

APPENDIX A-1:

**SCAQMD Permit to Construct/Operate
for an Experimental Research Project**



South Coast Air Quality Management District



21865 Copley Drive, Diamond Bar, CA 91765-4178
(909) 396-2000 • www.aqmd.gov

October 15, 2009
A/N 497717

ORANGE COUNTY SANITATION DISTRICT
10844 Ellis Avenue
Fountain Valley, CA 92708

Attention: Mike D. Moore
Manager - Environmental Compliance & Regulatory Affairs

Gentlemen:

PERMIT TO CONSTRUCT / OPERATE FOR AN EXPERIMENTAL RESEARCH PROJECT

The system described below is granted a Permit to Construct and Operate (Application Number 497717) as allowed by and under the conditions set forth by Rule 441 of the Rules and Regulations of the South Coast Air Quality Management District and is subject to the special conditions listed.

EQUIPMENT DESCRIPTION:

DIGESTER GAS FUEL PRETREATMENT, POST-COMBUSTION CATALYTIC OXIDATION AND SELECTIVE CATALYTIC REDUCTION SYSTEMS FOR ENGINE NO. 1 (PO G2957), CONSISTING OF;

1. DIGESTER GAS (DG) CLEANING VESSEL, 7.5' DIA. X 8' H., CONTAINING MINIMUM OF 9,500 LBS OF GRANULAR ACTIVATED CARBON MEDIA, WITH ASSOCIATED DIGESTER GAS SUPPLY AND RETURN LINES, VALVES, TEMPERATURE, DIFFERENTIAL PRESSURE DROP GAUGES, AND CONDENSATE DRIP TRAP.
2. CATALYTIC OXIDIZER (CATOX), JOHNSON MATTHEY INC., HOUSING MODEL NO. 4040-30-36-4, 200 CPSI OXIDATION CATALYST, ALUMINUM SUBSTRATE WITH OTHER METALS, 8' L. X 0' - 4" W. X 8' H., WITH ONE LAYER OF MODULE, 18.67 CUBIC FOOT TOTAL VOLUME, AND WITH ASSOCIATED AUTOMATIC TEMPERATURE AND PRESSURE MONITORING DEVICES AND CONTROLS.
3. SELECTIVE CATALYTIC REDUCTION (SCR) CATALYST, JOHNSON MATTHEY INC., HOUSING MODEL NO. 4040-36-4, ALUMINUM SUBSTRATE WITH OTHER METALS, 8' L. X 0' - 4" W. X 8' H., WITH TWO LAYERS OF MODULE, 37.33 CUBIC FOOT TOTAL VOLUME, AND WITH ASSOCIATED AUTOMATIC TEMPERATURE AND PRESSURE MONITORING DEVICES, AND CONTROL SYSTEMS WITH EXISTING CONTINUOUS EMISSIONS MONITORING SYSTEM (CEMS).
4. STORAGE TANK, AQUEOUS UREA SOLUTION (32.5%), 1000 GALLON CAPACITY, WITH ASSOCIATED PIPING, PUMP, FLOW CONTROL VALVES, UREA INJECTION LANCE, COMPRESSED AIR SUPPLY, AND WITH ASSOCIATED AUTOMATIC CONTROLS.

TO BE LOCATED AT: ORANGE COUNTY SANITATION DISTRICT (OCS D)
WASTEWATER TREATMENT PLANT NO. 1
10844 ELLIS AVENUE
FOUNTAIN VALLEY, CA 92708

Cleaning the air that we breathe...

Conditions:

1. OPERATION OF THIS EQUIPMENT SHALL BE CONDUCTED IN COMPLIANCE WITH ALL DATA AND SPECIFICATIONS SUBMITTED WITH THE APPLICATION UNDER WHICH THIS PERMIT IS ISSUED, UNLESS OTHERWISE NOTED BELOW.
2. THIS EQUIPMENT SHALL BE PROPERLY MAINTAINED AND KEPT IN GOOD OPERATING CONDITION AT ALL TIMES.
3. THIS EQUIPMENT SHALL BE OPERATED BY PERSONNEL PROPERLY TRAINED IN ITS OPERATION.
4. THIS EXPERIMENTAL RESEARCH PERMIT SHALL EXPIRE ON OCTOBER 31, 2010.
5. SAMPLES SHALL BE COLLECTED FROM THE INLET AND THE OUTLET OF THE DIGESTER FUEL GAS CLEANING (DFGC) SYSTEM AND ANALYZED FOR TOTAL SILICON, SILOXANE AND SILOXANE COMPOUNDS, AND TOTAL SULFUR COMPOUNDS AS H₂S, USING DISTRICT OR OTHER APPROVED METHODS. RESULTS SHALL BE RECORDED.
6. WHENEVER THE DFGC SYSTEM IS IN OPERATION, THE FUEL GAS FLOW RATE (SCFM) AND TOTAL VOLUME (CUBIC FEET) PROCESSED EACH DAY SHALL BE RECORDED.
7. WHEN CATALYTIC OXIDIZER IS IN OPERATION, THE OXIDIZER'S INLET AND OUTLET TEMPERATURE AND PRESSURE DROP READINGS SHALL BE RECORDED ONCE A SHIFT.
8. WHEN CATALYTIC OXIDIZER IS IN OPERATION, THE CATALYTIC OXIDIZER'S INLET AND OUTLET CO AND VOC CONCENTRATIONS (PPMV) SHALL BE MONITORED, USING A PORTABLE ANALYZER AND AQMD APPROVED TEST METHODS. READINGS SHALL BE RECORDED AT START-UP AND AT LEAST ON A WEEKLY BASIS.
9. WHEN CATALYTIC OXIDIZER IS IN OPERATION, INLET AND OUTLET SAMPLES SHALL BE COLLECTED AND SPECIATED ANALYSIS SHALL BE CONDUCTED FOR TOTAL VOCs (PPMV), INCLUDING BUT NOT LIMITED TO, FOR FORMALDEHYDE AND OTHER TOXIC COMPOUNDS PRESENT (PPMV) USING DISTRICT OR OTHER APPROVED METHODS.
10. WHEN SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM IS IN OPERATION, THE INLET AND OUTLET TEMPERATURE AND PRESSURE DROP READINGS SHALL BE RECORDED ONCE A SHIFT.
11. EXCEPT DURING STARTUP, THE OPERATOR SHALL MAINTAIN THE TEMPERATURE AT THE INLET TO THE CATALYST BEDS BETWEEN 600 AND 850 DEG. F.
12. THE OPERATOR SHALL INSTALL AND MAINTAIN A UREA FLOW RATE MEASURING SYSTEM TO ACCURATELY INDICATE THE UREA INJECTION RATE TO THE SELECTIVE CATALYTIC REDUCTION SYSTEM.

October 15, 2009

13. THE OPERATOR SHALL CONTINUOUSLY ANALYZE THE UREA INJECTION RATE, AND THE SCR INLET AND OUTLET NOX EMISSION RATE TO ESTIMATE THE AMMONIA CONCENTRATION IN THE SCR OUTLET, BASED ON ONE HOUR AVERAGE.
14. WITHIN 90 DAYS OF COMPLETION OF THE RESEARCH EXPERIMENTS, THE ORANGE COUNTY SANITATION DISTRICT SHALL SUBMIT TO AQMD A COMPLETE REPORT WITH EQUIPMENT OPERATING PARAMETERS AND EMISSIONS RESULTS TO;
ATTENTION: GAURANG RAWAL, REFINERY AND WASTE MANAGEMENT PERMITTING,
21865 COPLEY DRIVE, DIAMOND BAR, CA 91765. THE SUBMITTAL SHALL INCLUDE A COPY OF THIS PERMIT.
15. EMISSIONS FROM THIS EQUIPMENT, AVERAGED OVER 15 MINUTES, CORRECTED TO 15% O2 ON A DRY BASIS, SHALL NOT EXCEED THE FOLLOWING;

POLLUTANT	PPMVD
CO	590
NO _x	45
VOC	209
NH ₃	<10
PM10	0.0087 GRAINS/DSCF
16. ALL RECORDS SHALL BE KEPT AND MAINTAINED FOR A PERIOD OF AT LEAST TWO YEARS AND SHALL BE MADE AVAILABLE TO AQMD PERSONNEL UPON REQUEST.

It is your responsibility to comply with all laws, ordinances and regulations of other government agencies, which are applicable to this equipment.

If you have any questions, please call Mr. Gaurang Rawal at (909) 396-2543.

Yours truly,



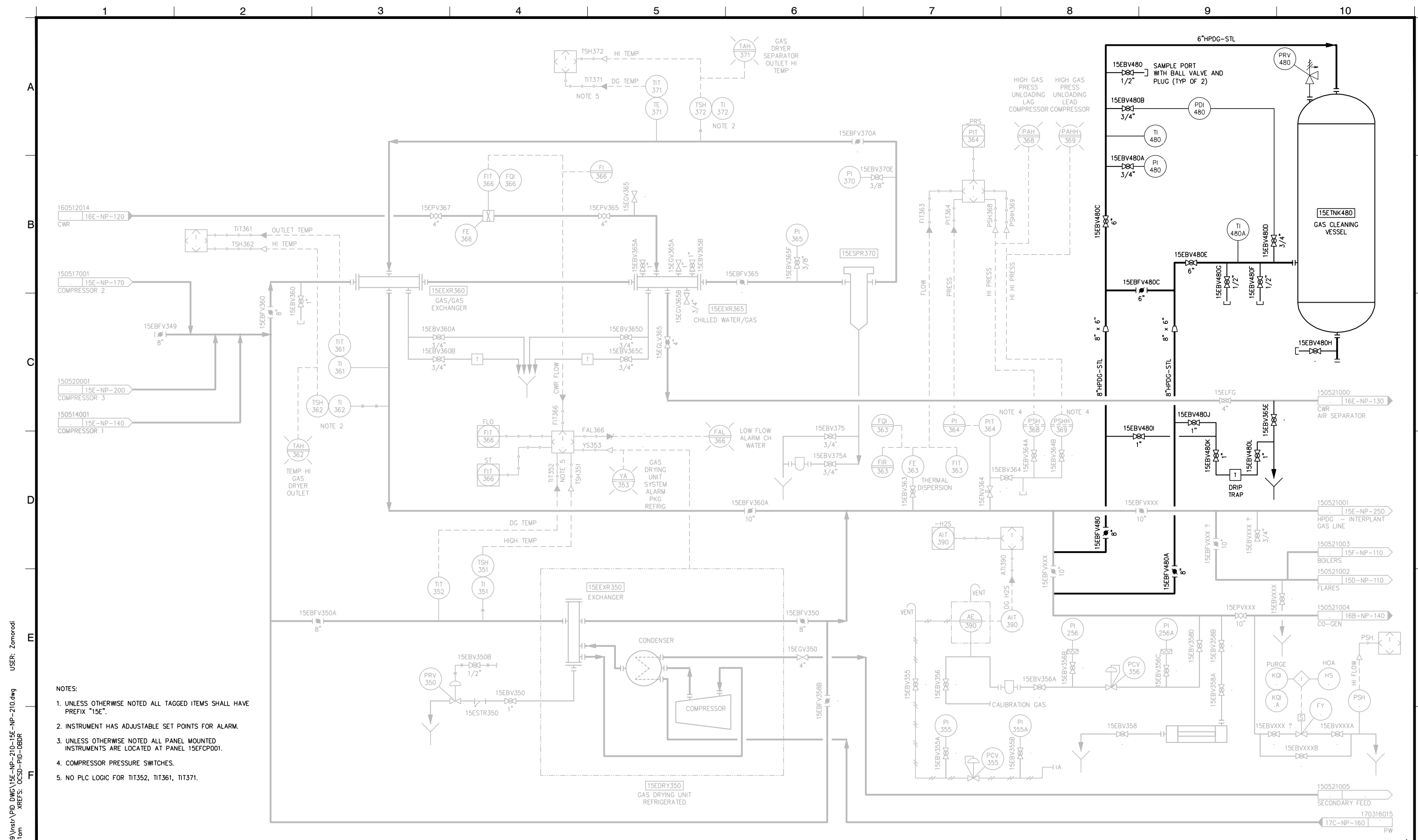
Charles Tupac, P.E.
A.Q.A.C. Supervisor
Refinery and Waste Management Permitting

CDT: GCR

cc: Mohan Nagavedu, AQMD
A/N 497717 folder

APPENDIX A-2:

Schematic of Project Set-up and Process and Instrumentation Diagrams



- NOTES:
1. UNLESS OTHERWISE NOTED ALL TAGGED ITEMS SHALL HAVE PREFIX "15E".
 2. INSTRUMENT HAS ADJUSTABLE SET POINTS FOR ALARM.
 3. UNLESS OTHERWISE NOTED ALL PANEL MOUNTED INSTRUMENTS ARE LOCATED AT PANEL 15EFCP001.
 4. COMPRESSOR PRESSURE SWITCHES.
 5. NO PLC LOGIC FOR TIT352, TIT361, TIT371.

DWG: I:\ACAD\PROJ\179\instr\PID DWG\15E-NP-210-15E-NP-210.dwg
 DATE: Mar 23, 2011 9:10am
 USER: Zomorodi
 XREFS: OCS0-PID-DBDR

DESIGNED BY: ZOMORODI, S. - 1/11
 DRAWN BY: RIVAS, A - 1/11
 CHECKED BY: NIU, E - 1/11

LINE IS 2 INCHES
 AT FULL SIZE
 (IF NOT 2"-SCALE ACCORDINGLY)

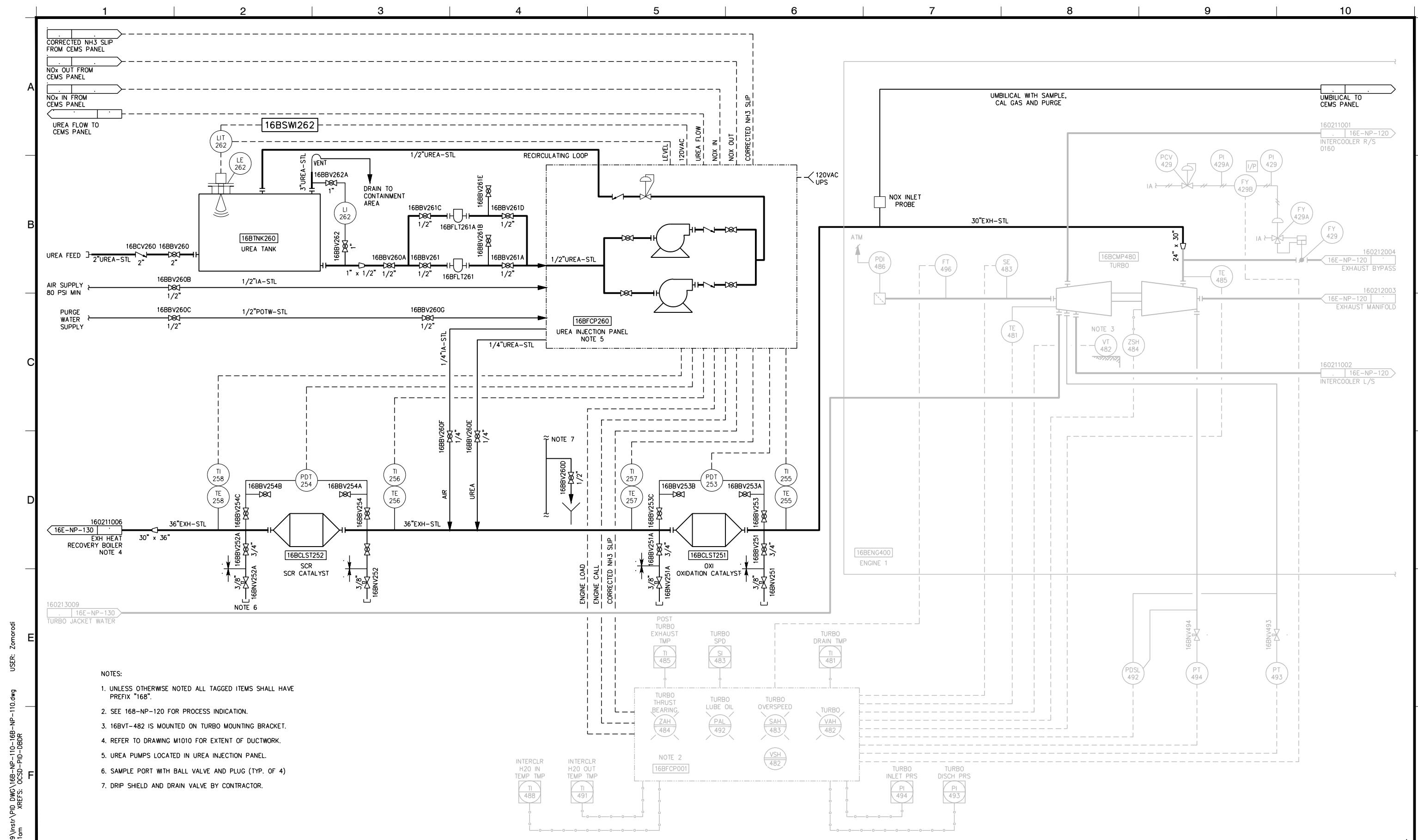


**ORANGE COUNTY
 SANITATION DISTRICT**

PLANT NO.1-PILOT TEST-SCR/CATALYTIC OXIDIZER
 AND GAS CLEANING SYSTEMS
PROCESS & INSTRUMENTATION DIAGRAM
DIGESTER GAS FACILITIES
GAS DRYING UNIT

PLC NO. 15GCOMP
 PROJECT NO. J-79
 DRAWING NO. **15E-NP-210**
 19 OF 20

MARK	DESCRIPTION	DATE	APPR.




- NOTES:
1. UNLESS OTHERWISE NOTED ALL TAGGED ITEMS SHALL HAVE PREFIX "16B".
 2. SEE 16B-NP-120 FOR PROCESS INDICATION.
 3. 16BVT-482 IS MOUNTED ON TURBO MOUNTING BRACKET.
 4. REFER TO DRAWING M1010 FOR EXTENT OF DUCTWORK.
 5. UREA PUMPS LOCATED IN UREA INJECTION PANEL.
 6. SAMPLE PORT WITH BALL VALVE AND PLUG (TYP. OF 4)
 7. DRIP SHIELD AND DRAIN VALVE BY CONTRACTOR.


USER: Zomorodi
 DWG: I:\CAD\PROJ\79\Instr\PID.DWG\16B-NP-110-16B-NP-110.dwg
 DATE: Mar 23, 2011 9:11am
 XREFS: OCSD-PID-DBDR

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: ZOMORODI, S. - 1/11
 DRAWN BY: RIVAS, A. - 1/11
 CHECKED BY: Jost, First - Date
 LINE IS 2 INCHES AT FULL SIZE
 (IF NOT 2"-SCALE ACCORDINGLY)



**MALCOLM
PIRNIE**



**ORANGE COUNTY
SANITATION DISTRICT**

PLANT NO.1-PILOT TEST-SCR/CATALYTIC OXIDIZER AND GAS CLEANING SYSTEMS	PLC NO. XX
PROCESS & INSTRUMENTATION DIAGRAM ENGINE AND EXHAUST FLOW WITH SCR/OXI CAT	PROJECT NO. J-79
	DRAWING NO. 16B-NP-110
	20 OF 20

APPENDIX A-3:

**Technical Memorandum:
Comparison of Digester Gas Sampling Method for Speciated Siloxanes**

Date: July 13, 2011
To: File
From: Kit Liang, Malcolm Pirnie, WHI; Daniel Stepner, Malcolm Pirnie, WHI
Re: OCSD Cat Ox/SCR Pilot Study: Comparison of Digester Gas Sampling Method for Speciated Siloxanes
Project No.: 0788-187

Project Background

The Orange County Sanitation District (OCSD) requested pilot testing of a catalytic oxidizer/selective catalytic reduction (Cat Ox/SCR) system for controlling air toxics and priority pollutants from the Central Generation Systems (CGS) engines to meet February 2008 South Coast Air Quality Management District (SCAQMD) amendments to Rule 1110.2. The amendments to Rule 1110.2 included changes to the existing limits of 36 ppm to 11 ppm of oxides of nitrogen (NO_x), 250 ppm to 30 ppm of volatile organic compounds (VOCs), and 2000 to 250 ppm of carbon monoxide (CO) at 15% O₂. The Cat Ox/SCR system reduces NO_x, CO and VOC (i.e., formaldehyde, acrolein, etc.) emissions from IC engine exhaust.

The pilot testing project took place at Plant No. 1 on Engine No. 1 and included the installation of a Cat Ox/SCR system on the engine exhaust. This technology has been proven effective for controlling NO_x, CO, and VOCs from combustion units burning natural gas. However, fouling or rapid performance degradation of the catalytic oxidizers has been an issue for engines burning digester gas. Typically, digester gas fuel contains contaminants such as volatile methyl-siloxanes and sulfurous compounds that tend to foul the catalytic oxidizers. Therefore, Malcolm Pirnie proposed a scope of work for a pilot test to verify the performance of the Cat Ox/SCR system with a digester gas cleaning system (DGCS). Based on the pilot testing performed at Plant No. 2 Engine No. 3 in 2007, the DGCS proved successful in removing contaminants such as siloxanes and hydrogen sulfide from the digester gas such that the catalyst performance is comparable to that of an internal combustion (IC) engine operating on natural gas.

Identification of Digester Gas Sampling Methods

The purpose of the digester gas cleaning system is to remove siloxanes and any potential contaminants, such as hydrogen sulfides in the digester gas, that can potentially foul or reduce the performance of the Cat Ox/SCR system. There are two sampling methods that are commonly used for measuring siloxanes: gas chromatography-mass spectrometry (GC/MS) or wet chemistry method. Digester gas analyzed using GC/MS can be collected using either Tedlar® bags or SUMMA canisters. The wet chemistry method requires samples to be collected using methanol impingers over a two to four hour sampling

period, and then sent to a lab for analysis. After discussions with several certified laboratories, and review of several published papers, samples collected using Tedlar®, SUMMA canister or methanol impingers each has advantages and disadvantages based on the speciated siloxanes in the digester gas. However, collection of the samples using Tedlar® bags provides the most flexibility for minimum sampling time and equipment required.

