



TEST REPORT

SULFUR DIOXIDE COMPLIANCE EMISSIONS TESTING

GREAT LAKES WATER AUTHORITY (GLWA)

JANUARY 15, 2019

PREPARED FOR: NEFCO
500 Victory Road
Quincy, MA 02171

CONCERNING: Sulfur Dioxide Compliance Testing
Detroit Biosolids Drying Facility
Four (4) Dryer Trains
9125 W. Jefferson Avenue
Detroit, MI 48209

PREPARED BY: CK Environmental, Inc.
1020 Turnpike Street, Suite 8
Canton, MA 02021

CK Project No. 5468

B2103-TEST-20181212



REPORT REVIEW CERTIFICATION

We, the undersigned, hereby certify that we have personally reviewed and are knowledgeable of the information presented in the Test Report. We believe that all submitted information and calculations contained here in are true, accurate, and complete. CK has accreditation by A2LA and operates in conformance with the ASTM D7036-04 requirements.

Prepared by: *Ale Kuncaitis*
Ale Kuncaitis, Project Engineer

Reviewed by: *Michael Kelley*
Michael Kelley, QSTI, Project Manager

Approved by: *Michael Kelley*
Michael Kelley, President



TABLE OF CONTENTS

- 1.0 Introduction
- 2.0 Facility Description
 - 2.1 Process Description
 - 2.2 Process Parameters
- 3.0 Test Program
 - 3.1 Objectives
 - 3.2 Test Matrix
 - 3.3 Deviations of Test Plan
 - 3.4 Summary of Results
- 4.0 Sampling Locations
- 5.0 Sampling and Analytical Procedures
 - 5.1 Test Methods – Emissions Testing
 - 5.1.1 Flow Rate and Moisture – EPA Methods 1-4
 - 5.1.2 Oxygen/Carbon Dioxide - EPA Method 3A
 - 5.1.3 Sulfur Dioxide – EPA Method 6C
 - 5.2 Emissions Sampling Procedures
 - 5.2.1 Flow and Moisture Sampling Procedures
 - 5.2.2 CEMS Sampling System and Procedures (O₂, CO₂, SO₂)
 - 5.3 Stratification Check
- 6.0 Quality Assurance/Quality Control
 - 6.1 General
 - 6.1.1 Sampling
 - 6.1.2 Analytical
 - 6.1.3 Reporting



TABLES

- 1-1 Key Personnel
- 3-1 Test Matrix – Emission Limits
- 3-2 Summary of Results – EUDryerTrain A
- 3-3 Summary of Results – EUDryerTrain B
- 3-4 Summary of Results – EUDryerTrain C
- 3-5 Summary of Results – EUDryerTrain D
- 4-1 Dryer/RTO Stack Train Exhaust Stack Dimensions
- 4-2 Exhaust Gas Flow Traverse Point Locations

FIGURES

- 4-1 Dryer/RTO Stack Train Exhaust Stack Diagram
- 5-1 Schematic of Typical RM CEM System

APPENDICES

- APPENDIX A REDUCED DATA
- APPENDIX B FIELD DATASHEETS
- APPENDIX C REFERENCE METHOD CEMS
- APPENDIX D PROCESS DATA
- APPENDIX E CALIBRATION DOCUMENTATION
- APPENDIX F SAMPLING LOCATION PICTURES



TEST SUMMARY

Facility Name: **Detroit Biosolids Drying Facility**
9125 W. Jefferson Avenue
Detroit, MI 48209

Facility Contact: **Perry Leong, Assistant Plant Manager**
pleong@nefcobiosolids.com

Facility Consultant: **NEFCO**
500 Victory Road
Quincy, MA 02171

Consultant Contact: **Manuel Irujo, VP of Operations**
mirujo@nefcobiosolids.com
(617) 376-2500 x 104

Regulatory Agency: **Michigan Department of Environmental Quality**
Air Quality Division, Technical Programs Unit
P.O. Box 30260
Lansing, MI 48909-7760

Regulatory Contact: **Regina Angellotti, Environmental Quality Analyst**
Angellottir1@michigan.gov
(313) 418-0895

Testing Organization: **CK Environmental, Inc.**
1020 Turnpike Street, Suite 8
Canton, MA 02021

Project Manager: **Michael Kelley, QSTI**
mkelley@ckenvironmental.com
(781) 828-5200

Test Personnel: Michael Kelley, Michael O'Connor

Test Methods: 1-4, 3A, 6C (SO₂)

Sources Tested: Four (4) Dryers – 1 Exhaust Stacks Per Dryer

Test Dates: December 12 & 13, 2018

Consent Order: AQD No. 7-2017

SRN: B2103



1.0 INTRODUCTION

CK Environmental was retained by NEFCO to perform compliance emission testing at the Great Lakes Water Authority Biosolids Drying facility, 9125 W. Jefferson Avenue, Detroit, MI. The purpose of this test program was to demonstrate and document continued performance of four Dryer Trains with respect to sulfur dioxide (SO₂) emissions. The SO₂ emission test program documented in this report occurred December 12 and 13, 2018.

