Au: Whole[2] Ore	Rougher Tailings, oz Au/t
F-26	82.5% -100 mesh	Whole ore, treated H_2O	0.039	12.40	0.257	82.0	--	0.008
F-27	82.5% -100 mesh	Whole ore, treated H_2O	0.043	9.78	0.373	85.2	--	0.007
F-28	82.5% -100 mesh	Whole ore, untreated H_2O	0.046	9.56	0.414	86.2	--	0.007
F-29	81.9% -100 mesh	Gravity tails, treated H_2O	0.021	4.86	0.276	65.3	80.7	0.008
F-30	81.9% -100 mesh	Gravity tails, untreated H_2O	0.021	4.27	0.324	67.3	79.8	0.007

[1] Feed to flotation, i.e., based on gravity tailings.
[2] Based on whole ore.

TAILINGS DETOXIFICATION

In an earlier Hazen Project (HRI 7407) conducted for Brohm (per Bechtel), scoping tests were performed to detoxify the residual cyanide in the combined concentrate and tailings leached slurries using ferrous sulfate. Roberts & Schaefer requested that we include the results of that work here for completeness, since the data were to be used as part of their study for Brohm.

Bechtel previously had requested that ferrous sulfate only be investigated as a reagent for cyanide destruction. This was done on the leached residues form gravity concentrate and tailings cyanidation. The gravity tailings CIL flowsheet was abandoned in the current work in favor of flotation.

Hazen was instructed to conduct the test at a slurry density of 40% solids and with the free cyanide level adjested by water dilution to approximately 200 ppm, versus the original leach free CN^- content of approximately 1000 ppm. The Fe-to-CN^- ratios were varied from 0.25 to two times the stoichiometric requirements and reaction time was five minutes. Some of the tests were repeated for 24 hours. The objective of the work was to achieve a treated and filtered free CN^- level of less than 20 ppm.

Hazen noted at the time that ferrous sulfate would complex only free cyanide to ferrocyanide. Ferrous sulfate would have little or no effect on destruction of total cyanide, weak or strongly complexed cyanicides, or thiocyanate or cyanate.

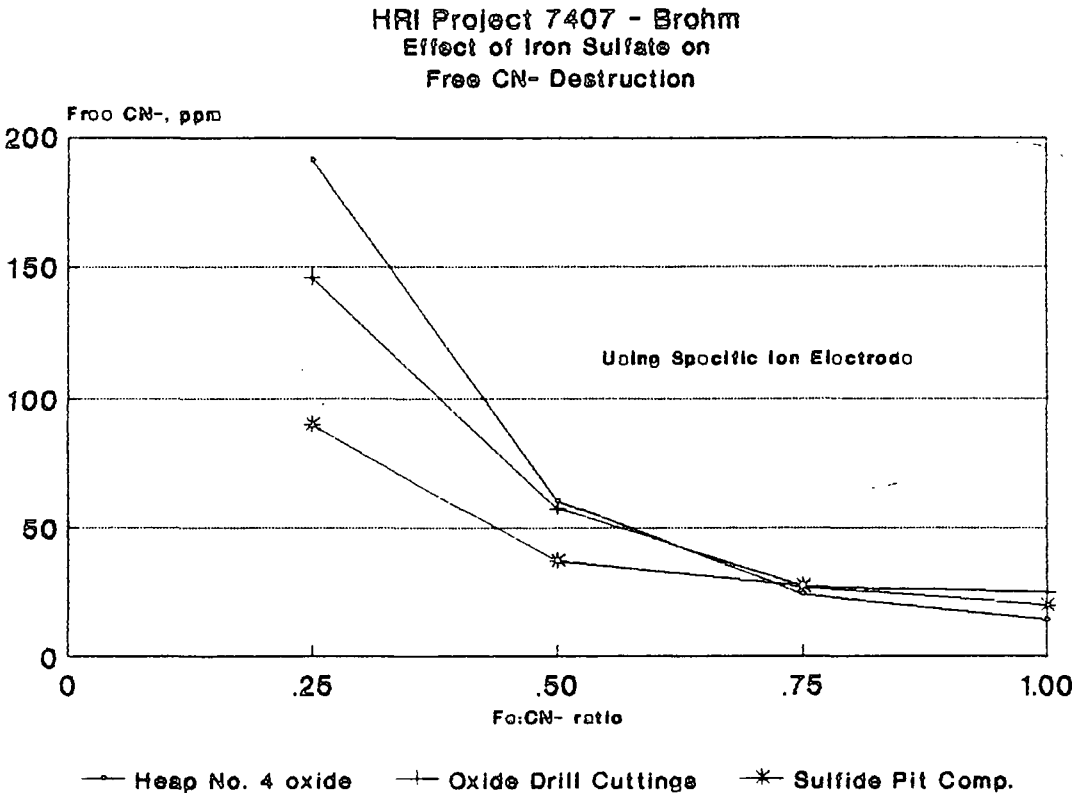
Test data are shown in Table 25 and graphically in Figure 9. The tests showed that a Fe/CN^- ratio of approximately 0.75 to 1 resulted in free CN^- levels of less than 20 ppm for the three ore samples tested. Reaction times were rapid, with five minutes being sufficient at the above-noted Fe/CN^- ratios.

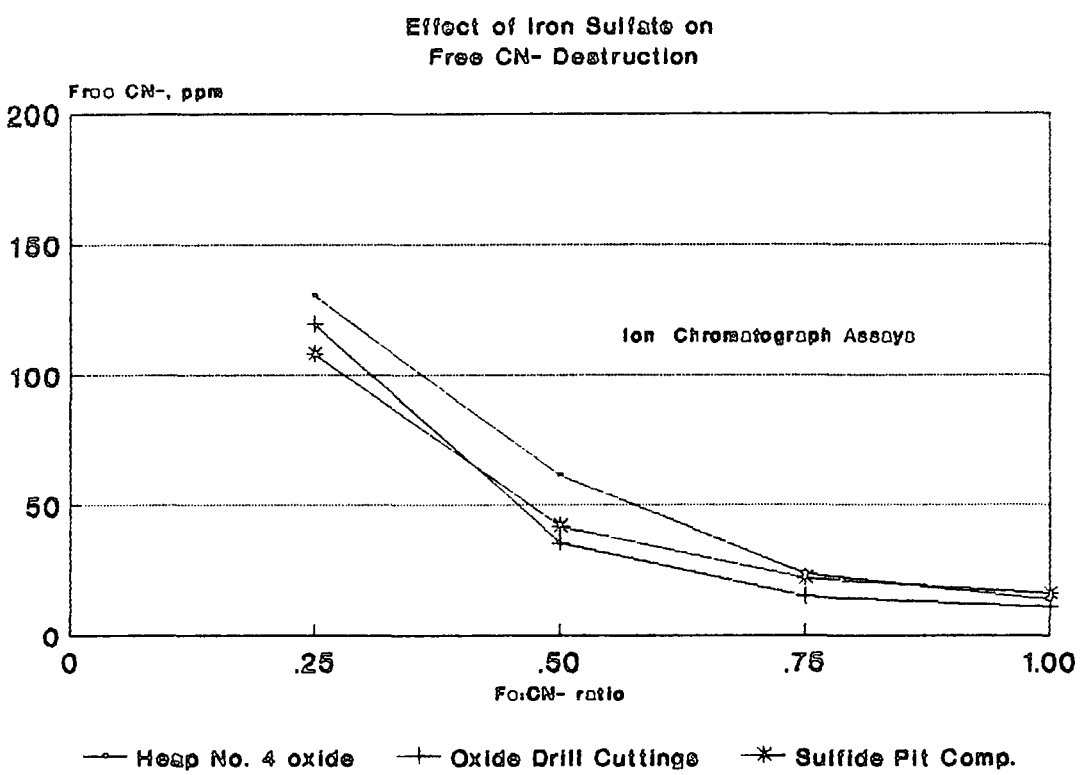
Table 25

Cyanide Destruction Results
(Ferrous Sulfate)

Sample Description	Fe:CN	pH	Specific Ion, ppm	Lab Assay[1/] ppm
Al-1+5, 200 ppm feed		11.54	216	178
Al-1+5, 5 min	0.25:1	11.60	191	130
Al-1+5, 5 min	0.50:1	11.60	61	27.2
Al-1+5, 5 min	0.75:1	11.55	24	10.4
Al-1+5, 5 min	1:1	11.50	14	5.5
Al-1+5, 5 min	2:1	11.40	26	3.8
Al-1+5, 24 hour	0.25:1	11.50	73	127
Al-1+5, 24 hour	0.50:1	11.50	30	24.7
Al-1+5, 24 hour	0.75:1	11.50	10	10.5
Al-1+5, 24 hour	1:1	11.55	5	6.2
Al-1+5, 5 min slurry	1:1	11.60	8	10.2
Al-1+5, 24 hr slurry	1:1	11.60	5	9.5
Al-3+7, 200 ppm feed	1:1	11.70	176	163
Al-3+7, 5 min	0.25:1	11.6	146	119
Al-3+7, 5 min	0.50:1	11.60	58	35.8
Al-3+7, 5 min	0.75:1	11.55	27	15.4
Al-3+7, 5 min	1:1	11.55	25	11.4
Al-3+7, 24 hour	0.25:1	11.55	154	116
Al-3+7, 24 hour	0.50:1	11.50	29	25.2
Al-3+7, 24 hour	0.75:1	11.55	10	13.2
Al-3+7, 24 hour	1:1	11.50	7	9.5
Al-3+7, 5 min slurry	1:1	11.50	8	11.7
Al-3+7, 24 hr slurry	1:1	11.50	13	10.9
Al-10+12, 200 ppm feed		11.80	145	130
Al-10+12, 5 min	0.25:1	11.65	90	108
Al-10+12, 5 min	0.50:1	11.65	37	41.7
Al-10+12, 5 min	0.75:1	11.60	27	22.4
Al-10+12, 5 min	1:1	11.60	20	16.6
Al-10+12, 24 hour	0.25:1	11.50	89	89.1
Al-10+12, 24 hour	0.50:1	11.50	19	23.5
Al-10+12, 24 hour	0.75:1	11.50	11	15.1
Al-10+12, 24 hour	1:1	11.50	9	10.6
Al-9+11, 5 min slurry	1:1	11.80	24	24.9
Al-9+11, 24 hr slurry	1:1	11.65	13	17.6

1/ Ion chromatography


HRI Project 7407 - Brohm
Effect of Iron Sulfate on
Free CN- Destruction
Free CN-, ppm
200
150
100
50
0
0
.25
.50
.75
1.00
Fe:CN- ratio
Using Specific Ion Electrode
Heap No. 4 oxide
Oxide Drill Cuttings
Sulfide Pit Comp.


Effect of Iron Sulfate on
Free CN- Destruction
Free CN-, ppm
200
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.25
.50
.75
1.00
Fe:CN- ratio
Ion Chromatograph Assays
Heap No. 4 oxide
Oxide Drill Cuttings
Sulfide Pit Comp.

Figure 9

OVERALL METALLURGICAL BALANCES AND PROCESS COMPARISON

Overall ore basis metallurgical results for the three flowsheets examined in the Brohm work are summarized in Table 27. A more succinct summary follows in Table 26.

Table 26

Overall Process Comparison

	Combined NaCN		
Flowsheet	Total Au[1] Recovery, %	Tailings[2] oz Au/t	Consumption lb/t ore
Gravity/All Leach	72.7	0.012	1.64
Gravity/Flotation/Leach	69.7	0.013	1.19
Flotation/Leach	66.2	0.014	1.26

1 All recoveries are based on a normalized head assay of 0.044 oz Au/ton.
2 Based on mathematical combination of concentrate leach reside and flotation tailings or gravity tailing leach residue.

The gravity/all leach (per Bechtel) flowsheet yielded the highest overall gold recovery of 72.7%, but at the expense of more extensive cyanidation and carbon handling, along with the need for detoxification of essentially 100% of the ore feed (less the free gold concentrate). Flowsheet 2 yielded a gold recovery of 69.7%, or three percentage points lower than for Flowsheet 1, but Flowsheet 2 has the great advantage of not needing to detoxify the flotation tailings which represent almost 90% of the weight of ore feed.

Flowsheet 3 gave the lowest overall gold recovery of only 66.2%, the difference between this recovery and that of Flowsheet 2 being attributed essentially to the free gold recovery in the Gemeni concentrate.

Based on these results, Flowsheet 2 would be the preferred on offering the highest gold recovery for less extensive processing requirements.

A more detailed presentation of overall metallurgical data for the three flowsheets is shown in Tables 28 through 30.

Table 27

Comparison of Overall Metallurgical Results
with Three Process Flowsheets

Flowsheet	Gemeni Conc. Au Recov. %	Gravity Concentrate Au Dist., %	Gravity Concentrate Leach Recovery % Conc.	Gravity Concentrate Leach Recovery % Ore	Gravity Tailings Au Dist., %	Gravity Tailings Leach Recovery % Conc.	Gravity Tailings Leach Recovery % Ore	Flotation Concentrate Au Dist., %	Flotation Concentrate Flot. Recov. %	Flotation Concentrate Leach Recovery % Conc.	Flotation Concentrate Leach Recovery % Ore	Total Ore Basis Gold Recov. %	Total NaCN Consump. lb/t ore
Gravity/All Leach (per Bechtel)	12.9	43.4	76.2	33.1	41.1	64.9	26.7					72.7	1.64
Gravity/Flotation/ Leach	9.0	47.6	77.4	36.8				43.4	31.4	76.2	23.9	69.7	1.19
Flotation/Leach								100.0	86.0	76.8	66.2	66.2	1.26

Note: 1. Total recoveries are based on:
Flowsheet 1 - Gemeni concentrate + gravity concentrate leach + gravity tailings leach.
Flowsheet 2 - Gemeni concentrate + gravity concentrate leach + flotation concentrate leach.
Flowsheet 3 - Flotation concentrate leach.

2. All data are based on normalized head assay of 0.044 oz Au/ton.

Table 28

Gravity/All Leach
(Ref: 7245 Test 6)

2.	Gemeni Conc. Au Recovery:	12.9% of total
3.	Gemini Tailings:	
	◦ Wt %:	6.11
	◦ oz Tu/ton	0.32
	◦ Au Dist.:	43.4% of total
	Leach:	
	◦ Au Recovery:	
	Conc.	76.2%
	Ore	33.1%
	◦ Residue	0.076 oz Au/ton
	◦ NaCN Consump.,	
	lb/ton: Conc.	5.4
	Ore	0.33
4.	Table Tailings	
	◦ Wt. %:	93.88
	◦ oz Au/to:	0.022
	◦ Au Dist.:	41.1% of total
	Leach:	
	◦ Au Recovery:	
	Tails:	64.9%
	Ore	26.7%
	◦ Residue:	0.008 oz Au/ton
	◦ NaCN Consump.,	
	lb/ton: Tails:	1.4
	Ore	1.31
	Total NaCN Consump.	1.64 lb/ton ore
5.	Combined Tailings:	0.012 oz Au/ton
	Au Dist.:	27.3%
6.	Total Au Recovery:	12.9% Gemeni
		33.1% Grav. Conc. Leach
		26.7% Tail Leach
		72.7%

Flotation Conc. Leach

- Au Recovery:
  Conc.: 76.2
  Ore: 23.9

Residue: 0.060 oz Au/ton

NaCN Consump.,
lb/ton: Conc.: 15.9
Ore: 0.78
Total NaCN Consump: 1.19 lb/ton ore

5. Combined Tailings:

Grav. Conc. Leach	6.00	0.076	36
Flot. Conc. Leach	4.90	0.072	22
Flot. Tails	89.10	0.006	42
	100.0	0.013	100

6. Total Au Recovery:

9.0%	Gemeni
36.8%	Grav. Conc. Leach
23.9%	Flot. Conc. Leach
69.7%	of Total

Table 29

Metallurgical Data Gravity/All Leach
(Ref. 7481, TT-1, F-15, F-25, AL-5, Al-15, AL-19)

1.	Head:	0.044 oz Au/ton
2.	Gemeni Conc. Au Recovery:	9.0% of total (8 to 14% range)
3.	Gemini Tailings:	
	◦ Wt %:	6.00
	◦ oz Tu/ton	0.34
	◦ Au Dist.:	47.6% of total
	Leach:	
	◦ Au Recovery:	
	Conc.	77.4%
	Ore	36.8%
	◦ Residue	0.076 oz Au/ton
	◦ NaCN Consump., lb/ton: Conc.	6.9
	Ore	0.41
4.	Rougher Flotation Concentrate (Averaged F-25 & F-15)	
	Feed:	
	◦ Wt. %:	94.00
	◦ oz Au/ton:	0.020
	◦ Au Dist.:	43.4% of total
	Grind:	
	80% minus 100 mesh	
	Conc.:	
	◦ Wt. %:	5.21 (4.90% or ore)
	◦ oz Au/ton:	0.264
	◦ Au Recy:	72.3% flot. feed 31.4% of total
	Tailings:	
	◦ Wt. %:	89.1
	◦ oz Au/ton:	0.006
	◦ Au Dist.:	12.0% of total

Table 30

Metallurgical Data Flotation/Leach
(Ref. 7481 Test F-2, AL-9)

2.	Grind:	80% minus mesh
3.	Rougher Flotation:	
	Conc:	
	◦ Wt. %:	10.8
	◦ oz Au/ton:	0.342
	◦ Au Recy:	86% of total
	Tailings:	
	◦ Wt. %:	89.2
	◦ oz Au/ton:	0.007
	◦ Au Dist.:	14.0% of total
4.	Flotation Conc. Leach (Regrind - 90% minus 400 mesh)	
	◦ Au Recovery:	
	Conc.:	76.8%
	Ore:	66.2%
	Residue:	0.076 oz Au/ton
	NaCN Consump:	1.26 lb/ton ore, total
5.	Combined Tailings:	0.014 oz Au/ton
	Au Dist.:	33.8%
6.	Total Au Recovery:	
	Flotation Conc. Leach	66.2%

PROCESS CRITERIA

The following describes various process criteria which were used or have energed from this testwork for Flowsheet 2. Certain data and process recommendations, where necessary, were based on prior Hazen projects for Brohm.

GRINDING

1. Product sizing = 100% minus 10 mesh.

GRAVITY

The gravity processing criteria were established through testing at Hazen in this current work and by previous studies for Brohm under different Hazen project numbers. Additional consulting with engineers at Mineral Deposits (Americas), Inc., and at Roberts & Schaefer Company, provided further support for these criteria. The criteria was established as follows:

1. Feed is "gravity Circuit screen" undersize, minus 10 mesh, dewatered.

2. Gravity concentration requires primary circuit with concentrate going to final upgrade circuit. The primary circuit tailing product goes forward to flotation. The final upgrade circuit tailing goies to leaching while final concentrate goes to direct smelting.

3. The primary gravity circuit requires two stages of Reichert cones (rougher and cleaner) followed by one stage of primary spirals. Based on a feed grade of 0.044 oz Au/t, it is reasonable to expect a primary circuit tailing grade of 0.018 to 0.025 oz Au/t. Reichert cones should be fed at a solids density of 60 to 65% solids. The primary spirals should be fed at a density of 30 to 35% solids.

4. The final upgrade circuit requires two stages of spiral concentrators followed by final separation on a Gemeni shaking table. The cleaner and recleaner spiral should be operated at feed pulp densities of 25 to 30% solids.

FLOTATION

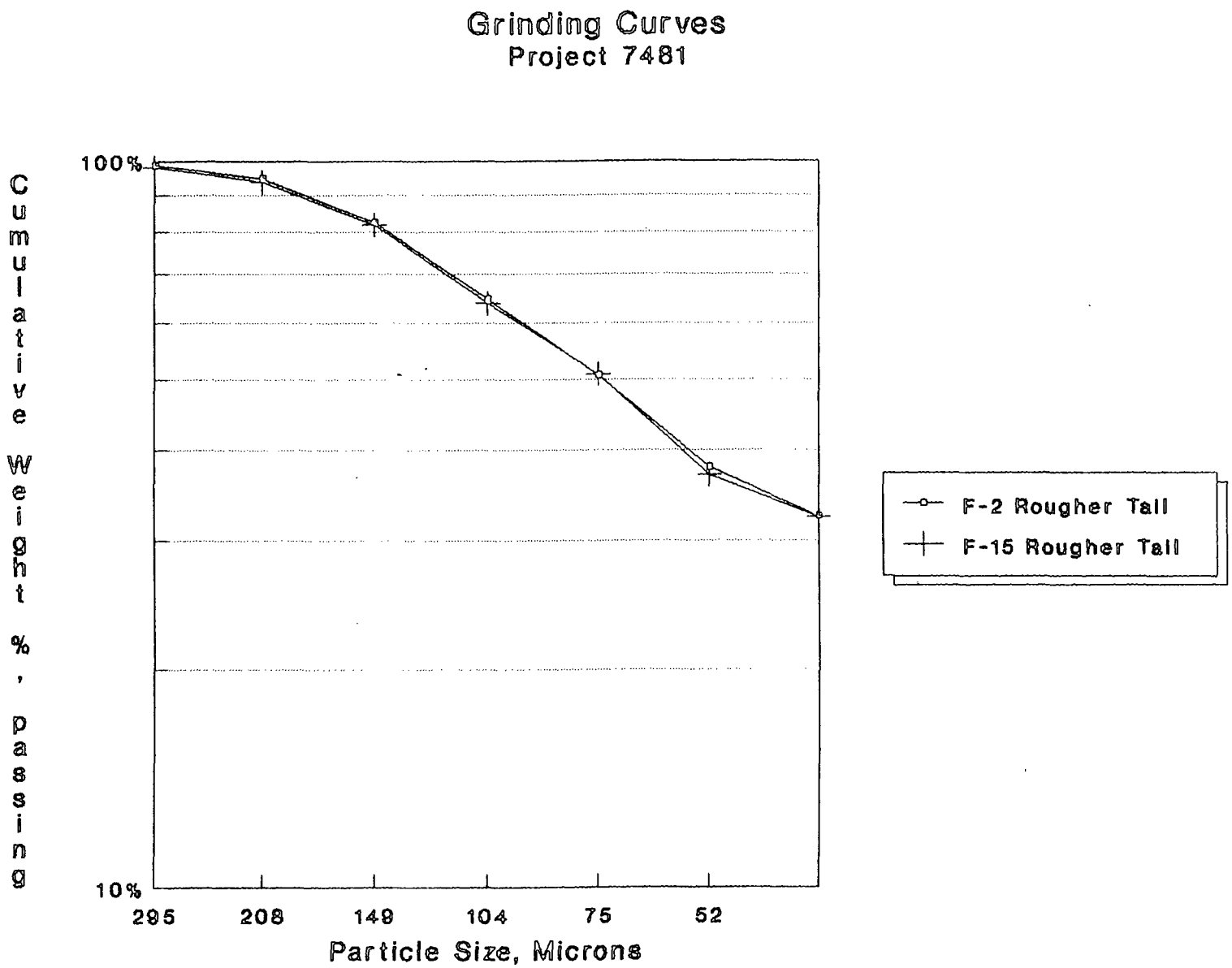
1. Feed is the Riechert cone tailings stream.
2. Grinding Product Sizing = 80% minus 100 mesh.
3. Screen Analysis of typical product is shown in Figure 10.

