Evaluation of EPA Method 30B for the Determination of Mercury Concentrations from a Nickel Smelter Stack

By: Mike Denomme, LEHDER Environmental Services Limited

Abstract

EPA Method 30B is a reference method used to validate the relative accuracy of mercury continuous emission monitors at coal fired power plants. The method has very good mercury detection qualities, is easy to use in the field and does not involve hazardous materials. These qualities make the Method an ideal candidate for mercury determination from other sources.

The objective of the study was to demonstrate the suitability of EPA Method 30B for the determination of total mercury concentrations from a nickel smelter stack. The source has a control system for particulate and is characterized by SO_2 concentrations ranging from 1,000 ppmv to 10,000 ppmv. Historical mercury concentrations vary from 1 to 6 ug/R.m^3.

EPA Method 30B underwent the required QA/QC procedures to assess precision and recovery. In addition, the method was compared against simultaneous data collected using EPA Method 29. Three 160 minute test runs were carried out.

Based on the results, Method 30B was well within the acceptable specifications for precision and spike recovery. The Method 30B mercury data also compared extremely well with the simultaneous mercury data from the isokinetic Method 29 runs.

Introduction

Particulate, metals and mercury discharges from industrial emission sources are sampled in accordance with USEPA Method 29 entitled *Determination of Metals Emissions from Stationary Sources*. The sampling method involves isokinetically extracting a known volume of effluent gases from the stack and passing the sample through a quartz fiber filter and a series of impingers containing specific absorbing solutions. Total suspended particulate and particle-bound metals are collected on the previously weighed quartz fibre filter with low metals background. Condensable metals and mercury are recovered in impingers containing an acidic peroxide solution. Elemental mercury that passes through the first two impingers is collected in two impingers containing acidified permanganate. During recovery, a concentrated HCl solution is used for rinsing the permanganate impingers and saved in a separate sample bottle.

Method 29 is a validated method for total suspended particulate, various metals and mercury. It is used extensively to demonstrate compliance with applicable metals and mercury emission standards. In instances that require only total suspended particulate and metals without mercury, then the two acidified permanganate solutions are omitted from the sampling train.

The disadvantages of the method are:

- Equipment intensive
- Use of hazardous solutions in the field, i.e acidified permanganate/acidified peroxide
- Difficulty shipping samples from the source to the laboratory due to TDG requirements
- Long turnaround time for sample analysis, i.e. two weeks or more
- Acidified permanganate and acid rinse samples may require venting during transport to avoid the excessive pressure buildup resulting in the potential for explosion.

US EPA Method 30B was originally designed as a method to certify and prove the relative accuracy of mercury continuous emission monitors (CEMs). This method involves the extraction of a known volume of effluent gases through an in-stack sorbent tube at a single point in the stack and at a fixed rate. After the sample period, the sorbent is removed from the probe and sent to laboratory for mercury analysis. To demonstrate precision and bias, the test runs are carried out in pairs, either both unspiked, or one spiked and one unspiked. The advantages of this method for mercury determination at the source are:

- Less equipment required in the field, easy to use in the field
- No hazardous materials inherent in the method
- Samples can be shipped by regular courier for quick submission to the laboratory
- Analysis is quick and data turnaround time is very fast
- Mercury detection limits are excellent meaning that representative data can be obtained from a source in shorter sampling period
- The method is self-validating if QA/QC specifications are followed

Since Method 30B is not an isokinetic method, it is restricted to sources that have low particulate concentrations and pollution control systems such as baghouses and ESPs. In addition, if the source is known to be stratified, then a more integrated approach may be required involving sampling at multiple points in the stack.

Although Method 30B has been used mostly for mercury CEMs relative accuracy determination, the apparent ease of use in the field and low detection limits for mercury make it ideal for other source categories.

A formal evaluation of Method 30B was carried out at a nickel smelter, specifically on the main smelter stack. The stack discharges the roaster acid plant, furnaces, converter aisle and the calciner custom feed processes. Based on previous testing, the mercury concentration ranges between 1 and 6 ug/R.m^3 at about 17% oxygen. Effluent gases from the various processes are controlled for particulate prior to discharge by a Cottrell Baghouse, however, SO_2 concentrations can range from 2,500 ppmvd to 10,000 ppmvd.

Description of the Source

Sampling was carried out at the Xstrata Nickel Smelter Stack located in Sudbury, Ontario, Canada. The facility consists of two parallel fluidized-bed roasters followed by one electric furnace. The off-gases from the roasters are passed through cyclones, followed by a water-quenched cooler and into a set of electrostatic precipitators (ESPs). The cleaned off-gas subsequently goes into the acid plant and finally vented to the main smelter stack. The off-gases from the furnaces and the converters are treated in their own smelter Cottrell ESPs before venting to the main smelter stack. Process gases from the converters, the acid plant, and the electric furnaces exhaust through the main smelter stack.

All compliance emission tests are conducted from a permanent platform located on the main smelter stack. This platform provides access to four sampling ports separated by 90^{o} and situated about 46 m (152 feet) above ground level. The sampling platform is outfitted with separate shelters around each port complete with roof protection, power for sampling trains and heating. The platform is fully equipped with safety railings and the access ladder is caged with a supplementary fall-arrest system.

The stack diameter at the sampling location is 6.93 m (273 inches) and the ports are located approximately 6.5 stack diameters downstream and more than 2 stack diameters upstream from flow disturbances.

Methodology

The evaluation of Method 30B for mercury determination from the nickel smelter stack involved the following elements:

1. Conduct mercury sampling using Method 30B simultaneously with and for the same duration as three EPA Method 29 test runs. Mercury concentration data from Method 30B runs were compared to Method 29 runs.

2. Conduct paired sampling for each of the three Method 30B runs to assess breakthrough, precision and spike recovery.

Sampling was carried out during normal smelter operations. For Method 29 test runs, sampling occurred isokinetically over 32 points across perpendicular diameters. The Method 30B train extracted a sample from a single point in the stack approximately 0.4 meters into the stack. The sampling port for the Method 30B train was located approximately 0.5 meters below one of the four primary ports used for isokinetic sampling

The specifications of EPA Method 29 employed for this experiment are presented in Table 1. The Method 30B specifications are presented in Table 2.

Table 1: Method 29 Test Specifications

Item	Specification
Test Method	
Reference:	EPA Method 29 *Determination of Metal Emissions from Stationary Sources*.
Method Modifications:	• 200 mLs of acidified peroxide were put in the first two impingers instead of 100 mLs to avoid premature SO_2 saturation of the acidified permanganate solutions.
Sampling Technique:	Isokinetic at multiple points as per OSTC Method 1
Number of Test Runs/Source:	3
Sampling Parameters	
Sampling Ports/Source:	4
Total # of Sample Points:	8
Sample Matrix:	4 ports x 8 points per port = 32 points
Sample Time / Point (min):	5.0 minutes
Total Test Time/Run (min):	160 minutes
Sampling Train	
Nozzle:	Glass (size calibrated)
Probe liner:	Glass heated to 120˚C ± 14˚C
Filter:	Pre-tared quartz fibre heated to 120˚C ± 14˚C
Glass connectors:	Ball/socket with O-rings
Back-half:	Full sized impingers chilled in ice bath • Imp #1 & #2: 200 mLs 5% nitric/10% H_2O_2 Sol'n • Imp #3: Empty • Imp #4 & #5: 100mLs acidified $KMnO_4$ Sol'n • Imp #6: Known quantity of silica gel
Sample Recovery	
Front-half Recovery Solvents:	• Front-half wash for PM/Metals: Acetone • Front-half wash for Metals: 0.1N Nitric Acid
Back-Half Recovery Solvents:	• Rinse for Imp. #1& #2: 0.1N Nitric Acid • Rinse for Imp. #3: 0.1N Nitric Acid • 1st Rinse for Imp. #4 & #5: Acidified $KMnO_4$ • 2nd Rinse for Imp. #4 & #5: Distilled water • 3rd Rinse for Imp. #4 & #5: 8N HCl
Sample Recovery Location:	LEHDER office trailer located on-site
Laboratory:	ALS Analytical – Burlington, ON
Analysis:	• Sample preparation via EPA Method 29 • Sum of five analytical fractions • Analysis via CVAA Method USEPA 7470A
Detection Limit:	0.075 µg /train (sum of five analytical fractions)

