

SOURCE TEST REPORT ACTI PARAMOUNT FACILITY

PREPARED FOR:

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7300 Alondra Boulevard, Suite 203
Paramount, California 90723

EQUIPMENT LOCATION:

American Combustion Technologies, Inc.
7300 Madison Street
Paramount, California 90723

TEST DATES:

December 9-11, 2009

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1.0 Executive Summary

Biosolids Reduction Technologies, Inc. (BRT) and American Combustion Technologies, Inc. retained SCEC to conduct a toxics and criteria engineering test program for the plant located at the Paramount facility. The test program was designed to collect engineering data. Sampling procedures were done in strict adherence to the identified test methods.

The test program objective was to establish the emission rates for O₂, CO₂, NO_x, CO, sulfur oxides (SO_x), ammonia (NH₃), Particulate Matter (PM), total non-methane non-ethane organics (TGNMNEO), Polychlorinated Dibenzo-p-dioxins (PCDD) and Polychlorinated Dibenzofurans (PCDF), aldehydes, polycyclic aromatic hydrocarbon (PAHs), volatile organic compounds (VOCs) and Heavy Metals. Table 2-1 identifies the sample parameters, test methods and sample duration.

All testing was performed at the exhaust of the system while the gasifier was operating while using process gas. This process gas is produced from waste tires during the gasification process to heat the pyrolysis system. Testing was conducted on the combusted process gas at the exhaust of the system. Testing was done on December 9-11, 2009. Table 2-2 identifies the sample extraction times and dates.

Tables 1-1 through 1-4 summarizes results of the test program. Table 1-3 is a tabulated presentation of gas samples collected and analyzed by ACTI. Table 1-4 presents the test results and compared to the permit application values.

1.0 Executive Summary (Continued)

Table 1-1

**SOURCE TEST RESULTS
BRT
LACSD Carson
December 10 & 11, 2009**

Parameter	First Run	Second Run
O₂, %	6.17	6.49
CO₂, %	11.01	11.82
DSCFM, exhaust flow:	50.0	47.9
NOx:		
ppm	9.9	
ppm @ 3% O ₂	12.3	
lb/hr	0.0035	
CO:		
ppm	26.1	
ppm @ 3% O ₂	32.4	
lb/hr	0.006	
SOx:		
ppm	3.3	
ppm @ 3% O ₂	4.1	
lb/hr	0.002	
Hydrocarbons (Total Gaseous Non-Methane, Non-Ethane Organics):		
TGMNEO, ppm (as CH ₄)	2.4	1.9
TGMNEO, ppm @ 3% O ₂ (as CH ₄)	3.0	2.4
TGMNEO, lb/hr (as CH ₄)	2.91E-04	2.31E-04
Ammonia Results:		
NH ₃ , ppm	0.62	
NH ₃ , ppm @ 3% O ₂	0.76	
NH ₃ , lb/hr	0.0001	
Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans		
PCDD/PCDF, ng/dscm	< 0.11	
PCDD/PCDF, ng/dscm @ 3% O ₂	< 0.14	
PCDD/PCDF, ng/dscm (TEV) @ 3% O ₂	< 0.02	
PCDD/PCDF, lb/hr	< 2.21E-11	
Polycyclic Aromatic Hydrocarbons		
Total PAH, lb/hr	< 3.20E-07	
Total PAH (excluding naphthalene), lb/hr	< 2.51E-07	
Total Particulate Matter - SCAQMD		
PM, gr/dscf @ 12% CO ₂	0.0015	
PM, gr/dscf	0.0015	
PM, lb/hr	0.001	
PM - Front Half Only - EPA		
PM, gr/dscf @ 12% CO ₂	0.0003	
PM, gr/dscf	0.0003	
PM, lb/hr	0.0001	

1.0 Executive Summary (Continued)

Table 1-1 (Continued)

SOURCE TEST RESULTS
BRT
LACSD Carson
December 10 & 11, 2009

Parameter	First Run	Second Run	Third Run
Metals			
Arsenic, mg/dscm @ 3% O ₂	7.87E-02		
Arsenic, lb/hr	1.10E-05		
Barium, mg/dscm @ 3% O ₂	< 1.18E-04		
Barium, lb/hr	< 1.66E-08		
Chromium, mg/dscm @ 3% O ₂	7.03E-02		
Chromium, lb/hr	9.88E-06		
Lead, mg/dscm @ 3% O ₂	< 1.18E-04		
Lead, lb/hr	< 1.66E-08		
Mercury, mg/dscm @ 3% O ₂	< 7.24E-05		
Mercury, lb/hr	< 1.02E-08		
Aldehydes			
Formaldehyde, ppm _v	0.220	0.024	3.454
Formaldehyde, lb/hr	5.22E-05	5.71E-06	8.22E-04
Acetaldehyde, ppm _v	0.055	0.022	0.045
Acetaldehyde, lb/hr	1.90E-05	7.66E-06	1.56E-05
Acrolein, ppm _v	< 0.017	< 0.010	< 0.013
Acrolein, lb/hr	< 7.39E-06	< 4.50E-06	< 5.91E-06