The objective of this emission testing program was to determine the compliance status of four Dryer Trains operating at the Biosolids Drying Facility with respect to emissions of sulfur dioxide (SO₂). This program was conducted in order to comply with a Consent Order issued by the Michigan Department of Environmental Quality (MDEQ), Air Quality Division, which required testing each Dryer Train for SO₂ emissions only.

All testing and analysis was conducted in accordance with the applicable procedures as found in 40 CFR 60, Appendix A. The EPA Quality Assurance Handbook and the approved pretest protocol were adhered to as well. A detailed explanation of the methodology, procedures and equipment used to conduct the emission test program can be found in Section 5 of this report.

Michael Kelley of CK Environmental was responsible for the emissions compliance test program. He was assisted by Michael O'Connor. Perry Leong of NEFCO coordinated facility operations with the emissions testing. The MDEQ was the regulatory authority mandating the SO₂ emission test program. Regina Angellotti and Stephen Weis were the agency's representative and witnessed the test program. Table 1-1 provides contact information of pertinent parties.

Table 1-1
Key Personnel

Contact	Company Name	Telephone
Michael Kelley, Project Manager	CK Environmental, Inc.	(781) 828-5200
Manuel Irujo, Vice President of Operations	NEFCO	(617) 851-6297
Perry Leong, Assistant Plant Manager	NEFCO	(313) 551-5278
Mark Dziadosz Environmental Quality Analyst	MDEQ Air Quality Division	(586) 753-3745



2.0 FACILITY DESCRIPTION

2.1 Process Description

CK tested four dryer trains designated as EUDryerTrainA, EUDryerTrainB, EUDryerTrainC, and EUDryerTrainD. The biosolids dryer trains consist of a triple-pass rotary natural gas-fired dryer equipped with a low-NO_x burner and exhaust gas recirculation, a cyclone collector, a vibrating screener, a recycle bin, and a crusher. Emissions from each dryer train's cyclone exhaust through a three-stage impingement tray scrubber followed by a regenerative thermal oxidizer (RTO) followed by a packed tower liquid counterflow scrubber. Emissions from the recycle bin are controlled with a fabric filter collector. Each of the four dryer trains exhausts through two stacks (two stacks per dryer train).

The equipment used to prepare the feed to the dryer trains consists of eight sludge grinders (two per dryer train), eight electrically-powered dewatering centrifuges (two per dryer train), a cake bin and an enclosed pug mill from each dryer train, and conveyors to transfer materials. The facility also has a hot water heater, an air handling unit, and make-up air units for the building, all natural-gas fired.

The facility processes a blend of primary and waste activated sludge from the GLWA Water Resource Recovery Facility. Normal rated capacity of each dryer train is 105.4 dry tons per day with maximum capacity 10-15% higher.

A MDEQ consent order required Dryer Train/RTO stack testing for SO₂ emissions only.

2.2 Process Parameters

The following process and pollution control device operating parameters were monitored and recorded during the test program:

- feed rate of centrifuge cake as measured by liquid sludge flowmeters and % solids samples
- temperature in the RTO combustion chamber
- liquid flow rate to the impingement tray scrubber
- pressure drop across the impingement tray scrubber
- the pH of the impingement tray scrubber liquid effluent samples
- pressure drop across the recycle bin fabric filter collector
- liquid flow rate to the packed tower liquid scrubber, measured by magmeter
- the pH of the scrubber liquid in the packed tower liquid scrubber, measured by online pH probe

Appendix D contains the process data recorded during the test program.



3.0 TEST PROGRAM

3.1 Objectives

The objective of the testing program was to conduct sulfur dioxide emission testing from the four dryer trains utilized at the Detroit Biosolids Drying Facility (BDF) per the MDEQ Consent Order requirements. Emissions are reported in units of standard in accordance with emission limits presented in Table 3-1.

