TEST REPORT

2021 EMISSIONS COMPLIANCE TEST PROGRAM

GREAT LAKES WATER AUTHORITY
WASTEWATER RESOURCE RECOVERY FACILITY

August 6, 2021
Revision 0

PREPARED FOR:	Great Lakes Water Authority 9300 W. Jefferson Avenue Detroit, Michigan 48209
CONCERNING:	Compliance Emissions Test Multiple hearth incinerators: units 12, 13, 14 ROP No. MI-ROP-B2103-2014d State Registration No. B2103
PREPARED BY:	CK Environmental, Inc. 1020 Turnpike Street, Suite 8 Canton, MA 02021

CK Project No. 5866

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REPORT REVIEW CERTIFICATION

I, the undersigned, hereby certify that I have personally reviewed and am knowledgeable of the information presented in this Test Report, and I believe that all submitted information and calculations contained herein 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
Esther Durex, Project Coordinator

Reviewed and
Approved by:
Michael Kelley, QSTI /Project Manager

TEST SUMMARY

Facility Name:	**Great Lakes Water Authority** **Detroit Wastewater Resource Recovery Facility** 9300 W. Jefferson Avenue Detroit, MI 48209
Facility Contact:	**Melvin Dacres** (313) 297-0363 Melvin.dacres@glwater.org
Regulatory Agency:	**Michigan Department of Environment, Great Lakes & Energy** Air Quality Division, Technical Programs Unit P.O. Box 30260 Lansing, MI 48909-7760
Regulatory Contact:	**Regina Angellotti, Environmental Quality Analyst** (313) 418-0895 angellottir1@michigan.gov
Testing Organization:	**CK Environmental, Inc.** 1020 Turnpike Street, Suite 8 Canton, Massachusetts 02021
Project Manager:	**Michael Kelley/ Project Manager** (781) 828-5200 mkelley@cke.us
Source Tested:	3 multiple hearth incinerators
Methods Used:	1, 2, 3A, 4, 5,6C, 7E, 10, 23, 26A, 29
Renewable Operating Permit:	ROP No. MI-ROP-B2103-2014d
Analytical Laboratory:	**Bureau Veritas** 6740 Campobello Road Mississauga, OH L5N 2L8
Laboratory Contact:	**Marinela Sim**, Project Manager (905) 817-5712 msin@maxxam.ca
Test Dates:	Week of June 14th, 2021

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1.0 INTRODUCTION

CK Environmental Inc. (CK) was contracted by Great Lakes Water Authority (GLWA) to conduct the Emission Compliance test program at the Detroit Wastewater Resource Recovery Facility (WRRF). This test program was conducted to demonstrate that three (units 12,13 & 14) of the facility's multiple hearth incinerators (MHI) meets regulatory mandated emissions limitations listed while under the facility's full operating capacity.

The purpose of this source test program was to quantify the controlled emissions and set new operating parameters for the following: multiple metals (cadmium, lead, and mercury), polychlorinated dibenzo-p-dioxins (PCDD)/polychlorinated dibenzofurans (PCDF), hydrogen chloride (HCl), sulfur dioxide (SO2), nitrogen oxides (NOx), particulate matter (PM), and carbon monoxide (CO). Volumetric flow rate measurements, consisting of exhaust gas velocity, oxygen (O2) and carbon dioxide (CO2) concentrations, and exhaust gas moisture content was made concurrently with the pollutant measurements. Emission test results are reported in units of standard in accordance with Tables 3-1 and 3-2, 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 MMMM - Emission Guidelines for Existing Sewage Sludge Incineration Units (Model Rule).

Testing was completed the week of June 14, 2021. Michael Kelley, QSTI, was the CK Project Manager, responsible for all aspects of the emissions testing program. Assisting Michael Kelley with field testing activities was a group of CK engineers. Melvin Dacres served as the facility contact and was responsible for coordinating the facility operations and the facility's operations staff. A representative of the EPA and/or EGLE was expected to be present to observe on-site emissions testing activities.

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. Three (3) MHIs are included in this group that require testing, they include: EUINC12, EUINC13, EUINC14.

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 parameters. 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 (oF)
- 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.