Table 1-2
BRT
LACSD Carson
December 10 & 11, 2009

Parameter	Three Run Average lb/hr
Vinyl chloride	< 7.75E-07
Methylene Chloride	< 2.77E-06
Chloroform	< 1.11E-06
1,2 - Dichloroethane	< 1.23E-06
1,1,1 - Trichloroethane	< 1.24E-06
Benzene	< 8.51E-07
Carbon Tetrachloride	< 1.43E-06
Trichloroethene	< 1.22E-06
Toluene	2.28E-06
Perchloroethylene	< 1.54E-06
Chlorobenzene	< 1.57E-06
m+p - Xylenes	< 1.32E-06
Styrene	< 1.29E-06
o-Xylene	< 1.32E-06
1,4-Dichlorobenzene	< 1.37E-06

1.0 Executive Summary (Continued)

Table 1-3 presents the gas analysis collected and analyzed by LACSD.

**Table 1-3
BRT Process Clean Gas Produced, Stored and Used for Source Test**

Compound Name	Units	Result	Result	Result	Result	Result	Result
		<i>12/09/09 0850 Tanks 2-4</i>	<i>12/09/09 1215 Produced</i>	<i>12/10/09 0825 Tanks 2-4</i>	<i>12/10/09 1255 Produced</i>	<i>12/11/09 0845 Tanks 2-4</i>	<i>12/11/09 1240 Produced</i>
Carbon Dioxide*	%v/v	20.6	22.8	18.4	20.1	21.0	18.8
Hydrogen*	%v/v	34.3	40.3	29.5	31.9	32.9	37.0
Carbon monoxide*	%v/v	11.7	13.6	10.2	12.3	11.7	9.6
Methane*	%v/v	18.7	11.7	29.5	11.9	15.2	10.4
Ethane*	%v/v	1.9	1.9	1.9	2.0	1.8	1.7
Ethylene*	%v/v	1.6	2.0	1.5	1.9	1.7	1.6
Argon*	%v/v	0.14	0.07	0.11	0.17	0.13	0.19
Nitrogen*	%v/v	13.8	8.8	11.6	17.7	13.8	18.8
Oxygen*	%v/v	<0.2	<0.2	0.5	<0.2	<0.2	<0.2
n-Propyl Mercaptan**	ppmv	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2
Carbonyl Sulfide**	ppmv	0.4	0.4	3.0	5.0	24.0	9.0
Dimethyl Disulfide**	ppmv	0.7	0.3	0.3	0.2	0.3	<0.2
Methyl Mercaptan**	ppmv	<0.1	0.3	0.1	<0.1	0.4	<0.2
Ethyl Mercaptan**	ppmv	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2
Carbon Disulfide**	ppmv	0.2	0.4	<0.1	<0.1	<0.2	<0.2
Dimethyl Sulfide**	ppmv	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2
Isopropyl Mercaptan**	ppmv	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2
Hydrogen Sulfide**	ppmv	<0.1	1.4	0.1	2.2	0.7	130

* Method SM 2720C (Bag)

** Method AQMD 307.91 High

1.0 Executive Summary (Continued)

Table 1-4

**SUMMARY OF SOURCE TEST RESULTS - SCAQMD LIMITS
BRT
LACSD Carson
December 10 & 11, 2009**

Parameter	Average	Permit Appl. Values
NOx:		
ppm @ 3% O ₂	12.34	30
lb/hr	0.0035	0.029
CO:		
ppm @ 3% O ₂	32.39	400
lb/day	0.006	0.2370
SOx, lb/hr	0.0016	0.00046
PM₁₀, lb/hr	0.001	0.0057
PAH (excluding naphthalene):		
lb/hr (at full detection levels)	< 2.51E-07	7.62E-08
lb/hr (at 1/2 detection levels)	2.43E-07	7.62E-08
Formaldehyde, lb/hr	2.93E-04	1.30E-05
Acetaldehyde, lb/hr	1.41E-05	3.28E-06
Acrolein, lb/hr	< 5.93E-06	2.06E-06
Benzene, lb/hr	< 8.51E-07	6.10E-06
Toulene, lb/hr	2.28E-06	2.79E-05
Xylene, lb/hr	< 2.63E-06	2.07E-05

2.0 Introduction

The employed test methods can be found in Table 2-1. The testing sampling log can be found in Table 2-2.