As part of the Monitoring Test Procedure, the initial performance testing of the gas cleaning system collected samples using Tedlar® bags, SUMMA canister and methanol impinger methods at the digester gas inlet location during the same day and compared the analytical results to determine the most appropriate method for monitoring media breakthrough. The initial performance testing was performed by Malcolm Pirnie, except where noted. The following information was collected for the digester gas cleaning system test:

- Tedlar® bag collection at the DGCS inlet – Malcolm Pirnie collected and sent samples to a certified laboratory to test for speciated siloxanes, speciated VOCs using TO-15, total reduced sulfide using TO-15 and overall gas components and quality (%CH₄, %CO₂, %N₂, heating value) using EPA Method 3C.
- SUMMA canister collection at the DGCS inlet – Malcolm Pirnie collected and sent samples to a certified laboratory to test for speciated siloxanes, speciated VOCs using TO-15, total reduced sulfide using ASTM D-5504, and overall gas components and quality (%CH₄, %CO₂, %N₂, heating value) using ASTM D-1946.
- Wet chemistry method at the DGCS inlet – Engine 1 was operated for five hours at actual operating conditions with the digester gas cleaning system for performance testing. The performance test was performed for a continuous period of at least five hours (1 hour for stabilization and 4 hours for testing). During the test, individual measurements of inlet total siloxane, D4, D5, hexamethyl-disiloxane, octamethyltrisiloxane and any other siloxane compounds identifiable according to the test method was monitored and recorded.

Information obtained from the initial performance testing was used to select the most appropriate sampling method for the determining breakthrough and change-out.

Summary of Results

On March 16, 2010, digester gas was collected at the Plant 1 DGCS using the three sampling methods described above. Table 1 shows a summary of sampling results.

Table 1
Summary Comparison of Sampling Methods

OCSD Plant 1	Total Siloxane (ppbv)
Tedlar® – Inlet	3,584
SUMMA Canister – Inlet	546
Methanol Impinger – Inlet	1,457

Selection of the Sampling Method

The primary focus of the digester gas testing is to analyze for siloxane compounds. These compounds are most likely to foul the catalytic oxidizer catalyst. Of the three testing methods, the Tedlar® bag method resulted in the highest concentration of siloxanes. Siloxanes can be lost if a sample degrades. It is believed that the Tedlar® bag method provides a conservative estimate of siloxanes in the gas sample. The Tedlar® bag method also requires the least set-up and sampling time as well as the least equipment required. Although these were not the main criteria for selecting the sampling methods, they are benefits to using this method. When breakthrough of the carbon media is suspected, it is important to take a gas sample quickly to minimize potential fouling of the catalyst or downtime of the engine.

Based on the data presented above, the Tedlar® bag collection method was selected. Tedlar® bags provided the highest reported concentration of siloxanes and also provided the flexibility to test for VOCs and sulfurous compounds.

Conclusion

On March 16, 2010, digester gas was sampled at the inlet of the Plant 1 DGCS using three different methods: Tedlar® bags, SUMMA canisters, and methanol impingers. The gas samples collected using Tedlar® bags and SUMMA canisters were analyzed using GC/MS and the gas sample collected using methanol impingers was analyzed using the wet chemistry method. As shown in the summary of the results in Table 1, the Tedlar® bag sampling method detected the highest level of total siloxane. In addition, the Tedlar® bag sampling method provides the most flexibility of what compounds could be tested for and the minimum sampling time and equipment required. Based on these criteria, the Tedlar® bag method was chosen as the sampling method for future digester gas sampling.

APPENDIX A-4:

**Technical Memorandum:
OCSD Catalytic Oxidizer/SCR Pilot Study:
SCR Urea Injection Mapping**

Date: July 13, 2011
To: File
From: Kit Liang, Malcolm Pirnie, WHI; Daniel Stepner, Malcolm Pirnie, WHI
Re: OCSD Cat Ox/SCR Pilot Study: Urea Injection Mapping
Project No.: 0788-187

Project Background

To meet the South Coast Air Quality Management District (SCAQMD) Rule 1110.2 limit for oxides of nitrogen (NO_x), the Orange County Sanitation District (OCSD) installed a selective catalytic reduction (SCR) system with urea injection was installed in the internal combustion (IC) engine exhaust duct after a catalytic oxidizer (Cat Ox) (both systems supplied by Johnson Matthey) on Engine 1 at Plant 1. Under Amended Rule 1110.2, NO_x exhaust levels have a lower limit of 11 ppmv for biogas-fueled engines effective July 30, 2011. The SCR system was designed to remove NO_x through a chemical reaction between the NO_x in the engine exhaust and ammonia (provided by urea spray injected into the exhaust gas stream upstream of the SCR) on the surface of the SCR catalyst. The urea injection rate is selected (“mapped”) based on engine load and outlet NO_x concentration (related to the blend of digester gas and natural gas supplement used by the engines at Plant 1). This memorandum outlines the methodology developed to control the urea injection rate.

SCR Urea Control System

The function of the SCR control system is to balance urea injection rate to reduce NO_x exhaust concentration without emitting excess ammonia in the post-control exhaust gas. The excess ammonia that passes through the SCR catalyst unreacted is, known as “ammonia slip.” Ammonia slip occurs when too much ammonia, or in this case urea, is injected into the exhaust stream, when the temperature of the gas is too low for the ammonia to react, or when the catalyst is degraded. The Research Permit for the pilot study has a maximum allowable ammonia slip of 10 ppm at the stack exhaust. In addition to the unwanted emissions of ammonia from the stack exhaust, excess ammonia in the system can potentially cause damage to the heat recovery boiler and other equipment downstream from the SCR catalyst.

The control system determines the correct rate of urea injection according to the engine load signal, and this urea injection rate versus *engine load map* is programmed into the control system. The load map during the pilot testing period included 16 set points, and was programmed during commissioning by the system vendor, Johnson Matthey. This controller was able to interpolate between the tested load values to generate an overall curve of urea injection rate versus engine load. Thus, as the engine is brought to a load,

and as the engine load changes, the urea flow rate is adjusted by a flow control valve based on the monitored engine load.

In addition to the load map control, the injection system also uses a system of bias set points to more finely control, or “trim”, the urea injection rate. The “NOx curve bias” is a percentage that can be input by the operator to increase or decrease the urea injection rate. This bias is typically set to 0%, but can be modified if engine operation is expected to change the NOx produced in the exhaust emissions. “NOx-add bias” increases the urea injection rate setting (in terms of gallon per hour, gph) based on the NOx outlet concentration recorded by the stack exhaust CEMS analyzer. When the NOx outlet concentration reaches the level set by the control system, the urea injection rate will increase by the selected bias set point. Conversely, “NOx-subtract bias” decreases the urea injection rate in the same manner based on the NOx outlet concentration.

As the engine ran under varying loads during the load mapping procedure, Johnson Matthey measured NOx with a portable chemiluminescent analyzer, and ammonia slip with Draeger® tubes at the SCR catalyst outlet. The purpose of this was to develop a urea injection versus engine load map that met NOx and ammonia slip emissions requirements.

The initial load mapping performed by Johnson Matthey on April 1, 2010 is provided below in Table 1 and in Figure 1. The solid line in Figure 1 represents the set points for urea injection based on engine load. The dashed line represents the urea injection rate with the upper NOx-add bias that increases urea injection based on the NOx outlet emissions. Note that the bias is set for a lower and upper value of NOx outlet concentration. In the case of the April 1, 2010 set points, when the NOx outlet concentration reached the NOx lower add bias concentration (8 ppm), urea injection would increase by an additional 0.50 gph. If the NOx outlet concentration continued to increase and reached the NOx upper add bias concentration (10 ppm), the urea injection would increase by an additional 0.90 gph.

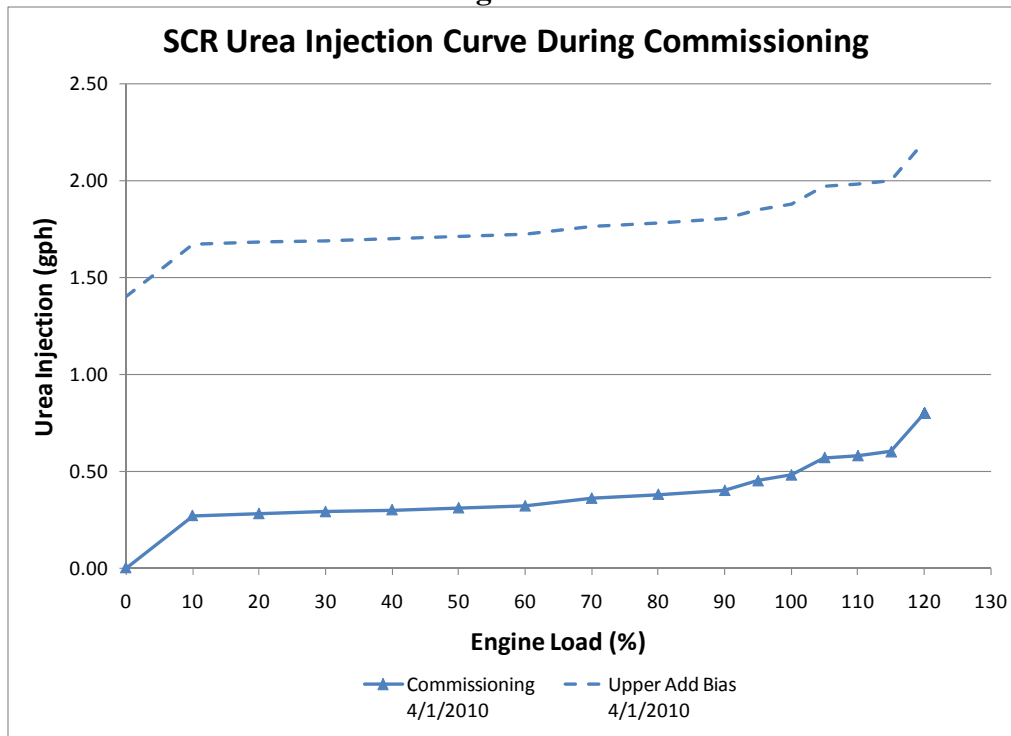
For the pilot testing period, a NOx-subtract bias was not set. A NOx-subtract bias would be used if the OCSO desired to keep the NOx outlet concentration above a threshold level. This could be set if there was a concern that urea would be over injected at low NOx outlet concentrations, causing ammonia slip issues. In the case of the pilot test, there was no desired lower NOx limit and no observed ammonia slip issues.

Table 1:

SCR Urea Injection Set Points at Commissioning (April 1, 2010)

Set Point	Engine Load (%)	Urea Injection Rate (gph)
1	0	0.00
2	10	0.27
3	20	0.28
4	30	0.29
5	40	0.30
6	50	0.31
7	60	0.32
8	70	0.36
9	80	0.38
10	90	0.40
11	95	0.45
12	100	0.48
13	105	0.57
14	110	0.58
15	115	0.60
16	120	0.80
NOx Bias Set Point	NOx Outlet Concentration (ppmv)	Bias (gph)
NOx curve bias	-	0%
NOx lower add bias	8	0.50
NOx upper add bias	10	0.90
NOx lower subtract bias	0	0.00
NOx upper subtract bias	0	0.00

Figure 1:



Urea Injection Set Point Adjustments During the Pilot Testing

During the pilot testing, Johnson Matthey made adjustments to the urea injection set points to refine control of the NO_x emissions. On May 13, 2010, the urea injection NO_x-add bias set points were decreased. The original NO_x-add biases increased the urea injection rates by 0.50 and 0.90 gph when the NO_x outlet concentrations hit 8 and 10 ppmv, respectively. Based on these set points, when the NO_x outlet concentration reached the level set for the NO_x-add bias, it was found that the system injected too much urea, so that the NO_x outlet concentration was lowered too quickly, resulting in rapid fluctuations in the NO_x outlet concentration. Therefore, the lower and upper NO_x-add bias set points were set to 0.05 and 0.09 gph when the NO_x outlet concentration reached 5 and 7 ppmv, respectively. With lower NO_x-add bias set points, the maximum amount of urea injected (urea injection rate plus NO lower and upper add bias) was decreased. Therefore, the risk of not injecting enough urea to compensate for the NO_x outlet concentration was increased. As a precautionary measure, the urea injection rate versus engine load set points were also increased slightly.

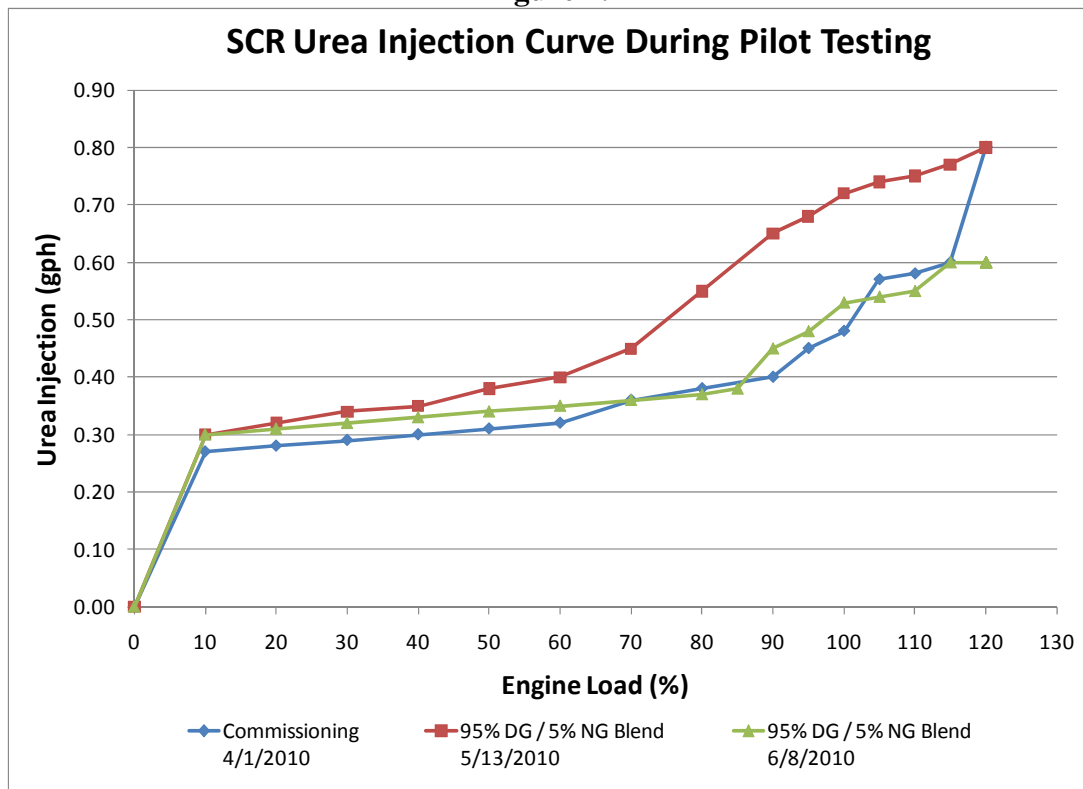
On June 8, 2010, the urea injection set points were readjusted. At the request of OCSD, the urea injection rate versus engine load set points were decreased to reduce possible ammonia slip resulting from over-injection of urea. This was a potential concern because the Plant 1 Engine 1 operates primarily on a greater than 95% digester gas to natural gas fuel ratio. The original set points were set higher to allow for a higher percentage of natural gas in the fuel, which in turn creates a higher NO_x concentration in the engine exhaust. One additional set point was added at an engine load of 85% to further refine the engine load range. The set points programmed into the SCR control system on June 8, 2010 ran for the remaining pilot testing period through the end of March 2011. The effectiveness of these set points is discussed in the pilot testing report. A summary of the urea injection rate set points through the pilot testing period is provided in Table 2 and Figure 2.

Table 2:

SCR Urea Injection Set Points During the Pilot Testing

Load/Urea Injection Set Point	Commissioning 4/1/2010		5/13/2010		6/8/2010	
	Engine Load (%)	Urea Injection (gph)	Engine Load (%)	Urea Injection (gph)	Engine Load (%)	Urea Injection (gph)
1	0	0.00	0	0.00	0	0.00
2	10	0.27	10	0.30	10	0.30
3	20	0.28	20	0.32	20	0.31
4	30	0.29	30	0.34	30	0.32
5	40	0.30	40	0.35	40	0.33
6	50	0.31	50	0.38	50	0.34
7	60	0.32	60	0.40	60	0.35
8	70	0.36	70	0.45	70	0.36
9	80	0.38	80	0.55	80	0.37
10	90	0.40	90	0.65	85	0.38
11	95	0.45	95	0.68	90	0.45
12	100	0.48	100	0.72	95	0.48
13	105	0.57	105	0.74	100	0.53
14	110	0.58	110	0.75	105	0.54
15	115	0.60	115	0.77	110	0.55
16	120	0.80	120	0.80	115	0.60
17	-	-	-	-	120	0.60
NOx Bias Set Point	NOx Outlet Concentration (ppmv)	Bias (gph)	NOx Outlet Concentration (ppmv)	Bias (gph)	NOx Outlet Concentration (ppmv)	Bias (gph)
NOx curve bias	-	0%	-	0%	-	0%
NOx lower add bias	8	0.50	5	0.05	5	0.05
NOx upper add bias	10	0.90	7	0.09	7	0.09
NOx lower subtract bias	0	0.00	0	0.00	0	0.00
NOx upper subtract bias	0	0.00	0	0.00	0	0.00

Figure 2:



Limitations of the Urea Injection Mapping

Based on previous source testing data, the NO_x concentration in the exhaust gas is higher when combusting natural gas than when combusting digester gas at a given load; therefore, there is a potential for variation in the NO_x concentration at the inlet to the SCR system at a given load due to the varying fuel blend in biogas-fueled engines. Since the urea injection rate can only be established based on engine load and outlet NO_x concentration, and not inlet NO_x concentration, it is difficult to maintain a targeted NO_x limit at the stack exhaust using this type of SCR system for fuel blend engines..

Conclusions and Recommendations

The urea injection set points were originally set during system commissioning on April 1, 2010 and were later readjusted on May 13, 2010 to refine NO_x reduction in the engine exhaust gas. The urea injection set points were readjusted for a final time during the pilot test on June 8, 2010 for analysis of the SCR system.

Attachment:
Johnson Matthey Commissioning Report, June 1, 2010

Commissioning Report



Johnson Matthey
Catalysts

Date: 6/1/2010

Malcolm Pirnie / Orange County Sanitation District
Oxidation Catalyst and SCR Emission Control System
System Location: Orange County, CA

Prepared for:
Daniel Stepner and Kit Liang
Malcolm Pirnie

Written by:
Ben Tatum
Sr. Project Engineer
Johnson Matthey - Stationary Emission Control (SEC)
400 Lapp Rd #200
Malvern, PA 19355

The SCR and Oxidation catalyst system at the Orange County Sanitation District is designed to control NOx, hydrocarbon, and CO emissions from a Cooper Model LSVB-12-SGC engine. The required reduction rates are shown in Table 1: Emissions Data (ppmVD @ 15% O₂). The reduction rates are guaranteed based on a 15 min average value per South Coast AQMD rule 1110.2.

Table 1: Emissions Data (ppmVD @ 15% O₂)

Exhaust Component	Catalyst Inlet (max)	Catalyst Outlet (max)*	Reduction Guaranteed
NOx	50 ppm	9 ppm	82.0%
VOC	120 ppm	25 ppm	79.2%
CO	800 ppm	100 ppm	87.5%
HCHO	60 ppm	9 ppm	85.0%
Ammonia Slip	---	10 ppm	---

The SCR system is designed to accommodate changes in the fuel usage of the LSVB-12-SGC engine. The fuel blend can range from 100% natural gas with 0% digester gas to 5% natural gas with 95% digester gas. Four engine load conditions were used for commissioning purposes to determine the necessary urea injection rates. The engine load values chosen were 60%, 80%, 100%, and 110% as this range includes the normal operating conditions of the engine. In addition to varying the engine load, the fuel ratio of natural gas to digester gas was set to one of three conditions to determine the necessary urea injection rates. The fuel ratio testing conditions starting with the most common include 5% natural gas with 95% digester gas, 50% natural gas with 50% digester gas, and 100% natural gas with 0% digester gas. Emission testing was performed for all of the resulting 12 conditions and recorded in Table 2: Emission Testing Results. The results show that the system successfully reduced CO and NOx emissions below the permit conditions while maintaining an NH₃ slip of below 10 ppm.

Table 2: Emission Testing Results

SP	Gas Ratio	OCS D Engine Load %	JM & DL Engine Load %	Valve %	Urea Flow gph	CEMS NOX Corr 15%	Ecom NOX Corr 15%	NH3 Slip	CEMS CO Corr 15%	Ecom CO Corr 15%	Ecom Temp Post SCR	JM Temp Pre SCR	JM Temp Post SCR
1	50/50	110	100	63	0.63	6.7	8	0.5	8.8	6.9	746	755	756
2	50/50	100	95	63	0.63	6.7	8	0.5	10	8	759	762	773
3	50/50	80	72.5	58	0.4	3.8	6	0.2	9.4	7	775	800	786
4	50/50	60	59.1	57	0.34	4.4	4	0.1	8.9	7	761	820	796
5	100ng/0d	110	98.1	69	0.91	4.5	7	0	10.9	9	737	752	754
6	100ng/0d	100	92	67	0.76	4.5	6	0	11.4	9	749	757	761
7	100ng/0d	80	73.7	62	0.54	3.4	5	0	11.7	10	766	781	782
8	100ng/0d	60	58.1	58	0.38	3.6	5	0	9.9	8	755	807	784
9	5ng/95d	110	98.8	63	0.58	5.6	5	0	9.7	6	758	756	762
10	5ng/95d	100	95.5	63	0.57	3.1	4	0.1	8.6	7	779	776	787
11	5ng/95d	80	72.2	58	0.38	3.7	5	0	9.1	8	791	811	812
12	5ng/95d	60	60	55	0.33	1.2	1	0.1	9	8	783	830	815

A urea injection map was created based on the results of the testing outlined in Table 2. The urea injection map serves as the base or default urea injection rate at the corresponding engine load, see Table 3 – Load Map. To compensate for changing NOx concentrations due to fuel ratio fluctuations a bias value is added to or subtracted from the base urea set point. If the NOx concentration at the system outlet climbs to 7 ppm or higher an additional 0.05 gph of urea is injected to bring the NOx levels down. If the NOx concentration at the system outlet continues to rise to 9 ppm or higher an additional 0.09 gph of urea will be injected via the additional bias. The resulting amount of urea will be injected upstream of the SCR catalyst to properly control NOx across all fuel ratios.