Figure 1: EPA Method 29 Sampling Train for Particulate/Metals/Hg

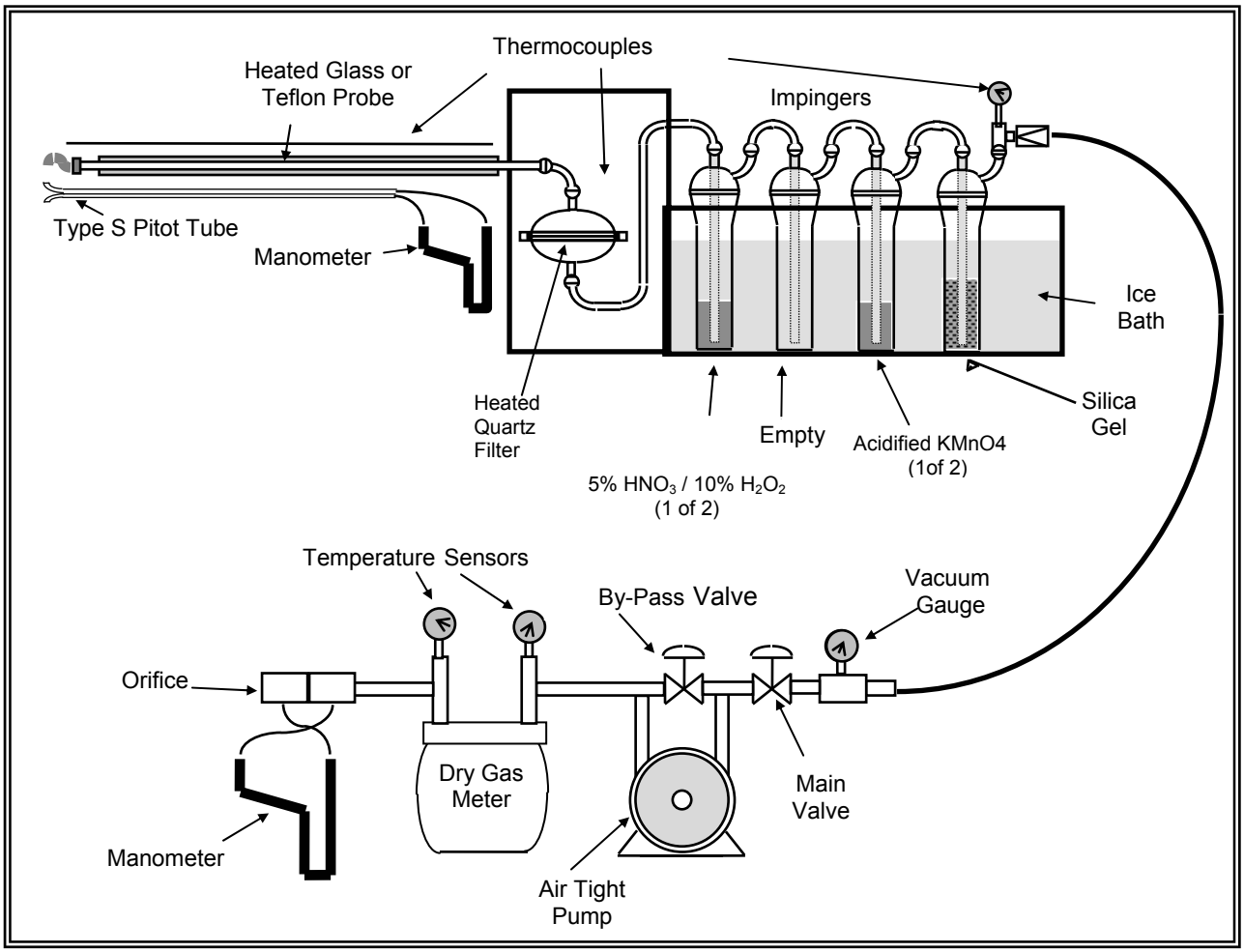


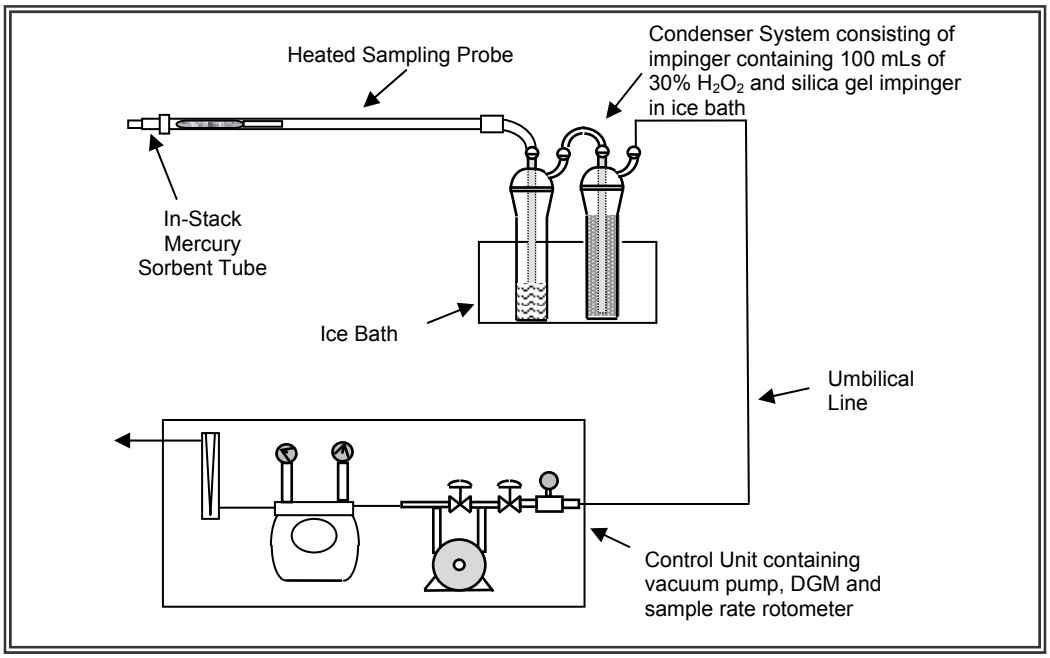
Table 2: Method 30B Test Specifications

Item	Specification
Test Method	
Reference:	USEPA Method 30B: *Determination of Total Vapour Phase Mercury from Coal Fired Combustion Sources using Carbon Sorbent Traps.*
Method Summary:	• Pull a fixed volume of effluent gases through an in-stack sorbent tube provided by Ohio Lumex. • Single point extraction at constant sample rate
Number of Test Runs/Source:	3 (simultaneous with EPA Method 29 test runs)
Sampling Parameters	
Sample Rate:	1 Lpm (metered)
Media:	• Activated carbon tubes provided by Ohio Lumex • 1 tube per test run • Each tube has three sections: SO_3 scrubber section, front section and back section
Total Test Time/Run (min):	160 minutes
Sampling Train	
Components:	• In-stack sorbent tube (provided by Ohio Lumex) • Stainless steel probe maintained at 120˚C • Condenser system consisting of a full sized impinger chilled in ice bath • Dryer tube consisting of silica gel in ice bath • Umbilical cord transition line • VOST control unit containing vacuum pump, calibrated rotometer and dry gas meter
Sample Recovery	
Sorbent Tubes:	Disconnect sorbent tubes from probe and cap ends.
Recovery Location:	At the stack platform
Submission to Laboratory:	Via express courier for fast turnaround (Non-Hazardous material)
Analysis	
Laboratory:	Ohio Lumex – Twinsburg, Ohio
Mercury Analytical Method:	Thermal Desorption with analysis by AAS
Detection Limit:	0.006 µg in 160 L of sample (0.04 µg/m^3)

Table 2: Method 30B Test Specifications *(Continued)*

Item	Specification
Specific QA/QC Activities	
Leak Check Criteria:	No vacuum drop in one minute when train isolated at @ 10 in Hg
Blanks:	1 field blank analyzed with samples
Evaluation of breakthrough:	Analysis of Hg in back section
Paired and Simultaneous Trains:	• Test #1: Paired train run (both unspiked) to evaluate precision. • Test #2 & #3: Paired train run (Spiked and Unspiked) train to evaluate recovery. • Compare M30B data against mercury data collected during simultaneous M29 sampling.
Spike Quantity:	200 ng for spiked train in Test Runs #2 & #3 (pre-spike tubes provided by Ohio Lumex)
Performance Specifications:	• % Recovery of Spike 85% to 115% • Precision of Paired Train: ≤10% Relative Deviation • Comparison with M29 Hg data: ≤15 % RD • Hg recovered in "back-half": <10% of total collected
Determination of Relative Deviation (RD)	$RD = \frac{(C_a - C_b)}{(C_a + C_b)} \times 100\%$ Where C_a = Hg concentration from sorbent Trap "a" C_b = Hg concentration from sorbent Trap "b"
Determination of Measured Spike Concentration (C_{rec}):	$C_{rec} = C_s - C_u$ Where: C_{rec} = Measured Hg spike concentration C_s = Hg concentration from spiked train C_u = Hg concentration from unspiked train
Determination of Spiked Hg Recovery (R):	$R = \frac{(C_{rec} \times V_s)}{m_{spike}} \times 100\%$ Where: V_s = Volume of gas sampled from spike train m_{spike} = Mass of Hg spiked on sorbent

Figure 2: Schematic of Method 30B Sampling Train



Test Results

Mercury test results from the Xstrata Smelter Stack using EPA Method 30B and 29 are presented in Tables 3 to 8. Data are reported to a maximum of three significant digits and minimum of two.