**TABLE 2-1
TESTING METHODOLOGIES
GASIFIER EXHAUST**

Parameter	Reference Method	Measurement Principle	Time	Runs
CH ₄ , TGNMO ⁽²⁾	SCAQMD 25.3	TCA/FID	60 min	1 tray
O ₂ , CO ₂ , N ₂ , CO, NO _x ⁽¹⁾	SCAQMD 100.1	CEM	60 min	1
Total Particulate/SO _x ⁽¹⁾	SCAQMD 5.2/6.1	Wet Impingement/ Gravimetric/Titration	110 min	1
NH ₃ ⁽¹⁾	SCAQMD 207.1	Wet Impingement/ ISE	40 min	1
Flow Rate and Temperature ⁽¹⁾	SCAQMD 2.1	Pitot Traverse	Varies	3
Lead and Mercury ⁽⁶⁾	CARB 436	Wet Impingement/ICP/GFAA	120 min	1
Trace Organic Compounds ⁽³⁾ (see Table 2)	EPA TO-15	GC/MS	60 min	3
Aldehydes and Acrolein ⁽⁴⁾	CARB 430	DNPH Solution	60 min	3
PAHs ⁽⁵⁾	CARB 429	XAD-2 Resin Trap	120 min	1
Dioxins/Furans ⁽⁵⁾	CARB 428	XAD-2 Resin Trap	127 min	1

⁽¹⁾ SCEC Laboratory, ⁽²⁾ AAC Laboratory, ⁽³⁾ AtmAA Laboratory, ⁽⁴⁾ Air Toxics Laboratory, ⁽⁵⁾ Vista Laboratory, ⁽⁶⁾ Exova Laboratory.

All raw data was reduced and used to calculate the final results as listed in Section 4. Computer programs that have passed quality control inspections performed the calculations.

Latif Mahjoob from ACTI and Cornelius Shields, IV from BRT coordinated the testing program. The testing was performed by Leslie Johnson – President / Senior Project Manager, and Joe Adamiak – Project Scientist and Mark Ake - Sampling Technician from SCEC.

2.0 Introduction (Continued)

**TABLE 2-2
SAMPLING LOG**

Parameter	Test Run	Test Date	Test Time
VOC	1	12/9/09	1122-1245
	2	12/10/09	1106-1206
	3	12/10/09	1223-1330
Aldehydes	1	12/10/09	1106-1206
	2	12/10/09	1224-1323
	3	12/11/09	1201-1303
PAH – M429	1	12/10/09	1130-1330
PM/SO _x – M5.2/6.1	1	12/11/09	1102-1118, 1200-1334
Dioxin/Furans – M23	1	12/10/09	1124-1331
Metals – M436	1	12/11/09	1200-1400
NO _x , CO and O ₂	1	12/11/09	1203-1403
TGNMNEO	1	12/11/09	1105-1245
NH ₃ – M207.1	1	12/11/09	1316-1356

3.0 Equipment and Process Description

The BRT process is a closed system that consists of two sub-systems. The first part of the system is responsible for the pyrolytic disintegration of Waste Tires. Tires are heated to temperatures between 750°F to 1050°F under vacuum conditions. The process then captures remaining gases and removes dust and dirt particles. The BRT process is also designed to capture and separate all heavy metals from the gas stream during the gas cleanup procedure. The venturi separator is designed to remove liquid droplets and heavy particles while cooling the gas stream. During this process, most metals and gas particles will separate from the gas stream and drop to the bottom of the first holding tank where metals can be recaptured and augured out. A few lighter particles, which travel through the heat exchanger, will be captured at the bottom of the second holding tank. Therefore, the gas used for combustion will not contain any metallic dust.

In the second part of the system, the gas is de-watered and conditioned for the liquefaction portion of the process. During liquefaction the gas is pre-conditioned by removing hydrogen sulfide and carbon dioxide (H₂S and CO₂). It is then reformed with steam in the presence of a catalyst into synthesis gases hydrogen and carbon monoxide (H₂ and CO). The liquid is collected, cleaned and segregated from the gas using a built-in distillation column.

Testing was conducted from the newly installed 5.75 inch horizontal duct. Several ports were installed to facilitate the numerous samples that were collected simultaneously. Twelve points (6 points per port) were measured at the beginning of each test day. The average pressure drop value (delta P) was used for all isokinetic tests. Single point sampling, center of the stack, was performed for all tests.

4.0 Discussion of Results

The testing was performed according to the reference methods. All isokinetic rates during testing were within the 100% ±10% tolerance.

The gasifier system was operated to ensure that 2-3 hours of operation could be completed at one time.

The detailed quality assurance quality control data package can be provided in magnetic format (compact disc).

All test methods that sample volume has a direct impact on the detection limits, all but VOC and TGNMNEO, had compounds detected. Due to the process operation sample volumes collected, detections were lower than originally planned. Since several compounds were detected the sample volume collected is considered to be sufficient.

4.0 Discussion of Results (Continued)

The lead test, CARB Method 436, had elevated field blank results higher than the sample. The values reported in Table 1-1 reflect lead emissions based on the analytical detection limit. Aldehyde sampling, CARB Method 430, found no acrolein. All values stated in Table 1-1 are based on the analytical detection limit. Acetaldehyde results were consistent for all three samples. Formaldehyde results show very little consistency from run to run with the results from December 11, 2009 being the highest. No process upset occurred while the December 11, 2009 testing was conducted.