Table 3: Load Map / Base Urea Set points and Bias

Engine Load %	Urea Set point (gal/min)	Initial High Bias 7 ppm NOx (gal/min)	Additional High Bias 9 ppm NOx (gal/min)	Initial Low Bias x ppm NOx (gal/min)	Additional Low Bias x ppm NOx (gal/min)
0	0	+0.05	+0.09	0	0
10	0.30	+0.05	+0.09	0	0
20	0.31	+0.05	+0.09	0	0
30	0.32	+0.05	+0.09	0	0
40	0.33	+0.05	+0.09	0	0
50	0.34	+0.05	+0.09	0	0
60	0.35	+0.05	+0.09	0	0
70	0.36	+0.05	+0.09	0	0
80	0.37	+0.05	+0.09	0	0
90	0.45	+0.05	+0.09	0	0
95	0.48	+0.05	+0.09	0	0
100	0.53	+0.05	+0.09	0	0
105	0.54	+0.05	+0.09	0	0
110	0.55	+0.05	+0.09	0	0
115	0.60	+0.05	+0.09	0	0
120	0.60	+0.05	+0.09	0	0

The load map urea set points were determined based on the most common operating condition, which is a high concentration of digester gas (approximately 95% digester gas and 5% natural gas). It was determined during testing that adding natural gas to the fuel blend increased the NOx concentration in the exhaust stream. For this reason, the baseline urea set points coincide with the 95% digester gas and 5% natural gas fuel ratio condition which is the most common and requires the least amount of urea injection. The low bias was disabled for this application because the base urea set points correspond to the minimum urea flow requirements.

Some of the challenges of this control system include the 80 second delay between the time the exhaust gas concentrations change the moment the corresponding NOx concentration signal is received from the CEMS. This lagging indication of NOx concentration, which is used by the control system to determine

if additional urea should be injected via the bias, causes an oscillation in the injection rate when the engine is running at high natural gas concentrations. At the lower and more common natural gas concentrations the system is more stable. These oscillations alone are not enough to bring the system out of compliance because the performance is based on a 15 minute average. The system is capable of being tuned to have an acceptable 15 minute average performance over all operating conditions. The second challenge is the fluctuation of the engine load signal. The engine load signal fluctuates very rapidly (a couple times per second) in a range of plus or minus 10%. The urea injection cabinet uses this signal to control the base urea injection set point. This engine load signal fluctuation causes an inherent fluctuation in the base urea injection rate although it is dampened somewhat by a PID loop.

The following is a table including all SCR system set points at the time of commissioning, see Table 4: System Set points. These set points are for informational purposes and should not be changed without the approval of Johnson Matthey.

Table 4: System Set Points

Component Description				
Urea Heat Control system:	JM P&ID Reference	Set Point	Initiates Purge	Description
Control SP	TT-0301	40°F	No	Urea heater activates 5 DegF below this setpoint and de-activates 5 DegF above this setpoint
Temp Low SP	TT-0301	30°F	No	Alarms if this temperature is met indicating Urea heater circuit failure
System Time Delays:				
Air/Water Purge Time Delay	SV-0103	15 sec.	No	Timer for water purge prior to standard air purge
Engine Time Delay	CP-1001	100 sec.	No	Times out any alarms upon startup until system is fully operational
Kick-Start Timer	CV-0501	45 sec.	No	Opens Control Valve CV-0501 to 100% upon injection to fill feed line
Purge Time Delay	FS-1501	45 sec.	No	Timer to initiate redundant pump
Heater SP Time Delay	TT-0301	NA	No	Time delay to initiate urea heater
Fill Rate Time Delay	NA	NA	No	Time delay to initiate transfer pump
Flow Alarm Time Delay	FT-0401	4.5sec.	Yes	Time delay to initiate low flow alarm
System Operation:				
Air Pressure Main	PR-0602	100 psig	No	System air pressure main
Air Pressure Switch SP	PS-1601	30 psig	Yes	System purge and alarms when air pressure drops below this setpoint
Air Pressure to Injection Module	PR-0603	30 psig	No	Injection Module operational pressure
Cat Pre-Temp High AL	TT-0302	900F	No	Alarms if this temperature is met
Injection Temp SP	TT-0302	600F	No	Turns on injection at 10 DegF above this sp and turns off 10 DegF below this setpoint
Load/Urea SP	CP-1001	Startup	No	Load to Urea setpoint set during startup
Low Load SP	ELS-1901	10%	Yes	Urea will not be injected below this load
Load Deadband	ELS-1901	0%	Yes	Urea pump activates 5% above low load setpoint and de-activates 5% below setpoint
Low Tank Level	LT-1201	10%	Yes	Alarms below this setpoint, injection will not occur to prevent dry pump
Low Urea Flow	FT-0401	0.1	Yes	Alarms if urea flow during injection drops below this setpoint
Reagent Supply Pressure	PR-0601	100 psig	No	Urea supply pressure
Stop Air SP	NA	300 sec	No	Injection Module purges for this amount of time after system shuts down.
Urea High PSI SP	PT-0201	160 psig	No	Alarms when urea pressure is above this setpoint
Urea Low Flow SP	FS-1501	0.10 gph	Yes*	Initiates redundant pump when below this setpoint
Urea Low PSI SP	PT-0201	20 psig	No	Alarms when urea pressure is below this setpoint
Post Urea PSI	PT-0202	-	No	This pressure sensor is for monitoring and diagnostical reference only.
CAT Diff PSI		5psig	No	Alarms when the differential pressure across the catalysts exceeds this value.
Load, Urea Setpoints Main:				
Flowmeter Max Scale	FT-0401	3.0 gph	No	Maximum Scale of Urea Flow Transmitter
Air/Water Purge Time Delay	SV-0103	15 sec.	No	Timer for water purge prior to standard air purge
Calibration Screen:				
Engine Load- mA in Max	ELS-1901	20	N/A	Max mA signal received from engine relative to load
Engine Load- mA in Min	ELS-1901	3.98	N/A	Min mA signal received from engine relative to load
Engine Load- Max Scale	ELS-1901	110	N/A	Load that correlates to receiving a 20mA signal
Engine Load- Min Scale	ELS-1901	0	N/A	Load that correlates to receiving a 4mA signal
Urea Scale	FT-0401	99.6	N/A	Utilized for scaling flow transmitter at initial commissioning
Tank Scale Upper	LT-1201	100	N/A	Utilized for scaling level transmitter at initial commissioning
Tank Scale Lower	LT-1201	19.9	N/A	Utilized for scaling level transmitter at initial commissioning
PID Screen:				
Proportional Setting- P	CV-0501	750	N/A	Proportional Setting for CV-0501
Integral Setting- I	CV-0501	0.025	N/A	Integral Setting for CV-0501

SP=Set Point

* Initiates Purge when second pump does not activate switch

APPENDIX B-1:
Fixed Gas Sampling Summary

Fixed Gas Sampling Summary
Plant 1 - Digester Gas Cleaning System

Collection Date	Lab	Collection Method	Carbon Dioxide		Methane		Nitrogen		Oxygen	
			Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
			(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
3/16/2010	Centek	Tedlar Bag	33.4	32.4	55.2	54.9	1.1	1.7	0.3	0.5
4/7/2010	Centek	Tedlar Bag	27.0	27.6	53.7	62.5	1.6	1.7	0.6	0.8
4/29/2010	Centek	Tedlar Bag	28.5	31.4	62.6	59.5	2.0	1.7	0.5	0.5
5/19/2010	Centek (1)	Tedlar Bag	19.1	24.6	44.4	55.3	27.0	13.2	7.1	3.3
5/27/2010	Centek	Tedlar Bag	31.4	31.0	54.0	54.3	4.0	1.1	1.2	0.5
6/11/2010	Centek	Tedlar Bag	25.5	23.1	56.3	45.0	1.4	1.5	0.5	0.5
6/29/2010	Centek (2)	Tedlar Bag	40.1	34.5	58.3	48.4	4.0	16.0	1.1	4.3
8/12/2010	AccuLabs, Inc. (3)	Summa Canister	0.3	0.3	0.5	0.5	77.5	77.9	21.3	20.5
8/12/2010	AtmAA Inc.	Tedlar Bag	36.6	36.4	61.0	60.9	1.0	1.2	0.3	0.3
8/19/2010	AccuLabs, Inc. (4)	Tedlar Bag	31.2	15.7	63.9	32.3	1.9	45.7	0.5	5.4
8/19/2010	AccuLabs, Inc. (4)	Summa Canister	31.7	25.8	65.8	60.4	0.8	10.8	0.1	0.7
9/1/2010	AtmAA Inc.	Tedlar Bag	35.0	35.7	60.4	60.6	2.5	1.9	0.5	0.4
9/15/2010	AtmAA Inc.	Tedlar Bag	36.6	36.6	60.5	60.6	1.3	1.6	0.2	0.3
9/20/2010	AtmAA Inc.	Tedlar Bag	36.2	36.4	60.8	60.7	1.2	1.2	0.3	0.3
11/4/2010	AtmAA Inc.	Tedlar Bag	35.9	N/A	59.9	N/A	2.6	N/A	0.6	N/A
1/12/2011	AtmAA Inc.	Tedlar Bag	34.0	N/A	59.0	N/A	5.1	N/A	1.4	N/A
2/9/2011	AtmAA Inc.	Tedlar Bag	37.7	37.2	60.4	60.7	0.9	1.1	0.1	0.1
2/24/2011	AtmAA Inc.	Tedlar Bag	36.6	N/A	60.1	N/A	1.9	N/A	0.2	N/A
Minimum			25.5	23.1	53.7	45.0	0.9	1.1	0.1	0.1
Maximum			40.1	37.2	62.6	62.5	5.1	1.9	1.4	0.8
Average			33.9	32.8	58.7	58.0	2.2	1.5	0.6	0.4

Notes:

- (1) Inlet and outlet sample results from 5/19/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (2) Outlet sample results from 6/29/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (3) Inlet and outlet sample results from AccuLabs on 8/12/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (4) Sample results from 8/19/10 are not consistent with sample results from other laboratories and are concluded to be erroneous and not included in the minimum, maximum and average.
- (5) N/A indicates not applicable because the compound was not analyzed for.

APPENDIX B-2:

Total Reduced Sulfide Summary

Total Reduced Sulfide Summary
Plant 1 - Digester Gas Cleaning System

Collection Date	Lab (1)	Collection Method	Hydrogen Sulfide				Carbonyl Sulfide				Methyl Mercaptan				Ethyl Mercaptan			
			Inlet		Outlet		Inlet		Outlet		Inlet		Outlet		Inlet		Outlet	
			Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)
4/21/2010	OCSD	AQMD 307-91	1,000	25,700	25	ND	6	20	6	ND	12	70	12	ND	19	225	19	ND
5/11/2010	OCSD	AQMD 307-91	2,500	31,700	25	263	6	20	6	8	12	53	12	ND	19	263	19	ND
6/8/2010	OCSD	AQMD 307-91	630	27,970	63	2,162	5	16	5	ND	3	49	3	ND	4	272	4	ND
6/22/2010	OCSD	AQMD 307-91	630	21,620	6	ND	5	14	5	ND	3	54	3	ND	4	301	4	ND
7/7/2010	OCSD	AQMD 307-91	630	28,570	6	ND	5	13	5	ND	3	57	3	ND	4	265	4	ND
7/21/2010	OCSD	AQMD 307-91	630	24,870	6	ND	5	10	5	ND	3	48	3	ND	4	272	4	ND
8/3/2010	OCSD	AQMD 307-91	630	27,450	6	ND	5	19	5	12	3	58	3	ND	4	293	4	ND
8/12/2010	OCSD	AQMD 307-91	630	28,190	6	ND	5	22	5	18	3	72	3	ND	4	304	4	ND
8/12/2010	AccuLabs, Inc. (2)	Summa Canister	5	<MDL	5	<MDL	2	<MDL	2	<MDL	2	<MDL	2	<MDL	2	<MDL	2	<MDL
8/12/2010	AtmAA Inc.	Tedlar Bag	500	30,700	200	<MDL	200	<MDL	200	<MDL	200	<MDL	200	<MDL	200	<MDL	200	<MDL
8/19/2010	AccuLabs, Inc. (3)	Tedlar Bag	100	14,600	10	<MDL	5	13	5	<MDL	20	181	5	<MDL	20	470	5	<MDL
8/19/2010	AccuLabs, Inc. (3)	Summa Canister	100	14,100	10	<MDL	5	13	5	<MDL	20	191	5	<MDL	20	478	5	<MDL
9/1/2010	OCSD	AQMD 307-91	630	14,690	6	ND	5	28	5	15	3	81	3	ND	4	301	4	ND
9/14/2010	OCSD	AQMD 307-91	630	23,010	6	545	5	17	5	17	3	62	3	ND	4	258	4	ND
1/25/2011	OCSD	AQMD 307-91	630	28,540	6	ND	5	28	5	16	3	61	3	ND	4	189	4	ND
2/9/2011	OCSD	AQMD 307-91	630	31,870	6	1,755	5	21	5	18	3	79	3	ND	4	210	4	ND
2/23/2011	OCSD	AQMD 307-91	630	24,460	6	ND	5	15	5	ND	3	58	3	ND	4	205	4	ND
Minimum			N/A	14,690	N/A	263	N/A	10	N/A	8	N/A	48	N/A	ND	N/A	189	N/A	ND
Maximum			N/A	31,870	N/A	2,162	N/A	28	N/A	18	N/A	81	N/A	ND	N/A	304	N/A	ND
Average			N/A	26,381	N/A	1,181	N/A	19	N/A	15	N/A	62	N/A	ND	N/A	258	N/A	ND

Notes:

- (1) Hydrogen sulfide results from Centek are above the operating range of the instrument and appear to be erroneous. Centek sample results are not included in the analysis of this pilot testing program.
- (2) Inlet and outlet sample results from AccuLabs on 8/12/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (3) Sample results from 8/19/10 are not consistent with sample results from other laboratories and are concluded to be erroneous and not included in the minimum, maximum and average.
- (4) N/A indicates not applicable or that the compound was not analyzed for.
- (5) ND indicates non-detect.
- (6) <MDL indicates that the result, if any, was less than the method detection limit.

Total Reduced Sulfide Summary
Plant 1 - Digester Gas Cleaning System

Collection Date	Lab (1)	Collection Method	Dimethyl Sulfide				Carbon Disulfide				n-Propyl Thiol				iso-Propyl Thiol			
			Inlet		Outlet		Inlet		Outlet		Inlet		Outlet		Inlet		Outlet	
			Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)
4/21/2010	OCSD	AQMD 307-91	18	ND	18	ND	13	ND	13	ND	21	584	21	ND	30	310	30	ND
5/11/2010	OCSD	AQMD 307-91	18	ND	18	ND	13	ND	13	ND	21	630	21	ND	30	360	30	ND
6/8/2010	OCSD	AQMD 307-91	5	8	5	10	3	4	3	3	320	536	3	ND	3	341	3	4
6/22/2010	OCSD	AQMD 307-91	5	6	5	ND	3	ND	3	ND	3	679	3	ND	3	406	3	ND
7/7/2010	OCSD	AQMD 307-91	5	12	5	ND	3	ND	3	ND	3	625	3	ND	3	381	3	ND
7/21/2010	OCSD	AQMD 307-91	5	8	5	12	3	ND	3	4	3	593	3	ND	3	373	3	ND
8/3/2010	OCSD	AQMD 307-91	5	13	5	12	3	ND	3	6	3	622	3	ND	3	401	3	ND
8/12/2010	OCSD	AQMD 307-91	5	17	5	20	3	ND	3	7	3	649	3	ND	3	416	3	ND
8/12/2010	AccuLabs, Inc. (2)	Summa Canister	2	15	2	11	2	5	2	4	2	<MDL	2	<MDL	2	<MDL	2	<MDL
8/12/2010	AtmAA Inc.	Tedlar Bag	200	<MDL	200	<MDL	200	<MDL	200	<MDL	320	<MDL	200	<MDL	250	<MDL	200	<MDL
8/19/2010	AccuLabs, Inc. (3)	Tedlar Bag	5	10	5	8	5	<MDL	5	<MDL	50	1,180	5	<MDL	5	<MDL	5	<MDL
8/19/2010	AccuLabs, Inc. (3)	Summa Canister	5	10	5	9	5	<MDL	5	2	50	1,190	5	<MDL	5	<MDL	5	<MDL
9/1/2010	OCSD	AQMD 307-91	5	13	5	18	3	9	3	12	3	565	3	ND	3	416	3	ND
9/14/2010	OCSD	AQMD 307-91	5	15	5	18	3	ND	3	7	3	631	3	ND	3	341	3	ND
1/25/2011	OCSD	AQMD 307-91	5	8	5	11	3	5	3	8	3	454	3	ND	3	214	3	ND
2/9/2011	OCSD	AQMD 307-91	5	14	5	ND	3	ND	3	6	3	514	3	ND	3	242	3	ND
2/23/2011	OCSD	AQMD 307-91	5	13	5	ND	3	ND	3	ND	3	476	3	ND	3	268	3	ND
Minimum			N/A	6	N/A	10	N/A	4	N/A	3	N/A	454	N/A	ND	N/A	214	N/A	4
Maximum			N/A	17	N/A	20	N/A	9	N/A	12	N/A	679	N/A	ND	N/A	416	N/A	4
Average			N/A	12	N/A	14	N/A	6	N/A	7	N/A	581	N/A	ND	N/A	344	N/A	4

Total Reduced Sulfide Summary
Plant 1 - Digester Gas Cleaning System

Collection Date	Lab (1)	Collection Method	Dimethyl Disulfide				Isopropyl Mercaptan				n-Propyl Mercaptan			
			Inlet		Outlet		Inlet		Outlet		Inlet		Outlet	
			Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)
4/21/2010	OCSD	AQMD 307-91	30	ND	30	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/11/2010	OCSD	AQMD 307-91	30	ND	30	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/8/2010	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/22/2010	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/7/2010	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/21/2010	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/3/2010	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/12/2010	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/12/2010	AccuLabs, Inc. (2)	Summa Canister	5	<MDL	5	<MDL	5	<2	5	<2	5	<2	5	<2
8/12/2010	AtmAA Inc.	Tedlar Bag	200	<MDL	200	<MDL	0.2	250	0.2	<MDL	0.2	320	0.2	<MDL
8/19/2010	AccuLabs, Inc. (3)	Tedlar Bag	5	<MDL	5	<MDL	5	<2	5	<2	50	1,180	5	<2
8/19/2010	AccuLabs, Inc. (3)	Summa Canister	5	<MDL	5	<MDL	5	<2	5	<2	50	1,190	5	<2
9/1/2010	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/14/2010	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/25/2011	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/9/2011	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/23/2011	OCSD	AQMD 307-91	4	ND	4	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Minimum			N/A	ND	N/A	ND	N/A	250	N/A	ND	N/A	320	N/A	ND
Maximum			N/A	ND	N/A	ND	N/A	250	N/A	ND	N/A	320	N/A	ND
Average			N/A	ND	N/A	ND	N/A	250	N/A	ND	N/A	320	N/A	ND

APPENDIX B-3:

Speciated Siloxane Sampling Detailed Summary

Siloxane Sampling Summary
Plant 1 - Digester Gas Cleaning System

Collection Date	Lab	Collection Method	Hexamethyldisiloxane (L2)				Hexamethylcyclotrisiloxane (D3)				Octamethyltrisiloxane (L3)				Octamethylcyclotetrasiloxane (D4)			
			Inlet		Outlet		Inlet		Outlet		Inlet		Outlet		Inlet		Outlet	
			Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)
3/16/2010	Centek	Tedlar Bag	20	ND	20	ND	20	10	20	ND	20	12	20	ND	20	600	20	ND
4/7/2010	Centek	Tedlar Bag	20	ND	10	ND	20	9.7	10	ND	20	11	10	ND	20	840	10	ND
4/29/2010	Centek	Tedlar Bag	50	ND	10	ND	50	ND	10	ND	50	10	10	ND	50	1600	10	ND
5/19/2010	Centek (1)	Tedlar Bag	20	ND	10	ND	20	15	10	ND	20	17	10	ND	20	810	10	7.6
5/27/2010	Centek	Tedlar Bag	20	ND	10	8.4	20	13	10	ND	20	17	10	0.1	20	1300	10	5.2
5/27/2010	Centek	Methanol Impinger	20	N/A	10	ND	20	N/A	10	ND	20	N/A	10	ND	20	369	10	ND
6/11/2010	Centek	Tedlar Bag	20	ND	10	7.4	20	12	10	12	20	15	10	ND	20	660	10	200
6/29/2010	Centek (2)	Tedlar Bag	20	ND	10	ND	20	17	10	ND	20	19	10	ND	20	620	10	ND
8/12/2010	AccuLabs (3)	Summa Canister	0.025	3.12	0.025	2.98	0.025	<0.01	0.025	<0.01	0.025	<0.01	0.025	<0.01	0.025	<0.01	0.025	<0.01
8/12/2010	AtmAA	Tedlar Bag	N/A	ND	N/A	ND	N/A	ND	N/A	ND	N/A	ND	N/A	ND	N/A	471	N/A	ND
8/19/2010	AccuLabs (4)	Tedlar Bag	0.025	1.61	0.025	0.26	0.025	4.84	0.025	0.03	0.025	4.97	0.025	ND	0.025	41.5	0.025	0.03
8/19/2010	AccuLabs (4)	Summa Canister	0.025	1.34	0.025	0.23	0.025	5.62	0.025	0.03	0.025	5.84	0.025	ND	0.025	43.1	0.025	0.03
9/1/2010	AtmAA	Tedlar Bag	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	510	60	<MDL
9/15/2010	AtmAA	Tedlar Bag	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	860	60	<MDL
9/20/2010	AtmAA	Tedlar Bag	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	864	60	<MDL
11/4/2010	AtmAA	Tedlar Bag	60	<MDL	N/A	N/A	60	<MDL	N/A	N/A	60	<MDL	N/A	N/A	60	597	N/A	N/A
1/12/2011	AtmAA	Tedlar Bag	60	<MDL	N/A	N/A	60	<MDL	N/A	N/A	60	<MDL	N/A	N/A	60	409	N/A	N/A
2/9/2011	AtmAA	Tedlar Bag	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	<MDL	60	420	60	<MDL
2/24/2011	AtmAA	Tedlar Bag	60	<MDL	N/A	N/A	60	<MDL	N/A	N/A	60	<MDL	N/A	N/A	60	438	N/A	N/A
Minimum			N/A	<MDL	N/A	7.4	N/A	9.7	N/A	12.0	N/A	10.0	N/A	0.1	N/A	369	N/A	5.2
Maximum			N/A	<MDL	N/A	8.4	N/A	17.0	N/A	12.0	N/A	19.0	N/A	0.1	N/A	1,600	N/A	200.0
Average			N/A	<MDL	N/A	7.9	N/A	12.3	N/A	12.0	N/A	14.0	N/A	0.1	N/A	704	N/A	102.6

Notes:

- (1) Inlet and outlet sample results from 5/19/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (2) Outlet sample results from 6/29/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (3) Inlet and outlet sample results from AccuLabs on 8/12/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (4) Sample results from 8/19/10 are not consistent with sample results from other laboratories and are concluded to be erroneous and not included in the minimum, maximum and average.
- (5) N/A indicates not applicable or that the compound was not analyzed for.
- (6) ND indicates non-detect.
- (7) <MDL indicates that the result, if any, was less than the method detection limit.