The following are the main objectives of this test program:

- Measure stack gas O₂/CO₂, and moisture content for emission calculation purposes
- Measure exhaust gas flow rate
- Conduct SO₂ testing at the exhaust stacks to determine compliance
- Obtain plant operational parameters for emission data reduction and validation

3.2 Test Matrix

The following table summarizes the pollutants monitored, the test methodologies used and the allowable emission limits. Each emission parameter was measured and analyzed in accordance with EPA and/or MDEQ-approved procedures as presented in the test protocol submitted to the MDEQ. A total of three test runs were performed on each dryer train and the average mass emission rate was used to determine the compliance status of the dryer trains.

Table 3-1
Test Matrix – Compliance Emission Limits

Pollutant	EPA Method(s)	Run Duration	SO₂ Emission Limits Dryer/RTO Stack
Flow Rate	1-2	Concurrent with other testing	N/A
O ₂ /CO ₂	3A	Concurrent with other testing	N/A
Moisture	4	Concurrent with other testing	N/A
SO ₂	6C	60 Minutes	0.82 lb/hr



3.3 Deviations from the Protocol

All test methods and procedures used during this test program were conducted in accordance with EPA and MDEQ-approved test methodology and the approved test protocol, except the following:

- On 12/12/18 while testing Train A Run 2 & Train B Run 1, moistures were found to be abnormally high. It was assumed that probe hit side wall and was pulling extra moisture. Due to high moisture, the volumetric flow was inaccurate as well. An extra moisture run was performed for Train A & Train B. This additional moisture run was combined with the average flow data from prior runs on the particular unit and used in calculations of emission rate. The probe was fixed to ensure it did not happen again. Regina Angelloti of MDEQ was on-site and aware of this.

3.4 Summary of Result

The results of the sulfur dioxide emission test program are summarized in Tables 3-2 to 3-5. These tables show that the Dryer Trains are in compliance with the emission limits imposed by the MDEQ in their Air Quality Division issued permit to operate. The tables also summarize the exhaust gas parameters measured from each Dryer Train. All data pertinent to arriving at the final results are presented in Appendices of this report.

Table 3-2
Summary of Results
EUDryerTrainA
Sulfur Dioxide Emissions

Test Run No. Date Time		Dryer Train A - Run 1 12/12/18 8:10 - 9:10	Dryer Train A - Run 2 12/12/18 9:25 - 10:25	Dryer Train A - Run 3 12/12/18 10:45 - 11:45	Average	Facility Permit Limit
Sample Conditions						
Volume	dscf ^a	31.989	24.300	25.625	27.305	
Volume	dscm ^b	0.906	0.688	0.726	0.773	
Stack Conditions						
Flow Rate	dscfm ^c	12,154	11,272	11,574	11,667	
Temperature	°F	125	122	123	123	
Moisture	%	16.8	10.7	13.8	13.8	
Oxygen	%	9.5	9.8	9.9	9.7	
Carbon Dioxide	%	6.6	6.5	6.5	6.5	
Sulfur Dioxide	PPM	0.0	0.0	0.0	0.0	
Sulfur Dioxide	PPM@15% O ₂	0.0	0.0	0.0	0.0	
Sulfur Dioxide	lb/hr	0.00	0.00	0.00	0.00	0.82

Note: SO₂ Run 2 using Flow & Moisture Run 3; SO₂ Run 3 using extra moisture & 3 run avg flow data

a) dry standard cubic feet

b) dry standard cubic meters

c) dry standard cubic feet per minute



Table 3-3
Summary of Results
EUDryerTrainB
Sulfur Dioxide Emissions

Test Run No.		Dryer Train B - Run 4	Dryer Train B - Run 5	Dryer Train B - Run 6	Average	Facility Permit Limit
Date		12/12/18	12/12/18	12/12/18		
Time		12:50 - 13:50	14:06 - 15:06	15:20 - 16:20		
Sample Conditions						
Volume	dscf ^a	25.325	21.352	26.765	24.481	
Volume	dscm ^b	0.717	0.605	0.758	0.693	
Stack Conditions						
Flow Rate	dscfm ^c	10,128	10,128	10,236	10,164	
Temperature	°F	121	125	120	122	
Moisture	%	14.3	16.9	12.8	14.7	
Oxygen	%	9.0	9.0	8.8	8.9	
Carbon Dioxide	%	6.9	6.9	7.0	6.9	
Sulfur Dioxide	PPM	0.2	0.1	0.1	0.1	
Sulfur Dioxide	PPM@15% O ₂	0.1	0.0	0.0	0.1	
Sulfur Dioxide	lb/hr	0.02	0.01	0.01	0.01	0.82

Note: For SO₂ emission rate, the next Flow & Moisture data runs were used (i.e. SO₂ Run 4 used F&M Run 5, etc.)

