MULTI-POLLUTANT EMISSIONS CONTROL: PILOT PLANT STUDY OF TECHNOLOGIES FOR REDUCING Hg, SO_3, NO_X AND CO_2 EMISSIONS

Semi-Annual Technical Progress Report No. 7
For The Period September 5, 2004 through March 4, 2005

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ABSTRACT

This is the seventh semi-annual Technical Progress Report for the subject agreement. During this period, Long Term Testing (Task 7) was completed. The Corrosion Study (Task 8) has continued. The Mercury Stability Study (Task 9), ESP Report (Task 11), Air Heater Report (Task 12) and Final Report (Task 14) were started. These aspects of the project, as well as progress on public outreach and contract administration issues, are discussed in detail in this report.

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INTRODUCTION

Coal-fired electric generating plants are the largest remaining unregulated source of anthropogenic mercury (Hg) emissions in the U.S. The U.S. Environmental Protection Agency issued the Clean Air Mercury Rule in March 2005 to reduce these emissions.

Although no technology currently available eliminates mercury emissions uniformly across the spectrum of power plant configurations, some technologies can reduce mercury emissions from power plants. For example, flue gas desulfurization systems can reduce stack mercury emissions by 50% to 70%. Activated carbon injection may be considered to be the leading technology currently available for maximum removal of mercury; it has been demonstrated at full-scale for short times, but it is very expensive to use.

CONSOL Energy Inc., Research & Development (CONSOL) and Allegheny Energy Supply (AES), with support from the U.S. Department of Energy's National Energy Technology Laboratory, are conducting a three-year program to construct and operate a 1.7 MWe equivalent pilot plant using flue gas from a coal-fired power generating station to develop innovative technology for reducing mercury emissions from coal-fired power plants. Other participants are ALSTOM Power Inc., Environmental Elements Corp., and Carmeuse Lime, Inc. The technology works by cooling the exhaust gases and permitting the mercury to absorb on the coal fly ash. The fly ash and mercury are then captured in the power plant's existing particulate collection device. An alkaline material is injected to prevent corrosion of the power plant's air heater and ductwork. In addition to controlling mercury emissions, the technology will reduce the emissions of sulfur trioxide and ameliorate the visible plume problem sometimes associated with selective catalytic reduction applications. The technology can also allow improved generating efficiency, which would lead to lower emissions of most pollutants and carbon dioxide.

The facility was built at AES's Mitchell Station in Courtney, PA, and the technology was tested on a 16,500 lb/h (3640 scfm) slipstream of the flue gases from the 288-megawatt, coal-fired Unit No. 3. The test program included an evaluation of the impact of the technology on the performance of specific power station components, and an evaluation of the stability of the mercury collected on the fly ash.

EXECUTIVE SUMMARY

This is the seventh semi-annual Technical Progress Report for the subject agreement. During this period, Long Term Testing (Task 7) was completed. The Corrosion Study (Task 8) has continued. The Mercury Stability Study (Task 9), ESP Report (Task 11), Air Heater Report (Task 12) and Final Report (Task 13) were started. Considerable maintenance work was done on the pilot electrostatic precipitator (ESP) and slurry injection nozzle during the Long Term Testing (Task 7). These aspects of the project, as well as progress on public outreach and contract administration issues, are discussed in detail in this report

EXPERIMENTAL

A diagram of the pilot plant is shown in Figure 1. Please refer to this diagram for sampling locations referred to in the following text.

RESULTS AND DISCUSSION

Plant Construction (Task 1)

Completed.

Start-up and Maintenance (Task 2)

A majority of the pilot plant maintenance this period involved the pilot ESP and slurry injection nozzle.

Baseline Testing (Task 3)

Baseline testing was started on August 28, 2003, and completed on January 29, 2004.

Upon completion of the Baseline Testing and preceding the start of $Mg(OH)_2$ injection (Task 4), one cold-end basket and one hot-end basket were removed from the air heater for inspection and replaced with two new baskets. ALSTOM's examination of the baskets to assess the condition of the metal surfaces revealed no sign of corrosion, or ash buildup or any other deposits on the metal surfaces.

Sorbent Testing (Task 4)

Sorbent Evaluation testing to reduce sulfur-trioxide at the air heater by injecting $Mg(OH)_2$ reagent was started on February 24, 2004, and completed on March 3, 2004.

The pilot air heater showed no signs of fouling during the four operating periods of 6 to 7 hours per day of reagent injection and low-temperature operation.

Parametric Testing (Task 5)

Parametric testing to increase mercury capture by reducing the flue gas operating temperature at the air heater outlet to 225 °F while $Mg(OH)_2$ reagent was injected at a rate of approximately 4:1 molar $Mg:SO_3$ was started on March 24 and completed on March 25, 2004.

Humidification Tests (Task 6)

Humidification tests to increase mercury capture by water-spray cooling to reduce the flue gas temperature at the ESP inlet to 240 °F were started on April 1 and completed on April 13, 2004. $Mg(OH)_2$ reagent was injected at a rate of approximately 4:1 molar $Mg:SO_3$ and the pilot air heater was operated to control its flue gas exit temperature at 312 °F.

Long-term Testing (Task 7)

Preparations for long term testing were started on April 16. Actual long-term testing began on August 21, 2004, and was completed on January 5, 2005. For all tests the gas was cooled to approximately 220 °F at the pilot ESP inlet via the pilot air heater alone or the combination of air heater cooling to 270 °F and water spray cooling to 220 °F. Magnesium hydroxide was injected at a molar ratio of approximately 4:1 with the anticipated sulfur trioxide.

During the week of August 9, one each of a cold-end and a hot-end basket from the pilot air heater were removed for inspection by Alstom. Replacement baskets were installed.

On August 21, long-term testing began. The magnesium hydroxide injection slurry nozzles plugged after only eight hours of operation. Lechler, the nozzle supplier, indicated that similar problems have occurred in another application, and they agreed to send us a redesigned nozzle. So that testing could continue until the new nozzle arrived, we chamfered the holes in the existing nozzle, per Lechler's recommendations. This modification allowed up to 30 hours of operation before cleaning was required. Long-term testing was re-started on August 27 with the re-designed nozzle. From August 27, 2004, through September 3, 2004, two 30-hour runs were completed.

From September 7 through 9 (for a total of 55 hours, with a one-hour interruption after 24 hours to clean the slurry nozzle), the flue gas was cooled via the pilot air heater to 220 ^{o}F at the pilot ESP inlet. Mercury sampling was conducted in triplicate via the Ontario Hydro method on September 8 and 9 at the pilot ESP inlet and outlet (locations F and G). Sulfur trioxide sampling was conducted via the controlled condensation method on September 8 and 9 upstream and downstream of the slurry injection location prior to the pilot air heater flue gas inlet (locations A and H). There was no apparent loss in performance of the pilot air heater and, thus, no sign of fouling during this period. The operation and performance of the ESP were stable during this period (only two of three fields were operating, Field #2 failed on September 8); flyash removal remained fairly constant at about 99.5%. Ontario Hydro sampling data for 9/8 thru 9 are shown in Table 1, sulfur trioxide sampling data for 9/8 thru 9 are shown in Table 2, the analyses of $Mg(OH)_2$ slurry samples are shown in Table 3, the analyses of flyash samples are shown in Table 4, and the analyses of coal samples are shown in Table 5.

An outage for maintenance at Mitchell Station Unit #3 started on September 10 and continued through mid-November.

On November 12 the pilot ESP Fields #1 and #2 were opened for inspection because Field #1 was experiencing some sparking under no-flow conditions and Field #2 had failed on September 8. There was a build up of what appeared to be high-carbon fly ash on the Teflon barrier in Field #1; this deposit was removed in order to restore full operation of the field. The build up of high-carbon ash most likely occurred on September 8 during the tests at maximum boiler load. An examination of Field #2 confirmed that the high voltage transformer had failed. The pilot ESP was operated without Field #2 for the remainder of the long-term tests. This inspection generally indicated that there was no detrimental effect of the low-temperature operation on the pilot ESP. The Teflon barrier is unique to the pilot ESP, and so the ash build up on that barrier is peculiar to the pilot ESP. EEC reviewed the long-term operating test data from the pilot ESP and concluded that there was no detrimental effect of the low-temperature operation on the pilot ESP. However, they cautioned that their conclusions could not yet address the potential for long-term corrosion.

After numerous maintenance problems were resolved during the week of November 29, startup of the pilot plant was attempted on December 3 until the variable speed drive on the Air ID Fan failed due to water accumulation inside the enclosure. The drive was replaced on December 6^{th} and the pilot plant was restarted on December 7. The plant was operated with flue temperatures at the ESP inlet of 215 °F for 64 hours and 200 °F for 8 hours. The air heater was operated the entire time from December 7 through December 11 (approx. 72 hours) without sootblowing without any noticeable change in pressure drop. Photographs of the cold end were taken to check for deposits before restarting. The ESP continued to operate normally. Coal samples and flyash samples were collected.

During December 14, 15 and 16 the pilot plant was operated with deep cooling via the air heater such that flue gas temperatures at the pilot ESP inlet were 215 to 205 °F. Three mercury sampling runs were completed at the pilot ESP and four SO_3 sampling runs were completed at the inlet of the air heater at these conditions. All pilot plant components worked well. Ontario Hydro sampling data for 12/15 thru 16 are shown in Table 6, sulfur trioxide sampling data for 12/15 thru 16 are shown in Table 7, the analyses of $Mg(OH)_2$ slurry samples are shown in Table 3, the analyses of flyash samples are shown in Table 4, and the analyses of coal samples are shown in Table 5.

During December 16 and 17, the pilot plant was operated such that the flue gas was cooled with the air-heater to 270 °F, and then with water spray cooling to about 215 °F at the pilot ESP inlet. Two mercury sampling runs were completed at the pilot ESP at these conditions. A planned third mercury sampling run could not be completed due to failure of the pilot ESP during the second sampling run. Ontario Hydro sampling data for December 16 thru 17 are shown in Table 8, the analyses of $Mg(OH)_2$ slurry samples are shown in Table 3, the analyses of flyash samples are shown in Table 4, and the analyses of coal samples are shown in Table 5.

From December 14 thru 17 the air heater was operated (approx. 72 hours) without sootblowing without any noticeable change in pressure drop. Visual inspection and photographs of the cold end did not reveal any accumulation of deposits.