Table 3: Method 30B Mercury Analysis of Samples

Sample ID	Date	Time Hr.	Hg Analysis, ng				
			SO_3 Scrubber	Primary Stage	Back Up Stage	Spike Value	Total Hg Recovered
1A	16-Sep-09	10:01-13:18	1.0	582	0.4	0.0	583
1B	16-Sep-09	10:01-13:18	2.5	642	0.7	0.0	645
2A	16-Sep-09	13:45-19:00	4.0	390	0.4	0.0	394
2B	16-Sep-09	13:45-19:00	1.5	617	0.5	200.0	419
3A	17-Sep-09	08:43-11:33	5.0	614	0.6	0.0	620
3B	17-Sep-09	08:43-11:33	5.1	829	0.8	200.0	635

Table 4: Method 30B Mercury Concentrations and Recovery Results

Sample ID	Date	Time Hr.	Total Hg Recovered ng	% in Front Stages	Sample Volume R.L	Total Concentration µg/R.m^3
1A	16-Sep-09	10:01-13:18	583	99.9	162.54	3.59
1B	16-Sep-09	10:01-13:18	645	99.9	170.36	3.79
2A	16-Sep-09	13:45-19:00	394	99.9	159.35	2.48
2B	16-Sep-09	13:45-19:00	419	99.9	167.64	2.50
3A	17-Sep-09	08:43-11:33	620	99.9	159.09	3.89
3B	17-Sep-09	08:43-11:33	635	99.9	165.77	3.83

Table 5: Test Results - Method 29 Mercury Concentration/Mass Rate Data

Test Parameter		Test #1 16-Sep-09 10:01-13:20	Test #2 16-Sep-09 13:55-18:59	Test #3 17-Sep-09 08:42-11:53	Avg.
Total Mercury (M29)					
Concentration	µg/R.m^3	3.55	2.46	3.74	3.25
Effluent Measurements					
Avg. Effluent Temperature	°C	150	148	141	147
Average Effluent Velocity	m/s	8.21	7.46	7.33	7.67
Average O_2 Content	% vol (d)	16.0	16.3	17.0	16.4
Average CO_2 Content	% vol (d)	1.6	1.6	1.2	1.4
Average CO Content	% vol (d)	0.023	0.031	0.023	0.023
Average SO_2 Content	% vol (d)	0.339	0.259	0.363	0.339
Particulate Concentration	mg/R.m^3	8.7	9.3	38.4	18.8
Average Moisture Content	% vol	3.66	2.85	4.12	3.54
Molecular Wt. (Dry Basis)	g/gmol.	29.0	29.0	28.9	29.0
Molecular Wt. (Wet Basis)	g/gmol.	28.6	28.7	28.5	28.6
Actual Effluent Flow Rate	A.m^3/s	310	282	277	290
Reference Flow Rate (wet)	R.m^3/s	212	193	192	199
Reference Flow Rate (dry)	R.m^3/s	204	188	184	192
Sample Parameters					
Sample Time	min.	160.0	160.0	160.0	160.0
Sample Volume	R.m^3	2.610	2.404	2.386	2.467
Total Hg Analysis	Hg	9.27	5.91	8.92	8.03
Isokinetic Variation	%	102.0	102.0	103.2	102.5

Table 6: Evaluation of Method 30B Precision using Paired Train

Test #	Hg Conc. ug/R.m^3	Relative Deviation %	Relative Deviation Specification	Within Specifications
1A 1B	3.59 3.79	-2.68%	±10%	Y
2A 2B	2.48 2.50	-0.49%	±10%	Y
3A 3B	3.89 3.83	0.84%	±10%	Y

Table 7: Evaluation of Method 30B Spike Recovery

Test #	Hg Conc. ug/R.m^3	Spike Recovery %	Specification	Within Specifications
1A 1B	N/A N/A	N/A	85% to 115%	N/A
2A 2B (w/spike)	2.48 3.69	102%	85% to 115%	Y
3A 3B (w/spike)	3.89 5.04	95%	85% to 115%	Y

Table 8: Comparison of Hg Concentrations Data – Method 30B vs. Method 29

Test #	Hg Analysis		Deviation %	Specifications
	M29	M30B		
1	3.55	3.69*	3.9%	± 15% from M29
2	2.46	2.48**	0.6%	± 15% from M29
3	3.74	3.89**	4.1%	± 15% from M29

** Based on average of paired samples*
***Based on unspiked Hg data only*

Summary and Conclusion

No problems were encountered in sampling or analysis and reported data are believed to be representative of the stack conditions at the time of testing. Recovery of the Method 30B samples in the field was much quicker than the simultaneous Method 29 samples.

Method 30B samples were shipped by regular courier to the laboratory in Ohio, USA without incident. The samples were received by Ohio Lumex the following day. The Method 30B analytical report was received by LEHDER more than two weeks prior to receiving the M29 analytical report.

Method 30B appears to be very applicable for the determination of mercury concentrations from nickel smelter emission sources that have particulate control systems. The method produced data that was well within the precision and spike recovery criteria stated in the method. Breakthrough of mercury into the second stage of the tube was less than 0.1% which is considered excellent. Most importantly, the Method 30B mercury data compared very favorably with the Method 29 mercury data.

Method 30B sampling was not conducted isokinetically or from multiple locations in the stack. Particulate concentrations from the source varied from an average of 9 mg/R.m^3 for Tests #1 and # 2 to a high of over 38 mg/R.m^3 for Test #3. The higher particulate concentrations did not appear to affect the representative quality of the Method 30B mercury data. EPA Method 30B Test #3 showed very good spike recovery and was tight with the mercury data obtained using the isokinetic EPA Method 29 protocol.

It is recommended that Method 30B be considered for the determination of total mercury concentration at nickel smelter sources and for sources of similar effluent characteristics.

Xstrata Nickel
Project No.: 093325
September 2009

Appendix

Emission Calculations and Analytical Reports

LEHDER

LEHDER Environmental Services Limited

Metals Analysis by Fraction
XStrata Smelter Stack
LEHDER Project No.: 093325
Sep-09

Test #	Day	Time
Test #1	16-Sep	10:01 - 13:20
Test #2	16-Sep	13:55 - 18:59
Test #3	17-Sep	08:42 - 11:53

Metals Species	Metal Analysis by Fraction, ug											
	Front-Half (1A/1B) Combined Probe Rinse and Filter			Back-Half (2A/2B) Combined HNO3/H2O2 Impingers & Rinses			Back-Half (3A,3B & 3C) Combined KMNO4 Impingers and Rinses			Total Collected		
	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
Mercury	0.000	0.000	*0.000*	8.31	5.41	7.91	0.963	0.499	1.01	9.27	5.91	8.92

ALS Environmental Analytical Report
Processed by : M.Denomme

* **Total Collected is the sum of the bold values across a particular row**

LEHDER Environmental Services Ltd

Revised by: M.Denomme
Date: 12-Oct-09

Company: Xstrata Nickel
Plant: Sudbury Smelter
Stack: Smelter Stack
Pollutant: **Particulate & Hg**
Method: EPA Method 29
Project No.: 093325
Operators PB
Data Entry: PB
Reviewed By: M.Denomme

Ref.Temperature:	77	deg. F
Ref. Pressure:	29.92	"Hg
Molar Volume:	24.45	l/mol

Sampling Data

		Test #1 16-Sep-09 10:01 - 13:20	Test #2 16-Sep-09 13:55 - 18:59	Test #3 17-Sep-09 08:42 - 11:53
No. of Sample Points		32	32	32
Sample Time /Point	min	5.0	5.0	5.0
Reading / Point	min	2.5	2.5	2.5
Total Sample Time,	min	160.0	160.0	160.0
Barometric Pressure, Pb	"Hg	29.09	29.06	28.92
Stack Gauge Pressure, Pgauge	"H2O	-0.57	-0.55	-0.55
Absolute Stack Pressure, Ps	"Hg	29.05	29.02	28.88
Pitot Tube Coefficient, Cp		0.823	0.823	0.823
Oxygen Content, O2	%	16.00	16.25	17.01
Carbon Dioxide Content, CO2	%	1.55	1.57	1.19
Carbon Monoxide Content, CO	%	0.0226	0.0305	0.0233
Sulphur Dioxide, SO2	%	0.3390	0.2586	0.3628
Nitrogen Content, N2	%	82.1	81.9	81.4
Condensate Collected, W_{H2O}	g	72.9	51.9	75.4
Nozzle Diameter, Dn	in	0.3120	0.3120	0.3120
Initial DGM Reading	ft^3	955.316	48.314	135.280
Final DGM Reading	ft^3	1046.304	133.582	219.592
DGM Unity, Y		1.0111	1.0111	1.0111
Stack Diameter, Ds	ft	22.75	22.75	22.75
Actual Volume of Dry Gas	ft^3	91.998	86.214	85.248
Stack Area, As	ft^2	406.49	406.49	406.49