Tables 3-1 through 3-2 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 3-1
Test Matrix
EUINC12, EUINC13, and EUINC14*

US EPA Method	Pollutant	# of Runs	Length of Run	Emission Limit
1-4	Flow Rate & Moisture	3	Concurrent	N/A
29	Metals	3	84 mins	*Mercury*: 0.28 mg/dscm @ 7% O$_2$ *Cadmium:* 0.095 mg/dscm @ 7% O$_2$ *Lead:* 0.30 mg/dscm @ 7% O$_2$
23	Dioxins/Furans (PCDD/PCDF)	3	84 minutes	*TEQ Basis:* 0.32 ng/dscm @ 7% O$_2$ OR *TMB Basis*: 5.0 ng/dscm @ 7% O$_2$
5^{**}	Filterable Particulate Mater	3	84 minutes	80 mg/dscm @ 7% O$_2$
$26A^{**}$	Hydrochloric Acid (HCl)	3	84 minutes	1.2 ppmvd @ 7% O$_2$
CEMS				
3A	Oxygen/Carbon Dioxide (O2/CO2)	3	84 minutes	N/A
6C	Sulfur Dioxide (SO$_2$)	3	84 minutes	26 ppmvd @ 7% O$_2$
7E*	Nitrogen Oxides (NO$_x$)	3	84 minutes	220 ppmvd @ 7% O$_2$
10	Carbon Monoxide (CO)	3	84 minutes	3,800 ppmvd @ 7% O$_2$

*EUINC14 – not testing for NOx
** Note: Method 5 and 26A trains were combined

Table 3-2
Test Matrix - By MHI

Testing Unit			US EPA Method	Pollutant	# of Runs	Length of Run	Emission Limit
12	13	14					
√	√	√	1-4	Flow Rate & Moisture	3	Concurrent	N/A
√	√	√	3A	O2/CO2	3	84 minutes	N/A
√	√	√	5*	PM	3	84 minutes	80 mg/dscm @ 7% O_2
√	√	√	26A*	(HCl)	3	84 minutes	1.2 ppmvd @ 7% O_2
√	√	X	7E	NO_x	3	84 minutes	220 ppmvd @ 7% O_2
√	√	√	23	Dioxins/Furans (PCDD/PCDF)	3	84 minutes	*TEQ Basis:* 0.32 ng/dscm @ 7% O_2 OR *TMB Basis*: 5.0 ng/dscm @ 7% O_2
√	√	√	29	Metals (Cd, Pb, Hg)	3	84 minutes	*Mercury*: 0.28 mg/dscm @ 7% O_2 *Cadmium:* 0.095 mg/dscm @ 7% O_2 *Lead:* 0.30 mg/dscm @ 7% O_2
√	√	√	6C	SO_2	3	84 minutes	26 ppmvd @ 7% O_2
√	√	√	10	CO	3	84 minutes	3,800 ppmvd @ 7% O_2

*Note: Method 5 and 26A trains was combined.

3.1 DEVIATIONS FROM APPROVED PROTOCOL

Testing was performed in accordance with the approved test protocol with the following deviations:

- Unit 13 Run 1 for PM/HCl was voided due to leak issues. The run failed the post run leak check for HCl.
- Unit 13 Run 2 for PM/HCl was voided due to O_2/CO_2 issues. About 30 minutes of O_2/CO_2 data was missed when completing calibrations.
- Unit 13 Run 2 for Dioxins/ Furans was voided due to O_2/CO_2 issues.
- Protocol stated that test runs would be 80 minutes; the actual duration of the test runs were 84 minutes.

3.2 SUMMARY OF RESULTS

The results of the testing program demonstrate compliance with the permit limits. Tables 3-3 to 3-14 provide a summary of test results with individual test run results and data.