The pilot ESP was opened for inspection on December 20 to find that a 1/8" layer of flyash had accumulated on the flue gas side of a Teflon barrier, and that this had shorted out the power supply. The fly ash deposits were removed easily; however, it was noticed that the Teflon surface developed a strong static charge as the flyash was bushed off. The cleaning restored the performance of the pilot ESP.

The plant was restarted on December 22 with air heater cooling of the flue gas to 270 °F and with water spray cooling to about 215 °F at the pilot ESP inlet. Within an hour after the water spray was started, the ESP failed. To the operators, it appeared that the addition of water changed the characteristics of the flyash such that the flyash would quickly accumulate on the surface of the Teflon barrier in the pilot ESP.

On January 5, 2005, one each of a cold-end basket and a hot-end basket from the pilot air heater were removed for inspection by Alstom.

Table 9 summarizes the operation of the Pilot Plant during Task 7.

The mercury removals (see Tables 12 and 13) in the long-term tests calculated on the basis of gas sampling across the pilot ESP were quite high (61 to 96%); however, the mercury balances for these periods (59 to 87%) were generally lower than our desirable range of 80% to 120%. This raises questions about the mercury removals calculated on the basis of gas sampling for those periods with poor mercury balances. For those periods with poor mercury balances, we may want to consider, mercury removals calculated from the mercury contained in the captured flyash. The mercury balances were less than 100% for all the long-term tests; therefore, the mercury removal calculated from the flyash mercury content is a conservatively low value. For the Task 7, long-term tests, this value ranged from 44 to 66% mercury removal. Further analysis of the flyash samples collected at the ESP inlet and outlet will be done to establish the validity of mercury removals calculated on the basis of gas sampling or captured flyash.

Corrosion Study (Task 8)

A temperature-controlled (150 ^{o}F) coupon at the pilot ESP inlet (location F) and in-duct coupons at the pilot ESP outlet (location G) were exposed to flue gas from Task 3 thruough Task 7. The corrosion coupons were removed for analysis in January 2005. The corrosion coupon examination procedure will include photographing, weighing, and measuring the thickness of the coupons, and the deposits will be analyzed.

Mercury Stability Study (Task 9)

The Mercury Stability Study includes exposing the fly ash, containing captured mercury, to volatilization and leaching tests, and determining the fate of the mercury. Samples of pilot-plant ESP ash were taken from baseline test and during the test program (with and without humidification), and a sample of the station ESP ash. The experimental matrix is shown in Table 10. The volatility tests will be conducted at 140 °F. The volatilization tests on four samples of flyash were started on November 18, 2004. Analyses of samples taken on February 10 (after 84 days at 140 °F) gave mercury contents of 0.99 to 1.14 times that of the analyses of the same samples before testing. Samples will again be taken at the end of March 2005 and mercury will be determined on the samples.

The leaching tests will include Toxic Characteristic Leaching Procedure testing at three pH’s (3, 5, and 7), and mercury will be determined in the leachates and the solids.

ESP Report (Task 11)

Tables summarizing pilot ESP operation during Tasks 3 through 7, photographs, data logs and various reports were recorded on a compact disc, which was sent to EEC to assist in their preparation of the topical report on the performance of the pilot ESP.

Air Heater Report (Task 12)

Tables summarizing pilot air heater operation during tasks 3 through 7, photographs, data logs and various reports were recorded on a compact disc, which was sent to Alstom to assist in their preparation of the topical report on the performance of the pilot air heater. Alstom has examined the baskets removed from the pilot air heater on January 5, 2005.

A preliminary report titled "Evaluation of Ljungstrom Air Preheater Test Baskets" from Alstom was reviewed. The baskets were removed after 291 hours of low temperature (230 ^{o}F) operation during Task 7 and after operating 24 hours with no sootblowing. The preliminary conclusions were as follows:

The hot end deposits were from particles mechanically wedged in the tighter hot end element channels, causing a build-up of fly ash behind the blockage.

The cold end deposits were fly ash and other particles trapped in sulfuric acid on the surface of the cold end element. This is typical cold end fouling for an air heater.

The cold end deposits could be removed during the sootblowing test conducted as part of the analysis.

The deposits were fly ash and corrosion products formed upstream of the air heater and collected on the element within the air heater.

There was little free sulfuric acid in the deposits.

The results of the analysis included in the report are based on a short period of operation at the reduced gas outlet temperatures. Although the results do not indicate major corrosive activity on the element sheets, and the deposit could be removed with sootblowing, long-term operating results are difficult to predict from the data. The use of the magnesium hydroxide injection system appears to condition the flue gas prior to the entry into the air heater such that rapid cold end fouling and/or corrosion of the element do not occur. Longer duration testing at the reduced gas outlet temperatures will be required to validate this conclusion.

Final Report (Task 13)

Summary tables of all gas sampling and laboratory analysis data were developed. The sulfur trioxide sampling results are shown in Table 11. The Ontario Hydro mercury sampling results at the Pilot ESP are shown in Table 12. The Ontario Hydro mercury sampling speciation results at the Pilot ESP are shown in Table 13.

Public Outreach (Task 14)

An abstract was submitted for the International Conference on Air Quality V, Mercury, Trace elements, SO3, and Particulate Matter, which will be held in Arlington, VA, on September 19-21, 2005. The paper, "Control of Mercury Emissions By Absorption On Flyash – Final Experimental Results of the CONSOL/Allegheny Pilot Plant Program, is authored by R. A. Winschel, M. L. Fenger, K. H. Payette, and L. A. Brickett and is included as Attachment A.

Program Management and Contract Administration (Task 16)

DOE extended the contract through May 2005. The working schedule for the entire project is shown in Figure 2.

CONCLUSIONS

The following principal conclusions can be drawn at this stage of the test program:

- $Mg(OH)_2$ slurry injection between the economizer and air heater is effective for removal of sulfur trioxide and in turn eliminates fouling of the air heater elements.
- Mercury removal with the ESP is improved with decreased ESP inlet temperature and higher unburned carbon content in the flyash will further increase mercury removal.
- 44 to 96% ESP mercury removal was demonstrated with cooling via air heater or water spray. At baseline conditions, mercury removal was about 25%. Further evaluation of the data will be used to further define of the mercury removals.
- Emissions of elemental mercury were about the same at low-temperature short term tests (Task 4-6) and at baseline tests (Tasks 3). Emissions of elemental mercury were lower during long term tests (Task 7) at low-temperature conditions.
- The Ontario-Hydro mercury speciation method appears to suffer problems with high-dust streams at temperatures of less than or equal to 250 °F.

REFERENCES

1. DeVito, M. S.; Smith, D. L. "Controlled Condensation Method: New Option for SO_3 Sampling"; *Power* magazine; February 1991.

Figure 1. Diagram of Pilot Plant Showing Sampling Locations "A" Through "I"