Particulate/Metals Analysis

Front-Half Acetone Residue	mg	14.5	13.7	43.7
Filter Loading	mg	8.1	8.7	47.8
Mercury	µg	9.27	5.91	8.92

LEHDER Environmental Services Ltd
Point by Point Sampling Data

Company: Xstrata Nickel
Plant: Sudbury Smelter
Stack: Smelter Stack
Pollutant: Particulate & Hg
Project No.: 093325

Test #1 16-Sep-09 10:01 - 13:20								Test #2 16-Sep-09 13:55 - 18:59								Test #3 17-Sep-09 08:42 - 11:53							
#	Time min	Vd ft^3	Delta P H_2O	Delta H H_2O	Ts F	Tmi F	Tmo F	#	Time min	Vd ft^3	Delta P H_2O	Delta H H_2O	Ts F	Tmi F	Tmo F	#	Time min	Vd ft^3	Delta P H_2O	Delta H H_2O	Ts F	Tmi F	Tmo F
S1	0.0	955.32	0.15	1.00	295	60	59	W1	0.0	48.31	0.15	1.00	302	70	70	S1	0.0	135.28	0.12	0.80	303	74	75
	2.5	956.80	0.15	0.98	304	60	60		2.5	49.69	0.14	0.93	302	72	70		2.5	136.62	0.11	0.73	303	69	74
2	5.0	958.23	0.18	1.17	310	61	60	2	5.0	51.05	0.16	1.07	302	73	71	2	5.0	137.91	0.12	0.80	304	70	74
	7.5	959.69	0.18	1.17	312	61	60		7.5	52.50	0.15	1.02	291	73	71		7.5	139.26	0.13	0.86	308	70	73
3	10.0	961.16	0.17	1.11	312	61	60	3	10.0	53.96	0.15	1.02	293	74	72	3	10.0	140.65	0.13	0.86	309	70	73
	12.5	962.60	0.18	1.17	312	62	60		12.5	55.39	0.16	1.08	298	75	72		12.5	142.04	0.14	0.92	311	70	72
4	15.0	964.10	0.18	1.17	312	62	60	4	15.0	56.85	0.15	1.01	298	75	72	4	15.0	143.45	0.14	0.93	308	70	72
	17.5	965.59	0.19	1.24	312	63	60		17.5	58.25	0.15	1.01	297	76	72		17.5	144.86	0.14	0.92	311	70	71
5	20.0	967.12	0.18	1.17	313	62	60	5	20.0	59.66	0.15	1.01	297	76	72	5	20.0	146.24	0.13	0.85	313	69	71
	22.5	968.60	0.18	1.17	311	62	60		22.5	61.09	0.15	1.01	296	76	73		22.5	147.61	0.14	0.94	293	70	71
6	25.0	970.08	0.18	1.14	310	62	60	6	25.0	62.50	0.15	1.01	297	76	73	6	25.0	149.07	0.15	1.02	283	69	70
	27.5	971.54	0.18	1.14	310	62	60		27.5	63.91	0.15	1.01	296	76	73		27.5	150.48	0.14	0.96	276	69	69
7	30.0	973.00	0.18	1.18	309	62	60	7	30.0	65.34	0.13	0.88	296	75	73	7	30.0	151.89	0.12	0.83	271	69	69
	32.5	974.50	0.16	1.05	307	61	60		32.5	66.68	0.11	0.74	294	74	73		32.5	153.24	0.11	0.76	268	68	69
8	35.0	975.90	0.17	1.11	307	61	60	8	35.0	67.90	0.08	0.54	292	73	73	8	35.0	154.48	0.07	0.49	266	68	69
	37.5	977.36	0.15	0.98	305	61	60		37.5	68.99	0.08	0.54	291	72	72		37.5	155.48	0.08	0.56	261	67	68
E1	40.0	978.83	0.16	1.02	303	59	59	N1	40.0	70.05	0.14	0.94	301	71	72	E1	40.0	156.52	0.14	0.95	252	65	65
	42.5	980.20	0.17	1.08	306	60	59		42.5	71.40	0.14	0.93	301	70	72		42.5	157.87	0.16	1.12	257	63	65
2	45.0	981.58	0.17	1.10	306	60	59	2	45.0	72.75	0.15	1.00	301	70	71	2	45.0	159.31	0.17	1.18	261	64	65
	47.5	983.04	0.18	1.17	305	60	59		47.5	74.17	0.15	1.00	301	71	71		47.5	160.85	0.15	1.05	255	64	65
3	50.0	984.50	0.17	1.10	305	60	59	3	50.0	75.57	0.15	1.00	301	71	71	3	50.0	162.26	0.14	0.98	253	64	64
	52.5	985.95	0.18	1.17	304	60	59		52.5	76.97	0.14	0.93	301	71	71		52.5	163.65	0.14	0.99	252	65	64
4	55.0	987.43	0.18	1.17	304	61	59	4	55.0	78.41	0.15	1.00	301	72	71	4	55.0	165.05	0.13	0.92	251	64	63
	57.5	988.90	0.18	1.17	304	60	59		57.5	79.81	0.15	1.00	301	72	71		57.5	166.40	0.15	1.05	253	64	63
5	60.0	990.39	0.17	1.11	304	60	59	5	60.0	81.22	0.14	0.94	301	72	71	5	60.0	167.84	0.15	1.03	268	64	63
	62.5	991.84	0.17	1.08	301	61	59		62.5	82.59	0.14	0.93	301	71	71		62.5	169.26	0.15	1.02	275	64	63
6	65.0	993.27	0.16	1.04	302	61	59	6	65.0	83.96	0.14	0.93	301	71	71	6	65.0	170.67	0.14	0.95	281	64	62
	67.5	994.68	0.16	1.05	301	62	60		67.5	85.33	0.13	0.87	301	71	71		67.5	172.04	0.16	1.10	268	65	62
7	70.0	996.08	0.17	1.08	301	62	60	7	70.0	86.68	0.13	0.87	302	71	70	7	70.0	173.51	0.13	0.90	265	65	62
	72.5	997.51	0.17	1.11	301	61	60		72.5	88.00	0.13	0.87	301	70	70		72.5	174.85	0.13	0.91	259	65	62
8	75.0	999.00	0.10	0.65	301	61	60	8	75.0	89.30	0.09	0.60	301	70	70	8	75.0	176.17	0.10	0.69	261	65	62
	77.5	1000.14	0.08	0.53	296	61	60		77.5	90.42	0.08	0.53	298	69	70		77.5	177.36	0.09	0.63	258	65	62
N1	80.0	1001.14	0.18	1.18	301	60	60	E1	80.0	91.45	0.13	0.88	289	69	68	N1	80.0	178.49	0.12	0.81	280	63	63
	82.5	1002.66	0.18	1.17	304	60	60		82.5	92.75	0.14	0.93	302	69	69		82.5	179.74	0.13	0.87	289	64	63
2	85.0	1004.15	0.18	1.17	305	62	60	2	85.0	94.10	0.14	0.93	303	69	69	2	85.0	181.06	0.13	0.86	294	65	63
	87.5	1005.68	0.18	1.17	305	63	61		87.5	95.47	0.15	1.00	303	70	69		87.5	182.37	0.12	0.80	297	66	63
3	90.0	1007.15	0.17	1.11	302	63	61	3	90.0	96.86	0.14	0.93	303	71	69	3	90.0	183.63	0.13	0.85	305	66	63
	92.5	1008.63	0.18	1.18	301	62	61		92.5	98.23	0.15	1.00	303	71	69		92.5	184.94	0.14	0.92	308	67	64
4	95.0	1010.15	0.18	1.17	288	62	61	4	95.0	99.63	0.14	0.93	303	72	70	4	95.0	186.28	0.13	0.84	314	67	64
	97.5	1011.66	0.17	1.12	295	62	61		97.5	100.99	0.15	1.00	303	72	70		97.5	187.59	0.13	0.84	317	67	64
5	100.0	1013.14	0.16	1.05	298	62	61	5	100.0	102.40	0.14	0.93	303	72	70	5	100.0	188.87	0.13	0.84	319	67	64
	102.5	1014.58	0.15	0.99	297	63	61		102.5	103.76	0.14	0.93	302	72	70		102.5	190.16	0.14	0.90	322	67	64
6	105.0	1015.97	0.14	0.93	296	64	61	6	105.0	105.13	0.14	0.93	302	72	70	6	105.0	191.49	0.13	0.83	324	67	64
	107.5	1017.32	0.14	0.93	295	65	61		107.5	106.50	0.13	0.87	302	71	70		107.5	192.77	0.12	0.78	312	66	64
7	110.0	1018.66	0.13	0.86	296	66	62	7	110.0	107.84	0.11	0.74	290	71	70	7	110.0	194.01	0.10	0.66	303	66	64
	112.5	1020.01	0.13	0.83	295	67	62		112.5	109.06	0.11	0.74	296	70	70		112.5	195.16	0.09	0.60	294	66	64
8	115.0	1021.27	0.12	0.80	296	68	63	8	115.0	110.27	0.06	0.40	299	70	70	8	115.0	196.24	0.08	0.53	293	66	64
	117.5	1022.53	0.11	0.73	295	68	63		117.5	111.22	0.08	0.53	298	70	69		117.5	197.26	0.08	0.54	290	66	64
W1	120.0	1023.75	0.15	0.99	299	67	65	S1	120.0	112.25	0.14	0.94	290	68	69	W1	120.0	198.29	0.14	0.94	283	64	63
	122.5	1024.95	0.16	1.06	300	68	66		122.5	113.61	0.14	0.93	302	69	69		122.5	199.60	0.14	0.93	292	64	63
2	125.0	1026.40	0.17	1.13	301	69	67	2	125.0	114.96	0.15	1.00	302	70	69	2	125.0	200.93	0.16	1.07	291	65	63
	127.5	1027.90	0.18	1.20	301	70	67		127.5	116.37	0.15	1.00	302	70	69		127.5	202.35	0.15	1.00	291	66	63
3	130.0	1029.43	0.18	1.19	301	69	67	3	130.0	117.86	0.15	1.00	301	70	69	3	130.0	203.74	0.15	1.00	291	66	64
	132.5	1030.95	0.17	1.13	301	69	67		132.5	119.18	0.15	1.00	301	70	69		132.5	205.13	0.15	1.00	291	66	64
4	135.0	1032.44	0.17	1.13	301	69	67	4	135.0	120.59	0.15	1.00	301	70	69	4	135.0	206.53	0.14	0.94	290	67	64
	137.5	1033.93	0.17	1.13	302	68	67		137.5	122.00	0.15	1.00	301	70	69		137.5	207.87	0.15	1.01	288	68	64
5	140.0	1035.41	0.17	1.13	301	68	67	5	140.0	123.40	0.16	1.06	301	70	69	5	140.0	209.26	0.16	1.08	288	69	64
	142.5	1036.90	0.17	1.13	300	67	66		142.5	124.85	0.16	1.07	300	70	68		142.5	210.70	0.15	1.01	286	69	65
6	145.0	1038.38	0.17	1.13	301	67	66	6	145.0	126.28	0.15	1.00	300	70	68	6	145.0	212.08	0.15	1.02	285	71	65
	147.5	1039.87	0.15	0.99	301	67	66		147.5	127.71	0.14	0.93	300	70	68		147.5	213.47	0.14	0.95	285	71	66
7	150.0	1041.28	0.16	1.06	301	67	66	7	150.0	129.04	0.11	0.73	298	70	68	7	150.0	214.84	0.13	0.88	285	72	66
	152.5	1042.71	0.14	0.93	300	68	66		152.5	130.25	0.11	0.73	298	69	68		152.5	216.13	0.13	0.88	286	72	67
8	155.0	1044.08	0.09	0.60	291	68	66	8	155.0	131.48	0.08	0.54	296	70	68	8	155.0	217.44	0.09	0.61	285	72	67
	157.5	1045.19	0.09	0.60	297	68	66		157.5	132.52	0.08	0.54	294	69	68		157.5	218.55	0.08	0.55	284	73	67
	160.0	1046.30							160.0	133.58							160.0	219.59					

