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AIR QUALITY DIVISION

TEST REPORT

COMPLIANCE EMISSIONS TESTING

GREAT LAKES WATER AUTHORITY

DECEMBER 22, 2021

REVISION 0

PREPARED FOR: NEFCO
500 Victory Road
Quincy, MA 02171

CONCERNING: Stack 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. 5971

B2103-test-20211105



PROTOCOL REVIEW CERTIFICATION

We, the undersigned, hereby certify that we have personally reviewed and are knowledgeable of the information presented in this report. We believe that all submitted information and calculations contained here in are true, accurate, and complete. CK Environmental, Inc. has accreditation as an Air Emissions Testing Body (AETB) from the American Association for Laboratory Accreditation (A2LA) and the Stack Testing Accreditation Council (STAC) and operates in conformance with the ASTM D7036-04 requirements.

Prepared by: Esther Durex
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Approved by: Michael Kelley
Michael Kelley, QSTI, Project Manager



TEST SUMMARY

Facility Name: **Detroit Biosolids Drying Facility**
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Detroit, MI 48209

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Facility Consultant: **NEFCO**
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Test Personnel: Nick Garber, Colin Thoener

Test Methods: 1-4 (Flow & Moisture), 3A, 7E, 10, & 5/202 (PM)

Sources Tested: 1 Exhaust Stacks Per Dryer CO, NOx and PM on Two (2) Dryer Trains (Trains C & D) and PM for their respective Recycle Bins

Test Date: November 5, 2021

SRN: B2103



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1.0 INTRODUCTION

CK Environmental Inc. (CK) was retained by NEFCO to perform compliance emissions testing at the Great Lakes Water Authority Biosolids Drying facility in Detroit, Michigan. Testing occurred November 4-5, 2021.

The purpose of the test program was to determine the compliance status of two of the four dryers (C & D) operating at the drying facility per Michigan Department of Environment, Great Lakes, and Energy (EGLE), Air Quality Division, Renewable Operating Permit No. MI-ROP-B2103-2014d.

All testing and analysis were 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 can be found in Section 5 of this protocol.

Michael Kelley of CK Environmental was responsible for the emissions compliance test program. A crew of qualified Environmental Engineers and Technicians assisted him. Steve Miller of NEFCO coordinated facility operations with the emissions testing. EGLE is the regulatory authority. 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
Steve Miller, Plant Manager	NEFCO	(313) 551-5278
Mark Dziadosz Environmental Quality Analyst	EGLE Air Quality Division	(586) 753-3745



2.0 FACILITY DESCRIPTION

2.1 PROCESS DESCRIPTION

The facility has 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 recirculation, a cyclone product collector, a vibrating screener, a recycle bin, and a crusher. Emissions from the 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 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.

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
- temperature in the RTO combustion chamber
- liquid flow rate to the impingement tray scrubber
- pressure drop across the impingement tray scrubber
- pressure drop across the recycle bin fabric filter collector
- liquid flow rate to the packed tower liquid scrubber
- the pH of the scrubber liquid in the packed tower liquid scrubber



3.0 TEST PROGRAM

3.1 OBJECTIVES

The objective of the program was to conduct compliance emission testing on (2) dryer trains in order to determine the compliance status of the sources with respect to the EGLE Renewable Operating Permit No. MI-ROP-B2103-2014d. Emissions are reported in units of standard in accordance with Table 3-1.

The following are the main objectives for this test program:

- Measure O₂/CO₂, and moisture for calculation purposes on the stack
- Measure exhaust flow
- Conduct PM/CPM, NO_x, and CO testing at the dryer train exhaust stacks to determine emission compliance
- Conduct PM/CPM testing at the recycle bin/ fabric filter exhaust stack to determine emission compliance
- Obtain normal plant operation for data reduction

3.2 TEST MATRIX

The following table outlines the test methodologies used, pollutants measured, and allowable limits. Each parameter was measured and analyzed in accordance with EPA or EGLE-approved procedures as presented the approved test protocol. A total of three test runs for each compliance test parameter was performed.

Table 3-1
Test Matrix – Compliance Emission Limits

Pollutant	EPA Method(s)	Run Duration	Emission Limits (Dryer/RTO Stack Only)
<u>All Locations</u>			
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
<u>Dryer Train (C & D)</u>			
PM/PM ₁₀ /PM _{2.5}	5/202	120 Minutes	PM: 1.22 lb/hr PM ₁₀ : 1.63 lb.hr PM _{2.5} : 1.14 lb.hr
NO _x	7E	60 Minutes	3.95 lb/hr
CO	10	60 Minutes	3.67 lb.hr
<u>Recycle Bin (C & D)</u>			
Recycle Bin PM/CPM	5/202	120 Minutes	PM: 0.005 gr/dscf



3.3 DEVIATIONS FOR APPROVED TEST 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 with the following exception:

- Run 1 for Dryer D was voided due to leak check issues.