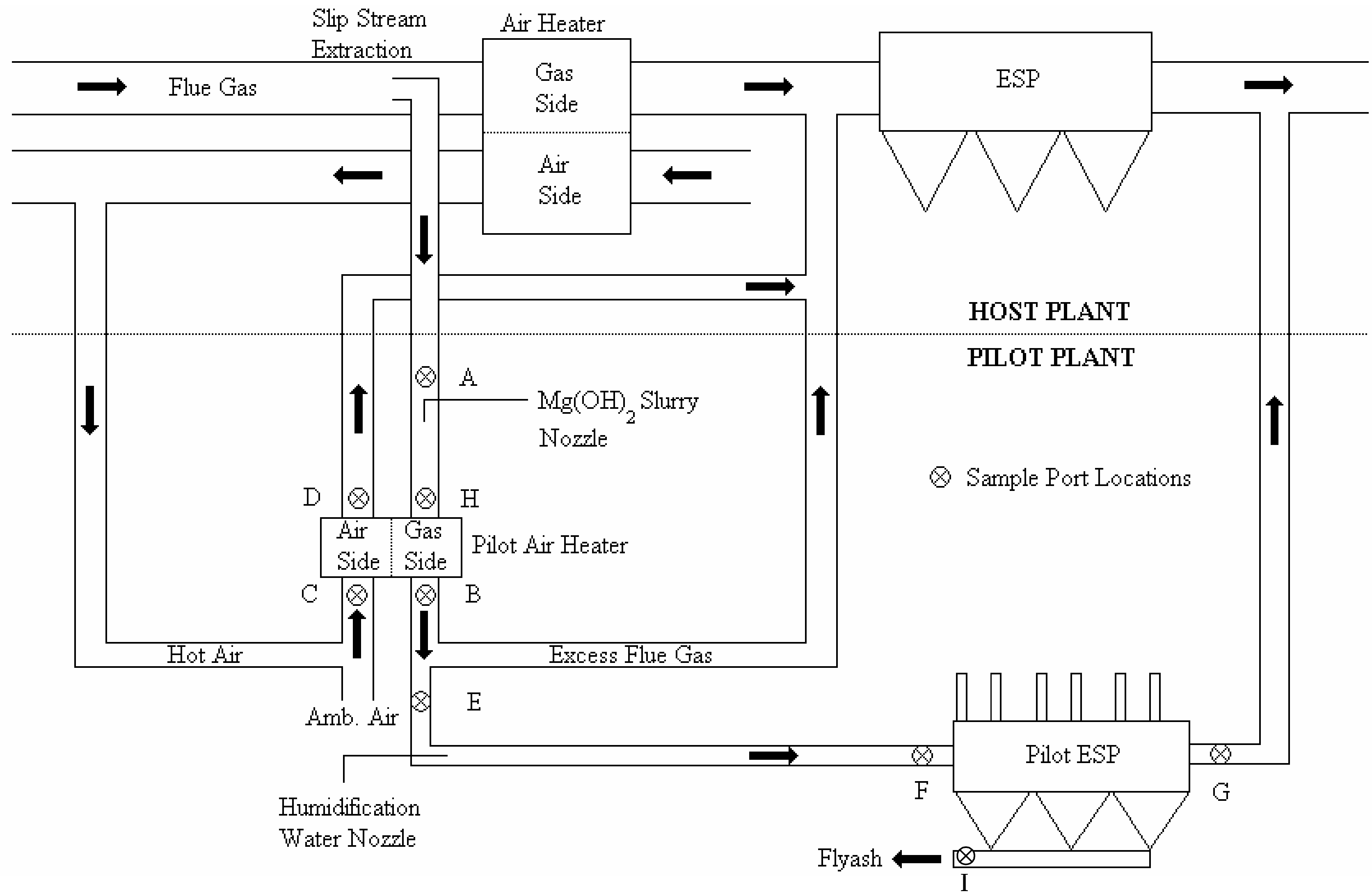

Figure 2. Project Timetable

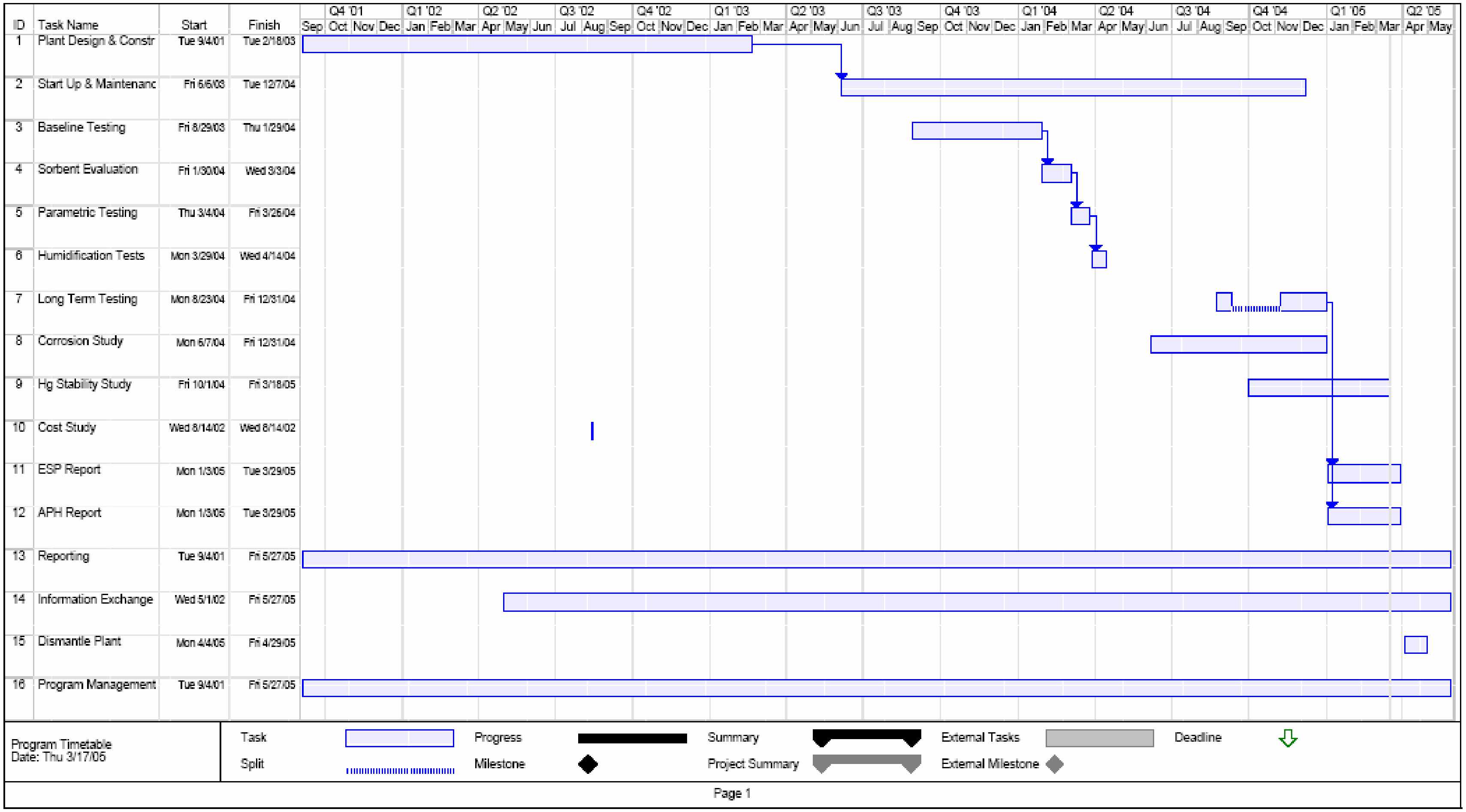

Table 1. Mitchell MPEC Hg Sampling - Ontario Hydro Sampling Train Data
Task 7 - Long Term Testing:Round1

Location		F	G	F	G	F	G
Date		9/8/2004	9/8/2004	9/9/2004	9/9/2004	9/9/2004	9/9/2004
Start Time		1125	1125	934	920	1251	1245
Stop Time		1423	1325	1138	1120	1513	1445
Test Number		F-7-1	G-7-1	F-7-2	G-7-2	F-7-3	G-7-3
Sample Type		OH-Hg	OH-Hg	OH-Hg	OH-Hg	OH-Hg	OH-Hg
Y factor of dry gas meter		0.976	0.984	0.976	0.984	0.976	0.984
Gas Volume	ft^3	51.03	97.16	42.47	57.21	43.04	82.17
Delta H of dry gas meter	" H_20	0.60	2.24	0.41	0.73	0.41	1.59
Meter Temperature	°F	77.8	86.4	75.2	84.9	81.8	87.8
C Factor of pitot tube		0.806	0.835	0.806	0.835	0.806	0.835
Nozzle Diameter	inches	0.212	0.275	0.194	0.263	0.194	0.263
A n (area of nozzle)	ft^2	0.00025	0.00041	0.00021	0.00038	0.00021	0.00038
Area of Stack (Single of Dual)	ft^2	0.5	0.5	0.5	0.5	0.5	0.5
H_2O Weight	gm	121.6	203.5	84.4	101.1	84.0	154.7
Sample Time	minutes	120	120	120	120	120	120
Barometric Pressure	" Hg	29.15	29.15	29.01	29.01	29.11	29.11
Static Pressure	" H_20	-10.75	-10.50	-5.20	-5.50	-5.50	-5.50
% Oxygen		2.7	5.2	5.5	7.3	6.3	7.5
% Carbon Dioxide		17.0	14.9	11.5	10.2	11.0	10.0
% N_2 + CO		80.3	79.9	83.0	82.5	82.7	82.5
Stack Temp (Dry Bulb)	°F	198	217	203	222	210	223
Stack Temp (Wet Bulb)	°F	123.3	125.0	123.3	125.0	123.3	125.0
"S" sample (rms vel head)	" H_20	0.452	0.557	0.402	0.199	0.399	0.435
Dust Wt.	gm	10.6056	0.0452	9.1930	0.0666	6.9258	0.0627
Sample Volume	DSCF	47.69	90.48	39.67	52.97	39.85	76.10
Sample Volume	dscm	1.351	2.562	1.124	1.500	1.129	2.155
ABS ST PRES	" Hg	28.36	28.38	28.63	28.61	28.71	28.71
ABS ST TEMP	°R	658	677	663	682	670	683
H_2O - % by Vol	vapor	10.7	9.6	9.1	8.2	9.0	8.7
Water Volume	std ft^3	5.73	9.58	3.98	4.76	3.96	7.29
Dry Molecular Weight	lb/lb-mole	30.83	30.59	30.06	29.92	30.01	29.90
Wet Molecular Weight	lb/lb-mole	29.45	29.39	28.96	28.94	28.93	28.86
% EXCESS AIR		14.6	32.7	33.5	50.4	40.6	52.5
Dry Mole Frac.		0.893	0.904	0.909	0.918	0.910	0.913
Wet Mole Frac.		0.107	0.096	0.091	0.082	0.090	0.087
Gas Velocity, Direct	ft/sec	41.13	48.00	39.08	28.90	39.09	42.76
ACFM		1345	1570	1278	945	1278	1398
DSCFM		913	1050	885	642	879	946
DSCFM (rounded)		900	1000	900	600	900	900
DSCMM		26	30	25	18	25	27
Excess Air Free DSCFM		795	789	652	418	614	607
CALCULATED FIRING RATE:							
Dry	lb/min	6	6	5	3	5	4
Wet	lb/min	6	6	5	3	5	5
Dry	lb/hr	353	351	290	186	273	269
Wet	lb/hr	361	358	296	190	279	275
CALCULATED FIRING RATE:							
Dry	tons/hr	0.2	0.2	0.1	0.1	0.1	0.1
Wet	tons/hr	0.2	0.2	0.1	0.1	0.1	0.1
HEAT INPUT:							
MM Btu/hr		5	5	4	3	4	4
PARTICULATE LOADING:							
Grains/DSCF		3.4313	0.0077	3.5753	0.0194	2.6814	0.0127
lb/hr		26.48	0.07	27.59	0.10	20.69	0.10
lb/MM Btu		5.34	0.01	6.79	0.04	5.43	0.03
Removal			99.78		99.46		99.53
Ash Production	lb/hr	25	25	20	13	20	20
Bagouse Ash		26	0.07	28	0.10	21	0.10
Bottom Ash		-2	25	-7	13	0	20
Percent Fly Ash		106.5%	0.3%	135.3%	0.7%	102.3%	0.5%
% ISOKINETIC		96.9	95.0	99.3	99.4	100.4	96.9