Siloxane Sampling Summary
Plant 1 - Digester Gas Cleaning System

Collection Date	Lab	Collection Method	Decamethyltetrasiloxane (L4)				Decamethylcyclopentasiloxane (D5)				Total Siloxane	
			Inlet		Outlet		Inlet		Outlet		Inlet	Outlet
			Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)	Rpt Lmt (ppbv)	Amt (ppbv)		
3/16/2010	Centek	Tedlar Bag	20	84	20	ND	20	2900	20	7.0	3,584.0	<MDL
4/7/2010	Centek	Tedlar Bag	20	170	10	ND	20	7500	10	8.8	8,510.0	<MDL
4/29/2010	Centek	Tedlar Bag	50	100	10	ND	50	14000	10	ND	15,700.0	ND
5/19/2010	Centek (1)	Tedlar Bag	20	83	10	ND	20	3500	10	ND	4,393.0	<MDL
5/27/2010	Centek	Tedlar Bag	20	73	10	0.22	20	1300	10	15	2,673.0	15.0
5/27/2010	Centek	Methanol Impinger	20	N/A	10	ND	20	2478	10	ND	2,847.0	ND
6/11/2010	Centek	Tedlar Bag	20	130	10	ND	20	7700	10	36	8,490.0	248.0
6/29/2010	Centek (2)	Tedlar Bag	20	170	10	ND	20	7900	10	39	8,690.0	39.0
8/12/2010	AccuLabs (3)	Summa Canister	0.025	<0.01	0.025	<0.01	0.025	<0.01	0.025	<0.01	3.1	3.0
8/12/2010	AtmAA	Tedlar Bag	N/A	ND	N/A	ND	N/A	3254	N/A	ND	3,725.0	ND
8/19/2010	AccuLabs (4)	Tedlar Bag	0.025	6.36	0.025	ND	0.03	860	0.03	ND	919.3	0.3
8/19/2010	AccuLabs (4)	Summa Canister	0.025	6.72	0.025	ND	0.1	908	0.025	ND	970.6	0.3
9/1/2010	AtmAA	Tedlar Bag	80	<MDL	80	<MDL	80	4058	80	<MDL	4,568.0	<0.4
9/15/2010	AtmAA	Tedlar Bag	80	<MDL	80	<MDL	80	3486	80	<MDL	4,346.0	<0.4
9/20/2010	AtmAA	Tedlar Bag	80	<MDL	80	<MDL	80	4862	80	<MDL	5,726.0	<0.4
11/4/2010	AtmAA	Tedlar Bag	80	<MDL	N/A	N/A	80	4632	N/A	N/A	5,229.0	N/A
1/12/2011	AtmAA	Tedlar Bag	80	<MDL	N/A	N/A	80	6140	N/A	N/A	6,549.0	N/A
2/9/2011	AtmAA	Tedlar Bag	80	<MDL	80	<MDL	80	4160	80	<MDL	4,580.0	<MDL
2/24/2011	AtmAA	Tedlar Bag	80	<MDL	N/A	N/A	80	6200	N/A	N/A	6,638.0	N/A
Minimum			N/A	73	N/A	0.2	N/A	1,300	N/A	7.0	919	0.3
Maximum			N/A	170	N/A	0.2	N/A	14,000	N/A	36.0	15,700	248.0
Average			N/A	121	N/A	0.2	N/A	5,371	N/A	16.7	5,452	60.5

APPENDIX B-4:

Volatile Organic Compound Summary

VOC Data Summary
Plant 1 - Digester Gas Cleaning System

Analyte	3/16/2010				3/16/2010		4/7/2010				4/29/2010			
	Centek				AccuLabs (Summa Canister)		Centek				Centek			
	Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)	
	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt
Acetone	40	ND	40	40	2.5	<2.5	40	ND	20	17	100	63	20	15
Benzene	20	13	20	ND	0.5	9.25	20	8.2	10	ND	50	10	10	ND
Carbon Disulfide	20	ND	20	ND	0.5	0.97	20	ND	10	3.4	50	ND	10	5
Chlorobenzene	20	ND	20	ND	0.5	<0.21	20	ND	10	ND	50	ND	10	ND
Cyclohexane	20	ND	20	ND	0.5	2.94	20	18	10	ND	50	22	10	ND
1,2-Dichlorobenzene	20	ND	20	ND	0.5	0.33	20	ND	10	ND	50	ND	10	ND
1,4-Dichlorobenzene	20	5	20	ND	0.5	12.6	20	ND	10	ND	50	28	10	ND
cis-1,2-Dichloroethene	20	35	20	4.3	0.5	30.6	20	23	10	ND	50	45	10	12
trans-1,2-Dichloroethene	20	ND	20	ND	0.5	<0.20	20	ND	10	ND	50	ND	10	ND
Ethanol	N/A	N/A	N/A	N/A	1.0	<0.37	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ethyl Acetate	40	ND	40	ND	1.0	<0.45	40	ND	20	ND	100	ND	20	ND
Ethylbenzene	20	37	20	ND	0.5	33.4	20	44	10	ND	50	100	10	ND
4-Ethyltoluene	20	20	20	ND	0.5	14.7	20	21	10	ND	50	43	10	ND
Freon 11	20	ND	20	ND	N/A	N/A	20	ND	10	ND	50	ND	10	2.9
n-Heptane	20	73	20	ND	0.5	55.9	20	75	10	ND	50	100	10	ND
Hexane	20	ND	20	ND	0.5	80.2	20	88	10	ND	50	210	10	ND
Isopropyl Alcohol	20	ND	20	300	N/A	N/A	20	ND	10	30	50	ND	10	13
Methylene Chloride	20	7.7	20	ND	2.5	7.63	20	5.2	10	3.8	50	12	10	5.2
Methyl Isobutyl Ketone (MIBK)	40	ND	40	ND	2.0	<0.57	40	ND	20		100	ND	20	ND
2-Propanol (IPA)	N/A	N/A	N/A	N/A	1.0	4.05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Propene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Propylene	20	ND	20	ND	5.0	2140	20	ND	10	ND	50	ND	10	ND
Styrene	20	4.7	20	ND	0.5	5.65	20	4.2	10	ND	50	19	10	ND
Tetrachloroethene (PCE)	N/A	N/A	N/A	N/A	0.5	5.16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tetrachloroethylene	20	8.2	20	ND	N/A	N/A	20	ND	10	ND	50	ND	10	ND
Toluene	20	1200	20	ND	5.0	1350	20	1300	10	4.1	50	1600	10	ND
1,2,4-Trichlorobenzene	20	ND	20	ND	0.5	<0.26	20	ND	10	ND	50	ND	10	ND
Trichloroethene (TCE)	20	12	20	11	0.5	7.26	20	9.6	10	ND	50	14	10	ND
Trichloroethylene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Trichlorofluoromethane(F-11)	N/A	N/A	N/A	N/A	2.0	2.36	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,2,4-Trimethylbenzene	20	76	20	ND	0.5	110	20	70	10	ND	50	240	10	ND
1,3,5-Trimethylbenzene	20	33	20	ND	0.5	38.5	20	30	10	ND	50	88	10	ND
2,2,4-Trimethylpentane	20	27	20	ND	N/A	N/A	20	66	10	ND	50	65	10	ND
Vinyl Chloride	20	ND	20	ND	0.5	2.39	20	ND	10	ND	50	ND	10	ND
m & p-Xylene	40	69	40	ND	1.0	76.8	40	76	20	ND	100	100	20	ND
o-Xylene	20	24	20	ND	0.5	27.9	20	26	10	ND	50	41	10	ND
Total VOCs	N/A	1,594	N/A	340	N/A	4,019	N/A	1,819	N/A	30	N/A	2,403	N/A	25

Notes:

- (1) Inlet and outlet sample results from 5/19/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (2) Outlet sample results from 6/29/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (3) Inlet and outlet sample results from AccuLabs on 8/12/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (4) Sample results from 8/19/10 are not consistent with sample results from other laboratories and are concluded to be erroneous and not included in the minimum, maximum and average.
- (5) N/A indicates not applicable or that the compound was not analyzed for.
- (6) ND indicates non-detect.
- (7) <MDL indicates that the result, if any, was less than the method detection limit.

VOC Data Summary
Plant 1 - Digester Gas Cleaning System

Analyte	5/11/2010				5/19/2010				5/25/2010				5/27/2010			
	OCS D				Centek (1)				OCS D				Centek			
	Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)	
	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt
Acetone	4.300	7.24	4.640	7.01	40	ND	20	45	4.640	10.2	4.300	9.67	40	ND	20	ND
Benzene	3.900	9.53	4.210	ND	20	22	10	11	4.210	9.28	3.900	ND	20	9.8	10	4.1
Carbon Disulfide	6.280	ND	6.780	ND	20	9.8	10	21	6.780	ND	6.280	ND	20	ND	10	3.5
Chlorobenzene	3.780	4.57	4.080	ND	20	9.6	10	ND	4.080	5.85	3.780	ND	20	ND	10	ND
Cyclohexane	3.820	ND	4.130	ND	20	33	10	12	4.130	ND	3.820	ND	20	12	10	6.5
1,2-Dichlorobenzene	3.520	ND	3.810	ND	20	ND	10	ND	3.810	ND	3.520	ND	20	ND	10	ND
1,4-Dichlorobenzene	3.580	20.8	3.860	ND	20	47	10	ND	3.860	26.8	3.580	ND	20	5.3	10	ND
cis-1,2-Dichloroethene	3.080	37.7	3.320	17.1	20	360	10	54	3.320	103	3.080	72.4	20	80	10	63
trans-1,2-Dichloroethene	3.680	ND	3.970	ND	20	32	10	4.4	3.970	ND	3.680	3.71	20	ND	10	5.8
Ethanol	4.300	ND	4.640	ND	N/A	N/A	N/A	N/A	4.640	ND	4.300	ND	N/A	N/A	N/A	N/A
Ethyl Acetate	5.450	ND	5.890	ND	40	ND	20	ND	5.890	ND	5.450	ND	40	ND	20	4.3
Ethylbenzene	3.380	85.4	3.640	ND	20	250	10	2.6	3.640	141	3.380	ND	20	96	10	7.8
4-Ethyltoluene	3.000	59.3	3.240	ND	20	65	10	ND	3.240	51.1	3.000	ND	20	16	10	ND
Freon 11	N/A	N/A	N/A	N/A	20	ND	10	5.1	N/A	N/A	N/A	N/A	20	6.3	10	4.8
n-Heptane	3.080	83.8	3.320	ND	20	210	10	3	3.320	87.2	3.080	41.8	20	76	10	36
Hexane	3.620	37	3.920	ND	20	200	10	47	3.920	36.6	3.620	9.55	20	150	10	27
Isopropyl Alcohol	2.950	ND	3.190	ND	20	ND	10	27	3.190	ND	2.950	ND	20	ND	10	ND
Methylene Chloride	5.220	ND	5.640	ND	20	9	10	9.4	5.640	ND	5.220	ND	20	8.2	10	7.3
Methyl Isobutyl Ketone (MIBK)	2.950	ND	3.190	ND	40	ND	20	ND	3.190	ND	2.950	ND	40	ND	20	ND
2-Propanol (IPA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Propene	44.600	3270	48.800	3480	N/A	N/A	N/A	N/A	49.300	3130	45.400	3470	N/A	N/A	N/A	N/A
Propylene	N/A	N/A	N/A	N/A	20	ND	10	ND	N/A	N/A	N/A	N/A	20	ND	10	ND
Styrene	2.080	7.92	2.240	ND	20	49	10	ND	2.240	24.7	2.080	ND	20	13	10	4.3
Tetrachloroethene (PCE)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tetrachloroethylene	3.350	ND	3.620	ND	20	370	10	ND	3.620	ND	3.350	6.56	20	6	10	4.2
Toluene	23.600	1340	2.560	ND	20	2700	10	25	26.000	2010	23.900	1030	50	1200	20	360
1,2,4-Trichlorobenzene	2.600	ND	2.810	ND	20	ND	10	ND	2.810	ND	2.600	ND	20	ND	10	ND
Trichloroethene (TCE)	N/A	N/A	N/A	N/A	20	610	10	22	N/A	N/A	N/A	N/A	20	14	10	7.6
Trichloroethylene	3.520	9.67	3.810	ND	N/A	N/A	N/A	N/A	3.810	12.7	3.520	10.2	N/A	N/A	N/A	N/A
Trichlorofluoromethane(F-11)	7.120	ND	7.700	ND	N/A	N/A	N/A	N/A	7.700	ND	7.120	ND	N/A	N/A	N/A	N/A
1,2,4-Trimethylbenzene	3.300	178	3.560	ND	20	430	10	ND	3.560	188	3.300	ND	20	81	10	ND
1,3,5-Trimethylbenzene	4.100	77.1	4.430	ND	20	150	10	ND	4.430	76.2	4.100	ND	20	35	10	ND
2,2,4-Trimethylpentane	N/A	N/A	N/A	N/A	20	89	10	3.2	N/A	N/A	N/A	N/A	20	60	10	25
Vinyl Chloride	5.200	ND	5.620	ND	20	12	10	5.8	5.620	ND	5.200	6.81	20	ND	10	6.6
m & p-Xylene	4.220	103	4.560	ND	40	240	20	ND	4.560	88.5	4.220	ND	40	47	20	ND
o-Xylene	4.050	42.6	4.370	ND	20	91	10	ND	4.370	35.6	4.050	ND	20	20	10	ND
Total VOCs	N/A	5,374	N/A	3,504	N/A	5,948	N/A	264	N/A	6,037	N/A	4,651	N/A	1,845	N/A	511

VOC Data Summary
Plant 1 - Digester Gas Cleaning System

Analyte	6/8/2010				6/11/2010				6/29/2010				7/7/2010			
	OCSD				Centek				Centek (2)				OCSD			
	Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)	
	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt
Acetone	4.470	ND	4.820	ND	40	ND	40	200	40	88	20	65	4.640	9.24	5.160	ND
Benzene	4.060	11	4.370	6.01	20	15	20	7.2	20	14	10	ND	4.210	7.34	4.680	ND
Carbon Disulfide	6.530	ND	7.030	ND	20	ND	20	5.8	20	ND	10	3.2	6.780	ND	7.530	ND
Chlorobenzene	3.930	ND	4.230	ND	20	5.9	20	ND	20	6.4	10	ND	4.080	ND	4.530	ND
Cyclohexane	3.980	ND	4.280	ND	20	ND	20	9.2	20	16	10	ND	4.130	ND	4.590	ND
1,2-Dichlorobenzene	3.670	ND	3.950	ND	20	ND	20	ND	20	ND	10	ND	3.810	ND	4.230	ND
1,4-Dichlorobenzene	3.720	19.2	4.000	ND	20	16	20	ND	20	17	10	ND	3.860	ND	4.290	ND
cis-1,2-Dichloroethene	3.200	37.6	3.440	59.6	20	42	20	55	20	44	10	ND	3.320	22.7	3.690	ND
trans-1,2-Dichloroethene	3.820	ND	4.120	ND	20	ND	20	ND	20	4.6	10	ND	3.970	ND	4.410	ND
Ethanol	4.470	ND	4.820	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.640	ND	5.160	ND
Ethyl Acetate	5.670	ND	6.100	ND	40	ND	40	ND	40	ND	20	ND	5.890	ND	6.540	ND
Ethylbenzene	3.510	74.1	3.780	38.9	20	110	20	61	20	84	10	ND	3.640	62.4	4.050	ND
4-Ethyltoluene	3.120	68.6	3.360	ND	20	31	20	9	20	21	10	ND	3.240	28.8	3.600	ND
Freon 11	N/A	N/A	N/A	N/A	20	ND	20	5.9	20	5.2	10	3.5	N/A	N/A	N/A	N/A
n-Heptane	3.200	62.4	3.440	45.8	20	94	20	44	20	99	10	ND	3.320	79.1	3.690	ND
Hexane	3.770	33.7	4.060	26.6	20	130	20	35	20	160	10	3.2	3.920	35.6	4.350	ND
Isopropyl Alcohol	3.070	ND	3.300	ND	20	ND	20	ND	20	ND	10	ND	3.190	ND	3.540	ND
Methylene Chloride	5.430	ND	5.850	5.96	20	9.3	20	13	20	14	10	8.8	5.640	ND	6.270	6.38
Methyl Isobutyl Ketone (MIBK)	3.070	ND	3.300	ND	40	ND	40	ND	40	ND	20	ND	3.190	ND	3.540	ND
2-Propanol (IPA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Propene	47.200	3630	49.900	4130	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	47.900	3270	53.800	3600
Propylene	N/A	N/A	N/A	N/A	20	ND	20	ND	20	ND	10	ND	N/A	N/A	N/A	N/A
Styrene	2.160	8.4	2.320	ND	20	23	20	6.2	20	15	10	2.6	2.240	7.18	2.490	ND
Tetrachloroethene (PCE)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tetrachloroethylene	3.480	ND	3.750	11.5	20	21	20	7.5	20	13	10	ND	3.620	ND	4.020	ND
Toluene	24.900	3080	26.300	1400	20	3600	20	800	20	2000	10	3.7	25.300	2090	2.850	ND
1,2,4-Trichlorobenzene	2.700	ND	2.910	ND	20	ND	20	ND	20	9.2	10	ND	2.810	ND	3.120	ND
Trichloroethene (TCE)	N/A	N/A	N/A	N/A	20	28	20	16	20	17	10	ND	N/A	N/A	N/A	N/A
Trichloroethylene	3.670	6.24	3.950	12.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.810	7.14	4.230	ND
Trichlorofluoromethane(F-11)	7.410	ND	7.980	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.700	ND	8.550	ND
1,2,4-Trimethylbenzene	3.430	117	3.700	ND	20	190	20	ND	20	120	10	ND	3.560	124	3.960	ND
1,3,5-Trimethylbenzene	4.260	38.4	4.590	ND	20	69	20	ND	20	44	10	ND	4.430	36.2	4.920	ND
2,2,4-Trimethylpentane	N/A	N/A	N/A	N/A	20	55	20	31	20	39	10	ND	N/A	N/A	N/A	N/A
Vinyl Chloride	5.410	ND	5.820	ND	20	ND	20	ND	20	ND	10	ND	5.620	ND	6.240	ND
m & p-Xylene	4.390	60.5	4.730	31.4	40	100	40	52	40	180	20	ND	4.560	111	5.070	7.90
o-Xylene	4.210	24.4	4.540	ND	20	42	20	10	20	64	10	ND	4.370	41.6	4.860	ND
Total VOCs	N/A	7,272	N/A	5,768	N/A	4,535	N/A	1,278	N/A	2,943	N/A	65	N/A	5,932	N/A	3,614

VOC Data Summary
Plant 1 - Digester Gas Cleaning System

Analyte	7/21/2010				8/3/2010				8/12/2010				8/12/2010			
	OCSD				OCSD				OCSD				AccuLabs, Inc. - Summa Canisters (3)			
	Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)	
	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt
Acetone	4.300	6.97	4.820	12.7	4.640	17.7	4.990	13.8	4.820	10.7	4.640	13	N/A	N/A	N/A	N/A
Benzene	3.900	8.70	4.370	ND	4.210	10.9	4.520	ND	4.370	9.15	4.210	ND	N/A	N/A	N/A	N/A
Carbon Disulfide	6.280	ND	7.030	ND	7.280	ND	7.280	ND	7.030	ND	6.780	ND	N/A	N/A	N/A	N/A
Chlorobenzene	3.780	ND	4.230	ND	4.380	ND	4.380	ND	4.230	ND	4.080	ND	N/A	N/A	N/A	N/A
Cyclohexane	3.820	ND	4.280	ND	4.440	ND	4.440	ND	4.280	8.88	4.130	ND	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	3.520	ND	3.950	ND	4.090	ND	4.090	ND	3.950	ND	3.810	ND	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	3.580	ND	4.000	ND	4.150	ND	4.150	ND	4.000	ND	3.860	ND	N/A	N/A	N/A	N/A
cis-1,2-Dichloroethene	3.080	17.2	3.440	17.3	3.320	44.2	3.570	65.1	3.440	24.6	3.320	60.2	N/A	N/A	N/A	N/A
trans-1,2-Dichloroethene	3.680	ND	4.120	ND	4.260	ND	4.260	ND	4.120	ND	3.970	ND	N/A	N/A	N/A	N/A
Ethanol	4.300	ND	4.820	9.89	4.990	ND	4.990	5.52	4.820	ND	4.640	ND	N/A	N/A	N/A	N/A
Ethyl Acetate	5.450	ND	6.100	ND	6.320	ND	6.320	ND	6.100	ND	5.890	ND	N/A	N/A	N/A	N/A
Ethylbenzene	3.380	60.7	3.780	ND	3.640	50.2	3.920	4.07	3.780	52.8	3.640	ND	N/A	N/A	N/A	N/A
4-Ethyltoluene	3.000	34.2	3.360	ND	3.240	32.1	3.480	ND	3.360	26.3	3.240	ND	N/A	N/A	N/A	N/A
Freon 11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
n-Heptane	3.080	84.1	3.440	ND	3.320	82.8	3.570	26.3	3.440	122	3.320	17.3	N/A	N/A	N/A	N/A
Hexane	3.620	40.5	4.060	13.8	3.920	48.4	4.200	21.4	4.060	65.1	3.920	26.8	N/A	N/A	N/A	N/A
Isopropyl Alcohol	2.950	ND	3.300	ND	3.420	ND	3.420	ND	3.300	ND	3.190	ND	N/A	N/A	N/A	N/A
Methylene Chloride	5.220	ND	5.850	9.52	5.640	5.87	6.060	ND	5.850	6.01	5.640	6.19	N/A	N/A	N/A	N/A
Methyl Isobutyl Ketone (MIBK)	2.950	ND	3.300	ND	3.420	ND	3.420	ND	3.300	ND	3.190	ND	N/A	N/A	N/A	N/A
2-Propanol (IPA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Propene	45.200	3140	49.500	3540	48.100	3630	52.400	3590	50.400	3140	49.300	3600	N/A	N/A	N/A	N/A
Propylene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Styrene	2.080	7.19	2.320	ND	2.240	4.95	2.410	ND	2.320	6.01	2.240	ND	N/A	N/A	N/A	N/A
Tetrachloroethene (PCE)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tetrachloroethylene	3.350	ND	3.750	ND	3.620	26.3	3.890	ND	3.750	ND	3.620	ND	N/A	N/A	N/A	N/A
Toluene	23.800	2510	2.660	ND	25.400	2110	2.760	ND	26.600	2680	2.560	9.76	N/A	N/A	N/A	N/A
1,2,4-Trichlorobenzene	2.600	ND	2.910	ND	3.560	ND	3.020	ND	2.910	ND	2.810	ND	N/A	N/A	N/A	N/A
Trichloroethene (TCE)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Trichloroethylene	3.520	9.78	3.950	ND	3.810	22.9	4.090	5.67	3.950	12.8	3.810	5.21	N/A	N/A	N/A	N/A
Trichlorofluoromethane(F-11)	7.120	ND	7.980	ND	8.260	ND	8.260	ND	7.980	ND	7.700	ND	N/A	N/A	N/A	N/A
1,2,4-Trimethylbenzene	3.300	154	3.700	ND	3.560	121	3.830	ND	3.700	115	3.560	ND	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.100	45.8	4.590	ND	4.430	39.9	4.760	ND	4.590	39.6	4.430	ND	N/A	N/A	N/A	N/A
2,2,4-Trimethylpentane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vinyl Chloride	5.200	ND	5.820	ND	6.030	ND	6.030	ND	5.820	ND	5.620	ND	N/A	N/A	N/A	N/A
m & p-Xylene	4.220	110	4.730	ND	4.560	82.9	4.900	15.4	4.730	83.2	4.560	ND	N/A	N/A	N/A	N/A
o-Xylene	4.050	43.3	4.540	ND	4.370	33.4	4.700	ND	4.540	31.4	4.370	ND	N/A	N/A	N/A	N/A
Total VOCs	N/A	6,272	N/A	3,593	N/A	6,364	N/A	3,747	N/A	6,434	N/A	3,738	N/A	N/A	N/A	N/A

