SOURCE EMISSION TESTING
ON
GOLD ROASTER STACK

SEPTEMBER 22-23, 1998

Prepared for:

ROYAL OAK MINES INC.
N.W.T. DIVISION
P.O. BAG 3000
YELLOWKNIFE, N.W.T.
X1A 2M2

ATTN: BRIAN CROSS

DATE: OCTOBER 07, 1998
FILE: 7640/9801

Prepared by:

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Director of Operations

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October 7, 1998

Royal Oak Mines Inc.
N.W.T. Division
P.O. Bag 3000
Yellowknife, N.W.T.
X1A 2M2

ATTENTION: Brian Cross

Re: Source Emission Survey - Gold Roaster Stack
Entech File Number 7640/9801

The attached report presents the results of the source emission survey conducted by Entech Environmental Services Ltd., on September 22-23, 1998.

At this time, testing was performed on the Gold Roaster Stack to determine the concentrations and emission rates of arsenic and sulphur dioxide.

A total of three tests were completed with the results indicating the following :

	Average	Maximum	Minimum
Arsenic			
- mg/m3 dry at Ref.	2.95	4.54	1.94
- kg/h	0.145	0.224	0.102
Sulphur Dioxide			
- g/m3 dry at Ref.	33.59	35.56	32.20
- kg/h	1660.5	1757.0	1499.8

* ref - 25 C and 760 mm Hg.

Should you have any questions concerning the results or if we may be of further assistance, please contact us at your earliest convenience.

Yours Truly
Entech Environmental Services

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Introduction

Entech Environmental Services Ltd., working on behalf of Royal Oak Mines, conducted a compliance source emission survey at the Royal Oak Mines, N.W.T. Division, on September 22-23, 1998. The purpose of the survey was to determine the concentrations and emission rates of arsenic and sulphur dioxide from the Gold Roaster Stack.

Discussion

The compliance source emission survey consisted of three tests, during each of which the following flue gas parameters were determined:

- flue gas water concentration,
- flue gas composition and molecular weight,
- velocity profiles, temperature and static pressure,
- arsenic concentration and
- sulphur dioxide concentration.

There were no problems reported during the collection of the samples or during the subsequent analysis.

Calculations and Results

The results of the test program are summarized on table 1 and detailed in the appendices.
In all, three appendices are attached which provide the detailed computer output, copies of the field data sheets and point by point isokinetics results.

Methods and Procedures

Sampling and analysis were conducted as follows;

- water determination.....EPS 1/RM/8
- flue gas composition and molecular weight.....EPS 1/RM/8
- velocity profiles, temperature and static.....EPS 1/RM/8
- arsenic determination.....EPS 1-AP-79-1
- sulphur dioxide determination.....EPS 1-AP-74-3

ROASTER CONTROL QUEST September 23/98

Mineralogy Calculations

Atomic weights Used -	Arsenopyrite FeAsS	162.8286	Arsenic Trioxide	197.84
	Stibnite Sb2S3	339.6800	Scorodite FeAsO4	194.77
	Pyrite FeS2	119.9670	Antimony Trioxide	291.50
	Iron	55.8470	Nitrogen Gas N2	28.01
	Arsenic	74.9216	Sulphur Dioxide SO2	64.06
	Sulphur	32.0660	Hematite Fe2O3	159.69
	Antimony	121.7590	Quartz SiO2	60.08
	Oxygen	15.9994	Sulphur Trioxide SO3	80.06

		Assays				Tonnage			
		S	As	Fe	Sb	S	As	Fe	Sb
Product	TONNAGE	%	%	%	%	Tons	Tons	Tons	Tons
Assayed Mill Feed	897.1	1.70%	0.74%	6.75%	0.01%	15.25	6.64	60.55	0.09
Flotation Concentrate	80.1	17.15%	6.95%	24.25%	0.70%	13.73	5.56	19.41	0.56
Roaster Feed Inventory	(60.6)					(7.05)	(3.01)	(11.52)	(0.49)
Roaster Feed	149.6	14.78%	6.10%	22.69%	0.75%	20.78	8.58	30.93	1.05
Roaster Calcine	109.3	2.25%	1.16%	28.00%	0.41%	2.46	1.27	30.61	0.45
Hot Cottrell Dust	13.37	3.79%	1.32%	17.00%	1.25%	0.51	0.18	2.27	0.17
Baghouse Dust	11.12		64.14%	1.98%	1.04%		7.13	0.22	0.12
Stack						17.68			
Roasting Products Tons						20.65	8.58	33.10	0.73

	Mill Feed	F Conc	R Feed	R Calcine	HCD	BHD	Calc RC
Arsenopyrite - Tons	14.43	12.09	18.42	0.64	0.013		New RF
Fe in Arsenopyrite - Tons	4.95	4.15	6.32	0.22	0.005		Calc RF
S in Arsenopyrite - Tons	2.84	2.38	3.63	0.13	0.003		
As in Arsenopyrite - Tons	6.64	5.56	8.47	0.30	0.006		
As in Arsenate - Tons			0.094	0.966	0.165		
As in Silicates - Tons			0.0086	0.005	0.005		
Scorodite - Tons			0.245	2.512	0.430	0.768	
Stibnite Sb2S3 - Tons	0.13	0.78	1.47	0.63			
Antimony Tons	0.09	0.56	1.05	0.45	0.17	0.12	
S in Stibnite - Tons	0.04	0.22	0.42	0.18			
Total S Tons	15.25	13.73	20.78	2.46			
Total S avail. for Pyrite	12.37	11.13	16.74	2.16			
Total Fe avail. for Pyrite			19.08	2.41	0.44		
Possible Pyrite / S - Tons	23.15	20.82	31.32	4.03			
Possible Pyrite / Fe - Tons			40.99	5.18	0.947		
Pyrite : FeS2 - Tons	23.15	20.82	31.32	4.03	0.947		
S in Pyrite - Tons	12.37	11.13	16.74	2.16	0.51		
S as Sulphate - Tons			0.00	0.00			

	Mill Feed	F Conc	R Feed	R Calcine	HCD	BHD
% Arsenopyrite	1.61%	15.10%	13.10%	0.59%	0.10%	
% Stibnite	0.01%	0.98%	1.05%	0.57%		
% Pyrite	2.58%	26.01%	22.27%	3.69%	7.08%	
% Scorodite			0.17%	2.30%	3.21%	6.91%

Roasting

Scorodite Content of BHD =	0.77 Tons FeAsO4	Arsenopyrite in HCD =	0.01 Tons FeAsS
As in BHD Scorodite =	0.30 Tons As	Scorodite in HCD =	0.43 Tons FeAsO4
As in BHD as As2O3 =	9.03 Tons As2O3	Pyrite in HCD =	0.95 Tons FeS2
Antimony Trioxide in BHD =	0.14 Tons Sb2O3	6.84 Hematite in HCD =	1.49 Tons Fe2O3
Quartz in BHD =	1.19 Tons of Quartz	Sb2O3 in HCD =	0.20 Tons Sb2O3
		Quartz in HCD =	10.29 Tons Quartz

Total BHD Tons =	11.12		Total HCD Tons =	13.37	
Assume:	RF	RC	HCD		
% Sulphide As	98.8%	23.4%	3.5%	* From Lakefield Research	
% Arsenate As	1.1%	76.2%	93.6%		
% Silicate As	0.1%	0.4%	2.9%		
Actual Tons As	8.58	1.27	0.18	7.13 (Baghouse As)	
Tons Sulphide As	8.47	0.30	0.01	8.17 Sulphide As Tons Eliminated	
Tons Arsenate As	0.094	0.97	0.17	1.33 mate Created as As)	
Tons Silicate As	0.009	0.005	0.005		
% Sulphide As Eliminated =		96.43%			
% As Eliminated =		83.16% exit to Baghouse		Daily Sheet % As Elimination	85.06%
% As Eliminated =		85.22% from Feed to Calcine			
As2O3 Gasified =	6.84	x((197.84/2*74.922)) =		9.05 tons As2O3	
FeAsO4 Created =	1.33	x((194.77/74.922)) =		3.45 tons FeAsO4	
lb moles As2O3 =	9.05	x 2000/197.84 =	91.25		
lb moles FeAsO4 =	3.45	x 2000/194.77 =	35.57		
Gaseous Volume of As2O3 =	91.25	x 359 =	32,760 NCF As2O3		
Oxygen Required to Roast Arsenopyrite to As2O3 =					
5 x 359 x 2000 / 2 x 74.92 x	6.84	equals	163,800 NCF O2		
Reaction 1 also produces 2 mols of SO2 for each 5 mols of O2					
163,800	x 2 / 5 =	65,520 NCF SO2			
Oxygen Required to Roast Arsenopyrite to FeAsO4 =					
3 x 359 x 2000 / 74.92 x	1.33	equals	38,310 NCF O2		
Reaction 3 also produces 1 mols of SO2 for each 3 mols of O2					
38,310	x 1 / 3 =	12,770 NCF SO2			
Stibnite :					
Sb Eliminated = BHD Sb + HCD Sb Tons =			0.28 Sb Tons		
Sb2O3 Gasified =	0.28	x 291.496/(2*121.5)=	0.34 Sb2O3Tons		
Volume Sb2O3 =	0.34	x 2000 x 359 /291.496 =	834 NCF Sb2O3		
Oxygen Required to Roast Stibnite to Sb2O3 =					
9 x 359 x 2000 / 4 x 121.7	times	0.28	equals	3,753 NCF O2	
Reaction 4 also produces 6 mols of SO2 for each 9 mols of O2					
3,753	x 6 / 9 =	2,502 NCF SO2			

SULPHUR ELIMINATION

Assume:	RF	RC	HCD							
% Sulphide Fe	82.1%	8.0%	19.6%	* From Lakefield Research						
% Sulphide As	98.8%	23.4%	3.5%							
% Oxide Fe	17.1%	91.0%	51.2%							
Iron Content of RC		30.61 Tons Fe		Iron Content of HCD		2.27 Tons Fe				
Iron as Sulphide in RC		2.63 Tons Fe		Fe as Sulphide in HCD		0.45 Tons Fe		Fe as HCD Oxide		
Sulphur Content of RC		2.45 Tons S		As Content of HCD		0.18 Tons As		Fe as HCD Silicate		
Arsenic Content of RC		1.27 Tons As		As with unroasted S		0.01 Tons As				
Arsenic with unroasted S		0.30 Tons As		FeAsS in HCD		0.013 tons FeAsS				
FeAsS in Calcine	0.30	times	162.82/74.91 =		0.64 tons FeAsS		Iron in FeAsS in HCD		0.00	
Iron in FeAsS in Calcine	0.64	times	55.85/162.82 =		0.22 tons Fe		Fe as other S in HCD		0.44	
Iron as other Sulphide in RC	2.63	less	0.22 =		2.41 tons Fe		Fe as Pyrite in HCD		0.95	
S in FeAsS in Calcine	0.64	times	32.06/162.82 =		0.13 tons S		Scorodite in HCD		0.45	
Sb2S3 in Calcine	0.45	times	339.68/243.5 =		0.63 tons Sb2S3		Fe in HCD Scorodite		0.12	
S in Sb2S3 in Calcine	0.63	times	96.18/339.68 =		0.18 tons S		Remaining Oxide Iron		1.04	
S Remaining in Calcine	2.46	less	0.13	less	0.16 equals	2.16 tons S				
Sulphide Iron as Pyrite	2.41	times	119.97/55.85 =		5.18 tons Pyrite		Hematite in HCD		1.49	
Sulphur needed for Pyrite	5.18	times	64.12/119.97 =		2.77 tons S					
Sulphate S in Calcine	2.16	less	2.77 equals		-0.61 tons Sulphate S					
Max Pyrite in Calcine	4.03 tons Pyrite									
Assume sulphate come from reacting SO2, O2, H2O, & gangue										
Pyrite Roasted in Roast	31.32	less	4.03	less	0.95 equals	26.34 tons Pyrite				
OXYGEN to roast Pyrite										
5.5 x 359 x2000/2 x 119.97	times	26.34	equals	433,475 NCF O2						
Volume of SO2	433,475	times	4/5.5 =	315,255 NCF SO2						
SO3 Produced	0.00	Tons SO3	0.00 lb mol SO3	0 NCF SO3						
OXYGEN to Create SO3	0 NCF O2		0.00 lb mol O2							

SO2 used to Make SO3	0.09	Tons SO2	x 2000/64.048 x 359 =		0 NCF SO2	0.00 lb mol SO2	
CALCULATION OF OFF - GASES							
Water Content							
Avg Fil Slurry Density	2237	or	76.57% Solids				
Wt of Slurry Fil Tons % Sol	183.64	tons					
Wt of Dry Solids	140.60	tons					
Wt of Water in Slurry	43.03	tons H2O					
1st Stage Spray	0.17	lgpm	1.22	stpd H2O			
Cloud Water	1.07	lgpm	7.70	stpd H2O			
2nd Stage Spray	1.40	lgpm	10.08	stpd H2O			
Total	2.64	lgpm	19.01	stpd H2O			
Total Tpd	19.01	tons H2O					
Total Tpd Water	62.04	tons H2O					
Water Volume	2,474,824	NCF					
SO2 Volume	396,047	NCF					
O2 Volume Reacting	639,338	NCF					
Air is 20.9% O2 by volume (or 23.2% by weight)							
Volume of Air for Roasting: O2 volume / 0.209 =			3,059,036				
Less O2 Volume Gives the N2 Volume			2,419,697				
EXCESS AIR							
Feed Gas	15.69	SCFM					
1st Stage Air	2,743	SCFM	Total 1st St. =	2758.00	SCFM		
Transfer Air	75	SCFM		3,757,669	NCF Air / Day		
2nd Stage Air	960	SCFM	1st St. AF =	1.25			
Total	3,733	SCFM					
or	5,086,682	NCF Air / Day					
Air Factor = Actual/ Theoretical =		**1.66**					
O2 Content of Actual Air		1,063,117	NCF O2 / Day				
Less O2 Used for Roasting		639,338	NCF O2 / Day				
EXCESS O2		**423,778**	**NCF O2 / Day**				
N2 Content of Excess Air	1,603,868	NCF					
Plus N2 with reacting O2	2,419,697	NCF					
Total N2	**4,023,565**	**NCF**					

This calculation includes the inerts that will pass through the cyclones, but not the inerts that will be caught in the cyclone under-flows.

OFF-GAS Composition

	NCF	% by Vol	lb Mols	stpd	BTU/lb Mol	BTU/Day
Total Gas	7.352E+06	100.00	20,479	282.61	6,562	1.35E+08
N2	4.024E+06	54.73	11,253	156.93	5,939	6.625E+07
H2O	2.475E+06	33.66	6,894	62.04	6,998	4.824E+07
O2	4.238E+05	5.76	1,180	16.89	6,088	7.186E+06
SO2	3.960E+05	5.39	1,103	35.33	8,925	9.846E+06
As2O3	3.276E+04	0.45	91	0.63	17,551	1.600E+06
SO3	0.000E+00	0.00	0	0.00	12,467	0.000E+00
Sb2O3	8.339E+02	0.01	2	0.34	22,570	5.243E+04
Total Inerts			429.06	15.13	12,221	5.24E+06
Quartz			382.17	11.48	11,878	4.538E+06
Hematite			18.64	1.49	25,758	4.801E+05
Scorodite			12.30	1.20		
Pyrite			15.79	0.95	14,187	2.240E+05
Arsenopyrite			0.16	0.01		
Combined Total			2.693E+04	2.977E+02	6,629	1.784E+08

@ 2.8 gm/cc or 174.8 lb/ft3 15.13 x 2000/174.8* minutes = 0.120 ACFM Inerts

Heat Content of Gases Exiting 2nd Stage @ 848.32 Deg F 726.7 Deg K 453.3 Deg C

7,351,899 x ((460 + 848.32) / (460 + 32)) = 19,562,884 ACF/Day

Divided by minutes = 13,576 ACFM

Or at Standard Conditions: 7,770,204 SCF / Day or 5,396 SCFM

Heat Content of Gases at Cottrell Inlet @ 770.00 Deg F 665.2 Deg K 410.9 Deg C

(DOES NOT INCLUDE TEMPERING AIR)

7,351,899 x ((460 + 770) / (460 + 32)) = 18,379,522 ACF/Day

Divided by minutes = 12,764 ACFM

Or at Standard Conditions: 7,770,204 SCF / Day or 5,396 SCFM

	NCF	lb Mols	BTU/lb Mol	BTU/Day
N2	4.024E+06	1.121E+04	5,321	5.964E+07
SO2	3.960E+05	1.103E+03	7,982	8.806E+06
SO3	0.000E+00	0.000E+00	11,037	0.000E+00
O2	4.238E+05	1.180E+03	5,481	6.471E+06
As2O3	3.276E+04	9.125E+01	15,867	1.448E+06
Sb2O3	8.339E+02	2.323E+00	20,130	4.676E+04
H2O	2.475E+06	6.894E+03	6,280	4.329E+07
Total Gas	7.352E+06	2.048E+04	5,845	1.197E+08
Inerts : Arsenopyrite		0.16		

Scorodite	12.30			
Pyrite	15.79	12,611	1.992E+05	
Hematite	18.64	22,973	4.282E+05	
Quartz	382.17	10,566	4.038E+06	
Total Inerts	429.06	10,874	4.665E+06	
Combined Total	20,907.64	5,948	1.244E+08	BTU/Day

The Cottrell Inlet Gases include the Tempering Air and this air is at 770.00 Deg F 683.2 Deg K

Heat in must equal heat out. Therefore, the Tempering Air must carry ;

1.384E+08 less 1.244E+08 equals 1.404E+07 BTU/Day

The Heat Capacity of air at this temp is : 5,300.4 BTU/lb Mol I is valid only down to 32 Deg F

Average Outside Air Temperature is : 58.90 Deg F

Extra Heat to Heat air to 32 Deg F 0.0 BTU/lb Mol

Total Heat to Tempering Air 5,300.4 BTU/lb Mol

Quantity of Tempering Air

14,041,511 divided by 5,300 equals 2,649 lb Mol

Volume of Tempering Air

359/ Operating Minutes x 2649.1 x ((460 + 60)/(460 + 32)) = 696.9 SCFM

Volume of Cottrell Inlet Gases

Rooster Gas	20,479	lb Mol
Tempering Air	2,649	lb Mol
Total	23,128	lb Mol

359/ Operating Minutes x 23,128 x ((Inlet T Deg F+ 460)/(460 + 32)) = 14,414.7 ACFM

Cottrell Dust Catch	lb Mols	Tons	%	% Fe	% As	% Sb	Locked in Au ozs	Au oz/Tn
Quartz	342.67	10.29	76.98%	4.98%	0.04%		0.02	0.60
Hematite	18.64	1.49	11.13%	7.78%			0.38	0.25
Pyrite	15.79	0.95	7.08%	3.30%				
Scorodite	4.41	0.43	3.21%	0.92%	1.24%		1.85	4.31
Antimony Trioxide	1.37	0.20	1.50%			1.25%		
Arsenopyrite	0.16	0.01	0.10%	0.03%	0.03%		0.12	8.90
Total HCD	383.05	13.37	100.00%	17.00%	1.32%	1.25%	2.37	0.18
DTR Solids		13.37					5.56	0.42

CALCULATION OF QUENCH AIR TO BAGHOUSE

Heat Content of Gases at Cottrell Outlet @ 675.00 Deg F 630.4 Deg K 357.2 Deg C

(ASSUME NO LEAKAGE)

	NCF	lb Mols	BTU/lb Mol	BTU/Day
N2	4.924E+06	11,208	4,613	51,700,847
SO2	3.960E+05	1,103	6,856	7,563,793
O2	4.238E+05	1,180	4,752	5,609,598
As2O3	3.276E+04	91	13,825	1,261,536
Tempering Air	9.510E+05	2,649	4,593	12,168,481
H2O	2.475E+06	6,894	5,421	37,371,446
Total Gas	8.302E+06	23,125	5,002	1.16E+08
Inerts : Scorodite		7.88		
Quartz		39.50	9,028	356,273
Sb2O3		0.95	17,249	16,384
Total Inerts		48.33	7,710	372,656
Combined Total		23,174	5,008	1.16E+08 BTU/Day

The Baghouse Inlet Gases include the Quench Air and this air is at 222.22 Deg F 378.8 Deg K 105.7 Deg C