Table 3-3
Summary of Results
CEMS
Great Lakes Water Authority @ Detroit WRRF
EU-INC 12

Test Run No. Date Time		Run 14 06/16/21 16:00 - 17:33	Run 15 06/16/21 18:00 - 19:29	Run 16 06/16/21 19:55 - 20:55	Averages	Facility Permit Limits
Sample & Stack Conditions (M5/26A data)						
Volume	(dscf)[a]	61.188	62.250	62.086	61.841	
Volume	(dscm)[b]	1.733	1.763	1.758	1.751	
Isokinetics	(%)	102.7	102.7	99.8	101.7	
Flow Rate	(dscfm)[c]	14,788	15,039	15,189	15,005	
Temperature	(°F)	69	74	67	70	
Moisture	(%)	3.0	3.2	3.0	3.1	
Continuous Emissions Monitoring Systems						
Oxygen	(%)	7.0	6.3	7.2	6.8	
Carbon Dioxide	(%)	10.5	11.4	10.9	10.9	
Oxides of Nitrogen	(PPM)	149.2	131.1	172.8	151.0	
	(PPM@7% O_2)	149.20	124.81	175.32	**149.78**	**220**
	(lb/mmBtu)	0.2333	0.1952	0.2742	0.2342	
	(lb/hr)	16.24	13.90	18.63	16.26	
Carbon Monoxide	(PPM)	195.8	115.5	500.5	270.6	
	(PPM@7% O_2)	195.8	110.0	507.8	**271.2**	**3,800**
	(lb/mmBtu)	0.1864	0.1047	0.4834	0.2582	
	(lb/hr)	12.97	7.45	32.84	17.75	
Sulfur Dioxide	(PPM)	0.0	0.0	0.0	0.0	
	(PPM@7% O_2)	0.00	0.00	0.00	**0.00**	**26**
	(lb/mmBtu)	0.0000	0.0000	0.0000	0.0000	
	(lb/hr)	0.00	0.00	0.00	0.00	

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

Table 3-4
Summary of Results
Method 5/26A – PM and HCl
Great Lakes Water Authority @ Detroit WRRF
EU-INC 12

Test Run No. Date Time		PM-HCL Run 9 06/17/21	PM-HCL Run 10 06/17/21	PM-HCL Run 11 06/17/21	Average	Facility Permit Limit
	Start	10:00	11:38	13:27		
	Stop	11:27	13:05	14:53		
Sample Conditions						
Volume	(dscf)^a	61.188	62.250	62.086	61.841	
Volume	(dscm)^b	1.733	1.763	1.758	1.751	
Isokinetics	(%)	103	103	100	102	
Stack Conditions						
Flow Rate	(dscfm)^c	14,788	15,039	15,189	15,005	
Temperature	(°F)	68.9	74.3	66.8	70.0	
Moisture	(%)	3.0	3.2	3.0	3.1	
Oxygen	(%)	8.1	7.7	8.8	8.2	
Carbon Dioxide	(%)	10.3	11.0	10.2	10.5	
Particulate Matter Emissions						
Total PM Catch	Front Half (mg)	50.3	54.7	49.9	51.6	
Emission Rate - Front Half	(mg/dscf)	0.8	0.9	0.8	0.8	
	(mg/dscm@7% O2)	31.5	32.7	32.6	32.3	80
	(lb/hr)	1.6	1.7	1.6	1.7	
Hydrogen Chloride Emissions						
Emission Rate - **HCl**	(PPM)	0.1	0.1	0.1	0.1	
	(PPM @ 7% O2)	0.1	0.1	0.1	0.1	1.2
	(lb/hr)	0.0	0.0	0.0	0.0	

Table 3-5

Summary of Results
Method 29 – Multiple Metals
Great Lakes Water Authority @ Detroit WRRF
EU-INC 12