LEHDER Environmental Services Ltd
Point by Point Calculations

Company: Xstrata Nickel **Stack:** Smelter Stack **Project No.:** 093325
Plant: Sudbury Smelter **Pollutant:** Particulate & Hg **Data Entry:** PB

Test #1 16-Sep-09 10:01 - 13:20							Test #2 16-Sep-09 13:55 - 18:59							Test #3 17-Sep-09 08:42 - 11:53						
Point	Period min	Sample Volume m^3	Sample Volume ft^3	Stack Velocity m/s	Stack Velocity ft/s	Isokinecity %	Point	Period min	Sample Volume m^3	Sample Volume ft^3	Stack Velocity m/s	Stack Velocity ft/s	Isokinecity %	Point	Time min	Sample Volume m^3	Sample Volume ft^3	Stack Velocity m/s	Stack Velocity ft/s	Isokinecity %
S1	2.5	0.042	1.50	7.9	26.0	109.9	W1	2.5	0.039	1.39	7.9	26.1	99.6	S1	2.5	0.038	1.35	7.2	23.5	108.2
	2.5	0.041	1.45	8.0	26.1	106.4		2.5	0.039	1.38	7.7	25.2	101.6		2.5	0.037	1.30	6.9	22.5	109.4
2	2.5	0.042	1.48	8.8	28.7	99.5	2	2.5	0.042	1.47	8.2	26.9	101.2	2	2.5	0.039	1.36	7.2	23.5	109.6
	2.5	0.042	1.48	8.8	28.8	100.0		2.5	0.042	1.48	7.9	25.9	104.5		2.5	0.040	1.40	7.5	24.5	108.5
3	2.5	0.041	1.46	8.5	28.0	101.5	3	2.5	0.041	1.45	7.9	25.9	102.3	3	2.5	0.040	1.41	7.5	24.5	109.3
	2.5	0.043	1.52	8.8	28.8	102.3		2.5	0.042	1.47	8.2	26.9	101.0		2.5	0.040	1.43	7.8	25.5	106.7
4	2.5	0.043	1.51	8.8	28.8	101.6	4	2.5	0.040	1.42	7.9	26.0	100.7	4	2.5	0.040	1.42	7.8	25.5	106.1
	2.5	0.044	1.54	9.0	29.6	101.1		2.5	0.040	1.43	7.9	26.0	100.9		2.5	0.040	1.40	7.8	25.5	104.9
5	2.5	0.043	1.50	8.8	28.8	101.3	5	2.5	0.041	1.45	7.9	26.0	102.4	5	2.5	0.039	1.39	7.5	24.6	107.9
	2.5	0.042	1.50	8.8	28.8	100.8		2.5	0.040	1.42	7.9	26.0	100.4		2.5	0.042	1.48	7.7	25.2	109.3
6	2.5	0.042	1.47	8.6	28.3	100.5	6	2.5	0.041	1.43	7.9	26.0	101.2	6	2.5	0.040	1.43	7.9	25.9	101.5
	2.5	0.042	1.48	8.6	28.3	101.2		2.5	0.041	1.45	7.9	26.0	102.2		2.5	0.040	1.43	7.6	24.9	104.7
7	2.5	0.043	1.52	8.8	28.7	102.1	7	2.5	0.038	1.35	7.4	24.2	102.9	7	2.5	0.039	1.36	7.0	23.0	107.8
	2.5	0.040	1.42	8.2	27.0	101.0		2.5	0.035	1.23	6.8	22.2	101.8		2.5	0.035	1.25	6.7	22.0	102.9
8	2.5	0.042	1.48	8.5	27.9	102.2	8	2.5	0.031	1.10	5.8	18.9	106.6	8	2.5	0.029	1.02	5.3	17.5	104.8
	2.5	0.042	1.48	8.0	26.1	109.0		2.5	0.030	1.07	5.8	18.9	103.5		2.5	0.030	1.05	5.7	18.6	101.4
E1	2.5	0.039	1.39	8.2	27.0	99.3	N1	2.5	0.039	1.37	7.7	25.2	101.3	E1	2.5	0.039	1.37	7.3	24.1	101.2
	2.5	0.040	1.40	8.5	27.9	96.7		2.5	0.039	1.36	7.7	25.2	100.8		2.5	0.041	1.46	8.0	26.3	99.7
2	2.5	0.042	1.48	8.5	27.9	102.3	2	2.5	0.041	1.43	7.9	26.1	102.2	2	2.5	0.044	1.55	8.3	27.2	103.3
	2.5	0.042	1.48	8.7	28.6	99.4		2.5	0.040	1.42	7.9	26.1	101.4		2.5	0.041	1.43	7.7	25.4	100.9
3	2.5	0.042	1.47	8.5	27.8	101.5	3	2.5	0.040	1.41	7.9	26.1	100.7	3	2.5	0.040	1.40	7.5	24.5	102.2
	2.5	0.042	1.50	8.7	28.6	100.7		2.5	0.041	1.46	7.7	25.2	107.9		2.5	0.040	1.42	7.5	24.5	103.1
4	2.5	0.042	1.49	8.7	28.6	99.9	4	2.5	0.040	1.42	7.9	26.1	100.9	4	2.5	0.039	1.36	7.2	23.6	103.3
	2.5	0.043	1.50	8.7	28.6	101.0		2.5	0.040	1.43	7.9	26.1	101.7		2.5	0.041	1.46	7.7	25.4	102.7
5	2.5	0.042	1.47	8.5	27.8	101.8	5	2.5	0.039	1.39	7.7	25.2	102.2	5	2.5	0.041	1.44	7.8	25.6	102.4
	2.5	0.041	1.44	8.3	27.3	100.9		2.5	0.039	1.39	7.7	25.2	102.3		2.5	0.041	1.43	7.9	25.8	102.5
6	2.5	0.040	1.43	8.2	26.9	101.5	6	2.5	0.039	1.38	7.7	25.2	102.0	6	2.5	0.039	1.38	7.6	25.0	102.8
	2.5	0.040	1.42	8.2	26.9	100.8		2.5	0.039	1.36	7.4	24.3	104.6		2.5	0.042	1.49	8.1	26.5	102.6
7	2.5	0.041	1.45	8.3	27.3	101.1	7	2.5	0.038	1.34	7.4	24.3	102.9	7	2.5	0.039	1.36	7.3	23.8	103.9