Table 2. Mitchell MPEC Pilot Plant Long-Term SO3 Sampling Results

DATE	9/8/2004	9/8/2004	9/9/2004	9/9/2004	9/9/2004	9/9/2004
START TIME	1201	1203	1000	1000	1205	1205
END TIME	1241	1243	1100	1100	1305	1305
RUN	A-1	H-1	A-2	H-2	A-3	H-3
MEASURED METER VARIABLES						
SAMPLE TIME [Minutes]	40	40	60	60	60	60
BAROMETRIC PRESSURE [" Hg]	29.15	29.15	29.01	29.01	29.11	29.11
SAMPLE VOLUME [ft^3]	3.74	4.01	6.00	6.00	5.94	6.01
METER TEMPERATURE [^oF]	78.9	75.0	75.2	70.1	77.8	71.3
ORIFICE PRESSURE [" H_2O]	0.03	0.03	0.03	0.04	0.03	0.03
Y FACTOR	1.006	0.966	1.006	0.966	1.006	0.966
DSCF SAMPLED	3.587	3.725	5.774	5.598	5.708	5.613
APPROX CONDENSER TEMP [^oF]	122	121	137	140	117	139
WATER BATH TEMP [^oF]	146	142	144	145	144	144
CC/MIN @ CONDENSER	2915	3007	3118	3026	3080	3030
DUCT STATIC PRESSURE, in H_2O	-5.76	-5.76	-5.76	-5.76	-5.76	-5.76
DUCT PRESSURE, " Hg	28.73	28.73	28.59	28.59	28.69	28.69
DUCT MOISTURE, % VOL	6.00	6.00	6.00	6.00	6.00	6.00
DUCT OXYGEN [%]	1.50	1.60	4.30	4.50	5.20	7.50
DUCT TEMP DURING TEST [^oF]	636.5	581.8	538.8	499.3	531.3	486.0
SO_2						
SO_2 in IMPINGERS						
lb/DSCF	4.22E-04	4.28E-04	3.52E-04	3.34E-04	3.16E-04	2.67E-04
PPMV, As Sampled	2551	2588	2126	2018	1908	1611
PPMV, @ 0% Oxygen	2748	2802	2676	2571	2539	2512
SO_3						
SO_3 in FILTER PLUG						
lb/DSCF	<6.27E-08	<6.04E-08	<3.90E-08	<4.02E-08	<3.94E-08	<4.01E-08
PPMV, As Sampled	<0.3	<0.3	<0.2	<0.2	<0.2	<0.2
PPMV, @ 0% Oxygen	<0.3	<0.3	<0.2	<0.2	<0.3	<0.3
SO_3 in PROBE						
lb/DSCF	2.07E-07	<6.04E-08	5.45E-07	8.04E-08	5.71E-07	2.60E-07
PPMV, As Sampled	1.0	<0.3	2.6	0.4	2.8	1.3
PPMV, @ 0% Oxygen	1.1	<0.3	3.3	0.5	3.7	2.0
SO_3 in CONDENSER						
lb/DSCF	5.96E-07	6.04E-08	3.12E-06	8.04E-08	3.55E-06	4.81E-07
PPMV, As Sampled	2.9	0.3	15.1	0.4	17.1	2.3
PPMV, @ 0% Oxygen	3.1	0.3	19.0	0.5	22.8	3.6
GAS PHASE SO_3 [lb/DSCF]	8.02E-07	1.21E-07	3.66E-06	1.61E-07	4.12E-06	7.41E-07
GAS PHASE SO_3 [As Sampled PPM]	3.9	0.6	17.7	0.8	19.9	3.6
GAS PHASE SO_3, PPM @ 0% O_2	**4.2**	**0.6**	**22.3**	**1.0**	**26.5**	**5.6**
TOTAL PHASE SO_3 [lb/DSCF]	8.65E-07	1.81E-07	3.70E-06	2.01E-07	4.16E-06	7.81E-07
TOTAL PHASE SO_3 [As Sampled PP	4.2	0.9	17.9	1.0	20.1	3.8
TOTAL SO_3, PPM @ 0% O_2	4.5	0.9	22.5	1.2	26.7	5.9
% SO_3 in SOLIDS [filter plug/total]	7.2	33.3	1.1	20.0	0.9	5.1
Volumetric Flow Rate, SCFM	3174	3174	3174	3174	3174	3174
Volumetric Flow Rate, DSCFM	2984	2984	2984	2984	2984	2984
Gas Phase SO3 Throughput, lb/hr	0.1437	0.0216	0.6555	0.0288	0.7371	0.1327
SO_3 Mass Throughput, lb/hr	0.1549	0.0324	0.6625	0.0360	0.7442	0.1399
DEW POINT DETERMINATION						
Partial Pressure H_2O, mmHg	43.78	43.78	43.57	43.57	43.72	43.72
Partial Pressure SO_3, mmHg	0.0031	0.0006	0.0130	0.0007	0.0146	0.0028
Calculated SO_3 Dew Point, ^oF	253	227	279	228	282	251

Table 3. Mg(OH)2 Slurry Analysis and Molar Ratio

				SOLIDS ANALYSIS													LIQUIDS ANALYSIS			*All percentages are based on weight			
Analytical Number	Sample Number	Date	Mg(OH)2 Slurry Description	As Det. Moisture	SiO2	Al2O3	TiO2	Fe2O3	CaO	MgO	Na2O	K2O	P2O5	SO3	As Det. Hg	Slurry %Solids	Ca	Mg	Hg	D. Slurry Injection Rate	Flue Gas Flow Rate	SO3 in Flue Gas (wet)	Molar Ratio Mg(OH)2 : SO3
				%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	ppm	(dry)%	mg/L	mg/L	NG/ML	lb/hr	lb/hr	PPMv	mol/mol
			Mitchell Task 7																				
20044963	84	08/24/04	CONCENTRATE-1	1.97	2.90	0.87	0.02	0.28	9.03	54.64	0.02	0.03	0.01	12.20	0.74	21.46							
20044964	86	08/25/04	CONCENTRATE-1	1.22	2.83	0.84	0.02	0.27	9.17	53.56	0.04	0.05	0.01	12.51	0.80	16.52							
20044965	90	08/31/04	CONCENTRATE-1	2.39	2.94	0.87	0.02	0.28	8.53	55.09	0.03	0.03	0.01	11.66	0.77	20.43							
20044966	85	08/24/04	DILUTE	3.23	3.41	0.99	0.03	0.32	4.30	62.37	0.01	0.01	0.02	4.04	0.85	2.90				103	14631	22	4.40
20044967	89	08/25/04	DILUTE	3.49	3.29	0.97	0.03	0.31	4.81	60.98	0.01	0.02	0.02	5.35	0.80	2.13				103	14631	22	3.16
20044968	94	08/31/04	DILUTE	3.75	3.40	0.97	0.03	0.31	4.69	61.19	0.01	0.01	0.02	5.23	0.83	3.06				103	14631	22	4.56
20044969	93	09/01/04	DILUTE	4.14	3.40	0.97	0.03	0.31	4.51	61.50	0.01	0.01	0.01	5.72	0.80	3.32				103	14631	22	4.97
20044970	100	09/02/04	DILUTE	4.43	3.40	0.96	0.03	0.31	4.72	61.35	0.00	0.01	0.01	5.92	0.76	3.38				103	14631	22	5.05
20044971	101	09/03/04	DILUTE	4.27	3.41	0.97	0.03	0.30	4.45	61.33	0.01	0.01	0.01	5.69	0.80	3.38				103	14631	22	5.05
20044972	108	09/08/04	DILUTE	4.47	3.18	0.95	0.03	0.30	5.52	59.58	0.01	0.02	0.02	7.13	0.77	3.53				103	14631	4	26.83
20044973	115	09/09/04	DILUTE	4.36	3.25	0.96	0.03	0.30	5.22	60.47	0.01	0.01	0.01	6.66	0.78	3.64				103	14631	27	4.45
20050014	119	12/01/04	CONCENTRATE-2	0.81	3.21	0.84	0.03	0.29	9.48	53.07	0.00	0.01	0.02	12.46	0.47	17.20							
20050015	120	12/07/04	DILUTE	1.61	3.55	0.95	0.03	0.31	4.96	60.20	0.00	0.00	0.04	5.89	0.79	3.20				103	14000	22	4.69
20050016	121	12/08/04	DILUTE	1.75	3.35	0.90	0.03	0.29	6.11	57.64	0.00	0.00	0.05	7.63	0.76	3.30				103	14000	22	4.63
20050017	125	12/09/04	DILUTE	1.94	3.42	0.93	0.03	0.30	4.88	59.36	0.00	0.00	0.04	6.13	0.83	3.00				103	13561	22	4.34
20050018	132	12/10/04	DILUTE	1.95	3.41	0.93	0.03	0.31	4.72	59.78	0.00	0.00	0.04	5.93	0.82	3.00				103	13561	22	4.37
20050019	133	12/15/04	DILUTE	2.17	3.40	0.94	0.03	0.31	4.50	60.03	0.00	0.00	0.04	5.64	0.79	3.00				103	13561	5	20.98
20050020	140	12/15/04	DILUTE	1.86	3.40	0.95	0.03	0.30	4.34	60.42	0.00	0.00	0.04	5.45	0.22	2.90				103	13561	8	11.31
20050021	141	12/15/04	CONCENTRATE-3	1.90	2.80	0.79	0.03	0.26	10.31	50.90	0.04	0.03	0.03	13.50	0.73	16.60							
20050022	145	12/16/04	DILUTE	1.96	3.31	0.92	0.03	0.30	5.24	58.75	0.00	0.00	0.03	6.67	0.82	2.90				103	13561	23	4.02
20050023	149	12/16/04	DILUTE	2.19	3.02	0.84	0.03	0.28	8.11	54.00	0.00	0.00	0.04	10.29	0.75	3.20				103	13561	27	3.42
20050024	153	12/17/04	DILUTE	2.14	3.04	0.85	0.03	0.28	7.72	54.38	0.00	0.00	0.04	9.63	0.18	3.10				103	13561	22	4.11
20050025	157	12/22/04	DILUTE	1.99	3.20	0.90	0.03	0.29	6.23	57.08	0.00	0.00	0.04	7.49	0.79	2.80				103	11390	22	3.89
20050026	158	12/23/04	DILUTE	2.00	3.17	0.89	0.03	0.29	6.55	56.63	0.00	0.00	0.04	8.09	0.77	2.60				103	11390	22	3.59