4. Flotation

a. % Solids =	34
b. Retention time =	15 minutes, laboratory basis, no scaleup factor applied
c. Reagents:	multi-stage additions; refer to Table 16
d. pH =	± 6 (no adjustments)
e. Product	= combined rougher concentrate

CONCENTRATE LEACHING

1.	Feed =	combined Gemeni tailings plus rougher flotation concentrate
2.	Regrind =	90% minus 400 mesh
3.	% Solids =	40
4.	Preaeration =	20 minutes at pH 12 with lime
5.	NaCN =	2.5 g/l = 3.75 lb/ton of concentrate
6.	CaO =	maintain >1.0 g/l, pH >12
7.	Carbon =	30 g/l of slurry, 6 x 14 mesh
8.	Time =	12 hours
9.	Aeration =	continuous



Hazen Research, Inc.

Figure 10

APPENDICES

HAZEN PROJECT 7452

Data Sheets

HAZEN RESEARCH
TABLE TEST METALLURGICAL RESULTS

TEST NO.: TT-1 PROJECT NO.: 7452

ORE: Client identified "0.03 sulfide". HRI Sample No. 44343-1.

PURPOSE: To produce gravity tails to do flotation studies on.

PROCEDURE: A 60 kg.sample was ground in 10 kg. batches in a 12x15" steel ball mill. Each batch was then screened at 10 mesh and the +10 mesh fraction was reground in a 5x12" steel ball mill. All batches were recombined and passed over a pilot scale Wilfley Table, recycling the middlings. The Wilfley table concentrate was run on a Gemini table to remove the free gold.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS, oz/ton, Au	ASSAYS, oz/ton, Ag	mg, Au	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
Ro Table Concentrate (calculated)	(3779.4)	(6.4)	(0.433)	(0.609)	(56.15)	(59.6)	(34.1)
C1 (Gemini) Table Conc.	1.78	< 0.1	189.968	65.51	11.60	12.3	1.7
C1 (Gemini) Table Tailing	3777.62	6.4	0.344	0.58	44.55	47.3	32.4
Ro (Wilfley) Table Tailing	55600.00	93.6	0.020	0.08	37.78	40.4	65.9
HEAD, CALC'D	59379	100.00	0.046	0.114	94.28	100.0	100.0
HEAD, DIRECT			0.046	0.087	93.65	-	

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 1

PROJECT NO.: 7452
TEST DATE: 8/28/90

PURPOSE: FLOTATION OF GRAVITY TAILINGS - "0.03 sulfide"

ORE: HRI NO. 44348-1 Table Test 1 Hilfley tails.

GRIND: 93.8 % -200 mesh: 40 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	12.70	0.65	0.804	2.43	25.6	15.2
2. Rougher concentrate 2	27.66	1.41	0.372	1.11	25.8	15.1
3. Rougher concentrate 3	17.97	0.92	0.134	0.54	6.0	4.8
4. Rougher concentrate 4	10.56	0.54	0.116	0.70	3.1	3.6
5. Rougher concentrate 5	63.35	3.24	0.076	0.24	12.1	7.5
6. Rougher tailing	1,825.77	93.25	0.006 ⁸	0.06	27.5	53.9
HEAD, CALC'D	1,958.01	100.00	0.020	0.104	100.0	100.0
HEAD, DIRECT			0.020	0.080		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	2.06	0.508	1.525	51.4	30.3
5 minute rougher	1 to 3	2.98	0.393	1.222	57.4	35.0
7 minute rougher	1 to 4	3.52	0.350	1.142	60.5	38.7
13 minute rougher	1 to 5	6.75	0.219	0.710	72.5	46.1

⁸ Average of three 2 assay ton fire assays.

	Au	Ag
Split A:	0.007	0.06
Split B:	0.006	0.04
Split C:	0.006	0.08

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 2

PROJECT NO.: 7452
TEST DATE: 8/28/90

PURPOSE: FLOTATION OF GRAVITY TAILINGS - "0.03 sulfide"

ORE: HRI NO. 44348-1 Table Test 1 Wilfley tails.

GRIND: 97.8 % -100 mesh: 20 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	38.90	1.94	0.474	1.14	45.3	28.0
2. Rougher concentrate 2	23.86	1.19	0.256	0.86	15.0	12.9
3. Rougher concentrate 3	9.34	0.47	0.084	0.59	1.9	3.5
4. Rougher concentrate 4	8.28	0.41	0.073	0.44	1.5	2.3
5. Rougher concentrate 5	33.53	1.68	0.046	0.27	3.8	5.7
6. Rougher tailing	1,886.30	94.31	0.007 8	0.04	32.5	47.6
HEAD, CALC'D	2,000.21	100.00	0.020	0.079	100.0	100.0
HEAD, DIRECT			0.020	0.080		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	3.14	0.391	1.034	60.3	40.9
5 minute rougher	1 to 3	3.60	0.351	0.976	62.3	44.4
7 minute rougher	1 to 4	4.02	0.323	0.921	63.8	46.7
13 minute rougher	1 to 5	5.69	0.241	0.729	67.5	52.4

8 Average of three 2 assay ton fire assays.

	Au	Ag
Split A:	0.007	0.04
Split B:	0.007	0.04
Split C:	0.007	0.04

FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 3 PROJECT NO.: 7452

ORE: 2000 grams TT-1 tails, 44348-1 "sulfide 0.03".

GRIND: 20 minutes at 65% solids, 97.3% -100 mesh.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS, oz/ton Au	ASSAYS, oz/ton Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. 1st cleaner concentrate	37.98	1.88	0.436	1.17	40.8	42.8
2. 1st cleaner tail	73.25	3.63	0.120	0.55	21.7	38.8
3. Rougher tail	1,904.58	94.48	0.008*	0.01	37.5	18.4
HEAD, CALC'D	2,015.81	100.00	0.020	0.051	100.0	100.0
HEAD, DIRECT			0.020	0.080		
CALCULATED PRODUCTS						
	1 and 2	5.52	0.228	0.762	62.5	81.6

* Average of three 2 assay ton fire assays.

	Au	Ag
Split A:	0.007	0.03
Split B:	0.008	0.01
Split C:	0.008	0.01

FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 4 PROJECT NO.: 7452

ORE: 2000 grams TT-1 tails, 44348-1 "sulfide 0.03".

GRIND: 40 minutes at 65% solids, 93.8% -200 mesh.

CONDITIONS: Ax-350, Ap-242, $CuSO_4$, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS, oz/ton Au	ASSAYS, oz/ton Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. 1st cleaner concentrate	55.19	2.76	0.456	1.11	57.3	35.3
2. 1st cleaner tail	118.32	5.91	0.066	0.33	17.8	22.5
3. Rougher tail	1,829.33	91.34	0.006*	0.04	25.0	42.2
HEAD, CALC'D	2,002.84	100.00	0.022	0.087	100.0	100.0
HEAD, DIRECT			0.020	0.080		
CALCULATED PRODUCTS						
	1 and 2	8.66	0.190	0.578	75.0	57.8

* Average of three 2 assay ton fire assays.

	Au	Ag
Split A:	0.005	0.04
Split B:	0.008	0.04
Split C:	0.004	0.05

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 5

PROJECT NO.: 7452
TEST DATE: 8/30/90

PURPOSE: FLOTATION OF WHOLE ORE - "0.03 sulfide"

ORE: HRI NO. 44348-1

GRIND: 81.1 % -100 mesh: 22 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	100.12	4.99	0.424	0.86	48.4	50.8
2. Rougher concentrate 2	57.46	2.86	0.420	0.76	27.5	25.8
3. Rougher concentrate 3	30.76	1.53	0.202	0.43	7.1	7.8
4. Rougher concentrate 4	10.75	0.54	0.080	0.22	1.0	1.4
5. Rougher concentrate 5	42.32	2.11	0.034	0.12	1.6	3.0
6. Rougher concentrate 6	10.01	0.50	0.028	0.15	0.3	0.9
7. Rougher tailing	1,755.23	87.47	0.007 8	0.01	14.0	10.4
HEAD, CALC'D	2,006.65	100.00	0.044	0.08	100.0	100.0
HEAD, DIRECT			0.046	0.09		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	7.85	0.423	15.305	76.0	76.6
5 minute rougher	1 to 3	9.39	0.387	18.437	83.0	84.4
7 minute rougher	1 to 4	9.92	0.370	19.580	84.0	85.8
11 minute rougher	1 to 5	12.03	0.311	24.101	85.7	88.8
13 minute rougher	1 to 6	12.53	0.300	25.257	86.0	89.6

8 Average of three 2 assay ton fire assays.

	Au	Ag
Split A:	0.007	0.01
Split B:	0.006	0.01
Split C:	0.008	0.02

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: F-6

PROJECT NO.: 7452
TEST DATE: 8/30/90

PURPOSE: FLOTATION OF WHOLE ORE - "0.03 sulfide"

ORE: HRI NO. 44348-1

GRIND: 90.3 % -200 mesh: 42 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	122.95	6.18	0.386	0.60	51.3	46.7
2. Rougher concentrate 2	69.11	3.47	0.412	0.78	30.8	34.1
3. Rougher concentrate 3	37.29	1.87	0.078	0.15	3.1	3.5
4. Rougher concentrate 4	13.38	0.67	0.072	0.23	1.0	1.9
5. Rougher concentrate 5	42.37	2.13	0.050	0.07	2.3	1.9
6. Rougher concentrate 6	20.72	1.04	0.024	0.09	0.5	1.2
7. Rougher tailing	1,683.53	84.63	0.006 &	0.01	10.9	10.7
HEAD, CALC'D	1,989.35	100.00	0.047	0.08	100.0	100.0
HEAD, DIRECT			0.046	0.09		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	9.65	0.395	16.233	82.1	80.8
5 minute rougher	1 to 3	11.53	0.344	19.488	85.2	84.3
7 minute rougher	1 to 4	12.20	0.329	20.846	86.3	86.3
11 minute rougher	1 to 5	14.33	0.287	24.371	88.5	88.2
13 minute rougher	1 to 6	15.37	0.270	26.332	89.1	89.3

& Average of three 2 assay ton fire assays.

	Au	Ag
Split A:	0.006	0.01
Split B:	0.006	0.01
Split C:	0.007	0.02

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 7

PROJECT NO.: 7452
TEST DATE: 9/6/90

PURPOSE: FLOTATION OF GRAVITY TAILINGS - "0.03 sulfide"

ORE: HRI NO. 44348-1 Table Test 1 Hilfley tails.

GRIND: 79% -100 mesh: 10 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	33.33	1.65	0.448	1.06	36.7	17.9
2. Rougher concentrate 2	23.90	1.19	0.322	0.98	18.9	11.9
3. Rougher concentrate 3	13.96	0.69	0.152	0.64	5.2	4.5
4. Rougher concentrate 4	7.90	0.39	0.126	0.61	2.4	2.4
5. Rougher concentrate 5	27.37	1.36	0.058	0.37	3.9	5.1
6. Rougher tailing	1,907.78	94.71	0.007 8	0.06	32.8	58.1
HEAD, CALC'D	2,014.24	100.00	0.020	0.098	100.0	100.0
HEAD, DIRECT			0.020	0.080		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	2.84	0.395	1.027	55.6	29.8
5 minute rougher	1 to 3	3.53	0.348	0.951	60.8	34.3
7 minute rougher	1 to 4	3.93	0.326	0.917	63.3	36.8
13 minute rougher	1 to 5	5.29	0.257	0.776	67.2	41.9

8 Average of three 2 assay ton fire assays.

Split A:	0.007	0.05
Split B:	0.007	0.06
Split C:	0.006	0.08

FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 8 PROJECT NO.:

ORE: 2 kg. 44348-1, "0.03 sulfide", whole ore.

GRIND: 20 minutes at 65% solids in the 5x12" steel ball mill. 81.1% -100 mesh.

CONDITIONS: Ax-350, Ap-242, $CuSO_4$, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS, oz/ton Au	ASSAYS, oz/ton Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. 2nd cleaner concentrate	139.66	7.05	0.442	0.91	82.1	68.2
2. 2nd cleaner tail	18.83	0.95	0.160	0.70	4.0	7.1
3. 1st cleaner tail	82.27	4.15	0.064	0.35	7.0	15.4
4. Rougher tail	1,741.08	87.85	0.003	0.01	6.9	9.3
HEAD, CALC'D	1,981.84	100.00	0.038	0.094	100.0	100.0
HEAD, DIRECT			0.046	0.09		
CALCULATED PRODUCTS						
	1 and 2	8.00	0.408	0.885	86.1	75.2
	1 to 3	12.15	0.291	0.702	93.1	90.7

Flotation Test Report

TEST No: F-1 PROJECT NO: 7452 OPERATOR: SM DATE: 3/29/90

PURPOSE: To evaluate Au and Ag recovery by rougher flotation of Wilfley table tails.

PROCEDURE: Follows

FEED: 2000 grams TT-1 tails, 44348-1 "0.03 sulfide".

GRIND: 40 minutes at 65% solids in the 5x12" steel ball mill. 93.8% -200 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					40			6.4
Rougher (1)	0.03	0.03	0.15	0.02		2+1	1	6.4
Rougher (2)				0.01			2	6.0
Rougher (3)	0.03	0.03		0.01		1	2	6.1
Rougher (4)							2	
Rougher (5)	0.03	0.03		0.01		1	2	
Rougher (6)				0.01			2	
Rougher (7)	0.03	0.03		0.005		1	2	
Rougher (8)				0.005			2	
Rougher (9)	0.03	0.03		0.005		1	2	6.1

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: Very slow pyrite float.
Rougher concentrate nos. 5 thru 9 were combined to form final (Ro conc. 5) concentrate.

TEST No: F-2 PROJECT NO: 7452 OPERATOR: SM DATE: 8/23/90

PURPOSE: To evaluate Au and Ag recovery by rougher flotation of Wilfley table tails.

PROCEDURE: Follows

FEED: 2000 grams TT-1 tails, 44348-1 "0.03 sulfide".

GRIND: 20 minutes at 65% solids in the 5x12" steel ball mill. 97.8% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					20			5.8
Rougher (1)	0.03	0.03	0.15	0.01		2+1	1	
Rougher (2)				0.01			2	
Rougher (3)	0.03	0.03		0.01		1	2	
Rougher (4)				0.01			2	
Rougher (5)	0.03	0.03		0.005		1	2	5.4
Rougher (6)	0.03	0.03	0.15	0.01		2+1	2	5.4->5.1
Rougher (7)				0.005		1	2	5.0

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: Very slow pyrite float.
Rougher concentrate nos. 5 thru 7 were combined to form final (Ro conc. 5) concentrate.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-3 PROJECT NO: 7452 OPERATOR: SM DATE: 8/29/90

PURPOSE: An evaluation of cleaning response following the conditions of test F-2.

PROCEDURE: Follows

FEED: 2000 grams TT-1 tails, 44348-1 "0.03 sulfide".

GRIND: 20 minutes at 65% solids in the 5x12" steel ball mill. 97.8% -100 mesh.
Regrind 5 minutes in the medium pebble mill.

CONDITIONS

	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			
STAGE	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	PULP pH
GRIND					20			5.8
Rougher (1)	0.06	0.06	0.40	0.02		2+1	1	5.3
Rougher (2)							2	
Rougher (3)	0.06	0.06		0.01		1	2	
Rougher (4)				0.01			2	
Rougher (5)	0.06	0.06		0.005		1	2	
Rougher (6)				0.01			2	
Rougher (7)	0.06	0.06		0.005		1	2	
Rougher (8)				0.005			2	
REGRIND					5			5.4
1st clnr (1)				0.005			5	5.4
1st clnr (2)	0.02	0.02		0.005		1	3	

STAGE:	Rougher	Cleaner
EQUIPMENT:	D-1, 4.2 l	D-1, 1.2 l
SPEED, RPM:	1900	1200
% SOLIDS:	34	34

OBSERVATIONS:

TEST No: F-4 PROJECT NO: 7452 OPERATOR: BM DATE: 8/29/90

PURPOSE: An evaluation of cleaning response following the conditions of test F-1.

PROCEDURE: Follows

FEED: 2000 grams TT-1 tails, 4434B-1 "0.03 sulfide".

GRIND: 40 minutes at 65% solids in the 5x12" steel ball mill. 93.8% -200 mesh.
Regrind 5 minutes in the medium pebble mill.

CONDITIONS

	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			
STAGE	Aw-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	PULP pH
GRIND					40			6.5
Rougher (1)	0.06	0.06	0.40	0.02		2+1	1	6.5->5.9
Rougher (2)				0.01			2	
Rougher (3)	0.06	0.06		0.01		1	2	
Rougher (4)				0.01			2	
Rougher (5)	0.06	0.06		0.005		1	2	
Rougher (6)				0.01			2	
Rougher (7)	0.06	0.06		0.005		1	2	
Rougher (8)				0.01			2	
Rougher (9)	0.06	0.06		0.005		1	2	
REGRIND					5			6.6
1st clnr (1)							5	6.6
1st clnr (2)	0.02	0.02				1	3	

STAGE:	Rougher	Cleaner
EQUIPMENT:	D-1, 4.2 l	D-1, 1.2 l
SPEED, RPM:	1900	1200
% SOLIDS:	34	34

OBSERVATIONS:

TEST No: F-5 PROJECT NO: 7452 OPERATOR: SM DATE: 9/20/90

PURPOSE: To evaluate flotation response on whole ore.

PROCEDURE: Follows

FEED: 2000 grams 44348-1, "0.03 sulfide".

GRIND: 22 minutes at 65% solids in the 5x12" steel ball mill. 81.1% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP pH
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	
GRIND					22			6.0
Rougher (1)	0.05	0.05		0.025		1	2	
Rougher (2)							2	
Rougher (3)	0.05	0.05		0.01		1	2	5.7
Rougher (4)				0.01			2	
Rougher (5)	0.05	0.05		0.005		1	2	
Rougher (6)	0.02	0.02		0.01			2	
Rougher (7)	0.02	0.02	0.25	0.005		2+1	2	5.0

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: Very intense pyrite float.
Rougher concentrate nos. 5 and 6 were combined to form Ro conc. 5.

TEST No: F-6 PROJECT NO: 7452 OPERATOR: GM DATE:3/31/90

PURPOSE: To evaluate flotation response on whole ore.

PROCEDURE: Follows

FEED: 2000 grams 44348-1, "0.03 sulfide".

GRIND: 42 minutes at 66% solids in the 5x12" steel ball mill. 90.3% -200 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON Ax-350	Ap-242	CuSO4	MIBC	TIME, MINUTES GRIND	COND	FROTH	PULP pH
GRIND					42			6.1
Rougher (1)	0.05	0.05		0.025		1	2	
Rougher (2)				0.01			2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)				0.01			2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)	0.02	0.02		0.01			2	
Rougher (7)	0.02	0.02	0.25	0.015		2+1	2	5.2

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: Very intense pyrite float.
Rougher concentrate nos. 5 and 6 were combined to produce Ro conc. 5.

Flotation Test Report

TEST No: F-7 PROJECT NO: 7452 OPERATOR: SM DATE: 9/6/90

PURPOSE: To evaluate Au and Ag recovery by rougher flotation of Wilfley table tails. Repeat of test F-2 only at the correct grind, 79% -100 mesh

PROCEDURE: Follows

FEED: 2000 grams TT-1 tails, 44348-1 "0.03 sulfide".

GRIND: 10 minutes at 65% solids in the 5x12" steel ball mill. 79% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP pH
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	
GRIND					20			5.5
Rougher (1)	0.03	0.03	0.15	0.02		2+1	1	5.5->5.1
Rougher (2)							2	
Rougher (3)	0.03	0.03		0.01		1	2	
Rougher (4)							2	
Rougher (5)	0.03	0.03		0.01		1	2	5.2
Rougher (6)	0.03	0.03	0.15	0.005		2+1	2	5.2->5.0
Rougher (7)				0.005		1	2	5.0

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: Appeared to be more middling particles than in finer grind tests.
Rougher concentrate nos. 5 thru 7 were combined to form final (Ro conc. 5) concentrate.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-9 PROJECT NO: 7452 OPERATOR: SM DATE: 9/12/90

PURPOSE: An evaluation of cleaning response following the conditions of test F-4.

PROCEDURE: Follows

FEED: 2000 grams 44348-1 "0.03 sulfide", whole ore .

GRIND: 22 minutes at 66% solids in the 5x12" steel ball mill. 81.1% -100 mesh.
Regrind 5 minutes in the medium pebble mill.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					22			5.9
Rougher (1)	0.05	0.05		0.02		1	1	5.9
Rougher (2)							2	
Rougher (3)	0.05	0.05		0.02		1	2	5.4
Rougher (4)							2	
Rougher (5)	0.05	0.05		0.015		1	2	
Rougher (6)							2	
Rougher (7)	0.05	0.05	0.25	0.015		2+1	2	5.4->4.8
Rougher (8)								
REGRIND					5			
1st clnr (1)							2	5.3
1st clnr (2)	0.01	0.01				1	3	
2nd clnr	0.02	0.02				1	3	

STAGE:	Rougher	Cleaner
EQUIPMENT:	D-1, 4.2 l	D-1, 1.2 l
SPEED, RPM:	1900	1200
% SOLIDS:	34	34

OBSERVATIONS: Cleaner stages appeared to clean more effectively than tests performed on the gravity tails.

ASSAY PARTICLE SIZE ANALYSIS

TEST NO.: 1 PROJECT NO.: 7452
DATE: 9/19/90

ORE: Flotatation test #7 Rougher tailings. Table test #1, Hilfley table tails.

GRIND: 79% -100 mesh.