3.4 SUMMARY OF RESULTS

The results of the dryer train 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 EGLE in their Air Quality Division issued permit to operate. The tables also summarize the exhaust gas parameters measured from each Dryer Train and corresponding Recycle Bin. All data pertinent to arriving at the final results summarized in the tables are presented in Appendices of this report.

Table 3-2
Summary of Results
EU Dryer Train C

Test Run No.		Run 5	Run 6	Run 7	Average	Facility Permit Limit
Date		11/05/21	11/05/21	11/05/21		
Time	Start	8:18	11:35	14:54		
	Stop	10:24	13:38	16:59		
Sample Conditions						
Volume	(dscf) ^a	85.621	67.718	77.995	76.670	
Volume	(dscm) ^b	2.425	1.918	2.209	2.172	
Isokinetics	(%)	98.4	109.1	89.3	103.7	
Stack Conditions						
Flow Rate	(dscfm) ^c	9,659	8,021	9,693	8,840	
Temperature	(°F)	130	131	127	130	
Oxygen	(%)	9.8	9.9	N/A	9.9	
Carbon Dioxide	(%)	6.4	6.3	N/A	6.4	
Oxides of Nitrogen	(PPM)	19.9	18.5	9.9	19.2	
Oxides of Nitrogen	lb/hr	1.38	1.06	0.69	1.22	3.95
Carbon Monoxide	(PPM)	31.6	28.1	15.1	29.9	
Carbon Monoxide	lb/hr	1.33	0.98	0.64	1.16	3.67
Particulate Matter Emissions						
Total PM Catch	(mg)	13.4	1.7	8.7	7.6	
Emission Rate - Front Half	(Grains/dscf)	0.002	0.000	0.002	0.001	
	lb/hr	0.200	0.027	0.142	0.1	1.22
	tons/yr	0.88	0.12	0.62	0.5	
Emission Rate - Front & Back Half	(mg)	88.7	35.8	63.4	62.25	
	(Grains/dscf)	0.016	0.008	0.013	0.012	
	lb/hr	1.322	0.560	1.032	0.9	1.22
	tons/yr	5.79	2.45	4.52	4.1	



Table 3-3
Summary of Results
EU Recycle Bin C

Test Run No.		Recycle Bin C, Run 5	Recycle Bin C, Run 6	Recycle Bin C, Run 7	Average	Facility Permit Limit
Date		11/05/21	11/05/21	11/05/21		
Time	Start	8:18	11:35	14:54		
	Stop	10:18	13:39	16:56		
Sample Conditions						
Volume	(dscf) ^a	85.401	81.695	73.983	80.360	
Volume	(dscm) ^b	2.419	2.314	2.095	2.276	
Isokinetics	(%)	104.4	104.2	101.4	103.3	
Stack Conditions						
Flow Rate	(dscfm) ^c	929	1,059	829	939	
Temperature	(°F)	126	129	127	127	
Oxygen	(%)	20.9	20.9	20.9	20.9	
Carbon Dioxide	(%)	0.0	0.0	0.0	0.0	
Particulate Matter Emissions						
Emission Rate - Front Half	(mg)	10.6	5.2	5.0	6.9	
	(Grains/dscf)	0.002	0.001	0.001	0.001	
Emission Rate - Back Half	(mg)	22.8	13.9	21.9	19.5	
	(Grains/dscf)	0.004	0.003	0.005	0.004	
Emission Rate - Front & Back Half	(mg)	33.4	19.1	26.9	26.467	
	(Grains/dscf)	0.006	0.004	0.006	0.005	0.005



Table 3-4
Summary of Results
EU Dryer Train D

Test Run No.		Run 2	Run 3	Run 4	Average	Facility Permit Limit
Date		11/04/21	11/04/21	11/04/21		
Time	Start	13:10	15:58	19:10		
	Stop	15:20	18:17	21:12		
<u>Sample Conditions</u>						
Volume	(dscf) ^a	83.229	69.604	61.955	71.6	
Volume	(dscm) ^b	2.357	1.971	1.755	2.028	
Isokinetics	(%)	99.3	108.3	96.1	101.2	
<u>Stack Conditions</u>						
Flow Rate	(dscfm) ^c	9,376	8,298	7,158	8277.3	
Temperature	(°F)	119	124	121	121	
Oxygen	(%)	14.6	13.5	14.6	14.2	
Carbon Dioxide	(%)	3.4	4.1	3.5	3.7	
Oxides of Nitrogen	(PPM)	12.3	14.6	11.3	12.7	
Oxides of Nitrogen	lb/hr	0.83	0.87	0.58	0.76	3.95
Carbon Monoxide	(PPM)	10.3	8.5	6.4	8.4	
Carbon Monoxide	lb/hr	0.42	0.31	0.20	0.31	3.67
<u>Particulate Matter Emissions</u>						
Total PM Catch	(mg)	2.1	6.4	4.7	4.4	
Emission Rate - Front Half	(Grains/dscf)	0.000	0.001	0.001	0.001	
	lb/hr	0.031	0.100	0.072	0.068	1.22
	tons/yr	0.14	0.44	0.31	0.30	
Emission Rate - Front & Back Half	(mg)	13.4	22.3	14.9	16.9	
	(Grains/dscf)	0.002	0.005	0.004	0.004	
	lb/hr	0.200	0.349	0.228	0.259	1.22
	tons/yr	0.87	1.53	1.00	1.13	