Table 4. Task 7 Flyash Analysis

				SOLIDS ANALYSIS													
Analytical Number	Sample Number	Date	Description	As Det. Moisture	ASH	C	As Det. Hg	SiO2	Al2O3	TiO2	Fe2O3	CaO	MgO	Na2O	K2O	P2O5	SO3
				%	(dry)%	(dry)%	ppm	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%
			Task 7														
20044985	87	08/25/04	Pilot ESP	1.42	79.76	17.87	0.778	37.58	18.64	0.8	14.39	4.25	1.87	1	1.39	0.33	1.79
20044987	91	08/31/04	Pilot ESP	1.87	81.38	15.36	1.190	38.41	19.08	0.83	13.39	4.38	2.45	1.04	1.35	0.38	2.3
20044989	95	09/01/04	Pilot ESP	1.75	83.78	13.92	1.060	38.87	19.5	0.85	13.05	4.59	2.65	1.11	1.37	0.42	2.51
20044991	98	09/02/04	Pilot ESP	0.8	83.04	15.85	0.947	40.65	19.73	0.88	12.7	4.02	2.28	0.95	1.56	0.39	1.48
20044993	103	09/03/04	Pilot ESP	0.8	82.34	16.65	0.955	39.62	19.29	0.87	12.9	4.17	2.17	0.96	1.47	0.41	1.52
20044995	106	09/08/04	Pilot ESP	0.92	84.3	14.65	0.810	42.63	20.03	0.92	12.43	3.35	1.9	0.72	1.75	0.42	1.31
20044997	110	09/09/04	Pilot ESP	1.55	90.7	7.22	1.090	46.55	22.1	1.02	10.24	3.27	2.78	0.71	2	0.44	2.04
20044999	112	09/09/04	Pilot ESP	1.8	91.67	5.53	0.990	47.34	22.88	1.02	9.21	2.86	2.74	0.67	2.18	0.34	2.28
20050038	123	12/09/04	Pilot ESP	1.58	88.5	10.97	0.795	41.05	19	0.84	20.99	2.3	1.77	0.46	1.62	0.16	1.73
20050040	127	12/10/04	Pilot ESP	1.05	88.87	10.67	0.902	41.92	19.82	0.9	17.82	2.47	1.68	0.49	1.73	0.18	1.38
20050042	130	12/10/04	Pilot ESP	1.41	93.43	5.82	0.787	44.36	20.87	0.96	19.06	2.69	1.99	0.51	1.81	0.19	1.75
20050044	135	12/15/04	Pilot ESP	1.01	88.59	10.62	0.742	44.81	20.86	1	13.82	2.57	1.65	0.53	1.88	0.2	1.12
20050048	138	12/15/04	Pilot ESP	1.08	88.96	10.7	0.770	44.47	20.77	1.01	13.2	2.6	1.69	0.52	1.84	0.21	1.12
20050052	143	12/16/04	Pilot ESP	1.26	92.13	7.34	0.799	45.92	21.56	1.04	13.02	2.71	1.91	0.52	1.89	0.22	1.55
20050056	147	12/16/04	Pilot ESP	1.27	93.34	5.82	0.734	46.62	21.93	1.06	13.14	2.78	1.96	0.54	1.96	0.22	1.65
20050060	151	12/17/04	Pilot ESP	0.26	92.24	7.21	0.746	46.39	22.23	1	14.15	2.62	1.66	0.54	1.91	0.21	1.37
20050064	155	12/22/04	Pilot ESP	0.31	88	11.99	0.670	38.32	18.55	0.84	22.07	2.9	1.75	0.55	1.5	0.15	1.47
20044986	88	08/25/04	Station ESP	0.43	81.38	16.87	0.370	35.42	17.94	0.79	19.81	3.61	0.74	0.81	1.4	0.37	1.75
20044988	92	08/31/04	Station ESP	0.44	82.94	15.89	0.382	35.9	18.21	0.82	19.66	4.21	0.8	0.98	1.33	0.47	1.66
20044990	96	09/01/04	Station ESP	0.39	82.9	16	0.366	35.8	18.51	0.84	19.07	4.47	0.83	1.06	1.34	0.54	1.81
20044992	99	09/02/04	Station ESP	0.23	82.11	17	0.408	34.3	17.43	0.79	22.45	4.17	0.76	0.92	1.25	0.46	1.58
20044994	104	09/03/04	Station ESP	0.36	81.5	17.81	0.458	35.81	17.89	0.81	19.63	3.98	0.76	0.86	1.34	0.47	1.44
20044996	107	09/08/04	Station ESP	0.24	84.1	15.14	0.470	37.81	18.33	0.85	20.26	3.4	0.73	0.67	1.51	0.47	1.41
20044998	111	09/09/04	Station ESP	0.4	80.76	18.08	0.900	36.7	18.32	0.85	14.9	2.85	0.7	0.64	1.67	0.47	1.23
20045000	113	09/09/04	Station ESP	0.39	79.76	18.17	1.110	38.56	19.38	0.91	13.68	2.9	0.75	0.67	1.76	0.52	1.56
20050039	124	12/09/04	Station ESP	0.32	87.8	10.76	0.302	41.69	19.96	0.92	20.05	2.35	0.71	0.51	1.73	0.22	1.36
20050041	128	12/10/04	Station ESP	0.68	88.08	10.28	0.339	41.2	20.28	0.95	19.68	2.43	0.73	0.53	1.77	0.26	1.84
20050043	131	12/10/04	Station ESP	0.49	76.9	22.48	1.020	36.47	17.82	0.82	18.62	2.16	0.64	0.45	1.51	0.24	1.13
20050046	136	12/15/04	Station ESP	0.2	79.17	21.38	0.808	38.41	18.28	0.85	18.05	2.22	0.65	0.45	1.061	0.22	1.07
20050050	139	12/15/04	Station ESP	0.26	78.89	22.11	0.735	37.59	17.88	0.85	16.59	2.11	0.63	0.42	1.52	0.21	0.85
20050054	144	12/16/04	Station ESP	0.22	82.65	17.09	0.799	38.83	18.63	0.9	17.23	2.26	0.67	0.44	1.61	0.23	0.93
20050058	148	12/16/04	Station ESP	0.39	86.77	12.18	1.070	42.52	20.92	1.06	14.68	2.65	0.81	0.55	1.89	0.38	1.39
20050062	152	12/17/04	Station ESP	0.24	88.06	10.82	0.648	43.02	21.16	1.07	15.11	2.63	0.81	0.55	1.91	0.37	1.46
20050066	156	12/22/04	Station ESP	0.37	75.46	24.62	0.785	33.22	17.02	0.8	18.27	2.5	0.63	0.53	1.41	0.25	1.54

Table 5. Task 7 Coal Analysis

				SOLIDS ANALYSIS															
Analytical Number	Sample Number	Date	Description	As Det. Moisture	ASH	C	S	CL	As Det. Hg	SiO2	Al2O3	TiO2	Fe2O3	CaO	MgO	Na2O	K2O	P2O5	SO3
				%	(dry)%	(dry)%	(dry)%	(dry)%	ppm	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%	(dry)%
			Task 7																
20045001	97	09/02/04	Station Coal	1.33	9.92	75.73	3.13	0.09	0.114	45.72	21.76	0.9	19.65	4.07	0.89	0.86	1.97	0.49	3.56
20045002	102	09/03/04	Station Coal	1.28	8.47	77.23	3.16	0.09	0.102	41.87	20.37	0.87	22.95	4.94	0.89	1.04	1.59	0.51	4.82
20045003	105	09/08/04	Station Coal	1.37	8.88	76.93	3.22	0.09	0.109	42.61	20.8	0.88	22.6	4.23	0.83	0.85	1.77	0.52	3.72
20045004	109	09/09/04	Station Coal	1.41	11.45	73.81	3.24	0.08	0.141	46.36	22.18	0.93	20.64	3.04	0.82	0.66	2.18	0.42	2.66
20045005	114	09/09/04	Station Coal	1.43	11.75	73.85	2.97	0.07	0.120	47.77	23.02	0.96	17.76	3.14	0.87	0.63	2.2	0.33	2.88
20050027	122	12/09/04	Station Coal	1.96	10.11		4.52	0.053	0.099	41.67	19.81	0.91	29.5	2.43	0.7	0.47	1.57	0.19	2.54
20050028	126	12/10/04	Station Coal	1.8	10.6		4.2	0.052	0.110	42.69	20.59	0.96	27.33	2.64	0.72	0.49	1.62	0.21	2.74
20050029	129	12/10/04	Station Coal	1.77	10.45		4.21	0.051	0.111	43.8	20.97	0.99	26.34	2.61	0.72	0.47	1.66	0.23	2.67
20050030	134	12/15/04	Station Coal	1.63	12.15		3.34	0.057	0.101	48.67	22.62	1.07	19.75	2.68	0.8	0.52	1.99	0.26	2.91
20050031	137	12/15/04	Station Coal	1.47	12.21		3.18	0.057	0.119	48.83	23.33	1.1	18.07	2.47	0.81	0.55	2.04	0.26	2.66
20050032	142	12/16/04	Station Coal	1.59	12.63		3.59	0.057	0.121	47.52	23.17	1.07	20.43	2.19	0.77	0.53	1.98	0.24	2.54
20050033	146	12/16/04	Station Coal	1.73	13.2		3.38	0.063	0.096	46.29	21.66	1	18.75	4.33	0.79	0.51	1.93	0.21	4.75
20050034	150	12/17/04	Station Coal	1.71	11.94		3.29	0.053	0.100	47.75	22.56	1.05	19.53	2.67	0.8	0.54	1.96	0.26	3.02
20050036	154	12/22/04	Station Coal	1.77	10.1		4.69	0.053	0.095	41.08	18.99	0.88	28.94	3.06	0.68	0.58	1.53	0.19	2.88

Table 6. Mitchell MPEC Hg Sampling - Ontario Hydro Sampling Train Data
Task 7 - Long Term Testing: Round 2 - Air Heater Adjustments