	SCREEN FRACTION 1/	WEIGHT g	WEIGHT %	ASSAYS, oz/ton Au	ASSAYS, oz/ton Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1.	48 x 65	94.60	6.8	0.007		7.3	
2.	65 x 100	197.70	14.2	0.007		15.2	
3.	100 x 150	220.60	15.8	0.005		12.1	
4.	150 x 200	154.90	11.1	0.006		10.2	
5.	200 x 270	135.10	9.7	0.006		8.9	
6.	270 x 325	55.00	3.9	0.005		3.0	
7.	325 x 400	44.50	3.2	0.006		2.9	
8.	-400	492.60	35.3	0.008		40.5	
HEAD, CALC'D		1,395.00	100.00	0.007		100.0	
HEAD, DIRECT				0.007 *			
CALCULATED PRODUCTS							
		1 and 2	21.0	0.007		22.4	
		1 to 3	36.8	0.006		34.5	
		1 to 4	47.9	0.006		44.7	
		1 to 5	57.6	0.006		53.6	
		1 to 6	61.5	0.006		56.6	
		1 to 7	64.7	0.006		59.5	
		1 to 8	100.0	0.007		100.0	

* Based on an average of three 2 assay ton fire assays.

ASSAY PARTICLE SIZE ANALYSIS

TEST NO.: 2

PROJECT NO.: 7452
DATE: 9/19/90

ORE: Flotatation test 85 Rougher tailings. 44348-1 "0.03 sulfide".

GRIND: 81% -100 mesh.

	SCREEN FRACTION 1/	WEIGHT g	WEIGHT %	ASSAYS, oz/ton Au	ASSAYS, oz/ton Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1.	48 x 65	16.06	3.2	0.006		3.5	
2.	65 x 100	78.64	15.7	0.005		14.4	
3.	100 x 150	71.80	14.3	0.005		13.1	
4.	150 x 200	67.90	13.6	0.005		12.4	
5.	200 x 270	56.40	11.3	0.005		10.3	
6.	270 x 325	11.70	2.3	0.006		2.6	
7.	325 x 400	26.60	5.3	0.006		5.8	
8.	-400	172.00	34.3	0.006		37.8	
HEAD, CALC'D		501.10	100.00	0.005		100.0	
HEAD, DIRECT				0.007 *			
CALCULATED PRODUCTS							
		1 and 2	18.9	0.005		17.9	
		1 to 3	33.2	0.005		31.1	
		1 to 4	46.8	0.005		43.5	
		1 to 5	58.0	0.005		53.8	
		1 to 6	60.4	0.005		56.4	
		1 to 7	65.7	0.005		62.2	
		1 to 8	100.0	0.005		100.0	

* Based on an average of three 2 assay ton fire assays.

ASSAY PARTICLE SIZE ANALYSIS

TEST NO.: 4

PROJECT NO.: 7452
DATE: 9/19/90

ORE: 44348-1, "0.03 sulfide"

GRIND: 86.3% -100 mesh.

	SCREEN FRACTION	WEIGHT g	WEIGHT %	ASSAYS, oz/ton Au	ASSAYS, oz/ton Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1.	+ 65	52.10	5.2	0.029		3.5	
2.	65 x 100	84.40	8.4	0.029		5.7	
3.	100 x 150	150.60	15.1	0.032		11.2	
4.	150 x 200	144.50	14.5	0.050		16.7	
5.	200 x 270	120.60	12.1	0.051		14.2	
6.	270 x 325	18.90	1.9	0.060		2.6	
7.	325 x 400	54.30	5.4	0.063		7.9	
8.	-400	374.50	37.5	0.044		38.2	
HEAD, CALC'D		999.90	100.00	0.043		100.0	
HEAD, DIRECT				0.046 *			
CALCULATED PRODUCTS							
		1 and 2	13.7	0.029		9.2	
		1 to 3	28.7	0.031		20.3	
		1 to 4	43.2	0.037		37.1	
		1 to 5	55.2	0.040		51.3	
		1 to 6	57.1	0.041		53.9	
		1 to 7	62.5	0.043		61.8	
		1 to 8	100.0	0.043		100.0	

* Based on an average of three 2 assay ton fire assays.

FEED MATERIAL SCREEN ANALYSIS SHEET

Project: 7452
Test No: 1
Sample: F-4, Rougher tail, 40 minute grind in the 5x12" steel ball mill.
44348-1, TT-1, Wilfley table tails flotation test.

Screen Size, Mesh	Micron	Direct Weight, Grams	%	Cummulative Weight, % Retained	Passing
10	1651		0.0	0.0	100.0
14	1168		0.0	0.0	100.0
20	833		0.0	0.0	100.0
28	589		0.0	0.0	100.0
35	420		0.0	0.0	100.0
48	295		0.0	0.0	100.0
65	208		0.0	0.0	100.0
100	149	0.7	0.1	0.1	99.9
150	104	3.3	0.7	0.8	99.2
200	75	26.6	5.5	6.3	93.7
270	52	65.9	13.6	19.9	80.1
325	44	15.2	3.2	23.1	76.9
400	37	43.6	9.0	32.1	67.9
PAN		328.4	67.9	100.0	0.0
TOTAL		483.7	100.0		

Lowest % passing above 80% is 80.1 at 52 microns
Highest % passing below 80% is 76.9 at 44 microns
The P80 in microns is 52

FEED MATERIAL SCREEN ANALYSIS SHEET

Project: 7452
Test No: 2
Sample: F-5, Rougher tail, 20 minute grind in the 5x12" steel ball mill.
44348-1, whole ore flotation test.

Screen Size, Mesh	Micron	Direct Height, Grams	%	Cumulative Height, % Retained	Passing
10	1651		0.0	0.0	100.0
14	1168		0.0	0.0	100.0
20	833		0.0	0.0	100.0
28	589		0.0	0.0	100.0
35	420		0.0	0.0	100.0
48	295		0.0	0.0	100.0
65	208	16.1	3.2	3.2	96.8
100	149	78.6	15.7	18.9	81.1
150	104	71.8	14.3	33.2	66.8
200	75	67.9	13.6	46.8	53.2
270	52	56.4	11.3	58.0	42.0
325	44	11.7	2.3	60.4	39.6
400	37	26.6	5.3	65.7	34.3
PAN		172.0	34.3	100.0	0.0
TOTAL		501.1	100.0		

Lowest % passing above 80% is 81.1 at 149 microns
Highest % passing below 80% is 66.8 at 104 microns
The P80 in microns is 146

FEED MATERIAL SCREEN ANALYSIS SHEET

Project: 7452
Test No: 3
Sample: F-6, Rougher tail, 42 minute grind in the 5x12" steel ball mill.
44348-1, whole ore flotation test.

Screen Size, Mesh	Micron	Direct Weight, Grams	%	Cummulative Weight, % Retained	Passing
10	1651		0.0	0.0	100.0
14	1168		0.0	0.0	100.0
20	833		0.0	0.0	100.0
28	589		0.0	0.0	100.0
35	420		0.0	0.0	100.0
48	295		0.0	0.0	100.0
65	208		0.0	0.0	100.0
100	149	4.2	0.8	0.8	99.2
150	104	8.3	1.7	2.5	97.5
200	75	36.6	7.3	9.7	90.3
270	52	86.7	17.2	27.0	73.0
325	44	12.7	2.5	29.5	70.5
400	37	46.9	9.3	38.8	61.2
PAN		308.3	61.2	100.0	0.0
TOTAL		503.8	100.0		

Lowest % passing above 80% is 90.3 at 75 microns
Highest % passing below 80% is 73.0 at 52 microns
The P80 in microns is 61

FEED MATERIAL SCREEN ANALYSIS SHEET

Project: 7452
Test No: 6
Sample: Test #7, Rougher tail, 10 minute grind in the 5x12" steel ball mill.

Screen Size, Mesh	Screen Size, Micron	Direct Weight, Grams	Direct Weight, %	Cummulative Weight, % Retained	Cummulative Weight, % Passing
10	1651		0.0	0.0	100.0
14	1168		0.0	0.0	100.0
20	833		0.0	0.0	100.0
28	589		0.0	0.0	100.0
35	420		0.0	0.0	100.0
48	295		0.0	0.0	100.0
65	208	94.6	6.8	6.8	93.2
100	149	197.7	14.2	21.0	79.0
150	104	220.6	15.8	36.8	63.2
200	75	154.9	11.1	47.9	52.1
270	52	135.1	9.7	57.6	42.4
325	44	55.0	3.9	61.5	38.5
400	37	44.5	3.2	64.7	35.3
PAN		492.6	35.3	100.0	0.0
TOTAL		1395.0	100.0		

Lowest % passing above 80% is 93.2 at 208 microns
Highest % passing below 80% is 79.0 at 149 microns
The P80 in microns is 130

HAZEN PROJECT 7481

Data Sheets

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HAZEN RESEARCH
TABLE TEST METALLURGICAL RESULTS

TEST NO.: 77-1 PROJECT NO.: 7481

ORE: HRI Sample No. 44671.

PURPOSE: To produce gravity tails to do flotation studies on.

PROCEDURE: A 150 kg.sample was ground in 10 kg. batches in a 12x15" steel ball mill. Each batch was then screened at 10 mesh and the +10 mesh fraction was reground in a 3x12" steel ball mill. All batches were recombined and passed over a pilot scale Wilfley Table, recycling the middlings. The Wilfley table concentrate was run on a Gemini table to remove the free gold.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS, oz/ton, Au	ASSAYS, oz/ton, Ag	mg, Au	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
Rc Table Concentrate (calculated)	(8370.88)	(6.0)	(0.409)	(0.586)	(120.06)	(66.6)	(31.8)
C1 (Gemini) Table Conc.	5.73	< 0.1	63.450	5.87	19.10	9.3	0.5
C1 (Gemini) Table Tailing	8561.80	6.0	0.344	0.58	100.96	57.3	31.3
Rc (Wilfley) Table Tailing	134500	94.0	0.024	0.08	92.23	46.0	68.2
HEAD, CALC'D	143071	100.00	0.047	0.110	212.31	100.0	100.0
HEAD, DIRECT			0.046	0.087	225.64		

HAZEN RESEARCH
TABLE TEST METALLURGICAL RESULTS

TEST NO.: TT-1 PROJECT NO.: 7481

ORE: HRI Sample No. 44671.

PURPOSE: To produce gravity tails to do flotation studies on.

PROCEDURE: A 150 kg.sample was ground in 10 kg. batches in a 12x15" steel ball mill. Each batch was then screened at 10 mesh and the +10 mesh fraction was reground in a 5x12" steel ball mill. All batches were recombined and passed over a pilot scale Wilfley Table, recycling the middlings. The Wilfley table concentrate was run on a Genini table to remove the free gold.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS, oz/ton, % Au	ASSAYS, oz/ton, % S	mg, Au	DISTRIBUTION, % Au	DISTRIBUTION, % S
Ro Table Concentrate (calculated)	(8570.58)	(6.0)	(0.409)		(120.08)	(56.6)	
C1 (Genini) Table Conc.	8.78	< 0.1	63.450		19.10	8.3	0.0
C1 (Genini) Table Tailing	8561.80	6.0	0.344	43.30	100.98	43.8	65.7
Ro (Wilfley) Table Tailing	134500	94.0	0.024	1.44	92.23	48.0	34.3
HEAD, CALC'D	143071	100.00	0.047	3.945	212.31	100.0	100.0
HEAD, DIRECT			0.046	3.820	225.64		

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 1

PROJECT NO.: 7481
TEST DATE: 10/5/90

PURPOSE: FLOTATION OF WHOLE ORE, recovery rate based on grind fineness.

ORE: HRI NO. 44671

GRIND: 83.9 % -200 mesh: 36 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	HEIGHT g	HEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	106.37	5.39	0.450	0.66	58.6	47.5
2. Rougher concentrate 2	57.40	2.91	0.326	0.54	22.9	21.0
3. Rougher concentrate 3	18.35	0.93	0.120	0.30	2.7	3.7
4. Rougher concentrate 4	13.02	0.66	0.084	0.24	1.3	2.1
5. Rougher concentrate 5	12.33	0.62	0.028	0.02	0.4	0.2
6. Rougher concentrate 6	6.99	0.35	0.057	0.02	0.5	0.1
7. Rougher Conentrate 7	12.35	0.63	0.052	0.22	0.8	1.8
8. Rougher tailing	1,747.52	88.51	0.006	0.02	12.8	23.6
HEAD, CALC'D	1,974.33	100.00	0.041	0.07	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	8.29	0.407	12.608	81.4	68.4
5 minute rougher	1 to 3	9.22	0.378	14.311	84.1	72.1
7 minute rougher	1 to 4	9.88	0.358	15.536	85.5	74.2
9 minute rougher	1 to 5	10.51	0.338	16.478	85.9	74.4
11 minute rougher	1 to 6	10.86	0.329	16.959	86.4	74.5
13 minute rougher	1 to 7	11.49	0.314	18.212	87.2	76.4

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 2

PROJECT NO.: 7481
TEST DATE: 10/5/90

PURPOSE: FLOTATION OF WHOLE ORE, recovery rate based on grind fineness.

ORE: HRI NO. 44671

GRIND: 82.5 % -100 mesh: 18 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	75.07	3.77	0.495	0.94	43.0	46.2
2. Rougher concentrate 2	54.53	2.74	0.403	0.71	25.5	25.4
3. Rougher concentrate 3	34.81	1.75	0.241	0.44	9.7	10.0
4. Rougher concentrate 4	8.78	0.44	0.120	0.38	1.2	2.2
5. Rougher concentrate 5	15.79	0.79	0.292	0.35	5.3	3.6
6. Rougher concentrate 6	9.14	0.46	0.054	0.11	0.6	0.7
7. Rougher Conentrate 7	17.94	0.90	0.012	0.02	0.2	0.2
8. Rougher tailing	1,777.48	89.16	0.007	0.01	14.4	11.6
HEAD, CALC'D	1,993.54	100.00	0.043	0.08	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	6.50	0.456	12.014	68.5	71.6
5 minute rougher	1 to 3	8.25	0.411	15.218	78.2	81.7
7 minute rougher	1 to 4	8.69	0.396	16.207	79.4	83.8
9 minute rougher	1 to 5	9.48	0.387	17.286	84.8	87.5
11 minute rougher	1 to 6	9.94	0.372	18.137	85.3	88.1
13 minute rougher	1 to 7	10.84	0.342	19.774	85.6	88.4

FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: F-3 PROJECT NO.: 7481

ORE: HRI 844671

GRIND: 81.7% -65 mesh, 13 minutes at 65% solids in the 5x12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS, oz/ton, % Au	Ag	S	DISTRIBUTION, % Au	Ag	S
1. Rougher Concentrate 1	76.66	3.85	0.481	0.91	47.70	46.9	39.4	46.4
2. Rougher Concentrate 2	42.30	2.12	0.400	0.67	44.00	21.5	16.0	23.6
3. Rougher Concentrate 3	35.66	1.79	0.251	0.32	36.40	11.4	6.4	16.5
4. Rougher Concentrate 4	9.69	0.49	0.168	0.45	16.90	2.1	2.5	2.1
5. Rougher Concentrate 5	16.99	0.85	0.258	0.29	18.70	5.6	2.8	4.0
6. Rougher Concentrate 6	6.28	0.32	0.078	0.37	6.52	0.6	1.3	0.5
7. Rougher Concentrate 7	12.46	0.63	0.028	0.18	3.21	0.4	1.3	0.5
8. Rougher Tailing	1,793.46	89.97	0.005	0.03	0.28	11.4	30.4	6.4
HEAD, CALC'D	1,993.50	100.00	0.039	0.09	3.95	100.0	100.0	100.0
HEAD, DIRECT			0.046	0.08	3.82			
CALCULATED PRODUCTS								
3 minute rougher	1 and 2	5.97	0.452	0.825	46.38	68.5	55.4	70.0
5 minute rougher	1 to 3	7.76	0.406	0.708	44.08	79.9	61.8	86.5
7 minute rougher	1 to 4	8.24	0.392	0.693	42.48	81.9	64.3	88.6
9 minute rougher	1 to 5	9.09	0.379	0.655	40.25	87.5	67.1	92.6
11 minute rougher	1 to 6	9.41	0.369	0.646	39.12	88.1	68.4	93.1
13 minute rougher	1 to 7	10.03	0.348	0.617	36.88	88.6	69.6	93.6

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 4

PROJECT NO.: 7491
TEST DATE: 10/9/90

PURPOSE: FLOTATION OF WHOLE ORE, recovery rate based on grind fineness.

ORE: HRI NO. 44671

GRIND: 79.2 % -325 mesh: 50 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	HEIGHT g	HEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	110.66	5.59	0.412	0.64	56.1	56.7
2. Rougher concentrate 2	62.11	3.14	0.258	0.25	19.7	12.4
3. Rougher concentrate 3	48.57	2.45	0.076	0.27	4.5	10.5
4. Rougher concentrate 4	18.23	0.92	0.070	0.13	1.6	1.9
5. Rougher concentrate 5	36.35	1.83	0.040	0.09	1.8	2.6
6. Rougher concentrate 6	16.31	0.82	0.046	0.11	0.9	1.4
7. Rougher Conentrate 7	27.54	1.39	0.032	0.05	1.1	1.1
8. Rougher tailing	1,661.23	83.86	0.007	0.01	14.3	13.3
HEAD, CALC'D	1,981.00	100.00	0.041	0.06	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	8.72	0.357	12.222	75.8	69.1
5 minute rougher	1 to 3	11.17	0.295	17.017	80.3	79.6
7 minute rougher	1 to 4	12.09	0.278	18.496	81.9	81.5
9 minute rougher	1 to 5	13.93	0.247	21.517	83.7	84.2
11 minute rougher	1 to 6	14.75	0.235	22.925	84.6	85.6
13 minute rougher	1 to 7	16.14	0.218	25.087	85.7	86.7

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 5

PROJECT NO.: 7481
TEST DATE: 10/9/90

PURPOSE: FLOTATION OF WHOLE ORE, recovery rate based on grind fineness.

ORE: HRI NO. 44671

GRIND: 92.4 % -150 mesh: 31 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	79.44	3.99	0.494	0.84	47.5	48.2
2. Rougher concentrate 2	56.31	2.83	0.327	0.51	22.3	20.7
3. Rougher concentrate 3	42.18	2.12	0.173	0.33	8.8	10.1
4. Rougher concentrate 4	16.65	0.84	0.123	0.15	2.5	1.8
5. Rougher concentrate 5	21.95	1.10	0.080	0.14	2.1	2.2
6. Rougher concentrate 6	14.34	0.72	0.064	0.23	1.1	2.4
7. Rougher Conentrate 7	13.11	0.66	0.050	0.21	0.8	2.0
8. Rougher tailing	1,745.46	87.74	0.007	0.01	14.8	12.6
HEAD, CALC'D	1,989.44	100.00	0.041	0.07	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	6.82	0.425	11.296	69.8	68.9
5 minute rougher	1 to 3	8.94	0.365	15.059	78.7	79.0
7 minute rougher	1 to 4	9.78	0.344	16.330	81.2	80.8
9 minute rougher	1 to 5	10.88	0.318	18.194	83.3	83.0
11 minute rougher	1 to 6	11.60	0.302	19.693	84.4	85.4
13 minute rougher	1 to 7	12.26	0.288	21.097	85.2	87.4

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 6

PROJECT NO.: 7481
TEST DATE: 10/9/90

PURPOSE: FLOTATION OF WHOLE ORE, recovery rate based on grind fineness.

ORE: HRI NO. 44671

GRIND: 79.6 % -48 mesh: 9 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	HEIGHT g	HEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	85.98	4.33	0.473	0.91	48.8	46.4
2. Rougher concentrate 2	42.72	2.15	0.350	0.68	17.9	17.2
3. Rougher concentrate 3	16.38	0.82	0.204	0.47	4.0	4.6
4. Rougher concentrate 4	7.52	0.38	0.554	0.91	5.0	4.1
5. Rougher concentrate 5	13.13	0.66	0.213	0.47	3.4	3.7
6. Rougher concentrate 6	5.62	0.28	0.102	0.31	0.7	1.0
7. Rougher Conentrate 7	9.79	0.49	0.064	0.28	0.8	1.6
8. Rougher tailing	1,806.58	90.89	0.009	0.02	19.5	21.4
HEAD, CALC'D	1,987.72	100.00	0.042	0.08	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	6.47	0.432	12.490	66.7	63.6
5 minute rougher	1 to 3	7.30	0.406	14.234	70.7	68.2
7 minute rougher	1 to 4	7.68	0.414	14.816	75.7	72.3
9 minute rougher	1 to 5	8.34	0.398	16.189	79.1	75.9
11 minute rougher	1 to 6	8.62	0.388	16.820	79.7	76.9
13 minute rougher	1 to 7	9.11	0.371	17.987	80.5	78.6

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 7

PROJECT NO.: 7481
TEST DATE: 10/10/90

PURPOSE: FLOTATION OF WHOLE ORE, pH 11.0 using NaOH.

ORE: HRI NO. 44671

GRIND: 82.5 % -100 mesh: 18 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, NaOH, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	124.44	6.27	0.406	0.69	58.2	41.4
2. Rougher concentrate 2	68.04	3.43	0.290	0.68	22.7	22.3
3. Rougher concentrate 3	42.17	2.12	0.046	0.24	2.2	4.9
4. Rougher concentrate 4	16.65	0.84	0.108	0.25	2.1	2.0
5. Rougher concentrate 5	23.95	1.21	0.044	0.19	1.2	2.2
6. Rougher concentrate 6	15.84	0.80	0.032	0.21	0.6	1.6
7. Rougher Conentrate 7	13.00	0.65	0.028	0.22	0.4	1.4
8. Rougher tailing	1,681.11	84.68	0.007	0.03	12.6	24.3
HEAD, CALC'D	1,985.20	100.00	0.044	0.10	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	9.70	0.365	18.235	80.9	63.7
5 minute rougher	1 to 3	11.82	0.308	23.290	83.1	68.5
7 minute rougher	1 to 4	12.66	0.294	25.049	85.2	70.5
9 minute rougher	1 to 5	13.87	0.273	27.891	86.4	72.7
11 minute rougher	1 to 6	14.66	0.260	29.944	87.0	74.3
13 minute rougher	1 to 7	15.32	0.250	31.709	87.4	75.7

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 8

PROJECT NO.: 7481
TEST DATE: 10/10/90

PURPOSE: FLOTATION OF WHOLE ORE, pH 8.0 using Ca(OH)2.