Test Run No.		Metals - Run 7	Metals - Run 8	Metals - Run 9	Average	Facility Permit Limits
Date		06/16/21	06/16/21	06/17/21		
Time Start		16:00	18:00	8:10		
Stop		17:33	19:29	9:40		
Sample Conditions						
Volume	(dscf)^a	58.55	72.89	61.29	64.24	
	(dscm)^b	1.66	2.06	1.74	1.82	
Isokinetics	(%)	95	97	96	96	
Stack Conditions						
Flow Rate	(dscfm)^c	15,115	18,713	15,708	16,512	
Temperature	(°F)	75	75	72	74	
Moisture	(%)	3.6	3.2	3.2	3.3	
Oxygen	(%)	7.0	6.3	8.0	7.1	
Carbon Dioxide	(%)	10.5	11.4	10.2	10.7	
Trace Metals						
Cadmium (Cd) Catch	(mg)	0.0189	0.0326	0.0193	0.024	
Cd Concentration	(mg/dscm @ 7%O_2)	0.0114	0.0150	0.0120	**0.013**	**0.095**
Cd Concentration	(mg/dscm @ 12%CO_2)	0.01304	0.01664	0.01309	0.014	
Cd Emission Rate	(lb/hr)	6.45E-04	1.11E-03	6.54E-04	0.001	
Lead (Pb) Catch	(mg)	0.1474	0.3094	0.1514	0.203	
Pb Concentration	(mg/dscm @ 7%O_2)	0.0889	0.1427	0.0940	**0.11**	**0.30**
Pb Concentration	(mg/dscm @ 12%CO_2)	0.10159	0.15778	0.10261	0.121	
Pb Emission Rate	(lb/hr)	5.03E-03	1.05E-02	5.13E-03	0.007	
Mercury (Hg) Catch	(mg)	0.0381	0.0571	0.0462	0.047	
Hg Concentration	(mg/dscm @ 7%O_2)	0.0230	0.0263	0.0287	**0.03**	**0.28**
Hg Concentration	(mg/dscm @ 12%CO_2)	0.0263	0.0291	0.0313	0.029	
Hg Emission Rate	(lb/hr)	1.30E-03	1.94E-03	1.56E-03	0.002	
	(lb/yr)	11.40	16.98	13.70	14.02	25

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

Table 3-6
Summary of Results
Method 23 – Dioxins & Furans
Great Lakes Water Authority @ Detroit WRRF
EU-INC 12

Test Run No. Date Time Start Stop		D/F - Run 8 06/16/21 16:00 17:33	D/F - Run 9 06/16/21 18:00 19:29	D/F - Run 10 06/17/21 8:10 9:39	Average	Facility Permit Limits
Sample Conditions						
Volume	(dscf)[a]	64.977	62.042	61.418	62.812	
	(dscm)[b]	1.840	1.757	1.739	1.779	
Isokinetics	(%)	104.4	103.7	103.1		
Stack Conditions						
Flow Rate	(dscfm)[c]	15,354	14,765	14,551	14,890	
Temperature	(°F)	70.0	71.0	69.1	70.0	
Moisture	(%)	3.7	3.4	2.6	3.2	
Oxygen	(%)	7.0	6.3	8.0	7.1	
Carbon Dioxide	(%)	10.5	11.4	10.2	10.7	
Total Tetra through Octa Dioxins & Furans Emissions						
Total PCDD/PCDF Catch (TMB)	(pg)	443.6	213.3	538.4	398.4	
Total PCDD/PCDF Concentration (TMB)	(ng/dscm)	0.241	0.121	0.310	0.224	
Total PCDD/PCDF Concentration (TMB)	**(ng/dscm@7%O_2)**	**0.241**	**0.116**	**0.334**	**0.230**	**5.0**
Total PCDD/PCDF Emission Rate (TMB)	(lb/hr)	1.39E-08	6.71E-09	1.69E-08	1.25E-08	
Total PCDD/PCDF Concentration TEQ (EPA TEF)	(pg)	18.3	20.1	16.8	18.4	
Total PCDD/PCDF Concentration TEQ (EPA TEF)	**(ng/dscm@7%O_2)**	**0.0099**	**0.0109**	**0.0104**	**0.0104**	**0.32**
Total PCDD/PCDF Concentration TEQ (EPA TEF)	(lb/hr)	5.72E-10	6.33E-10	5.27E-10	5.77E-10	

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

Table 3-7
Summary of Results
CEMS
Great Lakes Water Authority @ Detroit WRRF
EU-INC 13