Sampling procedures were done in strict adherence to the identified test methods, but the required sample repetitions were not collected due to limited operations of the facility. Due to the limited operations some methods were combined. Due to the on-site gas storage the process was operated for 3-4 hours at a time.

5.0 Sampling Methodology

The field sampling procedures that were used for this test program are described in this section. The purpose of this section is to provide an overview of the sampling methods.

5.1 Measured Stack Gas Flow Rate by SCAQMD Methods 1.1 to 4.1

Velocity traverses were performed in conjunction with all the isokinetic sampling moisture trains according to SCAQMD Method 1.1 to 4.1 to determine an average “measured” dry standard flow rate (DSCFM) of the stack gas. The average measured DSCFM was also used to calculate NO_x and CO emission rates in units of lb/hr according to the following equation.

$$\text{lb/hr} = [\text{ppmv}] [1.583 \times 10^{-7}] [\text{MW}_{\text{pollutant}}] [\text{DSCFM}]$$

Where: ppmv = pollutant concentration
MW_{pollutant} = Molecular weight of pollutant

SCAQMD METHOD 1.1 - SAMPLING AND VELOCITY TRAVERSE FOR STATIONARY SOURCES

A preliminary source test site assessment was performed prior to the source test in order to determine applicable testing port locations and sample point traverse locations. The stack diameter, and the distance from sample ports to disturbances, i.e. bends, flanges, etc., both upstream and downstream, were measured. This information was utilized to determine the minimum number of sampling points per traverse, and the distance from the inner stack wall to each sample point location. Additionally, this method takes into account cyclonic flow patterns and *in situ* stratified pollutant concentrations.

SCAQMD METHOD 2.1 - VELOCITY AND VOLUMETRIC FLOW RATE

The velocity of the gas stream was determined by using an "S" type pitot tube, an inclined manometer and type "K" thermocouple with a digital temperature-measuring device. The calibrated pitot tube was connected to the manometer and leak checked. A temperature and velocity pressure (delta P) was obtained at each traverse point, and a duct static pressure was measured and recorded. The dry volumetric flow rate was determined from the gas velocity data, stack pressure, stack gas moisture content, stack gas molecular weight, and cross-sectional area of duct.

SCAQMD METHOD 3.1 - GAS ANALYSIS FOR DRY MOLECULAR WEIGHT AND EXCESS AIR

Volume fractions of O₂ and CO₂ expressed in percent were determined from SCAQMD Method 100.1 sampling system. These values were used for calculating the dry molecular weight of the flue gas.

5.0 Sampling Methodology (Continued)

SCAQMD METHOD 4.1 - DETERMINATION OF MOISTURE CONTENT IN STACK GASES

Moisture content was determined using a sampling train consisting of a stainless steel probe, Teflon™ line, four impingers in an ice water bath, leak free pump, vacuum gauge, and temperature compensated dry gas meter. Prior to sampling a leak check of the sampling train was performed to insure system integrity. Additionally, tare weights of the charged individual impingers were recorded using an electronic top loader balance capable of weighing to the nearest 0.1 grams or less.

After sampling, the final weights of each impinger were determined and recorded. Percent moisture content was calculated from the weight of water collected and the dry gas volume sampled.

Equations:

$$\text{Moisture (B}_w\text{)} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}} \times 100$$

$$\text{Where: } V_{wstd} = \frac{0.0464 \text{ ft}^3}{\text{ml}} \times \text{Vol. H}_2\text{O Collected (ml)}$$

$$V_{mstd} = Y \text{ Meter} \times \frac{520 \text{ }^\circ\text{R}}{29.92 \text{ in Hg}} \times \frac{\text{Vol. Metered}}{\text{Meter}} \times \text{Meter Pressure}$$

5.0 Sampling and Analytical Procedures (Continued)

5.2 EPA Method 23 – Determination of PCDD and PCDF Emissions

INTRODUCTION

PCDD and PCDF concentrations and emission rates were determined by wet impingement following EPA Method 23. A quartz probe with an integral quartz nozzle was used to sample the exhaust stream. The sample train consists of the probe and nozzle, a heated particulate filter, condenser and sorbent module, followed by an impinger train. A thermocouple and a pitot probe are attached to the probe to facilitate isokinetic sampling at each of the traverse points.

SAMPLING PROCEDURE

The sample was drawn isokinetically through a nozzle and a pre-cleaned Teflon™ filter. From the filter, the sample transferred to the condenser and sorbent module through flexible Teflon™ tubing.

The impinger train immediately follows the sorbent module and consists of five impingers in series. The first and fourth impingers are empty, the second and third impingers contain 100 ml of DI H₂O, and the fifth impinger contains silica gel to protect the leak-tight vacuum pump and calibrated dry gas meter from moisture.

All surfaces in contact with the sample were pre-cleaned and constructed of Teflon™, quartz, or borosilicate glass.