However, excluding the Quench Air the remaining gases and inerts carry:

	lb Mols	BTU/lb Mol	BTU/Day	
N2	11,208	1,332	14,924,700	
SO2	1,103	1,857	2,049,120	
O2	1,180	1,372	1,619,398	
Tempering Air	2,649	1,328	3,517,251	
H2O	6,894	1,531	10,552,504	
Total Gas	23,034	1,418	32,662,973	BTU/Day

Inerts :				
Scorodite	*7.88*			
Quartz	*39.50*	*2,362*	*93,282*	
Sb2O3	*0.95*	*4,694*	*4,458*	
Arsenic Trioxide	*91.25*	*4,696*	*420,305*	
Total Inerts	*139.59*	*3,711*	*518,045*	*BTU/Day*
Combined Total	*23,174*	*1,432*	*33,181,019*	*BTU/Day*

Heat in must equal heat out. Therefore, the Quench Air must carry ;

1.160E+08	*less*	*3.318E+07*	*equals*	*8.287E+07* *BTU/Day*

The Heat Capacity of air at this temp is : *1,328* *BTU/lb Mol* *it is valid only down to 32 Deg F*

Average Outside Air Temperature is : *38.90* *Deg F*

Extra Heat to Heat air to 32 Deg F *0.0* *BTU/lb Mol*

Total Heat to Quench Air *1,327.7* *BTU/lb Mol*

Quantity of Quench Air

82,867,339	*divided by*	*1,328*	*equals*	*62,414* *lb Mol/Day*

Volume of Quench Air

359' Operating Minutes x *62414.2 x ((460 + 69)/(460 + 32)) =* *16,445.8* *SCFM*

Volume of Baghouse Inlet Gases

	lb Mols	*% Vol*
N2	*11,208*	*13.12%*
SO2	*1,103*	*1.29%*
O2	*1,180*	*1.38%*
H2O	*6,894*	*8.07%*
Tempering Air	*2,649*	*3.10%*
Quench Air	*62,414*	*73.04%*
Total Gas	*85,448*	*100.00%*

359/Operating minutes x *85,448* *x ((460 +* *222)/(460+32)) =* *29,539* *ACFM*

Baghouse Catch

	lb Mols	*lbs*	*Tons*	*%*	*% Fe*	*% As*	*% Sb*
Arsenic Trioxide	*91.25*	*18,054*	*9.03*	*81.18%*		*61.48%*	
Scorodite	*7.88*	*1,536*	*0.77*	*6.91%*	*1.98%*	*2.66%*	
Quartz	*39.50*	*2,373*	*1.19*	*10.67%*			
Sb2O3	*0.95*	*277*	*0.14*	*1.25%*			*1.04%*
Total Dust Catch	*139.59*	*22,240*	*11.12*	*100.00%*	*1.98%*	*64.14%*	*1.04%*

Air is 20.9% O2 by volume (or 23.2% by weight)

Tempering + Quench Air =	*65,063*	*lb Mols*
O2 Content =	*1.360E+04*	*lb Mols*
N2 Content =	*5.147E+04*	*lb Mols*

Stack Gas	*lb Mols*	*% Vol*	*NCFM*	
N2	*62,673*	*73.35%*	*15,625*	
O2	*14,779*	*17.30%*	*3,684*	
H2O	*6,894*	*8.07%*	*1,719*	
SO2	*1,103*	*1.29%*	*275*	
Total Gas	*85,448*	*100.00%*	*21,303*	

IF Stack @ 180 Deg F and no air leakage *27,711* ***ACFM***

ROASTER CONTROL QUEST — September 23/98

Reaction Equations

No. 1 $2FeAsS + 5O2 \Rightarrow Fe2O3 + As2O3 + 2SO2$
Arsenopyrite — Hematite and Arsenic Trioxide

No. 2 $2FeAsS + 6O2 \Rightarrow 2FeAsO4 + 2SO2$
Scorodite

No. 3 $2Sb2S3 + 9O2 \Rightarrow 2Sb2O3 + 6SO2$
Stibnite — Antimony Trioxide

No. 4 $2FeS2 + 5.5O2 \Rightarrow Fe2O3 + 4SO2$
Pyrite

No. 5 $2SO2(g) + O2(g) \Rightarrow 2SO3(g)$

							Tonnage			
Au			S	As	Fe	Sb	S	As	Fe	Sb
ozs	Product	TONNAGE	%	%	%	%	Tons	Tons	Tons	Tons
265.477	Assayed Mill Feed	20,167.2	1.84%	0.79%	6.32%	0.06%	372.0	158.91	1,274.3	11.36
236.061	Flotation Concentrate	1,962.3	17.16%	4.96%	20.41%	0.77%	336.6	97.39	400.5	15.10
(154.818)	Roaster Feed Inventory	(20.6)					-4.4	-20.6	-55.3	-3.3
390.879	Roaster Feed	1,982.9	17.20%	5.95%	22.99%	0.93%	341.06	117.97	455.8	18.38
365.877	Roaster Calcine	1,503.3	3.49%	1.31%	29.43%	0.66%	52.42	19.66	442.5	9.95
19.926	Hot Cottrell Dust	433.37		2.11%	18.31%	1.92%	17.59	9.16	79.4	8.31
2.357	Baghouse Dust	143.72		62.03%	2.87%	1.82%		89.15	4.1	2.62
	Stack						271.80			
388.16	Roasting Products Total Tons						341.81	117.97	525.96	20.88

280.17		Mill Feed	F Conc	R Feed	R Calcine	HCD	BHD
302.45	Arsenopyrite - Tons	345.36	211.65	253.32	10.00	0.697	
388.16	Fe in Arsenopyrite - Tons	118.45	72.59	86.88	3.4292	0.239	
	S in Arsenopyrite - Tons	68.00	41.67	49.88	1.9686	0.137	
	As in Arsenopyrite - Tons	158.91	97.39	116.56	4.6005	0.321	
	As in Arsenate - Tons			1.298	14.981	8.573	
	As in Silicates - Tons			0.118	0.079	0.266	
	Scorodite - Tons			3.373	38.945	22.285	14.386
	Stibnite Sb2S3 - Tons	15.84	21.07	25.64	13.88		
	Antimony Tons	11.36	15.10	18.38	9.95	8.31	2.62
	S in Stibnite - Tons	4.49	5.96	7.26	3.93		
	Total S Tons	371.97	336.65	341.06	52.42	17.59	
	Total S avail. for Pyrite	299.49	289.01	283.92	46.52		
	Total Fe avail. for Pyrite			287.36	34.62	15.32	
	Possible Pyrite / S - Tons	560.33	540.73	531.21	87.04		
	Possible Pyrite / Fe - Tons			617.30	74.37	32.905	
	Pyrite : Fe S2 - Tons	560.33	540.73	531.21	74.37	32.905	
	S in Pyrite - Tons	299.49	289.01	283.92	39.75	17.59	
	S as Soluble Product Sulphate			0.00	6.77		

	Mill Feed	F Conc	R Feed	R Calcine	HCD	BHD
% Arsenopyrite	1.71%	10.79%	12.77%	0.67%	0.16%	433
% Stibnite	0.08%	1.07%	1.29%	0.92%		
% Pyrite	2.78%	27.56%	26.79%	4.95%	7.59%	
% Scorodite			0.17%	2.59%	5.14%	10.01%

Roasting - MTD

Scorodite Content of BHD =	14.39 Tons FeAsO4	Arsenopyrite in HCD =	0.70 Tons FeAsS
As in BHD Scorodite =	5.53 Tons As	Scorodite in HCD =	22.29 Tons FeAsO4
As in BHD as As2O3 =	110.41 Tons As2O3	Pyrite in HCD =	32.90 Tons FeS2
Antimony Trioxide in BHD =	3.13 Tons Sb2O3	83.62 Hematite in HCD =	48.97 Tons Fe2O3
Quartz in BHD =	15.80 Tons of Quartz	Sb2O3 in HCD =	9.95 Tons Sb2O3
		Quartz in HCD =	318.57 Tons Quartz

Total BHD Tons =	143.72			Total HCD Tons =	433.37	
Assume:	RF	RC	HCD			
% Sulphide As	96.8%	23.4%	3.5%	* From Lakefield Research		
% Arsenate As	1.1%	76.2%	93.6%			
% Silicate As	0.1%	0.4%	2.9%			
Actual Tons As	117.97	19.66	9.16	89.15 (Baghouse As)		
Tons Sulphide As	116.56	4.60	0.32	111.64 Sulphide As Tons Eliminated		
Tons Arsenate As	1.30	14.98	8.57	27.79 note Created as As)		
Tons Silicate As	0.118	0.079	0.266			
% Sulphide As Eliminated =		95.78%				
% As Eliminated =		75.97% mill to Baghouse		Daily Sheet % As Elimination	83.14%	
% As Eliminated =		83.34% from Feed to Calcine				
As2O3 Gasified =	83.62	x((197.84/2*74.922)) =		110.41 tons As2O3		
FeAsO4 Created =	27.79	x((194.77/74.922)) =		72.24 tons FeAsO4		
To moles As2O3 =	110.41	x 2000/197.84 =		1116.10		
To moles FeAsO4 =	72.24	x 2000/194.77=		741.83		
Hence Volume of As2O3 =	1116.10	x 359 =		**400,679 NCF As2O3 MTD**		
Oxygen Required to Roast Arsenopyrite to As2O3 =						
5 x 359 x 1000 / 2 x 74.92 x	83.62	equals		2,003,396 NCF O2		
Reaction 1 also produces 2 mols of SO2 for each 5 mols of O2						
	2,003,396	x 2 / 5 =		**801,358 NCF SO2**		
Oxygen Required to Roast Arsenopyrite to FeAsO4 =						
3 x 359 x 2000 / 74.92 x	27.79	equals		798,955 NCF O2		
Reaction 3 also produces 1 mols of SO2 for each 3 mols of O2						
	798,955	x 1 / 3 =		**266,318 NCF SO2**		
Stibnite :						
Sb Eliminated = BHD Sb + HCD Sb Tons =				10.93 Sb Tons		
Sb2O3 Gasified =	10.93	x 291.496/(2*121.5)=		13.08 Sb2O3Tons		
Volume of Sb2O3 =	13.08	x (2000 /291.496) x 359 =		32,218 NCF Sb2O3 MTD		
Oxygen Required to Roast Stibnite to Sb2O3 =						
9 x 359 x 2000 / 4 x 121.7	times	10.93	equals	**144,982 NCF O2**		
Reaction 4 also produces 6 mols of SO2 for each 9 mols of O2						
	144,982	x 6 / 9 =		**96,654 NCF SO2**		
SULPHUR ELIMINATION						
Assume:	RF	RC	HCD			
% Sulphide Fe	82.1%	8.6%	19.6%	* From Lakefield Research		
% Sulphide As	98.8%	23.4%	3.5%			
% Oxide Fe	17.1%	91.0%	51.2%			
	Iron Content of RC	442.46 Tons Fe		Iron Content of HCD	79.57 Tons Fe	Fe as HCD Oxide
1.16	Fe as Sulphide in RC	38.05 Tons Fe		Fe as Sulphide in HCD	15.56 Tons Fe	Fe as HCD Silicate
0.55	Sulphur Content of RC	52.42 Tons S		As Content of HCD	9.16 Tons As	
	Arsenic Content of RC	19.66 Tons As		As with unroasted S	0.32 Tons As	
	Arsenic with unroasted S	4.60 Tons As		FeAsS in HCD	0.70 tons FeAsS	
Tons Fe	FeAsS in Calcine	4.60	times	162.82/74.91 =	10.00 tons FeAsS	Iron in FeAsS in HCD 0.24
Tons Fe	Iron in FeAsS in Calcine	10.00	times	55.85/162.82 =	3.43 tons Fe	Fe as other S in HCD 15.32
tons Pyrite	Iron as other Sulphide in RC	38.05	less	3.43 =	34.62 tons Fe	Fe as Pyrite in HCD 32.90
Tons	S in FeAsS in Calcine	10.00	times	32.06/162.82 =	1.97 tons S	Scorodite in HCD 22.29
Tons Fe	Sb2S3 in Calcine	9.95	times	339.68/243.5 =	13.88 tons Sb2S3	Fe in HCD Scorodite 6.39
Tons Fe	S in Sb2S3 in Calcine	13.88	times	96.18/339.68 =	3.93 tons S	Remaining Oxide Iron 34.25
	S Remaining in Calcine	52.42	less	1.97 less	3.93 equals	46.52 tons S
Tons	Sulphide Iron as Pyrite	34.62	times	119.97/55.85 =	74.37 tons Pyrite	Hematite in HCD 48.97
	Sulphur needed for Pyrite	74.37	times	64.12/119.97 =	39.75 tons S	
	Sulphate S in Calcine	46.52	less	39.75 equals	6.77 tons Sulphate S	
	Max Pyrite in Calcine	74.37 tons Pyrite				
	Assume sulphate come from reacting SO2, O2, H2O, & gangue					
	Pyrite Reacted in Roast	531.21	less	74.37 less	32.90 equals	423.93 tons Pyrite
	OXYGEN to roast Pyrite					
	5.5 x 359 x2000/2 x 119.97	times	423.93	equals	**6,977,368 NCF O2**	
	Volume of SO2	6,977,368	times	4/5.5 =	**5,074,450 NCF SO2**	
	SO3 Produced	16.91	Tons SO3	422.44 lb mol SO3	**151,457 NCF SO3**	
	OXYGEN to Create SO3	75,829 NCF O2		211.22 lb mol O2		

SO2 used to Make SO3 13.53 Tons SO2 x 2000/64.048 x 359 = 151,457 NCF SO2 422.44 lb mol SO2

CALCULATION OF OFF - GASES

Water Content

Avg RF Slurry Density	2,259	or	76.93% Solids
Wt of Slurry RF Tons % S	2,577.53	tons	
Wt of Dry Solids	1,982.91	tons	
Wt of Water in Slurry	595.11	tons H2O	
1st Stage Spray / oper. min	0.23	lgpm	
Closed Water / oper. min	1.16	lgpm	
2nd Stage Spray /oper. min	2.10	lgpm	
Total/ operating minute	3.49	lgpm	
Total MID	350.47	tons H2O	
Total Tpm Water	**945.58**	**tons H2O**	
Water Volume	**3.772E+07**	**NCF MID**	
SO2 Volume	**6,087,324**	**NCF MID**	
O2 Volume Reacting	**1.088E+07**	**NCF**	

Air is 20.9% O2 by volume (or 23.2% by weight)

Volume of Air for Roasting: O2 volume / 0.209 = 47,849,424

Less O2 Volume Gives the N2 Volume 37,848,894

EXCESS AIR

Feed Gun - est.	15.60	SCFM			
1st Stage Air - Avg	2,815	SCFM	Total 1st St. =	2829.85	SCFM
Transfer Air -Avg	74	SCFM		54,023,445	NCF Air / Day
2nd Stage Air- Avg	914	SCFM	1st St. AF =	1.13	
Total Avg	3,818	SCFM			
or (Accumulated Total)	72,807,191	NCF Air / MID			

Air Factor = Actual/ Theoretical = 1.52

O2 Content of Actual Air 15,235,513 NCF O2 / MID

Less O2 Used for Roasting 10,089,338 NCF O2 / MID

EXCESS O2 5.23E+06 NCF O2 / MID

N2 Content of Excess Air 19,812,784 NCF

Plus N2 with reacting O2 37,848,894 NCF

Total N2 57,661,678 NCF MID

OFF-GAS Composition This calculation includes the inerts that will pass through the cyclones, but not the inerts that will be caught in the cyclone under-flows.

	NCF MID	% by Vol	lb Mols	MID tons	BTU/lb Mol	BTU/MID
Total Gas	1.073E+08	100.00	236,846	4,112.1	6,312	1.65E+09
N2	5.766E+07	53.75	160,617	2,249.7	5,716	9.18E+08
H2O	3.772E+07	35.16	105,054	945.6	6,761	7.10E+08
O2	5.235E+06	4.88	14,582	233.3	5,888	8.586E+07
SO2	6.087E+06	5.67	16,956	543.1	8,614	1.461E+08
As2O3	4.007E+05	0.37	1,116	110.4	16,968	1.89E+07
SO3	1.517E+05	0.14	422	16.9	12,011	5.07E+06
Sb2O3	3.222E+04	0.03	90	13.1	21,762	1.95E+06
Total Inerts			12,677	454	11,840	1.50E+08
Quartz			11,153	334.4	11,443	1.27E+08
Hematite			613	49.0	24,887	1.52E+07
Scorodite			377	36.7		
Pyrite			549	32.9	13,664	7.49E+06
Arsenopyrite			9	0.7		
Combined Total			3.11E+05	4.56E+03	6,537	2.03E+09

@ 2.8 gm/cc or 174.8 lb/ft3 453.61 x 2000/174.8*minutes = 0.258 ACFM Inerts

Heat Content of Gases Exiting 2nd Stage @ 822.00 Deg F 712.4 Deg K 439.2 Deg C

107,286,324 x((460 + 823)/(460 + 32)) = 270,685,945 ACF/MID

Divided by minutes = 13,908 ACFM

Or at Standard Conditions: 113,392,049 SCF / MID or 5,639 SCFM

Heat Content of Gases at Cottrell Inlet @ 699.55 Deg F 616.2 Deg K 343.1 Deg C

(DOES NOT INCLUDE TEMPERING AIR)

107,286,324 x((460 + 650)/(460 + 32)) = 241,950,854 ACF/MID

Divided by minutes = 12,031 ACFM

Or at Standard Conditions: 113,392,049 SCF / MID or 5,639 SCFM

	NCF MID	lb Mols	BTU/lb Mol	BTU/Mn.
N2	5.766E+07	1.606E+05	4,424	7.106E+08
SO2	6.087E+06	1.696E+04	6,558	1.112E+08
SO3	1.517E+05	4.224E+02	9,037	3.669E+06
O2	5.235E+06	1.455E+04	4,558	6.643E+07
As2O3	4.007E+05	1.116E+03	13,277	1.482E+07
Sb2O3	3.222E+04	8.974E+01	16,491	1.480E+06
H2O	3.772E+07	1.051E+05	5,194	5.457E+08
Total Gas	1.073E+08	2.988E+05	4,866	1.454E+09
Inerts : Arsenopyrite		8.56		

Scorodite	376.57			
Pyrite	549	10,277	5.637E+06	
Hematite	613	18,808	1.153E+07	
Quartz	11,130	8,614	9.587E+07	
Total Inerts	12,677	8,917	1.136E+08	BTU/Mo.
Combined Total	311,525	5,031	1.567E+09	BTU/Mo.

The Cottrell Inlet Gases include the Tempering Air and this air is at 649.55 Deg F 616.2 Deg K 343.1 Deg C

Heat in must equal heat out. Therefore, the Tempering Air must carry ;

2.036E+09 less 1.567E+09 equals 4.693E+08 BTU/Day

The Heat Capacity of air at this temp is : 4,405.4 BTU/lb Mol (is valid only down to 32 Deg F

Average Outside Air Temperature is : 49.17 Deg F

Extra Heat to Heat air to 32 Deg F 0.0 BTU/lb Mol

Total Heat to Tempering Air 4,425.4 BTU/lb Mol

Quantity of Tempering Air

469,257,918 divided by 4,405 equals 106,519 lb Mol

Volume of Tempering Air

359/ Operating Minutes x 106519.4 x ((460 + 60)/(460 + 32)) 2,669.8 SCFM

Volume of Cottrell Inlet Gases

Roaster Gas	298,848	lb Mol
Tempering Air	106,519	lb Mol
Total	405,367	lb Mol

359/ Operating Minutes x 405,367 x ((Inlet T Deg F+ 460)/(460 + 32)) = 16,319.8 ACFM

Cottrell Dust Catch	lb Mols	Tons	%	% Fe	% As	% Sb	Locked in As ozs	As oz/Tn
Quartz	342.67	318.57	73.51%	5.35%	0.66%		0.72	0.00
Hematite	18.64	48.97	11.30%	7.98%			13.76	0.28
Pyrite	15.79	32.90	7.59%	3.53%				
Scorodite	4.41	22.29	5.14%	1.47%	1.98%		67.35	3.02
Antimony Trioxide	1.37	9.95	2.30%			1.92%		
Arsenopyrite	0.16	0.70	0.16%	0.06%	0.07%		4.35	6.24
Total HCD	383.05	433.37	100.00%	18.31%	2.11%	1.92%	86.19	9.29
DIR Solids		433.37					132.51	0.31

CALCULATION OF QUENCH AIR TO BAGHOUSE

Heat Content of Gases at Cottrell Outlet @ 554.55 Deg F 563.5 Deg K 290.3 Deg C

(ASSUME NO LEAKAGE)

	NCF	lb Mols	BTU/lb Mol	BTU/Day
N2	5.766E+07	160,617	3,725	598,301,662
SO2	6.087E+06	16,956	5,462	92,626,642
O2	5.235E+06	14,582	3,837	55,956,576
As2O3	4.007E+05	1,116	11,235	12,539,227
Tempering Air	3.824E+07	106,519	3,708	395,024,942
H2O	3.772E+07	105,064	4,353	4.574E+08
Total Gas	1.453E+08	404,855	3,981	1.612E+09
Inerts : Scorodite		147.72		
Quartz		525.81	7,139	3,753,836
Sb2O3		21.49	13,719	294,755
Total Inerts		695.02	5,818	4,043,591
Combined Total		405,550	3,984	1.62E+09 BTU/Mo.

