



## 1.0 INTRODUCTION

CK Environmental Inc. (CK) was contracted by the Great Lakes Water Authority (GLWA) to conduct an Emission Compliance test program at the Detroit Wastewater Resource Recovery Facility (WRRF), 9300 W. Jefferson Avenue, Detroit, MI. This test program was being conducted to demonstrate that two (2) of the facility’s seven (7) multiple hearth incinerators (MHI) meet the regulatory mandated emissions limitations listed in the facility’s permit to operate while under the facility’s full operating capacity.

The purpose of this source test program was to quantify the controlled emissions of polychlorinated dibenzo-p-dioxins (PCDD)/polychlorinated dibenzofurans (PCDF), and nitrogen oxides (NO<sub>x</sub>). Volumetric flow rate measurements, consisting of exhaust gas velocity, oxygen (O<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>) concentrations, and exhaust gas moisture content were also made concurrently with the pollutant measurements. Emission test results are reported in units of standard in accordance with Tables 3-1 through 3-3, Emission Limits.

The tests were conducted in accordance with the conditions and monitoring requirements for compliance testing as set forth in the State of Michigan Department of Environment, Great Lakes, and Energy (EGLE) and United States Environmental Protection Agency (USEPA) Part 60, Subpart M -Emission Guidelines for Existing Sewage Sludge Incineration Units (Model Rule).

Testing was performed July 14 – 15, 2020. The test schedule, as performed, can be found in Table 3-2. Michael Kelley, QSTI, was the CK Project Manager, responsible for all aspects of performing the emissions testing program. Assisting Michael Kelley with field testing activities were Chris Lepke, Dimitris Bethanis, Kevin Kwedor and Liam Kelley (Env. Technicians). Representatives from the Michigan Department of Environmental Quality were on hand to observe testing.

**Table 1-1**  
Project Contacts

Company Name	Role	Contact	Telephone/Email
CK Environmental	Testing Firm	Michael Kelley	(781) 828-5200 mkelley@cke.us
Great Lakes Water Authority	Facility	Melvin Dacres	(313) 297-0363 melvin.dacres@glwater.org
Michigan Department of Environment, Great Lakes & Energy	EGLE	Regina Angellotti	(313) 418-0895 angellottir1@michigan.gov



## **2.0 PROCESS DESCRIPTION**

GLWA operates a flexible group. The flexible group covers all sewage sludge incinerators subject to the 40 CFR Part 60, Subpart Mmmm emissions guidelines though Rule 972. Two (2) MHIs are included in this group that require testing: EUINC12, EUINC13.

Sludge is dewatered with belt filter presses and conveyed to the multiple hearth furnaces with belt conveyors. The sludge conveyors are equipped with weigh scales for continuous monitoring of the amount of sludge being incinerated. The dewatered sludge is introduced at the top hearth and rabbled down through successive hearths in a spiral path. The moisture in the sludge is evaporated in the upper hearths as hot combustion gases traveling concurrently from the middle hearths where combustion takes place. The maximum feed rate is 3.2 dry tons per hour at 25% solids and 75% volatiles condition. It is a continuous feed process. Under normal operating conditions each incinerator runs between 2.0 and 2.5 dry tons per hour with temperature of the solids between 50 and 80 °F. The furnace is equipped with auxiliary natural gas burners at hearths 2, 4, 6, 8, 10, and 12. The firing rate of the burners is modulated by a central control system to sustain the desired hearth temperatures.

Each air pollution control system is comprised of a Double Zero Hearth afterburner section of Hearths 1 and 2, a quench section, and EnviroCare® Venturi-Pak (venturi throat sections and mist eliminator) scrubber system. The total pressure drop across the wet scrubber ranges between 25 and 40 inches of water column (in. wc). The total scrubber water flow should be greater than 1330 gallons per minute (gpm). Exhaust gases pass through this MHI via an induced draft (ID) fan and exit the scrubber at 100-150 °F.