ORE: HRI NO. 44671

GRIND: 82.5 % -100 mesh: 18 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, Ca(OH)2, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	104.75	5.28	0.454	0.64	56.1	50.9
2. Rougher concentrate 2	52.29	2.63	0.424	0.41	26.1	16.3
3. Rougher concentrate 3	25.91	1.30	0.169	0.09	5.2	1.8
4. Rougher concentrate 4	9.88	0.50	0.056	0.22	0.7	1.6
5. Rougher concentrate 5	23.86	1.20	0.032	0.05	0.9	0.9
6. Rougher concentrate 6	7.28	0.37	0.053	0.15	0.5	0.8
7. Rougher Conentrate 7	9.93	0.50	0.024	0.15	0.3	1.1
8. Rougher tailing	1,751.76	88.22	0.005	0.02	10.3	26.6
HEAD, CALC'D	1,985.66	100.00	0.043	0.07	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	7.91	0.444	10.036	82.2	67.1
5 minute rougher	1 to 3	9.21	0.405	11.290	87.4	68.9
7 minute rougher	1 to 4	9.71	0.387	12.095	88.0	70.6
9 minute rougher	1 to 5	10.91	0.348	13.626	88.9	71.5
11 minute rougher	1 to 6	11.28	0.338	14.175	89.4	72.3
13 minute rougher	1 to 7	11.78	0.325	14.988	89.7	73.4

FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 9 PROJECT NO.: 7452

ORE: 2 kg. 44671, whole ore.

GRIND: 18 minutes at 65% solids in the 5x12" steel ball mill. 82.5% -100 mesh. 5 minute regrind.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS, oz/ton Au	ASSAYS, oz/ton Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. 2nd cleaner concentrate	118.05	5.92	0.380	0.03	64.8	12.3
2. 2nd cleaner tail	10.65	0.53	0.268	0.20	4.1	7.4
3. 1st cleaner tail	48.78	2.44	0.124	0.10	8.7	17.0
4. Rougher tail	1,818.21	91.11	0.009	0.01	22.3	63.3
HEAD, CALC'D	1,995.69	100.00	0.035	0.014	100.0	100.0
HEAD, DIRECT			0.046	0.09		
CALCULATED PRODUCTS						
	1 and 2	6.45	0.371	0.044	68.9	19.7
	1 to 3	8.89	0.303	0.059	77.7	36.7

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 10

PROJECT NO.: 7481
TEST DATE: 10/12/90

PURPOSE: UNIT CELL FLOTATION OF WHOLE ORE

ORE: HRI NO. 44671

GRIND: ~80 % -48 mesh: 5 min at 65% solids in the 5 x 12" steel ball mill.
Regrind 13 minutes.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Unit cell conc.	60.24	3.05	0.505	0.58	37.2	31.6
2. Rougher concentrate 1	52.63	2.67	0.426	0.53	27.4	25.2
3. Rougher concentrate 2	27.94	1.41	0.376	0.57	12.8	14.4
4. Rougher concentrate 3	19.80	1.00	0.184	0.27	4.5	4.8
5. Rougher concentrate 4	4.98	0.25	0.132	0.02	0.8	0.1
6. Rougher concentrate 5	23.24	1.18	0.064	0.08	1.8	1.7
7. Slimes (grab)	87.74	4.44	0.031	0.09	3.3	7.1
8. Unit cell tails (grab)	46.2	2.34	0.029	0.01	0.0	0.0
9. Rougher tailing	1,651.83	83.65	0.006	0.01	12.1	15.0
HEAD, CALC'D	1,974.60	100.00	0.041	0.05	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	5.72	0.468	6.797	64.6	56.9
5 minute rougher	1 to 3	7.13	0.450	8.866	77.5	71.3
7 minute rougher	1 to 4	8.13	0.417	10.212	81.9	76.1
9 minute rougher	1 to 5	8.39	0.409	10.438	82.7	76.2
11 minute rougher	1 to 6	9.56	0.366	11.905	84.6	77.9
13 minute rougher	1 to 7	14.01	0.260	18.315	87.9	85.0

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 11

PROJECT NO.: 7431
TEST DATE: 10/12/90

PURPOSE: UNIT CELL FLOTATION OF WHOLE ORE

ORE: HRI NO. 44671

GRIND: ~80% -35 mesh, 2 min at 65% solids in the 5 x 12" steel ball mill. Regrind 12 minutes.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	HEIGHT g	HEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Unit cell conc.	75.29	3.82	0.590	0.48	51.8	18.9
2. Rougher concentrate 1	63.27	3.21	0.261	0.67	19.2	22.2
3. Rougher concentrate 2	24.38	1.24	0.261	0.46	7.4	5.9
4. Rougher concentrate 3	18.49	0.94	0.099	0.57	2.1	5.5
5. Rougher concentrate 4	9.47	0.48	0.071	0.21	0.8	1.0
6. Rougher concentrate 5	31.48	1.60	0.051	0.21	1.9	3.5
7. Slimes (grab)	75.21	3.81	0.034	0.15	3.0	5.9
8. Unit cell tails (grab)	98.14	4.98	0.024	0.08		
9. Rougher tailing	1,576.80	79.94	0.008	0.05	13.8	37.1
HEAD, CALC'D	1,972.53	100.00	0.043	0.09	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	7.02	0.440	9.053	71.0	41.1
5 minute rougher	1 to 3	8.26	0.413	11.016	78.4	47.0
7 minute rougher	1 to 4	9.20	0.381	13.343	80.6	52.5
9 minute rougher	1 to 5	9.68	0.366	14.180	81.4	53.5
11 minute rougher	1 to 6	11.27	0.321	17.191	83.2	57.0
13 minute rougher	1 to 7	15.09	0.249	24.511	86.2	62.9

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 12

PROJECT NO.: 7481
TEST DATE: 10/16/90

PURPOSE: FLOTATION OF WHOLE ORE, evaluation of different collectors.

ORE: HRI NO. 44671

GRIND: 82.5 % -100 mesh: 18 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ap-3477, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	94.16	4.76	0.446	0.92	44.2	51.2
2. Rougher concentrate 2	48.15	2.43	0.415	0.15	21.0	4.3
3. Rougher concentrate 3	36.19	1.83	0.264	0.23	10.1	4.9
4. Rougher concentrate 4	16.88	0.85	0.098	0.18	1.7	1.8
5. Rougher concentrate 5	22.15	1.12	0.062	0.25	1.4	3.3
6. Rougher concentrate 6	9.28	0.47	0.083	0.36	0.8	2.0
7. Rougher Conentrate 7	11.45	0.58	0.046	0.25	0.6	1.7
8. Rougher tailing	1,740.38	87.96	0.011	0.03	20.2	30.9
HEAD, CALC'D	1,978.64	100.00	0.048	0.08	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	7.19	0.436	10.891	65.2	55.5
5 minute rougher	1 to 3	9.02	0.401	12.886	75.3	60.4
7 minute rougher	1 to 4	9.87	0.375	14.195	77.0	62.2
9 minute rougher	1 to 5	10.99	0.343	16.330	78.5	65.5
11 minute rougher	1 to 6	11.46	0.332	17.361	79.3	67.4
13 minute rougher	1 to 7	12.04	0.318	18.565	79.8	69.1

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 13

PROJECT NO.: 7481
TEST DATE: 10/16/90

PURPOSE: FLOTATION OF WHOLE ORE, evaluation of different collectors.

ORE: HRI NO. 44671

GRIND: 82.5 % -100 mesh: 18 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ap-404, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	80.55	4.08	0.441	0.17	40.5	17.2
2. Rougher concentrate 2	52.39	2.65	0.343	0.60	20.5	39.5
3. Rougher concentrate 3	18.65	0.94	0.170	0.21	3.6	4.9
4. Rougher concentrate 4	11.70	0.59	0.164	0.02	2.2	0.3
5. Rougher concentrate 5	12.35	0.63	0.036	0.66	0.5	10.2
6. Rougher concentrate 6	10.76	0.54	0.112	0.14	1.4	1.9
7. Rougher Conentrate 7	13.55	0.69	0.058	0.21	0.9	3.6
8. Rougher tailing	1,775.58	89.88	0.015	0.01	30.4	22.3
HEAD, CALC'D	1,975.53	100.00	0.044	0.04	100.0	100.0
HEAD, DIRECT			0.046	0.08		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	6.73	0.402	5.677	61.0	56.7
5 minute rougher	1 to 3	7.67	0.374	6.642	64.6	61.7
7 minute rougher	1 to 4	8.27	0.359	6.953	66.8	62.0
9 minute rougher	1 to 5	8.89	0.336	8.650	67.3	72.2
11 minute rougher	1 to 6	9.44	0.323	9.232	68.7	74.1
13 minute rougher	1 to 7	10.12	0.305	10.248	69.6	77.7

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 14 PROJECT NO.: 7481
TEST DATE: 10/22/90

PURPOSE: FLOTATION OF GRAVITY TAILINGS - Table test 01

ORE: HRI NO. 44671 Table Test 1 Wilfley tails.

GRIND: 83.1% % -200 mesh: 30 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	45.03	2.27	0.380	0.78	47.2	22.5
2. Rougher concentrate 2	39.68	2.00	0.200	0.77	21.9	19.6
3. Rougher concentrate 3	42.66	2.15	0.056	0.23	6.6	6.3
4. Rougher concentrate 4	22.44	1.13	0.042	0.19	2.6	2.7
5. Rougher concentrate 5	25.66	1.29	0.026	0.15	1.8	2.5
6. Rougher tailing	1,809.64	91.16	0.004	0.04	19.9	46.4
HEAD, CALC'D	1,985.11	100.00	0.018	0.079	100.0	100.0
HEAD, DIRECT			0.024	0.028		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	4.27	0.296	0.775	69.0	42.1
5 minute rougher	1 to 3	6.42	0.215	0.593	75.6	48.4
7 minute rougher	1 to 4	7.55	0.189	0.532	78.2	51.1
9 minute rougher	1 to 5	8.84	0.166	0.476	80.1	53.6

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 15

PROJECT NO.: 7481
TEST DATE: 10/22/90

PURPOSE: FLOTATION OF GRAVITY TAILINGS - Table test 01

ORE: HRI NO. 44671 Table Test 1 Wilfley tails.

GRIND: 81.9% % -100 mesh: 12 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	HEIGHT g	HEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	36.91	1.85	0.444	1.14	49.0	32.9
2. Rougher concentrate 2	22.74	1.14	0.257	0.77	17.5	13.7
3. Rougher concentrate 3	20.95	1.05	0.116	0.38	7.3	6.2
4. Rougher concentrate 4	11.07	0.55	0.067	0.13	2.2	1.1
5. Rougher concentrate 5	13.30	0.67	0.036	0.15	1.4	1.6
6. Rougher tailing	1,893.80	94.75	0.004	0.03	22.6	44.5
HEAD, CALC'D	1,998.77	100.00	0.017	0.064	100.0	100.0
HEAD, DIRECT			0.024	0.028		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	2.98	0.373	0.999	66.4	46.6
5 minute rougher	1 to 3	4.03	0.306	0.838	73.7	52.9
7 minute rougher	1 to 4	4.59	0.277	0.753	75.9	54.0
9 minute rougher	1 to 5	5.25	0.247	0.676	77.4	55.5

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 15 PROJECT NO.: 7481
TEST DATE: 10/22/90

PURPOSE: FLOTATION OF GRAVITY TAILINGS - Table test 01

ORE: HRI NO. 44671 Table Test 1 Hilfley tails.

GRIND: 75.1% % -65 mesh: 6 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, HIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	29.21	1.32	0.417	1.02	27.4	13.9
2. Rougher concentrate 2	23.51	1.06	0.315	0.84	16.7	9.2
3. Rougher concentrate 3	12.55	0.57	0.160	0.51	4.5	3.0
4. Rougher concentrate 4	6.71	0.30	0.104	0.67	1.6	2.1
5. Rougher concentrate 5	10.33	0.47	0.077	0.40	1.8	1.9
6. Rougher tailing	2,132.92	96.28	0.010	0.07	48.0	69.8
HEAD, CALC'D	2,215.23	100.00	0.020	0.097	100.0	100.0
HEAD, DIRECT			0.024	0.028		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	2.38	0.372	0.940	44.1	23.2
5 minute rougher	1 to 3	2.95	0.331	0.857	48.6	26.2
7 minute rougher	1 to 4	3.25	0.310	0.840	50.2	28.3
9 minute rougher	1 to 5	3.72	0.280	0.784	52.0	30.2

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 17

PROJECT NO.: 7481
TEST DATE: 10/22/90

PURPOSE: FLOTATION OF GRAVITY TAILINGS - Table test 01

ORE: HRI NO. 44671 Table Test 1 Hilfley tails.

GRIND: 71.7% % -48 mesh: 3 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	HEIGHT g	HEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	30.19	1.52	0.424	0.98	33.1	31.4
2. Rougher concentrate 2	16.01	0.81	0.300	0.82	12.4	13.9
3. Rougher concentrate 3	10.38	0.52	0.184	0.72	4.9	7.9
4. Rougher concentrate 4	8.92	0.45	0.124	0.39	2.9	3.7
5. Rougher concentrate 5	7.10	0.36	0.112	0.32	2.1	2.4
6. Rougher tailing	1,915.19	96.35	0.009	0.02	44.6	40.6
HEAD, CALC'D	1,987.79	100.00	0.019	0.047	100.0	100.0
HEAD, DIRECT			0.024	0.028		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	2.32	0.381	0.925	45.5	45.3
5 minute rougher	1 to 3	2.85	0.345	0.887	50.5	53.3
7 minute rougher	1 to 4	3.30	0.315	0.819	53.3	56.9
9 minute rougher	1 to 5	3.65	0.295	0.771	55.4	59.4

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 19

PROJECT NO.: 7481
TEST DATE: 10/12/90

PURPOSE: ROUGHER CONCENTRATE PRODUCTION FROM WHOLE ORE FOR LEACH TESTS

ORE: HRI NO. 44671

GRIND: ~80 % -65 mesh: 28 min/10 kg at 65% solids in the ~~8~~ x ~~12~~" steel ball mill. 10"x15"

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate	3,487.86	9.04	0.322	0.57	72.7	55.5
8. Rougher tails	35080	90.96	0.012	0.045	27.3	44.5
HEAD, CALC'D	38567.9	100.00	0.040	35.492	100.0	100.0
HEAD, DIRECT			0.046	0.08		

FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 20 PROJECT NO.: 7452

ORE: 2 kg. 44671, whole ore.

GRIND: 13 minutes at 65% solids in the 5x12" steel ball mill. 81.7% -100 mesh. 5 minute regrind.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS, oz/ton Au	ASSAYS, oz/ton Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. 2nd cleaner concentrate	129.79	6.54	0.382	0.95	53.7	63.8
2. 2nd cleaner tail	19.93	1.00	0.140	0.37	3.0	4.1
3. 1st cleaner tail	47.06	2.37	0.318	0.27	16.2	7.1
4. Rougher tail	1,788.07	90.09	0.014	0.02	27.1	20.0
HEAD, CALC'D	1,984.85	100.00	0.047	0.090	100.0	100.0
HEAD, DIRECT			0.046	0.09		
CALCULATED PRODUCTS						
	1 and 2	7.54	0.350	0.873	56.7	72.9
	1 to 3	9.91	0.342	0.729	72.9	80.0

FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 21 PROJECT NO.: 7452

ORE: 2 kg. 44671, whole ore.

GRIND: 13 minutes at 65% solids in the 5x12" steel ball mill. 81.7% -100 mesh. 5 minute regrind.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS, oz/ton Au	ASSAYS, oz/ton Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. 2nd cleaner concentrate	125.02	6.27	0.412	0.73	57.8	55.7
2. 2nd cleaner tail	20.31	1.02	0.240	0.29	5.5	3.6
3. 1st cleaner tail	43.01	2.16	0.172	0.50	8.3	13.1
4. Rougher tail	1,806.66	90.56	0.014	0.03	28.4	27.6
HEAD, CALC'D	1,995.00	100.00	0.045	0.082	100.0	100.0
HEAD, DIRECT			0.046	0.09		
CALCULATED PRODUCTS						
	1 and 2	7.28	0.388	0.669	63.3	59.3
	1 to 3	9.44	0.339	0.630	71.6	72.4

FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: CT1 A-->H

PROJECT NO.: 7481
TEST DATE: 11/4/90

ORE: HRI No. 44671

GRIND: Cycles A thru C 81.7% -65 mesh, Cycles D thru H 82.5% -100 mesh.

CONDITIONS: Ax-350, Ap-242, CuSO4, HIBC as needed, with recirculation of 1st cleaner tails to the rougher stage, and 2nd cleaner tails to the 1st cleaner stage.

PURPOSE: An evaluation of flotation response in a locked cycle test.

PRODUCT	WEIGHT		Assays, oz/ton, %			DISTRIBUTION, %		
	g	%	Au	Ag	S	Au	Ag	S
1. 2nd Cleaner Concentrate A	125.1	0.79	0.378	0.76	41.00	7.3	7.5	8.7
2. 2nd Cleaner Concentrate B	135.2	0.85	0.360	0.73	42.30	7.5	7.8	9.8
3. 2nd Cleaner Concentrate C	168.8	1.07	0.394	0.65	40.30	10.3	8.7	11.6
4. 2nd Cleaner Concentrate D	168.0	1.06	0.320	0.64	35.40	8.3	8.5	10.1
5. 2nd Cleaner Concentrate E	183.9	1.16	0.412	0.75	37.00	11.7	10.9	11.6
6. 2nd Cleaner Concentrate F	191.5	1.21	0.320	0.72	37.00	9.4	10.9	12.1
7. 2nd Cleaner Concentrate G	179.6	1.13	0.390	0.71	38.80	10.8	10.1	11.9
8. 2nd Cleaner Concentrate H	199.8	1.26	0.324	0.70	38.90	10.0	11.1	13.3
9. 2nd Cleaner Tail H	69.0	0.44	0.222	0.43	16.30	2.4	2.4	1.9
10. 1st Cleaner Tail H	99.3	0.63	0.344	0.26	14.00	5.3	2.0	2.4
11. Rougher Tail A	1,775.0	11.20	0.008	0.02	0.36	2.2	2.8	1.1
12. Rougher Tail B	1,786.9	11.27	0.008	0.01	0.33	2.2	1.4	1.0
13. Rougher Tail C	1,821.5	11.49	0.009	0.03	0.33	2.5	4.3	1.0
14. Rougher Tail D	1,798.7	11.35	0.008	0.03	0.25	2.2	4.3	0.8
15. Rougher Tail E	1,819.6	11.48	0.007	0.01	0.30	2.0	1.4	0.9
16. Rougher Tail F	1,767.0	11.15	0.007	0.02	0.16	1.9	2.8	0.5
17. Rougher Tail G	1,771.2	11.17	0.007	0.01	0.20	1.9	1.4	0.6
18. Rougher Tail H	1,793.3	11.31	0.008	0.01	0.24	2.2	1.4	0.7
HEAD, CALC'D	15,853.4	100.00	0.041	0.08	3.70	100.0	100.0	100.0
HEAD, DIRECT			0.046	0.08	3.82			

CALCULATED PRODUCTS

Weighted Avg, Cycles G & H Concentrates			0.365	0.73			
Weighted Avg, Cycles G & H Ro tailings			0.008	0.01			
Two-product formula projected recoveries, (for combined cycles G & H)		9.34				83.4	88.6

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 22

PROJECT NO.: 7481
TEST DATE: 10/22/90

PURPOSE: FLOTATION OF WHOLE ORE - Repeat of test 02.

ORE: HRI NO. 44671

GRIND: 82.5% % -100 mesh: 18 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	84.78	4.26	0.504	0.98	50.7	46.0
2. Rougher concentrate 2	55.29	2.78	0.332	0.65	21.8	19.9
3. Rougher concentrate 3	23.80	1.20	0.172	0.38	4.9	5.0
4. Rougher concentrate 4	11.83	0.59	0.088	0.47	1.2	3.1
5. Rougher concentrate 5	51.85	2.61	0.042	0.23	2.6	6.6
6. Rougher tailing	1,761.53	88.56	0.009	0.02	18.8	19.5
HEAD, CALC'D	1,989.08	100.00	0.042	0.091	100.0	100.0
HEAD, DIRECT			0.046	0.080		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	7.04	0.436	0.850	72.5	65.8
5 minute rougher	1 to 3	8.24	0.398	0.782	77.4	70.8
7 minute rougher	1 to 4	8.83	0.377	0.761	78.6	73.9
13 minute rougher	1 to 5	11.44	0.301	0.640	81.2	80.5

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 23

PROJECT NO.: 7481
TEST DATE: 10/22/90

PURPOSE: FLOTATION OF WHOLE ORE - Repeat of test 03.

ORE: HRI NO. 44671

GRIND: 81.7% % -100 mesh: 13 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	60.53	3.05	0.506	1.06	37.3	37.0
2. Rougher concentrate 2	55.29	2.79	0.396	0.87	26.7	27.8
3. Rougher concentrate 3	23.99	1.21	0.240	0.41	7.0	5.7
4. Rougher concentrate 4	9.61	0.48	0.188	0.54	2.2	3.0
5. Rougher concentrate 5	54.85	2.76	0.110	0.19	7.3	6.0
. Rougher tailing	1,780.54	89.71	0.009	0.02	19.5	20.5
HEAD, CALC'D	1,984.81	100.00	0.041	0.087	100.0	100.0
HEAD, DIRECT			0.046	0.080		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	5.84	0.453	0.969	63.9	64.8
5 minute rougher	1 to 3	7.04	0.417	0.873	70.9	70.4
7 minute rougher	1 to 4	7.53	0.402	0.852	73.1	73.4
13 minute rougher	1 to 5	10.29	0.324	0.674	80.5	79.5

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 24

PROJECT NO.: 7431
TEST DATE: 11/14/90

PURPOSE: ROUGHER CONCENTRATE PRODUCTION FROM GRAVITY TAILS FOR LEACH TESTS

ORE: 2000 grams TT-1 Wilfley table tails.