Table 3-5
Summary of Results
EU Recycle Bin D

Test Run No.		Recycle Bin D, Run 1	Recycle Bin D, Run 2	Recycle Bin D, Run 3	Average	Facility Permit Limit
Date		11/04/21	11/04/21	11/04/21		
Time	Start	8:40	13:10	16:37		
	Stop	10:41	16:08	18:37		
Sample Conditions						
Volume	(dscf) ^a	134.256	79.891	108.287	107.478	
Volume	(dscm) ^b	3.802	2.263	3.067	3.044	
Isokinetics	(%)	106.7	99.6	107.1	104.5	
Stack Conditions						
Flow Rate	(dscfm) ^c	1,043	911	1,148	1,034	
Temperature	(°F)	116	124	138	126	
Oxygen	(%)	20.9	20.9	20.9	20.9	
Carbon Dioxide	(%)	0.0	0.0	0.0	0.0	
Particulate Matter Emissions						
Emission Rate - Front Half	(mg)	5.9	4.7	2.2	4.3	
	(Grains/dscf)	0.001	0.001	0.000	0.001	
Emission Rate - Back Half	(mg)	12.4	7.8	25.5	15.2	
	(Grains/dscf)	0.001	0.002	0.004	0.002	
Emission Rate - Front & Back Half	(mg)	18.3	12.5	27.7	19.500	
	(Grains/dscf)	0.002	0.002	0.004	0.003	0.005

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4.0 SAMPLING LOCATIONS

The dryer trains exhaust through two stacks. Stack height is 130 feet, and the internal duct diameter is 30 inches on the Dryer/RTO stack. The Recycle Bin/Fabric Filter Stack height is 130 feet with an internal diameter of 8 inches. The upstream and downstream disturbance distances were verified by test personnel while onsite to determine the appropriate number of sampling points. The test port on the Recycle Bin/Fabric Filter stack is located 16 inches from the outlet flange on the last elbow before the vertical stack. The sampling location is accessed from the roof. Appendix D contains a picture of the sampling location.

A cyclonic flow check was conducted by CK personnel. In addition, a stratification check was performed. Instrumental sampling was conducted at a minimum of twice the system response time at each traverse point. Figures 4-1 and 4-2 present stack diagrams and Tables 4-1 and 4-2 present applicable stack dimensions.

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

Description	Dimension
Sample Port to Downstream Distance	~75'
Upstream Distance to Sample Port	5'
Duct Diameter	2.5'
Stack Height	130' above grade
Number of Ports	2
Number of Points	24
Sample Port to Downstream Distance	~75'

Table 4-2
Recycle Bin Filter Exhaust
Stack Dimensions

Description	Dimension
Sample Port To Downstream Distance	~75'
Upstream Distance To Sample Port	16"
Duct Diameter	8"
Stack Height	130' above grade
Number of Ports	1
Number of Points	1 point, center