### **2.1 Process Monitoring**

An appointed facility personnel recorded and monitored key process parameter. The process parameters monitored during each test, at a minimum, consisted of the following:

- Biosolids Feed Rate (wet tons/hr)
- Biosolid Cake Solids (%)
- Biosolids Feed Rate (dry tons/hr)
- Afterburner Exit Temp (°F)
- Total Scrubber Water Flow (gal/min)
- Total Scrubber Pressure Drop (in. wc)
- Scrubber Water Outlet pH



### **3.0 TEST PROGRAM**

The emissions compliance testing was conducted at the scrubber exhaust duct of each MHI details are described in section 4.0.

Table 3-1 through 3-3 are the matrices of the test methodologies, pollutants tested, and allowable limits used for this program. Each parameter was measured and analyzed in accordance with EPA or EGLE-approved procedures as presented in this test report. Table 3-4 presents the test schedule.

**Table 3-1**  
Test Matrix – EUINC12 and EUINC13

<b>US EPA Method</b>	<b>Pollutant</b>	<b># of Runs</b>	<b>Length of Run</b>	<b>Emission Limit</b>
1-4	Flow Rate & Moisture	3	Concurrent	N/A
3A	Oxygen/Carbon Dioxide (O <sub>2</sub> /CO <sub>2</sub> )	3	60 mins	N/A
7E	Nitrogen Oxides (NO <sub>x</sub> )	3	60 mins	220 ppmvd @ 7% O <sub>2</sub>

**Table 3-2**  
Test Matrix –EUINC12 for M23 only

<b>US EPA Method</b>	<b>Pollutant</b>	<b># of Runs</b>	<b>Length of Run</b>	<b>Emission Limit</b>
1-4	Flow Rate & Moisture	3	Concurrent	N/A
23	Dioxins/Furans (PCDD/PCDF)	3	120 mins	<i>TEQ Basis: 0.32 ng/dscm @ 7% O<sub>2</sub> OR TMB Basis: 5.0 ng/dscm @ 7% O<sub>2</sub></i>
<b><u>CEMS</u></b>				
3A	Oxygen/Carbon Dioxide (O <sub>2</sub> /CO <sub>2</sub> )	3	60 mins	N/A
7E	Nitrogen Oxides (NO <sub>x</sub> )	3	60 mins	220 ppmvd @ 7% O <sub>2</sub>



Facility personnel were also responsible for collecting a composite sludge sample during each units' PCDD/PCDF testing. CK sent out one (1) sample for each unit to determine percent solids from collected sludge and NO<sub>x</sub> samples in accordance with Method SM2540B (Standard Methods) and ASTM Method D3684-01, respectively.

**Table 3-3  
Test Schedule**

<u>Day</u>	<u>Date</u>	<u>Activity</u>
Day 1	July 13, 2020	Set-up on Incinerator 12
Day 2	July 14, 2020	R1-3, M7E & M23 on Incinerator 12 Set-up on Incinerator 13
Day 3	July 15, 2020	R1-3 M7E on Incinerator 13

### 3.1 Deviations from Protocol

The handwritten system calibration sheets for unit 12 had to be rewritten (both are included in the appendices). While onsite the test team was intending to break a two-hour block of NO<sub>x</sub> data into 2 separate 1 hour test runs. EGLE said this was not in compliance with the test method. The test team had run 1 be 2 hours long and runs 2 and 3 were 1 hour long with each having calibration performed between test runs. The run adjustments made the system calibration sheet difficult to follow which is why new sheets were rewritten. Test run CEM 13-7 had to be shifted 3 minutes (start @ 13:53 and end @ 14:53) could not retrieve the first 3 minutes of data when putting report together.



### 3.2 Summary of Results

Tables 3-4 through 3-6 present the results for Incinerators 12 and 13. Each incinerator was in compliance with its emission limits for all pollutants measured. The Total Tetra through Octa Dioxins are permitted as follows: The permittee has the option to comply with either the dioxin/furan limit on a total mass basis or the dioxin/furan emission limit on a toxic equivalency basis.