Test Run No. Date Time		Run 1 06/14/21 09:00 - 10:36	Run 3 06/14/21 14:05 - 15:39	Run 4 06/14/21 16:30 - 17:49	Averages	Facility Permit Limits
Sample & Stack Conditions (M5/26A data)						
Volume	(dscf)[a]	64.317	65.520	67.685	65.841	
Volume	(dscm)[b]	1.821	1.856	1.917	1.865	
Isokinetics	(%)	103.8	105.5	103.6	104.3	
Flow Rate	(dscfm)[c]	14,971	15,161	15,952	15,361	
Temperature	(°F)	76	78	73	76	
Moisture	(%)	2.9	2.8	2.8	2.8	
Continuous Emissions Monitoring Systems						
Oxygen	(%)	7.5	7.9	6.5	7.3	
Carbon Dioxide	(%)	11.2	10.3	12.3	11.3	
Oxides of Nitrogen	(PPM)	108.6	108.6	147.9	121.7	
	(PPM@7% O_2)	112.65	116.12	142.76	**123.8**	**220**
	(lb/mmBtu)	0.1762	0.1816	0.2232	0.1937	
	(lb/hr)	12.42	11.65	16.07	13.38	
Carbon Monoxide	(PPM)	200.1	180.9	688.5	356.5	
	(PPM@7% O_2)	207.6	193.4	664.6	**355.2**	**3,800**
	(lb/mmBtu)	0.1976	0.1841	0.6327	0.3381	
	(lb/hr)	13.92	11.81	45.54	23.76	
Sulfur Dioxide	(PPM)	-0.2	0.5	0.2	0.2	
	(PPM@7% O_2)	-0.21	0.53	0.19	**0.17**	**26**
	(lb/mmBtu)	-0.0005	0.0012	0.0004	0.0004	
	(lb/hr)	-0.03	0.07	0.03	0.02	

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

Table 3-8

Summary of Results
Method 5/26A – PM and HCl
Great Lakes Water Authority @ Detroit WRRF
EU-INC 13

Test Run No.		PM-HCL Run 5	PM-HCL Run 3	PM-HCL Run 4	Average	Facility Permit Limit
Date		06/15/21	06/14/21	06/14/21		
Time Start		8:00	14:05	16:30		
Stop		9:30	15:40	18:01		
Sample Conditions						
Volume	(dscf)[a]	67.685	64.317	65.520	65.841	
Volume	(dscm)[b]	1.917	1.821	1.856	1.865	
Isokinetics	(%)	104	104	106	104	
Stack Conditions						
Flow Rate	(dscfm)[c]	15,952	14,971	15,161	15,361	
Temperature	(°F)	73.3	75.6	77.9	75.6	
Moisture	(%)	2.8	2.9	2.8	2.8	
Oxygen	(%)	9.4	7.9	6.5	7.9	
Carbon Dioxide	(%)	9.4	10.2	12.3	10.6	
Particulate Matter Emissions						
Total PM Catch	Front Half (mg)	29.6	23.3	31.6	28.2	
Emission Rate - Front Half	(mg/dscf)	0.4	0.4	0.5	0.4	
	(mg/dscm@7% O2)	18.7	13.7	16.4	**16.3**	**80**
	(lb/hr)	0.9	0.7	1.0	0.9	
Hydrogen Chloride Emissions						
Emission Rate - **HCl**	(PPM)	0.1	0.1	0.2	0.1	
	(PPM @ 7% O2)	0.2	0.2	0.2	**0.2**	**1.2**
	(lb/hr)	0.0	0.0	0.0	0.0	

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

Table 3-9
Summary of Results
Method 29 – Multiple Metals
Great Lakes Water Authority @ Detroit WRRF
EU-INC 13