The Baghouse Inlet Gases include the Quench Air and this air is at 199.33 Deg F 366.1 Deg K 93.0 Deg C

However, excluding the Quench Air the remaining gases and inerts carry:

	lb Mols	BTU/lb Mol	BTU/Month
N2	160,617	1,170	187,911,738
SO2	16,956	1,625	27,554,158
O2	14,582	1,205	17,575,403
H2O	105,064	1,343	141,126,261
Tempering Air	106,519	1,167	124,278,568
Total Gas	403,739	1,235	498,446,668 BTU/Mo.

Inerts :				
Scorodite	*147.72*			
Quartz	*525.81*	*2,061*	*1,083,537*	
Sb2O3	*21.49*	*4,111*	*88,321*	
Arsenic Trioxide	*1116.10*	*4,000*	*4,464,419*	
Total Inerts	*1811.12*	*3,112*	*5,636,277*	*BTU/Mo.*
Combined Total	*405,550*	*1,243*	*504,082,345*	*BTU/Mo.*

Heat in must equal heat out. Therefore, the Quench Air must carry ;

1.616E+09 less 5.041E+08 equals 1.112E+09 BTU/Day

The Heat Capacity of air at this temp is : 1,167 BTU/lb Mol † is valid only down to 32 Deg F

Average Outside Air Temperature is : 49.17 Deg F

Extra Heat to Heat air to 32 Deg F 0.0 BTU/lb Mol

Total Heat to Quench Air 1,166.7 BTU/lb Mol

Quantity of Quench Air

1,111,769,793 divided by 1,167 equals 952,901 lb Mol/Mo

Volume of Quench Air

359/ Operating Minutes x 952900.8 x ((460 + 60)/(460 + 32)) = 17,979.2 SCFM

Volume of Baghouse Inlet Gases

	lb Mols	*% Vol*
N2	*160,617*	*11.84%*
SO2	*16,956*	*1.25%*
O2	*14,582*	*1.07%*
H2O	*105,064*	*7.74%*
Tempering Air	*106,519*	*7.85%*
Quench Air	*952,901*	*70.24%*
Total Gas	*1,356,640*	*100.00%*

359/Operating minutes x 1,356,640 x ((460 + 199)/(460+32)) = 32,455 ACFM

Baghouse Catch

	lb Mols	*lbs*	*Tons*	*%*	*% Fe*	*% As*	*% Sb*
Arsenic Trioxide	*1,116.10*	*220,810*	*110.41*	*76.82%*		*58.18%*	
Scorodite	*147.72*	*28,771*	*14.39*	*10.01%*	*2.87%*	*3.85%*	
Quartz	*525.81*	*31,593*	*15.80*	*10.99%*			
Sb2O3	*21.49*	*6,263*	*3.13*	*2.18%*			*1.82%*
Total Dust Catch	*1,811.12*	*287,437.95*	*143.72*	*100.00%*	*2.87%*	*62.03%*	*1.82%*

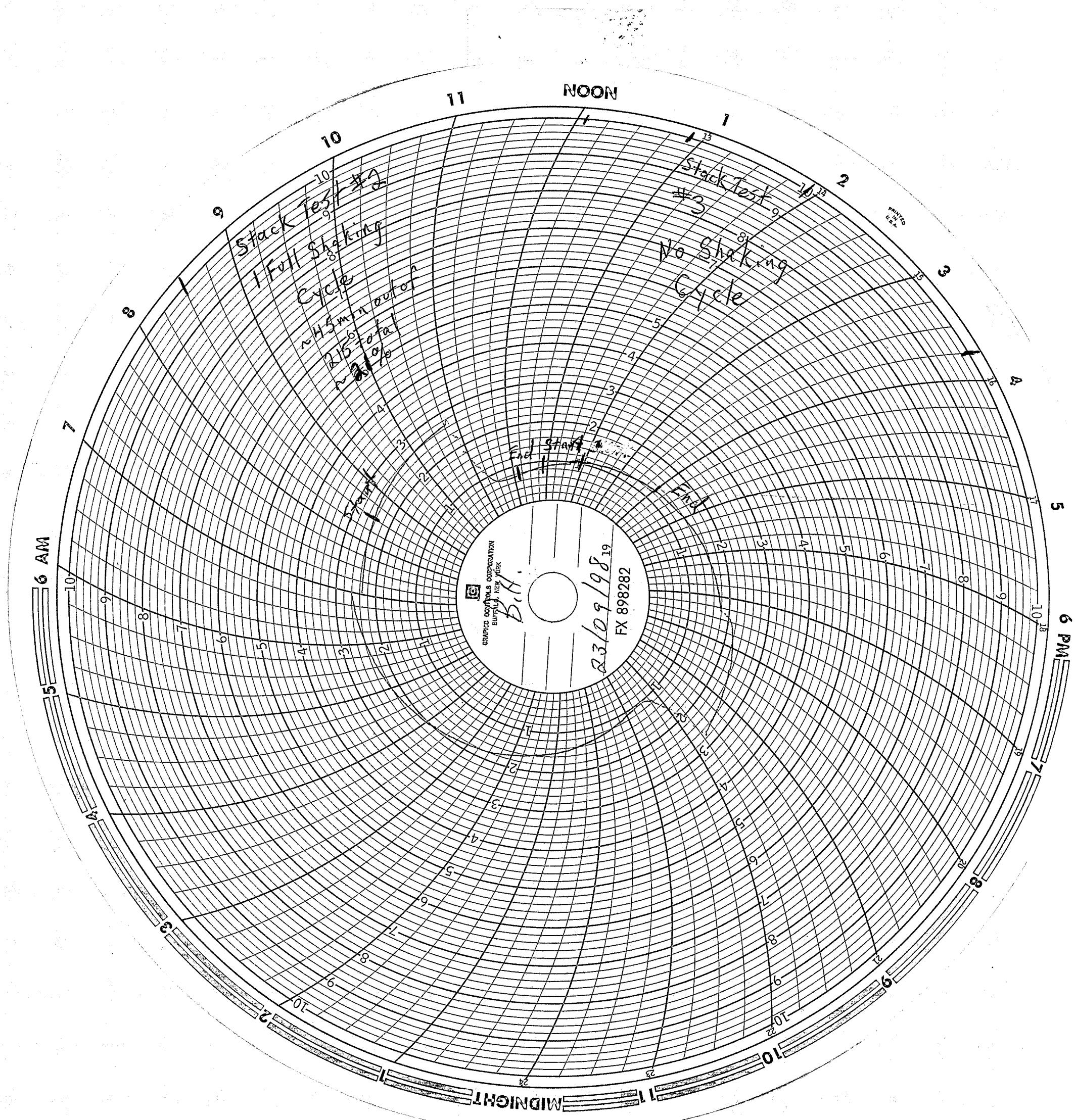
Air is 20.9% O2 by volume (or 23.2% by weight)

Tempering + Quench Air = 1,059,420 lb Mols

O2 Content = 2.214E+05 lb Mols

N2 Content = 8.380E+05 lb Mols

Stack Gas	*lb Mols*	*% Vol*	*NCFM*	
N2	*998,619*	*73.61%*	*17,827*	
O2	*236,001*	*17.40%*	*4,213*	
H2O	*105,064*	*7.74%*	*1,876*	
SO2	*16,956*	*1.25%*	*303*	
Total Gas	*1,356,640*	*100.00%*	*24,219*	
IF Stack @ 180 Deg F and no air leakage			*31,504*	*ACFM*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BUFFALO NEW YORK
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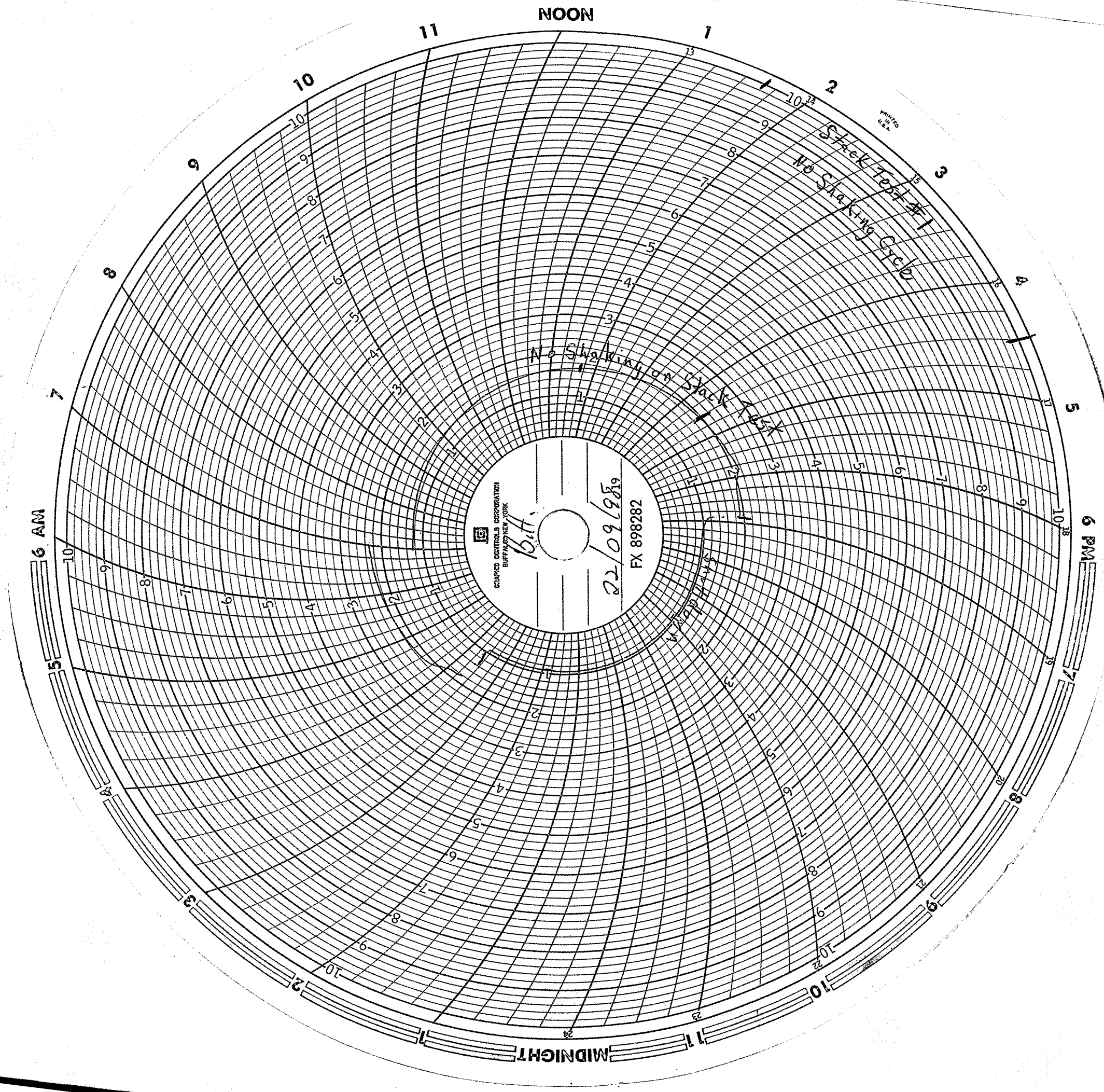
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Stack Test #1
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Bill

ROASTER CONTROL QUEST September 22/98

Mineralogy Calculations

Atomic weights Used -	Arsenopyrite FeAsS	162.8286	Arsenic Trioxide	197.84
	Stibnite Sb2S3	339.6800	Scorodite FeAsO4	194.77
	Pyrite FeS2	119.9670	Antimony Trioxide	291.50
	Iron	55.8470	Nitrogen Gas N2	28.01
	Arsenic	74.9216	Sulphur Dioxide SO2	64.06
	Sulphur	32.0600	Hematite Fe2O3	159.69
	Antimony	121.7500	Quartz SiO2	60.08
	Oxygen	15.9994	Sulphur Trioxide SO3	80.06

		Assays				Tonnage			
		S	As	Fe	Sb	S	As	Fe	Sb
Product	TONNAGE	%	%	%	%	Tons	Tons	Tons	Tons
Assayed Mill Feed	822.6	1.70%	0.85%	5.50%	0.08%	13.98	6.99	45.24	0.66
Flotation Concentrate	77.7	18.67%	8.08%	20.75%	0.62%	14.52	6.28	16.13	0.48
Roaster Feed Inventory	(1.1)					2.83	1.28	(0.42)	(0.08)
Roaster Feed	78.8	14.82%	6.34%	21.00%	0.71%	11.68	5.00	16.56	0.56
Roaster Calcine	61.7	1.84%	0.54%	26.25%	0.65%	1.14	0.33	16.20	0.40
Hot Cottrell Dust	12.64	3.67%	1.55%	16.50%	1.30%	0.46	0.20	2.09	0.16
Baghouse Dust	6.97		64.14%	2.71%	2.01%		4.47	0.19	0.14
Stack						10.14			
Roasting Products Tons						11.74	5.00	18.48	0.71

	Mill Feed	F Conc	R Feed	R Calcine	HCD	BHD	Calc RC
Arsenopyrite - Tons	15.20	13.65	10.73	0.17	0.015		New RF
Fe in Arsenopyrite - Tons	5.21	4.68	3.68	0.06	0.005		Calc RF
S in Arsenopyrite - Tons	2.99	2.69	2.11	0.03	0.003		
As in Arsenopyrite - Tons	6.99	6.28	4.94	0.08	0.007		
As in Arsenate - Tons			0.055	0.254	0.183		
As in Silicates- Tons			0.0050	0.001	0.006		
Scorodite - Tons			0.143	0.660	0.477	0.659	
Stibnite Sb2S3 - Tons	0.92	0.67	0.78	0.56			
Antimony Tons	0.66	0.48	0.56	0.40	0.16	0.14	
S in Stibnite - Tons	0.26	0.19	0.22	0.16			
Total S Tons	13.98	14.52	11.68	1.14			
Total S avail. for Pyrite	10.73	11.64	9.35	0.94			
Total Fe avail. for Pyrite			9.91	1.34	0.40		
Possible Pyrite / S - Tons	20.08	21.77	17.49	1.77			
Possible Pyrite / Fe - Tons			21.29	2.87	0.867		
Pyrite : FeS2 - Tons	20.08	21.77	17.49	1.77	0.867		
S in Pyrite - Tons	10.73	11.64	9.35	0.94	0.46		
S as Sulphate - Tons			0.00	0.00			

	Mill Feed	F Conc	R Feed	R Calcine	HCD	BHD
% Arsenopyrite	1.85%	17.56%	13.61%	0.27%	0.12%	
% Stibnite	0.11%	0.86%	0.99%	0.91%		
% Pyrite	2.44%	28.00%	22.19%	2.86%	6.86%	
% Scorodite			0.18%	1.07%	3.77%	9.45%

Roasting

Scorodite Content of BHD =	0.66 Tons FeAsO4	Arsenopyrite in HCD =	0.01 Tons FeAsS
As in BHD Scorodite =	0.25 Tons As	Scorodite in HCD =	0.48 Tons FeAsO4
As in BHD as As2O3 =	5.57 Tons As2O3	Pyrite in HCD =	0.87 Tons FeS2
Antimony Trioxide in BHD =	0.17 Tons Sb2O3	4.22 Hematite in HCD =	1.33 Tons Fe2O3
Quartz in BHD =	0.58 Tons of Quartz	Sb2O3 in HCD =	0.20 Tons Sb2O3
		Quartz in HCD =	9.75 Tons Quartz

Total BHD Tons =	6.97		Total HCD Tons =	12.64	
Assume:	RF	RC	HCD		
% Sulphide As	98.8%	23.4%	3.5%	* From Lakefield Research	
% Arsenate As	1.1%	76.2%	93.0%		
% Silicate As	0.1%	0.4%	2.9%		
Actual Tons As	5.00	0.33	0.20	4.47 (Baghouse As)	
Tons Sulphide As	4.94	0.08	0.01	4.85 Sulphide As Tons Eliminated	
Tons Arsenate As	0.055	0.25	0.18	0.64 note Created as As)	
Tons Silicate As	0.005	0.001	0.006		

% Sulphide As Eliminated =	93.28%		
% As Eliminated =	89.41% emit to Baghouse	Daily Sheet % As Elimination	93.19%
% As Eliminated =	93.33% from Feed to Calcine		
As2O3 Gasified =	4.22 x((197.842*74.922)) =	5.57 tons As2O3	
FeAsO4 Created =	0.64 x((154.77/74.922)) =	1.65 tons FeAsO4	
lb moles As2O3 =	5.57 x 2000/197.84 =	56.27	
lb moles FeAsO4 =	1.65 x 2000/154.77=	16.97	
Ounce Volume of As2O3 =	56.27 x 359 =	29,282 NCF As2O3	

Oxygen Required to Roast Arsenopyrite to As2O3 =

5 x 359 x 16.00 / 2 x 74.92 x	4.22	equals	161,069	NCF O2

Reaction 1 also produces 2 mols of SO2 for each 5 mols of O2

101,069 x 2 / 5 =	40,483	NCF SO2

Oxygen Required to Roast Arsenopyrite to FeAsO4 =

3 x 359 x 2000 / 74.92 x	0.64	equals	18,276	NCF O2

Reaction 3 also produces 1 mols of SO2 for each 3 mols of O2

18,276 x 1 / 3 =	6,092	NCF SO2

Stibnite :

Sb Eliminated = BHD Sb + HCD Sb Tons =		0.30	Sb Tons
Sb2O3 Gasified =	0.30 x 291.496/(2*121.5)=	0.36	Sb2O3Tons
Volume Sb2O3 =	0.36 x 2000 x 359 /291.496 =	897	NCF Sb2O3

Oxygen Required to Roast Stibnite to Sb2O3 =

9 x 359 x 2000 / 4 x 121.7	times	0.30	equals	4,039	NCF O2

Reaction 4 also produces 6 mols of SO2 for each 9 mols of O2

4,039 x 6 / 9 =	2,692	NCF SO2

SULPHUR ELIMINATION

Assume:	RF	RC	HCD	
% Sulphide Fe	82.1%	8.6%	19.8%	* From Lakefield Research
% Sulphide As	98.8%	23.4%	3.5%	
% Oxide Fe	17.1%	91.0%	51.2%	

Iron Content of RC		16.20	Tons Fe	Iron Content of HCD		2.09	Tons Fe	
Iron as Sulphide in RC		1.39	Tons Fe	Fe as Sulphide in HCD		0.41	Tons Fe	Fe as HCD Oxide
Sulphur Content of RC		1.14	Tons S	As Content of HCD		0.20	Tons As	Fe as HCD Silicate
Arsenic Content of RC		0.33	Tons As	As with unroasted S		0.01	Tons As	
Arsenic with unroasted S		0.08	Tons As	FeAsS in HCD		0.015	tons FeAsS	
FeAsS in Calcine	0.08	times	162.82/74.91 =		0.17	tons FeAsS	Iron in FeAsS in HCD	0.01
Iron in FeAsS in Calcine	0.17	times	55.85/162.82 =		0.06	tons Fe	Fe as other S in HCD	0.40
Iron as other Sulphide in RC	1.39	Less	0.06 =		1.34	tons Fe	Fe as Pyrite in HCD	0.87
S in FeAsS in Calcine	0.17	times	32.06/162.82 =		0.03	tons S	Scorodite in HCD	0.48
Sb2S3 in Calcine	0.40	times	339.68/243.5 =		0.56	tons Sb2S3	Fe in HCD Scorodite	0.14
S in Sb2S3 in Calcine	0.56	times	96.18/339.68 =		0.16	tons S	Remaining Oxide Iron	0.93
S Remaining in Calcine	1.14	less	0.03	less	0.16	equals	0.94 tons S	
Sulphide Iron as Pyrite	1.34	times	119.97/55.85 =		2.87	tons Pyrite	Hematite in HCD	1.33
Sulphur needed for Pyrite	2.87	times	64.12/119.97 =		1.53	tons S		
Sulphate S in Calcine	0.94	less	1.53	equals	-0.59	tons Sulphate S		