VOC Data Summary
Plant 1 - Digester Gas Cleaning System

Analyte	8/12/2010				8/19/2010				8/19/2010				9/1/2010			
	AtmAA Inc. - Tedlar Bags				AccuLabs, Inc. - Tedlar Bags (4)				AccuLabs, Inc. - Summa Canisters (4)				OCS D			
	Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)	
	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt
Acetone	N/A	79	N/A	42.2	2.5	62	2.5	33.7	2.5	27.3	2.5	20.5	4.640	11	4.640	14.9
Benzene	N/A	15.70	N/A	7.83	0.5	14.80	0.5	3.72	0.5	15.20	0.5	3.4	4.210	7.75	4.210	7.55
Carbon Disulfide	8	ND	8	ND	0.5	1.21	0.5	3.13	0.5	1.16	0.5	3.91	6.780	ND	6.780	9.3
Chlorobenzene	8	ND	8	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	4.080	ND	4.080	ND
Cyclohexane	8	ND	8	ND	0.5	7.61	0.5	ND	0.5	7.82	0.5	1.72	4.130	ND	4.130	ND
1,2-Dichlorobenzene	6	ND	6	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	3.810	ND	3.810	ND
1,4-Dichlorobenzene	6	8.32	6	ND	0.5	4.47	0.5	ND	0.5	10.8	0.5	ND	3.860	17.9	3.860	ND
cis-1,2-Dichloroethene	N/A	34.1	N/A	66.9	0.5	45.2	0.5	44.2	0.5	47.3	0.5	44.7	3.320	47.3	3.320	70.3
trans-1,2-Dichloroethene	8	ND	8	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	3.970	ND	3.970	ND
Ethanol	N/A	N/A	N/A	N/A	1.0	ND	1.0	ND	1.0	ND	1.0	ND	4.640	ND	4.640	ND
Ethyl Acetate	N/A	22.2	N/A	15.3	1.0	ND	1.0	ND	1.0	ND	1.0	ND	5.890	ND	5.890	ND
Ethylbenzene	8	52.4	8	ND	0.5	54.2	0.5	1.85	0.5	59.7	0.5	1.2	3.640	73.2	3.640	ND
4-Ethyltoluene	8	64.1	8	ND	0.5	11.5	0.5	ND	0.5	14.9	0.5	1.3	3.240	12.7	3.240	ND
Freon 11	N/A	ND	N/A	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
n-Heptane	8	ND	8	36.2	0.5	95.1	0.5	10.1	0.5	91.1	0.5	9.21	3.320	85.3	3.320	9.94
Hexane	N/A	97.9	N/A	44	0.5	90.1	0.5	10.2	0.5	89.5	0.5	9.9	3.920	52.1	3.920	33.4
Isopropyl Alcohol	12	ND	12	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.190	ND	3.190	ND
Methylene Chloride	8	ND	8	ND	2.5	14.4	2.5	6.54	2.5	12.1	2.5	6.26	5.640	ND	5.640	ND
Methyl Isobutyl Ketone (MIBK)	N/A	N/A	N/A	N/A	2.0	5.91	2.0	ND	2.0	5.82	2.0	ND	3.190	ND	3.190	ND
2-Propanol (IPA)	N/A	N/A	N/A	N/A	1.0	ND	1.0	ND	1.0	ND	1.0	ND	N/A	N/A	N/A	N/A
Propene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	101.000	3320	47.900	3980
Propylene	N/A	N/A	N/A	N/A	5.0	2910	5.0	1620	5.0	2870	5.0	1510	N/A	N/A	N/A	N/A
Styrene	8	ND	8	ND	0.5	4.96	0.5	ND	0.5	6.9	0.5	ND	2.240	12.9	2.240	ND
Tetrachloroethene (PCE)	6	11	6	ND	0.5	8.32	0.5	0.95	0.5	8.97	0.5	0.86	N/A	N/A	N/A	N/A
Tetrachloroethylene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.620	6.64	3.620	ND
Toluene	N/A	1630	N/A	18.6	5.0	1430	0.5	42.7	5.0	1570	0.5	40.4	53.400	7300	2.560	287
1,2,4-Trichlorobenzene	8	ND	8	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	2.810	ND	3.560	ND
Trichloroethene (TCE)	N/A	16.3	N/A	8.38	0.5	16.6	0.5	3.72	0.5	18.1	0.5	3.37	N/A	N/A	N/A	N/A
Trichloroethylene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.810	9.21	3.810	10.6
Trichlorofluoromethane(F-11)	N/A	N/A	N/A	N/A	2.0	4.6	2.0	1.23	2.0	4.11	2.0	3.66	7.700	ND	7.700	ND
1,2,4-Trimethylbenzene	8	70.2	8	ND	0.5	38.5	0.5	1.57	0.5	56.7	0.5	6.49	3.560	67.1	3.560	ND
1,3,5-Trimethylbenzene	8	33	8	ND	0.5	18.8	0.5	0.44	0.5	23.9	0.5	1.82	4.430	34	4.430	ND
2,2,4-Trimethylpentane	8	ND	8	ND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vinyl Chloride	6	ND	6	ND	0.5	2.19	0.5	2.43	0.5	2.97	0.5	2.28	5.620	ND	5.620	ND
m & p-Xylene	8	91.6	8	ND	1.0	117	1.0	4.07	1.0	134	1.0	5.28	4.560	54.6	4.560	ND
o-Xylene	8	33.4	8	ND	0.5	40.2	0.5	2.19	0.5	45.6	0.5	2.48	4.370	21.6	4.370	ND
Total VOCs	N/A	2,259	N/A	239	N/A	4,998	N/A	1,791	N/A	5,124	N/A	1,679	N/A	11,133	N/A	4,423

VOC Data Summary
Plant 1 - Digester Gas Cleaning System

Analyte	9/14/2010				1/13/2011				2/9/2011			
	OCSD				OCSD				OCSD			
	Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)		Inlet (ppbv)		Outlet (ppbv)	
	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt	Rpt Lmt	Amt
Acetone	4.820	7.29	4.640	14.2	4.820	19.6	4.990	15.2	4.820	8.69	4.640	ND
Benzene	4.370	10.40	4.210	23	4.370	12.10	4.520	5.57	4.370	11.40	4.210	ND
Carbon Disulfide	7.030	ND	6.780	7.22	7.030	ND	7.280	ND	7.030	ND	6.780	ND
Chlorobenzene	4.230	ND	4.080	ND	4.230	4.5	4.380	ND	4.230	ND	4.080	ND
Cyclohexane	4.280	4.91	4.130	9.71	4.280	ND	4.440	4.52	4.280	ND	4.130	ND
1,2-Dichlorobenzene	3.950	ND	3.810	ND	3.950	ND	4.090	ND	3.950	ND	3.810	ND
1,4-Dichlorobenzene	4.000	ND	3.860	ND	4.000	ND	4.150	ND	4.000	ND	3.860	ND
cis-1,2-Dichloroethene	3.440	41.2	3.320	82.3	3.440	35.5	3.570	61.1	3.440	31.8	3.320	29.1
trans-1,2-Dichloroethene	4.120	ND	3.970	ND	4.120	ND	4.260	ND	4.120	ND	3.970	ND
Ethanol	4.820	ND	4.640	ND	4.820	ND	4.990	ND	4.820	ND	5.720	ND
Ethyl Acetate	6.100	ND	5.890	ND	6.100	ND	6.320	ND	6.100	ND	5.890	ND
Ethylbenzene	3.780	92.7	3.640	13.2	3.700	58	3.920	ND	3.780	61.2	3.640	22.2
4-Ethyltoluene	3.360	23.2	3.240	ND	3.360	30.3	3.480	ND	3.360	23.6	3.240	ND
Freon 11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
n-Heptane	3.440	106	3.320	86	3.440	63.9	3.570	46.6	3.440	57.8	3.320	10.9
Hexane	4.060	57.2	3.920	130	4.060	27	4.200	47.6	4.060	31.1	3.920	13.4
Isopropyl Alcohol	3.300	ND	3.190	ND	3.300	ND	3.420	ND	3.300	ND	3.190	ND
Methylene Chloride	5.850	ND	5.640	ND	5.850	11.6	6.060	16.3	5.850	9.32	5.640	8.19
Methyl Isobutyl Ketone (MIBK)	3.300	ND	3.190	ND	3.300	4.51	3.420	ND	3.300	4.38	3.190	ND
2-Propanol (IPA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Propene	50.200	3730	48.800	4100	50.900	2410	51.500	2370	49.900	2820	48.400	2370
Propylene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Styrene	2.320	9.27	2.240	ND	2.320	8.06	2.410	ND	2.320	6.83	2.240	ND
Tetrachloroethene (PCE)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tetrachloroethylene	3.750	ND	3.620	ND	3.750	ND	3.890	ND	3.750	ND	3.620	ND
Toluene	26.500	2690	25.700	2860	26.900	1090	2.760	9.72	26.300	1900	25.600	377
1,2,4-Trichlorobenzene	2.910	ND	2.810	ND	2.910	ND	3.020	ND	2.910	ND	2.810	ND
Trichloroethene (TCE)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Trichloroethylene	3.950	8.06	3.810	26.5	3.950	21.4	4.090	9.21	3.950	9.34	3.910	5.18
Trichlorofluoromethane(F-11)	7.980	ND	7.700	ND	7.980	ND	8.260	ND	7.980	ND	7.700	ND
1,2,4-Trimethylbenzene	3.700	104	3.560	ND	3.700	99	3.830	ND	3.700	101	3.560	ND
1,3,5-Trimethylbenzene	4.590	38.3	3.240	ND	4.590	33.2	4.760	ND	4.590	33.2	4.430	ND
2,2,4-Trimethylpentane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vinyl Chloride	5.820	ND	5.620	ND	5.820	ND	6.030	ND	5.820	ND	5.620	ND
m & p-Xylene	4.730	159	4.560	ND	4.730	111	4.900	6.41	4.730	102	4.560	31.1
o-Xylene	4.540	57.8	4.370	ND	4.540	38	5.890	ND	4.540	34.1	4.370	ND
Total VOCs	N/A	7,139	N/A	7,352	N/A	4,078	N/A	2592	N/A	5,246	N/A	2867

APPENDIX B-5:

Speciated Siloxane and Hydrogen Sulfide Sampling Summary

Digester Gas Sampling Summary
Plant 1 - Digester Gas Cleaning System

Date of Sampling	Approximate Volume of Gas Treated (Million Cubic Feet)	Total Siloxane (ppmv)		H2S			
				OCSD AQMD 307-91 (ppmv)		OCSD Draeger Tube (ppmv)	
		Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
3/16/2010	0.00	3.58	<MDL	N/A	N/A	N/A	N/A
4/7/2010	27.26	8.51	<MDL	N/A	N/A	N/A	N/A
4/21/2010	53.41	N/A	N/A	25.70	ND	26	ND
4/29/2010	68.93	15.70	ND	N/A	N/A	N/A	N/A
5/11/2010	91.86	N/A	N/A	31.70	0.263	31	ND
5/27/2010	122.58	2.67	0.015	N/A	N/A	N/A	N/A
6/8/2010	144.70	N/A	N/A	27.97	2.162	30	2
6/11/2010	146.46	8.49	0.248	N/A	N/A	N/A	N/A
6/12/2010	Carbon media changed.						
6/22/2010	18.44	N/A	N/A	21.62	ND	27	-
6/29/2010	32.70	8.69	N/A	N/A	N/A	N/A	N/A
7/7/2010	46.34	N/A	N/A	28.57	ND	25	N/A
7/21/2010	68.89	N/A	N/A	24.87	ND	25	N/A
8/3/2010	90.04	N/A	N/A	27.45	ND	25	N/A
8/12/2010	106.00	N/A	N/A	28.19	ND	26	N/A
8/12/2010	106.00	3.73	ND	N/A	N/A	N/A	N/A
9/1/2010	137.15	4.57	<MDL	N/A	N/A	N/A	N/A
9/1/2010	137.15	N/A	N/A	14.69	ND	14	N/A
9/14/2010	162.45	N/A	N/A	23.01	0.545	23	N/A
9/15/2010	164.63	4.35	<MDL	N/A	N/A	N/A	N/A
9/17/2010	168.63	N/A	N/A	N/A	N/A	-	2.5
9/20/2010	173.62	5.73	<MDL	N/A	N/A	N/A	N/A
9/21/2010	Carbon media changed.						
11/4/2010	43.40	5.23	N/A	N/A	N/A	N/A	N/A
1/12/2011	114.53	6.55	N/A	N/A	N/A	N/A	N/A
1/25/2011	137.78	N/A	N/A	28.54	ND	27	N/A
2/9/2011	156.47	N/A	N/A	31.87	1.755	30	N/A
2/9/2011	156.47	4.58	<MDL	N/A	N/A	N/A	N/A
2/14/2011	Carbon media changed.						
2/23/2011	17.72	N/A	N/A	24.46	ND	25	N/A
2/24/2011	20.09	6.64	N/A	N/A	N/A	N/A	N/A

Notes:

- (1) All samples are taken using Tedlar Bags, except where otherwise noted as using Draeger® tubes f
- (2) Inlet and outlet sample results from 5/19/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum
- (3) Outlet sample results from 6/29/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum, maximum and average.
- (4) Inlet and outlet sample results from AccuLabs on 8/12/10 are not accurate due to an error in collection, indicated by high nitrogen composition (>5%), and are not included in the minimum,
- (5) Sample results from 8/19/10 are not consistent with sample results from other laboratories and are concluded to be erroneous and not included in the minimum, maximum and average.
- (6) N/A indicates that the compound was not analyzed for.
- (7) ND indicates non-detect.
- (8) <MDL indicates that the result, if any, was less than the method detection limit.

APPENDIX C-1:

CO and NO_x with Portable Analyzer Summary

CO and NOx with Portable Analyzer Summary
Plant 1 - Catalytic Oxidizer and Selective Catalytic Reduction

Date	Load (%)	DG (%)	Testing Time (min)	NH3 Draeger Tube (ppm)	Before Cat Ox		After Cat Ox		After SCR		CO Reduction	NOx Reduction
					CO (ppm) Adj to 15% O2	NOx (ppm) Adj to 15% O2	CO (ppm) Adj to 15% O2	NOx (ppm) Adj to 15% O2	CO (ppm) Adj to 15% O2	NOx (ppm) Adj to 15% O2		
3/29/2010	80	88	15	N/A	448.4	38.7	5.8	39.8	5.3	1.3	98.8%	96.6%
3/30/2010	82	95	15	N/A	453.0	33.5	0.1	34.2	3.3	4.9	99.3%	85.2%
3/31/2010	60	95	10	N/A	353.9	29.7	N/A	N/A	4.0	1.4	98.9%	95.4%
3/31/2010	80	95	10	N/A	431.2	33.9	N/A	N/A	9.2	4.5	97.9%	86.8%
3/31/2010	100	95	10	N/A	452.3	36.5	N/A	N/A	0.0	6.7	100.0%	81.6%
3/31/2010	110	95	10	N/A	446.2	41.9	N/A	N/A	0.3	5.8	99.9%	86.1%
3/31/2010	60	50	10	N/A	347.3	39.6	N/A	N/A	13.8	7.3	96.0%	81.6%
3/31/2010	80	50	10	N/A	472.0	39.9	N/A	N/A	11.5	6.0	97.6%	85.0%
3/31/2010	100	50	10	N/A	513.5	43.7	N/A	N/A	15.7	6.8	97.0%	84.5%
3/31/2010	110	50	10	N/A	478.7	45.8	N/A	N/A	3.4	9.3	99.3%	79.7%
4/1/2010	60	0	10	N/A	380.9	43.6	N/A	N/A	0.6	0.9	99.8%	97.9%
4/1/2010	80	0	10	N/A	559.9	44.1	N/A	N/A	1.3	1.3	99.8%	97.1%
4/1/2010	100	0	10	N/A	591.8	48.1	N/A	N/A	6.0	10.2	99.0%	78.7%
4/1/2010	110	0	10	N/A	532.9	51.9	N/A	N/A	1.3	11.4	99.8%	77.9%
4/7/2010	110	95	15	<MDL	367.5	46.2	1.7	47.3	1.6	10.1	99.6%	78.2%
4/14/2010	100	95	15	N/A	435.5	37.4	0.9	37.8	4.0	5.7	99.1%	84.8%
4/21/2010	90	95	15	<MDL	369.3	41.4	0	41.9	1.5	6.7	99.6%	83.8%
4/29/2010	94	95	15	<MDL	369.3	40.3	2.3	40.1	5.1	8.5	98.6%	78.8%
5/6/2010	100	95	15	<MDL	440.8	41.3	0.7	39.6	2.2	2.7	99.5%	93.5%
5/19/2010	100	95	15	<MDL	525.1	34.5	3.0	36.5	4.7	1.2	99.1%	96.5%
6/29/2010	100	97	15	<MDL	439.7	42.4	2.4	40.5	17.0	8.1	96.1%	81.0%
7/28/2010	95	97	15	<MDL	458.8	39.8	0.1	37.8	8.8	7.3	98.1%	81.7%
8/12/2010	100	96	15	<MDL	408.4	43.5	4.9	44.0	7.6	10.1	98.1%	76.7%
11/4/2010	100	96	15	<MDL	598.7	43.2	0.0	42.5	0.0	10.2	100.0%	76.3%
1/12/2011	100	96	15	<MDL	509.4	37.9	15.1	36.4	17.2	7.7	96.6%	79.7%
2/24/2011	100	95	15	<MDL	496.8	38.5	0.0	39.1	0.1	6.9	100.0%	82.1%

Notes:

- (1) N/A indicates that this data was not collected.
- (2) <MDL indicates that the result, if any, was less than the detection limit.

APPENDIX C-2:

**Technical Memorandum:
OCSD Catalytic Oxidizer/SCR Pilot Study: VOC Evaluation**

Date: July 13, 2011
To: File
From: Kit Liang, Malcolm Pirnie, WHI; Daniel Stepner, Malcolm Pirnie, WHI
Re: OCSD Cat Ox/SCR Pilot Study: VOC Evaluation
Project No.: 0788-187

Project Background

The internal combustion (IC) engines at Orange County Sanitation District (OCSD) are subject to South Coast Air Quality Management District (SCAQMD) Rule 1110.2. Rule 1110.2 provides emission limits and monitoring requirements for all stationary and portable engines over 50 brake-horsepower (bhp). Rule 1110.2 (Emissions from Gaseous- and Liquid- Fueled Engines) was promulgated to reduce the NO_x, CO and volatile organic compounds (VOC) emissions from engines over 50 bhp. On February 1, 2008, Rule 1110.2 was amended in order to achieve further emissions reductions from stationary engines based on the cleanest available technologies. Under the February 2008 amendments to Rule 1110.2 shown below, more stringent NO_x, CO, and VOC limits were adopted, to become effective for biogas-fueled engines in July 2012 provided a technology assessment confirms that the limits below are achievable.

- NO_x limit was lowered from 36 ppm (or ~ 45 ppm*) to 11 ppm at 15% O₂.
- VOC limit was lowered from 250 ppm* to 30 ppm at 15% O₂.
- CO limit was lowered from 2,000 ppm to 250 ppm at 15% O₂.

* Existing limits allow for an alternative emission limit for OCSD engines based on the engine efficiency correction factor.

A pilot study of a Johnson Matthey catalytic oxidizer/Selective Catalytic Reduction (Cat Ox/SCR) system was performed at OCSD Plant 1 on Engine 1 from April 2010 through March 2011. Design of the pilot system included an SCR system for NO_x emission reduction, an oxidation catalyst unit for CO and VOC reduction (including formaldehyde), and a DGCS upstream from the IC engines for removal of siloxanes to prevent fouling of the catalysts. Additional benefits of the DGCS include the removal of total reduced sulfur and total volatile organic compounds. The DGCS cleaned the digester gas fuel for all three Plant 1 IC engines. However, the Cat Ox/SCR system was only installed on Engine 1. As part of this pilot testing program, a sampling program was initiated to determine the concentrations of VOCs at the inlet and outlet of the Cat Ox/SCR system. The sampling was performed by SCEC, a firm listed in the SCAQMD Laboratory Approval Program (LAP). The VOC sampling was performed using SCAQMD Method 25.3.

This memorandum describes the sampling method for VOCs used during the testing and the VOCs concentration results. In addition, the memorandum compares the result found for Engine 1 with results from a recent regulatory compliance study performed on Engines 1, 2, and 3 at Plant 1.

VOC Sampling SCAQMD Method 25.3

The SCAQMD compliance methods for testing for VOCs are SCAQMD Methods 25.1 and 25.3. In general, SCAQMD Method 25.1 is used to collect samples where VOC concentrations are greater or equal to 50 ppm as carbon (ppmC). SCAQMD Method 25.3 is used where VOC concentrations are less than 50 ppmC. With both methods, exhaust gas samples are drawn into evacuated canisters through condensate traps. In Method 25.3, the condensate, largely consisting of water, is collected in the traps at ice water temperature (~32°F), preventing unrecoverable VOC from being collected in the canisters. Based on previous sampling, VOC concentrations in the exhaust gas are expected to be below 50 ppm; therefore, SCAQMD Method 25.3 was used for this pilot study. During the pilot study, exhaust samples are taken at the engine exhaust, prior to the catalyst oxidizer, and at the stack exhaust, following the SCR and heat recovery boiler. Analysis was performed at the laboratory.