Location			F	G	F	G	F	G
Date			12/15/2004	12/15/2004	12/15/2004	12/15/2004	12/16/2004	12/16/2004
Start Time			940	945	1350	1405	924	929
Stop Time			1147	1145	1557	1605	1127	1129
Test Number			F-7-4	G-7-4	F-7-5	G-7-5	F-7-6	G-7-6
Sample Type			OH-Hg	OH-Hg	OH-Hg	OH-Hg	OH-Hg	OH-Hg
Y factor of dry gas meter	-		1.006	0.976	1.006	0.976	1.006	0.976
Gas Volume	-	ft^3	41.80	79.89	41.60	95.64	41.65	92.31
Delta H of dry gas meter	-	" H_20	0.48	1.60	0.46	2.38	0.46	2.18
Meter Temperature	-	°F	44.8	42.5	48.6	50.4	47.0	44.2
C Factor of pitot tube	-		0.806	0.844	0.806	0.844	0.806	0.844
Nozzle Diameter	-	inches	0.194	0.263	0.194	0.263	0.194	0.263
A n (area of nozzle)	-	ft^2	0.00021	0.00038	0.00021	0.00038	0.00021	0.00038
Area of Stack (Single of Dual)	-	ft^2	0.545	0.545	0.545	0.545	0.545	0.545
H_2O Weight	-	gm	67.4	132.6	70.6	164.4	65.9	143.0
Sample Time	-	minutes	120	120	120	120	120	120
Barometric Pressure	-	" Hg	29.57	29.57	29.55	29.55	29.41	29.41
Static Pressure	-	" H_20	-10.00	-10.00	-10.00	-10.40	-7.30	-7.30
% Oxygen	-		3.2	5.0	4.4	5.9	5.6	6.7
% Carbon Dioxide	-		16.8	15.1	15.7	14.2	12.5	13.7
% N_2 + CO	-		80.0	79.9	79.9	79.9	81.9	79.6
Stack Temp (Dry Bulb)	-	°F	201	200	198	201	205	203
Stack Temp (Wet Bulb)	-	°F						
"S" sample (rms vel head)	-	" H_20	0.451	0.584	0.434	0.603	0.431	0.578
Dust Wt.	-	gm	12.4380	0.1603	13.2243	0.1659	10.5968	0.1258
Sample Volume	-	DSCF	43.50	81.26	42.94	95.90	42.92	93.21
Sample Volume	-	dscm	1.232	2.301	1.216	2.716	1.216	2.640
ABS ST PRES	-	" Hg	28.83	28.83	28.81	28.79	28.87	28.87
ABS ST TEMP	-	°R	661	660	658	661	665	663
H_2O - % by Vol	-	vapor	6.8	7.1	7.2	7.5	6.7	6.7
Water Volume	-	std ft^3	3.17	6.25	3.33	7.74	3.10	6.74
Dry Molecular Weight	-	lb/lb-mole	30.82	30.62	30.69	30.51	30.22	30.46
Wet Molecular Weight	-	lb/lb-mole	29.94	29.72	29.78	29.57	29.40	29.62
% EXCESS AIR	-		17.9	31.1	26.4	38.8	35.0	46.8
Dry Mole Frac.	-		0.932	0.929	0.928	0.925	0.933	0.933
Wet Mole Frac.	-		0.068	0.071	0.072	0.075	0.067	0.067
Gas Velocity, Direct	-	ft/sec	40.47	48.39	39.74	49.36	40.04	48.30
ACFM	-		1323	1582	1299	1614	1309	1579
DSCFM	-		950	1133	933	1148	936	1132
DSCFM (rounded)			1000	1100	900	1100	900	1100
DSCMM			27	32	26	33	26	32
Excess Air Free DSCFM	-		805	862	736	824	685	769
CALCULATED FIRING RATE:								
Dry	-	lb/min	6	6	5	6	5	6
Wet	-	lb/min	6	7	6	6	5	6
Dry	-	lb/hr	358	383	327	367	304	341
Wet	-	lb/hr	365	391	334	375	311	349
CALCULATED FIRING RATE:								
Dry	-	tons/hr	0.2	0.2	0.2	0.2	0.2	0.2
Wet	-	tons/hr	0.2	0.2	0.2	0.2	0.2	0.2
HEAT INPUT:								
MM Btu/hr	-		5	5	5	5	4	5
PARTICULATE LOADING:								
Grains/DSCF	-		4.4116	0.0304	4.7519	0.0267	3.8093	0.0208
lb/hr	-		37.83	0.29	36.67	0.25	29.40	0.20
lb/MM Btu	-		7.54	0.05	7.99	0.05	6.92	0.04
ESP Particulate Removal	-	percent, mass	99.24		99.31		99.33	
Ash Production		lb/hr	25	27	23	26	23	25
Bagouse Ash			38	0.29	37	0.25	29	0.20
Bottom Ash			-13	27	-14	26	-7	25
Percent Fly Ash			150.2%	1.1%	159.2%	1.0%	130.3%	0.8%
% ISOKINETIC	-		101.4	86.4	102.0	100.6	101.6	99.2

Table 7. Mitchell MPEC Pilot Plant Long-Term SO3 Sampling Results
Final Long-Term Tests

DATE	12/15/2004	12/15/2004	12/15/2004	12/15/2004	12/16/2004	12/16/2004	12/16/2004	12/16/2004	12/16/2004	12/16/2004
START TIME	1030	1030	1335	1335	SAMPLE	945	1220	1220	1520	1520
END TIME	1130	1130	1435	1435	VOID	1045	1320	1320	1620	1620
RUN	A-7-4	H-7-4	A-7-5	H-7-5	A-7-6	H-7-6	A-7-7	H-7-7	A-7-8	H-7-8
MEASURED METER VARIABLES										
SAMPLE TIME [Minutes]	60	60	60	60		60	60	60	60	60
BAROMETRIC PRESSURE [" Hg]	29.57	29.57	29.55	29.55		29.41	29.33	29.33	29.26	29.26
SAMPLE VOLUME [ft^3]	5.66	5.33	6.09	5.99		5.72	6.23	6.00	6.64	6.00
METER TEMPERATURE [^oF]	42.2	33.2	44.7	36.3		38.0	48.0	44.1	51.5	48.3
ORIFICE PRESSURE [" H_2O]	0.03	0.02	0.03	0.02		0.02	0.02	0.02	0.03	0.02
Y FACTOR	0.984	0.966	0.984	0.966		0.966	0.984	0.966	0.984	0.966
DSCF SAMPLED	5.787	5.442	6.191	6.079		5.755	6.245	5.945	6.595	5.887
APPROX CONDENSER TEMP [^oF]	138	129	138	138		124	141	135	143	136
WATER BATH TEMP [^oF]	146	157	150	158		156	156	156	153	157
CC/MIN @ CONDENSER	3132	3000	3377	3359		3170	3435	3270	3610	3244
DUCT STATIC PRESSURE, in H_2O	-6.00	-6.00	-6.00	-6.00		-6.00	-6.00	-6.00	-6.00	-6.00
DUCT PRESSURE, " Hg	29.13	29.13	29.11	29.11		28.97	28.89	28.89	28.82	28.82
DUCT MOISTURE, % VOL	6.00	6.00	6.00	6.00		6.00	6.00	6.00	6.00	6.00
DUCT OXYGEN [%]	1.28	6.40	1.72	2.60		4.80	3.80	4.50	4.80	5.30
DUCT TEMP DURING TEST [^oF]	618.0	577.3	619.3	578.0		522.2	561.0	520.5	541.7	507.7
SO_2										
SO_2 in IMPINGERS										
lb/DSCF	4.41E-04	3.43E-04	4.21E-04	4.18E-04		3.62E-04	3.70E-04	3.71E-04	3.40E-04	3.51E-04
PPMV, As Sampled	2664	2074	2545	2522		2188	2238	2243	2055	2121
PPMV, @ 0% Oxygen	2837	2990	2774	2881		2840	2735	2859	2667	2841
SO_3										
SO_3 in FILTER PLUG										
lb/DSCF	3.81E-08	Filter Lost,	3.56E-08	3.63E-08		3.83E-08	<3.53E-08	3.71E-08	3.34E-08	3.75E-08
PPMV, As Sampled	0.2	sucked out	0.2	0.2		0.2	<0.17	0.2	0.2	0.2
PPMV, @ 0% Oxygen	0.2	of probe	0.2	0.2		0.2	<0.21	0.2	0.2	0.2
SO_3 in PROBE										
lb/DSCF	1.52E-07	4.05E-08	2.67E-07	3.63E-08		4.02E-07	4.77E-07	2.78E-07	6.02E-07	5.43E-07
PPMV, As Sampled	0.7	0.2	1.3	0.2		1.9	2.3	1.3	2.9	2.6
PPMV, @ 0% Oxygen	0.8	0.3	1.4	0.2		2.5	2.8	1.7	3.8	3.5
SO_3 in CONDENSER										
lb/DSCF	7.43E-07	6.08E-08	1.30E-06	1.63E-07		1.72E-07	3.37E-06	2.04E-07	3.71E-06	5.06E-07
PPMV, As Sampled	3.6	0.3	6.3	0.8		0.8	16.3	1.0	17.9	2.4
PPMV, @ 0% Oxygen	3.8	0.4	6.8	0.9		1.1	19.9	1.3	23.3	3.3
GAS PHASE SO_3 [lb/DSCF]	8.95E-07	1.01E-07	1.57E-06	2.00E-07		5.75E-07	3.85E-06	4.82E-07	4.31E-06	1.05E-06
GAS PHASE SO_3 [As Sampled PPM]	4.3	0.5	7.6	1.0		2.8	18.6	2.3	20.8	5.1
GAS PHASE SO_3, PPM @ 0% O_2	**4.6**	**0.7**	**8.3**	**1.1**		**3.6**	**22.7**	**3.0**	**27.1**	**6.8**
TOTAL PHASE SO_3 [lb/DSCF]	9.34E-07	1.01E-07	1.60E-06	2.36E-07		6.13E-07	3.88E-06	5.19E-07	4.35E-06	1.09E-06
TOTAL PHASE SO_3 [As Sampled PPM]	4.5	0.5	7.7	1.1		3.0	18.8	2.5	21.0	5.3
TOTAL SO_3, PPM @ 0% O_2	4.8	0.7	8.4	1.3		3.8	22.9	3.2	27.3	7.0
% SO_3 in SOLIDS [filter plug/total]	4.1	0.0	2.2	15.4		6.3	0.9	7.1	0.8	3.4
Volumetric Flow Rate, SCFM	3174	3174	3174	3174		3174	3174	3174	3174	3174
Volumetric Flow Rate, DSCFM	2984	2984	2984	2984		2984	2984	2984	2984	2984
Gas Phase SO3 Throughput, lb/hr	0.1603	0.0181	0.2805	0.0357		0.1029	0.6890	0.0863	0.7721	0.1877
SO_3 Mass Throughput, lb/hr	0.1671	0.0181	0.2869	0.0422		0.1097	0.6953	0.0930	0.7780	0.1944
DEW POINT DETERMINATION										
Partial Pressure H_2O, mmHg	44.39	44.39	44.36	44.36		44.15	44.03	44.03	43.92	43.92
Partial Pressure SO_3, mmHg	0.0033	0.0004	0.0057	0.0008		0.0022	0.0138	0.0018	0.0154	0.0038
Calculated SO_3 Dew Point, ^oF	255	218	265	231		247	281	244	283	257

Table 8. Mitchell MPEC Hg Sampling - Ontario Hydro Sampling Train Data
Task 7 - Long Term Testing: Round 2 - Humidification