**Table 3-4  
Summary of Results EUINC12 – M23**

Test Run No.		D/F - Run 12-1	D/F - Run 12 - 2	D/F - Run 12 - 3	Average	Facility Permit Limits
Date		07/14/20	07/14/20	07/14/20		
Time	Start	9:55	12:45	15:30		
	Stop	12:01	14:52	17:34		
<b>Sample Conditions</b>						
Volume	(dscf) <sup>a</sup>	84.855	79.269	81.654	81.926	
	(dscm) <sup>b</sup>	2.403	2.245	2.312	2.320	
Isokinetics	(%)	104.9	101.3	98.3		
<b>Stack Conditions</b>						
Flow Rate	(dscfm) <sup>c</sup>	14,119	13,659	14,505	14,094	
Temperature	(°F)	82.8	77.2	76.6	78.8	
Moisture	(%)	5.9	3.6	2.3	3.9	
Oxygen	(%)	8.7	6.4	7.8	7.6	
Carbon Dioxide	(%)	9.8	12.0	11.0	10.9	
<b>Total Tetra through Octa Dioxins &amp; Furans Emissions</b>						
Total PCDD/PCDF Catch (TMB)	(pg)	11,510.2	19,276.9	16,292.3	15,693.1	
Total PCDD/PCDF Concentration (TMB)	(ng/dscm)	4.790	8.587	7.045	6.807	
Total PCDD/PCDF Concentration (TMB)	<b>(ng/dscm@7%O<sub>2</sub>)</b>	<b>5.457</b>	<b>8.232</b>	<b>7.476</b>	<b>7.055</b>	<b>5.0</b>
Total PCDD/PCDF Emission Rate (TMB)	(lb/hr)	2.53E-07	4.39E-07	3.82E-07	3.58E-07	
Total PCDD/PCDF Concentration TEQ (EPA TEF)	(pg)	457.7	682.4	586.0	575.4	
Total PCDD/PCDF Concentration TEQ (EPA TEF)	<b>(ng/dscm@7%O<sub>2</sub>)</b>	<b>0.217</b>	<b>0.291</b>	<b>0.269</b>	<b>0.259</b>	<b>0.32</b>
Total PCDD/PCDF Concentration TEQ (EPA TEF)	(lb/hr)	1.01E-08	1.55E-08	1.38E-08	1.31E-08	



**Table 3-5  
Summary of Results EUINC12 – M7E**

Test Run No. Date Time	CEM Run 12-1 07/14/20 09:55 - 11:59	CEM Run 12-2 07/14/20 12:45 - 13:45	CEM Run 12-3 07/14/20 14:12 - 15:12	Averages	Facility Permit Limits
<b><u>Continuous Emissions Monitoring Systems</u></b>					
Oxygen	8.7	7.9	5.8	7.5	
Carbon Dioxide	9.8	10.9	12.5	11.1	
Oxides of Nitrogen	164.6	195.4	221.1	193.7	
	PPM@7% O <sub>2</sub> 187.54	208.93	203.53	200	<b>220</b>

**Table 3-6  
Summary of Results EUINC13 – M7E**

Test Run No. Date Time	CEMS Run 13-5 07/15/20 11:15 - 12:15	CEMS Run 13-6 07/15/20 12:35 - 13:35	CEMS Run 13-7 07/15/20 13:50 - 14:50	Averages	Facility Permit Limits
<b><u>Continuous Emissions Monitoring Systems</u></b>					
Oxygen	10.0	7.7	8.9	8.9	
Carbon Dioxide	8.5	11.0	9.9	9.8	
Oxides of Nitrogen	137.6	147.8	167.1	150.8	
	PPM@7% O <sub>2</sub> 175.5	155.6	193.6	175	<b>220</b>



#### **4.0 SAMPLING LOCATION**

All MHI sampling locations are identical. Outlet flue gas sampling was performed at a location that is between the scrubber exhaust and induced draft fan. The inside diameter of the exhaust duct is 54 inches. Two test ports, spaced 90° apart, are located 120 inches (2.2 duct diameters) to the nearest upstream disturbance and 108 inches (2.0 duct diameters) to the nearest downstream disturbance. In accordance with EPA Method 1, twenty-four (24) traverse points (12 per port) were used for isokinetic sampling and volumetric flowrate determinations. Continuous emissions monitoring (CEM) was conducted through a single port that is located adjacent to the GLWA total hydrocarbons (THC) sampling probe (same elevation). Prior to the start of the continuous emissions monitoring (CEM) a three-point stratification check was performed at the following traverse points (9", 27", and 45"). All measurements were verified on-site.