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

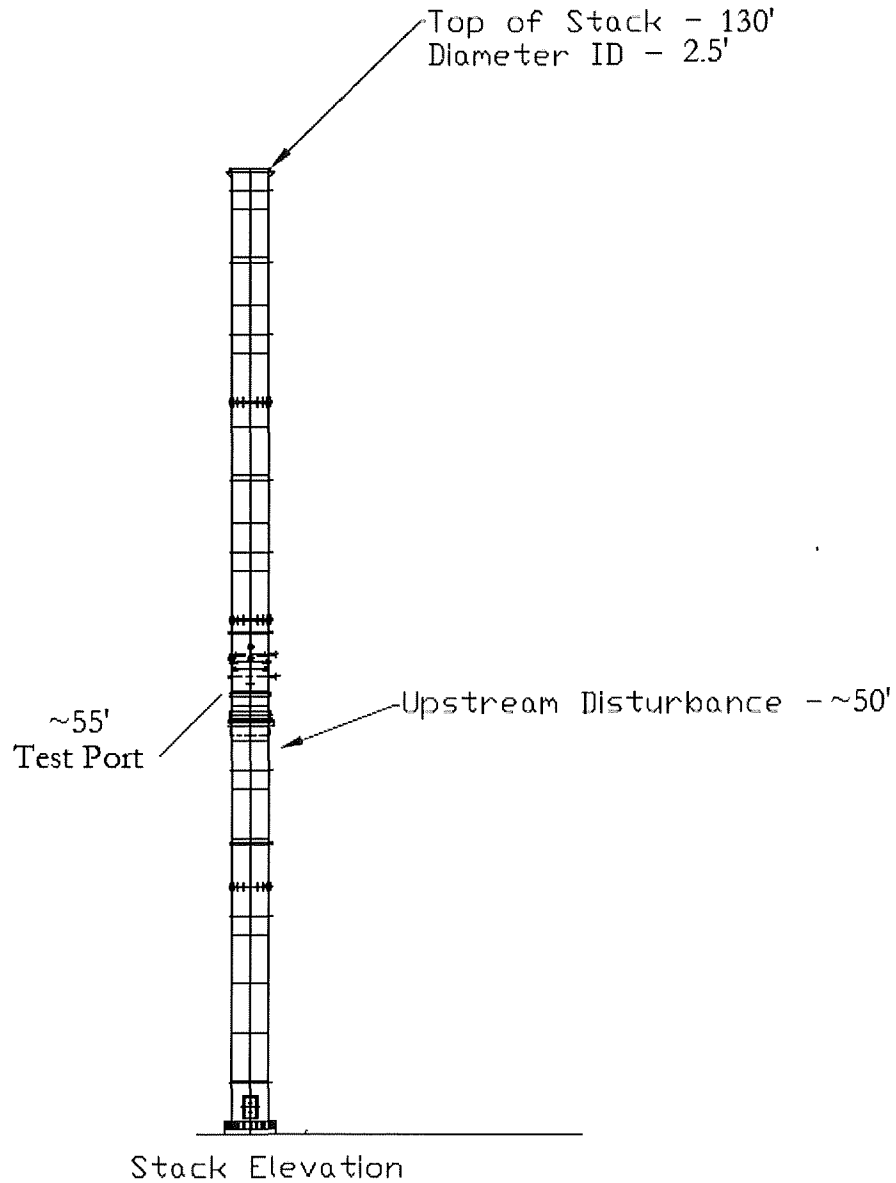
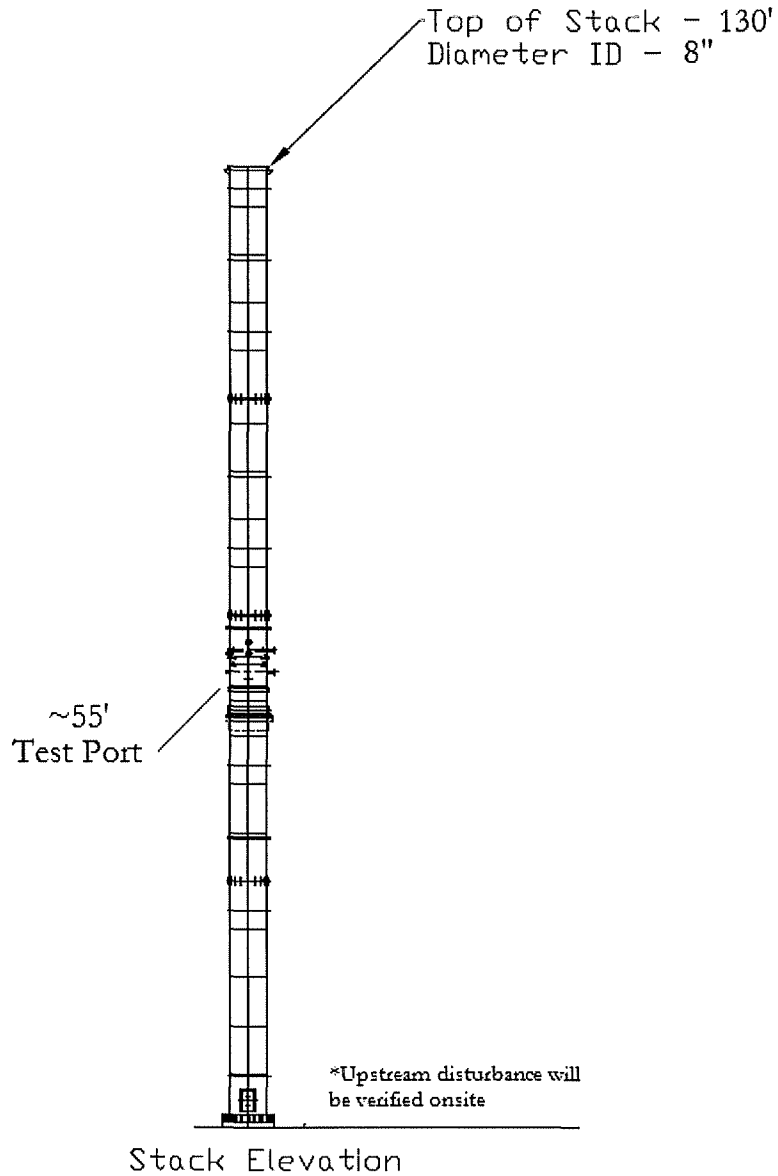




Figure 4-2
Recycle Bin Filter Exhaust
Stack Diagram





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 will be used during the performance of the emissions compliance:

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 5	Determination of Particulate Emissions from Stationary Sources
US EPA Method 7E	Determination of Nitrogen Oxides from Stationary Sources
US EPA Method 10	Determination of Carbon Monoxide Emissions from Stationary Sources
US EPA Method 202	Determination of Condensible Particulate Emissions from Stationary Sources

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 or EGLE approved procedures as presented in the test protocol. All samples were collected at the sampling locations detailed in Section 4. All isokinetic trains were directly connected from the hot filter to the first impinger or condenser. No flexible lines from the hot filter to the first impinger or condenser were used. Three test runs constituted a compliance test.