Location			F	G	F	G
Date			12/16/2004	12/16/2004	12/17/2004	12/17/2004
Start Time			1345	1350	1113	1123
Stop Time			1549	1550	1316	1323
Test Number			F-7-7	G-7-7	F-7-8	G-7-8
Sample Type			OH-Hg	OH-Hg	OH-Hg	OH-Hg
Y factor of dry gas meter	-		1.006	0.976	1.006	0.976
Gas Volume	-	ft^3	43.58	93.66	40.67	90.58
Delta H of dry gas meter	-	" H_20	0.50	2.40	0.43	2.04
Meter Temperature	-	°F	56.3	54.2	51.9	50.8
C Factor of pitot tube	-		0.806	0.844	0.806	0.844
Nozzle Diameter	-	inches	0.194	0.263	0.194	0.263
A n (area of nozzle)	-	ft^2	0.00021	0.00038	0.00021	0.00038
Area of Stack (Single of Dual)	-	ft^2	0.545	0.545	0.545	0.545
H_2O Weight	-	gm	83.8	131.1	80.4	160.8
Sample Time	-	minutes	120	120	120	120
Barometric Pressure	-	" Hg	29.30	29.30	29.45	29.45
Static Pressure	-	" H_20	-7.00	-7.30	-9.50	-7.40
% Oxygen	-		6.3	8.5	5.9	7.4
% Carbon Dioxide	-		13.9	11.7	14.2	12.9
% N_2 + CO	-		79.8	79.8	79.9	79.7
Stack Temp (Dry Bulb)	-	°F	208	206	209	207
Stack Temp (Wet Bulb)	-	°F				
"S" sample (rms vel head)	-	" H_20	0.469	0.604	0.408	0.576
Dust Wt.	-	gm	8.5553	0.1371	10.4634	0.5734
Sample Volume	-	DSCF	43.94	92.44	41.57	90.37
Sample Volume	-	dscm	1.244	2.618	1.177	2.559
ABS ST PRES	-	" Hg	28.79	28.76	28.75	28.91
ABS ST TEMP	-	°R	668	666	669	667
H_2O - % by Vol	-	vapor	8.2	6.3	8.3	7.7
Water Volume	-	std ft^3	3.95	6.17	3.79	7.57
Dry Molecular Weight	-	lb/lb-mole	30.48	30.21	30.51	30.36
Wet Molecular Weight	-	lb/lb-mole	29.45	29.45	29.46	29.40
% EXCESS AIR	-		42.7	67.6	38.8	54.2
Dry Mole Frac.	-		0.918	0.937	0.917	0.923
Wet Mole Frac.	-		0.082	0.063	0.083	0.077
Gas Velocity, Direct	-	ft/sec	41.88	49.74	39.11	48.50
ACFM	-		1370	1626	1279	1586
DSCFM	-		956	1161	889	1120
DSCFM (rounded)			1000	1200	900	1100
DSCMM			27	33	25	32
Excess Air Free DSCFM	-		668	689	638	723
CALCULATED FIRING RATE:						
Dry	-	lb/min	5	5	5	5
Wet	-	lb/min	5	5	5	5
Dry	-	lb/hr	297	306	284	322
Wet	-	lb/hr	303	313	290	329
CALCULATED FIRING RATE:						
Dry	-	tons/hr	0.1	0.2	0.1	0.2
Wet	-	tons/hr	0.2	0.2	0.1	0.2
HEAT INPUT:						
MM Btu/hr	-		4	4	4	5
PARTICULATE LOADING:						
Grains/DSCF	-		3.0040	0.0229	3.8843	0.0979
lb/hr	-		25.76	0.24	29.97	0.92
lb/MM Btu	-		6.19	0.05	7.54	0.20
ESP Particulate Removal	-	percent, mass	99.09		96.92	
Ash Production		lb/hr	21	22	20	23
Bagouse Ash			26	0.24	30	0.92
Bottom Ash			-5	21	-10	22
Percent Fly Ash			123.3%	1.1%	150.1%	4.0%
% ISOKINETIC	-		101.8	95.9	103.6	97.3

Table 9. Task 7 Pilot Plant Operation

Date	Air Heater Time	Air Heater Run Time	Mg(OH)2 Slurry Injection Time	Mg(OH)2 Slurry Injection Run Time	Molar Ratio $Mg(OH)_2 : SO_3$ mol/mol	Air Heater Gas Outlet - B °F	ESP Inlet - Loc. F °F	AH Photo	Sampling Program
		Gas In = 14,631 #/hr							
8/23/04	9:44:00					300			
8/24/04			08:54-15:55	6 hrs, 10 min	4.4*	230	225		
8/25/04		78 hrs, 11 min	09:15-17:04	7 hrs, 49 min	3.16*	230	223		FL
8/26/04	15:55					300			
		Gas In = 14,631 #/hr							
8/30/04	13:00								
8/31/04			8:30 to		4.56*	230	219		FL
9/1/04		87 hrs, 4 min	14:00	29 hrs, 30 min	4.97*	230	219		FL
9/2/04			8:30 to		5.05*	230	219		FL
9/3/04	15:04		15:00	30 hrs, 30 min	5.05*	230	219		FL
		Gas In = 14,631 #/hr							
9/7/04	11:00		15:15		~4	230	219		FL
9/8/04		55 hrs	to		26.83**	230	219(198)		Hg, SO3
9/9/04	18:00		17:17	50 hrs, 2 min	4.45**	230	219(210)		Hg, SO3
		Gas In = 14,000 #/hr						30-Nov	
12/7/04	11:00		1:30 to		4.69*	230	218		
12/9/04	6:00	43 hrs	6:00	40 hrs, 30 min	4.34*	230	218		
		Gas In = 13,561 #/hr							
12/9/04	8:30		9:30 to		4.34*	230	218		FL
12/10/04	16:00	31 hrs, 30 min	16:00	30 hrs, 30 min	4.37*	230	218		FL
		Gas In = 13,561 #/hr							
12/14/04	12:00		13:15		~4	230	215	14-Dec	
12/15/04			to		20.98**	230	215		Hg, SO3
12/16/04		75 hrs			4.02**	230/250	215		Hg, SO3
12/17/04	15:00		15:00	73 hrs, 45 min	4.11*	250/270	215		Hg
		Gas In = 11,390 #/hr							
12/22/04	11:30		11:47 to		3.89*	270/240	220	22-Dec	FL
12/23/04	11:30	24 hrs	11:30	23 hrs, 13 min	3.59*	240/217	220	23-Dec	
1/3/05		Removed 1 Set of Baskets							
		Total 393 hrs, 45 min		**Total** 291 hrs, 29 min		**Average** 233	**Average** 219		
		Average 56 hrs		**Average** 32 hrs, 23 min					

(   ) - Average sample run temperature
Hg - Mercury Testing
SO3 - Sulfur Trioxide
PSD - Particle Size Distribution
AHF - Air Heater Flows
FL - Flyash Sample
* - Based on Average SO_3 of 22 _PPMv
** - Based on Actual SO_3

Table 10. Sample Matrix for Hg Stability Testing of ESP Flyash

Flyash Sample Number	ESP Inlet Temp, °F	Humidification	$Mg(OH)_2$ Injection	Sample Number	EPA TCLP Testing – pH Conditions & Qty. (Weight for each test, 20 gm)			Sample Number	Volatility Tests, Qty.[c] At 140 °F
					3 pH	5 pH	7 pH		
1	320	NO	NO	32	2	2	2	34	2
2	220	NO	YES	1P	2	2	2	1P	2
3	240	YES	YES	78[a]	1[b]	1[b]	1[b]	76[a]	1
4	Station Flyash			79[a]	2	2	2	64[a]	2

[a] Hg & C Already Determined
[b] Weight for each test, 15 gm
[c] Wt. For each test, 50 gm

Table 11. Task 3, 4, 7 Sulfur Trioxide Sampling Results

	Time		%Coal	Molar Ratio	Location A			Location H			% A - H	Location B			Location D			Location F			Location G		
Date	Start	Stop	Sulfur	Mg(OH)2 : SO3	SO3 PPMv	Gas °F	SO3 DP °F	SO3 PPMv	Gas °F	SO3 DP °F	Reduction	SO3 PPMv	Gas °F	SO3 DP °F	SO3 PPMv	Gas °F	SO3 DP °F	SO3 PPMv	Gas °F	SO3 DP °F	SO3 PPMv	Gas °F	SO3 DP °F
Task 3 Baseline																							
12/19/03	14:07	14:47	3.22		15.6	633	278											5.9	293	253	1.0	285	228
12/19/03	16:10	16:50	3.22		17.4	629	280											2.0	291	236	2.6	285	241
1/20/04	14:00	14:40	2.78		14.2	619	276					0.9	339	226	46.8	542	219						
1/21/04	10:22	11:02	2.76		11.8	612	273					3.3	314	245	53.2	540	222						
1/21/04	12:45	13:25	2.76		11.5	613	273					2.3	316	239	44.6	543	218						
1/21/04	14:20	15:00	2.76									2.0	315	237									
Task 4 Sorbent Evaluation																							
3/2/04	13:09	14:09	3.13	1.7	33.3	610	288	10.2	579	265	69	1.0	252	227	25.8	485	214						
3/2/04	15:45	16:45	3.36	1.7	29.5	613	286	3.3	581	247	89	1.5	254	232	31.3	487	217						
3/3/04	11:00	12:00	2.99	4.05	34.3	613	289	2.1	588	239	94	0.8	254	224	8.5	491	192						
3/3/04	14:35	15:35	3.11	4.05	30.7	594	287	1.4	558	234	95	0.6	254	220	4.4	475	192						
Task 7 Long Term																							
9/8/04	12:01	12:41	3.22	26.83	4.2	636	253	0.6	582	227	86												
9/9/04	10:00	11:00	3.24	4.45	22.3	538	279	1.0	499	228	96												
9/9/04	12:05	13:05	2.97	4.45	26.5	531	282	5.6	486	251	79												
12/15/04	10:30	11:30	3.34	20.98	4.6	618	255	0.7	577	218	85												
12/15/04	13:35	14:35	3.18	11.31	8.3	619	265	1.1	578	231	87												
12/16/04	9:45	10:45	3.59	~4	Probe Failed			3.6	522	247													
12/16/04	12:20	13:20	3.38	4.02	22.7	561	281	3.0	520	244	87												
12/16/04	15:20	16:20	3.38	3.42	27.1	541	283	6.8	508	257	75												
Average during Mg(OH)2 Injection					22.1		277	3.3		241	86			226									