Max Pyrite in Calcine 1.77 tons Pyrite

Assume sulphate came from roasting SO2, O2, H2O, & gangue

Pyrite Roasted in Roast	17.49	Less	1.77	less	0.87	equals	14.86 tons Pyrite

OXYGEN to roast Pyrite

5.5 x 359 x2000/2 x 119.97	times	14.86	equals	244,583	NCF O2
Volume of SO2	244,583	times	415 =	177,879	NCF SO2

SO3 Produced	0.00	Tons SO3	0.00 lb mol SO3	0 NCF SO3
OXYGEN to Create SO3	0	NCF O2	0.00 lb mol O2	

SO2 used to Make SO3	0.09	TonsSO2	x 2000/64.04S x 359 =		0 NCF SO2	0.09 lb mol SO2	
CALCULATION OF OFF - GASES							
Water Content							
Avg RF Slurry Density	2235	or	76.59% Solids				
Wt of Slurry RFTons % Sol	102.99	tons					
Wt of Dry Solids	78.84	tons					
Wt of Water in Slurry	24.15	tons H2O					
1st Stage Spray	0.16	lgpm	0.67	stpd H2O			
Gland Water	1.20	lgpm	5.04	stpd H2O			
2nd Stage Spray	1.15	lgpm	4.83	stpd H2O			
Total	2.51	lgpm	10.54	stpd H2O			
Total Tpd	10.54	tons H2O					
Total Tpd Water	34.69	tons H2O					
Water Volume	1,383,862	NCF					
SO2 Volume	227,067	NCF					
O2 Volume Reacting	367,987	NCF					
Air is 20.9% O2 by volume (or 23.2% by weight)							
Volume of Air for Roasting: O2 volume / 0.209 =			1,760,319				
Less O2 Volume Gives the N2 Volume			1,392,413				
EXCESS AIR							
Feed Gun	15.00	SCFM					
1st Stage Air	2,600	SCFM	Total 1st St. =	2615.00	SCFM		
Transfer Air	80	SCFM		2,078,322	NCF Air / Day		
2nd Stage Air	940	SCFM	1st St. AF =	1.18			
Total	3,595	SCFM					
or	2,857,195	NCF Air / Day					
Air Factor = Actual/ Theoretical =		1.62					
O2 Content of Actual Air		597,154	NCF O2 / Day				
Less O2 Used for Roasting		367,987	NCF O2 / Day				
EXCESS O2		229,247	NCF O2 / Day				
N2 Content of Excess Air	867,629	NCF					
Plus N2 with reacting O2	1,392,413	NCF					
Total N2	2,260,042	NCF					

OFF-GAS Composition — This calculation includes the inerts that will pass through the cyclones, but not the inerts that will be caught in the cyclone underflows.

	NCF	% by Vol	lb Mols	stpd	BTU/lb Mol	BTU/Day
Total Gas	4.121E+06	100.00	11,460	159.26	6,182	7.10E+07
N2	2.260E+06	54.84	6,295	88.18	5,615	3.535E+07
H2O	1.384E+06	33.58	3,855	54.09	6,688	2.579E+07
O2	2.292E+05	5.56	639	10.22	5,785	3.694E+06
SO2	2.271E+05	5.51	632	20.26	8,453	5.340E+06
As2O3	2.020E+04	0.49	56	5.57	16,711	9.434E+05
SO3	0.000E+00	0.00	0	0.00	11,778	0.000E+00
Sb2O3	8.974E+02	0.02	2	0.36	21,346	5.336E+04
Total Inerts			386.73	13.68	11,524	4.46E+06
Quartz			343.76	10.33	11,219	3.85E+06
Hematite			16.67	1.33	24,361	4.06E+05
Scorodite			11.66	1.14		
Pyrite			14.45	0.87	13,395	1.936E+05
Arsenopyrite			0.18	0.01		
Combined Total			1.187E+04	1.750E+02	6,356	7.543E+07

@ 2.8 gm/cc or 174.8 lb/ft3 — 13.68 x 2000/174.8* minutes = 0.185 ACFM Inerts

Heat Content of Gases Exiting 2nd Stage @ 809.25 Deg F 905.0 Deg K 431.8 Deg C

4,121,317 x ((459 + 809.25) / (459 + 32)) = 10,632,075 ACF/Day

Divided by minutes = 12,657 ACFM

Or at Standard Conditions: 4,355,863 SCF / Day or 5,186 SCFM

Heat Content of Gases at Cottrell Inlet @ 615.50 Deg F 595.9 Deg K 322.6 Deg C

(DOES NOT INCLUDE TEMPERING AIR)

4,121,317 x ((459 + 615.50) / (459 + 32)) = 8,988,156 ACF/Day

Divided by minutes = 10,700 ACFM

Or at Standard Conditions: 4,355,863 SCF / Day or 5,186 SCFM

	NCF	lb Mols	BTU/lb Mol	BTU/Day
N2	2.260E+06	6.295E+03	4,155	2.615E+07
SO2	2.271E+05	6.325E+02	6,133	3.879E+06
SO3	0.000E+00	0.000E+00	8,408	0.000E+00
O2	2.292E+05	6.384E+02	4,259	2.733E+06
As2O3	2.020E+04	5.627E+01	12,492	7.029E+05
Sb2O3	8.974E+02	2.500E+00	15,414	3.853E+04
H2O	1.384E+06	3.855E+03	4,869	1.877E+07
Total Gas	4.121E+06	1.148E+04	4,554	5.228E+07
Inerts : Arsenopyrite		0.18		

Scorodite	11.66			
Pyrite	14.45	9,590	1.386E+05	
Hematite	16.67	17,572	2.929E+05	
Quartz	343.76	8,037	2.763E+06	
Total Inerts	386.73	8,260	3.194E+06	
Combined Total	11,866.72	4,674	5.547E+07	BTU/Day

The Cottrell Inlet Gases include the Tempering Air and this air is at 613.00 Deg F 595.9 Deg K

Heat in must equal heat out. Therefore, the Tempering Air must carry ;

7.543E+07 less 5.547E+07 equals 1.996E+07 BTU/Day

The Heat Capacity of air at this temp is : 4,136.3 BTU/lb Mol 1 is valid only down to 32 Deg F

Average Outside Air Temperature is : 47.94 Deg F

Extra Heat to Heat air to 32 Deg F 0.0 BTU/lb Mol

Total Heat to Tempering Air 4,136.3 BTU/lb Mol

Quantity of Tempering Air

19,960,776 divided by 4,136 equals 4,826 lb Mol

Volume of Tempering Air

359/ Operating Minutes x 4825.7 x ((460 + 60)/(460 + 32)) = 2,179.8 SCFM

Volume of Cottrell Inlet Gases

Rooster Gas	11,480	lb Mol
Tempering Air	4,826	lb Mol
Total	16,306	lb Mol

359/ Operating Minutes x 16,306 x ((Inlet T Deg F+ 460)/(460 + 32)) = 15,198.1 ACFM

Cottrell Dust Catch	lb Mols	Tons	%	% Fe	% As	% Sb	Locked in Au ozs	Au oz/Tn
Quartz	324.61	9.75	77.16%	4.82%	0.04%		0.02	0.00
Hematite	16.67	1.33	10.53%	7.37%			0.37	0.28
Pyrite	14.45	0.87	6.86%	3.19%				
Scorodite	4.80	0.48	3.77%	1.08%	1.45%		1.83	3.85
Antimony Trioxide	1.35	0.20	1.56%			1.30%		
Arsenopyrite	0.18	0.01	0.12%	0.04%	0.05%		0.12	7.94
Total HCD	362.16	12.64	100.00%	16.50%	1.55%	1.30%	2.35	0.19
DTR Solids		12.64					4.90	0.39

CALCULATION OF QUENCH AIR TO BAGHOUSE

Heat Content of Gases at Cottrell Outlet @ 518.00 Deg F 543.2 Deg K 270.0 Deg C

(ASSUME NO LEAKAGE)

	NCF	lb Mols	BTU/lb Mol	BTU/Day
N2	2.266E+06	6,295	3,458	21,767,377
SO2	2.271E+05	632	5,047	3,191,952
O2	2.292E+05	639	3,562	2,274,554
As2O3	2.020E+04	56	10,449	587,988
Tempering Air	1.732E+06	4,826	3,442	16,612,037
H2O	1.384E+06	3,855	4,034	15,549,847
Total Gas	5.853E+06	16,303	3,679	6.00E+07
Inerts : Scorodite		6.76		
Quartz		19.15	6,572	125,871
Sb2O3		1.15	12,675	14,581
Total Inerts		27.07	5,189	140,451
Combined Total		16,330	3,682	6.01E+07 BTU/Day

The Boghouse Inlet Gases include the Quench Air and this air is at 181.00 Deg F 355.9 Deg K 82.8 Deg C

However, excluding the Quench Air the remaining gases and inerts carry:

	lb Mols	BTU/lb Mol	BTU/Day
N2	6,295	1,041	6,551,537
SO2	632	1,441	911,169
O2	639	1,072	684,631
Tempering Air	4,826	1,038	5,009,252
H2O	3,855	1,194	4,601,398
Total Gas	16,247	1,093	17,757,986 BTU/Day

Inerts :				
Scorodite	*6.76*			
Quartz	*19.15*	*1,823*	*34,907*	
Sb2O3	*1.15*	*3,647*	*4,196*	
Arsenic Trioxide	*56.27*	*3,525*	*198,354*	
Total Inerts	*83.34*	*2,849*	*237,457*	*BTU/Day*
Combined Total	*16,330*	*1,102*	*17,995,443*	*BTU/Day*

Heat in must equal heat out. Therefore, the Quench Air must carry ;

6.012E+07 less 1.800E+07 equals 4.213E+07 BTU/Day

The Heat Capacity of air at this temp is : 1,038 BTU/lb Mol 1 is valid only down to 32 Deg F

Average Outside Air Temperature is : 47.94 Deg F

Extra Heat to Heat air to 32 Deg F 0.0 BTU/lb Mol

Total Heat to Quench Air 1,038.0 BTU/lb Mol

Quantity of Quench Air

42,128,764 divided by 1,038 equals 40,585 lb Mol/Day

Volume of Quench Air

359/ Operating Minutes x 40585.4 x ((460 + 60)/(460 + 32)) = 18,332.6 SCFM

Volume of Baghouse Inlet Gases

	lb Mols	*% Vol*
N2	*6,295*	*11.08%*
SO2	*632*	*1.11%*
O2	*639*	*1.12%*
H2O	*3,855*	*6.78%*
Tempering Air	*4,826*	*8.49%*
Quench Air	*40,585*	*71.41%*
Total Gas	*56,832*	*100.00%*

359/Operating minutes x 56,832 x ((460 + 181)/(460+32)) = 31,645 ACFM

Baghouse Catch

	lb Mols	*lbs*	*Tons*	*%*	*% Fe*	*% As*	*% Sb*
Arsenic Trioxide	*56.27*	*11,133*	*5.57*	*79.89%*		*60.50%*	
Scorodite	*6.76*	*1,317*	*0.66*	*9.45%*	*2.71%*	*3.64%*	
Quartz	*19.15*	*1,151*	*0.58*	*8.26%*			
Sb2O3	*1.15*	*335*	*0.17*	*2.41%*			*2.01%*
Total Dust Catch	*83.34*	*13,936*	*6.97*	*100.00%*	*2.71%*	*64.14%*	*2.01%*

Air is 20.9% O2 by volume (or 23.2% by weight)

Tempering + Quench Air = 45,411 lb Mols

O2 Content = 9.491E+03 lb Mols

N2 Content = 3.592E+04 lb Mols

Stack Gas	*lb Mols*	*% Vol*	*NCFM*	
N2	*42,216*	*74.28%*	*18,042*	
O2	*10,130*	*17.82%*	*4,329*	
H2O	*3,855*	*6.78%*	*1,647*	
SO2	*632*	*1.11%*	*270*	
Total Gas	*56,832*	*100.00%*	*24,289*	
IF Stack @ 180 Deg F and no air leakage			*31,596*	*ACFM*

ROASTER CONTROL QUEST — September 22/98

Reaction Equations

No. 1 $2FeAsS + 5O2 \Rightarrow Fe2O3 + As2O3 + 2SO2$
Arsenopyrite → Hematite and Arsenic Trioxide

No. 2 $2FeAsS + 6O2 \Rightarrow 2FeAsO4 + 2SO2$
→ Scorodite

No. 3 $2Sb2S3 + 9O2 \Rightarrow 2Sb2O3 + 6SO2$
Stibnite → Antimony Trioxide

No. 4 $2FeS2 + 5.5O2 \Rightarrow Fe2O3 + 4SO2$
Pyrite

No. 5 $2SO2(g) + O2(g) \Rightarrow 2SO3(g)$

Au ozs	Product	TONNAGE	S %	As %	Fe %	Sb %	Tonnage S Tons	Tonnage As Tons	Tonnage Fe Tons	Tonnage Sb Tons
222.199	Assayed Mill Feed	19,270.1	1.85%	0.79%	6.30%	0.06%	356.7	152.27	1,213.7	11.27
206.152	Flotation Concentrate	1,882.3	17.16%	4.88%	20.25%	0.77%	322.9	91.82	381.1	14.54
(50.872)	Roaster Feed Inventory	40.0					2.6	-17.6	-43.8	-2.8
257.023	Roaster Feed	1,842.3	17.38%	5.94%	23.06%	0.94%	320.28	109.40	424.9	17.32
173.204	Roaster Calcine	1,394.0	3.58%	1.32%	29.55%	0.68%	49.96	18.39	411.9	9.50
19.716	Hot Cottrell Dust	420.00		2.14%	18.36%	1.94%	17.08	8.98	77.1	8.14
2.195	Baghouse Dust	132.60		61.86%	2.94%	1.89%		82.02	3.9	2.50
	Stack						254.12			
195.11	Roasting Products Total Tons						321.16	109.40	492.85	20.15

197.70		Mill Feed	F Conc	R Feed	R Calcine	HCD	BHD
219.61	Arsenopyrite - Tons	330.94	199.56	234.90	9.35	0.683	
195.11	Fe in Arsenopyrite - Tons	113.50	68.45	80.57	3.2080	0.234	
	S in Arsenopyrite - Tons	65.16	39.29	46.25	1.8416	0.135	
	As in Arsenopyrite - Tons	152.27	91.82	108.08	4.3037	0.314	
	As in Arsenate - Tons			1.203	14.015	8.407	
	As in Silicates - Tons			0.109	0.074	0.260	
	Scorodite - Tons			3.128	36.433	21.856	13.618
	Stibnite Sb2S3 - Tons	15.72	20.28	24.17	13.25		
	Antimony Tons	11.27	14.54	17.32	9.50	8.14	2.50
	S in Stibnite - Tons	4.45	5.74	6.84	3.75		
	Total S Tons	356.72	322.92	320.28	49.96	17.08	
	Total S avail. for Pyrite	287.11	277.88	267.18	44.37		
	Total Fe avail. for Pyrite			268.28	32.21	14.88	
	Possible Pyrite / S - Tons	537.18	519.92	499.89	83.01		
	Possible Pyrite / Fe - Tons			576.31	69.19	31.957	
	Pyrite : Fe S2 - Tons	537.18	519.92	499.89	69.19	31.957	
	S in Pyrite - Tons	287.11	277.88	267.18	36.98	17.08	
	S as Soluble Product Sulphate			0.00	7.38		

	Mill Feed	F Conc	R Feed	R Calcine	HCD	BHD
% Arsenopyrite	1.72%	10.60%	12.75%	0.67%	0.16%	420
% Stibnite	0.08%	1.08%	1.31%	0.95%		
% Pyrite	2.79%	27.62%	27.13%	4.96%	7.61%	
% Scorodite			0.17%	2.61%	5.20%	10.27%

Roasting - MTD

Scorodite Content of BHD =	13.62 Tons FeAsO4	Arsenopyrite in HCD =	0.68 Tons FeAsS
As in BHD Scorodite =	5.24 Tons As	Scorodite in HCD =	21.86 Tons FeAsO4
As in BHD as As2O3 =	101.38 Tons As2O3	Pyrite in HCD =	31.96 Tons FeS2
Antimony Trioxide in BHD =	2.99 Tons Sb2O3	76.78 Hematite in HCD =	47.48 Tons Fe2O3
Quartz in BHD =	14.61 Tons of Quartz	Sb2O3 in HCD =	9.75 Tons Sb2O3
		Quartz in HCD =	308.28 Tons Quartz

Total BHD Tons =	132.60			Total HCD Tons =	420.09	
Assume:	RF	RC	HCD			
% Sulphide As	98.8%	23.4%	3.5%	* From Lakefield Research		
% Arsenate As	1.1%	76.2%	95.6%			
% Silicate As	0.1%	0.4%	2.9%			
Actual Tons As	109.40	18.39	8.98	82.02 (Baghouse As)		
Tons Sulphide As	108.03	4.30	0.31	103.46 Sulphide As Tons Eliminated		
Tons Arsenate As	1.20	14.01	8.41	26.46 mols Created as As)		
Tons Silicate As	0.109	0.074	0.269			
% Sulphide As Eliminated =		95.73%				
% As Eliminated =		74.95% mill to Baghouse		Daily Sheet % As Elimination	83.09%	
% As Eliminated =		83.19% from Feed to Calcine				
As2O3 Gasified =	76.78 x((197.84/2*74.922)) =			101.38 tons As2O3		
FeAsO4 Created =	26.46 x(194.77/74.922)) =			68.78 tons FeAsO4		
3 moles As2O3 =	101.38 x 2000/197.84 =			1024.84		
3 moles FeAsO4 =	68.78 x 2000/194.77=			706.26		
Volume of As2O3 =	1024.84 x 359 =			367,919 **NCF As2O3 MTD**		
Oxygen Required to Roast Arsenopyrite to As2O3 =						
5 x 359 x 2000 / 2 x 74.92 x	76.78	equals		1,839,595 NCF O2		
Reaction 1 also produces 2 mols of SO2 for each 5 mols of O2						
1,839,595 x 2 / 5 =				735,838 NCF SO2		
Oxygen Required to Roast Arsenopyrite to FeAsO4 =						
3 x 359 x 2000 / 74.92 x	26.46	equals		760,645 NCF O2		
Reaction 3 also produces 1 mols of SO2 for each 3 mols of O2						
760,645 x 1 / 3 =				253,548 NCF SO2		
Stibnite :						
Sb Eliminated = BHD Sb + HCD Sb Tons =				10.64 Sb Tons		
Sb2O3 Gasified =	10.64 x 291.496/(2*121.5)=			12.74 Sb2O3Tons		
Volume of Sb2O3 =	12.74 x (2000/291.496) x 359 =			31,384 NCF Sb2O3 MTD		
Oxygen Required to Roast Stibnite to Sb2O3 =						
9 x 359 x 2000 / 4 x 121.7	times	10.64	equals	141,229 NCF O2		
Reaction 4 also produces 6 mols of SO2 for each 9 mols of O2						
141,229 x 6 / 9 =				94,153 NCF SO2		
SULPHUR ELIMINATION						
Assume:	RF	RC	HCD			
% Sulphide Fe	82.1%	8.6%	19.6%	* From Lakefield Research		
% Sulphide As	98.8%	23.4%	3.5%			
% Oxide Fe	17.1%	91.0%	51.2%			
Iron Content of RC		411.85 Tons Fe		Iron Content of HCD	77.10 Tons Fe	Fe as HCD Oxide
1.07 Fe as Sulphide in RC		35.42 Tons Fe		Fe as Sulphide in HCD	15.11 Tons Fe	Fe as HCD Silicate
0.61 Sulphur Content of RC		49.95 Tons S		As Content of HCD	8.93 Tons As	
Arsenic Content of RC		18.39 Tons As		As with unroasted S	0.31 Tons As	
Arsenic with unroasted S		4.30 Tons As		FeAsS in HCD	0.68 tons FeAsS	
Tons Fe FeAsS in Calcine	4.30	times	162.82/74.91 =	9.35 tons FeAsS	Iron in FeAsS in HCD	0.23
Tons Fe Iron in FeAsS in Calcine	9.35	times	55.85/162.82 =	3.21 tons Fe	Fe as other S in HCD	14.88
tons Pyrite Iron as other Sulphide in RC	35.42	Less	3.21 =	32.21 tons Fe	Fe as Pyrite in HCD	31.95
Tons S in FeAsS in Calcine	9.35	times	32.06/162.82 =	1.84 tons S	Scorodite in HCD	21.56
Tons Fe Sb2S3 in Calcine	9.50	times	339.68/243.5 =	13.25 tons Sb2S3	Fe in HCD Scorodite	6.27
Tons Fe S in Sb2S3 in Calcine	13.25	times	96.18/339.68 =	3.75 tons S	Remaining Oxide Iron	33.21
S Remaining in Calcine	49.96	less	1.84 less	3.75 equals	44.37 tons S	
Tons Sulphide Iron as Pyrite	32.21	times	119.97/55.85 =	69.19 tons Pyrite	Hematite in HCD	47.48
Sulphur needed for Pyrite	69.19	times	64.12/119.97 =	36.98 tons S		
Sulphate S in Calcine	44.37	less	36.98 equals	7.38 tons Sulphate S		
Max Pyrite in Calcine	69.19 tons Pyrite					
Assume sulphate came from reacting SO2, O2, H2O, & gangue						
Pyrite Roasted in Roast	490.89	Less	69.19 less	31.95 equals	328.74 tons Pyrite	
OXYGEN to roast Pyrite						
5.5 x 359 x2000/2 x 119.97	times	398.74	equals	6,562,761 NCF O2		
Volume of SO2	6,562,761	times	4/5.5 =	4,772,917 NCF SO2		
SO3 Produced	18.44	Tons SO3	460.67 lb mol SO3	165,379 NCF SO3		
OXYGEN to Create SO3	82,690 NCF O2		230.33 lb mol O2			