- a) dry standard cubic feet
- b) dry standard cubic meters
- c) dry standard cubic feet per minute

Table 3-4
Summary of Results
EUDryerTrainC
Sulfur Dioxide Emissions

Test Run No.		Dryer Train C - Run 7	Dryer Train C - Run 8	Dryer Train C - Run 9	Average	Facility Permit Limit
Date		12/13/18	12/13/18	12/13/18		
Time		8:16 - 9:16	9:28 - 10:28	10:40 - 11:40		
Sample Conditions						
Volume	dscf ^a	25.881	25.771	25.569	25.740	
Volume	dscm ^b	0.733	0.730	0.724	0.729	
Stack Conditions						
Flow Rate	dscfm ^c	11,402	10,549	10,683	10,878	
Temperature	°F	125	128	128	127	
Moisture	%	13.2	15.1	14.1	14.1	
Oxygen	%	8.3	8.4	8.9	8.5	
Carbon Dioxide	%	7.4	7.3	7.0	7.2	
Sulfur Dioxide	PPM	0.0	0.2	0.4	0.2	
Sulfur Dioxide	PPM@15% O ₂	0.0	0.1	0.2	0.1	
Sulfur Dioxide	lb/hr	0.00	0.02	0.04	0.02	0.82

- a) dry standard cubic feet
- b) dry standard cubic meters
- c) dry standard cubic feet per minute



Table 3-5
Summary of Results
EUDryerTrainD
Sulfur Dioxide Emissions

Test Run No.		Dryer Train C - Run 10	Dryer Train C - Run 11	Dryer Train C - Run 12	Average	Facility Permit Limit
Date		12/13/18	12/13/18	12/13/18		
Time		12:34 - 13:34	13:54 - 14:54	15:12 - 16:12		
Sample Conditions						
Volume	dscf ^a	25.945	23.570	26.078	25.198	
Volume	dscm ^b	0.735	0.668	0.739	0.714	
Stack Conditions						
Flow Rate	dscfm ^c	12,179	12,225	12,294	12,233	
Temperature	°F	138	141	135	138	
Moisture	%	17.9	20.2	17.8	18.6	
Oxygen	%	9.7	9.6	11.2	10.2	
Carbon Dioxide	%	6.6	6.6	5.7	6.3	
Sulfur Dioxide	PPM	0.7	0.6	0.6	0.6	
Sulfur Dioxide	PPM@15% O ₂	0.4	0.3	0.4	0.3	
Sulfur Dioxide	lb/hr	0.09	0.07	0.07	0.08	0.82

- a) dry standard cubic feet
- b) dry standard cubic meters
- c) dry standard cubic feet per minute



4.0 SAMPLING LOCATIONS

The dryer trains exhaust through two stacks. One stack exhausts the Dryer and ancillary RTO and one stack exhausts a Recycle Bin. The Dryer/RTO stack height is 130 feet and has an internal diameter of 30 inches. The Recycle Bin stack height is 130 feet and has an internal diameter of 8.0 inches. Testing was conducted from (2) four inch sample access ports installed in the Dryer/RTO stack. The upstream and downstream disturbance distances were verified by test personnel while onsite to determine the appropriate number of sampling points. The sampling location is accessed from the roof. Appendix F contains pictures of the sampling locations typical of the Dryer Train exhaust stacks.