5.1.1 Flow Rate and Moisture – EPA Methods 1-4

The exhaust gas flow rate and moisture content was measured using EPA Methods 1 through 4. These measurements include the determination of the proper number of traverse points and their locations in the stack (RM1), stack velocity 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 was 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 was taken and recorded at each of the traverse points in the exhaust stack. A cyclonic flow check was conducted prior to the test in accordance with US EPA Test Method 1 to demonstrate the presence or absence of cyclonic flow.



The moisture content was determined by trains consisting of a series of impingers and water. The impingers are housed in an impinger bucket filled with water and ice to assure the moisture condenses out. The last impinger contains a known quantity of silica gel to capture the remaining moisture from the gas stream. 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 was measured in accordance with EPA Method 3A. This Method utilizes continuous emissions monitoring instrumentation. CK used 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 or equivalent with a range of 0-20%. 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. Stability test and interference test data sheets were on-site and in the final report.

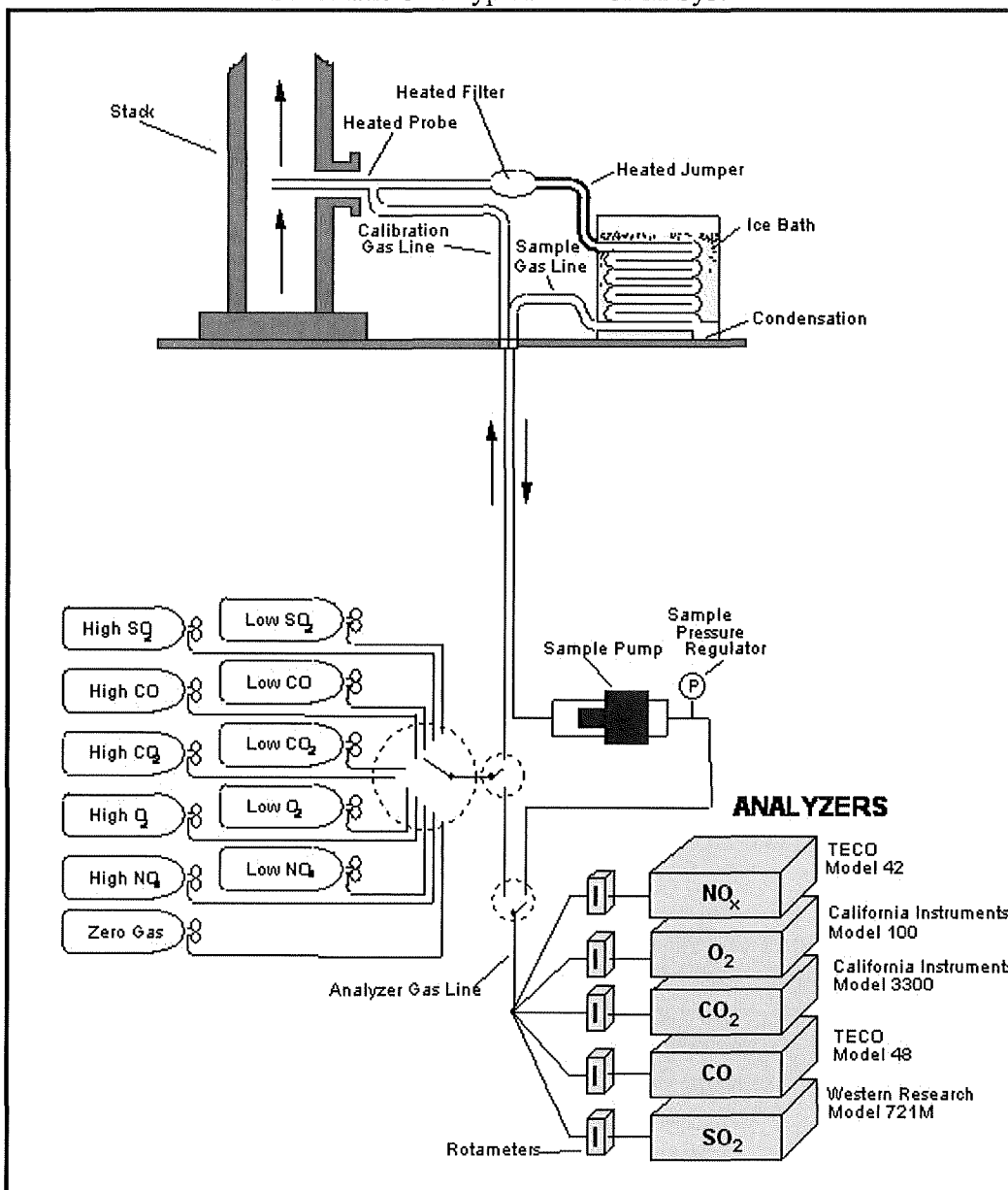
5.1.3 Nitrogen Oxides – EPA Method 7E

Oxides of Nitrogen (NO_x) were measured in accordance with US EPA Method 7E. This method utilizes continuous emissions monitoring instrumentation. CK used a Thermo Electron Model 42C NO_x chemiluminescent analyzer with a range from 0-5,000 ppm. During this program the instrument was operated in the 0-100 ppm range. This instrument meets all of the performance specifications of the utilized method. The instrument was calibrated before and after each test period using calibration gases prepared according to US EPA protocol specifications.