SO2 used to Make SO3	14.75	Tons SO2	x 2000/64.048 x 359 =	165,379	NCF SO2	460.67	lb mol SO2	
CALCULATION OF OFF - GASES								
Water Content								
Avg RF Slurry Density	2,251	gr	76.92% Solids					
Wt of Slurry RF Tons % S	2,394.25	tons						
Wt of Dry Solids	1,842.30	tons						
Wt of Water in Slurry	552.07	tons H2O						
1st Stage Spray / oper. min	0.23	Igpm						
Hood Water / oper. min	1.16	Igpm						
2nd Stage Spray / oper. min	2.15	Igpm						
Total/ operating minute	3.55	Igpm						
Total MTD	331.46	tons H2O						
Total Tpm Water	**883.53**	**tons H2O**						
Water Volume	**3.524E+07**	**NCF MTD**						
SO2 Volume	**5,691,877**	**NCF MTD**						
O2 Volume Reacting	**9.387E+06**	**NCF**						
Air is 20.9% O2 by volume (or 23.2% by weight)								
Volume of Air for Roasting: O2 volume / 0.209 =			44,913,496					
Less O2 Volume Gives the N2 Volume			35,526,575					
EXCESS AIR								
Feed Gun - est.	15.00	SCFM						
1st Stage Air - Avg	2,818	SCFM	Total 1st St. =	2833.12	SCFM			
Transfer Air -Avg	74	SCFM		50,260,868	NCF Air / Day			
2nd Stage Air- Avg	915	SCFM	1st St. AF =	1.12				
Total Avg	3,822	SCFM						
or (Accumulated Total)	67,810,509	NCF Air / MTD						
Air Factor = Actual/ Theoretical =		**1.51**						
O2 Content of Actual Air		14,172,396	NCF O2 / MTD					
Less O2 Used for Roasting		9,392,921	NCF O2 / MTD					
EXCESS O2		**4.79E+06**	**NCF O2 / MTD**					
N2 Content of Excess Air	18,111,538	NCF						
Plus N2 with reacting O2	35,526,575	NCF						
Total N2	**53,638,113**	**NCF MTD**						

This calculation includes the inerts that will pass through the cyclones, but not the inerts that will be caught in the cyclone under-flows.

OFF-GAS Composition

	NCF MTD	% by Vol	lb Mols	MTD tons	BTU/lb Mol	BTU MTD
Total Gas	9.99E+07	100.00	278,356	3,829.9	6,565	1.75E+09
N2	5.36E+07	53.68	149,410	2,092.7	5,707	8.52E+08
H2O	3.52E+07	35.27	98,170	883.5	6,750	6.62E+08
O2	4.78E+06	4.79	13,330	213.3	5,879	7.83E+07
SO2	5.69E+06	5.70	15,853	507.7	8,600	1.36E+08
As2O3	3.67E+05	0.37	1,025	101.4	16,973	1.73E+07
SO3	1.65E+05	0.17	461	18.4	11,990	5.52E+06
Sb2O3	3.13E+04	0.03	87	12.7	21,726	1.89E+06
Total Inerts			12,248	438	11,822	1.45E+08
Quartz			10,748	322.9	11,424	1.22E+08
Hematite			595	47.5	24,795	1.47E+07
Scorodite			364	35.5		
Pyrite			533	32.0	13,641	7.26E+06
Arsenopyrite			8	0.7		
Combined Total			2.90E+05	4.26E+03	6,537	1.96E+09

@ 2.8 gm/cc or 174.8 lb / ft3 438.48 x 2000 / 174.8 minutes = 0.269 ACFM Inerts

Heat Content of Gases Existing 2nd Stage @ 821.43 Deg F 711.7 Deg K 438.6 Deg C

99,922,508 x ((460 + 821)/(460 + 32)) = 290,251,628 ACF/MTD

Divided by minutes = 13,940 ACFM

Or at Standard Conditions: 105,609,155 SCF / MTD or 5,657 SCFM

Heat Content of Gases at Cottrell Inlet @ 644.88 Deg F 613.2 Deg K 340.6 Deg C

(DOES NOT INCLUDE TEMPERING AIR)

99,922,508 x ((460 + 644)/(460 + 32)) = 224,232,145 ACF/MTD

Divided by minutes = 12,010 ACFM

Or at Standard Conditions: 105,609,155 SCF / MTD or 5,657 SCFM

	NCF MTD	lb Mols	BTU/lb Mol	BTU/Mo.
N2	5.36E+07	1.49E+05	4,384	6.55E+08
SO2	5.69E+06	1.58E+04	6,495	1.03E+08
SO3	1.65E+05	4.60E+02	8,924	4.11E+06
O2	4.78E+06	1.33E+04	4,516	6.02E+07
As2O3	3.67E+05	1.02E+03	13,160	1.34E+07
Sb2O3	3.13E+04	8.74E+01	16,329	1.42E+06
H2O	3.52E+07	9.81E+04	5,145	5.05E+08
Total Gas	9.99E+07	2.78E+05	4,822	1.34E+09
Inerts : Arsenopyrite		8.39		

Scorodite	364.27			
Pyrite	533	10,173	5.420E+06	
Hematite	595	18,622	1.107E+07	
Quartz	10,748	8,527	9.165E+07	
Total Inerts	12,248	8,839	1.083E+08	BTU/Mo.
Combined Total	290,584	4,991	1.45CE+09	BTU/Mo.

The Cottrell Inlet Gases include the Tempering Air and this air is at 644.08 Deg F 613.2 Deg K 340.0 Deg C

Heat in must equal heat out. Therefore, the Tempering Air must carry ;

1.900E+09 less 1.450E+09 equals 4.493E+08 BTU/Day

The Heat Capacity of air at this temp is : 4,365.0 BTU/lb Mol (is valid only down to 32 Deg F

Average Outside Air Temperature is : 49.65 Deg F

Extra Heat to Heat air to 32 Deg F 0.0 BTU/lb Mol

Total Heat to Tempering Air 4,365.0 BTU/lb Mol

Quantity of Tempering Air

449,250,854 divided by 4,365 equals 102,921 lb Mol

Volume of Tempering Air

359/ Operating Minutes x 102921.2 x ((460 + 60)/(460 + 32)) 2,691.7 SCFM

Volume of Cottrell Inlet Gases

Roaster Gas	278,336	lb Mol
Tempering Air	102,921	lb Mol
Total	381,257	lb Mol

359/ Operating Minutes x 381,257 x ((Inlet T Deg F+ 460)/(460 + 32)) = 16,451.4 ACFM

Cottrell Dust Catch	lb Mols	Tons	%	% Fe	% As	% Sb	Locked in Au ozs	Au oz/Tn
Quartz	324.61	368.28	73.43%	5.36%	0.06%		0.70	0.00
Hematite	16.67	47.48	11.30%	7.91%			13.38	0.28
Pyrite	14.45	31.96	7.61%	3.54%				
Scorodite	4.89	21.86	5.20%	1.49%	2.00%		65.50	3.00
Antimony Trioxide	1.35	9.75	2.32%			1.94%		
Arsenopyrite	0.18	0.68	0.16%	0.06%	0.07%		4.23	6.19
Total HCD	362.16	420.00	100.00%	18.36%	2.14%	1.94%	83.81	0.20
DTR Solids		420.00					126.95	0.30

CALCULATION OF QUENCH AIR TO BAGHOUSE

Heat Content of Gases at Cottrell Outlet @ 549.08 Deg F 560.4 Deg K 287.3 Deg C

(ASSUME NO LEAKAGE)

	NCF	lb Mols	BTU/lb Mol	BTU/Day
N2	5.364E+07	149,410	3,685	550,560,731
SO2	5.691E+06	15,853	5,399	85,591,760
O2	4.785E+06	13,330	3,796	50,601,872
As2O3	3.679E+05	1,025	11,117	11,393,360
Tempering Air	3.695E+07	102,921	3,669	377,571,528
H2O	3.524E+07	98,170	4,305	4.227E+08
Total Gas	1.367E+08	380,709	3,936	1.498E+09
Inerts : Scorodite		159.84		
Quartz		486.32	7,046	3,426,378
Sb2O3		20.54	13,561	278,496
Total Inerts		646.69	5,729	3,704,874
Combined Total		381,355	3,939	1.50E+09 BTU/Mo.

The Baghouse Inlet Gases include the Quench Air and this air is at 198.29 Deg F 365.3 Deg K 92.4 Deg C

However, excluding the Quench Air the remaining gases and inerts carry:

	lb Mols	BTU/lb Mol	BTU/Month
N2	149,410	1,163	173,702,661
SO2	15,853	1,615	25,594,821
O2	13,330	1,198	15,965,466
H2O	98,170	1,335	131,031,782
Tempering Air	102,921	1,159	119,328,122
Total Gas	379,684	1,226	465,622,852 BTU/Mo.

Inerts :				
Scorodite	*139.84*			
Quartz	*486.32*	*2,047*	*995,537*	
Sb2O3	*20.54*	*4,084*	*83,875*	
Arsenic Trioxide	*1024.84*	*3,973*	*4,071,523*	
Total Inerts	*1671.53*	*3,082*	*5,150,934*	*BTU/Mo.*
Combined Total	*381,355*	*1,234*	*470,773,786*	*BTU/Mo.*

Heat in must equal heat out. Therefore, the Quench Air must carry ;

1.502E+09 less 4.768E+08 equals 1.031E+09 BTU/Day

The Heat Capacity of air at this temp is : 1,159 BTU/lb Mol This is valid only down to 32 Deg F

Average Outside Air Temperature is : 49.63 Deg F

Extra Heat to Heat air to 32 Deg F 0.0 BTU/lb Mol

Total Heat to Quench Air 1,159.4 BTU/lb Mol

Quantity of Quench Air

1,031,308,295 divided by 1,159 equals 889,509 lb Mol/Mo

Volume of Quench Air

359/ Operating Minutes x 889509.3 x ((460 + 60)/(460 + 32)) = 18,077.6 SCFM

Volume of Baghouse Inlet Gases

	lb Mols	*% Vol*
N2	*149,410*	*11.77%*
SO2	*15,853*	*1.25%*
O2	*13,330*	*1.05%*
H2O	*98,170*	*7.73%*
Tempering Air	*102,921*	*8.11%*
Quench Air	*889,569*	*70.08%*
Total Gas	*1,269,193*	*100.00%*

359/Operating minutes x 1,269,193 x ((460 + 198)/(460+32)) = 32,654 ACFM

Baghouse Catch

	lb Mols	*lbs*	*Tons*	*%*	*% Fe*	*% As*	*% Sb*
Arsenic Trioxide	*1,024.84*	*202,757*	*101.38*	*76.45%*		*57.91%*	
Scorodite	*139.84*	*27,236*	*13.62*	*10.27%*	*2.94%*	*3.95%*	
Quartz	*486.32*	*29,220*	*14.61*	*11.02%*			
Sb2O3	*20.54*	*5,986*	*2.99*	*2.26%*			*1.89%*
Total Dust Catch	*1,671.53*	*265,198.35*	*132.60*	*100.00%*	*2.94%*	*61.86%*	*1.89%*

Air is 20.9% O2 by volume (or 23.2% by weight)

Tempering + Quench Air = 992,430 lb Mols

O2 Content = 2.074E+05 lb Mols

N2 Content = 7.850E+05 lb Mols

Stack Gas	*lb Mols*	*% Vol*	*NCFM*
N2	*934,422*	*73.62%*	*17,968*
O2	*220,748*	*17.39%*	*4,245*
H2O	*98,170*	*7.73%*	*1,888*
SO2	*15,853*	*1.25%*	*305*
Total Gas	*1,269,193*	*100.00%*	*24,405*

IF Stack @ 180 Deg F and no air leakage 31,746 ACFM

Table 1 **Summary of Emission Test Results**
Royal Oak Mines, Yellowknife, N.W.T.
Gold Roaster Stack
September 22-23, 1998

		Test One	Test Two	Test Three	Averages
	Test Date	98/09/22	98/09/23	98/09/23	
	Start Time	13:40	08:30	12:55	
	End Time	16:30	12:05	15:45	
Average Gas Temperature	- DegC	67.1	56.0	45.8	56.3
Average Gas Velocity	- m/s	3.07	2.83	2.58	2.83
Total Effluent Flow Rate	- Rm3/s	15.64	14.81	13.91	14.79
Dry Effluent Flow Rate	- Rm3/s	14.51	13.73	12.94	13.73
Water Concentration	mole - %	7.2	7.3	7.0	7.2
Arsenic					
Concentration - dry basis	- mg/Rm3	1.94	4.54	2.37	2.95
Emission Rate	- kg/h	0.102	0.224	0.110	0.145
Sulphur Dioxide					
Concentration - dry basis	- mole %	1.2596	1.3572	1.2289	1.2819
Concentration - dry basis	- g/Rm3	33.00	35.56	32.20	33.59
Emission Rate	- kg/h	1724.5	1757.0	1499.8	1660.5
Isokinetics	- %	100.9	102.7	99.8	

Reference Conditions of 25 degC and 760 mm Hg.

Entech Environmental Services Ltd., Calgary, Alberta

LOCATION OF SAMPLING POINT	NA metre level
STACK DIAMETER OR TRAVERSE LENGTH	2.743 metres
RECTANGULAR DUCT WIDTH	0.000 metres
BAROMETRIC PRESSURE	747.3 mm Hg.
AMBIENT TEMPERATURE	14.0 C

AVERAGE COMPOSITION OF FLUE GAS

	DRY BASIS PERCENT	WET BASIS PERCENT
O2	7.500	6.960
CO2	0.000	0.000
N2 by Difference	92.500	85.836
H2O		7.204
CO	0.0000	0.000

SPECIFIC GRAVITY OF FLUE GAS (AIR = 1.0)	0.951
MOLECULAR WEIGHT OF FLUE GAS	27.558 g/g-mole
MOLECULAR WEIGHT OF FLUE GAS (DRY BASIS)	28.300 g/g-mole

STACK GAS FLOW RATE DATA AND CALCULATIONS

PITOT CALIBRATION FACTOR	0.802
STATIC PRESSURE	-0.318 mm Hg.
AVERAGE SQUARE ROOT VELOCITY HEAD	0.169
AVERAGE STACK GAS TEMPERATURE	67.1 C
AVERAGE STACK GAS VELOCITY	3.073 m/s
EFFLUENT FLOW RATE - WET (INCLUDING WATER)	15.641 m3/s **
	2302.479 kg-mole/h
EFFLUENT FLOW RATE - DRY (EXCLUDING WATER)	14.514 m3/s **
	2136.608 kg-mole/h

kghcond 2993.25

** At Reference of 25 degrees C and 760 mm Hg.

POLLUTANT DATA AND CALCULATIONS - ISOKINETIC SAMPLING TRAIN

VOLUME OF FLUE GAS METERED					2.9853	m3
AVERAGE ORIFICE PRESSURE					2.3556	mm Hg.
AVERAGE DRY GAS METER TEMPERATURE					17.7	C
VACUUM AT LAST IMPINGER					4.9	mm Hg.
WATER VAPOUR PRESSURE AT LAST IMPINGER					13.1213	mm Hg.
VOLUME OF WATER CONDENSED					125.0	mL
VOLUME OF FLUE GAS METERED AT REF.					3.0189	m3 **
		50%EA	NA	NA	ACTUAL	
Particulates - Front Half	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	kg/1000kg wet
		NA	NA	NA	NA	kg/1000kg dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h
		50%EA	NA	NA	ACTUAL	
Particulates - Back Half	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	kg/1000kg wet
		NA	NA	NA	NA	kg/1000kg dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h
		50%EA	NA	NA	ACTUAL	
Particulates - Total Train	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	kg/1000kg wet
		NA	NA	NA	NA	kg/1000kg dry
		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h
		50%EA	NA	NA	ACTUAL	
Arsenic	%EA =	NA			5.8700	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			0.0018	g/m3**wet
		NA	NA	NA	0.0019	g/m3**dry
MASS FLOW					0.1016	kg/h

** At Reference of 25 degrees C and 760 mm Hg.

Royal Oak	TEST One	PAGE ABS01
Yellowknife	Roaster Stack	TEST START 13:50
DATA FILE NUMBER 980581	September 22, 1998	TEST END 14:50

POLLUTANT DATA AND CALCULATIONS - PROPORTIONAL SAMPLING TRAINS

	ABS #1	ABS #2	
VOLUME OF FLUE GAS METERED	0.4186	0.0000	m3
AVERAGE ORIFICE PRESSURE	0.0000	NA	mm Hg.
AVERAGE DRY GAS METER TEMPERATURE	19	NA	C
VACUUM AT LAST IMPINGER	76.2	NA	mm Hg.
WATER VAPOUR PRESSURE AT LAST IMPINGER	6.543	NA	mm Hg.
VOLUME OF WATER CONDENSED	24.0	NA	
VOLUME OF FLUE GAS METERED AT REF.	0.4201	NA	m3 **

		50%EA	NA	NA	ACTUAL	
Sulphur Dioxide	%EA =	NA			13864.5000	mg
CONCENTRATION		NA			11689.0292	ppmv wet
		NA	NA	NA	12596.4797	ppmv dry
		NA			30.6270	g/m3**wet
		NA	NA	NA	33.0046	g/m3**dry
MASS FLOW					1724.5169	kg/h

		50%EA	NA	NA	ACTUAL	
not applicable	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h

		50%EA	NA	NA	ACTUAL	
not applicable	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h

		50%EA	NA	NA	ACTUAL	
not applicable	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h

** At Reference of 25 degrees C and 760 mm Hg.

CALCULATIONS PAGE 1 — Average Square Root, Dry Gas Matered, Water Concentration and Gas Molecular Weight

Square Roots of Traverse Data

0.200	0.141	0.173	0.000
0.200	0.141	0.141	0.000
0.200	0.100	0.141	0.000
0.224	0.100	0.141	0.000
0.224	0.224	0.141	0.000
0.200	0.200	0.100	0.000
0.200	0.200	0.100	0.000
0.200	0.224	0.100	0.000
0.173	0.200	0.000	0.000
0.173	0.200	0.000	0.000
0.141	0.200	0.000	0.000
0.141	0.173	0.000	0.000

dP = 0.169 Average Square Root

Dry Gas Volume Metered at Reference Conditions — Vm(std) = K1 * Vm * Y * (Pb+(dH/13.6)) / Tm

	ISO	ABS #1	ABS #2	
K1 =	0.3923	0.3923	0.3923	K/mm Hg.
Y =	1.0000	1.0000	NA	
Vm =	2.9853	0.4186	0.0000	m3 actual
Tm =	290.81	292.15	NA	degrees K
Pb =	747.3	747.3	747.3	mm Hg.
dH =	32.0	0.0	NA	mm H2O
Vm(std) =	3.0189	0.4201	NA	m3 @ ref

Volume of Water Condensed at Reference Conditions — Vwc(std) = K2 * Vlc

	ISO	ABS #1	ABS #2	
K2 =	0.0014	0.0014	0.0014	m3/mL
Vlc =	125.0	24.0	NA	mL
Vwc(std) =	0.1694	0.0325	NA	m3 @ ref

Volume of Water in Silica Gel at Reference Conditions — Vwv(std) = F * Vm(std) / (1-F); F = VPI / (Pb - Vac)

	ISO	ABS #1	ABS #2	
VPI =	13.121	6.543	NA	
Vac =	124.5	76.2	NA	
F =	0.0211	0.0098	NA	
Vwv(std) =	0.0650	0.0041	NA	m3 @ ref

Total Volume Sampled at Reference — Sv = Vm(std) + Vwc(std) + Vwv(std)

	ISO	ABS #1	ABS #2	
Sv =	3.2533	0.4567	NA	m3 @ ref

Volume Fraction of Water in Total Sample Volume, Condensatio — Bwsc = (Vwc(std) + Vwv(std)) / Sv

	ISO	
Bwsc =	0.0720	volume fraction by condensation

Volume Fraction of Water in Total Sample Volume, Saturated St — Bwss = VPts/Ps

Ts =	67.125	Bws =	0.0720
VPts =	206.089		volume fraction
Ps =	747.0		
Bwss =	0.2759	volume fraction for saturated stack	

kg/h H2O by condensation 2993.245337 kg/h H2O by saturation 2987.159437

Dry Gas Molecular Weight — Msd = (0.44*CO2)+(0.32*O2)+(0.28*(N2+CO))

CO2 =	0	mole %
O2 =	7.5	mole %
N2 =	92.5	mole %
CO =	0.000	mole %
Msd =	28.30	kg/kg-mole

Wet Gas Molecular Weight — Msw = (Msd * (1-Bws)) + (18*Bws)

	ISO	
Msw =	27.56	kg/kg-mole

CALCULATIONS PAGE 2 Stack Flow, Pollutant Concentrations and Pollutant Emission Rates

Absolute Stack Pressure — Ps = Pb + Pg

Pg =	-0.3	mm Hg.
Ps =	747.0	mm Hg.