After testing, the impingers were weighed for moisture determination and the following sample recovery procedure was followed:

- (1) Nozzle, probe, and front half of the filter holder were brushed then sequentially rinsed with known volumes of acetone and methylene chloride, three times each. All rinses were contained for analysis.
- (2) Nozzle, probe, and front half of the filter holder were brushed and rinsed with toluene three times. All rinses were contained for analysis.
- (3) Filter was removed from the filter holder and transferred to a sealed container.
- (4) Back half of the filter holder, transfer line, and the condenser were rinsed three times each with known volumes of acetone and methylene chloride, three times each. All rinses were contained for analysis.
- (5) Back half of the filter holder, transfer line, and the condenser were rinsed with toluene three times. All rinses were contained for analysis.
- (6) XAD-2 resin trap was capped with pre-cleaned aluminum foil and stored for analysis.

Vista Analytical Laboratory in El Dorado Hills, California, analyzed the samples according the method specifications.

5.0 Sampling and Analytical Procedures (Continued)

5.3 CARB Method 429 – Polycyclic Aromatic Hydrocarbon (PAH) Emissions

INTRODUCTION

The Method 429 sampling train was used to extract and concentrate gaseous and particulate phase Polycyclic Aromatic Hydrocarbons (PAH). The extract was analyzed for PAH by Gas Chromatography/Mass Spectrometry (GC/MS) using an isotope dilution technique.

SAMPLE TRAIN PREPARATION

Nozzle, probe, filter holder, and impingers were pre rinsed with Distilled/Deionized water, Acetone, Hexane, and MeCl. 100ml of NaHCO₃/Na₂CO₃ was placed in the first and second impingers, the third impinger was left empty, and the fourth impinger was filled with approximately 400 grams of Silica gel. The filter holder was charged with a Teflon fiber filter.

SAMPLING PROCEDURE

The apparatus consisted of a quartz nozzle, quartz probe, heated filter holder, condenser, and XAD-2 resin trap, followed by a series of impinger/absorbers connected in tandem and immersed in an ice/water bath. In addition, both the condenser and the XAD-2 resin trap were enclosed within a circulating cold water blanket. The absorption train was followed by a vacuum pump, dry gas meter, and a calibrated restriction orifice fitted with a manometer.

After determining suitable sampling points and nozzle size, the apparatus was leak tested, the filter temperature brought to above 225°F, and the nozzle was positioned and adjusted to obtain the isokinetic sampling rate.

Duct conditions were monitored throughout the sampling period with a type "S" pitot tube and a type "K" thermocouple simultaneously positioned at each traverse point. Conditions at the sampling apparatus and metering device were constantly monitored and regularly recorded on the data sheet.

On completion of the sampling, the apparatus was removed from the stack, leak checked, and transported to the mobile laboratory for recovery.

5.0 Sampling and Analytical Procedures (Continued)

5.3 CARB Method 429 – Polycyclic Aromatic Hydrocarbon (PAH) Emissions (Continued)

SAMPLE RECOVERY

<u>Container No.</u>	<u>Item</u>	<u>Rinsing Solution</u>	<u>Quantity</u>
1	Filter	N/A	N/A
2	Front Half	Acetone, Hexane, and MeCl	100 ml ea
3	Back Half	Acetone, Hexane, and MeCl	100 ml ea
4	First Impinger	Acetone, Hexane, and MeCl	50 ml ea
5	Second Impinger	Acetone, Hexane, and MeCl	50 ml ea
6	DI H ₂ O Blank	DI H ₂ O	100 ml
7	Methanol Blank	Acetone	200 ml
8	Toluene Blank	Hexane	200 ml
9	MeCl Blank	MeCl	200 ml

SAMPLE ANALYSIS

The filter was removed and recovered. Sample was recovered from the nozzle, probe sections and filter housing with Distilled/Deionized water, Acetone, Hexane, MeCl, and Teflon bristle brush. Impinger liquid was removed and recovered. The XAD-2 resin trap was sealed from contamination and forwarded to the appropriate analytical Laboratory for analysis. During sample holding time all samples are maintained between 0-4°C.

The samples were analyzed according the method specifications by Vista Analytical Laboratory in El Dorado Hills, California.

5.0 Sampling and Analytical Procedures (Continued)

5.4 SCAQMD Method 25.3 – Total Gaseous Non-Methane Non-Ethane Organics

The Method 25.3 sampling apparatus was used to collect low concentration total gaseous non-methane non-ethane organics (TGNMNEO) in a six (6) liter evacuated SUMMA canister and ice water trap. The ice-water trap collects TGNMNEO condensable to 32 °F.

The sample was collected through a stainless steel probe connected by Teflon™ line to the ice water chilled trap regulated by a stainless steel critical orifice flow controller with vacuum/pressure gauge and drawn by an evacuated canister. Sampling began with the canister at 30 inches Hg vacuum and was complete when vacuum dropped to 6 inches Hg in approximately 40 minutes.