GRIND: 81.9 % -100 mesh: 12 min at 65% solids in the 8 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate	104.19	5.23	0.268	0.53	66.4	45.5
8. Rougher tails	1886.4	94.77	0.008	0.04	33.6	54.5
HEAD, CALC'D	1990.6	100.00	0.021	1.21	100.0	100.0
HEAD, DIRECT			0.024	0.03		

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 25

PROJECT NO.: 7461
TEST DATE: 11/14/90

PURPOSE: ROUGHER CONCENTRATE PRODUCTION FROM GRAVITY TAILS FOR LEACH TESTS

ORE: 2000 grams TT-1 Wilfley table tails.

GRIND: 81.9 % -100 mesh: 12 min at 65% solids in the 8 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

	WEIGHT		ASSAYS		DISTRIBUTION, %	
PRODUCT	g	%	oz/t Au	oz/t Ag	Au	Ag
1. Rougher concentrate	103.14	5.17	0.280	0.68	67.1	51.4
8. Rougher tails	1891.02	94.83	0.008	0.04	32.9	48.6
HEAD, CALC'D	1994.2	100.00	0.022	1.36	100.0	100.0
HEAD, DIRECT			0.024	0.03		

HAZEN RESEARCH, INC.
FLOTATION TEST METALLURGICAL RESULTS

TEST NO.: 26 PROJECT NO.: 7481
TEST DATE: 11/21/90

PURPOSE: FLOTATION OF WHOLE ORE - Using biologically treated Homestake mine water.

ORE: HRI NO. 44671

GRIND: 82.5% % -100 mesh: 18 min at 65% solids in the 5 x 12" steel ball mill.

CONDITIONS: Ax-350, Ap-242, CuSO4, MIBC as needed.

PRODUCT	WEIGHT g	WEIGHT %	ASSAYS oz/t Au	ASSAYS oz/t Ag	DISTRIBUTION, % Au	DISTRIBUTION, % Ag
1. Rougher concentrate 1	89.01	4.48	0.398	0.71	45.9	35.8
2. Rougher concentrate 2	62.71	3.16	0.324	0.58	26.3	20.6
3. Rougher concentrate 3	24.91	1.26	0.154	0.55	5.0	7.8
4. Rougher concentrate 4	15.80	0.80	0.087	0.19	1.8	1.7
5. Rougher concentrate 5	53.76	2.71	0.044	0.15	3.1	4.6
6. Rougher tailing	1,738.52	87.60	0.008	0.03	18.0	29.6
HEAD, CALC'D	1,984.71	100.00	0.039	0.089	100.0	100.0
HEAD, DIRECT			0.046	0.080		
CALCULATED PRODUCTS						
3 minute rougher	1 and 2	7.64	0.367	0.656	72.2	56.4
5 minute rougher	1 to 3	8.90	0.337	0.641	77.1	64.2
7 minute rougher	1 to 4	9.70	0.317	0.604	78.9	65.9
13 minute rougher	1 to 5	12.40	0.257	0.505	82.0	70.4

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-1 PROJECT NO: 7481 OPERATOR: SM DATE: 10/5/90

PURPOSE: An evaluation of whole ore flotation by varying the coarseness of the feed.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 36 minutes at 65% solids in the 5x12" steel ball mill. ~53.9% -200 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					36			5.9
Rougher (1)	0.05	0.05				1	1	5.9
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	5.1
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-2 PROJECT NO: 7481 OPERATOR: SM DATE:10/5/90

PURPOSE: An evaluation of whole ore flotation by varying the coarseness of the feed.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 18 minutes at 65% solids in the 5x12" steel ball mill. ~82.5% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					18			5.5
Rougher (1)	0.05	0.05				1	1	5.5
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	5.2
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.2->4.8

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-3 PROJECT NO: 7481 OPERATOR: SM DATE:10/5/90

PURPOSE: An evaluation of whole ore flotation by varying the coarseness of the feed.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 13 minutes at 65% solids in the 5x12" steel ball mill. ~81.7% -65 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					13			5.2
Rougher (1)	0.05	0.05				1	1	5.2
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	5.2
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.2->4.8

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: SLower than the finer grind tests. At reagent addition points good pyrite appeared.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-4 PROJECT NO: 7481 OPERATOR: SM DATE: 10/9/90

PURPOSE: An evaluation of whole ore flotation by varying the coarseness of the feed.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 50 minutes at 65% solids in the 5x12" steel ball mill. ~79.2% -325 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					13			6.2
Rougher (1)	0.05	0.05				1	1	6.2
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.4->5.0

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: Awesome pyrite to begin with.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-5 PROJECT NO: 7481 OPERATOR: GM DATE:10/9/90

PURPOSE: An evaluation of whole ore flotation by varying the coarseness of the feed.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 31 minutes at 65% solids in the 5x12" steel ball mill. ~92.5% -150 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON Ax-350	Ap-242	CuSO4	MIBC	TIME, MINUTES GRIND	COND	FROTH	PULP pH
GRIND					13			5.7
Rougher (1)	0.05	0.05				1	1	5.7
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.3->5.0

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-6 PROJECT NO: 7481 OPERATOR: SM DATE: 10/9/90

PURPOSE: An evaluation of whole ore flotation by varying the coarseness of the feed.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 9 minutes at 65% solids in the 5x12" steel ball mill. ~79.6% -48 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					12			5.4
Rougher (1)	0.05	0.05				1	1	5.4
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 2000
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-7 PROJECT NO: 7481 OPERATOR: SM DATE:10/10/90

PURPOSE: An evaluation of whole ore flotation at pH 11.0 using NaOH.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 13 minutes at 65% solids in the 5x12" steel ball mill. ~82.5% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON					TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	NaOH	MIBC	GRIND	COND	FROTH	pH
GRIND						13			5.7
Rougher (1)	0.05	0.05		0.14			1	1	5.7->10.5
Rougher (2)								2	
Rougher (3)	0.05	0.05		0.04			1	2	9.6->10.7
Rougher (4)								2	
Rougher (5)	0.05	0.05		0.02			1	2	10.1->10.
Rougher (6)								2	
Rougher (7)	0.02	0.02	0.25	0.02			1+2	2	10.1->10.

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 2000
% SOLIDS: 34

OBSERVATIONS: Appeared that more gangue materials were floating than in the natural pH tests. Froth was heavy with slimes.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-8 PROJECT NO: 7481 OPERATOR: SM DATE: 10/10/90

PURPOSE: An evaluation of whole ore flotation at pH 8.0 using Ca(OH)2.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 18 minutes at 65% solids in the 5x12" steel ball mill. ~82.5% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON					TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	Ca(OH)2	MIBC	GRIND	COND	FROTH	pH
GRIND						18			5.5
Rougher (1)	0.05	0.05		1.80			1	1	5.5->8.2
Rougher (2)								2	
Rougher (3)	0.05	0.05		0.03			1	2	7.9
Rougher (4)								2	
Rougher (5)	0.05	0.05		0.03			1	2	8.1
Rougher (6)								2	
Rougher (7)	0.02	0.02	0.25	0.02			1+2	2	7.9

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 2000
% SOLIDS: 34

OBSERVATIONS: Better froth than in test no. 7.
Pyrite was not as "bright" as in the natural pH tests.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-9 PROJECT NO: 7431 OPERATOR: SM DATE: 10/12/90

PURPOSE: Cleaner flotation of whole ore.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 18 minutes at 65% solids in the 5x12" steel ball mill. ~82.5% -100 mesh. Regrind 5 min.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					18			5.6
Rougher (1)	0.05	0.05				1	1	5.6
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.3->5.0
Regrind					5			5.3
1st Cleaner (1)							2	5.3
1st Cleaner (2)	0.02	0.02				1	3	
2nd Cleaner	0.025	0.025				1	4	5.5

STAGE:	Rougher	Cleaner
EQUIPMENT:	D-1, 4.2 l	D-1, 1.5 l
SPEED, RPM:	1800	1250
% SOLIDS:	34	

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-10 PROJECT NO: 7481 OPERATOR: SM DATE: 10/16/90

PURPOSE: Unit cell flotation test of whole ore

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 5 minutes at 65% solids in the 5x12" steel ball mill. Regrind for 11 min @ 65% solids.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					5			
Deslime						0.5		
Unit cell	0.02	0.02					1.5	
Regrind					11			5.9
Rougher (1)	0.05	0.05				1	1	5.9
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.7->5.2

STAGE:
EQUIPMENT:
SPEED, RPM:
% SOLIDS:

OBSERVATIONS: Had a hard time keeping unit cell float stage in suspension, increased RPM to 2200.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-11 PROJECT NO: 7481 OPERATOR: SM DATE: 10/16/90

PURPOSE: Unit cell flotation test of whole ore

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 2 minutes at 65% solids in the 5x12" steel ball mill. Regrind for 14 min @ 65% solids.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					5			
Deslime						0.5		
Unit cell	0.02	0.02					1.5	
Regrind					8			5.9
Rougher (1)	0.05	0.05				1	1	5.9
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.7->5.2

STAGE:	Rougher	Unit cell
EQUIPMENT:	D-1, 4.2 l	D-1, 4.2 l
SPEED, RPM:	1800	2200
% SOLIDS:	34	45

OBSERVATIONS: Had a hard time keeping unit cell float stage in suspension, increased RPM to 2200.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-12 PROJECT NO: 7481 OPERATOR: SM DATE: 10/16/90

PURPOSE: An evaluation of flotation response using different collectors.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 18 minutes at 65% solids in the 5x12" steel ball mill. ~82.5% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	3477	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					36			5.6
Rougher (1)	0.05	0.05				1	1	5.6
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.4->5.1

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: Nice pyrite, appears to float faster than using Ap-242 or Ap-404.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-13 PROJECT NO: 7481 OPERATOR: SM DATE: 10/16/90

PURPOSE: An evaluation of flotation response using different collectors.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 18 minutes at 65% solids in the 5x12" steel ball mill. ~82.5% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON Ax-350	Ap-404	CuSO4	MIBC	TIME, MINUTES GRIND	COND	FROTH	PULP pH
GRIND					36			5.6
Rougher (1)	0.05	0.05				1	1	5.5
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.3->5.0

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: No apparent difference, maybe a few more slimes.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-14 PROJECT NO: 7481 OPERATOR: SM DATE: 10/22/90

PURPOSE: An evaluation of gravity tailings flotation by varying the coarseness of the feed.

PROCEDURE: Follows

FEED: 2000 grams table test #1, Wilfley table tails.

GRIND: 30 minutes at 65% solids in the 5x12" steel ball mill. 83.1% -200 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					13			6.2
Rougher (1)	0.05	0.05				1	1	6.2
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.025	0.025	0.25			1	2	5.7->5.5

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-15 PROJECT NO: 7481 OPERATOR: SM DATE: 10/22/90

PURPOSE: An evaluation of gravity tailings flotation by varying the coarseness of the feed.

PROCEDURE: Follows

FEED: 2000 grams table test #1, Wilfley table tails.

GRIND: 12 minutes at 65% solids in the 5x12" steel ball mill. 81.9% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					13			5.7
Rougher (1)	0.05	0.05				1	1	5.7
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.025	0.025	0.25			1	2	5.6->5.3

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-16 PROJECT NO: 7481 OPERATOR: BM DATE: 10/22/90

PURPOSE: An evaluation of gravity tailings flotation by varying the coarseness of the feed.

PROCEDURE: Follows

FEED: 2000 grams table test #1, Wilfley table tails.

GRIND: 6 minutes at 65% solids in the 5x12" steel ball mill. 75.1% -65 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					13			5.4
Rougher (1)	0.05	0.05				1	1	5.4
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.025	0.025	0.25			1	2	5.3->5.1

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-17 PROJECT NO: 7481 OPERATOR: SM DATE: 10/22/90

PURPOSE: An evaluation of gravity tailings flotation by varying the coarseness of the feed.

PROCEDURE: Follows

FEED: 2000 grams table test #1, Wilfley table tails.

GRIND: 3 minutes at 65% solids in the 5x12" steel ball mill. 71.7% -48 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					13			5.4
Rougher (1)	0.05	0.05				1	1	5.4
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.025	0.025	0.25			1	2	5.3->5.1

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-18 PROJECT NO: 7481 OPERATOR: SM DATE:10/12/90

PURPOSE: To produce a concentrate to pass over a pilot scale Gemini table to remove the free gold.

PROCEDURE: Flotation in standard 7 rougher stages, de-reagentize the concentrate, pass both the concentrate and the rougher tails over a Gemini table.

FEED: 2000 grams HRI/No. 44671, whole ore.

GRIND: 18 minutes at 65% solids in the 5x12" steel ball mill. 82.5% -100 mesh.

CONDITIONS

	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
STAGE	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					36			5.9
Rougher (1)	0.05	0.05				1	1	5.9
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	5.1
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-19 PROJECT NO: 7481 OPERATOR: SM DATE:10/25/90

PURPOSE: To produce a large amount of concentrate for leach tests.

PROCEDURE: 2 x 20 kilogram rougher flotation tests using standard conditions.

FEED: 20 kg. per batch, 2 batches, TT-1 Wilfley table tails.

GRIND: 30 minutes/10 kg @ 65% solids in the red steel ball mill.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	pH
GRIND					36			5.9
Rougher (1)	0.05	0.05				1	6	5.9
Rougher (2)								
Rougher (3)	0.05	0.05				1	8	
Rougher (4)								
Rougher (5)	0.05	0.05				1	8	5.1
Rougher (6)								
Rougher (7)	0.02	0.02	0.25			1+2	11	

STAGE: Rougher
EQUIPMENT: Galligher
SPEED, RPM:
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-20 PROJECT NO: 7481 OPERATOR: SM DATE: 10/29/90

PURPOSE: Cleaner flotation of whole ore. No regrind.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 13 minutes at 65% solids in the 5x12" steel ball mill. 82.5% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON Ax-350	Ap-242	CuSO4	MIBC	TIME, MINUTES GRIND	COND	FROTH	PULP pH
GRIND					18			5.9
Rougher (1)	0.05	0.05				1	1	5.8
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	4	5.7->5.2
Regrind								
1st Cleaner (1)							2	5.8
1st Cleaner (2)	0.02	0.02				1	3	
1st Cleaner (3)	0.02	0.02				1	2	
2nd Cleaner	0.025	0.025				1	5	

STAGE:	Rougher	Cleaner
EQUIPMENT:	D-1, 4.2 l	D-1, 1.5 l
SPEED, RPM:	1800	1250
% SOLIDS:	34	

OBSERVATIONS: Coarse pyrite didn't want to float during the cleaning stages.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-21 PROJECT NO: 7481 OPERATOR: SM DATE:10/29/90

PURPOSE: Cleaner flotation of whole ore.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 13 minutes at 65% solids in the 5x12" steel ball mill. 82.5% -65 mesh. Regrind 5 minutes.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON Ax-350	Ap-242	CuSO4	MIBC	TIME, MINUTES GRIND	COND	FROTH	PULP pH
GRIND					13			5.8
Rougher (1)	0.05	0.05				1	1	5.9
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	4	5.7-5.2
Regrind								
1st Cleaner (1)							2	5.8
1st Cleaner (2)	0.02	0.02				1	3	
1st Cleaner (3)	0.02	0.02				1	2	
2nd Cleaner	0.025	0.025				1	5	

STAGE:	Rougher	Cleaner
EQUIPMENT:	D-1, 4.2 l	D-1, 1.5 l
SPEED, RPM:	1200	1250
% SOLIDS:	34	

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-22 PROJECT NO: 7481 OPERATOR: SM DATE: 11/6/90

PURPOSE: Repeat of test # 2.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 18 minutes at 65% solids in the 5x12" steel ball mill. 82.5% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON Ax-350	Ap-242	CuSO4	MIBC	TIME, MINUTES GRIND	COND	FROTH	PULP pH
GRIND					18			5.5
Rougher (1)	0.05	0.05				1	1	5.5
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	5.2
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.2->4.8

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS:

TEST No: F-23 PROJECT NO: 7481 OPERATOR: SM DATE:11/6/90

PURPOSE: Repeat of test # 3.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 13 minutes at 65% solids in the 5x12" steel ball mill. 81.7% -65 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON Ax-350	Ap-242	CuSO4	MIBC	TIME, MINUTES GRIND	COND	FROTH	PULP pH
GRIND					13			5.2
Rougher (1)	0.05	0.05				1	1	5.2
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.05	0.05				1	2	5.2
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.2->4.8

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS:

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-24 PROJECT NO: 7481 OPERATOR: SM DATE: 11/14/90

PURPOSE: To produce a concentrate from gravity tails to perform leach tests.

PROCEDURE: Follows

FEED: 2000 grams TT-1 Wilfley table tails

GRIND: 12 minutes at 65% solids in the 5x12" steel ball mill. 81.9% -100 mesh.

CONDITIONS

	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			
STAGE	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	PULP pH
GRIND					12			5.6
Rougher (1)	0.05	0.05				1	1	5.6
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.03	0.03				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.4->5.1

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: All products were combined to form one rougher concentrate.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-25 PROJECT NO: 7481 OPERATOR: GM DATE: 11/14/90

PURPOSE: To produce a conentrate from gravity tails to perform leach tests.

PROCEDURE: Follows

FEED: 2000 grams TT-1 Wilfley table tails

GRIND: 12 minutes at 65% solids in the 5x12" steel ball mill. 81.9% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON				TIME, MINUTES			PULP pH
	Ax-350	Ap-242	CuSO4	MIBC	GRIND	COND	FROTH	
GRIND					12			5.7
Rougher (1)	0.05	0.05				1	1	5.7
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.03	0.03				1	2	
Rougher (6)							2	
Rougher (7)	0.02	0.02	0.25			1+2	2	5.6->5.3

STAGE: Rougher
EQUIPMENT: D-1, 4.2 l
SPEED, RPM: 1900
% SOLIDS: 34

OBSERVATIONS: All products were combined to form one rougher concentrate.

HAZEN RESEARCH, INC.
Flotation Test Report

TEST No: F-26 PROJECT NO: 7481 OPERATOR: SM DATE:11/21/90

PURPOSE: Whole ore flotation using biologically treated Homestake mine water.

PROCEDURE: Follows

FEED: 2000 grams HRI No.44671, whole ore.

GRIND: 18 minutes at 65% solids in the 5x12" steel ball mill. 82.5% -100 mesh.

CONDITIONS

STAGE	REAGENTS ADDED, POUNDS/TON Ax-350	Ap-242	CuSO4	MIBC	TIME, MINUTES GRIND	COND	FROTH	PULP pH
GRIND					18			5.8
Rougher (1)	0.05	0.05				1	1	5.8
Rougher (2)							2	
Rougher (3)	0.05	0.05				1	2	
Rougher (4)							2	
Rougher (5)	0.03	0.03	0.25			1+2	2	5.7->5.2
Rougher (6)							2	
Rougher (7)	0.02	0.02					2	
Rougher (8)							2	
Rougher (9)	0.02	0.02					2	5.1

STAGE:	Rougher	Cleaner
EQUIPMENT:	D-1, 4.2 l	D-1, 1.5 l
SPEED, RPM:	1800	1250
% SOLIDS:	34	

OBSERVATIONS: Rougher concentrates #5 through #9 were combined.

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-1

PROJECT NO.: 7491
TEST DATE: 10/19/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of Gemini table tailings at various grind sizes.

SAMPLE: HRI #44671, TT-1, Gemini table tailings.

GRIND: 97% -65 mesh.

CONDITIONS: Pre-aerate 20 min., maintaining 1 g/l CaO. 2.0g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,22 hrs. Terminate at 25 hrs.
CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

REAGENT CONSUMPTION,		0 hr	4 hrs	8 hrs	23 hrs	25 hrs
lb/ton of tails..	NaCN:	-	4.08	4.33	4.57	5.18
	CaO:	-				8.9
NaCN STRENGTH, g/l . . .		2.00	1.82	1.87	1.96	1.77
DISSOLVED OXYGEN, ppm. .		1.0	4.9	6.0	6.8	7.0
pH		12.2	12.2	12.2	12.1	12.1

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
25 HOUR BARREN		0.618	0.004	0.02	0.0	0.1
WASH		1.070	0.004	0.02	0.1	0.2
CARBON	32.04		3.050	3.53	67.4	44.2
LEACH RESIDUE	489.93		0.096	0.29	32.4	55.5
HEAD, CALC'D	489.93		0.296	0.52	100.0	100.0
HEAD, DIRECT			0.332	0.52		

TOTAL DISSOLUTION, %	67.6	44.5
RECOVERY ON TO CARBON, %	99.8	99.1

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-2

PROJECT NO.: 7461
TEST DATE: 10/19/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of Gemini table tailings at various grind sizes.

SAMPLE: HRI #44671, TT-1, Gemini table tailings.

GRIND: 98% -100 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 2.0g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,22 hrs. Terminate at 25 hrs.
CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

REAGENT CONSUMPTION,	0 hr	4 hrs	8 hrs	23 hrs	25 hrs
lb/ton of tails.. NaCN:	-	2.50	3.29	3.92	4.09
CaO:	-				13.4
NaCN STRENGTH, g/l . . .	2.00	1.93	1.82	1.79	1.90
DISSOLVED OXYGEN, ppm. .	0.9	4.7	5.6	6.9	7.1
pH	12.3	12.3	12.3	12.2	12.2

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
25 HOUR BARREN		0.480	0.004	0.02	0.0	0.1
WASH		1.600	0.004	0.01	0.1	0.1
CARBON	30.36		3.690	4.44	64.5	38.3
LEACH RESIDUE	504.17		0.122	0.43	35.4	61.5
HEAD, CALC'D	504.17		0.345	0.70	100.0	100.0
HEAD, DIRECT			0.332	0.52		

	Au	Ag
TOTAL DISSOLUTION, %	64.6	38.5
RECOVERY ON TO CARBON, %	99.8	99.4

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-3

PROJECT NO.: 7481
TEST DATE: 10/19/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of Gemini table tailings at various grind sizes.

SAMPLE: HRI #44671, TT-1, Gemini table tailings.

GRIND: 90% -200 mesh.

CONDITIONS: Pre-aerate 20 min., maintaining 1 g/l CaO. 2.0g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,22 hrs. Terminate at 25 hrs.
CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

		0 hr	4 hrs	8 hrs	23 hrs	25 hrs
REAGENT CONSUMPTION, lb/ton of tails..	NaCN:	-	3.59	3.38	4.62	5.23
	CaO:	-				15.1
NaCN STRENGTH, g/l . . .		2.00	1.77	2.09	1.82	1.83
DISSOLVED OXYGEN, ppm. .		1.1	4.7	6.1	6.7	6.9
pH		12.3	12.3	12.3	12.2	12.2

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
25 HOUR BARREN		0.575	0.004	0.02	0.0	0.1
WASH		0.615	0.004	0.02	0.0	0.1
CARBON	30.21		3.880	4.87	66.8	37.2
LEACH RESIDUE	484.86		0.120	0.51	33.1	62.6
HEAD, CALC'D	484.86		0.362	0.81	100.0	100.0
HEAD, DIRECT			0.332	0.52		

TOTAL DISSOLUTION, %	66.9	37.4
RECOVERY ON TO CARBON, %	99.9	99.5

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-4

PROJECT NO.: 7481
TEST DATE: 10/19/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of Gemini table tailings at various grind sizes.