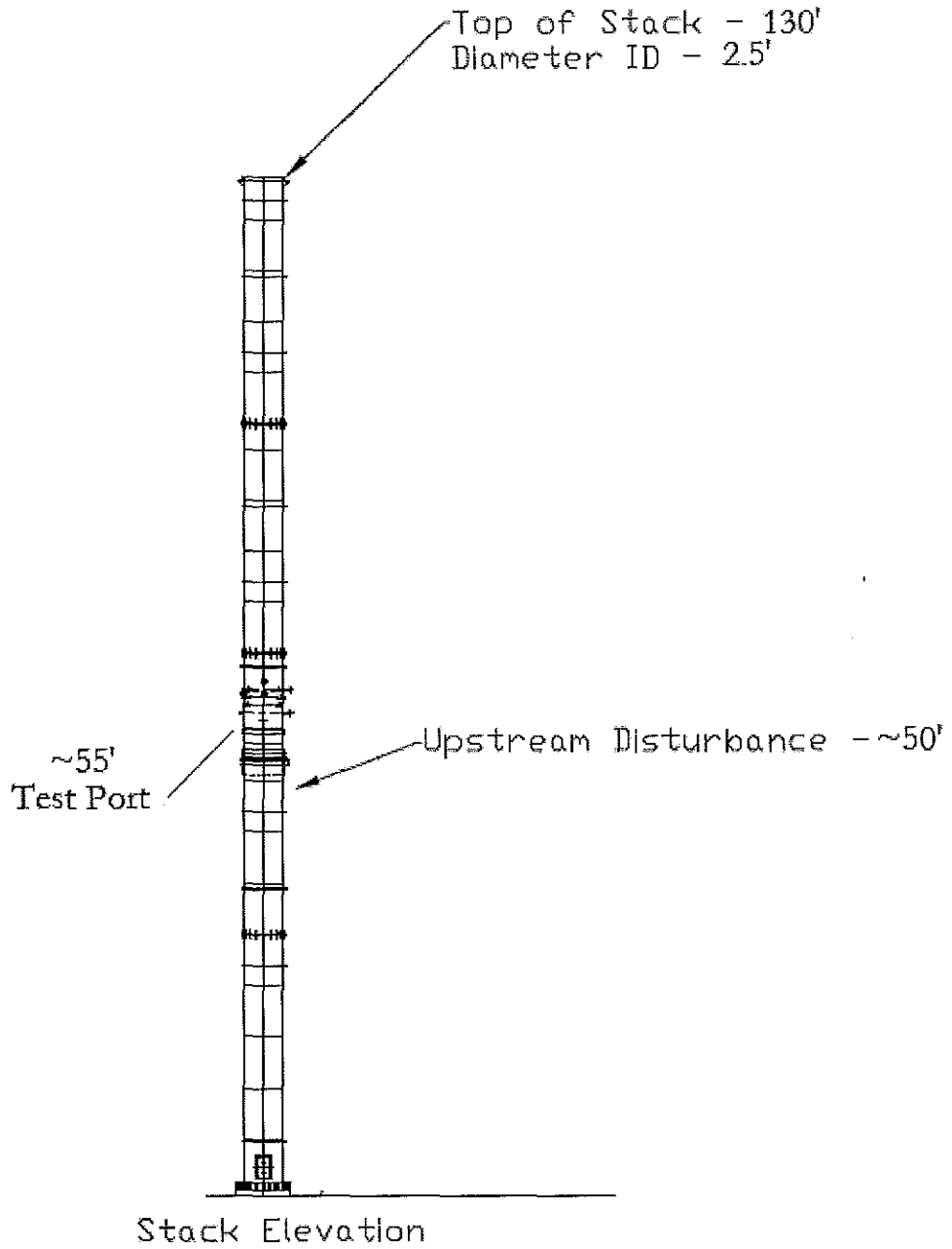
A cyclonic flow and gaseous stratification check was performed by CK personnel prior to testing each unit. For the stratification test, instrumental sampling was conducted at a minimum of twice the stacks. Table 4-1 summarizes the Dryer Train exhaust stack dimensions, system response time at each traverse point. Figure 4-1 presents a diagram typical of the Dryer Train exhaust

Table 4-1
 Dryer Train Exhaust
 Dryer/RTO Stack Dimensions

Description	Dimension
Sample Port To Downstream Distance	~75'-0"
Upstream Distance To Sample Port	5'-0"
Duct Diameter	2.5'
Stack Height	130' above grade



Figure 4-1
Dryer/RTO Stack Train Exhaust
Stack Diagram





4.1 Traverse Point Location

In accordance with EPA Method 1 a 16-point traverse (8 points per port) was used to make exhaust gas measurements in order to determine exhaust gas velocity, volumetric flow rate, temperature and pressure. The moisture content was determined from a single point. The traverse points within the stack were positioned in accordance with Table.4-2.