The VOC concentration as non-methane non-ethane organic compounds (NMNEOC) is determined by combining the independent analysis results of the condensate in each trap and the gas in the associated canister. The condensate is analyzed for total organic carbon by liquid injection into an infra-red organic carbon analyzer. The gaseous sample in the canister is analyzed for NMNEOC using a combination of gas chromatography, oxidizer, methanizer, and flame ionization detector. Carbon monoxide and fixed gases in the sample can be determined by analysis of the canister portion of the sample.

VOC Monitoring Results and Discussion

Pilot testing of the Cat Ox/SCR system commenced on April 1, 2010 and continued through March 31, 2011. Throughout the pilot testing, SCEC tested VOCs at the engine exhaust before the catalytic oxidizer and at the stack outlet after the SCR and heat recovery boiler on the roof of the Central Generator (CenGen) Building. Results of the VOC data are summarized in Table 1.

Table 1 presents a summary of the VOC field measurements using SCAQMD Method 25.3. The percent reduction of VOC ranged from 59.1% to 97.8%. The average concentration of VOC at the stack exhaust was 3.58 ppmv, below the emission limit of 30 ppmv in the Amended Rule 1110.2.

Table 1:
Measured VOC Concentrations – Plant 1 Engine 1

Date	Engine Exhaust (ppmv)	Stack Exhaust (ppmv)	% Reduction
4/7/2010	27.1	2.0	90.4
5/11/2010	33.0	0.7	97.8
8/12/2010	15.1	5.4	64.0
11/4/2010	10.3	4.2	59.1
2/24/2011	25.0	5.0	80.2
Average	21.8	3.6	83.6

- Notes:
1. All concentrations are adjusted to 15% O₂.
 2. All samples were collected using SCAQMD Method 25.3

Data measured during the pilot testing period was compared to VOC concentrations measured by SCEC for the *OCSD Plant No. 1 Unit Nos. 1, 2, 3 Rule 1110.2 8760 Hour & Permit Compliance Test Report for Year 2011*. Table 2 summarizes the annual permit compliance VOC test results for OCSD Plant No. 1. The Unit No. 1 (Engine 1) VOC stack exhaust concentration measured during the annual Rule 1110.2 compliance testing was 3.24 ppmv. This is in the same range of the VOC concentrations measured during the pilot testing period, confirming the effectiveness of the catalytic oxidizer in removing VOC from the engine exhaust.

Table 2:
Annual Rule 1110.2 Compliance Test VOC Concentrations - Plant No. 1

Date	Unit No. (Engine)	Sampling Method	Stack Exhaust (ppmv)
1/13/2011	1	SCAQMD Method 25.3	3.24
1/12/2011	2	SCAQMD Method 25.1	97.2
1/11/2011	3	SCAQMD Method 25.1	96.9

- Note:
1. All concentrations are adjusted to 15% O₂.

As discussed earlier, the DGCS was installed on the digester gas header and provides cleaned digester gas fuel to all three IC engines. The Cat Ox/SCR post-combustion control was installed on Engine 1, but not on Unit Nos. 2 and 3 (Engines 2 and 3). As shown in Table 2, the VOC stack exhaust concentrations for Engines 2 and 3 were 97.2 and 96.9 ppmv, respectively. This was much higher than the VOC concentrations measured at the Engine 1 exhaust before the Cat Ox/SCR system during the pilot testing period, which averaged 21.84 ppmv VOCs. One possible explanation to this is the arrangement of the sampling port at Engine No. 1 before the catalytic oxidizer. Due to restrictions on placement of the Method 25.3 probe at the Engine No. 1 exhaust before the Cat Ox/SCR system, accuracy in taking this sample is reduced. Typically using sampling Method SCAQMD 25.3, two samples are gathered from two separate probes and the results of the analyses are averaged. SCAQMD mandates that when the results from the two samples differ by more than 20%, that the higher value of the two samples be reported. In the experience of the SCEC lab, this occurs approximately half of the time. Otherwise, the values are averaged.

In this instance, the valve at the engine exhaust sampling port was not large enough to co-locate two probes next to each other and it was not possible to expand the sampling port. Therefore, the sample and duplicate sample were not taken at the same time, but one after the other. The data presented in Table 2 above for the engine exhaust represents the higher of the two sample data results, in line with AQMD's general mandate. Despite the lower accuracy in the engine exhaust sample, the sample taken at the stack exhaust met the SCAQMD accuracy criteria. Moving forward, it is recommended to install a larger sampling port to allow for greater accuracy through the co-location of the Method 25.3 probes.

Conclusions and Recommendations

Upon review of the data from the five sampling events, it was determined that the catalytic oxidizer (with a DGCS) is successful in reducing the VOC concentration to below the emission limit of 30 ppmv in Amended Rule 1110.2. The catalytic oxidizer system met the vendor guarantee of 25 ppmvd VOCs. During the pilot testing period, the average VOC inlet concentration at the engine exhaust was 21.8 ppmv, and the average VOC outlet concentration at the stack exhaust was 3.6 ppmv. The VOC outlet concentration was confirmed during the OCSD Plant No. 1 annual permit compliance testing in January 2011 (see Table 2).

During the annual permit compliance testing in January 2011, it was also found that the VOC concentration at the Engine Nos. 2 and 3 Stack Exhaust were 97.2 ppmv and 96.9 ppmv, respectively. This is much higher than that measured at the Engine No. 1 exhaust before the catalytic oxidizer. This may have occurred due to restrictions with the Engine No. 1 exhaust sample port. In the future, it is recommended to install a larger sampling port at the engine exhaust.

References

- 1 CARB, 1991. "Method 430 – Determination of Formaldehyde and Acetaldehyde in Emissions from Stationary Sources." December 1991.
- 2 EPA, 2003. "Appendix A to Part 63 – Test Methods. Method 323 – Measurement of Formaldehyde Emissions from Natural Gas-Fired Stationary Sources – Acetyl Acetone Derivatization Method." Federal Register, Vol. 68, No. 9, January 14, 2003.
- 3 SCAQMD, 2000. "Method 25.3 – Determination of Low Concentration Non-Methane Non-Ethane Organic Compound Emissions from Clean Fueled Combustion Sources." March 2000.

APPENDIX C-3:
CEMS Emissions Summary

Validated Daily 15-Minute Block Average
Daily Average and Maximum Emissions Summary Data from CEMS
Plant 1 - Catalytic Oxidizer and Selective Catalytic Reduction

Date	Avg. Engine Exhaust	Average Stack Exhaust		Maximum	Maximum Engine Exhaust	Maximum Stack Exhaust		Average Engine Load (%)	Max Engine Load (%)	Average Fuel Ratio (% DG)	Notes
	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)	Ammonia Slip	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)				
4/1/2010	33.49	-	6.20	-	44.32	-	8.97	96.13	113.65	0%	Note 1.
4/2/2010	31.28	-	5.70	-	34.35	-	6.28	96.84	100.74	96%	Note 1.
4/3/2010	30.16	-	5.75	-	31.61	-	6.24	97.55	101.02	91%	Note 1.
4/4/2010	30.05	-	5.82	-	32.05	-	6.33	96.80	103.18	83%	Note 1.
4/5/2010	33.96	-	5.84	-	36.08	-	6.31	95.15	101.43	90%	Note 1.
4/6/2010	34.03	-	5.78	-	37.00	-	6.73	94.82	100.79	74%	Note 1.
4/7/2010	35.47	-	5.58	-	38.97	-	6.08	96.88	105.06	96%	Note 1.
4/8/2010	32.89	-	5.93	-	37.44	-	7.87	91.57	101.69	94%	Note 1.
4/9/2010	31.93	-	5.78	-	33.69	-	6.28	97.27	100.60	96%	Note 1.
4/10/2010	31.49	-	5.93	-	33.18	-	6.34	96.90	100.78	92%	Note 1.
4/11/2010	30.94	-	6.04	-	33.04	-	6.55	94.72	99.67	91%	Note 1.
4/12/2010	31.69	-	6.05	-	34.34	-	6.71	88.29	96.25	88%	Note 1.
4/13/2010	33.11	-	5.95	-	37.06	-	6.53	88.30	98.81	90%	Note 1.
4/14/2010	31.98	-	5.87	-	35.12	-	6.31	95.47	100.75	89%	Note 1.
4/15/2010	31.09	-	5.98	-	34.46	-	6.37	97.02	100.38	90%	Note 1.
4/16/2010	31.36	-	5.95	-	33.19	-	6.26	96.80	100.46	92%	Note 1.
4/17/2010	30.94	-	5.92	-	32.69	-	6.25	97.66	104.81	93%	Note 1.
4/18/2010	30.70	-	5.95	-	34.11	-	6.47	95.54	100.86	95%	Note 1.
4/19/2010	30.28	-	6.09	-	33.10	-	6.81	90.86	99.29	88%	Note 1.
4/20/2010	29.62	-	6.10	-	33.35	-	6.44	83.53	93.10	90%	Note 1.
4/21/2010	33.03	-	5.61	-	34.76	-	5.88	95.39	100.22	93%	Note 1.
4/22/2010	33.03	-	5.62	-	35.49	-	5.91	97.64	100.88	96%	Note 1.
4/23/2010	33.73	-	5.87	-	35.89	-	7.05	96.10	100.84	96%	Note 1.
4/24/2010	33.49	-	5.98	-	35.68	-	6.15	97.92	102.18	96%	Note 1.
4/25/2010	30.79	-	6.18	-	32.34	-	6.54	96.58	100.34	91%	Note 1.
4/26/2010	30.40	-	6.22	-	32.20	-	6.75	92.60	99.67	86%	Note 1.
4/27/2010	31.10	-	6.13	-	32.92	-	6.83	95.33	101.54	86%	Note 1.
4/28/2010	32.11	-	6.19	-	36.67	-	7.37	93.53	102.53	53%	Note 1.
4/29/2010	35.53	-	5.67	-	38.83	-	6.40	98.71	107.61	96%	Note 1.
4/30/2010	34.85	-	5.58	-	37.68	-	5.79	103.15	106.09	96%	Note 1.
5/1/2010	32.93	-	5.78	-	34.68	-	6.00	102.47	106.53	96%	Note 1.
5/2/2010	34.26	-	5.81	-	36.48	-	6.25	102.95	106.06	92%	Note 1.
5/3/2010	34.39	-	6.18	-	42.06	-	9.72	96.31	105.57	53%	Note 1.
5/4/2010	32.80	-	5.97	-	34.46	-	6.53	92.11	100.49	0%	Note 1.
5/5/2010	26.49	-	4.80	-	27.54	-	5.18	83.99	92.92	0%	Note 1.
5/6/2010	32.64	-	5.19	-	35.45	-	5.81	102.76	106.54	0%	Note 1.
5/7/2010	32.33	-	5.52	-	34.26	-	5.96	103.38	107.95	96%	Note 1.
5/8/2010	32.14	-	5.66	-	34.01	-	6.13	103.18	106.94	85%	Note 1.
5/9/2010	31.33	-	5.82	-	36.50	-	6.30	96.36	105.53	89%	Note 1.
5/10/2010	31.77	-	5.76	-	36.68	-	7.46	85.73	98.86	86%	Note 1.
5/11/2010	33.55	-	5.59	-	38.04	-	6.35	97.79	106.06	89%	Note 1.
5/12/2010	32.02	-	5.73	-	37.30	-	6.66	102.01	106.44	55%	Note 1.
5/13/2010	31.47	-	5.93	-	33.54	-	6.54	97.90	106.97	0%	Note 1.
5/14/2010	33.74	-	5.68	-	35.92	-	5.94	102.47	107.02	87%	Note 1.
5/15/2010	34.32	-	5.74	-	36.26	-	5.92	102.79	106.02	87%	Note 1.
5/16/2010	32.94	-	5.77	-	35.24	-	6.25	103.30	106.55	87%	Note 1.
5/17/2010	32.28	-	5.75	-	34.83	-	6.31	100.58	105.76	94%	Note 1.
5/18/2010	30.24	-	5.90	-	34.62	-	6.57	100.79	106.94	96%	Note 1.
5/19/2010	30.15	-	5.85	-	31.65	-	6.68	101.48	107.08	86%	Note 1.
5/20/2010	31.29	-	5.88	-	34.10	-	6.42	103.01	107.64	90%	Note 1.
5/21/2010	30.16	-	6.12	-	33.08	-	6.66	102.86	107.93	96%	Note 1.
5/22/2010	32.54	-	5.84	-	35.08	-	6.09	103.12	106.52	90%	Note 1.
5/23/2010	34.07	-	5.90	-	36.53	-	6.40	102.80	107.51	93%	Note 1.
5/24/2010	32.96	-	5.99	-	36.36	-	6.39	102.46	109.29	90%	Note 1.
5/25/2010	30.21	-	5.98	-	33.13	-	6.43	98.64	107.62	91%	Note 1.

Validated Daily 15-Minute Block Average
Daily Average and Maximum Emissions Summary Data from CEMS
Plant 1 - Catalytic Oxidizer and Selective Catalytic Reduction

Date	Avg. Engine Exhaust	Average Stack Exhaust		Maximum	Maximum Engine Exhaust	Maximum Stack Exhaust		Average Engine Load (%)	Max Engine Load (%)	Average Fuel Ratio (% DG)	Notes
	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)	Ammonia Slip	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)				
5/26/2010	31.18	-	6.06	-	33.84	-	6.44	101.02	107.79	90%	Note 1.
5/27/2010	32.54	-	6.62	-	42.79	-	7.39	107.57	116.77	0%	Note 1.
5/28/2010	32.54	-	7.13	-	36.76	-	7.87	108.29	112.89	90%	Note 1.
5/29/2010	33.32	-	7.21	-	38.06	-	8.14	108.48	113.00	90%	Note 1.
5/30/2010	32.29	-	7.14	-	37.57	-	7.81	105.35	111.41	95%	Note 1.
5/31/2010	32.38	-	7.09	-	34.35	-	7.85	102.68	110.76	93%	Note 1.
6/1/2010	32.12	-	7.08	-	34.42	-	7.70	99.23	106.01	91%	Note 1.
6/2/2010	32.10	-	7.12	-	35.69	-	7.82	99.22	109.84	92%	Note 1.
6/3/2010	32.60	-	7.21	-	35.06	-	7.62	102.76	106.04	90%	Note 1.
6/4/2010	31.77	-	7.65	-	34.64	-	8.26	102.72	107.91	90%	Note 1.
6/5/2010	30.68	-	8.03	-	33.03	-	8.47	102.76	106.89	0%	Note 1.
6/6/2010	31.73	-	8.66	-	33.23	-	9.22	103.14	106.57	90%	Note 1.
6/7/2010	29.42	-	8.50	-	34.22	-	10.27	92.20	107.57	87%	Note 1.
6/8/2010	28.04	3.67	8.82	5.25	30.71	6.70	10.15	89.57	106.09	93%	Urea injection set points modified to reduce ammonia slip.
6/9/2010	29.08	5.14	11.05	1.75	30.72	6.98	12.65	100.68	108.52	90%	
6/10/2010	29.03	4.96	14.33	1.38	32.07	6.50	17.45	103.62	107.96	90%	
6/11/2010	35.28	8.58	14.73	3.66	39.35	10.49	17.69	88.07	107.98	0%	
6/12/2010	35.15	8.40	13.39	2.46	41.26	13.87	16.32	87.35	104.66	0%	Engine operated on Natural Gas from 17:26 to 17:31.
6/13/2010	28.12	4.80	10.94	1.31	30.63	6.24	12.90	92.08	101.85	96%	
6/14/2010	27.52	4.87	9.13	1.21	29.15	6.22	9.61	85.14	94.49	54%	The CEMS failed calibration repeatedly (both NOx and CO low range were out of control). Adjustments were made to bring it back into calibration (Note 2).
6/15/2010	28.04	4.60	9.54	1.12	32.15	6.77	11.00	91.91	99.76	87%	
6/16/2010	30.75	5.59	9.59	1.13	35.26	7.78	10.36	97.30	107.73	81%	
6/17/2010	30.87	5.62	9.92	1.15	34.07	7.32	10.61	103.26	105.74	96%	
6/18/2010	29.87	4.94	9.90	0.97	31.55	6.03	10.60	101.24	105.90	96%	
6/19/2010	31.23	6.02	9.03	1.34	33.29	7.23	9.56	97.62	101.06	96%	
6/20/2010	32.09	6.44	8.69	1.74	34.59	7.71	9.19	97.83	102.80	96%	
6/21/2010	34.17	7.36	8.40	1.69	36.50	9.06	9.07	99.29	103.92	91%	
6/22/2010	33.88	7.24	8.42	2.15	37.69	8.89	9.11	98.75	106.15	90%	
6/23/2010	33.03	6.83	8.28	2.11	36.24	8.99	9.10	97.58	104.97	94%	
6/24/2010	32.86	6.89	8.65	2.40	36.61	9.15	9.41	102.87	106.83	96%	Urea injection shut off for urea delivery and level sensor calibration from 8:08 to 9:22 (Note 3).
6/25/2010	32.53	6.83	8.91	2.09	34.24	7.73	9.31	103.43	106.78	92%	
6/26/2010	33.67	7.61	8.40	3.11	38.08	8.94	8.93	103.06	105.96	94%	
6/27/2010	33.46	7.88	8.21	4.39	38.36	8.96	8.89	103.32	106.45	98%	CEMS inlet sample flow alarm occurred causing invalid data. CEMTEK technician responded and found sample pump to be in need of a rebuild. Necessary repairs were made.
6/28/2010	34.80	7.67	8.38	2.47	36.82	9.10	8.98	103.11	106.70	98%	
6/29/2010	34.16	7.61	8.46	1.98	36.75	8.95	9.29	103.41	108.30	93%	
6/30/2010	34.39	7.83	8.09	3.01	37.94	10.29	9.57	99.16	110.60	85%	
7/1/2010	34.16	7.43	7.83	2.14	35.40	8.14	7.91	93.56	95.94	92%	
7/2/2010	N/A	N/A	N/A	N/A	0.00	N/A	N/A	N/A	N/A	0%	The engine experience high NOx inlet at the engine exhaust due to a new automation issue, which in turn caused high NOx at the stack outlet (Note 4).
7/3/2010	N/A	N/A	N/A	N/A	0.00	N/A	N/A	N/A	N/A	0%	
7/4/2010	36.43	8.74	8.02	2.06	39.94	10.37	9.18	99.37	105.85	90%	
7/5/2010	35.95	8.30	8.13	2.37	39.78	10.33	9.24	100.91	105.97	89%	
7/6/2010	34.81	7.86	7.80	2.21	38.84	9.78	9.13	97.97	105.00	0%	Note 2.
7/7/2010	33.89	7.49	7.47	2.68	37.70	9.38	8.32	93.48	100.26	92%	
7/8/2010	32.69	6.79	8.18	1.86	36.29	8.77	9.23	97.97	107.36	83%	
7/9/2010	32.07	6.43	8.70	1.32	34.42	7.76	9.33	97.63	99.70	83%	
7/10/2010	32.57	6.70	8.22	1.68	35.97	8.18	9.27	97.70	101.85	83%	
7/11/2010	31.92	6.56	8.09	1.56	36.21	8.52	9.15	92.72	99.52	87%	
7/12/2010	32.69	7.23	7.72	1.86	37.08	9.47	8.95	90.23	97.66	89%	
7/13/2010	33.00	7.19	7.79	2.12	36.37	8.91	8.93	96.10	101.79	88%	
7/14/2010	33.28	7.38	7.71	2.04	38.59	10.02	8.82	93.08	99.29	91%	
7/15/2010	33.49	7.34	7.93	2.26	37.32	9.50	8.58	98.93	103.17	97%	
7/16/2010	31.95	6.75	8.23	1.67	33.71	7.98	8.88	98.17	103.58	87%	

Validated Daily 15-Minute Block Average
Daily Average and Maximum Emissions Summary Data from CEMS
Plant 1 - Catalytic Oxidizer and Selective Catalytic Reduction