The sample was collected and analyzed in two parts; condensable (ice-water trap) and non-condensable (canister). Both fractions were analyzed separately and reported as TGNMNEO in ppmv as methane (CH₄).

EQUATIONS:

$$\text{TGNMNEO } \frac{\text{lb}}{\text{hr}} = \text{TGNMNEO ppmv} \times \text{DSCFM} \times \text{MW} \times \text{CF}$$

Where:

TGNMNEO ppmv = Total Gaseous Non-Methane Non-Ethane Organics in Parts per Million by Volume

DSCFM = Dry Standard Cubic Feet Per Minute

MW = Molecular Weight (lb/lb mole)

CF = Conversion Factor = 1.583 E-07 @ 60 °F Std.

5.0 Sampling and Analytical Procedures (Continued)

5.5 SCAQMD Method 100.1/EPA Methods 3A, 7E and 10

NO_x, CO, O₂, AND CO₂ Continuous Emissions Monitoring for Stationary Sources

Ref: South Coast Air Quality Management District (SCAQMD), Office of Operations Technical Services Division, March 1989, Method 100.1
EPA Code of Federal Regulations, Title 40, Part 60, Appendix A, Methods 3a, 7e, 10, 2006

A continuous sample was extracted from the stack through a stainless steel probe, coarse filter, heated sample line, sample conditioner (condensate train) and then drawn via 3/8" Teflon™ sample line to the analyzers. The sample was filtered again through a fine Balston filter and finally delivered to the analyzers through the sample manifold and dedicated flow meters.

Prior to beginning the compliance test, a system leak check and calibration check was performed. The leak check was accomplished by plugging the probe tip and drawing approximately 25" Hg vacuum on the entire sampling system. When all flow meters indicate 0.00 scfh flow, the system was proven to be free of all leaks.

A calibration error checks (CE) was performed before and after each run. The CE was performed as follows: The span range for each analyzer was selected to attempt to achieve pollutant and diluent concentrations which are above 30% and 20% of span, respectively. However, if concentrations are very low, these criteria may not be achievable due to the limits of detection of the individual analyzers. After zeroing all analyzers with ultra pure nitrogen, EPA Protocol 1 gases were used to calibrate each analyzer within 80-90% full scale of the selected range. Each analyzer, individually, was then spanned within 40-60% of the selected range by introducing a second EPA Protocol 1 gas.

Immediately following the CE, and before and after each sampling run, a system bias check (SB) was performed for each analyzer. The SB was performed as follows: A zero bias check is accomplished by sending nitrogen through the entire sample system via a three way valve, located between the probe and heated sample line, until a stable response is recorded. A calibration bias check was performed by sending either the upper (80-90%) or mid scale (40-60%) calibration gas through the sample system until a stable response is recorded.

All concentrations from the NO_x, CO, CO₂, and O₂ analyzers were recorded on a Yokogawa DR240 recorder connected to a data acquisition system (DAS). The data was interpreted from the DAS output, strip charts and reduced via computer in SCEC's Laboratory.

5.0 Sampling and Analytical Procedures (Continued)

5.5 SCAQMD Method 100.1/EPA Method 3A, 7E and 10 (Continued)

NO_x, CO, O₂, AND CO₂ Continuous Emissions Monitoring for Stationary Sources (Continued)

CALCULATIONS

$$C_{\text{gas}} = \frac{(\bar{C} - C_o) * C_{\text{ma}}}{(C_m - C_o)}$$

Where: C_{gas} = drift corrected gas concentration, ppmvd or %vd.

\bar{C} = average gas concentration indicated by analyzer, ppmvd.

C_o = average of initial and final zero bias check responses, ppmvd.

C_m = average of initial and final system calibration responses, ppmvd.

C_{ma} = certified concentration of the upscale calibration gas, ppmvd.

5.0 Sampling and Analytical Procedures (Continued)

5.6 SCAQMD Method 5.2/6.1 – Particulate Matter Emissions

A series of preliminary measurements were made prior to conducting the particulate test. Data collected on the morning of December 10 and 11, 2009 was used to determine location and number of traverse points, average gas velocity, gas molecular weight and percent moisture content. The results of these measurements were used to determine the appropriate nozzle size for isokinetic sampling.

SAMPLING PROCEDURES:

Prior to sampling, the Method 5.2/6.1 absorption train was charged as such; the first impinger contained distilled water, the second and third impingers contained 3% hydrogen peroxide, the fourth impinger was empty and the fifth impinger contained silica gel. The sample train was weighed on a top loading balance to the nearest 0.1 grams. The sample probe was cleaned by rinsing and brushing the probe three times with water. The filter was placed in the filter holder. The Method 5 sampling apparatus was sealed and transported to the sampling location where it was completely assembled and leak tested. The filter temperature was set at 250 +/- 25° F, and the probe was positioned into the duct at the middle traverse point with the nozzle out of the flow.