5.1.4 Carbon Monoxide – EPA Method 10

CO was measured in accordance with US EPA Method 10. CK used a TEI Model 48C gas filter correlation infrared analyzer with a series of ranges from 0-10,000 ppm CO. The range used during this emissions test were 0-100 ppm CO. This instrument meets all of the performance specifications of the utilized method. It was calibrated before and after each test period using calibration gases prepared according to US EPA protocol specifications.

Figure 5-1
Schematic of a Typical RM CEM System





5.1.5 Particulate Matter – EPA Method 5/202

Filterable Particulate Matter (PM) is measured using EPA Methods 1 through 5, including the determination of the proper number of sampling points and their locations in the stack (RM1), stack velocity and volumetric flow rate (RM2), stack gas molecular weight (RM3A) and stack gas moisture content (RM4). For this testing program, the EPA Method 5 sampling train was combined with a condensable particulate Method 202 sampling train (see Figure 5-2). Sampling was conducted isokinetically for a period of 120 minutes per run, collecting a minimum of 60 dry standard cubic feet.

The front-half of the sampling train consisted of a stainless steel or borosilicate glass nozzle, heated glass lined probe, and heated quartz glass filter.

All filters were prepared and analyzed by Bureau Veritas Laboratories (BV Labs). Each filter was weighed before and after sampling in accordance with the Method and the procedures outlined in the EPA Quality Assurance Handbook. They are desiccated for at least 24 hours, and then weighed at six-hour intervals until two consecutive weights demonstrated a constant weight, ± 0.5 milligrams.

Prior to sampling, the isokinetic correlation was established, and the train was carefully assembled, and leak checked. After the probe and filter compartment reach the desired operating temperature ($248^{\circ}\text{F} \pm 25^{\circ}$), the probe was placed in the stack and isokinetic sampling takes place.

At the completion of isokinetic sampling, the train was leak checked for leaks, disassembled, and sealed. All train recovery procedures were conducted in accordance with EPA Method 5. The filter was carefully removed from the filter holder and placed in a sample label identified petri dish. The nozzle, probe and the front portion of the filter holder were thoroughly brushed and rinsed with acetone and collected in a container labeled for sample identification. Sample volumes were noted, and liquid levels marked.

The samples were analyzed gravimetrically by BV Labs in accordance with the method. The acetone rinses were evaporated to dryness in tared beakers. All filters and beakers were desiccated before and after sampling for 24 hours, and weighed at 6-hour intervals until two consecutive weights were within ± 0.5 mg.

Condensable Particulate Matter (CPM) was quantified in accordance with the sample train operation and back end recovery and analysis procedures of EPA Method 202. The following is a description of the CPM sampling train and the procedures used to quantify CPM during the compliance testing. This includes the determination of the proper number of sampling points and their locations in the stack (RM1), stack velocity and volumetric flow rate (RM2), stack gas molecular weight (RM3) and stack gas moisture content (RM4).

For this test program, the PM10/PM2.5 emission rate was calculated as the sum of filterable PM emissions (M5) and CPM emissions (M202).



The CPM was collected in dry impingers after the filterable PM was collected on a heated, tared quartz fiber filter configured into the front-half of the sampling train. The potential CPM artifacts (sulfates) from the source's potential sulfur dioxide (SO₂) emissions were reduced by using a condenser and dropout impinger to separate CPM from potential reactive gases. No water was added to the impingers prior to the start of sampling. To improve the collection efficiency of CPM, an additional Teflon® filter (the CPM filter) was placed between the second and third impingers.

The back-half of the Method 202 sampling train consisted of a condenser and two condensate dropout impingers following the out-of-stack filterable PM heated filter assembly. These first two impingers were placed in an insulated "cold box" containing a water bath maintained at a temperature of less than 85°F which was recirculated through the condenser during sampling. The condenser is capable of cooling the stack gas to less than 85°F. At the start of testing, the water dropout and backup impingers were empty, without any water or reagent added.