Table 4-2
Exhaust Gas Flow Traverse Point Locations

Traverse Point	Diameter (%)	Distance from inside wall (inches)*
1	3.2	5
2	10.5	7.2
3	19.4	9.8
4	32.3	13.7
5	67.7	24.3
6	80.6	28.2
7	89.5	30.9
8	96.8	34

*accounts for 4" port depth



5.0 SAMPLING AND ANALYTICAL PROCEDURES

5.1 Test Methods – Emissions Testing

The following US EPA Reference Test Methods contained in Title 40 Code of Federal Regulations, Part 60 (40 CFR 60), “Standards of Performance for New Stationary Sources” Appendix A – Test Methods were used during the performance of the emission compliance test program:

US EPA Method 1	Sample and Velocity Traverses for Stationary Sources
US EPA Method 2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot tube)
US EPA Method 3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)
US EPA Method 4	Determination of Moisture Content in Stack Gases
US EPA Method 6C	Determination of Sulfur Dioxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)

The following is a description of the test methodologies, equipment, and procedures used for this program. Each parameter was measured and analyzed in accordance with EPA and/or MDEQ approved procedures as presented in the test protocol. All samples were collected at the sampling location detailed in Section 4. The average emission rate of three test runs was used to determine emission compliance status.

5.1.1 Flow Rate and Moisture – EPA Methods 1-4

The exhaust gas flow rate and moisture content were measured using EPA Methods 1 through 4. These measurements include the determination of the proper number of traverse points and their location in the stack (RM1), stack velocity, temperature, pressure and volumetric flow rate (RM2), stack gas molecular weight (RM3) and stack gas moisture content (RM4).

An S-type Pitot tube, inclined manometer and K-type thermocouple were used for the velocity pressure and temperature measurements. The Pitot tube meets the criteria of EPA Method 2 and was assigned a coefficient of 0.84. Velocity pressure and temperature readings were taken and recorded at each of the traverse point in the exhaust stack. A cyclonic flow check was conducted prior to the test of each unit in accordance with US EPA Test Method 1 to demonstrate the presence or absence of cyclonic flow.

The moisture content was determined using sample trains consisting of a series of four impingers connected to a metering system consisting of a monometer, temperature sensors, dry gas meter and vacuum pump. Impingers one and two contained known amounts of water, impinger three was empty (dry trap) and impinger four contained a known amount of silica gel. The impingers and their contents were weighed



before and after testing. These weights were recorded on a field data sheet. The impingers were housed in an impinger bucket filled with water and ice to assure the moisture condenses out from the sample exhaust gas. The net weight gain in the impinger train and sample volume, as recorded by the dry gas meter, was used to calculate the moisture content in the stack gas (%). A calibration check with certified weight was performed on the field balance and was noted on the first moisture run.

5.1.2 Oxygen/Carbon Dioxide - EPA Method 3A

Oxygen and carbon dioxide were measured in accordance with EPA Method 3A. This Method utilizes continuous emissions monitoring instrumentation. CK Environmental uses a Teledyne Model 326A oxygen analyzer with a range of 0-25%, and a California Analytical Instruments Model ZRH non-dispersive infrared carbon dioxide analyzer with a range of 0-20% to measure O₂ and CO₂ concentrations in the sample gas. The instruments meet all of the performance specifications of the Method. They were calibrated before and after each test period using calibration gases prepared according to EPA Protocol.

5.1.3 Sulfur Dioxide – EPA Method 6C

Method 6C utilizes continuous emissions monitoring instrumentation. CK Environmental uses a Western Research Model 721M ultraviolet (UV), non-dispersive infrared (NDIR) SO₂ gas analyzer. The instrument meets all of the performance specifications of the method. It was calibrated before and after each test period using calibration gases prepared according to EPA Protocol. The instrument was calibrated in the 0-50 ppm range. Stability test and interference test data sheets were on-site and can be found in an Appendix of this final report.