The nozzle was positioned into the gas flow and the vacuum pump started immediately and adjusted to obtain an isokinetic sample rate. Duct conditions (temperature, delta-P) and sampling conditions (meter temperature, meter volume, meter pressure, filter temperature, impinger temperature, and absorption train vacuum) were monitored and recorded regularly for each sample point.

Upon completion of sampling, the apparatus was leak checked at a vacuum greater than the highest observed vacuum. The Teflon™ filter-to-impinger line was rinsed with a known amount of IPA and combined with the first impinger contents.

The absorption train was inspected for abnormalities and disassembled. The impingers were weighed on a top loading balance for a percent moisture determination. The contents of the impingers and rinses was quantitatively transferred into a separate sample bottle, sealed, labeled, and the fluid level marked prior to transportation to the SCEC laboratory for analysis. PM results are reported as the sum of the probe wash, filter and impinger fraction.

The impinger catches were analyzed at SCEC' analytical laboratory using barium thorian titration for total SO₃ and SO₂.

5.0 Sampling and Analytical Procedures (Continued)

5.7 CARB Method 436 – Determination of Heavy Metal Emissions

INTRODUCTION

The CARB Method 436 sampling train was used to extract the sample from the stack to determine metals emissions from stationary sources. The samples were digested, and appropriate fractions were analyzed for mercury by cold vapor atomic absorption spectroscopy (CVAAS) and for lead by inductively coupled plasma mass spectroscopy (ICMS).

SAMPLE TRAIN PREPARATION

All glass components up to and including the adsorbent module were cleaned as described as stated in CARB 436. The sampling train was composed of six impingers. 100ml of HNO₃/H₂O₂ absorbing solution was placed in the first and second impingers, leaving the third impinger empty. 100 ml of acidic KMnO₄ absorbing solution was placed in the fourth and fifth impingers and the sixth was filled with approximately 400 grams of silica gel. The filter holder was charged with a quartz fiber filter.

SAMPLING PROCEDURE

The apparatus consisted of a quartz nozzle, quartz probe and a heated filter holder followed by a series of impinger/absorbers connected in tandem and immersed in an ice bath. The absorption train was followed by a vacuum pump, dry gas meter, and a calibrated restriction orifice fitted with a manometer.

After determining suitable sampling points and nozzle size, the apparatus was leak tested, the filter temperature brought to above 225°F, and the nozzle was positioned and adjusted to obtain an isokinetic sampling rate.

Duct conditions were monitored throughout the sampling period with a type "S" pitot tube and a type "K" thermocouple simultaneously positioned at each traverse point. Conditions at the sampling apparatus and metering device were constantly monitored and regularly recorded on the data sheet.

On completion of the sampling, the apparatus was removed from the stack, leak checked, and transported to the mobile laboratory for recovery.

5.0 Sampling and Analytical Procedures (Continued)

5.7 CARB Method 436 – Determination of Heavy Metal Emissions (Continued)

SAMPLE RECOVERY

<u>Container No.</u>	<u>Item</u>	<u>Rinsing Solution</u>	<u>Quantity</u>
1	Filter	N/A	
2	Probe Rinse	0.1 N HNO ₃	100 ml
3	Impingers 1-2	0.1 N HNO ₃	100 ml
5	Impinger 3	0.1 N HNO ₃	100 ml
6	Impingers 4-5	fresh acidic KmnO ₄ /DI H ₂ O	100 ml each
7	0.1 N HNO ₃ Blank	N/A	300 ml
8	DI H ₂ O Blank	N/A	300 ml
9	HNO ₃ /H ₂ O ₂ Blank	N/A	200 ml
10	KmnO ₄ Blank	N/A	100 ml
11	Filter Blank	N/A	

RECOVERY PROCEDURE

1. The filter was removed from the holder and place in labeled petri dish that was sealed and stored for analysis.
2. Probe nozzle, liner and front half of the filter holder were rinsed with 100 ml of 0.1 N HNO₃. The rinsed was placed in a labeled sample bottle that was sealed and stored for analysis. The nozzle, liner, and front half of filter holder were rinsed with water followed by acetone. These rinses were discarded.
3. The contents of impingers 1-2 were quantitatively measured and transferred to a labeled sample bottle. The impingers and back half of the filter holder and all connecting lines were rinsed with 100 ml of 0.1 N HNO₃. The rinse was added to the impinger contents and the sample bottle was sealed and stored for analysis.
4. The contents of impinger 3 were quantitatively measured and transferred to a labeled sample bottle. The impinger was rinsed with 100 ml of 0.1 N HNO₃. The rinse was added to the impinger contents and the sample bottle was sealed and stored for analysis.
5. The contents of impingers 4-5 were quantitatively measured and transferred to a labeled sample bottle. The impingers were rinsed with 100 ml fresh acidified KmnO₄ followed by 100 ml of DI H₂O. The rinses were added to the impinger contents and the sample bottle was sealed and stored for analysis.