	2.5	0.043	1.51	8.5	27.8	103.9		2.5	0.037	1.31	7.4	24.3	100.6		2.5	0.038	1.33	7.2	23.7	101.6
8	2.5	0.033	1.15	6.5	21.3	103.3	8	2.5	0.032	1.14	6.2	20.2	104.9	8	2.5	0.034	1.20	6.4	20.8	104.5
	2.5	0.029	1.01	5.8	19.0	101.1		2.5	0.029	1.04	5.8	19.0	101.5		2.5	0.032	1.14	6.0	19.7	104.5
N1	2.5	0.043	1.53	8.7	28.6	102.9	E1	2.5	0.037	1.32	7.3	24.1	100.6	N1	2.5	0.036	1.26	7.0	23.1	101.4
	2.5	0.043	1.51	8.7	28.6	101.3		2.5	0.039	1.36	7.7	25.2	101.3		2.5	0.038	1.33	7.4	24.2	103.2
2	2.5	0.044	1.55	8.7	28.6	103.8	2	2.5	0.039	1.38	7.7	25.2	102.5	2	2.5	0.038	1.32	7.4	24.3	103.1
	2.5	0.042	1.49	8.7	28.6	99.6		2.5	0.040	1.41	8.0	26.1	100.7		2.5	0.036	1.27	7.1	23.4	103.3
3	2.5	0.042	1.50	8.5	27.8	102.9	3	2.5	0.039	1.39	7.7	25.2	102.7	3	2.5	0.038	1.32	7.5	24.5	103.7
	2.5	0.044	1.54	8.7	28.6	102.8		2.5	0.040	1.42	8.0	26.1	101.7		2.5	0.039	1.36	7.8	25.5	102.7
4	2.5	0.043	1.53	8.5	27.9	103.0	4	2.5	0.039	1.38	7.7	25.2	101.7	4	2.5	0.037	1.32	7.5	24.6	103.8
	2.5	0.042	1.49	8.4	27.7	102.2		2.5	0.040	1.42	8.0	26.1	101.5		2.5	0.037	1.30	7.5	24.7	102.4
5	2.5	0.041	1.46	8.2	26.9	103.1	5	2.5	0.039	1.38	7.7	25.2	102.1	5	2.5	0.037	1.30	7.5	24.7	102.9
	2.5	0.040	1.41	7.9	26.0	102.6		2.5	0.039	1.39	7.7	25.2	102.4		2.5	0.038	1.34	7.8	25.7	102.4
6	2.5	0.039	1.37	7.7	25.1	103.3	6	2.5	0.039	1.39	7.7	25.2	102.4	6	2.5	0.037	1.29	7.6	24.8	102.0
	2.5	0.038	1.35	7.6	25.1	102.0		2.5	0.038	1.35	7.4	24.3	103.6		2.5	0.036	1.25	7.2	23.6	102.6
7	2.5	0.039	1.36	7.4	24.2	106.1	7	2.5	0.035	1.23	6.8	22.2	102.1	7	2.5	0.033	1.16	6.5	21.4	103.6
	2.5	0.036	1.28	7.2	23.7	101.3		2.5	0.035	1.23	6.8	22.2	102.2		2.5	0.031	1.10	6.2	20.2	102.4
8	2.5	0.036	1.28	7.1	23.2	103.5	8	2.5	0.027	0.96	5.0	16.5	107.7	8	2.5	0.029	1.03	5.8	19.1	101.5
	2.5	0.035	1.23	6.8	22.2	103.9		2.5	0.030	1.04	5.8	19.0	102.0		2.5	0.030	1.05	5.8	19.0	103.3
W1	2.5	0.034	1.22	7.9	26.0	88.3	S1	2.5	0.039	1.37	7.6	25.0	101.2	W1	2.5	0.037	1.32	7.6	25.0	98.5
	2.5	0.042	1.47	8.2	26.9	102.8		2.5	0.039	1.36	7.7	25.2	101.3		2.5	0.038	1.34	7.7	25.2	100.8
2	2.5	0.043	1.52	8.5	27.8	103.1	2	2.5	0.040	1.43	7.9	26.1	102.1	2	2.5	0.041	1.44	8.2	26.9	100.6
	2.5	0.044	1.54	8.7	28.6	101.8		2.5	0.043	1.51	7.9	26.1	107.9		2.5	0.040	1.41	7.9	26.1	101.6
3	2.5	0.044	1.54	8.7	28.6	101.9	3	2.5	0.038	1.34	7.9	26.1	95.9	3	2.5	0.040	1.41	7.9	26.1	101.5
	2.5	0.043	1.50	8.5	27.8	102.1		2.5	0.040	1.43	7.9	26.1	102.1		2.5	0.040	1.42	7.9	26.1	102.6
4	2.5	0.043	1.51	8.5	27.8	102.4	4	2.5	0.040	1.42	7.9	26.1	101.7	4	2.5	0.038	1.35	7.7	25.2	100.7
	2.5	0.043	1.50	8.5	27.8	102.2		2.5	0.040	1.42	7.9	26.1	101.3		2.5	0.040	1.41	7.9	26.0	101.1
5	2.5	0.043	1.50	8.5	27.8	102.1	5	2.5	0.042	1.47	8.2	26.9	101.6	5	2.5	0.041	1.46	8.2	26.9	101.3
	2.5	0.043	1.50	8.5	27.7	102.3		2.5	0.041	1.45	8.2	26.9	100.3		2.5	0.040	1.40	7.9	26.0	100.4
6	2.5	0.043	1.50	8.5	27.8	102.3	6	2.5	0.041	1.45	7.9	26.0	103.5	6	2.5	0.040	1.41	7.9	25.9	100.5
	2.5	0.041	1.43	7.9	26.1	103.8		2.5	0.038	1.34	7.7	25.2	99.7		2.5	0.039	1.38	7.6	25.1	102.0
7	2.5	0.041	1.45	8.2	26.9	101.6	7	2.5	0.035	1.23	6.8	22.3	102.5	7	2.5	0.037	1.31	7.4	24.2	100.4
	2.5	0.039	1.38	7.7	25.2	103.4		2.5	0.035	1.24	6.8	22.3	103.5		2.5	0.038	1.32	7.4	24.2	101.5
8	2.5	0.032	1.13	6.1	20.1	104.7	8	2.5	0.030	1.05	5.8	19.0	102.7	8	2.5	0.032	1.12	6.1	20.1	102.7
	2.5	0.032	1.12	6.1	20.1	104.6		2.5	0.030	1.08	5.8	18.9	105.0		2.5	0.030	1.06	5.8	18.9	102.8