Average Stack Gas Velocity — Vs = Kp * Cp * (((dP*Ts)/(Ps*Msw))^0.5)

	ISO	
Kp =	34.9219	
Cp =	0.802	
Ts =	340.275	K
Vs =	3.073	m/s

Average Stack Gas Wet Volumetric Flow Rate — Qsw = 3600 * Vs * A * Tstd/Pstd * Ps/Ts

	ISO	
A =	5.9102	m^2
Tstd =	298.15	K
Pstd =	760	mm Hg.
Qsw =	56307	scm/h
Qsw =	15.6	scm/s

Average Stack Gas Dry Volumetric Flow Rate — Qsd = (1-Bws) * Qsw

	ISO	
Qsd =	52251	dscm/h
Qsd =	14.5	dscm/s

Concentration, Dry Basis — Csd = 0.001 * mn / Vm(std)

	ISO	ABS #1	ABS #2	
Particulates - Front Half	NA			g/dscm
Particulates - Back Half	NA			g/dscm
Particulates - Total Train	NA			g/dscm
Arsenic	0.0019			g/dscm
Sulphur Dioxide		33.0046		g/dscm
not applicable		NA		g/dscm
not applicable			NA	g/dscm
not applicable			NA	g/dscm

Concentration, Dry Basis — Cpd = 0.0244654 * mn / (Vm(std) * Msd)

Particulates - Front Half	NA	kg/1000kg
Particulates - Back Half	NA	kg/1000kg
Particulates - Total Train	NA	kg/1000kg

Concentration, Wet Basis — Csw = Csd * (1-Bws)

	ISO	ABS #1	ABS #2	
Particulates - Front Half	NA			g/scm
Particulates - Back Half	NA			g/scm
Particulates - Total Train	NA			g/scm
Arsenic	0.0018			g/scm
Sulphur Dioxide		30.6270		g/scm
not applicable		NA		g/scm
not applicable			NA	g/scm
not applicable			NA	g/scm

Concentration, Wet Basis — Cpw = 0.0244654 * mn / ((1/(1-Bws)*Vm(std)) * Msw)

Particulates - Front Half	NA	kg/1000kg
Particulates - Back Half	NA	kg/1000kg
Particulates - Total Train	NA	kg/1000kg

Emission Rate — ER = Csd * Qsd / 1000

	ISO	ABS #1	ABS #2	
Particulates - Front Half	NA			kg/h
Particulates - Back Half	NA			kg/h
Particulates - Total Train	NA			kg/h
Arsenic	0.10			kg/h
Sulphur Dioxide		1724.52		kg/h
not applicable		NA		kg/h
not applicable			NA	kg/h
not applicable			NA	kg/h

LOCATION OF SAMPLING POINT	NA metre level
STACK DIAMETER OR TRAVERSE LENGTH	2.743 metres
RECTANGULAR DUCT WIDTH	0.000 metres
BAROMETRIC PRESSURE	743.5 mm Hg.
AMBIENT TEMPERATURE	8.0 C

AVERAGE COMPOSITION OF FLUE GAS

	DRY BASIS PERCENT	WET BASIS PERCENT
O2	8.000	7.416
CO2	0.000	0.000
N2 by Difference	92.000	85.288
H2O		7.296
CO	0.0000	0.000

SPECIFIC GRAVITY OF FLUE GAS (AIR = 1.0)	0.952
MOLECULAR WEIGHT OF FLUE GAS	27.567 g/g-mole
MOLECULAR WEIGHT OF FLUE GAS (DRY BASIS)	28.320 g/g-mole

STACK GAS FLOW RATE DATA AND CALCULATIONS

PITOT CALIBRATION FACTOR	0.802
STATIC PRESSURE	-0.355 mm Hg.
AVERAGE SQUARE ROOT VELOCITY HEAD	0.158
AVERAGE STACK GAS TEMPERATURE	56.0 C
AVERAGE STACK GAS VELOCITY	2.828 m/s
EFFLUENT FLOW RATE - WET (INCLUDING WATER)	14.805 m3/s **
	2179.445 kg-mole/h
EFFLUENT FLOW RATE - DRY (EXCLUDING WATER)	13.725 m3/s **
	2020.437 kg-mole/h

kghcond 2869.4

** At Reference of 25 degrees C and 760 mm Hg.

Royal Oak	TEST Two		PAGE ISO01
Yellowknife	Roaster Stack	TEST START	08:30
DATA FILE NUMBER 980582	September 23, 1998	TEST END	12:05

POLLUTANT DATA AND CALCULATIONS - ISOKINETIC SAMPLING TRAIN

VOLUME OF FLUE GAS METERED					1.5465	m3
AVERAGE ORIFICE PRESSURE					0.5329	mm Hg.
AVERAGE DRY GAS METER TEMPERATURE					12.7	C
VACUUM AT LAST IMPINGER					2.0	mm Hg.
WATER VAPOUR PRESSURE AT LAST IMPINGER					8.0457	mm Hg.
VOLUME OF WATER CONDENSED					78.0	mL
VOLUME OF FLUE GAS METERED AT REF.					1.5789	m3 **
		50%EA	NA	NA	ACTUAL	
Particulates - Front Half	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	kg/1000kg wet
		NA	NA	NA	NA	kg/1000kg dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h
		50%EA	NA	NA	ACTUAL	
Particulates - Back Half	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	kg/1000kg wet
		NA	NA	NA	NA	kg/1000kg dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h
		50%EA	NA	NA	ACTUAL	
Particulates - Total Train	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	kg/1000kg wet
		NA	NA	NA	NA	kg/1000kg dry
		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h
		50%EA	NA	NA	ACTUAL	
Arsenic	%EA =	NA			7.1700	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			0.0042	g/m3**wet
		NA	NA	NA	0.0045	g/m3**dry
MASS FLOW					0.2244	kg/h

** At Reference of 25 degrees C and 760 mm Hg.

Royal Oak	TEST Two		PAGE ABS01
Yellowknife	Roaster Stack	TEST START	08:15
DATA FILE NUMBER 980582	September 23, 1998	TEST END	09:15

POLLUTANT DATA AND CALCULATIONS - PROPORTIONAL SAMPLING TRAINS

	ABS #1	ABS #2	
VOLUME OF FLUE GAS METERED	0.4121	0.0000	m3
AVERAGE ORIFICE PRESSURE	0.0000	NA	mm Hg.
AVERAGE DRY GAS METER TEMPERATURE	9	NA	C
VACUUM AT LAST IMPINGER	76.2	NA	mm Hg.
WATER VAPOUR PRESSURE AT LAST IMPINGER	6.543	NA	mm Hg.
VOLUME OF WATER CONDENSED	35.0	NA	
VOLUME OF FLUE GAS METERED AT REF.	0.4260	NA	m3 **

		50%EA	NA	NA	ACTUAL	
Sulphur Dioxide	%EA =	NA			15146.9000	mg
CONCENTRATION		NA			12581.4761	ppmv wet
		NA	NA	NA	13571.6332	ppmv dry
		NA			32.9653	g/m3**wet
		NA	NA	NA	35.5597	g/m3**dry
MASS FLOW					1756.9965	kg/h

		50%EA	NA	NA	ACTUAL	
not applicable	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h

		50%EA	NA	NA	ACTUAL	
not applicable	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h

		50%EA	NA	NA	ACTUAL	
not applicable	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h

** At Reference of 25 degrees C and 760 mm Hg.

LOCATION OF SAMPLING POINT	NA	metre level
STACK DIAMETER OR TRAVERSE LENGTH	2.743	metres
RECTANGULAR DUCT WIDTH	0.000	metres
BAROMETRIC PRESSURE	743.5	mm Hg.
AMBIENT TEMPERATURE	8.0	C

AVERAGE COMPOSITION OF FLUE GAS

	DRY BASIS PERCENT	WET BASIS PERCENT
O2	6.000	5.580
CO2	0.000	0.000
N2 by Difference	94.000	87.425
H2O		6.995
CO	0.0000	0.000

SPECIFIC GRAVITY OF FLUE GAS (AIR = 1.0)	0.950	
MOLECULAR WEIGHT OF FLUE GAS	27.524	g/g-mole
MOLECULAR WEIGHT OF FLUE GAS (DRY BASIS)	28.240	g/g-mole

STACK GAS FLOW RATE DATA AND CALCULATIONS

PITOT CALIBRATION FACTOR	0.802	
STATIC PRESSURE	-0.355	mm Hg.
AVERAGE SQUARE ROOT VELOCITY HEAD	0.146	
AVERAGE STACK GAS TEMPERATURE	45.8	C
AVERAGE STACK GAS VELOCITY	2.575	m/s
EFFLUENT FLOW RATE - WET (INCLUDING WATER)	13.912	m3/s **
	2048.004	kg-mole/h
EFFLUENT FLOW RATE - DRY (EXCLUDING WATER)	12.939	m3/s **
	1904.745	kg-mole/h

kghcond 2585.2

** At Reference of 25 degrees C and 760 mm Hg.

Royal Oak	TEST Three		PAGE ISO01
Yellowknife	Roaster Stack	TEST START	12:55
DATA FILE NUMBER 980583	September 23, 1998	TEST END	15:45

POLLUTANT DATA AND CALCULATIONS - ISOKINETIC SAMPLING TRAIN

VOLUME OF FLUE GAS METERED					1.4208	m3
AVERAGE ORIFICE PRESSURE					0.4564	mm Hg.
AVERAGE DRY GAS METER TEMPERATURE					13.1	C
VACUUM AT LAST IMPINGER					2.0	mm Hg.
WATER VAPOUR PRESSURE AT LAST IMPINGER					7.9369	mm Hg.
VOLUME OF WATER CONDENSED					68.0	mL
VOLUME OF FLUE GAS METERED AT REF.					1.4485	m3 **
		50%EA	NA	NA	ACTUAL	
Particulates - Front Half	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	kg/1000kg wet
		NA	NA	NA	NA	kg/1000kg dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h
		50%EA	NA	NA	ACTUAL	
Particulates - Back Half	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	kg/1000kg wet
		NA	NA	NA	NA	kg/1000kg dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h
		50%EA	NA	NA	ACTUAL	
Particulates - Total Train	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	kg/1000kg wet
		NA	NA	NA	NA	kg/1000kg dry
		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h
		50%EA	NA	NA	ACTUAL	
Arsenic	%EA =	NA			3.4300	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			0.0022	g/m3**wet
		NA	NA	NA	0.0024	g/m3**dry
MASS FLOW					0.1103	kg/h

** At Reference of 25 degrees C and 760 mm Hg.

Royal Oak	TEST Three		PAGE ABS01
Yellowknife	Roaster Stack	TEST START	12:55
DATA FILE NUMBER 980583	September 23, 1998	TEST END	13:55

POLLUTANT DATA AND CALCULATIONS - PROPORTIONAL SAMPLING TRAINS

	ABS #1	ABS #2	
VOLUME OF FLUE GAS METERED	0.4651	0.0000	m3
AVERAGE ORIFICE PRESSURE	0.0000	NA	mm Hg.
AVERAGE DRY GAS METER TEMPERATURE	14.3	NA	C
VACUUM AT LAST IMPINGER	76.2	NA	mm Hg.
WATER VAPOUR PRESSURE AT LAST IMPINGER	6.543	NA	mm Hg.
VOLUME OF WATER CONDENSED	30.0	NA	
VOLUME OF FLUE GAS METERED AT REF.	0.4719	NA	m3 **

		50%EA	NA	NA	ACTUAL	
Sulphur Dioxide	%EA =	NA			15195.2000	mg
CONCENTRATION		NA			11429.3209	ppmv wet
		NA	NA	NA	12288.9377	ppmv dry
		NA			29.9465	g/m3**wet
		NA	NA	NA	32.1988	g/m3**dry
MASS FLOW					1499.8391	kg/h

		50%EA	NA	NA	ACTUAL	
not applicable	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h

		50%EA	NA	NA	ACTUAL	
not applicable	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h

		50%EA	NA	NA	ACTUAL	
not applicable	%EA =	NA			NA	mg
CONCENTRATION		NA			NA	ppmv wet
		NA	NA	NA	NA	ppmv dry
		NA			NA	g/m3**wet
		NA	NA	NA	NA	g/m3**dry
MASS FLOW					NA	kg/h

** At Reference of 25 degrees C and 760 mm Hg.

B

ENTECH ENVIRONMENTAL SERVICES LTD.

CHAIN OF CUSTODY

COMPANY:	Royal Oak (Giant)	LOCATION:	Yellowknife, NWT
SOURCE:	Gold Rooster stack	TEST NUMBER(S)	1-3
SAMPLED BY:	JJ / DEL	SAMPLE DATE:	22nd, 23rd Sept 98
RECOVERY BY:	JJ / DEL	RECOVERY DATE:	

FILTER NUMBER(S): E-143

TEST NUMBER(S)	SAMPLE BOTTLE NUMBER	DESCRIPTION OF SAMPLE
One	972806	impinger catch ($d.H_2O$ - arsenic)
One	972808	probe wash ($NaOH/d.H_2O$ - arsenic)
One	972810	mini-impinger SO_2 (H_2O_2)
One	~~fixed~~ bag	fixed gases

COLOR OF SILICA GEL:

DESCRIPTION OF IMPINGER WATER:

BOTTLE LEVEL MARKED: Y N

FILTER NUMBER(S): E-144

TEST NUMBER(S)	SAMPLE BOTTLE NUMBER	DESCRIPTION OF SAMPLE
Two	972812	impinger catch-arsenic ($NaOH/d.H_2O$)
Two	972805	probe wash-arsenic ($NaOH/d.H_2O$)
Two	972809	mini-impinger SO_2 (H_2O_2)
Two	bag	fixed gases

COLOR OF SILICA GEL:

DESCRIPTION OF IMPINGER WATER:

BOTTLE LEVEL MARKED: Y N

FILTER NUMBER(S): E-145

TEST NUMBER(S)	SAMPLE BOTTLE NUMBER	DESCRIPTION OF SAMPLE
Three	972811	impinger catch-arsenic ($NaOH/d.H_2O$)
Three	972553	probewash- " (" ")
Three	972815	mini-impinger catch-SO_2 (H_2O_2)
Three	bag	fixed gases

COLOR OF SILICA GEL:

DESCRIPTION OF IMPINGER WATER:

BOTTLE LEVEL MARKED: Y N

FILTER NUMBER(S):

TEST NUMBER(S)	SAMPLE BOTTLE NUMBER	DESCRIPTION OF SAMPLE

COLOR OF SILICA GEL:

DESCRIPTION OF IMPINGER WATER:

BOTTLE LEVEL MARKED: Y N

COMMENTS:

① shaker operating for 1 hour (1100-1200 hrs) during test two.

RELINQUISHED BY:	DE Lemma.	DATE:	25 Sept 98.	TIME: 1417 hrs.
RECEIVED BY:	BW.	DATE:	98-09-28	TIME: 14:30
RELINQUISHED BY		DATE:		TIME:
RECEIVED BY:		DATE:		TIME:

ISOKINETIC TEST DATA

581

CLIENT NAME / PLANT LOCATION: Royal Oak, Yellowknife

JOB / FILE NUMBER:

TEST CONDUCTED BY: J. Jackson / D. Lemm

PAGE 1 OF 6

CALCULATOR SET-UP		
ORIFICE FACTOR	176.07	
MINUTES PER POINT	5	
BAROMETRIC PRESSURE	29.42	in. Hg.
STATIC PRESSURE	-0.17	in. H2O
SPECIFIC GRAVITY	0.97	air = 1.0
WATER CONTENT	6	mole %
NOZZLE DIAMETER	0.4995	in. ½"(2)
PITOT FACTOR	0.802	
INITIAL METER READING	233.688	ft^3

DRY GAS ANALYSIS	C2	CO2
.....		
AVERAGES		

CO readings if taken: 20.072 / 0 / 0.110

Sample	Bottle Number	Initial Volume	Final Volume	mLs Condensed
Imp. 1	distilled H2O			
Imp. 2	"	600	725	125
Imp. 3	"			
Imp. 4	empty	—	—	—
Imp. 5	silica gel	—	—	—
Particulate Analytical				
EPA Filter	E-143			
P.W. Acet.				
P.W. Water				
Imp.				5.87
Imp.				1386.45

SOURCE INFORMATION
SOURCE NAME: Roaster Stack

TEST DATE: 22 Sept 98

TEST NUMBER: One

STACK I.D. – meters or traverse length: 108"

STACK WIDTH – meters if rectangular:

G.C. Sample Number:

Notes: leak check 0.009 cfm @ 15" Hg. Q = 105.426

[ ] See Over For Accitional Notes.