Table 12. Tasks 3 - 7 Ontario Hydro Mercury Sampling Results

						Location F				Location G			Location I								
Run		Time		Coal		Total	Gas	Flyash	Gas	Total		Gas	P. ESP Flyash		% Removal	% Removal	% Hg	Gas	ESP %ash	S. ESP Flyash	
#	Date	Start	Stop	Hg PPM	Cl dry %	ug/m3	°F	% C	dscfm	ug/m3	Gas °F	dscfm	Hg PPM	C dry %	Hg FtoG	Hg FtoAsh	Balance	Cooling	Removal	Hg PPM	C dry %
		Task 3 Baseline																			
	12/17/03	12:30	14:48	0.110	0.055	8.46	279		770	6.96	279	850	0.730	18.95	9	59	150		99.7	0.340	8.24
3-1	1/29/04	10:00	12:10	0.130	0.071	9.60	291	6.28	860	8.02	275	890	0.320	7.15	13	25	112		99.4	0.310	7.54
3-2	1/29/04	15:00	17:00	0.120	0.073	11.60	289	7.00	870	7.00	275	880	0.310	7.15	39	25	86		99.7	0.310	7.54
		Task 4 Sorbent Evaluation																			
4-1	2/24/04	12:25	14:40	0.110	0.09	14.74	235	7.15	855	8.56	247	994	0.670	8.42	40	51	110	AH	99.4	0.27	7.01
4-2	2/27/04	11:30	13:35	0.110	0.08	11.67	238	7.69	850	8.05	247	974	0.780	9.61	31	48	117	AH	99.8	0.20	5.59
4-3	3/1/04	12:05	14:05	0.120	0.07	15.18	239	7.08	847	10.66	251	972	0.670	7.86	29	43	114	AH	99.6	0.21	5.01
		Task 5 Parametric Testing																			
5-1	3/24/04	13:10	15:25	0.110	0.06	15.14	230	5.20	829	8.76	210	871	0.620	5.95	48	32	84	AH	98.9	0.30	8.65
5-2	3/25/04	10:32	12:45	0.110	0.07	15.01	233	5.90	831	10.90	215	878	0.850	8.39	35	38	102	AH	93.8	0.27	9.46
5-3	3/25/04	14:29	17:00	0.110	0.06	14.83	234	5.64	810	2.70	219	847	0.800	8.59	83	39	56	AH	95.6	0.23	8.89
		Task 6 Humidification Testing																			
6-1	4/1/04	15:15	17:36	0.090	0.05	12.45	249	5.28	788	11.25	219	832	Sampler Failed		17			WS	98.9	0.10	10.81
6-2	4/13/04	10:55	13:15	0.110	0.05	11.64	249	9.44	750	5.86	220	876	0.870	11.02	48	49	101	WS	99.5	0.21	11.41
6-3	4/13/04	15:15	17:28	0.110	0.06	12.41	250	8.98	751	6.14	220	889	0.860	9.83	50	48	98	WS	99.6	0.23	12.72
		Task 7 Long Term																			
7-1	9/8/04	11:25	14:23	0.109	0.09	10.66	198	16.05	913	0.35	217	1050	0.810	14.65	96	59	62	AH	99.8	0.470	15.14
7-2	9/9/04	9:30	11:38	0.141	0.08	14.91	203	5.36	885	3.69	222	950 est	1.090	7.22	73	61	87	AH	99.5	0.900	16.06
7-3	9/9/04	12:51	15:13	0.120	0.07	13.43	210	5.48	879	2.99	223	946	0.990	5.53	76	46	70	AH	99.5	1.110	16.17
7-4	12/15/04	9:40	11:45	0.101	0.06	11.88	201	10.75	950	0.60	200	1133	0.742	10.62	94	66	72	AH	99.2	0.806	21.36
7-5	12/15/04	13:50	15:57	0.119	0.06	14.84	198	10.71	933	0.53	201	1148	0.770	10.70	96	54	59	AH	99.3	0.735	22.11
7-6	12/16/04	9:24	11:27	0.121	0.06	14.01	205	6.38	936	2.54	203	1132	0.799	7.34	78	48	70	AH	99.3	0.799	17.09
7-7	12/16/04	13:45	15:49	0.096	0.06	11.19	208	5.22	956	3.58	206	1161	0.734	5.82	61	47	86	AH/WS	99.1	1.070	12.16
7-8	12/17/04	11:13	13:16	0.100	0.05	14.6	209	5.82	889	2.82	207	1120	0.746	7.21	76	44	69	AH/WS	97	0.648	10.82

-/+ 20% OK
Out / In x 100

Table 13. Task 3 - 7 Ontario Hydro Mercury Sampling, Speciation Results

Run #	Date	Time Start	Time Stop	Coal Hg PPM	Coal Cl dry %	Location F Gas °F	Location F Gas dscfm	Location F Total ug/m3	Location F Part. ug/m3	Location F Oxid. ug/m3	Location F Elem. ug/m3	Location G Gas °F	Location G Gas dscfm	Location G Total ug/m3	Location G Part. ug/m3	Location G Oxid. ug/m3	Location G Elem. ug/m3	Location I P. ESP Flyash Hg PPM	Location I P. ESP Flyash C dry %	% Removal Hg FtoG	% Removal Hg FtoAsh	% Hg Balance	Gas Cooling	ESP %ash Removal
	Task 3 Baseline																							
	12/17/03	12:30	14:48	0.110	0.055	279	770	10.46	6.20	3.22	1.04	279	850	9.83	0.015	7.83	1.99	0.730	18.95	9	59	150		99.7
3-1	1/29/04	10:00	12:10	0.130	0.071	291	860	12.49	3.52	7.21	1.75	275	890	11.81	0.003	9.35	2.45	0.320	7.15	13	25	112		99.4
3-2	1/29/04	15:00	17:00	0.120	0.073	289	870	14.97	6.80	6.87	1.30	275	880	10.00	0.006	7.89	2.1	0.310	7.54	39	25	86		99.7
	Task 4 Sorbent Evaluation																							
4-1	2/24/04	12:25	14:40	0.110	0.09	235	855	14.74	13.20	0.98	0.57	247	994	8.56	0.033	6.74	1.78	0.670	8.42	40	51	110	AH	99.4
4-2	2/27/04	11:30	13:35	0.110	0.08	238	850	11.67	10.96	0.72	0.00	247	974	8.05	0.009	5.92	2.12	0.780	9.61	31	48	117	AH	99.8
4-3	3/1/04	12:05	14:05	0.120	0.07	239	847	15.18	13.93	1.25	0.00	251	972	10.66	0.010	7.89	2.76	0.670	7.86	29	43	114	AH	99.6
	Task 5 Parametric Testing																							
5-1	3/24/04	13:10	15:25	0.110	0.06	230	829	15.14	12.29	2.31	0.55	210	871	8.76	0.079	5.91	2.78	0.620	5.95	48	32	84	AH	98.9
5-2	3/25/04	10:32	12:45	0.110	0.07	233	831	15.01	12.87	1.63	0.51	215	878	10.90	0.115	8.57	2.21	0.850	8.39	35	38	102	AH	93.8
5-3	3/25/04	14:29	17:00	0.110	0.06	234	810	14.83	13.55	0.75	0.53	219	847	2.70	0.200	2.09	0.41	0.800	8.59	83	39	56	AH	95.6
	Task 6 Humidification Testing																							
6-1	4/1/04	15:15	17:36	0.090	0.05	249	788	12.45	7.50	3.52	1.43	219	832	11.25	0.090	7.52	3.64	Sampler Failed		17			WS	98.9
6-2	4/13/04	10:55	13:15	0.110	0.05	249	750	11.64	10.39	0.70	0.54	220	876	5.86	0.020	3.80	2.04	0.870	11.02	48	49	101	WS	99.5
6-3	4/13/04	15:15	17:28	0.110	0.06	250	751	12.41	11.16	0.72	0.53	220	889	6.14	0.050	3.98	2.12	0.860	9.83	50	48	98	WS	99.6
	Task 7 Long Term																							
7-1	9/8/04	11:25	14:23	0.109	0.09	198	913	10.66	9.65	0.85	0.16	217	1050	0.35	0.070	0.18	0.10	0.810	14.65	96	59	62	AH	99.8
7-2	9/9/04	9:30	11:38	0.141	0.08	203	885	14.91	13.99	0.70	0.22	222	950 est	3.69	0.070	3.19	0.44	1.090	7.22	73	61	87	AH	99.5
7-3	9/9/04	12:51	15:13	0.120	0.07	210	879	13.43	12.56	0.64	0.23	223	946	2.99	0.020	2.58	0.38	0.990	5.53	76	46	70	AH	99.5
7-4	12/15/04	9:40	11:45	0.101	0.06	201	950	11.88	10.23	1.47	0.18	200	1133	0.62	0.024	0.49	0.11	0.742	10.62	94	66	72	AH	99.2
7-5	12/15/04	13:50	15:57	0.119	0.06	198	933	14.84	12.29	2.37	0.19	201	1148	0.54	0.011	0.44	0.10	0.770	10.70	96	54	59	AH	99.3
7-6	12/16/04	9:24	11:27	0.121	0.06	205	936	14.01	12.50	1.30	0.21	203	1132	2.55	0.018	2.05	0.48	0.799	7.34	78	48	70	AH	99.3
7-7	12/16/04	13:45	15:49	0.096	0.06	208	956	11.19	10.33	0.64	0.21	206	1161	3.60	0.040	2.94	0.62	0.734	5.82	61	47	86	AH/WS	99.1
7-8	12/17/04	11:13	13:16	0.100	0.05	209	889	14.60	13.75	0.63	0.22	207	1120	2.82	0.040	2.21	0.57	0.746	7.21	76	44	69	AH/WS	97
																						-/+ 20% OK Out / In x 100		

ATTACHMENT A

CONTROL OF MERCURY EMISSIONS BY ABSORPTION ON FLYASH – FINAL EXPERIMENTAL RESULTS OF THE CONSOL/ALLEGHENY PILOT PLANT PROGRAM

Related Session Code: A4 – Mercury, Control **Preference**: Paper

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Abstract: This paper will present final experimental results from pilot-scale tests of CONSOL Energy's technology for reducing mercury emissions from coal-fired power plants. Mercury emissions are controlled by cooling the exhaust gases with an air heater (or water spray) to about 220 ^{o} F, thereby promoting mercury absorption on the coal fly ash, which is then captured in the particulate collection device. Magnesium hydroxide slurry is injected to prevent corrosion from acid condensation. The performance of the process was evaluated at a 3640 scfm slip-stream pilot plant at the Allegheny Energy Supply Mitchell Station with support from DOE NETL. The performance of the process, the influence of operating variables, and the impacts of operating conditions on air heater and ESP performance will be described.