A glass filter holder containing a nonreactive, non-disintegrating polymer filter, usually Teflon, (the CPM filter) and Teflon backer followed the first two impingers. The filter holder was fitted with a thermocouple measuring the temperature of the sample gas exiting the filter holder. The temperature of the sample gas was maintained at or below 85°F. A modified Greenburg Smith impinger containing 100 mL of water follows the CPM filter. This impinger was used as a moisture trap to collect any moisture that passes through the CPM filter. A fourth impinger contained a known quantity of color indicating silica gel for additional moisture collection. The temperature at the outlet of the fourth impinger was maintained below 68°F during sampling by use of an ice bath containing the third and fourth impingers. A vacuum line connects the outlet of the fourth impinger to a Method 5 control module consisting of a leak free sample pump, a calibrated critical orifice, an inclined manometer, a calibrated dry gas meter and inlet and outlet thermocouples.

Prior to mobilizing to the test site, the first two impingers, CPM filter holder, and their connecting glassware were cleaned with soap and water, rinsed using tap water, and further rinsed with deionized, distilled water, acetone, and finally, hexane. After cleaning, the glassware was baked at 300°C for six hours. Prior to each sampling run, the train glassware was rinsed thoroughly with deionized, distilled ultra-filtered water, acetone, and hexane. Silicone grease was not used as a sealant in this sampling train.

Before and after each test the sampling train was leak checked to ensure a leakage rate of no greater than 0.02 cubic feet per minute (cfm) at a minimum of 15 inches of mercury (in. Hg) vacuum. The probe was then placed in the stack and stack gas was withdrawn isokinetically for an equal period of time at each traverse point. The velocity pressure, orifice differential pressure, dry gas meter volume, dry gas meter temperature, probe temperature, stack temperature, filter compartment temperature, CPM exit temperature, impinger outlet temperature, and sample vacuum were recorded at each traverse point during sampling. At the completion of each test, the sampling train was leak checked at the highest recorded sample vacuum to ensure a leakage rate of no greater than 0.02 cfm.

As soon as possible following the post-test leak check, the front-half of the sampling train was separated from the back-half, and the back half impingers re-weighed, for moisture determination. The front half of



the train was recovered in accordance with Method 5 for the determination of filterable particulate matter. The back half of the train (CPM portion) was re-assembled and configured for the post-test nitrogen (N₂) purge. Ice was left in the third and fourth impinger “cold box” to prevent removal of moisture during the purge. If necessary, additional ice was added during the purge cycle to maintain the gas temperature measured at the exit of the fourth impinger to below 68°F.

The short stem of the first impinger was replaced with a modified Greenberg Smith impinger insert with the impinger tip extending at least 1 centimeter below the surface of the collected condensate. The N₂ purge was performed by delivering N₂ through a Teflon line and inline membrane filter to the inlet of the CPM sampling train. The N₂ gas flow was slowly adjusted to a delivery rate 14 L/min and the purge conducted for 1 hour. After 1 hour the delivery system was turned off and the CPM train prepared for sample recovery.

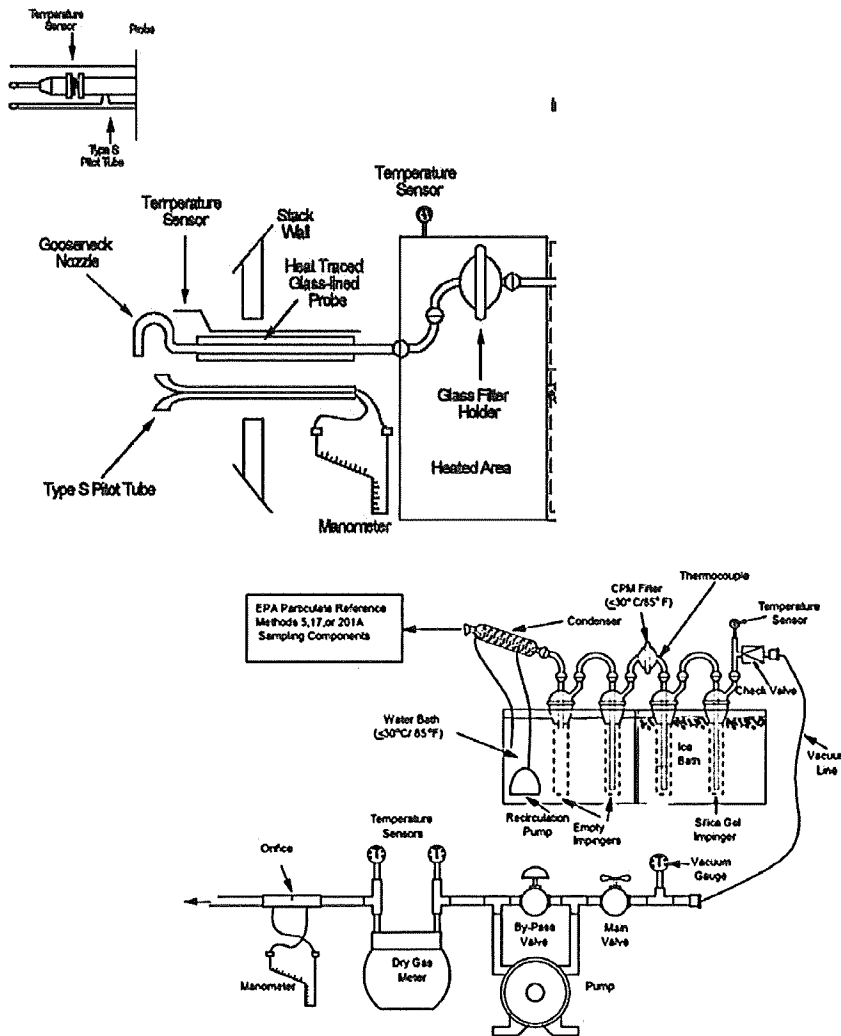
For sample recovery the CPM filter was carefully removed from the filter holder with tweezers / forceps and placed in a labeled plastic petri dish. Any particulate matter or filter fragments that adhere to the filter holder gasket were transferred to the petri dish using the forceps. The petri dish was then sealed for transport to the analytical laboratory.