Date	Avg. Engine Exhaust	Average Stack Exhaust		Maximum	Maximum Engine Exhaust	Maximum Stack Exhaust		Average Engine Load (%)	Max Engine Load (%)	Average Fuel Ratio (% DG)	Notes
	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)	Ammonia Slip	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)				
7/17/2010	33.16	7.43	7.87	2.39	37.15	9.46	9.08	93.85	105.06	89%	
7/18/2010	32.37	7.02	7.83	2.02	35.65	9.00	8.90	94.85	101.40	90%	
7/19/2010	32.74	7.22	7.91	2.46	36.69	9.50	9.16	95.15	101.60	88%	
7/20/2010	32.05	6.86	7.80	39.38	36.12	10.44	11.46	94.30	100.26	0%	The engine was brought offline at the request of the OCSd's contractor who is performing electrical upgrades (Note 2).
7/21/2010	32.46	6.85	7.99	1.88	34.65	7.73	8.99	98.29	102.81	94%	
7/22/2010	32.78	6.99	7.97	2.15	35.41	8.30	9.11	95.07	102.88	87%	
7/23/2010	30.76	5.96	8.36	1.75	33.43	7.40	9.44	95.39	99.27	87%	
7/24/2010	31.02	6.42	8.42	7.59	34.77	9.33	42.23	93.60	118.80	0%	Note 2.
7/25/2010	32.71	6.94	8.02	3.26	37.17	9.35	9.29	97.57	102.19	89%	
7/26/2010	34.25	7.62	7.55	100.43	41.43	9.23	8.48	96.06	107.34	0%	Note 2.
7/27/2010	32.69	6.99	7.57	2.16	38.25	9.15	8.49	92.14	99.98	87%	
7/28/2010	32.15	6.88	7.74	3.47	35.77	8.68	9.26	93.20	112.96	0%	Note 2.
7/29/2010	32.04	7.22	6.61	2.48	34.72	8.63	8.44	93.08	99.08	0%	Note 2.
7/30/2010	30.92	6.71	6.38	2.07	32.76	7.60	6.67	94.17	101.75	90%	
7/31/2010	30.03	6.34	6.48	2.73	31.93	7.27	7.61	92.62	100.70	90%	
8/1/2010	30.79	6.69	6.64	2.84	33.38	8.17	7.67	93.19	104.33	90%	
8/2/2010	31.93	7.34	6.42	2.42	36.03	9.55	7.36	91.59	97.50	89%	
8/3/2010	32.58	7.68	6.26	25.61	36.79	9.42	7.44	92.77	99.37	0%	Note 2.
8/4/2010	32.44	7.78	6.18	10.42	34.43	9.34	7.31	94.30	98.94	0%	Note 2.
8/5/2010	31.95	7.25	6.51	3.20	35.74	9.00	13.21	89.75	99.70	0%	Note 2. High Stack Exhaust NOx due to Natural Gas fuel.
8/6/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
8/7/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
8/8/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	Engine was offline from 8/5/10 16:09 through 8/11/10 7:48.
8/9/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
8/10/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
8/11/2010	34.39	9.27	6.08	3.49	37.74	10.98	6.88	90.62	95.53	0%	Note 2.
8/12/2010	34.01	8.74	6.41	3.19	37.25	10.07	7.49	93.14	102.71	0%	
8/13/2010	32.57	8.41	6.40	3.06	37.04	11.15	7.02	85.86	97.19	97%	
8/14/2010	33.00	8.53	6.38	3.91	37.21	10.60	7.03	86.13	92.47	96%	
8/15/2010	31.66	7.74	6.73	3.24	35.65	9.73	7.53	86.67	94.22	84%	
8/16/2010	32.48	8.43	6.52	3.42	37.09	11.79	7.34	82.17	86.64	0%	Note 2.
8/17/2010	32.96	8.93	6.48	3.45	37.66	11.46	7.01	84.22	91.31	0%	Note 2.
8/18/2010	34.78	9.68	6.46	4.98	40.13	12.49	6.99	90.49	97.30	0%	High Stack Exhaust NOx due to Natural Gas fuel.
8/19/2010	33.37	8.98	6.70	3.88	37.98	12.01	7.22	90.84	105.13	0%	High Stack Exhaust NOx due to Natural Gas fuel.
8/20/2010	33.29	8.98	6.55	5.40	38.36	11.54	7.31	91.00	95.18	90%	High Stack Exhaust NOx due to Natural Gas fuel.
8/21/2010	33.27	8.80	6.63	5.09	37.79	10.62	7.58	92.52	96.82	88%	
8/22/2010	32.57	8.36	6.71	4.44	37.77	11.61	7.57	90.78	98.04	87%	
8/23/2010	32.37	8.33	6.80	5.17	38.56	12.47	7.69	86.52	107.28	87%	
8/24/2010	29.99	7.10	6.83	3.93	37.32	12.07	7.72	80.59	105.53	0%	High Stack Exhaust NOx due to Natural Gas fuel.
8/25/2010	30.34	7.17	6.62	4.24	37.22	11.50	7.48	85.12	107.70	0%	High Stack Exhaust NOx due to Natural Gas fuel.
8/26/2010	29.45	6.37	6.92	3.98	34.92	9.43	7.51	87.33	105.39	86%	
8/27/2010	29.78	6.58	6.82	3.11	35.83	9.86	7.57	86.61	103.34	84%	
8/28/2010	30.79	7.18	6.75	3.30	36.03	10.15	7.15	86.40	100.08	90%	
8/29/2010	30.77	7.03	6.85	4.73	36.72	10.26	7.82	85.69	100.49	84%	
8/30/2010	29.61	6.07	7.11	1.88	35.04	9.48	8.06	79.22	99.68	0%	Note 2.
8/31/2010	29.05	5.76	7.07	5.45	35.34	9.77	7.77	78.41	97.15	0%	Note 2.
9/1/2010	33.39	8.60	6.69	4.19	40.53	14.28	7.51	87.49	106.41	84%	
9/2/2010	32.65	8.22	6.77	6.03	39.58	13.23	7.54	84.66	99.47	84%	
9/3/2010	32.90	8.40	6.63	8.72	39.26	12.82	7.07	89.29	109.77	91%	
9/4/2010	33.26	8.65	6.61	5.38	38.50	11.94	7.43	90.48	107.93	86%	
9/5/2010	30.00	6.86	7.14	2.32	35.04	9.24	7.90	83.59	99.00	72%	
9/6/2010	29.93	6.56	7.48	1.93	32.05	7.69	7.98	80.49	90.32	69%	
9/7/2010	31.27	7.36	7.27	2.65	33.15	8.54	7.75	79.44	83.96	71%	
9/8/2010	35.14	9.79	6.52	5.14	42.28	15.88	7.21	87.84	107.84	90%	

Validated Daily 15-Minute Block Average
Daily Average and Maximum Emissions Summary Data from CEMS
Plant 1 - Catalytic Oxidizer and Selective Catalytic Reduction

Date	Avg. Engine Exhaust	Average Stack Exhaust		Maximum	Maximum Engine Exhaust	Maximum Stack Exhaust		Average Engine Load (%)	Max Engine Load (%)	Average Fuel Ratio (% DG)	Notes
	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)	Ammonia Slip	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)				
9/9/2010	32.88	9.10	6.51	11.65	41.40	13.94	7.21	91.86	107.79	91%	
9/10/2010	31.34	8.32	6.78	6.44	37.96	12.85	7.26	91.29	108.76	90%	
9/11/2010	29.43	7.26	6.89	4.87	33.60	9.66	7.51	86.16	105.12	86%	
9/12/2010	28.30	6.60	7.12	3.58	32.01	8.68	7.70	84.15	100.06	84%	
9/13/2010	28.95	6.89	7.27	3.96	33.22	9.30	7.90	82.00	97.27	78%	
9/14/2010	29.73	7.52	7.10	4.40	38.04	13.94	9.50	84.29	99.48	22%	
9/15/2010	31.12	8.14	6.94	5.71	35.50	11.23	7.39	96.23	108.48	92%	
9/16/2010	31.08	8.35	6.84	7.25	39.84	15.22	7.35	93.14	108.14	82%	
9/17/2010	31.23	8.67	6.76	6.46	36.62	11.98	9.99	91.46	110.09	0%	
9/18/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	Engine was offline from 9/17/10 17:04 through 9/20/10 8:32.
9/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
9/20/2010	31.34	7.02	7.65	2.28	32.94	7.66	9.02	71.18	73.79	0%	Note 2.
9/21/2010	26.63	5.42	6.19	2.28	27.52	6.25	7.07	75.34	78.16	0%	Note 2.
9/22/2010	31.30	8.83	6.33	6.79	36.26	13.07	6.92	93.35	108.12	95%	
9/23/2010	31.26	8.62	6.52	6.13	36.23	12.79	7.10	96.28	108.32	98%	
9/24/2010	28.18	6.71	6.84	4.96	33.98	10.56	7.30	93.68	108.80	90%	
9/25/2010	27.04	6.35	6.68	3.71	29.74	8.06	7.15	83.96	103.31	92%	
9/26/2010	27.99	6.91	6.57	6.63	31.71	9.43	7.21	80.01	92.42	94%	
9/27/2010	28.73	7.14	6.69	4.94	34.90	12.61	7.70	81.03	97.24	85%	
9/28/2010	27.94	6.54	6.96	7.53	34.81	11.63	7.62	75.23	86.85	84%	
9/29/2010	28.91	7.65	6.80	9.74	33.59	10.20	7.48	81.73	91.75	81%	
9/30/2010	29.53	8.16	6.47	7.19	36.18	13.61	6.91	93.46	106.94	90%	
10/1/2010	27.07	6.68	6.58	5.20	29.46	8.08	7.00	83.91	92.78	89%	
10/2/2010	26.23	6.11	6.62	7.69	31.27	9.76	7.11	85.34	108.61	91%	
10/3/2010	25.86	5.71	6.65	3.04	28.55	7.08	7.14	82.10	98.20	90%	
10/4/2010	28.04	6.72	6.90	8.24	32.57	9.05	8.18	74.60	87.54	89%	
10/5/2010	28.81	6.89	6.83	7.19	33.02	10.71	8.00	72.84	83.41	89%	
10/6/2010	29.44	7.30	6.59	5.16	33.33	9.77	7.30	76.33	90.18	94%	
10/7/2010	29.43	7.25	6.66	14.29	32.75	9.50	7.31	76.26	91.66	95%	
10/8/2010	28.77	7.11	6.51	3.99	33.08	9.84	7.05	79.63	93.66	96%	
10/9/2010	28.78	7.31	6.47	4.17	32.12	9.47	6.90	85.42	99.26	98%	
10/10/2010	27.43	6.54	6.36	4.29	31.20	8.63	6.86	84.93	103.80	98%	
10/11/2010	27.52	6.30	6.45	3.76	33.05	8.60	7.23	79.05	101.14	93%	
10/12/2010	26.54	N/A	6.40	N/A	29.19	N/A	6.83	76.03	86.49	0%	
10/13/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/14/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/15/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/16/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/17/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/18/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/20/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/21/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	Engine was shut down at 8:40 due to lack of low range calibration gas for the Stack Exhaust CEMS monitor. Data is missing from 16:02 to 17:06.
10/22/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/23/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/24/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/25/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/26/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/27/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/28/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/29/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/30/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
10/31/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
11/1/2010	28.67	6.50	7.49	3.13	31.86	9.42	8.49	75.34	96.94	0%	Note 2.
11/2/2010	28.19	6.54	7.54	4.81	33.32	9.67	8.06	74.82	83.23	89%	

Validated Daily 15-Minute Block Average
Daily Average and Maximum Emissions Summary Data from CEMS
Plant 1 - Catalytic Oxidizer and Selective Catalytic Reduction

Date	Avg. Engine Exhaust	Average Stack Exhaust		Maximum	Maximum Engine Exhaust	Maximum Stack Exhaust		Average Engine Load (%)	Max Engine Load (%)	Average Fuel Ratio (% DG)	Notes
	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)	Ammonia Slip	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)				
11/3/2010	30.47	8.48	7.30	6.92	34.59	10.70	8.08	84.85	107.53	95%	
11/4/2010	31.14	8.99	7.19	7.27	34.38	10.70	7.68	91.85	109.16	93%	
11/5/2010	30.89	8.88	7.14	5.73	34.94	11.50	8.30	89.41	105.72	98%	
11/6/2010	28.41	7.19	7.19	6.18	32.85	10.10	8.08	85.70	96.36	88%	
11/7/2010	28.75	7.39	7.16	4.18	33.17	9.76	8.08	87.11	104.47	90%	
11/8/2010	30.20	8.10	6.93	5.35	37.51	13.37	8.61	90.50	105.21	48%	
11/9/2010	29.42	7.56	6.90	5.04	32.09	9.39	7.46	81.89	96.84	88%	
11/10/2010	27.07	6.11	7.01	2.81	29.85	8.39	7.61	79.84	97.91	92%	
11/11/2010	31.51	8.89	6.60	7.53	36.58	13.76	7.47	83.93	94.48	92%	
11/12/2010	31.50	8.90	6.86	5.30	37.28	13.42	7.62	88.38	102.32	98%	
11/13/2010	30.19	8.12	6.83	7.52	32.92	9.48	7.38	88.97	98.93	92%	
11/14/2010	28.00	6.92	7.06	6.65	32.41	8.95	7.98	80.73	91.53	90%	
11/15/2010	29.03	7.45	6.94	5.45	33.72	10.72	7.72	80.10	92.11	86%	
11/16/2010	28.04	7.06	6.87	3.45	43.68	13.94	7.92	88.64	102.38	0%	Note 2.
11/17/2010	24.94	5.16	7.08	1.84	26.49	6.38	7.76	82.87	89.68	0%	Note 2.
11/18/2010	25.33	5.25	7.09	4.72	28.62	7.14	7.74	83.83	102.51	0%	Note 2.
11/19/2010	26.67	6.58	7.00	4.28	32.24	12.23	7.82	84.51	95.55	73%	
11/20/2010	26.91	6.40	6.92	3.96	32.90	10.08	7.68	88.49	95.64	90%	
11/21/2010	26.92	6.21	7.00	3.63	31.24	8.02	7.93	79.79	91.55	91%	
11/22/2010	28.97	7.23	6.83	3.81	32.02	8.49	7.64	80.99	98.00	94%	
11/23/2010	28.19	6.83	6.65	3.49	31.73	9.26	7.24	84.08	97.69	98%	
11/24/2010	29.29	7.56	6.63	7.10	33.61	9.78	7.18	90.65	106.51	98%	
11/25/2010	31.81	8.98	6.51	5.52	34.83	10.43	7.06	90.37	96.97	0%	Note 2.
11/26/2010	33.06	9.83	6.51	5.39	36.68	12.59	7.11	90.34	100.05	94%	
11/27/2010	31.95	9.09	6.49	7.26	36.87	11.96	7.01	88.59	97.10	92%	
11/28/2010	31.77	8.99	6.55	7.36	35.35	11.16	7.46	85.58	96.93	93%	
11/29/2010	30.94	8.22	6.68	3.65	34.51	9.98	7.49	83.60	97.89	0%	
11/30/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/1/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/2/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/3/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/4/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/5/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/6/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/7/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/8/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/9/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/10/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/11/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/12/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/13/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/14/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/15/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/16/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/17/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/18/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/20/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/21/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/22/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/23/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/24/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/25/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/26/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/27/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	

Engine offline on 11/29/10 at 15:29 through 12/29/10 at 11:57.

Validated Daily 15-Minute Block Average
Daily Average and Maximum Emissions Summary Data from CEMS
Plant 1 - Catalytic Oxidizer and Selective Catalytic Reduction

Date	Avg. Engine Exhaust	Average Stack Exhaust		Maximum	Maximum Engine Exhaust	Maximum Stack Exhaust		Average Engine Load (%)	Max Engine Load (%)	Average Fuel Ratio (% DG)	Notes
	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)	Ammonia Slip	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)				
12/28/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/29/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	NOx probe at Engine Exhaust offline. The engine was not out of compliance and continued to run despite high NOx at the stack exhaust.
12/30/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
12/31/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
1/1/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	After restart of the system on 12/29/10, plant operators had isolated and not checked the urea injection system. Once checked, the urea supply line was isolated, the urea pump noisy, the air supply to the injection lance was isolated, and the urea filter housing was leaking. Johnson Matthey replaced the #1 urea pump on 1/13/11 (Note 4).
1/2/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
1/3/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
1/4/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
1/5/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	Engine offline to relocate engine exhaust NOx probe and replace umbilical line.
1/6/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
1/7/2011	31.43	7.75	7.43	3.34	32.61	8.39	7.76	104.77	107.37	96%	Urea injection was not turned on until 1 hour after engine start-up, data for the hour when the urea system was not online plus 30 minutes of start-up time is excluded from the data set (Note 3).
1/8/2011	31.05	7.35	7.63	2.57	32.70	8.42	8.05	102.22	106.83	95%	
1/9/2011	30.36	7.13	7.16	1.87	33.10	9.12	7.84	88.25	103.01	90%	
1/10/2011	30.98	7.45	7.02	2.26	34.84	9.52	7.50	84.08	96.68	94%	
1/11/2011	32.83	8.21	7.13	2.66	38.26	12.38	7.97	93.99	109.26	85%	
1/12/2011	31.94	7.33	7.70	1.96	34.05	9.25	8.22	100.93	107.27	96%	
1/13/2011	30.20	6.29	7.72	1.79	32.40	7.88	8.77	95.71	108.38	96%	
1/14/2011	32.85	7.97	7.59	2.64	35.06	9.50	8.06	104.41	108.41	96%	
1/15/2011	31.76	7.65	7.52	2.30	34.36	9.47	8.40	99.59	108.97	95%	
1/16/2011	30.89	7.16	8.14	2.01	32.24	8.08	8.73	103.93	110.94	98%	
1/17/2011	29.99	6.82	7.76	2.13	35.39	9.30	8.56	96.90	105.58	81%	
1/18/2011	29.70	6.77	7.59	2.49	32.44	8.50	8.38	94.12	106.01	90%	
1/19/2011	27.21	4.94	7.35	1.59	31.53	7.73	8.14	84.34	103.41	93%	
1/20/2011	30.55	7.39	7.21	13.98	35.22	11.59	7.93	86.34	101.04	91%	
1/21/2011	29.15	6.87	7.51	3.58	33.64	9.89	8.38	87.00	93.08	98%	
1/22/2011	26.97	5.23	7.45	1.60	30.15	7.37	8.44	85.37	96.58	97%	
1/23/2011	29.30	6.81	7.15	2.33	32.08	8.56	7.96	84.82	96.24	98%	
1/24/2011	29.55	6.73	7.01	2.49	32.13	8.12	8.05	78.79	92.24	87%	
1/25/2011	29.54	6.13	7.54	2.68	32.04	7.78	8.41	70.52	85.60	70%	
1/26/2011	31.52	7.78	6.99	3.18	34.94	9.54	8.05	87.50	108.13	86%	
1/27/2011	30.33	7.41	7.15	2.34	33.96	8.76	7.77	86.61	106.21	96%	
1/28/2011	29.42	6.73	7.56	2.37	32.77	8.88	8.16	92.70	107.40	96%	
1/29/2011	26.64	4.59	7.83	0.96	29.23	6.26	8.37	88.57	97.08	96%	
1/30/2011	26.98	5.02	7.08	1.03	28.37	6.04	7.56	80.00	86.47	94%	
1/31/2011	28.13	5.45	7.26	2.24	36.23	10.64	8.80	75.28	91.23	77%	
2/1/2011	28.53	5.75	7.32	2.79	32.14	7.92	8.48	73.98	84.95	87%	
2/2/2011	33.07	7.86	7.06	5.22	38.46	11.02	8.07	71.26	78.57	88%	
2/3/2011	29.41	6.08	7.14	1.60	32.47	7.39	7.71	80.11	87.92	94%	
2/4/2011	28.76	5.60	7.90	1.42	32.21	7.37	8.90	92.09	104.87	93%	
2/5/2011	27.35	5.33	7.83	0.93	29.39	6.31	8.46	88.44	96.01	91%	
2/6/2011	26.70	4.30	7.87	2.09	28.72	6.37	8.61	80.20	84.32	83%	
2/7/2011	28.87	6.01	7.70	1.25	30.14	7.24	8.18	80.59	84.04	0%	
2/8/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	Engine offline 2/7/11 9:48 to 2/14/11 17:08 to change DGCS carbon media.
2/9/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
2/10/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
2/11/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
2/12/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
2/13/2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	
2/14/2011	29.60	7.32	6.76	5.31	31.62	10.02	7.71	90.54	97.53	0%	
2/15/2011	29.97	7.00	7.40	2.70	34.01	8.68	7.93	95.74	106.86	98%	Note 2.
2/16/2011	29.37	6.58	7.55	2.65	33.09	8.65	8.24	98.00	105.83	98%	
2/17/2011	32.25	8.07	7.48	3.30	34.04	9.81	8.23	104.74	111.50	98%	
2/18/2011	31.24	7.53	7.82	2.31	33.91	9.15	8.54	106.56	111.92	98%	

Validated Daily 15-Minute Block Average
Daily Average and Maximum Emissions Summary Data from CEMS
Plant 1 - Catalytic Oxidizer and Selective Catalytic Reduction

Date	Avg. Engine Exhaust	Average Stack Exhaust		Maximum	Maximum Engine Exhaust	Maximum Stack Exhaust		Average Engine Load (%)	Max Engine Load (%)	Average Fuel Ratio (% DG)	Notes
	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)	Ammonia Slip	NOx @15% O2 (ppmvd)	NOx @15% O2 (ppmvd)	CO @15%O2 (ppmvd)				
2/19/2011	30.92	7.36	7.55	2.81	33.90	9.76	8.31	102.93	110.40	98%	
2/20/2011	29.65	6.85	7.06	2.09	32.21	8.18	7.83	91.32	103.02	96%	
2/21/2011	29.49	6.57	6.81	3.01	34.00	8.82	7.57	81.64	91.69	93%	
2/22/2011	29.82	6.69	6.69	1.67	32.47	8.87	7.38	82.92	94.52	98%	
2/23/2011	31.09	7.21	7.18	1.64	33.45	8.16	7.92	99.43	109.78	98%	
2/24/2011	31.65	7.30	7.47	1.73	34.03	8.36	8.49	102.95	110.44	98%	
2/25/2011	33.13	8.13	7.39	4.04	34.16	9.47	7.71	106.44	111.02	0%	
2/26/2011	31.50	7.57	7.07	2.48	33.15	8.55	7.76	101.16	110.09	98%	
2/27/2011	33.42	8.34	6.97	2.93	36.58	10.04	7.36	100.53	108.17	98%	
2/28/2011	31.80	7.81	6.86	3.10	36.29	9.77	7.51	90.10	107.79	95%	
3/1/2011	30.14	6.79	7.14	2.65	32.51	9.02	7.88	91.95	105.72	98%	
3/2/2011	29.41	6.16	7.89	2.23	37.66	8.02	8.71	97.69	107.61	0%	Note 2.
3/3/2011	27.86	5.47	8.17	1.59	29.72	6.73	8.74	96.80	107.33	94%	
3/4/2011	28.83	6.08	8.46	1.39	30.85	7.23	8.87	102.94	110.40	98%	
3/5/2011	29.09	6.35	8.42	2.79	31.91	8.58	9.06	102.87	109.47	98%	
3/6/2011	26.63	5.01	7.89	1.43	28.70	6.04	8.86	91.24	102.92	95%	
3/7/2011	27.81	6.04	7.38	3.36	32.91	9.41	8.20	89.45	100.37	98%	
3/8/2011	28.03	6.00	7.69	2.04	30.45	7.55	8.68	91.40	103.44	98%	
3/9/2011	27.70	5.78	7.74	1.63	28.67	6.37	8.21	91.79	96.55	0%	Note 2.
3/10/2011	26.98	5.87	7.92	2.28	28.96	7.08	8.73	93.76	101.35	0%	Note 2.
3/11/2011	27.73	6.20	7.84	2.26	29.32	7.36	8.68	93.95	102.83	98%	
3/12/2011	28.37	6.49	7.67	2.08	29.98	7.32	8.58	94.09	106.19	97%	
3/13/2011	28.04	6.55	7.24	2.32	30.87	7.94	7.92	86.38	94.42	96%	
3/14/2011	29.04	7.21	7.16	5.04	31.84	9.62	7.70	87.02	93.44	0%	High NOx at the stack exhaust was due to a plugged urea injection lance (Note 4).
3/15/2011	28.24	6.44	7.60	2.99	29.70	7.59	8.40	92.96	101.85	98%	
3/16/2011	28.44	6.31	8.23	3.16	30.97	7.93	8.93	102.24	112.00	0%	
3/17/2011	29.40	8.59	8.11	2.34	31.30	10.76	8.56	102.10	107.70	0%	High NOx at the stack exhaust was due to a plugged urea injection lance (Note 4).
3/18/2011	29.51	8.20	8.84	2.54	31.79	11.09	32.82	102.78	110.18	98%	
3/19/2011	29.74	8.35	8.26	1.65	30.91	9.75	8.78	104.74	110.34	98%	
3/20/2011	27.83	6.94	7.72	1.31	30.84	9.39	8.77	93.75	104.95	95%	
3/21/2011	28.21	7.40	7.07	1.89	32.24	11.51	7.72	86.26	93.65	96%	
3/22/2011	29.87	8.50	7.62	2.62	33.20	11.89	8.58	97.16	108.53	98%	High NOx at the stack exhaust was due to adjustments to the SCR system by the system vendor (Note 3).
3/23/2011	29.24	7.54	8.08	1.31	31.75	9.71	8.65	101.83	108.03	98%	
3/24/2011	30.65	8.85	7.80	1.82	33.25	11.38	8.64	104.13	111.30	98%	
3/25/2011	30.25	8.63	8.04	2.64	31.35	10.14	28.89	105.44	111.08	98%	
3/26/2011	29.18	7.42	7.68	1.61	31.17	9.73	8.31	102.28	109.88	97%	
3/27/2011	27.38	6.34	7.25	1.56	30.41	9.39	8.12	91.24	100.63	96%	
3/28/2011	28.92	7.97	6.98	1.78	30.98	9.74	7.51	91.25	100.68	98%	
3/29/2011	28.50	7.37	7.33	1.65	30.23	9.67	7.97	95.03	105.40	98%	
3/30/2011	29.35	8.24	7.90	2.25	31.85	11.35	8.37	103.55	110.65	98%	
3/31/2011	29.44	8.39	8.09	2.01	30.77	10.27	8.43	106.76	111.47	98%	

Notes:

- (1) Urea injection setpoints were modified on June 8, 2010. Therefore, stack exhaust NOx data prior to June 8, 2010 is not included in the analysis of the SCR system and is not provided in this table.
- (2) The first 30 minutes after start-up of the engine are exempt from Amended Rule 1110.2. Data was excluded where NOx at the stack exhaust exceeded 11 ppmvd during engine start-up.
- (3) Data was excluded where NOx at the stack exhaust exceeded 11 due to system adjustments to the urea injection system.
- (4) Data was excluded where operational issues occurred from 7/1/10-7/4/10, 12/29/10-1/4/11, 3/14/11, 3/17/11, and 3/22/11.
- (5) Values shown are average or maximum values (as indicated) for each calendar day and may not all occur at the same time within the day.
- (6) N/A indicates that data was not available because the engine was offline.