Kit Usec: ISO. Pitobe Used:

TRAV. POINT Number	START TIME	METER TEMP.C IN	METER TEMP.C OUT	STACK TEMP C	PITOT READING in.-H2O	ORIFICE SETTING in.H2O	METER READING ft.^3	IMP TEMP. C	IMP VAC. in.Hg.	OVEM TEMP. C	CALCULATED METER READING
1-16	1340	14	14	68	0.04	1.64	237.524	15	5.0	114	237.532
1-15	1345	14	14	67	0.04	1.65	241.398	17	5.0	122	241.382
1.14	1350	14	14	67	0.04	1.65	245.247	19	5.0	126	245.231
1-13	1355	16	14	68	0.05	2.10	249.553	19	5.5	118	249.544
1.12	1400	17	14	68	0.05	2.10	253.864	20	5.0	118	253.864
1-11	1405	19	15	69	0.04	1.68	257.748	19	5.0	119	257.748
1.10	1410	18	15	69	0.04	1.67	261.620	19	5.0	117	261.620
1-09	1415	19	15	69	0.04	1.68	265.509	18	6.0	118	265.498
1.08	1420	19	16	70	0.03	1.24	268.868	16	5.0	115	268.858
1-07	1425	20	16	70	0.03	1.24	272.231	16	5.5	129	272.223
1.06	1430	20	16	70	0.02	0.81	274.975	16	4.5	119	274.971
1-05	1435	20	17	70	0.02	0.81	277.738	15	4.5	126	277.724
1.04	1440	19	16	67	0.02	0.81	280.486	14	4.0	126	280.479
1-03	1445	19	16	67	0.02	0.81	283.215	15	4.0	122	283.234
1.02	1450	20	17	52	0.01	0.40	285.241	14	3.5	117	285.234
1-01	1455	20	18	44	0.01	0.42	287.270	13	3.0	116	287.262
							Averages	15.4	4.9		

ISOKINETIC TEST DATA

CLIENT NAME / PLANT LOCATION: Ø. Royal Oak ; Yellowknife

JOB / FILE NUMBER:

TEST CONDUCTED BY: J. Jackson / D. Lemna

CALCULATOR SET-UP		
ORIFICE FACTOR	176.07	
MINUTES PER POINT	5	
BAROMETRIC PRESSURE	29.42	in. Hg.
STATIC PRESSURE	-0.17	in. H2O
SPECIFIC GRAVITY	0.97	air = 1.0
WATER CONTENT	6	mole %
NOZZLE DIAMETER	0.4995	in. ½"(2)
PITOT FACTOR	0.802	
INITIAL METER READING	~~287.270~~	ft.^3

DRY GAS ANALYSIS	
O2	CO2
8.0	0
7.0	0
AVERAGES	

CO readings if taken:

	Sample Bottle Number	Initial Volume	Final Volume	mLs Condensed
Imp. 1	see sheet 1			
Imp. 2				
Imp. 3				
Imp. 4				
Imp. 5				
Particulate Analytical				
EPA Filter				
P.W. Acet.				
P.W. Water				
Imp.				
Imp.				

SOURCE INFORMATION
SOURCE NAME: Roaster Stack

TEST DATE: 22 Sept 98

TEST NUMBER: One

STACK I.D.-meters or traverse length: 108"

STACK WIDTH - meters if rectangular:

G.C. Sample Number:

Notes: see sheet 1

[ ] See Over For Additional Notes.

Kit Used: 150.005

Pitobe Used: B-012

TRAV. POINT	START TIME	METER TEMP.C IN	METER TEMP.C OUT	STACK TEMP C	PITOT READING in.H2O	ORIFICE SETTING in.H2O	METER READING ft.^3	IMP. TEMP C	IMP VAC. in.Hg	CVEM TEMP. C	CALCULATED METER READING
West (~~Start~~)											
2.16	1510	18	17	69	0.05	2.13	291.625	12	6.0	123	291.606
2.15	1515	19	17	69	0.04	1.69	295.506	14	7.0	116	295.497
2.14	1520	19	17	69	0.04	1.69	299.402	16	6.5	122	299.389
2.13	1525	19	17	70	0.05	2.13	303.739	17	6.5	124	303.734
2.12	1530	21	18	70	0.04	1.70	307.648	17	6.5	117	307.640
2.11	1535	21	18	71	0.04	1.70	311.552	16	6.5	116	311.540
2.10	1540	21	18	70	0.04	1.70	315.457	16	6.0	124	315.447
2.09	1545	20	17	70	0.03	1.25	318.825	15	4.5	116	318,818
2.08	1550	20	17	70	0.03	1.25	322.203	14	5.0	108	322.189
2.07	1555	19	17	70	0.02	0.81	324.937	14	4.5	127	324.937
2.06	1600	20	18	71	0.02	0.81	327.684	14	4.0	121	327.690
2.05	1605	20	18	71	0.02	0.81	330.448	14	4.0	119	330.444
2.04	1610	20	18	71	0.02	0.81	333.207	13	4.0	117	333.197
2.03	1615	20	18	67	0.01	0.36	335.162	13	3.0	127	335.155
2.02	1620	20	18	63	0.01	0.39	337.110	13	3.0	122	337.125
2.01	1625	17	16	52	0.01	0.40	339.114	11	3.0	113	339.111
										Averages	

EMISSION TEST DATA

Job Number		Test Number	ONE	Pitot #	Factor
Company Name	ROYAL OAK MINES	Barometric Pressure	29.42	NOVA [ ]	GC [ ] Fyrites [ ]
Plant Location	YELLOWKNIFE	Ambient Temperature	15	O2	mole %
Source Name	ROASTER STACK	Train Operators	JJ DEL	CO2	mole %
Test Date	SEPT 22 1998	Train Used	SO_2 KIT 6	CO	ppmv

SILICA GEL WEIGHT 332 START SILICA GEL END WEIGHT 337

Solution Used	Imp. 1	Imp. 2	Cyclonic Flow	Yes [ ] No [ ]	Angle
Initial mLs.	200	200	Static Pressure	+ [ ] - [ ]	in. H2O
Final mLs.	224		Leak Checks	✓ before	✓ After
mLs. Condensed	24	100 WASH		cfm@ in.Hg.	cfm@ in.Hg.

Sample Time	Clock Time	Meter Volume Units [ ]	Stack dP in. H2O	Imp. Vacuum in. Hg.	TEMPERATURES C meter	condenser	stack
0	13:50	071.558		3.0	14	05	
10	14:00	073.61		3.0	15	05	
20	14:10	075.90		3.0	17	05	
30	14:20	079.40		3.0	20	05	
40	14:30	081.19		3.0	21	05	
50	14:40	083.50		3.0	23	05	
60	14:50	086.342		3.0	23	05	
		14.784		3.0	19.0	5	

Ts C	dP in.H2O	Ts C	dP in.H2O	Ts C	dP in.H2O	Ts C	dP in.H2O
1		1		1		1	
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7		7		7		7	
8		8		8		8	
9		9		9		9	
10		10		10		10	
11		11		11		11	
12		12		12		12	
13		13		13		13	
14		14		14		14	
15		15		15		15	
16		16		16		16	
PORT IDENT.							

ISOKINETIC TEST DATA

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PAGE 3 OF 6

CLIENT NAME / PLANT LOCATION: Royal Oak, Yellowknife

JOB / FILE NUMBER:

TEST CONDUCTED BY: D. Lemna / J. Jackson

CALCULATOR SET-UP		
ORIFICE FACTOR	176.07	
MINUTES PER POINT	5	
BAROMETRIC PRESSURE	29.27	in. Hg.
STATIC PRESSURE	-0.19	in. H2O
SPECIFIC GRAVITY	0.97	air = 1.0
WATER CONTENT	6	mole %
NOZZLE DIAMETER	0.3693	in. 3/8"(2)
PITOT FACTOR	0.802	
INITIAL METER READING	343.207	ft.^3.

DRY GAS ANALYSIS		
	O2	CO2
	8.0	~~8.0~~ 0
	8.0	0
AVERAGES		

CO readings if taken: 2

	Sample Bottle Number	Initial Volume	Final Volume	mLs Condensed
Imp. 1	distilled water	600	-678	78
Imp. 2	"			
Imp. 3	"			
Imp. 4	empty			
Imp. 5	silica gel			
Particulate Analytical				
EPA Filter	E-144			
P.W. Acet.				
P.W. Water				
Imp.				7.17
Imp.				1546.9

SOURCE INFORMATION SOURCE NAME:	Roaster Stack
TEST DATE	23 Sept 98
TEST NUMBER	Two
STACK I.D.-meters or traverse length	108"
STACK WIDTH - meters if rectangular	
G.C. Sample Number	

Notes: leak check 0.006 cfm @ 15" Hg
Q = 28.183 + 25.269 = 53.452
* shaker operating ≅ 1100 - 1200 hrs.
[ ] See Over For Additional Notes.

Kit Used: 150.005 Pitobe Used: B-012

TRAV. POINT nom.	START TIME	METER TEMP.C IN	METER TEMP.C OUT	STACK TEMP C	PITOT READING in.H2O	ORIFICE SETTING in.H2O	METER READING ft.^3	IMP TEMP C	IMP VAC. in.Hg	OVEM TEMP. C	CALCULATED METER READING
1.16	0830	07	05	53	0.04	0.44	345.288	03	2.0	116	345.279
1.15	0835	10	07	40	0.05	0.59	347.651	03	2.0	119	347.663
1.14	0840	11	08	40	0.05	0.60	350.072	03	2.0	116	350.057
1.13	0845	12	08	41	0.05	0.60	352.463	07	2.0	124	352.450
1.12	0850	13	09	41	0.04	0.47	354.608	07	2.0	117	354.599
1.11	0855	13	09	44	0.04	0.47	356.745	07	2.0	123	356.737
1.10	0900	13	09	43	0.04	0.47	358.862	07	2.0	120	358.879
1.09	0905	13	09	42	0.03	0.34	360.748	07	2.0	117	360.736
1.08	0910	13	10	49	0.02	0.21	362.239	06	2.0	123	362.239
1.07	0915	14	10	56	0.02	0.21	363.719	06	2.0	118	363.729
1.06	0920	14	10	59	0.02	0.20	365.224	07	2.0	124	365.212
1.05	0925	14	10	59	0.02	0.20	366.678	07	2.0	119	366.694
1.04	0930	14	11	60	0.02	0.20	368.184	07	2.0	119	368.177
1.03	0935	14	12	58	0.01	0.09	369.237	07	2.0	121	369.231
1.02	0940	14	12	48	0.01	0.09	370.315	07	2.0	122	370.301
1.01	0945	15	13	40	0.01	0.10	371.390	07	2.0	121	371.388
							Averages	8.2	2.0		

ISOKINETIC TEST DATA

CLIENT NAME / PLANT LOCATION: Regal Oak, Yellowknife

JOB / FILE NUMBER:

TEST CONDUCTED BY: J. Jackson / D. Lemna

CALCULATOR SET-UP		
ORIFICE FACTOR	176.07	
MINUTES PER POINT	5	
BAROMETRIC PRESSURE	29.27	in. Hg.
STATIC PRESSURE	-0.19	in. H2O
SPECIFIC GRAVITY	0.97	air = 1.0
WATER CONTENT	6	mole %
NOZZLE DIAMETER	0.3693	in.
PITOT FACTOR	0.802	
INITIAL METER READING	372.553	ft.^3.

DRY GAS ANALYSIS		
O2	CO2	
AVERAGES		

CO readings if taken:

	Sample Bottle Number	Initial Volume	Final Volume	mLs Condensed
Imp. 1	see data sheet #3			
Imp. 2				
Imp. 3				
Imp. 4				
Imp. 5				
Particulate Analytical				
EPA Filter				
P.W. Acet.				
P.W. Water				
Imp.				
Imp.				

SOURCE INFORMATION	
SOURCE NAME:	Roaster Stack
TEST DATE	23 Sept 98
TEST NUMBER	Two (B) sheet
STACK I.D.-meters or traverse length	108"
STACK WIDTH - meters if rectangular	

G.C. Sample Number:

Notes: see data sheet #3
* shaker operating 1100 - 1200 hrs.
Q = 25.269
[ ] See Over For Additional Notes.
Kit Used: see data sheet #3 | Pitobe Used:

TRAV. POINT	START TIME	METER TEMP.C IN	METER TEMP.C OUT	STACK TEMP C	PITOT READING in.H2O	ORIFICE SETTING in.H2O	METER READING ft.^3	IMP TEMP C	IMP VAC. in.Hg	OVEM TEMP. C	CALCULATED METER READING
2.16 West	1045	13	13	55	0.02	0.21	374.058	10	2.0	123	374.050
2.15	1050	13	13	63	0.02	0.20	375.537	10	2.0	119	375.529
2.14	1055	14	14	65	0.02	0.20	377.015	11	2.0	117	377.009
2.13	1100	14	14	66	0.02	0.20	378.495	12.	2.0	119	378.486
2.12	1105	15	14	66	0.02	0.20	379.974	13	2.0	120	379.967
2.11	1110	15	14	67	0.02	0.20	381.458	12.	2.0	117	381.445
2.10	1115	15	14	68	0.03	0.32	383.268	12	2.0	114	383.252
2.09	1120	15	14	67	0.03	0.32	385.053	12	2.0	123	385.062
2.08	1125	15	14	67	0.04	0.44	387.163	11.	2.0	122	387.152
2.07	1130	15	14	68	0.03	0.32	388.958	10	2.0	126	388.960
2.06	1135	16	14	68	0.03	0.32	390.778	10	2.0	117	390.770
2.05	1140	15	14	68	0.02	0.20	392.251	09.	2.0	119	392.246
2.04	1145	15	14	67	0.02	0.20	393.710	09	2.0	118	393.724
2.03	1150	15	15	64	0.02	0.21	395.216	08.	2.0	125	395.211
2.02	1155	15	14	47	0.02	0.22	396.743	08	2.0	119	396.735
2.01	1200	15	15	52	0.01	0.09	397.822.	08	2.0	122	397.805
							Averages				

EMISSION TEST DATA

Job Number	Test Number TWO	Pitot #	Factor
Company Name ROYAL OAK MINES	Barometric Pressure 29.27	NOVA [ ] GC [ ] Fyrites [ ]	
Plant Location YELLOWKNIFE	Ambient Temperature	O2	mole %
Source Name ROASTER STACK	Train Operators TJ DEL	CO2	mole %
Test Date SEPT 23 1998	Train Used SOx # 6	CO	ppmv

SILICA GEL START WEIGHT 337 SILICA GEL END WEIGHT 343

Solution Used	Imp. 1	Imp. 2	Cyclonic Flow	Yes [ ] No [ ]	Angle
Initial mLs.	400		Static Pressure	+ [ ] - [ ]	in. H2O
Final mLs.	429		Leak Checks	Before ✓	After ✓
mLs. Condensed	29	WASH 100		cfm@ in.Hg.	cfm@ in.Hg.

Sample Time	Clock Time	Meter Volume Units [ ]	Stack dP in. H2O	Imp. Vacuum in. Hg.	TEMPERATURES C meter	condenser	stack
0	08:15	86.451		3.0	03	05	
10	08:25	87.63		3.0	04	05	
20	08:35	89.91		3.0	6.0	05	
30	08:45	92.64		3.0	8.0	05	
40	08:55	95.50		3.0	12.0	05	
50	09:05	97.10		3.0	14.0	05	
60	09:15	101.003		3.0	16.0	05	
		14.552		3.0	9.0	5.0	

	Ts C	dP in.H2O	Ts C	dP in.H2O	Ts C	dP in.H2O	Ts C	dP in.H2O
1			1		1		1	
2			2		2		2	
3			3		3		3	
4			4		4		4	
5			5		5		5	
6			6		6		6	
7			7		7		7	
8			8		8		8	
9			9		9		9	
10			10		10		10	
11			11		11		11	
12			12		12		12	
13			13		13		13	
14			14		14		14	
15			15		15		15	
16			16		16		16	
PORT IDENT.								

ISOKINETIC TEST DATA

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CLIENT NAME / PLANT LOCATION: Royal Oak, Yellowknife

JOB / FILE NUMBER:

TEST CONDUCTED BY: D. Lemna / J. Jackson

CALCULATOR SET-UP

ORIFICE FACTOR	176.07	
MINUTES PER POINT	5	
BAROMETRIC PRESSURE	29.27	in. Hg.
STATIC PRESSURE	-0.19	in. H2O
SPECIFIC GRAVITY	97	air = 1.0
WATER CONTENT	6	mole %
NOZZLE DIAMETER	0.3693	in. 3/8"(2)
PITOT FACTOR	0.802	
INITIAL METER READING	398.085	ft.^3

DRY GAS ANALYSIS

O2	CO2
6.0	0
6.0	0
AVERAGES	

CO readings if taken

	Sample Bottle Number	Initial Volume	Final Volume	mLs Condensed
Imp. 1	distilled water			
Imp. 2	"	600	668	68
Imp. 3	"			
Imp. 4	empty			
Imp. 5	silica gel			

Particulate Analytical

EPA Filter	E-145			
P.W. Acet.				
P.W. Water				
Imp.				3.43
Imp.				1519.5.2

SOURCE INFORMATION
SOURCE NAME: Roaster Stack

TEST DATE: 23 Sept 98

TEST NUMBER: Three

STACK I.D. – meters or traverse length: 108"

STACK WIDTH – meters if rectangular:

G.C. Sample Number:

Notes: leak check 0.001 cfm @ 15" Hg
Q = 50.174

[ ] See Over For Additional Notes.

Kit Used: 150.005

Pitobe Used: B-012

TRAV. POINT West	START TIME	METER TEMP.C IN	METER TEMP.C OUT	STACK TEMP C	PITOT READING in.H2O	ORIFICE SETTING in.H2O	METER READING ft.^3	IMP TEMP C	IMP VAC. in.Hg.	OVEM TEMP. C	CALCULATED METER READING
2.16	1255	10	11	44	0.02	0.21	399.606	07	2.0	120	399.594
2.15	1300	11	11	47	0.02	0.21	402.107	06	2.0	121	401.099
2.14	1305	11	11	46	0.02	0.21	402.615	06	2.0	122	402.607
2.13	1310	12	11	46	0.02	0.21	404.125	07	2.0	123	404.117
2.12	1315	12	11	47	0.02	0.21	405.633	07	2.0	119	405.624
2.11	1320	13	12	48	0.03	0.34	407.490	09	2.0	122	407.474
2.10	1325	13	12	49	0.03	0.34	409.335	10	2.0	120	409.321
2.09	1330	13	12	49	0.03	0.34	411.172	09	2.0	119	411.168
2.08	1335	14	12	49	0.04	0.47	413.294	08	2.0	126	413.305
2.07	1340	14	12	48	0.03	0.34	415.166	08	2.0	122	415.158
2.06	1345	14	12	47	0.03	0.34	417.029	07	2.0	117	417.014
2.05	1350	14	13	47	0.02	0.22	418.546	07	2.0	123	418.532
2.04	1355	14	13	46	0.02	0.22	420.059	07	2.0	121	420.053
2.03	1400	14	13	44	0.01	0.10	421.137	07	2.0	124	421.132
2.02	1405	14	13	39	0.01	0.10	422.228	07	2.0	120	422.219
2.01	1410	14	13	32	0.01	0.10		07	2.0	125	423.318
							Averages	7.8	2.0		

Entech Environmental Services Limited, #6, 1826–25 Avenue N.E., Calgary, Alberta, T2E 7K1 Phone(403) 250–3532 Fax(403) 250–9577

ISOKINETIC TEST DATA

CLIENT NAME / PLANT LOCATION: Royal Oak, Yellowknife

JOB / FILE NUMBER:

TEST CONDUCTED BY: D. Lemna / J. Jackson

CALCULATOR SET-UP		
ORIFICE FACTOR	176.07	
MINUTES PER POINT	5	
BAROMETRIC PRESSURE	29.27	in. Hg.
STATIC PRESSURE	-0.19	in. H2O
SPECIFIC GRAVITY	0.97	air = 1.0
WATER CONTENT	6	mole %
NOZZLE DIAMETER	0.3693	in. 3/8" (2)
PITOT FACTOR	0.802	
INITIAL METER READING	423.318	ft.^3

DRY GAS ANALYSIS		
	O2	CO2
~~5.0~~ 6.0		0
~~5.0~~ 6.0		0
AVERAGES		

CO readings if taken:

	Sample Bottle Number	Initial Volume	Final Volume	mLs Condensed
Imp. 1	see data sheet #5			
Imp. 2				
Imp. 3				
Imp. 4				
Imp. 5				

Particulate Analytical				
EPA Filter				
P.W. Acet.				
P.W. Water				
Imp.				
Imp.				

SOURCE INFORMATION	
SOURCE NAME:	Roaster Stack
TEST DATE	23 Sept 98
TEST NUMBER	Three
STACK I.D. – meters or traverse length	108"
STACK WIDTH – meters if rectangular	

G.C. Sample Number:

Notes: see data sheet #5

[ ] See Over For Additional Notes.