## **5.0 TESTING METHODOLOGY**

The following US EPA Reference Test Methods from Title 40 Code of Federal Regulations, Part 60 (40 CFR 60), “Standards of Performance for New Stationary Sources” Appendix A – Test Methods, and “Test Methods for Evaluating Solid Waste Physical / Chemical Methods” (SW-846), approved for use by US EPA – Region 1 and EGLE for this specific type of emissions source were strictly adhered to during the performance of the emissions compliance testing:

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 7E	Determination of Nitrogen Oxides Emissions from Station Sources (Instrumental Analyzer Procedure)
US EPA Method 23	Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans from Stationary Sources

The following sections describe the sampling and analytical methodologies utilized during the emissions compliance testing. Reduced data is contained in Appendix A, field data sheets are included in Appendix B. Supporting documentation for the results presented are contained in C, D, E and F.

### **5.1 Test Methods**

#### **5.1.1 Volumetric Flow Rate and Moisture – EPA Method 1, 2 & 4**

The exhaust gas flow rate and moisture content were measured using EPA Methods 1 through 4. These measurements included 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 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 points in the exhaust stack.





The moisture content was determined in conjunction with the Method sampling trains. The trains consisted of a series of impingers and applicable sampling reagents. The impingers were housed in an impinger bucket filled with water and ice to assure that the moisture in the stack gas condenses out. The impingers and their contents were weighed before and after testing. The last impinger contained a known quantity of silica gel to capture the remaining moisture from the gas stream. The resultant net weight gain of the impinger train was used to calculate the moisture content of 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% oxygen and a California Analytical Instruments Model ZRH non-dispersive infrared carbon dioxide analyzer with a range of 0-20% carbon dioxide. The instruments meet all of the performance specifications of the Method. They were calibrated before and after each test period using low, mid or high calibration gases prepared according to EPA Protocol. Sampling occurred simultaneously with flow measurements in order to obtain volumetric flow data for mass emission calculations.

### **5.1.3 Oxides of Nitrogen – EPA Method 7E**

Oxides of Nitrogen (NO<sub>x</sub>) will be measured in accordance with US EPA Method 7E. This method utilizes continuous emissions monitoring instrumentation. CK typically uses a Thermo Electron Model 42C NO<sub>x</sub> chemiluminescent analyzer with ranges from 0-5,000 ppm. During this program the instrument was operated in the 0-500 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 Polychlorinated Dibenzo-P-Dioxins and Polychlorinated Dibenzofurans - EPA Method 23**

Semi-volatile organic emissions of Polychlorinated Dibenzo-P-Dioxins and Polychlorinated Dibenzofurans compounds and their congeners (PCDDs/PCDFs) are measured using an EPA Method 23 sampling train. 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).

The sampling train consists of a basic EPA Method 5 train with the addition of a glass nozzle, Teflon union, glass probe liner, quartz filter, Teflon frit, glass coil condenser, sorbent resin trap placed vertically in-line after the filter and before a hybrid knock-out impinger. The usual EPA Method 5 condenser impingers follow these components. The sorbent resin trap contains pre-cleaned XAD-2 resin.



Prior to mobilization filters, sorbent traps and XAD-2 resin are pre-cleaned in accordance with the method at Maxxam Analytics, Mississauga, Ontario, Canada. The filters and traps, containing XAD-2 resin, are packed and shipped, at 4°C just prior to mobilization.