LEHDER Environmental Services Ltd.
Effluent and Emission Calculations

Company: Xstrata Nickel
Plant: Sudbury Smelter
Stack: Smelter Stack

Pollutant: Total Suspended Particulate
Method: EPA Method 29
Project No.: 093325

Reviewed by M.Denomme

Measurement Parameter		Test #1 16-Sep-09 10:01 - 13:20	Test #2 16-Sep-09 13:55 - 18:59	Test #3 17-Sep-09 08:42 - 11:53	Average
Filterable Particulate Concentration					
At measured O_2 Concentration	$mg/R.m^3$	8.66	9.32	38.4	18.8
	mg/dscf	0.25	0.26	1.09	0.53
	Gr/dscf	0.0038	0.0041	0.0168	0.0082
At 11% O_2 Concentration	$mg/R.m^3$	17.5	19.8	97.6	45.0
	mg/dscf	0.50	0.56	2.76	1.27
	Gr/dscf	0.008	0.009	0.043	0.020
Filterable Particulate Mass Rate	mg/s	1.77E+03	1.75E+03	7.07E+03	3.53E+03
	g/s	1.77	1.75	7.07	3.53
	kg/hr	6.37	6.30	25.5	12.7
	lb./hr	14.0	13.9	56.1	28.0
Effluent Characteristics					
Area of Sample Plane	m^2	37.764	37.764	37.764	37.764
Area of Sample Plane	ft^2	406.49	406.49	406.49	406.49
Average Stack Temperature	degrees C	150	148	141	147
Average Stack Temperature (Ts)	degrees F	302	299	286	296
Average Stack Gas Pressure	kPa	98.35	98.25	97.78	98
Average Stack Gas Pressure (Psa)	in Hg	29.05	29.02	28.88	28.98
Average Stack Gas Velocity	m/s	8.21	7.46	7.33	7.67
Average Stack Gas Velocity	ft/min	1616	1469	1443	1509
Oxygen Concentration	% vol	16.0	16.3	17.0	16.4
Carbon Dioxide Concentration	% vol	1.6	1.6	1.2	1.4
Effluent Molecular Weight (dry)	g/gmol	29.0	29.0	28.9	29.0
Effluent Molecular Weight (wet)	g/gmol	28.6	28.7	28.5	28.6
Effluent Moisture Content	% vol.	3.66	2.85	4.12	3.54
Dry Gas Fraction	% vol.	96.3	97.2	95.9	96.5
Actual Effluent Flow Rate	$A.m^3/s$	310	282	277	290
Actual Effluent Flow Rate	acfm	6.57E+05	5.97E+05	5.87E+05	6.14E+05
Reference Flow Rate (wet)	$R.m^3/s$	212	193	192	199
Standard Flow Rate (wet)	scfm	4.49E+05	4.10E+05	4.07E+05	4.22E+05
Reference Flow Rate (dry)	$R.m^3/s$ (dry)	**204**	**188**	**184**	**192**
Standard Flow Rate (dry)	scfm (dry)	**4.33E+05**	**3.98E+05**	**3.91E+05**	**4.07E+05**
Sample Parameters					
Sample Period	min	160.0	160.0	160.0	160.0
Sample Period	Hours	2.67	2.67	2.67	2.67
Front-Half Filterable Loading (Acetone)	mg	14.5	13.7	43.7	24.0
Front-Half Filterable Loading (Filter)	mg	8.1	8.7	47.8	21.5
Sample Volume	$A.m^3$	2.605	2.441	2.414	2.487
Sample Volume	acf	92.00	86.21	85.25	87.82
Dry Reference Sample Volume	**$R.m^3$**	**2.610**	**2.404**	**2.386**	**2.467**
Dry Standard Sample Volume	**scf**	**92.16**	**84.91**	**84.25**	**87.11**
Water Vapour Reference Volume	$R.m^3$	0.099	0.070	0.102	0.091
Water Vapour Reference Volume	scf	3.50	2.49	3.62	3.20
Average Meter Temperature	degrees C	17	22	19	19
Average Meter Temperature	degrees F	63	71	66	67
Average Absolute Meter Pressure	in Hg	29.17	29.13	28.98	29.09
Average Absolute Meter Pressure	mm Hg	98.75	98.61	98.13	98.50
Average Delta P	in H_2O	0.161	0.134	0.130	0.14
Average Delta H	in H_2O	1.05	0.90	0.88	0.94
Average Sample Rate	Lpm	16.28	15.26	15.09	15.54
Average Sample Rate	cfm	0.57	0.54	0.53	0.55
Average Isokinetic Variation	%	102.0	102.2	103.2	102.5

LEHDER Environmental Services Limited

Determination of Mercury Concentrations and Mass Rates (mg/s)

Company: Xstrata Nickel
Plant: Sudbury Smelter
Stack: Smelter Stack

Pollutant: Trace Metals
Method: EPA Method 29
Project: 093325

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)			
Metal	Test #1 16-Sep-09 10:01 - 13:20			Test #2 16-Sep-09 13:55 - 18:59			Test #3 17-Sep-09 08:42 - 11:53			Average		
	Analysis µg	Concentration µg/R.m^3	Rate **mg/s**	Analysis µg	Concentration µg/R.m^3	Rate **mg/s**	Analysis µg	Concentration µg/R.m^3	Rate **mg/s**	Analysis µg	Concentration µg/R.m^3	Rate **mg/s**
Mercury	9.27	3.55	0.726	5.91	2.46	0.462	8.92	3.74	0.689	8.03	3.25	0.626

Calculations

(A) Test #1 total loadng of metal species as per analytical report (ALS)
(B) = (A) / (Sample volume of Test #1)
(C) = (B) / 1000 x (Test #1 Dry Reference Efflluent Flow Rate)
(D) Test #2 total loadng of metal species as per analytical report (ALS)
(E) = (D) / (Sample volume of Test #2)
(F) = (E) / 1000 x (Test #2 Dry Reference Efflluent Flow Rate)
(G) Test #3 total loadng of metal species as per analytical report (ALS)
(H) = (G) / (Sample volume of Test #3)
(I) = (H) / 1000 x (Test #3 Dry Reference Efflluent Flow Rate)

Test #1 Sample volume = **2.610** R.m^3
Test #1 Effluent Rate = **204** R.m^3/s
Test #2 Sample volume = **2.404** R.m^3
Test #2 Effluent Rate = **188** R.m^3/s
Test #3 Sample volume = **2.386** R.m^3
Test #3 Effluent Rate = **184** R.m^3/s

LEHDER Environmental Services Limited
Sample Volume Corrections

Plant: Xstrata Nickel
Location: Sudbury, ON
Source: Smelter Stack
Project No. 093325

Reference Temperature, deg C:	**25**
Reference Pressure, kPa:	**101.3**
Molar Volume at STD Conditions L:	**24.45**

					(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)
Process Mode	**Test #**	**Sample ID**	**Date 2009**	**Time Hr**	**Test Duration min.**	**DGM Y**	**Initial DGM Volume L**	**Final DGM Volume L**	**Sample Volume L**	**Sample Rate LPM**	**DGM Temp. F**	**Barometric Pressure in Hg**	**Meter Pressure in H2O**	**ABS. Meter Pressure in Hg**	**Corrected Sample Volume R.L**
Compliance	**1A**	**58699**	**16-Sep**	**10:01-13:18**	**160.0**	**0.991**	**429.98**	**592.53**	161.071	1.007	**59**	**29.09**	**1.2**	29.18	**162.54**
Compliance	**1B**	**58715**	**16-Sep**	**10:01-13:18**	**160.0**	**1.004**	**1326.32**	**1495.48**	169.837	1.061	**62**	**29.09**	**1.1**	29.17	**170.36**
Compliance	**2A**	**58714**	**16-Sep**	**13:45-19:00**	**160.0**	**0.991**	**593.61**	**755.28**	160.199	1.001	**66**	**29.06**	**1.2**	29.15	**159.35**
Compliance	**2B**	**54782**	**16-Sep**	**13:45-19:00**	**160.0**	**1.004**	**1496.80**	**1666.62**	170.499	1.066	**72**	**29.06**	**1.1**	29.14	**167.64**
Compliance	**3A**	**58697**	**17-Sep**	**08:43-11:33**	**160.0**	**0.991**	**765.06**	**929.98**	163.419	1.021	**75**	**28.92**	**1.3**	29.02	**159.09**
Compliance	**3B**	**54728**	**17-Sep**	**08:43-11:33**	**160.0**	**1.004**	**1667.57**	**1837.53**	170.640	1.066	**76**	**28.92**	**1.2**	29.01	**165.77**

LEHDER Environmental Services Limited
USEPA Method 30B Mercury Concentration and Emission Rate Calculations

Client:	**Xstrata**
Location:	**Sudbury, ON**
Stack:	**Smelter Stack**
Project No.:	**093325**
Analysis By:	**Ohio Lumex**

					(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)
Process Mode	**Test #**	**Date**	**Time**	**Effluent Flow Rate $R.m^3/s$ (d)**	**SO_3 Scrubber Hg Analysis ng**	**Primary Stage Hg Analysis ng**	**Back Stage Hg Analysis ng**	**Spike Value Hg ng**	**Total Hg Recovered ng**	**% Recovered in Front Stage %**	**Gas Sample Volume L**	**Total Hg Concentration ug/m^3**	**Total Hg Emission Rate ug/s**	**mg/s**
Compliance	1A	16-Sep-09	10:01-13:18	**204**	**1.0**	**582**	**0.4**	**0.0**	583	99.9	162.54	**3.59**	732	0.732
Compliance	1B	16-Sep-09	10:01-13:18	**204**	**2.5**	**642**	**0.7**	**0.0**	645	99.9	170.36	**3.79**	773	0.773
Compliance	2A	16-Sep-09	13:45-19:00	**188**	**4.0**	**390**	**0.4**	**0.0**	394	99.9	159.35	**2.48**	465	0.465
Compliance	2B	16-Sep-09	13:45-19:00	**188**	**1.5**	**617**	**0.5**	**200.0**	419	99.9	167.64	**2.50**	470	0.470
Compliance	3A	17-Sep-09	08:43-11:33	**184**	**5.0**	**614**	**0.6**	**0.0**	620	99.9	159.09	**3.89**	717	0.717
Compliance	3B	17-Sep-09	08:43-11:33	**184**	**5.1**	**829**	**0.8**	**200.0**	635	99.9	165.77	**3.83**	705	0.705