SAMPLE: HRI #44671, TT-1, Gemini table tailings.

GRIND: 86% -270 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 2.0g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,22 hrs. Terminate at 25 hrs.

CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

REAGENT CONSUMPTION,		0 hr	4 hrs	8 hrs	23 hrs	25 hrs
lb/ton of tails..	NaCN:	-	3.28	3.36	5.04	5.26
	CaO:	-				14.4
NaCN STRENGTH, g/l . . .		2.00	1.90	1.96	1.71	1.80
DISSOLVED OXYGEN, ppm. .		1.0	5.7	6.0	7.0	7.0
pH		12.4	12.4	12.3	12.2	12.2

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
25 HOUR BARREN		0.520	0.004	0.03	0.0	0.2
WASH		1.000	0.004	0.02	0.1	0.2
CARBON	29.97		4.540	5.45	77.3	56.3
LEACH RESIDUE	524.35		0.076	0.24	22.6	43.4
HEAD, CALC'D	524.35		0.336	0.55	100.0	100.0
HEAD, DIRECT			0.332	0.52		
TOTAL DISSOLUTION, %					77.4	56.6
RECOVERY ON TO CARBON, %					99.9	99.4

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-5

PROJECT NO.: 7481
TEST DATE: 10/19/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of Gemini table tailings at various grind sizes.

SAMPLE: HRI #44671, TT-1, Gemini table tailings.

GRIND: 80% -400 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 2.0g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,22 hrs. Terminate at 25 hrs.
CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

REAGENT CONSUMPTION,		0 hr	4 hrs	8 hrs	23 hrs	25 hrs
lb/ton of tails..	NaCN:	-	4.23	3.99	5.83	6.89
	CaO:	-				9.7
NaCN STRENGTH, g/l . . .		2.00	1.93	2.10	1.66	1.65
DISSOLVED OXYGEN, ppm. .		1.2	4.9	6.0	6.9	6.9
pH		12.4	12.4	12.4	12.2	12.2

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
25 HOUR BARREN		0.630	0.004	0.03	0.0	0.2
WASH		1.480	0.004	0.02	0.1	0.4
CARBON	29.99		4.360	4.73	78.7	61.0
LEACH RESIDUE	510.79		0.069	0.18	21.2	38.4
HEAD, CALC'D	510.79		0.325	0.46	100.0	100.0
HEAD, DIRECT			0.332	0.52		

TOTAL DISSOLUTION, %	78.8	61.6
RECOVERY ON TO CARBON, %	99.8	99.0

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-6

PROJECT NO.: 7481
TEST DATE: 10/31/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of flotation concentrate at various grind sizes.

SAMPLE: Flotation Test #19 Concentrate

GRIND: None. Nominal 90% -65 mesh.

CONDITIONS: Pre-aerate 20 min., maintaining 1 g/l CaO. 2.5 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.

CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

	0 hr	4 hrs	8 hrs	20 hrs	24 hrs
REAGENT CONSUMPTION, lb/ton of tails.. NaCN:	-	5.68	6.16	7.52	10.48
CaO:	-				14.4
NaCN STRENGTH, g/l . . .	2.50	2.12	2.35	2.21	1.56
DISSOLVED OXYGEN, ppm. .	7.8	7.9	7.7	7.9	8.2
pH	12.6	12.2	12.5	12.3	12.1

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HOUR BARREN		0.302	0.004	0.03	0.0	0.2
"		0.500	0.004	0.01	0.1	0.1
CARBON	15.46		3.170	4.08	57.8	40.5
LEACH RESIDUE	249.77		0.143	0.37	42.1	59.3
HEAD, CALC'D	249.77		0.340	0.62	100.0	100.0
HEAD, DIRECT			0.332	0.52		
TOTAL DISSOLUTION, %					57.9	40.7
RECOVERY ON TO CARBON, %					99.8	99.4

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-7

PROJECT NO.: 7481
TEST DATE: 10/31/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of flotation concentrate at various grind sizes.

SAMPLE: Flotation Test #19 Concentrate

GRIND: 7.5 min @ 50% solids. ~90% -150 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 2.5 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.

CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

	0 hr	4 hrs	8 hrs	20 hrs	24 hrs
REAGENT CONSUMPTION, lb/ton of tails.. NaCN:	-	5.42	6.94	9.13	11.57
CaO:	-	—			21.6
NaCN STRENGTH, g/l . . .	2.50	2.35	2.01	2.21	1.71
DISSOLVED OXYGEN, ppm. .	0.8	5.7	7.8	8.0	6.6
pH	12.9	12.4	12.5	12.0	12.2

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HOUR BARREN		0.325	0.004	0.04	0.0	0.3
"		0.500	0.004	0.02	0.1	0.2
CARBON	15.11		4.120	5.33	75.6	62.5
LEACH RESIDUE	250.52		0.080	0.19	24.3	37.0
HEAD, CALC'D	250.52		0.329	0.51	100.0	100.0
HEAD, DIRECT			0.332	0.52		

TOTAL DISSOLUTION, %	75.7	63.0
RECOVERY ON TO CARBON, %	99.8	99.2

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-8

PROJECT NO.: 7481
TEST DATE: 10/31/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of flotation concentrate at various grind sizes.

SAMPLE: Flotation Test #19 Concentrate

GRIND: 9.5 min @ 50% slids. ~90% -270 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 2.5 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.
CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

	0 hr	4 hrs	8 hrs	20 hrs	24 hrs
REAGENT CONSUMPTION, lb/ton of tails.. NaCN:	-	7.48	7.64	9.55	11.46
CaO:	-				17.4
NaCN STRENGTH, g/l . . .	2.50	1.93	2.46	2.32	1.38
DISSOLVED OXYGEN, ppm. .	0.5	4.9	6.6	7.2	7.4
pH	12.2	12.6	12.2	12.0	12.1

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HOUR BARREN		0.315	0.004	0.04	0.0	0.3
		0.500	0.004	0.02	0.1	0.3
CARBON	15.10		3.960	5.35	75.7	72.4
LEACH RESIDUE	251.10		0.076	0.12	24.2	27.0
HEAD, CALC'D	251.10		0.315	0.44	100.0	100.0
HEAD, DIRECT			0.332	0.52		
TOTAL DISSOLUTION, %					75.8	73.0
RECOVERY ON TO CARBON, %					99.8	99.2

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-9

PROJECT NO.: 7481
TEST DATE: 10/31/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of flotation concentrate at various grind sizes.

SAMPLE: Flotation Test #19 Concentrate

GRIND: 11 min @ 50% solids. ~90% -400 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 2.5 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.
CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

	0 hr	4 hrs	8 hrs	20 hrs	24 hrs
REAGENT CONSUMPTION, lb/ton of tails.. NaCN:	-	7.00	9.10	10.12	11.63
CaO:	-				23.0
NaCN STRENGTH, g/l . . .	2.50	1.88	1.96	2.05	1.88
DISSOLVED OXYGEN, ppm. .	0.9	5.7	6.9	7.6	7.2
pH	12.6	12.4	12.4	12.2	12.1

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HOUR BARREN		0.317	0.004	0.04	0.0	0.4
		0.500	0.004	0.02	0.1	0.3
CARBON	14.87		4.300	5.88	76.7	96.5
LEACH RESIDUE	254.52		0.076	0.01	23.2	2.8
HEAD, CALC'D	254.52		0.328	0.36	100.0	100.0
HEAD, DIRECT			0.332	0.52		

	Au	Ag
TOTAL DISSOLUTION, %	76.8	97.2
RECOVERY ON TO CARBON, %	99.9	99.2

TEST NO.: 4L-10

PROJECT: 7481
TEST DATE: 11/14/90

OXIDATION METHOD: Roast at 600 C for 195 minutes

OFF GAS: Roast until SO2 < .5%

SAMPLE: 200 grams F-19 rougher concentrate

GRIND: 8 minutes at 65% solids 5x12" steel ball mill. Ground product approx 80% -200m

CONDITIONS: Pre-aerate 20 min., maintaining 1 g/l CaO. 3.0 g/l NaCN. Restore NaCN and CaO at 1,2,4,8, 12,20,hrs. Terminate at 24 hrs.

CIL: ### 30.0 g GRC22 Act. Carbon /l of pulp ###

REAGENT CONSUMPTIONS,	0 hrs	2 hrs	4 hrs	8 hrs	24 hrs
lb/t of Feed . . NaCN:	-	10.78	10.78	11.12	13.14
CaO:	-	-	-	-	35.2
NaCN STRENGTH, g/l: . .	3.00	2.89	3.20	2.26	2.46
DISSOLVED OXYGEN, ppm. .	5.1	7.9	8.0	7.9	9.6
pH	8.5	12.1	12.0	12.1	12.1

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HOUR BARREN		0.175	0.003	1.20	0.0	6.7
WASH		0.350	0.003	0.80	0.1	8.9
CARBON	10.12		3.590	0.55	91.2	6.0
LEACH RESIDUE	101.68		0.034	0.77	8.7	85.1
HEAD. CALC'D	101.68		0.392	0.91	100.0	100.0
CALCINE DIRECT HEAD ASSAY			0.402	0.84		
CALC'D ORE BASIS HEAD 1/			0.300	0.69		
DIRECT ORE BASIS HEAD			0.322	0.57		
TOTAL DISSOLUTION, LEACH FEED BASIS. %					91.3	14.9
RECOVERY ON TO CARBON, %					99.9	40.5
ACCOUNTABILITY FOR GOLD, %	97.4					

1/ Accounting for weight loss during roasting. Weight loss 23.48 %

TEST NO.: AL-11

PROJECT: 7481
TEST DATE: 11/14/90

OXIDATION METHOD: Roast at 750 C for 180 minutes

OFF GAS: Roast until SO2 < .5%

SAMPLE: 200 grams F-19 rougher concentrate

GRIND: 8 minutes at 65% solids 5x12" steel ball mill. Ground product approx 80% -200m

CONDITIONS: Pre-aerate 20 min., maintaining 1 g/l CaO. 3.0 g/l NaCN. Restore NaCN and CaO at 1,2,4,8, 12,20,hrs. Terminate at 24 hrs.

CIL: *** 30.0 g GRC22 Act. Carbon /l of pulp ***

REAGENT CONSUMPTIONS, lb/t of Feed . .	0 hrs	2 hrs	4 hrs	8 hrs	24 hrs
NaCN:	-	3.42	3.42	6.00	6.00
CaO:	-	-	-	-	25.8
NaCN STRENGTH, g/l: . .	3.00	3.53	3.17	2.68	2.48
DISSOLVED OXYGEN, ppm. .	5.1	8.4	7.9	8.4	7.5
pH	8.5	12.0	12.0	12.0	12.1

PRODUCT	WEIGHT, grams	VOLUME. liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HOUR BARREN		0.195	0.016	0.30	0.3	4.6
WASH		0.365	0.032	0.60	0.9	6.5
CARBON	10.62		2.190	0.45	64.2	4.9
LEACH RESIDUE	100.07		0.126	0.37	34.8	88.6
HEAD, CALC'D	100.07		0.362	0.98	100.0	100.0
CALCINE DIRECT HEAD ASSAY			0.378	0.86		
CALC'D ORE BASIS HEAD 1/			0.278	0.754		
DIRECT ORE BASIS HEAD			0.322	0.52		
TOTAL DISSOLUTION, LEACH FEED BASIS, %					65.2	11.4
RECOVERY ON TO CARBON, %					98.6	42.8
ACCOUNTABILITY FOR GOLD, %	95.7					

1/ Accounting for weight loss during roasting. Weight loss 23.14 %

TEST NO.: AL-12

PROJECT: 7461
TEST DATE: 11/14/90

OXIDATION METHOD: Nitric acid pre-treatment. Stoichiometric plus 10%.

SAMPLE: 200 grams F-19 rougher concentrate

GRIND: 8 minutes at 65% solids 5x12" steel ball mill. Ground product approx 80% -200#

CONDITIONS: Pre-aerate 20 min., maintaining 1 g/l CaO. 3.0 g/l NaCN. Restore NaCN and CaO at 1,2,4,8, 12,20,hrs. Terminate at 24 hrs.

CIL: ### 30.0 g GRC22 Act. Carbon /l of pulp ###

REAGENT CONSUMPTIONS,	0 hrs	2 hrs	4 hrs	8 hrs	24 hrs
lb/t of Feed . . NaCN:	-	8.02	15.96	20.00	22.34
CaO:	-	-	-	-	43.8
NaCN STRENGTH, g/l: . .	3.00	3.06	1.49	2.40	2.01
DISSOLVED OXYGEN, ppm. .	5.1	7.5	7.4	7.3	8.8
pH	12.1	11.4	11.9	11.9	12.0

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HOUR BARREN		0.230	0.003	1.20	0.0	9.7
WASH		0.235	0.003	0.80	0.1	6.6
CARBON	10.38		3.590	0.55	92.1	6.9
LEACH RESIDUE	93.49		0.034	0.77	7.9	86.5
HEAD, CALC'D	93.49		0.433	0.89	100.0	100.0
OXIDIZED DIRECT HEAD ASSAY			NA	NA		
CALC'D ORE BASIS HEAD 1/			0.201	0.41		
DIRECT ORE BASIS HEAD			0.322	0.57		
TOTAL DISSOLUTION, LEACH FEED BASIS, %					92.1	13.5
RECOVERY ON TO CARBON, %					99.9	51.0

1/ Accounting for weight loss during roasting. Weight loss 53.50 %

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-13 PROJECT NO.: 7481
TEST DATE: 11/14/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of flotation concentrate by introducing various oxidation methods. This sample pre-treated with CL2 (160 lbs CL2/Ton).

SAMPLE: Flotation Test #19 Concentrate

GRIND: To 90% -200 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 3.0 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.

CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

		0 hr	4 hrs	8 hrs	20 hrs	24 hrs
REAGENT CONSUMPTION, lb/ton of tails..	NaCN:	-	6.44	6.73	7.03	7.82
	CaO:	-				28.8
NaCN STRENGTH, g/l . . .		3.00	2.92	2.95	2.70	2.59
DISSOLVED OXYGEN, ppm. .		5.0	8.5	8.9	8.2	9.0
pH		10.7	12.1	12.1	12.1	12.1

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HR BARREN		0.440	0.003	0.03	0.1	0.3
WASH		0.465	0.003	0.01	0.1	0.1
CARBON	17.91		2.210	4.14	74.2	53.3
LEACH RESIDUE	201.62		0.068	0.32	25.7	46.4
HEAD, CALC'D	201.62		0.265	0.69	100.0	100.0
HEAD, DIRECT			0.322	0.57		

TOTAL DISSOLUTION, %	74.3	53.6
RECOVERY ON TO CARBON, %	99.8	99.3

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: PL-14 PROJECT NO.: 7491
TEST DATE: 11/14/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of flotation concentrate by introducing various oxidation methods. This sample pre-treated with Pb(NO3)2 (2 lbs/ton).

SAMPLE: Flotation Test #19 Concentrate

GRIND: To 80% -200 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 3.0 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.

CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

		0 hr	4 hrs	8 hrs	20 hrs	24 hrs
REAGENT CONSUMPTION, lb/ton of tails..	NaCN:	-	6.34	6.50	9.71	10.38
	CaO:	-				14.7
NaCN STRENGTH, g/l . . .		3.00	3.14	2.76	2.72	2.43
DISSOLVED OXYGEN, ppm. .		7.4	9.5	9.2	9.6	7.0
pH		11.5	12.2	12.1	12.2	12.1

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HR BARREN		0.420	0.008	0.03	0.2	0.2
WASH		0.560	0.003	0.01	0.1	0.1
CARBON	17.99		2.520	3.86	76.2	45.0
LEACH RESIDUE	205.62		0.068	0.41	23.5	54.6
HEAD, CALC'D	205.62		0.289	0.75	100.0	100.0
HEAD, DIRECT			0.322	0.57		
TOTAL DISSOLUTION, %					76.5	45.4
RECOVERY ON TO CARBON, %					99.7	99.2

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-15 PROJECT NO.: 7481
TEST DATE: 11/14/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of flotation concentrate by introducing various oxidation methods. This sample pre-aerated with O2 (4 hrs).

SAMPLE: Flotation Test #19 Concentrate

GRIND: To 80% -200 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 3.0 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.

CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

REAGENT CONSUMPTION, lb/ton of tails..	0 hr	4 hrs	8 hrs	20 hrs	24 hrs
NaCN:	-	7.54	8.60	13.27	13.33
CaO:	-				29.1
NaCN STRENGTH, g/l . . .	3.00	3.42	3.17	2.32	2.95
DISSOLVED OXYGEN, ppm. .	10.0	10.0	10.0	10.0	10.0
pH	12.2	12.2	12.1	12.2	12.1

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HR BARREN		0.485	0.003	0.03	0.1	0.3
WASH		0.690	0.003	0.01	0.1	0.1
CARBON	18.35		2.780	4.35	78.7	56.8
LEACH RESIDUE	207.12		0.066	0.29	21.1	42.7
HEAD, CALC'D	207.12		0.313	0.68	100.0	100.0
HEAD, DIRECT			0.322	0.57		
TOTAL DISSOLUTION, %					78.9	57.3
RECOVERY ON TO CARBON, %					99.8	99.2

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-16 PROJECT NO.: 7481
TEST DATE: 11/14/90

PURPOSE: To evaluate Au and Ag dissolution in CIL of flotation concentrate by introducing various oxidation methods. This sample pre-treated with NaOH (12 hrs, 60 lb/ton).

SAMPLE: Flotation Test #19 Concentrate

GRIND: To 80% -200 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 3.0 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.
CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

	0 hr	4 hrs	8 hrs	20 hrs	24 hrs
REAGENT CONSUMPTION, lb/ton of tails.. NaCN:	-	9.85	9.35	11.54	11.84
CaO:	-	NA			
NaCN STRENGTH, g/l . . .	5.00	4.71	5.11	4.75	4.39
DISSOLVED OXYGEN, ppm. .	6.6	7.6	6.6	8.2	7.4
pH	12.5	12.5	12.5	12.5	12.5

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HR BARREN		0.430	0.003	0.03	0.1	0.3
WASH		0.500	0.003	0.01	0.1	0.1
CARBON	18.08		2.520	3.71	76.3	57.4
LEACH RESIDUE	201.32		0.070	0.25	23.6	42.2
HEAD, CALC'D	201.32		0.297	0.58	100.0	100.0
HEAD, DIRECT			0.322	0.57		
TOTAL DISSOLUTION, %					76.4	57.8
RECOVERY ON TO CARBON, %					99.8	99.2

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-17

PROJECT NO.: 7481
TEST DATE: 11/17/90

PURPOSE: To evaluate Au and Ag dissolution in flotation concentration from gravity tails.

SAMPLE: Flotation Test #24 Concentrate

GRIND: 10 minutes med. pebble mill.
Nominal 80% -200 mesh.

CONDITIONS: Pre-areate 20 min., maintaining 1 g/l CaO. 3.0 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.
CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

	0 hr	4 hrs	8 hrs	12 hrs	24 hrs
REAGENT CONSUMPTION, lb/ton of tails.. NaCN:	-	10.66	12.18	13.96	14.97
CaO:	-				11.9
NaCN STRENGTH, g/l . . .	3.00	2.68	2.73	2.65	2.68
DISSOLVED OXYGEN, ppm. .	1.0	4.3	6.5	7.1	7.5
pH	12.1	12.1	12.0	12.0	12.1

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HR BARREN		0.220	0.260 *	3.40	7.9	48.8
		0.280	0.003	0.01	0.1	0.2
CARBON	7.95		1.870		70.4	0.0
LEACH RESIDUE	76.80		0.058	0.29	21.6	51.1
HEAD, CALC'D	78.80		0.268	0.57	100.0	100.0
HEAD, DIRECT			0.268	0.53		
TOTAL DISSOLUTION, %					78.4	48.9
RECOVERY ON TO CARBON, %					89.8	0.0

* assay is being checked

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-18 PROJECT NO.: 7481
TEST DATE: 11/17/90

PURPOSE: To evaluate Au and Ag dissolution in flotation concentration from gravity tails.

SAMPLE: Flotation Test #25 Concentrate

GRIND: 10 minutes med. pebble mill.
Nominal 80% -200 mesh.

CONDITIONS: Pre-aerate 20 min., maintaining 1 g/l CaO. 3.0 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.
CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

	0 hr	4 hrs	8 hrs	12 hrs	24 hrs
REAGENT CONSUMPTION, lb/ton of tails.. NaCN:	-	10.77	12.31	14.62	15.90
CaO:	-				12.4
NaCN STRENGTH, g/l . . .	3.00	2.73	2.73	2.59	2.65
DISSOLVED OXYGEN, ppm. .	0.8	4.5	6.7	7.2	7.3
pH . . . . . /	12.1	12.1	12.1	12.1	12.1

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HR BARREN		0.208	0.003	0.01	0.1	0.3
		0.260	0.003	0.01	0.1	0.3
CARBON	7.84		2.180		76.3	0.0
LEACH RESIDUE	73.04		0.060	0.30	21.5	99.4
HEAD, CALC'D	78.04		0.280	0.30	100.0	100.0
HEAD, DIRECT			0.280	0.69		

TOTAL DISSOLUTION, %	78.5	0.6
RECOVERY ON TO CARBON, %	99.8	0.0

HAZEN RESEARCH, INC.
CIL LEACHING METALLURGICAL RESULTS

TEST NO.: AL-19 PROJECT NO.: 7481
TEST DATE: 12/5/90

PURPOSE: To evaluate Au and Ag dissolution in combined Gemini tails and Flotation concentrate.
55% gemini tails, 45% flotation concentrate.

SAMPLE: Flotation Test #19 Concentrate

GRIND: 10 minutes med. pebble mill.
Nominal 80% -200 mesh.