The aqueous liquid impinger contents of impingers #1 and #2 (the dropout and backup dropout impingers) were quantitatively transferred into a clean glass sample container. The condenser, each impinger, connecting glassware and the front-half of the CPM filter holder were rinsed twice with deionized, distilled ultra-filtered water. The rinse water was recovered into the same bottle as the impinger contents, and the liquid level marked. This sample container held the water soluble (in organic) CPM captured in the sampling train.

Following the water rinses, the sampling train components were rinsed with acetone, then twice with hexane. These solvent rinses were collected in a separate glass sample container and the liquid level marked. This sample container held the organic CPM sample fraction captured in the sampling train.

The CPM sample fractions were maintained at or below 85°F during transport to the CK sub-contract analytical laboratory, BV Labs., for analysis in accordance with Method 202 procedures. The resulting masses of organic and aqueous (inorganic) CPM collected were then determined using the drying and weighing procedures of EPA Method 202. A field blank was submitted for identical QA/QC analyses.

Figure 5-2
Method 5 / 202 Sampling Train





5.2 EMISSIONS SAMPLING PROCEDURES

5.2.1 Isokinetic Sampling Procedures (Particulate Matter)

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 occur prior to and during the actual test.

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

Preliminary Traverse - A preliminary traverse was conducted. Readings include the velocity pressure, gas temperature and static pressure.

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

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

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

Sampling Train Set-Up –

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

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

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

Sampling - Isokinetic sampling, per the Reference Method took place. Sample gas was extracted isokinetically at each traverse point. The sample rate was established according to the velocity pressure



and temperature of measured at the sample point. Traverse points were 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 was leak checked at the highest vacuum recorded during that run. Leak checks less than 0.02 CFM were considered acceptable. If a leak check exceeded 0.02 cfm, the run was suspect and would have need repeated.

Sample Recovery - All samples were recovered in accordance with EPA Reference Methods 5 and 202 procedures.

Isokinetics - Once all sample recovery was completed (including moisture determination), calculations are conducted to determine the percent isokinetic of each test run.

5.2.2 CEMS Sampling System and Procedures (O₂, CO₂)

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) was used to transport the sample gas from the probe to the emission monitoring analyzers. The sample line was heated to 248°F, ±25°. Prior to entering the sample gas conditioning system, the gas stream was split. One portion of the sample stream was passed through the sample conditioning system before being delivered to the O₂, CO₂ and SO₂ analyzers. The unconditioned sample stream was delivered directly to the non-methane organic compound analyzer.

Sample Conditioning System-

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

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

Sample Pump - A diaphragm type vacuum pump was 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.

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Calibration Valve - A t-valve, located at the base of the probe allowed 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 allowed the operator to maintain constant flow and pressure conditions during sampling and calibration.

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

- Calibration Error** - Less than +2% of span for the zero, mid- and hi-range calibration gases.
- System Bias** - Less than $\pm 5\%$ 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 was 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 was downloaded to a computer. Separate files for each test run and associated calibrations are generated and saved. Data was 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, 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 were determined prior to testing in accordance with EPA Methods 3A, 6C.

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

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

Determination of Sampling System Bias - Sampling system bias was determined immediately prior to testing in accordance with EPA Methods 3A, 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 were determined. The pre-and post-test analyzer responses were compared to determine drift. The results are evaluated based upon specifications defined in EPA Methods 3A, 6C.



NO₂ to NO Converter Check- A NO₂ to NO converter check was conducted on the NO_x analyzer in accordance with Section 8.2.4 of Method 7E. A calibration gas of ≈50 ppm NO₂ was introduced into the analyzer in direct calibration mode. The NO_x concentration measured by the analyzer was recorded and the conversion efficiency calculated using equation 7E-7 in Method 7E. The converter check was acceptable if the calculated converter efficiency is between 90 and 110%.

Data Reduction - An average pollutant/diluent concentration for each test time interval was determined from the data acquisition system. This data was 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 portable 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 will be used are always US EPA Traceability Protocol certified. Other gas standards and analytical laboratory support gases that were used are always directly traceable to the National Institute of Standards and Technology (NIST). The certifications of the gas standards that were used during testing were available on-site during testing.

6.1.3 Reporting

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