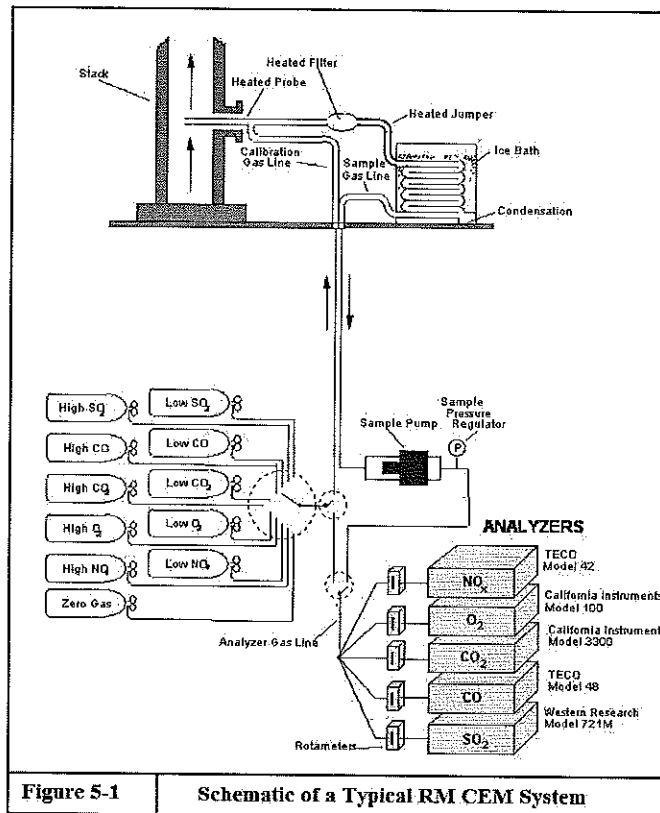


Figure 5-1 Schematic of a Typical RM CEM System



5.2 Emissions Sampling Procedures

5.2.1 Flow & Moisture Sampling Procedures

All sampling procedures were conducted in accordance with the Methods prescribed in the Code of Federal Regulations as found in 40 CFR 60 Appendix A and 40 CFR 61 Appendix B. The following is the sequence of events that occurred prior to and during the actual test.

Traverse Points - The traverse points are calculated in accordance with Method 1 and the probe marked accordingly.

Preliminary Traverse and Cyclonic Flow Check- A preliminary traverse is conducted. Readings include the velocity pressure, angle of flow, gas temperature and static pressure. The average angle of flow is used to determine whether the exhaust gas is considered “cyclonic” ($\geq 20^\circ$).

Stratification Check- Before any gaseous reference method test runs are performed, a stratification check is conducted to ensure that there is no stratification at the sampling location. Stratification is defined as a difference in excess of 10 percent between the average concentration of the stack and the concentration at any other point. Once the traverse is completed, each point is checked to see if it is less than or equal to 5% of the average of all the points, or ≤ 0.5 ppm.

Static Pressure - The static pressure of the stack is checked and recorded.

Nomograph - Once the above information is obtained, the nomograph for the actual test is set up to correlate the isokinetic relationships.

Barometric Pressure - Barometric pressure is obtained and recorded by use of a portable electronic barometer that gives 15-minute readings.

Sampling Train Set-Up -

- (a) The filter is placed in the filter holder and visually checked. Filter number and tare weights are recorded on the field data sheets.
- (b) The impingers are loaded with the appropriate solution and volumes are recorded on the field data sheets.
- (c) Approximately 200 grams of silica gel are placed in the final impinger. Exact weights are logged on the field data sheets.
- (d) Crushed ice is placed around the impingers.
- (e) Once the entire train is assembled, the probe and filter compartment heaters are turned on.

Pre-Test Leak Check - Once the filter compartment heater is at the desired temperature for testing, the system is leak checked at fifteen inches of vacuum (15"Hg). A leak rate of less than 0.02 CFM must be achieved prior to the start of sampling.



Final Check – When sampling is ready to commence, facility operations are checked to confirm that the process is operating at the desired capacity.

Sampling - Sample gas is extracted isokinetically at each traverse point. The sample rate is established according to the velocity pressure and temperature of measured at the sample point. Traverse points are sampled for equal periods over the course of the required test run time.

Post-Test Leak Check - Upon completion of each test run, the system is leak checked at the highest vacuum recorded during that run. Leak checks less than 0.02 CFM are considered acceptable. If a leak check exceeds 0.02 cfm the run is suspect and may be repeated.

5.2.2 CEMS Sampling System and Procedures (O₂, CO₂, SO₂)

What follows is a description of the transportable continuous emissions monitor system used to quantify oxygen, carbon dioxide and sulfur dioxide. The system meets all the specifications of Reference Methods 3A, 6C, and conforms to the requirements of The Measurement System Performance Tests as specified in 40 Code of Federal Regulations (CFR), Part 60, Appendix A.

Sample Probe - A heated stainless steel probe of sufficient length to sample the location specified in Section 2.0.

Sample Line - Approximately 200' of heated 3/8" Teflon tubing (1/16" wall) is used to transport the sample gas from the probe to the emission monitoring analyzers. The sample line is heated to 248°F, ± 25°. Prior to entering the sample gas conditioning system the gas stream is split. The sample stream is passed through a sample conditioning system before being delivered to the O₂, CO₂ and SO₂ analyzers.