CONDITIONS: Pre-aerate 20 min., maintaining 1 g/l CaO. 3.0 g/l NaCN 1g/l CaO, restore at 1,2,4,8,12,20, hrs. Terminate at 24 hrs.

CIL: 30 g GRC22 6x14 mesh act. carbon / L of pulp.

	0 hr	4 hrs	8 hrs	20 hrs	24 hrs
REAGENT CONSUMPTION, lb/ton of tails.. NaCN:	-	4.99	6.19	7.82	10.80
CaO:	-				7.5
NaCN STRENGTH, g/l . . .	3.00	3.04	2.59	2.46	1.76
DISSOLVED OXYGEN, ppm. .	0.9	6.3	6.5	6.7	4.9
pH	11.4	12.0	12.0	12.0	11.9

PRODUCT	WEIGHT, grams	VOLUME, liters	ASSAYS, mg/l, oz/ton Au	Ag	DISTRIBUTION, % Au	Ag
24 HR BARREN		0.850	0.200	3.20	3.3	21.1
WASH		1.480	0.003	0.01	0.1	0.1
CARBON	36.04		3.070	4.32	72.9	41.4
LEACH RESIDUE	501.37		0.072	0.28	23.8	37.4
HEAD, CALC'D	501.37		0.303	0.75	100.0	100.0
HEAD, DIRECT			NA*	NA*		
TOTAL DISSOLUTION, %					76.2	62.6
RECOVERY ON TO CARBON, %					95.6	66.1

* No head sample was taken on the feed to this test.

MATERIAL SAFETY

Data Sheets

CYANAMID

MSDS NO. 0290-01
CAS NO.
DATE: 08/14/82

MATERIAL SAFETY DATA

PRODUCT IDENTIFICATION

TRADEMARK:	**AERO® 350 Xanthate**
SYNONYMS:	None
CHEMICAL FAMILY:	Alkyl xanthate salt
MOLECULAR FORMULA:	n-C5H11OC(S)SK
MOLECULAR WGT.:	210

WARNING

CAUSES EYE AND SKIN IRRITATION

HAZARDOUS INGREDIENTS

COMPONENT	CAS. NO.	%	TWA/CEILING	REFERENCE
No Permissible Exposure Limits (PEL), have been established by OSHA				

NFPA HAZARD RATING

Not Established

HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE:	Acute oral (rat) LD50 value is between 1.0 and 2.0 g/kg. Skin or eye contact with solutions of the product may cause primary irritation. Airborne dust may cause significant eye and skin irritation or irritation of the respiratory tract. Overexposure to carbon disulfide may produce the following effects: eye or respirtory tract irritation, skin irritation or sensitization, dizziness, headache, degeneration of peripherial nerves, manic depressive pyschosis and cardiovascular disorders.
FIRST AID:	In case of skin contact, remove contaminated clothing without delay. Flush skin thoroughly with water. Do not reuse clothing without laundering. In case of eye contact, immediately irrigate with plenty of water for 15 minutes. Refer to a physician if irritation persists. If vapor of AERO 350 Xanthate is inhaled, remove from exposure. Administer oxygen if there is difficulty in breathing.

EMERGENCY PHONE: 201/835-3100

AMERICAN CYANAMID COMPANY, WAYNE, NEW JERSEY 07470

FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT:	This product has no flash point or explosive limits. Carbon disulfide may be evolved; however, (see Reactivity Data) with a flash point of -22 F.
FLAMMABLE LIMITS (% BY VOL):	1.25 lower; 50.0 upper (residual carbon disulfide)
AUTOIGNITION TEMP:	248 F; 120 C (residual carbon disulfide)
DECOMPOSITION TEMP:	491-536 F; 255-280 C (residual carbon disulfide)
FIRE FIGHTING:	Use carbon dioxide or dry chemical to extinguish fires. Do not use water. Do not flush to sewers. Wear self-contained, positive pressure breathing apparatus and full firefighting protective clothing. See Exposure Control Methods for special protective clothing. Dust may be explosive if mixed with air in critical proportions and in the presence of a source of ignition. Liberates carbon disulfide slowly in aqueous solution, when heated, or in presence of moisture. Due to its high vapor density (2.2 @ 100 F) carbon disulfide may accumulate in the bottom of tanks or drums containing this product or solutions of it and create a fire or explosion hazard.

REACTIVITY DATA

STABILITY:	Unstable
CONDITIONS TO AVOID:	Heat or moisture will liberate carbon disulfide which is toxic and explosive.
POLYMERIZATION:	Will Not Occur
CONDITIONS TO AVOID:	None known
INCOMPATIBLE MATERIALS:	Acids, strong oxidizing agents, water (including atmospheric moisture).
HAZARDOUS DECOMPOSITION PRODUCTS:	Heat or moisture will liberate carbon disulfide. Thermal decomposition may produce carbon monoxide, carbon dioxide, sulfur oxides and/or carbon disulfide.

PHYSICAL PROPERTIES

APPEARANCE AND ODOR:	Yellow pellets or powder; slight, disagreeable odor
BOILING POINT:	Not Applicable
MELTING POINT:	491-536 F; 255-280 C
VAPOR PRESSURE:	Not Applicable
SPECIFIC GRAVITY:	Not Available
VAPOR DENSITY:	Not Applicable
% VOLATILE (BY VOL):	<15.0
OCTANOL/H_2O PARTITION COEF.:	Not Available
pH:	Not Applicable
SATURATION IN AIR (BY VOL):	Not Applicable
EVAPORATION RATE:	Not Applicable
SOLUBILITY IN WATER:	Appreciable

EXPOSURE CONTROL METHODS

Utilize a closed system process where feasible. Where a closed system is not used, good enclosure and local exhaust ventilation should be provided to minimize exposure. Food, beverages, tobacco products should not be carried, stored or consumed where this chemcial is in use. Before eating, drinking or smoking wash face and hands with soap and water. Shower after completion of workshift. Launder work clothing at end of workshift prior to reuse. Store street clothing separately from work clothing and protective equipment. Work clothing and shoes must not be taken home. Where engineering controls are effective, respiratory protection is generally not required. If certain operations require respiratory protection, use a NIOSH approved respirator recommended by an industrial hygienist. Material causes eye or skin irritation on contact. A full facepiece respirator will provide eye and face protection. Wear the following as necessary to prevent skin contact; work pants, long sleeve work shirt and work gloves. For operations where eye or face contact can occur wear respiratory protection outlined above, (full facepiece) or dust proof goggles.

SPILL OR LEAK PROCEDURES	STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:	Wear NIOSH approved air purifying cartridge or canister respirator. Same protective clothing/equipment as in Exposure Control Methods. Vacuum spill instead of sweeping.
WASTE DISPOSAL	Disposal must be made in accordance with applicable governmental regulations.	
SPECIAL PRECAUTIONS	HANDLING AND STORAGE/OTHER:	Store in a cool, dry, well-ventilated area. Maintain good housekeeping to control dust accumulations. Areas where handling or use may result in the evolution of carbon disulfide should have fire safe practices and electrical equipment in accordance with Electrical and Fire Protection Codes (NFPA-30) governing Class I Flammable Liquids.

Marvin A. Friedman

Marvin A. Friedman, Ph.D., Director of Toxicology and Product Safety

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CYANAMID

MATERIAL SAFETY DATA

MSDS NO. 0308-01
CAS NO. ----------
DATE: 06/08/82

PRODUCT IDENTIFICATION

TRADEMARK:	**AEROFLOAT® 242 Promoter**
SYNONYMS:	None
CHEMICAL FAMILY:	Aryl phosphorodithioate
MOLECULAR FORMULA:	Mixture
MOLECULAR WGT.:	Mixture

WARNING

CAUSES BURNS OF EYES AND SKIN
HARMFUL IF INHALED

HAZARDOUS INGREDIENTS

COMPONENT	CAS. NO.	%	TWA/CEILING	REFERENCE
Cresol	001319-77-3	10-15	5 ppm (skin)	OSHA

NFPA HAZARD RATING

Not Established

HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE:	Acute oral (rat) and acute dermal (rabbit) LD50 values for cresol are approximately 2.0 g/kg. Cresol is a strong tissue irritant and also can be corrosive. Liquid may be irritating and/or corrosive to the eyes or skin. Dermal exposure or inhalation of cresol may lead to central nervous system depression with confusion, depression and irregular, rapid breathing.
FIRST AID:	If AEROFLOAT 242 Promoter is ingested give 2 glasses of water or milk and induce vomiting. Never give anything by mouth or induce vomiting in an unconscious person. In case of skin contact, remove contaminated clothing without delay. Wear impervious gloves. Cleanse skin thoroughly with soap and water. Do not omit cleaning hair or under fingernails if contaminated. Do not reuse clothing without launderng. Do not reuse contaminated leatherware. In case of eye contact, immediately irrigate with plenty of water for 15 minutes. Refer to physician. If AEROFLOAT 242 Promoter is inhaled, remove from exposure. Administer oxygen if there is difficulty in breathing.

EMERGENCY PHONE: 201/835-3100

AMERICAN CYANAMID COMPANY, WAYNE, NEW JERSEY 07470

FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT:	Not Available
FLAMMABLE LIMITS (% BY VOL):	Not Available
AUTOIGNITION TEMP:	Not Available
DECOMPOSITION TEMP:	Not Available
FIRE FIGHTING:	Use water, carbon dioxide or dry chemical to extinguish fires. Wear self-contained, positive pressure breathing apparatus and full firefighting protective clothing. See Exposure Control Methods for special protective clothing. Contact with acid liberates toxic and flammable hydrogen sulfide gas. Sulfur dioxide, hydrogen sulfide and/or ammonia may be formed under fire conditions. See Special Precautions. Do not flush to sewer which may contain acid.

REACTIVITY DATA

STABILITY: CONDITIONS TO AVOID:	Stable None known
POLYMERIZATION: CONDITIONS TO AVOID:	Will Not Occur None known
INCOMPATIBLE MATERIALS:	Contact with acid, or acidic material such as alum, liberates hydrogen sulfide. Strong mineral acids and/or strong oxidizers may cause exothermic reaction, Chlorosulfonic Acid.
HAZARDOUS DECOMPOSITION PRODUCTS:	Thermal decomposition or combustion may produce ammonia, carbon monoxide, carbon dioxide, sulfur oxides, hydrogen sulfide, phosphoric acid, oxides of phosphorus and/or oxides of nitrogen.

PHYSICAL PROPERTIES

APPEARANCE AND ODOR:	Dark brown to black liquid; cresol odor
BOILING POINT:	Not Available
MELTING POINT:	Not Available
VAPOR PRESSURE:	Not Available
SPECIFIC GRAVITY:	1.13
VAPOR DENSITY:	Not Available
% VOLATILE (BY VOL):	∾ 17.0
OCTANOL/H_2O PARTITION COEF.:	Not Available
pH:	Not Available
SATURATION IN AIR (BY VOL):	Not Available
EVAPORATION RATE:	Not Available
SOLUBILITY IN WATER:	Complete

EXPOSURE CONTROL METHODS

Where a "closed system" is not used, good enclosure and local exhaust ventilation should be provided to minimize exposure. Shower after completion of workshift. Launder work clothing at end of workshift prior to reuse. Store street clothing separately from work clothing and protective equipment. Work clothing and shoes must not be taken home. Where exposures exceed PEL use respirator approved by NIOSH for the material and level of exposure. See "GUIDE TO INDUSTRIAL RESPIRATORY PROTECTION" (NIOSH). Material causes burns of eyes and skin on contact. A full facepipece respirator will provide eye and face protection. Provide eyewash fountain and safety shower in close proximity to points of potential exposure. Wear the following as necessary to prevent skin contact; impervious boots, impervious gloves, impervious aprons, work pants and long sleeve work shirt. For operations where eye or face contact can occur wear respiratory protection outlined above (full facepiece) or chemical splash proof goggles and a faceshield.

SPILL OR LEAK PROCEDURES	STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:	Where exposure level is not known, wear NIOSH approved positive pressure self-contained respirator. Where exposure level is known, wear NIOSH approved respirator suitable for level of exposure. Same protective clothing/equipment as in Exposure Control Methods. Cover spills with some inert absorbent material; sweep up and place in a waste disposal container. Flush area with water, do not flush to sewers which may contain acid.
WASTE DISPOSAL	Disposal must be made in accordance with applicable governmental regulations.	
SPECIAL PRECAUTIONS	HANDLING AND STORAGE/OTHER:	Promoter should not be mixed with acids or aqueous solutions of acids since evolution of toxic and flammable hydrogen sulfide gas could result.

Marvin A. Friedman

Marvin A. Friedman, Ph.D., Director of Toxicology and Product Safety

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DU PONT

MATERIAL SAFETY DATA SHEET

59

IDENTIFICATION

NAME
Sodium Cyanide

GRADE
CYANOBRIK*; CYANOGRAN*;
Compounders Grade

SYNONYMS
Cyanide of Sodium; Prussiate of Soda

CAS NAME
Sodium Cyanide

I.D. NOS./CODES
NIOSH Registry No. VZ7525000

MANUFACTURER/DISTRIBUTOR
E. I. du Pont de Nemours & Co. (Inc.)

ADDRESS
Wilmington, DE 19898

CHEMICAL FAMILY
Alkali Metal Cyanide

FORMULA
NaCN

CAS REGISTRY NO.
143-33-9

TSCA INVENTORY STATUS
Reported/Included

PRODUCT INFORMATION PHONE
(800) 441-9442

MEDICAL EMERGENCY PHONE
(800) 441-3637

TRANSPORTATION EMERGENCY PHONE
Du Pont Cyanide HOTLINE
(For emergencies only)
(901) 357-1546
CHEMTREC (800) 424-9300

*Reg. U.S. Pat. & Tm. Off., Du Pont Company. CYANOBRIK(R) and CYANOGRAN(R) Sodium Cyanide are made only by Du Pont.

E-94784 Date: 6/87

The data in this Material Safety Data Sheet relates only to the specific material designated

PHYSICAL DATA

BOILING POINT, 760 mmHg
1496°C (2725°F)

MELTING POINT
564°C (1047°F)

SPECIFIC GRAVITY
1.6

VAPOR PRESSURE
Negligible

VAPOR DENSITY
Not volatile

SOLUBILITY IN WATER
37% at 20°C (68°F)

pH INFORMATION
11.3 to 11.7 (Typical for 5 to 25% solutions with no pH adjustment)

EVAPORATION RATE (BUTYL ACETATE = 1)
Not applicable

FORM
Solid

APPEARANCE
Granular or Briquettes

COLOR
White

ODOR
None (but can have slight ammonia and/or HCN odor if damp)

HAZARDOUS COMPONENTS

MATERIAL(S)	CAS NO.	APPROXIMATE %
Sodium Cyanide	143-33-9	100

HAZARDOUS REACTIVITY

INSTABILITY
Very stable when dry.

INCOMPATIBILITY
Large amounts of highly toxic, flammable hydrogen cyanide (HCN) gas will be evolved from contact with acids. Reacts violently with strong oxidizing agents. Water or weak alkaline solution can produce dangerous amounts of HCN in confined areas.

DECOMPOSITION
Moisture will cause slow decomposition, releasing poisonous HCN and ammonia gas.

POLYMERIZATION
Will not occur.

FIRE AND EXPLOSION DATA

FLASH POINT
Will not burn.

FLAMMABLE LIMITS IN AIR, % BY VOL.
LOWER Not applicable.
UPPER Not applicable.

AUTOIGNITION TEMPERATURE
Not applicable.

FIRE AND EXPLOSION HAZARDS
Will not burn. Sodium cyanide will not be destroyed in an ordinary fire involving combustible materials such as paper or wood.

EXTINGUISHING MEDIA
Use water on fires near sodium cyanide, but minimize amount of water if containers are opened or burned (see "Incompatibility", above). DO NOT use carbon dioxide (CO_2) which reacts with sodium cyanide to produce hydrogen cyanide if moisture is present.

SPECIAL FIRE FIGHTING INSTRUCTIONS
Sodium cyanide dissolves readily in water; therefore, cyanide solution runoff may occur if containers are opened or burned. Runoff should be contained to avoid environmental or safety problems. Contained cyanide solution can be detoxified with hypochlorite.

HEALTH HAZARD INFORMATION

PRINCIPAL HEALTH HAZARDS (Including Significant Routes, Effects, Symptoms of Over-Exposure, and Medical Conditions Aggravated by Exposure)

May be fatal if inhaled, swallowed, or absorbed through skin. Contact with acids or weak alkalis liberates poisonous gas. Causes eye burns and may irritate skin.

Oral LD50: 15 mg/kg in rats

Toxic effects described in animals from exposure include asphyxia, dyspnea, ataxia, tremors, coma, and lethality by disrupting oxidative metabolism. Tests in bacterial and mammalian cell cultures demonstrate no mutagenic activity. Tests in some animals indicate that the compound may affect the fetus, that is, it may be a developmental toxin.

Human health effects of overexposure may initially include: skin irritation with discomfort or rash, eye irritation or burns with discomfort, tearing, or blurring of vision, and possible permanent eye damage; and nonspecific discomfort such as nausea, headache, dizziness, vomiting, and weakness. Higher exposures may lead to these effects: rapid respiration; lowered blood pressure; unconsciousness; convulsions; and fatality. Evidence suggests that significant skin permeation can occur. Individuals with preexisting diseases of the central nervous system may have increased susceptibility to the toxicity of excessive exposures.

CARCINOGENICITY

Not listed as a carcinogen by IARC, NTP, OSHA, ACGIH, or Du Pont.

EXPOSURE LIMITS [PEL (OSHA), TLV (ACGIH), AEL (DU PONT), ETC.]

The OSHA 8-hour Time Weighted Average (TWA) and ACGIH TLV(R)-TWA are 5 mg/m^3, as CN. Both carry a "skin" notation indicating that cyanide may penetrate the skin (especially if the skin is broken). Control of vapor, dust, and mist inhalation alone may not be sufficient to prevent absorption of an excessive dose.

SAFETY PRECAUTIONS

Do not breath dust, mist, or HCN gas. Do not get in eyes. Avoid contact with skin and clothing. Do not carry foodstuffs, beverages, or tobacco where contamination with cyanide is possible. Wash thoroughly after handling. Wash contaminated clothing before reuse.

FIRST AID AND MEDICAL TREATMENT

Actions to be taken in case of cyanide exposure should be planned and practiced before beginning work with cyanides. In most cases, cyanide poisoning causes a deceptively healthy pink to red skin color; however, if a physical injury or lack of oxygen is involved, the skin color may be bluish.

Treatment for cyanide poisoning can be provided in two ways, "First Aid" and "Medical Treatment." Both require immediate action to prevent further harm or death. First aid using amyl nitrite and oxygen is generally given by a layman before medical help arrives.

Medical treatment involves intravenous injections and must be administered by qualified medical personnel. Even if a doctor or nurse is present, the need for fast treatment dictates using first aid treatment with amyl nitrite and oxygen while medical treatment materials for intravenous injection are being prepared. Experience shows that first aid given promptly is usually the only treatment needed.

Medical treatment is given if the victim does not respond to first aid. It provides a larger quantity of antidote including sodium thiosulfate to chemically destroy cyanide in the body. However, even under optimum conditions, amyl nitrite can be administered faster and should be used even if medical treatment follows. Do not overreact. Fast treatment is needed, but a conscious person usually does not need treatment beyond oxygen. Amyl nitrite and medical treatment kits for cyanide poisoning are available, with doctor's prescription, from pharmacies.

A. First Aid—Directions for Giving Amyl Nitrite Antidote and Oxygen

1. Conscious: For inhalation and/or absorption if the victim is alert, oxygen may be all that is needed. But if he is not fully conscious or shows signs of poisoning, follow paragraph A-2 below. For swallowing, see below paragraph C. "First Aid—Swallowing Cyanide."

2. Unconscious But Breathing: Break up amyl nitrite ampule in a cloth and hold lightly under the victim's nose for 15 seconds, then take away for 15 seconds. Repeat 5-6 times. If necessary, use a fresh ampule every 3 minutes until the victim regains consciousness (usually 1-4 ampules). Give oxygen to aid recovery. Where more severe poisoning has occurred, consider holding the amyl nitrite under the nose continuously for the first ampule or more.

3. Not Breathing:
   a. Give artificial respiration, preferably with an oxygen resuscitator. Give amyl nitrite antidote by placing a broken ampule inside the resuscitator face piece, being careful that the ampule does not enter the victim's mouth and cause choking.
   b. If using manual artificial respiration, give amyl nitrite antidote as in paragraph A-2 above except keep the first amyl nitrite ampule under the nose with replacement every 3 minutes.

4. Amyl Nitrite Notes:
   a. Amyl nitrite is highly volatile and flammable; do not smoke or use around source of ignition.
   b. If treating poison victim in a windy or drafty area, provide something—a rag, shirt, wall, drum, cupped hand, etc.—to prevent the amyl nitrite vapors from being blown away. Keep the ampule upwind from the nose. The objective is to get amyl nitrite into the victim's lungs.
   c. Rescuers should avoid amyl nitrite inhalation so they won't become dizzy and lose competence.
   d. Lay the victim down for treatment to maintain a good blood supply to the victim's head. Since amyl nitrite dilates the blood vessels and lowers blood pressure, lying down will help prevent unconsciousness.
   e. Do not overuse; excessive use might put the victim in shock. This has not occurred in practice at Du Pont plants and we are not aware of any death or serious aftereffects from treatment with amyl nitrite. (See paragraph E, "Medical Treatment.")

B. First Aid—Inhalation of Cyanide—Carry the victim to fresh air. Lay victim down. Administer amyl nitrite antidote and oxygen (Paragraph A). Check for and remove contaminated clothing. Keep patient quiet and warm. Call a physician.

C. First Aid—Swallowing Cyanide

1. Conscious: Immediately give patient one pint of 1% sodium thiosulfate solution (or plain water) by mouth and induce vomiting with finger in throat. Repeat until vomit fluid is clear. Never give anything by mouth to an unconscious person. Call a physician.

2. Unconscious: Follow first aid procedure as in paragraphs A-2 and A-3 (and/or medical treatment in paragraph E) and call a physician. If the victim revives, then proceed with paragraph C-1.

D. First Aid—Skin or Eye Contact (Skin Absorption)

1. Eye Contact: Immediately flush eyes with plenty of water, remove contaminated clothing, and keep victim quiet and warm. Call a physician.

2. Skin Contact: Wash skin to remove the cyanide while removing all contaminated clothing, including shoes. Do not delay. Skin absorption can occur from cyanide dust, solutions, or HCN vapor. Absorption is slower than inhalation, usually measured in minutes compared to seconds for inhalation.