Kit Used: see data sheet #5 | Pitobe Used:

TRAV. POINT north.	START TIME	METER TEMP.C IN	METER TEMP.C OUT	STACK TEMP C	PITOT READING in.H2O	ORIFICE SETTING in.H2O	METER READING ft.^3	IMP TEMP C	IMP VAC. in.Hg.	OVEM TEMP. C	CALCULATED METER READING
1.16	1425	14	13	46	0.01	0.10		08	2.0	121	
1.15	1430	13	13	46	0.02	0.22	425.922	08	2.0	125	425.911
1.14	1435	13	13	47	0.03	0.34	427.775	08	2.0	126	427.768
1.13	1440	13	13	48	0.02	0.21	429.295	08	2.0	116	429.281
1.12	1445	14	13	48	0.03	0.34	431.149	09	2.0	124	431.137
1.11	1450	14	13	49	0.02	0.21	432.638	09	2.0	119	432.651
1.10	1455	14	13	48	0.02	0.22	434.176	09	2.0	122	434.167
1.09	1500	14	13	48	0.03	0.34	436.014	09	2.0	121	436.023
1.08	1505	15	14	48	0.03	0.34	437.892	08	2.0	123	437.886
1.07	1510	15	13	47	0.03	0.34	439.758	08	2.0	118	439.749
1.06	1515	15	13	48	0.03	0.34	441.596	08	2.0	122	441.609
1.05	1520	15	14	47	0.03	0.34	443.483	08	2.0	118	443.474
1.04	1525	15	13	46	0.02	0.22	445.009	08	2.0	125	444.998
1.03	1530	15	14	46	0.01	0.10	446.064	08	2.0	121	446.077
1.02	1535	14	14	41	0.01	0.10	447.175	08	2.0	120	447.163
1.01	1540	14	14	35	0.01	0.10	448.259	08	2.0	125	448.259
							Averages				

EMISSION TEST DATA

Job Number		Test Number	THREE	Pitot #		Factor	
Company Name	ROYAL OAK MINES	Barometric Pressure	29.27	NOVA [ ]	GC [ ]	Fyrites [ ]	
Plant Location	YELLOWKNIFE	Ambient Temperature	18°C	O2			mole %
Source Name	ROASTER	Train Operators	SS DEL	CO2			mole %
Test Date	SEPT 23 1998	Train Used	SO_2 KIT 6	CO			ppmv

SILICA GEL START WEIGHT 343 SILICA GEL END WEIGHT 348

Solution Used	Imp. 1	Imp. 2	Cyclonic Flow	Yes [ ] No [ ]	Angle
Initial mLs.	400		Static Pressure	+ [ ] - [ ]	in. H2O
Final mLs.	425		Leak Checks	Before	After
mLs. Condensed	25	WASH 100		cfm@ in.Hg.	cfm@ in.Hg.

Sample Time	Clock Time	Meter Volume Units [ ]	Stack dP in. H2O	Imp. Vacuum in. Hg.	TEMPERATURES C meter	condenser	stack
0	12:55	101.010		3.0	09	05	
10	13:05	103.605		3.0	10	05	
20	13:15	105.81		3.0	12	05	
30	13:25	107.65		3.0	14	05	
40	13:35	110.35		3.0	16.0	05	
50	13:45	114.50		3.0	18.0	05	
60	13:55	117.435		3.0	21.0	05	
		16.425		3.0	14.3	5.0	

	Ts C	dP in.H2O		Ts C	dP in.H2O		Ts C	dP in.H2O		Ts C	dP in.H2O
1			1			1			1		
2			2			2			2		
3			3			3			3		
4			4			4			4		
5			5			5			5		
6			6			6			6		
7			7			7			7		
8			8			8			8		
9			9			9			9		
10			10			10			10		
11			11			11			11		
12			12			12			12		
13			13			13			13		
14			14			14			14		
15			15			15			15		
16			16			16			16		
PORT IDENT.											

PITOT TUBE/PITOBE CALIBRATION DATA

UPDATED 27-July-1998

A=>PITOT / B=>PITOBE	TYPE	Length Ft.	Pf A	Pf B	DATE
A-021	PITOT	2.0	0.793 A		09-Feb-98
A-04SH1	PITOT	5.0	0.794 A		05-Feb-98
A-051	PITOT	5.0	0.806 A		22-Jan-98
A-06SH1	PITOT	6.0	0.854 A		05-Feb-98
A-081	PITOT	8.0	0.802 A		09-Feb-98
A-082	PITOT	8.0	0.826 A		09-Feb-98
A-14SH1	PITOT	14.0	0.750 A		19-Feb-98
A-14SH2	PITOT	14.0	0.772 A		19-Feb-98
A-14SH3	PITOT	14.0	0.732 A		19-Feb-98
A-141	PITOT	14.0	0.823 A		09-Feb-98
A-142	PITOT	14.0	0.759 A		09-Feb-98
A-143 Mon.	PITOT	14.0	0.833 A		29-Jun-98
A-17SH1	PITOT	17.0	0.798 A		20-Jul-98
A-WEI01	PITOT	8.0	0.764 A		22-Jan-98
A-WEI02	PITOT	8.0	0.852 A		22-Jan-98
B-031	PITOBE	3.0	0.841 A		05-Feb-98
B-032	PITOBE	3.0	0.801 A		02-Jan-98
B-033	PITOBE	3.0	0.800 A		02-Jan-98
B-051	PITOBE	5.0	0.825 A		05-Feb-98
B-052	PITOBE	5.0	0.826 A		02-Jan-98
B-081	PITOBE	6.0	0.858 A		05-Feb-98
B-081	PITOBE	8.0	0.835 A		09-Feb-98
B-091	PITOBE	9.0	0.795 A		19-Feb-98
B-101	PITOBE	10.0	0.813 A		09-Feb-98
B-102	PITOBE	10.0	0.781 A		09-Feb-98
B-121	PITOBE	12.0	0.802 A		09-Feb-98
ASTM-02		Tip	0.846 A		05-Feb-98
ASTM-03		Tip	0.810 A		19-Feb-98
ASTM-04		Tip	0.807 A		04-Feb-97
ASTM-05		Tip	0.818 A		09-Feb-98
ASTM-10		Tip	0.815 A		19-Feb-98
B-H2O		Tip	0.812 A		19-Feb-98

NOx Bomb Calibrations

Bomb #	Volume
2000	2022
2001	2046
2002	2003
2003	1994
2004	2025
2005	2056
2006	1967
2007	2042
2008	1991
2009	2010
2010	1970
2011	2080
2012	1985
2013	1932
2014	1973
2015	2029
2016	1995
2017	2034
2018	1993
2019	2009
2020	1984
2021	1995
2022	1972
2023	2008
2024	1969
2025	1976
2027	2002
2028	2023
2029	2013
2030	1997
2031	1989
2032	2006
2033	2095
2034	1992
2035	2022
2036	2037
2037	2029
2038	1970
2039	2020
2040	2057
2041	2064
2042	1998
2043	2094
2044	2068
2045	1986
2046	2087
2047	2080
2048	2019

Nozzle	Size	Nozzle	Size	Nozzle	Size
3/32 SS-01	0.0903	1/4 SS-01	0.2483	5/16 SS-01	0.3155
3/32 SS-03	0.0950	1/4 SS-02	0.2525	5/16 SS-02	0.3148
		1/4 SS-03	0.2520	5/16 SS-03	0.3140
1/8 SS-01	0.1315	1/4 SS-04	0.2508	5/16 SS-04	0.3143
		1/4 SS-05	0.2493	5/16 SS-05	0.3143
3/16 SS-01	0.1913	1/4 SS-06	0.2508		
3/16 SS-02	0.1935	1/4 SS-07	0.2553	3/8 SS-01	0.3693
3/16 SS-03	0.1918	1/4 SS-08	0.2493	3/8 SS-02	0.3693
3/16 SS-04	0.1925	1/4 SS-09	0.2495	3/8 SS-03	0.3728
3/16 SS-05	0.1918	1/4 SS-10	0.2448	3/8 SS-04	0.3668
3/16 SS-07	0.1928			3/8 SS-05	0.3683
3/16 SS-08	0.1905	9/32 SS-01	0.2843	3/8 SS-06	0.3758
3/16 SS-09	0.1913	9/32 SS-02	0.2890	3/8 SS-07	0.3693
3/16 SS-10	0.1918	9/32 SS-03	0.2868	3/8 SS-08	0.3660
3/16 SS-12	0.1903	9/32 SS-04	0.2858	3/8 SS-10	0.3670
		9/32 SS-05	0.2853		
7/32 SS-01	0.2168	9/32 SS-06	0.2890	3/8 napp01	0.3700
7/32 SS-02	0.2210	9/32 SS-07	0.2868		
7/32 SS-03	0.2198	9/32 SS-08	0.2880		
7/32 SS-04	0.2188	9/32 SS-09	0.2840	1/2 SS-01	0.4970
7/32 SS-06	0.2203	9/32 SS-10	0.2888	1/2 SS-02	0.4995
				1/2 SS-03	0.5005
7/16 Q (N)	0.4360			1/2 SS-05	0.5063
3/16 Q (P)	0.1998	3/8 INC-07	0.3693		
1/4 Q (P1)	0.2315	3/8 INC-07	0.3735	1/2 NIC-06	0.4950
1/4 Q (P2)	0.2318			1/2 NIC-07	0.4925
1/4 Q (G)	0.2623				

METER/ORIFICE CALIBRATION DATA

FULL CERTIFICATION	DGM	ORIFICE	DATE	VERIFICATION DATES
ISO 002	0.9991	170.03	98/02/24	
ISO 003	1.0041	170.04	98/02/24	
ISO 004	0.9972	170.04	98/02/24	
ISO 005	0.9940	176.07	98/02/24	
ISO 006	1.0021	173.05	98/03/12	
ABS 001	1.001		98/02/10	
ABS 002	0.999		98/03/12	98/04/28
ABS 003	1.007 @ 20 l/min		97/12/01	
ABS 003	@ 1.0 l/min			
ABS 005	0.998		98/02/06	
ABS 006	1.004		98/05/22	
ABS 007	0.996		98/06/18	
ABS 008	1.006		98/03/13	
ABS 009	1.001		98/02/20	
ABS 010	0.994		98/02/12	
ABS 011	1.007		98/02/06	
REF 001	0.999 vs spirometer		98/01/30	
REF 002	1.000 vs. REF 001		98/02/03	

C

Royal Oak
Yellowknife
Roaster Stack

DATA FILE NUMBER 980581
TEST One
September 22, 1998

GAS SPEED AND ISOKINETIC CALCULATIONS

POINT #	VELOCITY PRES. in.H2O	ORIFICE PRES. in.H2O	VOLUME m3	STACK TEMP. C	METER-TEMP IN C	METER-TEMP OUT C	STACK VEL m/s	PERCENT ISOKIN.
1.16	0.040	1.640	0.1086	68.0	14.0	14.0	3.63	100.62
1.15	0.040	1.650	0.1096	67.0	14.0	14.0	3.63	101.46
1.14	0.040	1.650	0.1089	67.0	16.0	14.0	3.63	100.46
1.13	0.050	2.100	0.1219	68.0	16.0	14.0	4.06	100.55
1.12	0.050	2.100	0.1220	68.0	17.0	14.0	4.06	100.50
1.11	0.040	1.680	0.1099	69.0	19.0	15.0	3.64	100.96
1.10	0.040	1.670	0.1096	69.0	18.0	15.0	3.64	100.82
1.09	0.040	1.680	0.1101	69.0	19.0	15.0	3.64	101.09
1.08	0.030	1.240	0.0951	70.0	19.0	16.0	3.16	100.91
1.07	0.030	1.240	0.0952	70.0	20.0	16.0	3.16	100.85
1.06	0.020	0.810	0.0777	70.0	20.0	16.0	2.58	100.89
1.05	0.020	0.810	0.0782	70.0	20.0	17.0	2.58	101.42
1.04	0.020	0.810	0.0778	67.0	19.0	16.0	2.57	100.77
1.03	0.020	0.810	0.0772	67.0	19.0	16.0	2.57	100.07
1.02	0.010	0.400	0.0573	52.0	20.0	17.0	1.77	102.48
1.01	0.010	0.420	0.0574	44.0	20.0	18.0	1.75	101.18
2.16	0.050	2.130	0.1232	69.0	18.0	17.0	4.07	100.96
2.15	0.040	1.690	0.1098	69.0	19.0	17.0	3.64	100.53
2.14	0.040	1.690	0.1103	69.0	19.0	17.0	3.64	100.92
2.13	0.050	2.130	0.1227	70.0	19.0	17.0	4.07	100.52
2.12	0.040	1.700	0.1106	70.0	21.0	18.0	3.64	100.88
2.11	0.040	1.700	0.1105	71.0	21.0	18.0	3.65	100.90
2.10	0.040	1.700	0.1105	70.0	21.0	18.0	3.64	100.78
2.09	0.030	1.250	0.0953	70.0	20.0	17.0	3.16	100.83
2.08	0.030	1.250	0.0956	70.0	20.0	17.0	3.16	101.13
2.07	0.020	0.810	0.0774	70.0	19.0	17.0	2.58	100.52
2.06	0.020	0.810	0.0777	71.0	20.0	18.0	2.58	100.80
2.05	0.020	0.810	0.0782	71.0	20.0	18.0	2.58	101.43
2.04	0.020	0.810	0.0781	71.0	20.0	18.0	2.58	101.24
2.03	0.010	0.380	0.0553	67.0	20.0	18.0	1.81	100.97
2.02	0.010	0.390	0.0551	63.0	20.0	18.0	1.80	100.02
2.01	0.010	0.400	0.0567	52.0	17.0	16.0	1.77	102.06
AVG.		1.261		67.1	18.9	16.4	3.08	100.92
TOTAL			2.9836					
MAX								102.48
MIN								100.02

Royal Oak
Yellowknife
Roaster Stack

DATA FILE NUMBER 980582
TEST Two
September 23, 1998

GAS SPEED AND ISOKINETIC CALCULATIONS

POINT #	VELOCITY PRES. in.H2O	ORIFICE PRES. in.H2O	VOLUME m3	STACK TEMP. C	METER-TEMP IN C	METER-TEMP OUT C	STACK VEL m/s	PERCENT ISOKIN.
1.16	0.040	0.440	0.0589	53.0	7.0	5.0	3.56	100.60
1.15	0.050	0.590	0.0669	40.0	10.0	7.0	3.90	99.19
1.14	0.050	0.600	0.0685	40.0	11.0	8.0	3.90	101.26
1.13	0.050	0.600	0.0677	41.0	12.0	8.0	3.91	99.99
1.12	0.040	0.470	0.0607	41.0	13.0	9.0	3.50	99.97
1.11	0.040	0.470	0.0605	44.0	13.0	9.0	3.51	100.07
1.10	0.040	0.470	0.0599	43.0	13.0	9.0	3.51	98.98
1.09	0.030	0.340	0.0534	42.0	13.0	9.0	3.03	101.69
1.08	0.020	0.210	0.0422	49.0	13.0	10.0	2.50	99.41
1.07	0.020	0.210	0.0419	56.0	14.0	10.0	2.53	99.50
1.06	0.020	0.200	0.0426	59.0	14.0	10.0	2.54	101.78
1.05	0.020	0.200	0.0411	59.0	14.0	10.0	2.54	98.26
1.04	0.020	0.200	0.0426	60.0	14.0	11.0	2.55	101.75
1.03	0.010	0.090	0.0298	58.0	14.0	12.0	1.79	100.16
1.02	0.010	0.090	0.0305	48.0	14.0	12.0	1.77	100.98
1.01	0.010	0.100	0.0304	40.0	15.0	13.0	1.74	99.09
2.16	0.020	0.210	0.0755	55.0	13.0	13.0	2.53	178.58
2.15	0.020	0.200	0.0419	63.0	13.0	13.0	2.56	100.20
2.14	0.020	0.200	0.0418	65.0	14.0	14.0	2.56	100.08
2.13	0.020	0.200	0.0419	66.0	14.0	14.0	2.57	100.36
2.12	0.020	0.200	0.0419	66.0	15.0	14.0	2.57	100.12
2.11	0.020	0.200	0.0420	67.0	15.0	14.0	2.57	100.61
2.10	0.030	0.320	0.0512	68.0	15.0	14.0	3.15	100.31
2.09	0.030	0.320	0.0505	67.0	15.0	14.0	3.15	98.78
2.08	0.040	0.440	0.0597	67.0	15.0	14.0	3.64	101.09
2.07	0.030	0.320	0.0508	68.0	15.0	14.0	3.15	99.48
2.06	0.030	0.320	0.0515	68.0	16.0	14.0	3.15	100.69
2.05	0.020	0.200	0.0417	68.0	15.0	14.0	2.58	100.01
2.04	0.020	0.200	0.0413	67.0	15.0	14.0	2.57	98.91
2.03	0.020	0.210	0.0426	64.0	15.0	15.0	2.56	101.47
2.02	0.020	0.220	0.0432	47.0	15.0	14.0	2.50	100.43
2.01	0.010	0.090	0.0305	52.0	15.0	15.0	1.78	101.00
AVG.		0.285		56.0	13.7	11.8	2.82	102.65
TOTAL			1.5456					
MAX								178.58
MIN								98.26

Royal Oak
Yellowknife
Roaster Stack

DATA FILE NUMBER 980583
TEST Three
September 23, 1998

GAS SPEED AND ISOKINETIC CALCULATIONS

POINT #	VELOCITY PRES. in.H2O	ORIFICE PRES. in.H2O	VOLUME m3	STACK TEMP. C	METER-TEMP IN C	METER-TEMP OUT C	STACK VEL m/s	PERCENT ISOKIN.
1.16	0.020	0.210	0.0430	44.0	10.0	11.0	2.49	100.56
1.15	0.020	0.210	0.0708	47.0	11.0	11.0	2.50	165.85
1.14	0.020	0.210	0.0144	46.0	11.0	11.0	2.49	33.63
1.13	0.020	0.210	0.0427	46.0	12.0	11.0	2.49	99.80
1.12	0.020	0.210	0.0427	47.0	12.0	11.0	2.50	99.82
1.11	0.030	0.340	0.0526	48.0	13.0	12.0	3.06	100.14
1.10	0.030	0.340	0.0522	49.0	13.0	12.0	3.07	99.65
1.09	0.030	0.340	0.0520	49.0	13.0	12.0	3.07	99.22
1.08	0.040	0.470	0.0601	49.0	14.0	12.0	3.54	99.05
1.07	0.030	0.340	0.0530	48.0	14.0	12.0	3.06	100.77
1.06	0.030	0.340	0.0527	47.0	14.0	12.0	3.06	100.13
1.05	0.020	0.220	0.0429	47.0	14.0	13.0	2.50	99.72
1.04	0.020	0.220	0.0428	46.0	14.0	13.0	2.49	99.30
1.03	0.010	0.100	0.0305	44.0	14.0	13.0	1.76	99.77
1.02	0.010	0.100	0.0309	39.0	14.0	13.0	1.74	100.17
1.01	0.010	0.100	0.0311	32.0	14.0	13.0	1.72	99.86
2.16	0.010	0.100	0.0303	46.0	14.0	13.0	1.76	99.53
2.15	0.020	0.220	0.0431	46.0	13.0	13.0	2.49	100.06
2.14	0.030	0.340	0.0524	47.0	13.0	13.0	3.06	99.59
2.13	0.020	0.210	0.0430	48.0	13.0	13.0	2.50	100.25
2.12	0.030	0.340	0.0525	48.0	13.0	14.0	3.06	99.63
2.11	0.020	0.210	0.0421	49.0	14.0	13.0	2.50	98.18
2.10	0.020	0.220	0.0435	48.0	14.0	13.0	2.50	101.25
2.09	0.030	0.340	0.0520	48.0	14.0	13.0	3.06	98.77
2.08	0.030	0.340	0.0531	48.0	15.0	14.0	3.06	100.57
2.07	0.030	0.340	0.0528	47.0	15.0	13.0	3.06	99.94
2.06	0.030	0.340	0.0520	48.0	15.0	13.0	3.06	98.60
2.05	0.030	0.340	0.0534	47.0	15.0	14.0	3.06	100.89
2.04	0.020	0.220	0.0432	46.0	15.0	13.0	2.49	99.98
2.03	0.010	0.100	0.0299	46.0	15.0	14.0	1.76	97.61
2.02	0.010	0.100	0.0314	41.0	14.0	14.0	1.75	102.16
2.01	0.010	0.100	0.0307	35.0	14.0	14.0	1.73	98.72
AVG.		0.244		45.8	13.5	12.7	2.58	99.79
TOTAL			1.4199					
MAX								165.85
MIN								33.63