Prior to mobilization, all glassware and Teflon train components are rinsed three times with HPLC-grade acetone, HPLC-grade methylene chloride, and HPLC-grade toluene and allowed to dry. All prepared components are then sealed with hexane-rinsed aluminum foil.

All quartz glass fiber filters are rinsed with HPLC-grade toluene, allowed to dry on hexane rinsed foil, and stored in a hexane-rinsed petri dish and wrapped in rinsed foil. The XAD resin is soaked twice in water and extractions are performed using water, methanol, methylene chloride and toluene. All recovery tools, including Teflon-coated spatulas and forceps, Teflon dispenser bottles and Teflon recovery mat are also hexane-rinsed. Cotton gloves are worn during all preparation and recovery procedures.

In the field the sampling train is set up in accordance with Method 23 procedures while wearing cotton gloves. The first impinger (a moisture knock-out) is empty in order to collect any condensate that may come through the sorbent trap. The second and third impingers each contain 100 ml of deionized distilled water. The fourth impinger is left empty. The fifth impinger contains a pre-weighed amount of color indicating silica gel. The sorbent trap is wrapped in foil to avoid exposure to direct sunlight. The sorbent trap and condenser coil are both jacketed in a recirculating ice water bath designed to maintain the temperature in the trap at less than sixty-eight degrees Fahrenheit (68°F) for maximum organic compound adsorption. The front half of the train which includes the probe and glass filter assembly are heated and maintained at a temperature of 248°F ± 25°F.

Prior to sampling the train is leak checked at a vacuum of -15”Hg to ensure that there is a leak rate of less than 0.02 cfm. The train is operated in the same manner as an EPA Method 5 train for a period of 2 hours per run.

Following sampling, the train is disassembled and sealed with hexane-rinsed foil. Once in the field lab, the train components are recovered in four separate fractions: 1) front half rinse, 2) filter, 3) filter holder back half and condenser coil rinse and 4) sorbent trap. Fractions 1 and 3 components are rinsed three times with HPLC-grade acetone and methylene chloride (Container 2). The connecting line between the filter and the condenser is rinsed three times with acetone. Additionally, the condenser is soaked with three separate portions of methylene chloride for 5 minutes each. These soakings are added to Container 2. Fractions 1 and 3 components are rinsed again three times with HPLC-grade toluene (QA/QC rinse, Container 3). Additionally, the condenser is soaked with three separate portions of toluene for 5 minutes each. These soakings are added to Container 3. The QA/QC toluene rinses are kept separate until final analysis when they are combined with other fractions.



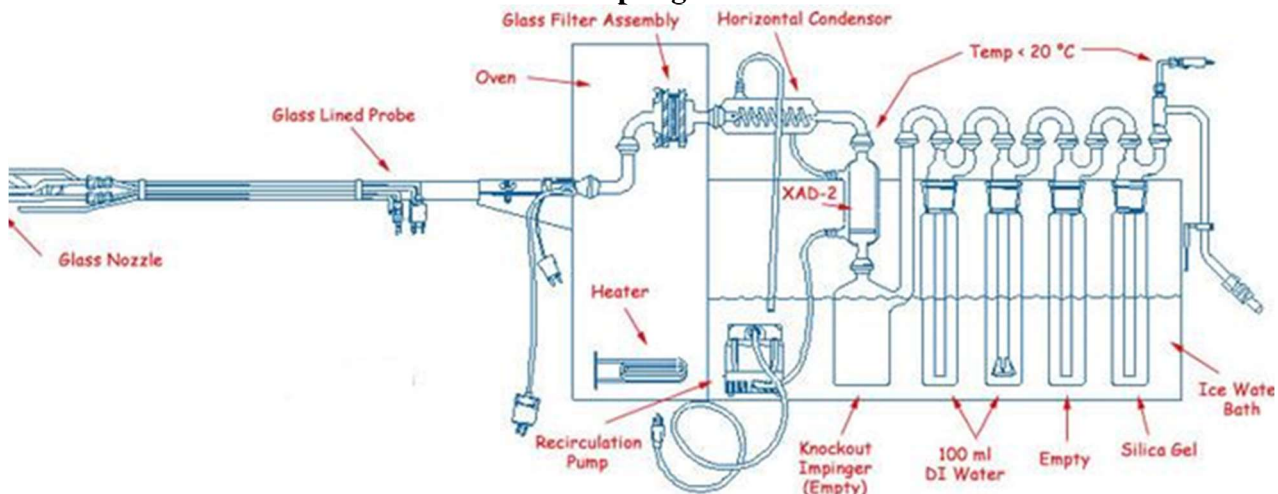
Following recovery, the samples are sealed, labeled and stored in a cooler or refrigerator until shipment to the analytical laboratory. The samples are overnight shipped to the laboratory in coolers containing a sufficient number of freezer packs to insure that the sample temperatures do not exceed 4°C.