5.0 Sampling and Analytical Procedures (Continued)

5.8 CARB Method 430 – Formaldehyde, Acetaldehyde and Acrolein Emissions

Introduction

The Method 430 sampling train was used to extract formaldehyde, acetaldehyde and acrolein emissions. The extract was analyzed for aldehydes by Air Toxics, Ltd. using High Performance Liquid Chromatograph (HPLC).

Sample Preparation

Probe and impingers were rinsed three times with DI H₂O and methanol. 10ml of DNPH was placed in the first and the second impinger, the third impinger was left empty, and the fourth impinger was filled with approximately 25 grams of silica gel. Between each run the sample line was replaced.

Sampling Procedure

The apparatus consisted of a quartz steel probe followed by a series of midget impinger/absorbers connected in tandem and immersed in an ice bath. The absorption train was followed by a vacuum pump, dry gas meter, and a calibrated restriction orifice fitted with a manometer.

The amount of sample volume required for each run was determined by the following equation:

$$\text{Sample Volume} = A \times \frac{100}{B} \times \frac{100}{C} \times \frac{1}{D}$$

where: A = The analytical minimum detection limit (ng)
B = Percent of the sample required per analytical run
C = Sample recovery (%)
D = Regulatory limit, or other target concentration (ng/DSCF)

The initial target aldehyde concentration was unknown. The planned sample volume (PSV) calculation was based on a minimum detection limit target of 1 ppmv. A sample rate of 0.5 l/min for 60 minutes was selected. Based on this selected rate and laboratory HPLC MDL the actual formaldehyde and acetaldehyde MDL were 13 ppbv and 9 ppbv, respectively.

On completion of the sampling, the apparatus was removed from the stack, leak checked, and transported to the laboratory. The sampling rate was 0.5 l/minute.

Impinger blanks were prepared and recovered with DNPH solution. The recovered samples served as field blanks. In addition, trip spikes and trip blanks were submitted for analysis. The sample results were corrected with the amount found in the field blank samples.

5.0 Sampling and Analytical Procedures (Continued)

5.9 SCAQMD Method 207.1 - Ammonia Emissions

Ammonia was collected according to SCAQMD Method 207.1 and analyzed using Ion Specific Electrode Method. A sample was extracted through a quartz probe fitted with a quartz nozzle pointed away from the gas flow. The sample was then drawn through four impingers. The first two impingers were filled with 100 ml of 0.1 N hydrochloric acid (HCl), the third was empty, and the fourth was filled with silica gel.

After the sampling was completed, a post test leak check was performed. The vacuum of the post-test leak check was increased until it exceeded the maximum vacuum achieved during the sampling test run. The impingers were then capped and the train returned to the laboratory. The impingers were weighed and the contents of the first three impingers were transferred to a 500ml-graduated cylinder. The impingers and connecting glassware were rinsed with de-ionized water into the graduated cylinder containing the impinger catch. The sample volume was increased to 500ml with the addition of de-ionized water and the contents transferred to a Nalgene jar and stored on ice until time for analysis. Analysis is done in-house by an Ion Specific Electrode.

5.10 Nomenclature and Equations for Sampling and Analytical Procedures

An	=	Cross-sectional area of nozzle (ft ²)
delta H	=	Average pressure differential across the orifice meter, (in H ₂ O)
Gs	=	Total mass of analytes in stack gas sample, (ng)
%I	=	Isokinetic Rate
K5	=	Applicable conversion factor
Mn	=	Total weight of pollutant collected, mg
Pbar	=	Barometric pressure at measurement site, (in Hg)
Ps	=	Absolute stack gas pressure, (in Hg)
Theta	=	Total sampling time (min)
Tm	=	Absolute temperature at meter, (°R)
Tstd	=	Standard absolute temperature, (520°R)
Vlc	=	Volume of water condensed in impingers and silica gel, (ml)
Vm	=	Dry gas volume measured by dry gas meter, (dcf)
Vmstd	=	Dry gas volume measured by dry gas meter, corrected to standard conditions, (dscf)
Vs	=	Average stack gas velocity, (ft/sec)
Y	=	Dry gas meter calibration factor

5.0 Sampling and Analytical Procedures (Continued)

5.10 Nomenclature and Equations for Sampling and Analytical Procedures (Continued)

EQUATIONS

Sample Gas Flow

$$Vmstd = Vm * Y * \frac{(Tstd)}{Tm} * \frac{(Pbar + 13.6)}{Pstd} \frac{\Delta H}{}$$

Pollutant Concentrations

$$\frac{ng}{dscm} = \frac{Ks * Gs}{Vm(std)}$$

Isokinetic Variation

$$\%I = \frac{100 * Ts * Vlc * K3 + Vm * Y / Tm * (Pbar + 13.6) \frac{\Delta H}{}}{60 * Theta * An * Vs * Ps}$$

Where K3 = 0.002669 in Hg - Ft₃/ml - °R