APPENDIX C-4:

**Technical Memorandum:
OCSD Catalytic Oxidizer/SCR Pilot Study:
Ammonia Sampling and Calculation Methods**

Date: July 31, 2011
To: File
From: Kit Liang ; Daniel Stepner, Malcolm Pirnie, WHI
Re: OCSD Cat Ox/SCR Pilot Study: Ammonia Sampling and Calculation Methods
Project No.: 0788-187

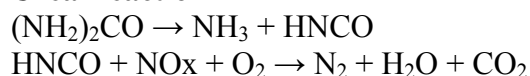
Introduction

To meet the South Coast Air Quality Management District (SCAQMD) Rule 1110.2 limit for oxides of nitrogen (NO_x), the Orange County Sanitation District (OCSD) installed a urea-based selective catalytic reduction (SCR) system after the internal combustion (IC) engine exhaust and catalytic oxidizer (Cat Ox) at the Plant 1 Engine 1. The SCR system was designed to remove NO_x through a chemical reaction between ammonia (provided by the urea (NH₂)₂CO)) and the NO_x on the SCR catalyst surface. During this process, a small amount of unreacted free ammonia (NH₃) or “*ammonia slip*” can be emitted into the exhaust gas. The objective of this memorandum is to discuss the reactions leading to ammonia slip, and a comparison of the different ammonia estimation methods.

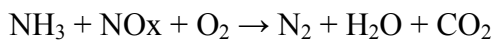
SCR Overview

SCR is an air pollution control method that reduces the NO_x emissions resulting from fossil fuel combustion through a chemical reaction between the NO_x in the exhaust stream and NH₃ provided by the injection of ammonia or urea. The reaction is facilitated by a catalyst to form nitrogen and water vapor.

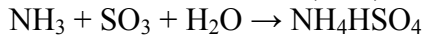
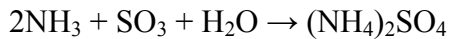
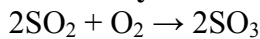
Engine 1 at OCSD Plant 1 is a four-stroke cycle engine, fueled with a blend of digester gas and natural gas. A Johnson Matthey® SCR system is located downstream of the engine and after a catalytic oxidizer. Aqueous urea is injected into the engine exhaust duct upstream of the SCR catalyst. Once urea is injected into the engine exhaust stream, it breaks down into ammonia and other constituents. Hydrolysis of the urea on the face of the catalyst generates more ammonia. This ammonia reagent reacts with the NO_x in the stack emissions, and with the aid of a catalyst, reduces the NO_x to harmless constituents: nitrogen, water vapor, and carbon dioxide. The ammonia can also react with sulfur dioxide (SO₂) and sulfur trioxide (SO₃) in secondary reactions to produce ammonium bisulfate (NH₄HSO₄) and ammonium sulfate ((NH₄)₂SO₄). The equations for these reactions are as follows:

Urea Reaction

Ammonia Reaction



Secondary Reactions:



The ammonia/NO_x reaction is optimal between 750°F and 850°F. The amount of NO_x in the engine exhaust gas varies with the engine load, and fuel type or fuel blend (in this case, the proportion of digester gas and natural gas). In the SCR system, the injection of the urea is controlled based on process variables, including engine operation (on/off), engine load (i.e., process flow), and NO_x concentration measured at the exhaust stack; and the quantity of urea to be injected is roughly proportional to the NO_x being reduced and the volume of exhaust flow.

It is important not to inject more urea than necessary in order to keep the unreacted, unconsumed, free ammonia levels to a minimum. Excess free ammonia can occur when:

- Ammonia or urea, is over-injected into the exhaust stream,
- The temperature of the gas is too low for the ammonia to react, or
- The catalyst is degraded.

Significantly high levels of free ammonia in the exhaust stack gases can often be identified by a visible plume above the stack. Not only can the excess ammonia exceed permitted limits (ammonia is regulated by SCAQMD), but it also indicates that more ammonia or urea than needed was injected, resulting in a greater urea supply and storage capacity than actually needed to control the NO_x emissions. In addition, compounds such as the sulfates formed in the secondary reactions presented above, in which free ammonia reacts with sulfur compounds, have been shown to result in the corrosion of downstream equipment and to cause line plugging. This has been discussed in the literature in particular for fuels with high sulfur content, such as coal. The general range of temperatures for the sulfate formation is reported to range from 390 to 450 °F for medium to low sulfur fuels.

Johnson Matthey® SCR Urea Control System

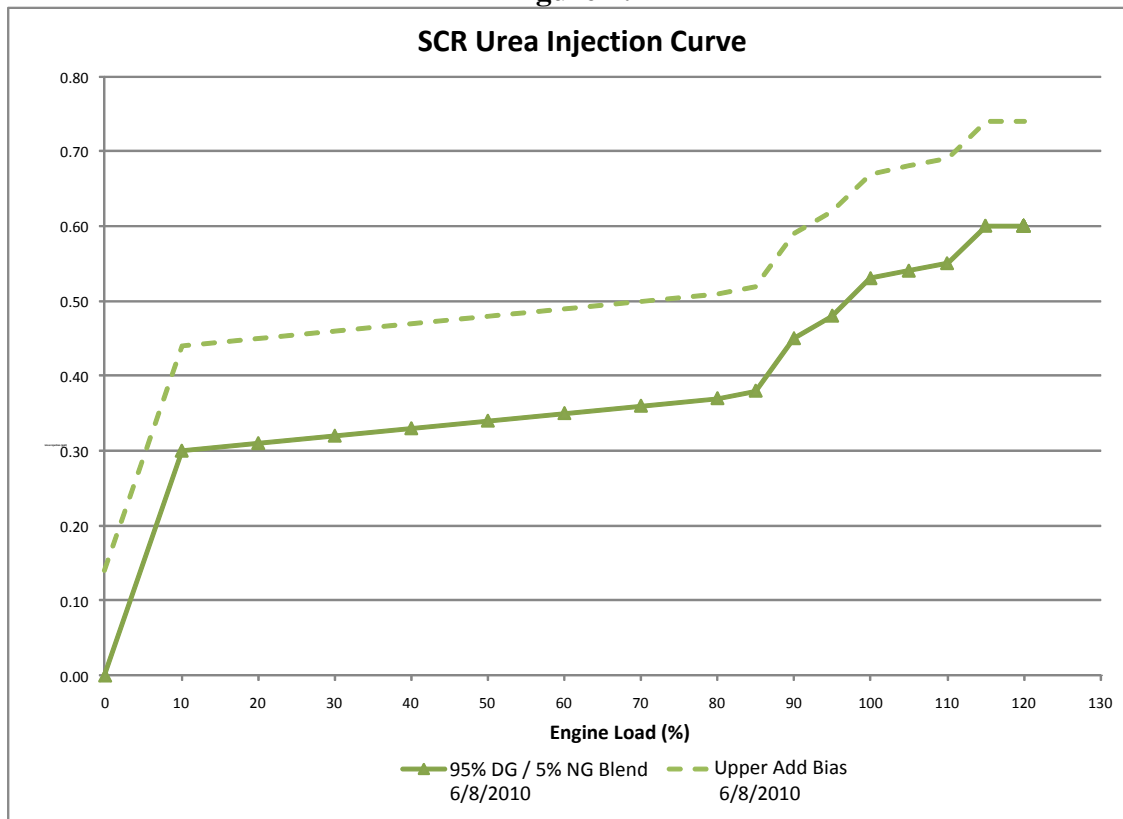
The goal of the SCR control system is to balance urea injection to reduce NO_x concentration in the exhaust gas to below 11 ppm with a minimum amount of unconsumed or free ammonia. The maximum concentration of free ammonia allowed for this Pilot Study Research Permit is 10 ppm NH₃.

The urea injection control system determines the correct rate of urea according to the engine load signal and the urea versus engine load map programmed into the control system. The load map, which correlates the urea injection rate to the engine load, was programmed during commissioning of the system by Johnson Matthey®. This load map allows the controller to interpolate between the prescribed load values and urea injection

rate to generate an overall curve of urea injection vs. engine load. As the engine is brought to load and as the engine load changes, urea flow rate is modulated by the flow control valve according to the determined urea injection rate. In addition to the load map control, the injection system also receives the NO_x concentration at the stack outlet from the continuous emissions monitoring system (CEMS) stack exhaust NO_x probe. This NO_x signal is then used to increase the actual urea injection rate by a set percent *bias* as needed in order to fine tune the NO_x emission rate.

As the engine was operated under varying loads during load mapping, Johnson Matthey® measured the NO_x concentration with a portable chemiluminescent analyzer and the ammonia slip with Draeger® tubes at the SCR catalyst outlet. The purpose of these measurements was to develop a plot (map) of urea injection rate versus engine load that would meet NO_x and ammonia slip emissions requirements. The urea injection rate versus engine load map is provided in Figure 1 below. The solid line represents the true set points for urea injection rate based on engine load set by Johnson Matthey® on June 8, 2010. The dashed line represents the urea injection rate with the injection rate bias to increase the urea injection rate based on the NO_x outlet emissions.

Figure 1:



Methods of Estimating Ammonia Concentration

Three methods were used for determining ammonia concentration:

- On-site field measurement using Draeger® or Sensidyne® tubes (free ammonia),
- SCAQMD Method 207.1 (free ammonia), and
- Estimated total ammonia calculation method using inlet and outlet NOx CEMS concentration and urea injection rate.

Draeger® and Sensidyne® Tubes

Free ammonia was measured in the field periodically using Draeger® and Sensidyne® tubes. A Draeger® or Sensidyne® tube is a glass vial filled with a chemical reagent that reacts and changes color in the presence of a targeted chemical. When a gas is pumped through the tube, the discoloration of the reagent is read against a scale on the outside of the tube to indicate the concentration of the chemical.

During the field sampling, a Tedlar® bag was filled with exhaust gas from the sample port located after the SCR outlet. The exhaust gas was pulled through the Draeger® or Sensidyne® tube; and the concentration of free ammonia was read against the scale on the tube. Two ranges of Draeger® tubes were used to detect ammonia: 0.25-3 ppm (low-scale) and 2-30 ppm (high-scale). If ammonia was detected and saturated the low-scale tube, the high-scale tube was used.

Estimated Ammonia Calculation Method

Using the estimated ammonia calculation formula, total ammonia is calculated based on the NOx inlet and NOx outlet concentrations, urea injection rate, and total exhaust flowrate. Data from the CEMS system and operational data from the data acquisition system (DAS) were used for the calculations. The NOx and urea react on a 1:2 basis. Therefore, the amount of urea reacted is theoretically equal to two times the amount of NOx reduced by the SCR.

$$\text{Ammonia} = \left[\text{Urea Fed} - \frac{\text{NOx in} - \text{NOx out}}{2} \right] \times CF$$

The CEMS vendor, Cemtek Environmental, Inc., programmed the following formula to calculate ammonia slip:

$$\text{Ammonia} = \left[\frac{(2 \times \rho \times \text{Urea Flow Rate} \times \% \text{ wt urea})}{\text{Urea Molecular Weight}} - \frac{\text{Dry Gas Flow Rate}}{29} \times \frac{(\text{NOx in} - \text{NOx out})}{10^6} \right] \times \frac{10^6}{\text{Dry Gas Flow Rate}/29} \times CF$$

The *Dry Gas Flow Rate* is calculated using the following equation:

$$\text{Dry Gas Flow Rate} = ((\text{Fuel Flow} \times \text{Fuel GCV}) \times \text{Fuel Factor}) \times (20.9/(20.9 - \% \text{ O}_2))$$

Where the following units apply:

- *Urea Flow Rate*: gallon per hour (gal/hr)
- *NOx in, NOx out* (inlet and outlet NOx concentration): parts per million (ppm_c) @ 15% O₂
- *Dry Gas Flow Rate*: pounds per hour (lbs/hr)
- *CF*: Correction factor (derived annually)
- *Fuel Flow Rate*: dry standard cubic feet of fuel (dscf)
- *Fuel GCV* (gas constant value): Btu value of the fuel / dscf
- *Fuel Factor*: dscf @ 0% O₂ / million Btu value of the fuel
- $\rho \left(\frac{H_2O}{Urea} \right) = 68.9 \frac{lb}{ft^3} \text{ or } 9.21 \frac{lb}{gal} \text{ with urea @ } 32.5\% \text{ wt @ } 4^\circ C$
- *Urea Molecular Weight* = $60.0553 \frac{lb}{mol}$

The estimated ammonia calculation method allows for adjustment of the ammonia estimation through use of the correction factor, CF. Without accounting for secondary reactions through consumption of free ammonia with other compounds in the engine exhaust gas, such as sulfates, the method actually estimates total ammonia (i.e., free ammonia plus combined ammonia). The method does allow for use of a correction factor which could be applied to account for these secondary reactions. During the pilot test, no correction factor for potential side reactions was programmed into the calculation, and the CF was assumed equal to 1.

SCAQMD Method 207.1

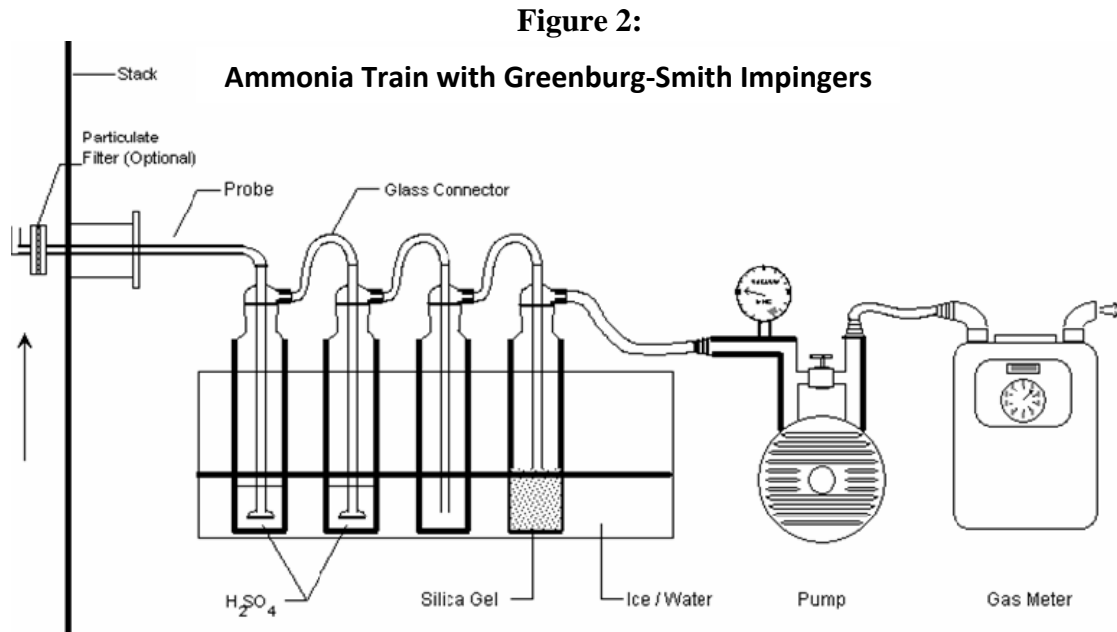
SCAQMD Method 207.1 is the regulatory approved method for determining free ammonia emissions from stationary sources. This method is a wet chemistry method in which the samples are collected from impingers containing a sulfuric acid solution. The samples are then analyzed by an ion selective electrode.

Figure 2 provides a standard setup for the SCAQMD Method 207.1. During the initial period of the pilot testing, the testing firm, SCEC, performed ammonia sampling at the stack exhaust for three loads on April 7 and 8, 2010.

Discussion

Table 1 presents a comparison of the free ammonia concentrations determined using the Draeger® and Sensidyne® tubes, the free ammonia concentrations determined using SCAQMD Method 207.1, and the theoretical total ammonia calculations. The ammonia concentration values were based on the same recorded 15-minute average CEMS data for all three methods.

While the field measurements taken with the Draeger® and Sensidyne® tubes show no measurable free ammonia, the total ammonia calculation method based on the CEMS data did provide a calculated value of total ammonia (free plus combined ammonia). Likewise, the results using SCAQMD Method 207.1 on 4/7/2010, 4/8/2010, and 5/10/2011 were less than 1 ppm of free ammonia, while the estimated total ammonia method calculated values using the CEMS data were noticeably higher.



The ammonia calculation method is dependent on the NO_x inlet and NO_x outlet concentrations, and the urea injection rate, which is continuously changing based on the engine load and the NO_x outlet concentration. The difference between the estimated total ammonia calculation method and the other techniques may be due to the conservative nature of the estimated method for determining ammonia slip, since it assumes that the ammonia from the urea consumes only NO_x. There is the potential for ammonia molecules to also be consumed in other secondary reactions in the exhaust stream, such as those with sulfur compounds (forming combined ammonia). However, no correction factors were applied to account for the consumption of ammonia in secondary reactions. Without a correction factor to account for these secondary reactions, the calculation method essentially estimates total ammonia, or the sum of free and combined ammonia.

Engine load fluctuates with time. When the IC engines are set to a base load, it was observed that the actual engine load fluctuated rapidly by as much as ten percent below the set point. This was found to be typical for the OCSD IC engines. However, since urea injection rate is mapped to engine load, rapid fluctuations in load can result in rapid changes in urea injection rates. Rapidly changing urea injection rates, instead of steady rates with smooth transitions, can also lead to inaccuracies in the ammonia calculation.

**Table 1:
Ammonia Concentration Sampling Event Summary**

Date	Engine Load	Draeger® and Sensidyne® Tube (Free Ammonia) (ppmv) ¹	Calculated Value (Total Ammonia) (ppmv) ²	SCAQMD Method 207.1 (Free Ammonia) (ppmv)
4/7/2010 & 4/8/2010	65%	<MDL	1.66	0.12
	90%			0.18
	105%			0.43
4/21/2010	110%	<MDL	0.09	N/A
4/29/2010	90%	<MDL	0.00	N/A
5/6/2010	94%	<MDL	2.18	N/A
5/19/2010	100%	<MDL	2.54	N/A
6/29/2010	100%	<MDL	0.97	N/A
7/28/2010	100%	<MDL	0.63	N/A
8/12/2010	95%	<MDL	2.50	N/A
11/4/2010	100%	<MDL	4.95	N/A
1/12/2011	100%	<MDL	0.32	N/A
2/24/2011	100%	<MDL	0.09	N/A
5/10/2011	70%	<MDL	1.12	0.37
	90%		1.60	0.31
	110%		3.12	0.38

- Notes:**
- Free ammonia field measurements were taken at the SCR outlet using 0.25-3 ppm range and 2-30 ppm range Draeger® tubes. On 5/10/2011, additional free ammonia field measurements were taken at the stack exhaust using Sensidyne® tubes with the same measurement results as the Draeger® tubes.
 - Total ammonia was determined based on the theoretical calculation which uses NOx inlet and NOx outlet of the Cat Ox/SCR system and the urea injection rate. The calculated value reported is based on the 15-minute block average from the CEMS for the time period when the exhaust gas sample was taken for the field measurement. No correction factor was applied.
 - <MDL – less than Method Detection Limit.
 - N/A indicates not applicable. No data was taken using Method 207.1 during these field measurement events.

Conclusions and Recommendations

Upon review of the field measurements for free ammonia and calculated values for total ammonia, the estimated total ammonia calculation method appears to overestimate the free ammonia in the SCR outlet over both the field sampling method and SCAQMD Method 207.1. This may be partially due to the varying urea injection rates. In addition, the estimated ammonia calculation method does not account for other potential ammonia reactions which may consume the unreacted ammonia, such as those with sulfur compounds in the exhaust gas. Without the application of a correction factor to account for these, the calculation method actually estimates total ammonia (free plus combined ammonia). However, this may be useful as a tool to prompt a field measurement to confirm free ammonia concentrations in the exhaust gases. Additional sampling of the

exhaust emissions could be performed to establish a correction factor for the theoretical ammonia slip calculation method. The presence of sulfur dioxide and sulfur trioxide in the exhaust gas before the SCR, and ammonium sulfate and ammonia bisulfate detected in the exhaust gas after the SCR, can indicate that secondary reactions are taking place due to the injection of urea.

Further study is needed to determine the potential for detrimental effects of ammonia sulfates formation in equipment downstream of the SCR system. For example, after two years of Engine 1 operation using the Cat Ox/SCR system with DGCS, it is recommended that OCSD examine the heat recovery boiler for any equipment deterioration or noticeable particulate buildup.

Although little, if any, free ammonia was found during the pilot study of the SCR system, it is recommended that the OCSD perform additional and routine testing for free ammonia during varying loads and fuel blends over a period of time. Additional testing for free ammonia can provide data to verify that the SCR system does not produce ammonia slip from the stack exhaust under the range of operating conditions for a given mapped urea injection versus engine load set point.

References

- Johnson Matthey. "*SCR Control System Description, Malcolm Pirnie/Orange County Sanitation District.*" January 2010.
- Cemtek, Environmental, Inc. Letter to Malcolm Pirnie. Re: NH₃ Slip Calculation. 25 March 2010.
- Falk, David. "*Ammonium Sulphate Deactivation of SCR DeNO_x Catalysts,*" Department of Chemical Engineering, Lund Instituted of Technology, Jan. 2007: 1-7.