Sample Conditioning System-

In-Stack Filter - A spun glass fiber filter is located at the probe tip to remove particulate from the gas stream.

Condenser (2) - a Universal Analyzer Sample Cooler or ice cooled condenser is located after the heated sample line for bulk moisture removal and a thermo-electric condenser system is located downstream from the pump to remove any remaining moisture from the gas stream.

Sample Pump - A diaphragm type vacuum pump is used to draw gas from the probe through the conditioning system and to the analyzers. The pump head is stainless steel, the valve disks are Viton and the diaphragm is Teflon coated.

Calibration Valve - A t-valve, located at the base of the probe allows the operator to select either the sample stream or introduce calibration gas to the system.

Sample Distribution System - A series of flow meters, valves and backpressure regulators allows the operator to maintain constant flow and pressure conditions during sampling and calibration.



Gas Analyzers – Analyzers capable of the continuous determination of O₂, CO₂ and SO₂ concentrations in a sample gas stream. They each meet or exceed the following specifications:

- | | |
|--------------------------|--|
| Calibration Error | - Less than +2% of span for the zero, mid- and hi-range calibration gases. |
| System Bias | - Less than ±5% of span for the zero, mid- or hi-range calibration gases. |
| Zero Drift | - Less than +3% of span over the period of each test run. |
| Calibration Drift | - Less than +3% of span over the period of each test run. |

Data Acquisition System - A Monarch Model 4600, or equivalent, data logger system is used to record analyzer response to the sample and calibration gas streams. The data logger records at 15-second intervals and the data used to report test interval averages. The Monarch saves data to a compact flash drive that is downloaded to a computer. Separate files for each test run and associated calibrations are generated and saved. Data is loaded into a Microsoft Excel® spreadsheet for calculation of test interval average concentrations and emission rates.

All sampling and analytical procedures are conducted in accordance with EPA Reference Methods 3A and 6C (40CFR60, Appendix A). The following is the sequence of events leading up to and including the test:

Selection of Sampling Traverse Point Locations - Sampling point locations are determined prior to testing in accordance with EPA Methods 3A and 6C.

Determination of System Response Time - System response times are determined prior to testing. System response time is determined according to procedures delineated in each method, as required (40CFR60, Appendix A).

Determination of Analyzer Calibration Error - Analyzer calibration error is determined immediately prior to testing in accordance with EPA Methods 3A and 6C.

Determination of Sampling System Bias - Sampling system bias is determined immediately prior to testing in accordance with EPA Methods 3A and 6C.

Determination of Zero and Calibration Drift - Before and after each test run, each analyzer's response to zero and mid- or hi-range calibration gases are determined. The pre-and post-test analyzer responses are compared to determine drift. The results are evaluated based upon specifications defined in EPA Methods 3A and 6C.

Data Reduction - An average pollutant/diluent concentration for each test time interval is determined from the data acquisition system. This data is then reduced to determine relative pollutant concentrations in units of ppm and mass, lb/hr.



6.0 QUALITY ASSURANCE / QUALITY CONTROL PROCEDURES (QA/QC)

6.1 General

CK's emissions testing teams are committed to providing high quality testing services. To meet this commitment, CK follows applicable US EPA sampling procedures and implements applicable quality assurance/quality control (QA/QC) procedures with all test programs. These procedures ensure that all sampling is performed by competent, trained individuals and that all equipment used is operational and properly calibrated before and after use. Records of all CK's equipment calibrations are maintained in CK's files.

The CK quality assurance program generally follows the guidelines of the US EPA *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III Stationary Source Specific Methods* (EPA/600/R-94/038c – September 1994) and CK's in house QA/QC Manual.

6.1.1 Sampling

The CK measurement devices, thermocouples, and transportable gas analyzers are uniquely identified and calibrated with documented procedures and acceptance criteria. Records of all calibration data are maintained in CK's files. Copies of all pertinent calibration data were available on site during testing.

6.1.2 Analytical

All applicable compressed gas audit / calibration standards that were used are US EPA Traceability Protocol certified. Other gas standards and analytical laboratory support gases that were used are directly traceable to the National Institute of Standards and Technology (NIST). The certificates of analysis of the gas standards that were used during testing were available on site during testing and are contained in an Appendix of this report.

6.1.3 Reporting

All reports undergo a tiered review. The first review of the report and calculations are made by a project coordinator or engineer. A second, detailed review of the report and calculations are then performed by the project manager. Signatures on a Report Review Certification contained in each report are used to document the review process.