Legend

(A): See effluent flow rate spreadsheet for isokinetic runs
(B): Ohio Lumex
(C): Ohio Lumex
(D): Ohio Lumex
(E): Ohio Lumex
(F) = (B) + (C) + (D) - (E)
(G) = (B + C) / (F) x 100%
(H): Sample volume in the field
(I) = (F) / (H)
(J) = (I) x (A)
(K) = (J) / 1000
(L) = (Absolute Value of the Difference between M30B Paired Concentrations) / (Sum of Paired Concentrations)
(M) = (Spiked Concentration - Unspiked Concentration) x (H) / (E) x 100%
(N) = Concentration from Simultaneous M29 Test Run
(O) : See (I)
(P) = [(O) - (N)] / (N) x 100%

Paired Sorbent Trap Agreement

		(L)		
Test #	**Hg Conc. $ug/R.m^3$**	**Deviation %**	**Specification**	**Within Specifications**
1A 1B	3.59 3.79	-2.68%	±10%	Y
2A 2B	2.48 2.50	-0.49%	±10%	Y
3A 3B	3.89 3.83	0.84%	±10%	Y

Spike Recovery

		(M)		
Test #	**Hg Conc. $ug/R.m^3$**	**Spike Recovery %**	**Specification**	**Within Specifications**
1A 1B	N/A N/A	N/A	85% to 115%	N/A
2A 2B (w/spike)	2.48 3.69	102%	85% to 115%	Y
3A 3B (w/spike)	3.89 5.04	95%	85% to 115%	Y

Comparison with Simultaneous EPA Method 29 Test Runs

	(N)	(O)	(P)		
Test #	**Hg Analysis M29**	**Hg Analysis M30B**	**Deviation %**	**Specifications**	**Within Specifications**
1	3.55	3.69	3.9%	± 15% from M29	Y
2	2.46	2.48	0.6%	± 15% from M29	Y
3	3.74	3.89	4.1%	± 15% from M29	Y

ALS Laboratory Group
5420 Mainway Drive, Unit 5, Burlington ON, L7L 6A4
Phone: 905-331-3111, FAX: 905-331-4567
CALA (ISO 17025:2005) Accreditation #: A3508
SCC (ISO 17025:2005) Accreditation Lab ID: 1003-15/779 Ont DW License #: 2285
NELAC Primary Accreditation, NJ DEP ID# CANA003: Secondary Accreditation, TX Cert# T104704433-08-TX

Certificate of Analysis

ALS Project Contact: Ron McLeod
ALS Project ID: LEH 200
ALS WO#: L821329
Date of Report 13-Oct-09
Date of Sample Receipt 2009-Sep-21

Client Name: Lehder Environmental Services Ltd.
Client Address: 704 Mara Street, Suite 210
Point Edward, ON N7V 1X4
(519) 336-4101
Client Contact: Michael Denomme
Client Project ID: 093325

COMMENTS:

Mercury Analysis via CVAA Method USEPA 7470A on 2009-10-07 by NOB
Sample Preparation via USEPA Method 29
Sample Particulate Analysis via Gravimetric USEPA Method 5

Definitions of Terms:
LOR = Limit of Reporting
LCB = Laboratory Control Blank
LCS = Laboratory Control Spike
LCSD = Laboratory Control Spike Duplicate

Certified by:
Ron McLeod, PhD
Laboratory Manager and Technical Director

ALS Laboratory Group

Sample Analysis Summary Report

Sample Name		**T#1 SMELTER**	**T#2 SMELTER**	**T#3 SMELTER**	**BLANK SMELTER**
ALS Sample ID		L821329-1	L821329-2	L821329-3	L821329-4
Matrix		STACK	STACK	STACK	STACK
Analysis Type		Sample	Sample	Sample	Sample
Sampling Date		16-Sep-09	16-Sep-09	17-Sep-09	17-Sep-09
Date of Receipt		21-Sep-09	21-Sep-09	21-Sep-09	21-Sep-09
PM via Gravimetric Analysis	**LOR**				
	mg	**mg**	**mg**	**mg**	**mg**
Filter Particulate Matter	0.1	14.5	13.7	43.7	2.1
Acetone Particulate Matter	0.1	8.1	8.7	47.8	3.3
	g	**g**	**g**	**g**	**g**
Acetone Mass	0.1	95.9	98.7	85.1	83.0
Mercury via FIMS CVAA	**LOR**				
	ug	**ug**	**ug**	**ug**	**ug**
Analytical Fraction 1B	0.015	<	<	<	<
Analytical Fraction 2B	0.005	8.31	5.41	7.91	<
Analytical Fraction 3A	0.005	<	<	<	<
Analytical Fraction 3B	0.025	<0.05	<0.05	0.847	<
Analytical Fraction 3C	0.025	0.963	0.499	0.160	<

ALS Laboratory Group

Sample QC Summary Report

Sample Name		**LCB**	**LCS**	**LCS**	**LCSD**	**LCSD**
ALS Sample ID		LCB	LCS	LCS	LCSD	LCSD
Matrix		STACK	STACK	STACK	STACK	STACK
Analysis Type		Blank	LCS	LCS	LCSD	LCSD
Sampling Date		n/a	n/a	n/a	n/a	n/a
Date of Receipt		n/a	n/a	n/a	n/a	n/a
Mercury via FIMS CVAA	**LOR**					
	ug	**ug**	**ug**	**% Rec**	**ug**	**% Rec**
Analytical Fraction 1B	0.02	<	0.312	104	0.311	103
Analytical Fraction 2B	0.01	<	0.104	104	0.104	104
Analytical Fraction 3A	0.01	<	0.102	102	0.102	103
Analytical Fraction 3B	0.03	<	0.509	102	0.512	103
Analytical Fraction 3C	0.03	<	0.509	101	0.512	102

ALS Laboratory Group

Sample QC Summary Report

Sample Name		**T#1 SMELTER**	**T#1 SMELTER**	**T#1 SMELTER**	**T#1 SMELTER**	**T#1 SMELTER**	**T#1 SMELTER**
ALS Sample ID		L821329-1	L821329-1	L821329-1 MS	L821329-1 MS	L821329-1	L821329-1
Matrix		STACK	STACK	STACK	STACK	STACK	STACK
Analysis Type		Sample	Duplicate	Matrix Spike	Matrix Spike	Matrix Spike Dup	Matrix Spike Dup
Sampling Date		16-Sep-09	16-Sep-09	16-Sep-09	16-Sep-09	16-Sep-09	16-Sep-09
Date of Receipt		21-Sep-09	21-Sep-09	21-Sep-09	21-Sep-09	21-Sep-09	21-Sep-09
Mercury via FIMS CVAA	**LOR ug**	**ug**	**ug**	**ug**	**% Rec**	**ug**	**% Rec**
Analytical Fraction 1B	0.02	<	<	0.329	105	0.331	105
Analytical Fraction 2B	0.01	8.31	8.25	13.7	99	13.6	97
Analytical Fraction 3A	0.01	<	<	0.0790	96	0.0792	96
Analytical Fraction 3B	0.03	<0.05	<0.05	0.998	99	0.997	99
Analytical Fraction 3C	0.03	0.963	0.951	2.12	116	2.12	116

Ohio Lumex Co., Inc.
9263 Ravenna Rd., Unit A-3
Twinsburg, OH 44087
Phone: (330) 405-0837
Fax: (330) 405-0847
www.ohiolumex.com

Turn - Around Time	
■	Standard
□	24 hour rush
Other	

Sorbent Trap Analysis Report

Report Number LehderEnv100109 Report

Client Name LEHDER Environmental Services Limited

Date 10/1/2009

Contact Name Michael Denomme mdenomme@lehder.com

Phone **519-336-4101 ext. 225**

Trap I.D.	*Date Analyzed*	*Scientist*	*Mass ng So3 scrubber*	*Mass ng Sect.1*	*Mass ng Sect.2*	*Spike Level*	*Spike Recovery %*	*Days in Stack*	*Comments*
54728	**10/1/2009**	**Dr. Qiao He**	5.1	829	0.8	200			Test # 3B
58697	**10/1/2009**	**Dr. Qiao He**	5	614	0.6				Test # 3A
54782	**10/1/2009**	**Dr. Qiao He**	1.5	617	0.5	200			Test # 2B
58714	**10/1/2009**	**Dr. Qiao He**	4	390	0.4				Test # 2A
58699	**10/1/2009**	**Dr. Qiao He**	1	582	0.4				Test # 1A
58715	**10/1/2009**	**Dr. Qiao He**	2.5	642	0.7				Test # 1B
55751	**10/1/2009**	**Dr. Qiao He**		0.7	0.4				Blank

Less than .81 ng is considered "< LDL." Which is less than the lowest detection limit.

Calibration Report Available

Variability 10%