Follow First Aid procedures in Paragraph A if treatment is needed, but even severe skin contact usually will not require treatment if 1) no inhalation or swallowing has occurred and 2) the cyanide is promptly washed from the skin and contaminated clothing and shoes are removed. If skin contact is prolonged, HCN poisoning may occur with nausea, unconsciousness, and then death possible if the source of cyanide intake is not removed and treatment provided. Even after washing the skin, the victim should be watched for at least 1 to 2 hours because absorbed cyanide can continue to work into the bloodstream. Wash clothing before reuse and destroy contaminated shoes.

E. Medical Treatment

Medical treatment is normally provided by a physician, but might be provided by a professionally trained "qualified medical person" where a need exists and where state and local laws permit.

While preparing for sodium nitrite and sodium thiosulfate injections, use amyl nitrite and oxygen as outlined in paragraph A. When ready and if the victim is not responding to first aid, first inject the solution of sodium nitrite (10 mL of a 3% solution) intravenously at the rate of 2.5 mL/minute, then immediately inject the sodium thiosulfate (50 mL of a 25% solution) at the same rate, taking care to avoid extravasation.

This is a fairly lengthy treatment (24 minutes) since a total of 10 + 50, or 60 mL is injected at a rate of 2.5 mL/minute. Consideration should be given to the size and condition of the victim as treatment is proceeding. The above sodium nitrite injection is about one-third of a lethal dose, so care should be taken to avoid excessive use. It is not essential that full quantities be given, just because treatment was started. Injections can be stopped at any point if recovery is evident.

Watch patient continuously for 24-48 hours if cyanide exposure was severe. If there is any return of symptoms during this period, repeat this treatment using one-half the amounts of sodium nitrite and sodium thiosulfate solutions. Caution should be used to avoid overuse of medical treatment chemicals as the prescribed dose is about 1/3 the lethal dose for an average individual.

If signs of excessive methemoglobinemia develop (i.e., blue skin and mucous membranes, vomiting, shock and coma), 1% methylene blue solution should be given intravenously. A total dose of 1 to 2 mg/kg of body weight should be administered over a period of five to ten minutes and should be repeated in one hour if necessary. In addition, oxygen inhalation will be helpful. Transfusion of whole fresh blood may be considered if there has been mechanical injury with external or internal bleeding and simultaneous cyanide exposure.

Du Pont's experience in treating cyanide poison cases is that first aid procedures using amyl nitrite and oxygen were effective and the only treatment needed in most cases. Medical treatment, using intravenous injections, was used in a few cases. Both procedures have been successful.

PROTECTION INFORMATION

GENERALLY APPLICABLE CONTROL MEASURES

Good general ventilation should be provided to keep dust, mist, and HCN gas below exposure limits.

PERSONAL PROTECTIVE EQUIPMENT

Recommended Minimum Protection—chemical splash goggles and rubber gloves (butyl or neoprene preferred).

Have available and use as appropriate: face shields; rubber suits, aprons, and boots; disposable toxic dust and mist respirators; self-contained breathing air supply (in case of emergency); HCN detector; first aid and medical treatment supplies,* including oxygen resuscitators.

*See Du Pont Sodium Cyanide Storage and Handling Bulletin for list of supplies.

DISPOSAL INFORMATION

AQUATIC TOXICITY

The compound is highly toxic (96-hour LC50 = 0.5 - 1 mg/L).

SPILL, LEAK OR RELEASE

Sweep up and shovel into a covered container or plastic bag, pending transfer, to secure the spill. Cover and keep spillage dry. Flush spill area with a dilute solution of sodium or calcium hypochlorite. Comply with Federal, State, and local regulations on reporting releases.

WASTE DISPOSAL

Comply with Federal, State, and local regulations. Do not flush cyanide into sewers which may contain an acid. Detoxify with sodium hypochlorite, or hydrogen peroxide; flush to waste water treatment system; or call a licensed disposal contractor.

SHIPPING INFORMATION

DOT(172.101)

PROPER SHIPPING NAME
Sodium Cyanide, Solid

HAZARD CLASS
Poison B

UN NO.
1689

DOT LABEL(S)
Poison

DOT/IMO (172.102)

PROPER SHIPPING NAME
Sodium Cyanide

HAZARD CLASS
Poison B, 6.1

UN NO.
1689

REPORTABLE QUANTITY
10 lb/4.54 kg

SHIPPING CONTAINERS
CYANO-DOL(R) railcars and trucks; hopper railcars; Flo-Bins(R) (3000 lb. net); 2000 lb. bag in a box; 100 kilo, 100 lb., and 200 lb. steel drums

STORAGE CONDITIONS
Store in properly labeled containers in dry, ventilated, secured areas. Keep containers closed and contents dry. Do not store with acids or acid salts, containers with water or weak alkalis, or oxidizing agents. Do not handle or store food, beverages, or tobacco in cyanide areas. Do not store near combustibles or flammables because of cyanide solution runoff from water used for fire fighting.

ADDITIONAL INFORMATION AND REFERENCES

NPCA -- HMIS RATINGS		NFPA RATINGS	
Health (Acute)	3	Health	3
Flammability	0	Flammability	0
Reactivity	1	Reactivity	0
Personal Protection	-	Unusual Hazards	-

Personal Protection rating to be supplied by user depending on use conditions.

For further information, see Du Pont Sodium Cyanide Storage and Handling Bulletin.

DATE OF LATEST REVISION/REVIEW: 5/87

PERSON RESPONSIBLE FOR MSDS:
J. C. Watts
Du Pont Co.
C&P Dept., Chestnut Run-709
Wilmington, DE 19898
(302) 999-4946

103800B

MATERIAL SAFETY DATA SHEET

Johnson Matthey Catalog Chemicals
Aesar Group/Alfa Products
30 Bond Street
Ward Hill, MA 01835-0747
Emergency Phone (800) 343-0660
Chemtrec (800) 424-9300

IDENTIFICATION

Product Code: 31884 Revision Date: 1/15/91
Product Name: 2-Methyl-1-pentanol
Formula: $CH_3CH_2CH_2CH(CH_3)CH_2OH$
Chemical Nature: Alcohol
% Activity: 100%

PHYSICAL DATA

Boiling Point: 148oC
Freeze Point: No data
Specific Gravity: 0.8254 g/ml
Vapor Pressure at 20oC: No data
Vapor Density (Air=1): 3.5 g/l
Solubility in H2O: Insoluble
Percent Volatiles by Weight: 100
Ionic Nature: No
Appearance and Odor: Colorless liquid.

HAZARDOUS INGREDIENTS

Material	%	TLV/TWA
2-Methyl-1-pentanol CAS# 105-30-6	100	Not established

FIRE AND EXPLOSION HAZARD DATA

Flash Point: 124oF
Autoignition Temperature: 590oF
Flammable Limits in Air, % by volume: Lower 1.1
Upper 9.65
Extinguishing Media: Use water, carbon dioxide, dry chemical extinguishing agents, dry sand, or dry ground dolomite.
Special Fire Fighting Procedures: No special firefighting procedures needed. Use normal procedures which include wearing NIOSH/MSHA approved self-contained breathing apparatus, flame and chemical resistant clothing, hats, boots and gloves. If without risk, remove material from fire area. Cool container with water from maximum distance.

Unusual Fire and Explosion Hazards: None known

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HEALTH HAZARD DATA

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Threshold Limit Value: Not established
Effects of Overexposure: May irritate skin and eyes on contact
Emergency and First Aid Procedures: Remove from exposure. Eyes: Flush with copious amounts of water for at least 15 minutes. Skin: Remove any contaminated clothing. Flood skin with large volumes of water for 15 minutes. Ingestion/Inhalation: Seek prompt, competent medical attention.

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REACTIVITY DATA

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Stability: Stable
Conditions to Avoid: Heat, sparks, open flames.
Incompatibility: Oxidizers, acids, acid fumes.
Hazardous Decomposition Products: CO, CO2
Hazardous Polymerization: Will not occur
Conditions to Avoid: None

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SPILL OR LEAK PROCEDURES

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Steps to be Taken if Material is Released or Spilled: Wearing full protective clothing and respiratory protection , eliminate all sources of ignition. Cover spill with dry sand or dry vermiculite, mix well and carefully transfer to a well-marked container. Close container tightly. Submit or retain for disposal.
Waste Disposal Method: Consult state, local, and federal regulations for proper disposal.

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SPECIAL PROTECTION INFORMATION

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Respiratory Protection: NIOSH/MSHA approved organic vapor respirator for ordinary use and self-contained breathing apparatus for emergency use.
Ventilation- Local exhaust: Acceptable
Mechanical: Not necessary
Special: Not necessary
Other: Not necessary
Protective Gloves: Rubber
Eye Protection: OSHA approved safety goggles
Other Protective Equipment: Lab coat and apron, flame and chemical resistant coveralls, eyewash capable of sustained flushing, safety drench shower and hygienic facilities for washing.

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SPECIAL PRECAUTIONS

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Precautionary Labeling: Danger: Flammable, may irritate skin and eyes

Other Handling and Storage Conditions: Keep container tightly closed. Store in a cool, dry, well-ventilated area. Wash thoroughly after use.

Employers should use this information only as a supplement to other information gathered by them, and should make independent judgement of suitability of this information to ensure proper use and protect the health and safety of employees. This information is furnished without warranty, and any use of the product not in conformance with this Material Safety Data Sheet, or in combination with any other product or process, is the responsibility of the user.

Johnson Matthey

J. T. BAKER CHEMICAL CO. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865
M A T E R I A L S A F E T Y D A T A S H E E T
24-HOUR EMERGENCY TELEPHONE -- (201) 859-2151
CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8802

C0407 -01 **CALCIUM HYDROXIDE,** PAGE: 1
EFFECTIVE: 09/26/85 ISSUED: 01/23/86

SECTION I - PRODUCT IDENTIFICATION

PRODUCT NAME: CALCIUM HYDROXIDE
FORMULA: CA(OH)2
FORMULA WT: 74.09
CAS NO.: 01305-62-0
NIOSH/RTECS NO.: EW2800000
COMMON SYNONYMS: CALCIUM HYDRATE; SLAKED LIME
PRODUCT CODES: 1372,5143,5033,1374

PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 1
FLAMMABILITY - 0
REACTIVITY - 1
CONTACT - 2

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

PRECAUTIONARY LABEL STATEMENTS

WARNING
CAUSES IRRITATION
AVOID CONTACT WITH EYES, SKIN, CLOTHING.
KEEP IN TIGHTLY CLOSED CONTAINER. WASH THOROUGHLY AFTER HANDLING.

SECTION II - HAZARDOUS COMPONENTS

COMPONENT	%	CAS NO.
CALCIUM HYDROXIDE	90-100	1305-62-0

SECTION III - PHYSICAL DATA

BOILING POINT: N/A
VAPOR PRESSURE(MM HG): N/A

MELTING POINT: 580 C (1076 F)
VAPOR DENSITY(AIR=1): 2.5

SPECIFIC GRAVITY: 2.24 (H2O=1)
EVAPORATION RATE: N/A (BUTYL ACETATE=1)

SOLUBILITY(H2O): NEGLIGIBLE (LESS THAN 0.1 %)
% VOLATILES BY VOLUME: 0

APPEARANCE & ODOR: SOFT, ODORLESS SOLID OR CRYSTALS.

CONTINUED ON PAGE: 2

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: N/A

FIRE EXTINGUISHING MEDIA
USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE (TLV/TWA): 5 MG/M3 (PPM)

TOXICITY: LD50 (ORAL-RAT)(MG/KG) - 7340

EFFECTS OF OVEREXPOSURE
DUST MAY IRRITATE NOSE AND THROAT.
CONTACT WITH SKIN OR EYES MAY CAUSE IRRITATION.

EMERGENCY AND FIRST AID PROCEDURES
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. FLUSH SKIN WITH WATER.

SECTION VI - REACTIVITY DATA

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

INCOMPATIBLES: STRONG ACIDS

SECTION VII - SPILL AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE
WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING. WITH CLEAN SHOVEL, CAREFULLY PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER; REMOVE FROM AREA. FLUSH SPILL AREA WITH WATER.

DISPOSAL PROCEDURE
DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

SECTION VIII - PROTECTIVE EQUIPMENT

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.

RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS ABOVE 2 PPM, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GLASSES WITH SIDESHIELDS, UNIFORM, RUBBER

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J. T. BAKER CHEMICAL CO. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

M A T E R I A L S A F E T Y D A T A S H E E T

24-HOUR EMERGENCY TELEPHONE -- (201) 859-2151
CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8802

SECTION VIII - PROTECTIVE EQUIPMENT (CONTINUED)

GLOVES ARE RECOMMENDED.

SECTION IX - STORAGE AND HANDLING PRECAUTIONS

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. SUITABLE FOR ANY GENERAL CHEMICAL STORAGE AREA.

SECTION X - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

DOMESTIC (D.O.T.)

PROPER SHIPPING NAME CHEMICALS, N.O.S.

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME CHEMICALS, N.O.S.

(TM) AND (R) DESIGNATE TRADEMARKS.
N/A = NOT APPLICABLE OR NOT AVAILABLE

THE INFORMATION PUBLISHED IN THIS MATERIAL SAFETY DATA SHEET HAS BEEN COMPILED FROM OUR EXPERIENCE AND DATA PRESENTED IN VARIOUS TECHNICAL PUBLICATIONS. IT IS THE USER'S RESPONSIBILITY TO DETERMINE THE SUITABILITY OF THIS INFORMATION FOR THE ADOPTION OF NECESSARY SAFETY PRECAUTIONS. WE RESERVE THE RIGHT TO REVISE MATERIAL SAFETY DATA SHEETS PERIODICALLY AS NEW INFORMATION BECOMES AVAILABLE.

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J.T.BAKER INC., 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

SECTION I - PRODUCT IDENTIFICATION

PRODUCT NAME: FERROUS SULFATE, 7-HYDRATE
COMMON SYNONYMS: IRON (II) SULFATE, HEPTAHYDRATE; COPPERAS; GREEN VITRIOL
CHEMICAL FAMILY: IRON COMPOUNDS
FORMULA: FESO4 7H2O
FORMULA WT.: 278.02
CAS NO.: 7782-63-0
NIOSH/RTECS NO.: NO8510000
PRODUCT USE: LABORATORY REAGENT
PRODUCT CODES: 2070,2075,2074

PRECAUTIONARY LABELING

BAKER SAF-T-DATA* SYSTEM

HEALTH	-	1	SLIGHT
FLAMMABILITY	-	0	NONE
REACTIVITY	-	0	NONE
CONTACT	-	0	NONE

LABORATORY PROTECTIVE EQUIPMENT

GOGGLES; LAB COAT

U.S. PRECAUTIONARY LABELING

DURING USE AVOID CONTACT WITH EYES, SKIN, CLOTHING. WASH THOROUGHLY AFTER HANDLING. WHEN NOT IN USE KEEP IN TIGHTLY CLOSED CONTAINER.

INTERNATIONAL LABELING

HARMFUL IF SWALLOWED.
AVOID CONTACT WITH SKIN.

SAF-T-DATA* STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

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SECTION II - COMPONENTS

COMPONENT	CAS NO.	WEIGHT %	OSHA/PEL	ACGIH/TLV
FERROUS SULFATE, 7-HYDRATE	7782-63-0	99-100	1 MG/M3	1 MG/M3

TLV AND PEL ARE FOR IRON SALTS, SOLUBLE, AS FE.

SECTION III - PHYSICAL DATA

BOILING POINT: N/A

VAPOR PRESSURE (MMHG): N/A

MELTING POINT: N/A

VAPOR DENSITY (AIR=1): N/A

SPECIFIC GRAVITY: 1.90
(H2O=1)

EVAPORATION RATE: N/A

SOLUBILITY(H2O): APPRECIABLE (>10%)

% VOLATILES BY VOLUME: 0
(21 C)

PH: N/A

ODOR THRESHOLD (P.P.M.): N/A

PHYSICAL STATE: SOLID

COEFFICIENT WATER/OIL DISTRIBUTION: N/A

APPEARANCE & ODOR: BLUE-GREEN CRYSTALS OR GRANULES. ODORLESS.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (CLOSED CUP): N/A

AUTOIGNITION TEMPERATURE: N/A

FLAMMABLE LIMITS: UPPER - N/A LOWER - N/A

FIRE EXTINQUISHING MEDIA
USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

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SECTION IV - FIRE AND EXPLOSION HAZARD DATA (CONTINUED)

SPECIAL FIRE-FIGHTING PROCEDURES
FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE.

UNUSUAL FIRE & EXPLOSION HAZARDS
NONE IDENTIFIED.

TOXIC GASES PRODUCED
SULFUR DIOXIDE

EXPLOSION DATA-SENSITIVITY TO MECHANICAL IMPACT
NONE IDENTIFIED.

EXPLOSION DATA-SENSITIVITY TO STATIC DISCHARGE
NONE IDENTIFIED.

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE (TLV/TWA): 1 MG/M3

TLV IS FOR IRON SALTS, SOLUBLE, AS FE.

SHORT-TERM EXPOSURE LIMIT (STEL): NOT ESTABLISHED

PERMISSIBLE EXPOSURE LIMIT (PEL): 1 MG/M3

PEL IS FOR IRON SALTS, SOLUBLE, AS FE.

TOXICITY OF COMPONENTS

ORAL MOUSE LD50 FOR FERROUS SULFATE, 7-HYDRATE 1520 MG/KG
INTRAVENOUS MOUSE LD50 FOR FERROUS SULFATE, 7-HYDRATE 51 MG/KG
CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

CARCINOGENICITY
NONE IDENTIFIED.

CONTINUED ON PAGE: 4

SECTION V - HEALTH HAZARD DATA (CONTINUED)

REPRODUCTIVE EFFECTS
NONE IDENTIFIED.

EFFECTS OF OVEREXPOSURE

INHALATION: NONE IDENTIFIED

SKIN CONTACT: NONE IDENTIFIED

EYE CONTACT: NONE IDENTIFIED

SKIN ABSORPTION: NONE IDENTIFIED

INGESTION: NONE IDENTIFIED

CHRONIC EFFECTS: NONE IDENTIFIED

TARGET ORGANS
EYES, SKIN

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
NONE IDENTIFIED

PRIMARY ROUTES OF ENTRY
NONE INDICATED

EMERGENCY AND FIRST AID PROCEDURES

INGESTION: IF SWALLOWED AND THE PERSON IS CONSCIOUS, IMMEDIATELY GIVE LARGE AMOUNTS OF WATER. GET MEDICAL ATTENTION.

INHALATION: IF A PERSON BREATHES IN LARGE AMOUNTS, MOVE THE EXPOSED PERSON TO FRESH AIR.

SKIN CONTACT: IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH PLENTY OF SOAP AND WATER FOR AT LEAST 15 MINUTES.

EYE CONTACT: IN CASE OF EYE CONTACT, IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES.

SARA/TITLE III HAZARD CATEGORIES AND LISTS

ACUTE: YES CHRONIC: YES FLAMMABILITY: NO PRESSURE: NO REACTIVITY: NO

CONTINUED ON PAGE: 5

SECTION V - HEALTH HAZARD DATA (CONTINUED)

EXTREMELY HAZARDOUS SUBSTANCE: NO
CERCLA HAZARDOUS SUBSTANCE: YES CONTAINS FERROUS SULFATE (RQ = 1000 LBS)
TOXIC CHEMICALS: NO
TSCA INVENTORY: YES

SECTION VI - REACTIVITY DATA

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: MOISTURE

INCOMPATIBLES: STRONG BASES, CARBONATES, POTASSIUM

DECOMPOSITION PRODUCTS: OXIDES OF SULFUR

SECTION VII - SPILL & DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE
WEAR SUITABLE PROTECTIVE CLOTHING. CAREFULLY SWEEP UP AND REMOVE.

DISPOSAL PROCEDURE
DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

SECTION VIII - INDUSTRIAL PROTECTIVE EQUIPMENT

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.

RESPIRATORY PROTECTION: NONE REQUIRED WHERE ADEQUATE VENTILATION CONDITIONS EXIST. IF AIRBORNE CONCENTRATION EXCEEDS TLV, A DUST/MIST RESPIRATOR IS RECOMMENDED. IF CONCENTRATION EXCEEDS CAPACITY OF RESPIRATOR, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GOGGLES, PROPER GLOVES ARE RECOMMENDED.

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IN, CHEMICAL HANDLING. THE USER IS RESPONSIBLE FOR DETERMINING THE PRECAUTIONS AND DANGERS OF THIS CHEMICAL FOR HIS OR HER PARTICULAR APPLICATION. DEPENDING ON USAGE, PROTECTIVE CLOTHING INCLUDING EYE AND FACE GUARDS AND RESPIRATORS MUST BE USED TO AVOID CONTACT WITH MATERIAL OR BREATHING CHEMICAL VAPORS/FUMES.
EXPOSURE TO THIS PRODUCT MAY HAVE SERIOUS ADVERSE HEALTH EFFECTS. THIS CHEMICAL MAY INTERACT WITH OTHER SUBSTANCES. SINCE THE POTENTIAL USES ARE SO VARIED, BAKER CANNOT WARN OF ALL OF THE POTENTIAL DANGERS OF USE OR INTERACTION WITH OTHER CHEMICALS OR MATERIALS. BAKER WARRANTS THAT THE CHEMICAL MEETS THE SPECIFICATIONS SET FORTH ON THE LABEL.
BAKER DISCLAIMS ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED WITH REGARD TO THE PRODUCT SUPPLIED HEREUNDER, ITS MERCHANTABILITY OR ITS FITNESS FOR A PARTICULAR PURPOSE.
THE USER SHOULD RECOGNIZE THAT THIS PRODUCT CAN CAUSE SEVERE INJURY AND EVEN DEATH, ESPECIALLY IF IMPROPERLY HANDLED OR THE KNOWN DANGERS OF USE ARE NOT HEEDED. READ ALL PRECAUTIONARY INFORMATION. AS NEW DOCUMENTED GENERAL SAFETY INFORMATION BECOMES AVAILABLE, BAKER WILL PERIODICALLY REVISE THIS MATERIAL SAFETY DATA SHEET. IF YOU HAVE ANY QUESTIONS, PLEASE CALL CUSTOMER SERVICE (1-800-JTBAKER) FOR ASSISTANCE.

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