All samples are extracted, combined and analyzed for Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans and their congeners by High-Resolution Chromatography / High Resolution Mass Spectrometry. Maxxam Analytics, Mississauga, Ontario, Canada, perform the analysis in accordance with the Method. The samples are analyzed with a gas chromatograph coupled to a mass spectrometer (GC/MS) using the instrumental parameters specified in the Method. Immediately prior to analysis a 20 µl aliquot of the Recovery Standard solution is added to each sample. A 2 µl aliquot of the extract is injected into the GC. Sample extracts are first analyzed using a DB-5 capillary column to determine the concentration of each isomer of PCDD's and PCDF's (tetra-through octa-). If tetra-chlorinated dibenzofurans are detected in this analysis, another aliquot of the sample is analyzed in a separate run, using the DB-225 column to measure the 2,3,7,8 tetra-chloro dibenzofuran isomer.

A group of nine carbon labeled PCDD's and PCDF's representing, the tetra-through octa chlorinated homologues, is added to every sample prior to extraction. The role of the internal standards is to quantify the native PCDD's and PCDF's present in the sample as well as to determine the overall method efficiency. Recoveries of the internal standards must be between 40 to 130 percent for the tetra-through hexa- chlorinated compounds while the range is 25 to 130 percent for the higher hepta- and octa- chlorinated homologues.

Five surrogate compounds are added to the resin in the adsorbent sampling cartridge before the sample is collected. The surrogate recoveries are measured relative to the internal standards and are a measure of collection efficiency. They are not used to measure native PCDD's and PCDF's. All recoveries are to be between 70 and 130 percent. Poor recoveries for all the surrogates may be an indication of breakthrough in the sampling train. If the recovery of all standards is below 70 percent, the sampling runs must be repeated. As an alternative, the sampling runs do not have to be repeated if the final results are divided by the fraction of surrogate recovery. Poor recoveries of isolated surrogate compounds should not be grounds for rejecting an entire set of the samples.

**Figure 5-1  
Method 23 Sampling Train Schematic**



## 5.2 Emissions Sampling Procedures

### 5.2.1 Isokinetic Sampling Procedures

All sampling procedures are 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 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 0.5ppm NOx.

**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 from the Weather Channel application

**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** - Isokinetic sampling, per the Reference Method takes place. 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 will be repeated to get an exact leak rate.

**Sample Recovery** - All samples are recovered in accordance with EPA Reference CTM 027 procedures.

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





### 5.2.2 CEMS Sampling System and Procedures (O<sub>2</sub>, CO<sub>2</sub>, NO<sub>x</sub>)

What follows is a description of the transportable continuous emissions monitor system used to quantify oxygen, carbon dioxide, carbon monoxide, sulfur dioxide, and oxides of nitrogen. The system meets all the specifications of Reference Methods 3A, 6C, 7E, 10 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. One portion of the sample stream is passed through the sample conditioning system before being delivered to the O<sub>2</sub>, CO<sub>2</sub>, SO<sub>2</sub>, CO and NO<sub>x</sub> analyzers. The unconditioned sample stream is delivered directly to the non-methane organic compound analyzer.

#### **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.

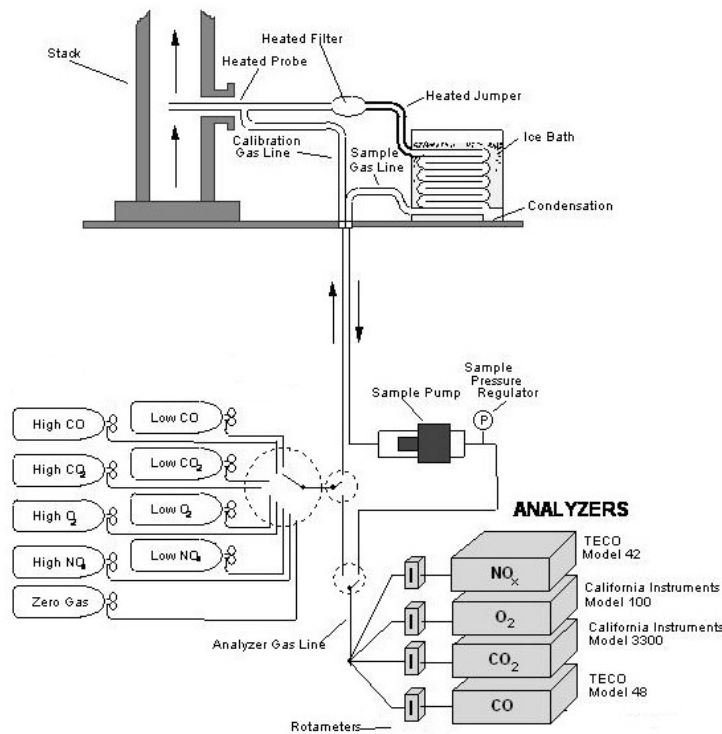
**Gas Analyzers** - capable of the continuous determination of O<sub>2</sub>, CO<sub>2</sub>, SO<sub>2</sub>, CO, and NO<sub>x</sub> concentrations in a sample gas stream. They each meet or exceed the following specifications:

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

**Figure 5-2**  
Schematic of Reference Method CEMS



All sampling and analytical procedures are conducted in accordance with EPA Reference Methods 3A, 6C, 7E, 10 (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 will be determined prior to testing in accordance with EPA Methods 3A, 6C, 7E, 10.

**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, 6C, 7E, 10.

**Determination of Sampling System Bias** - Sampling system bias is determined immediately prior to testing in accordance with EPA Methods 3A, 6C, 7E, 10.

**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, 6C, 7E, 10.

**NO<sub>2</sub> to NO Converter Check**- A NO<sub>2</sub> to NO converter check is conducted on the NO<sub>x</sub> analyzer in accordance with Section 8.2.4 of Method 7E. A calibration gas of  $\approx 50$  ppm NO<sub>2</sub> is introduced into the analyzer in direct calibration mode. The NO<sub>x</sub> concentration measured by the analyzer is recorded and the conversion efficiency calculated using equation 7E-7 in Method 7E. The converter check is acceptable if the calculated converter efficiency is between 90 and 110%.

**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 (QA/QC) PROCEDURES**

CK's emission testing teams are committed to providing high quality testing services. To meet this commitment, CK follows appropriate US EPA sampling procedures and implements applicable 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.

The CK QA 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).

### **6.1 Sampling**

The CK measurement devices, thermocouples, and portable gas analyzers are uniquely identified and calibrated with documented procedures and acceptance criteria. Records of all equipment calibration data are maintained in CK's files. Copies of all calibration data pertinent to this test program will be available on site during testing and will be included in the final Test Report.

Compressed gases used as calibration standards are always National Institute of Standards and Technology (NIST) traceable, either directly or indirectly. For this test program, US EPA Traceability Protocol certified calibration gas standards will be used. The Certificates of Analysis for all Protocol standards will be available on site during the testing. The Certificates of Analysis will be presented in the final report

### **6.2 Reporting**

All Test Reports undergo a tiered review. The first review of the report and calculations is made by the report's author. A second review will then be performed by another senior project scientist, or engineer. A Report Review Certification will be included in the report to verify the review process was completed.