Test Run No.		Metals - Run 1	Metals - Run 2	Metals - Run 3	Average	Facility Permit Limits
Date		06/15/21	06/15/21	06/15/21		
Time Start		8:55	10:08	11:55		
Stop		11:01	11:35	13:27		
Sample Conditions						
Volume	(dscf)[a]	62.26	56.14	54.31	57.57	
	(dscm)[b]	1.76	1.59	1.54	1.63	
Isokinetics	(%)	97	97	96	97	
Stack Conditions						
Flow Rate	(dscfm)[c]	15,771	14,293	13,839	14,634	
Temperature	(°F)	80	74	79	78	
Moisture	(%)	2.8	3.4	3.8	3.3	
Oxygen	(%)	9.9	12.1	10.4	10.8	
Carbon Dioxide	(%)	8.8	6.3	7.8	7.6	
Trace Metals						
Cadmium (Cd) Catch	(mg)	0.0112	0.0112	0.0082	0.0102	
Cd Concentration	(mg/dscm @ 7%O_2)	0.0080	0.0111	0.0109	**0.010**	**0.095**
Cd Concentration	(mg/dscm @ 12%CO_2)	0.01508	0.02718	0.02076	0.0210	
Cd Emission Rate	(lb/hr)	3.76E-04	3.78E-04	4.25E-04	3.93E-04	
Lead (Pb) Catch	(mg)	0.0659	0.0862	0.0884	0.0802	
Pb Concentration	(mg/dscm @ 7%O_2)	0.0472	0.0856	0.0761	**0.07**	**0.30**
Pb Concentration	(mg/dscm @ 12%CO_2)	0.04948	0.10813	0.10524	0.0876	
Pb Emission Rate	(lb/hr)	2.21E-03	2.90E-03	2.98E-03	2.69E-03	
Mercury (Hg) Catch	(mg)	0.0446	0.0469	0.0501	0.0472	
Hg Concentration	(mg/dscm @ 7%O_2)	0.0320	0.0465	0.0431	**0.04**	**0.28**
Hg Concentration	(mg/dscm @ 12%CO_2)	0.0061	0.0885	0.0652	0.0533	
Hg Emission Rate	(lb/hr)	1.49E-03	1.58E-03	1.69E-03	1.59E-03	
	(lb/yr)	13.08	13.81	14.77	13.9	25

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

Table 3-10

Summary of Results
Method 23 – Dioxins & Furans
Great Lakes Water Authority @ Detroit WRRF
EU-INC 13

Test Run No. Date Time Start Stop		D/F - Run 1 06/14/21 8:00 9:30	D/F - Run 3 06/14/21 14:05 15:40	D/F - Run 4 06/14/21 16:30 18:01	Average	Facility Permit Limits
Sample Conditions						
Volume	(dscf)[a]	64.175	62.223	61.954	62.784	
	(dscm)[b]	1.817	1.762	1.755	1.778	
Isokinetics	(%)	103.1	102.7	102.1		
Stack Conditions						
Flow Rate	(dscfm)[c]	15,357	14,955	14,900	15,071	
Temperature	(°F)	80.9	80.8	77.4	79.7	
Moisture	(%)	2.7	2.7	4.7	3.4	
Oxygen	(%)	7.5	7.9	6.5	7.3	
Carbon Dioxide	(%)	11.2	10.3	12.3	11.3	
Total Tetra through Octa Dioxins & Furans Emissions						
Total PCDD/PCDF Catch (TMB)	(pg)	483.6	358.8	459.7	434.03	
Total PCDD/PCDF Concentration (TMB)	(ng/dscm)	0.266	0.204	0.262	0.24	
Total PCDD/PCDF Concentration (TMB)	**(ng/dscm@7%O_2)**	**0.276**	**0.218**	**0.253**	**0.25**	**5.0**
Total PCDD/PCDF Emission Rate (TMB)	(lb/hr)	1.53E-08	1.14E-08	1.46E-08	1.38E-08	
Total PCDD/PCDF Concentration TEQ (EPA TEF)	(pg)	20.2	18.5	22.0	20.22	
Total PCDD/PCDF Concentration TEQ (EPA TEF)	**(ng/dscm@7%O_2)**	**0.0115**	**0.0112**	**0.0121**	**0.01**	**0.32**
Total PCDD/PCDF Concentration TEQ (EPA TEF)	(lb/hr)	6.38E-10	5.87E-10	7.00E-10	6.42E-10	

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

Table 3-11
Summary of Results
CEMS
Great Lakes Water Authority @ Detroit WRRF
EU-INC 14

Test Run No. Date Time		Run 8 06/15/21 14:32 - 16:01	Run 9 06/15/21 16:38 - 18:09	Run 10 06/15/21 18:50 - 20:18	Averages	Facility Permit Limits
Sample & Stack Conditions (M5/26A data)						
Volume	(dscf)[a]	65.186	63.411	63.155	63.917	
Volume	(dscm)[b]	1.846	1.796	1.789	1.810	
Isokinetics	(%)	102.5	104.7	103.1	103.4	
Flow Rate	(dscfm)[c]	15,779	15,027	15,202	15,336	
Temperature	(°F)	75	73	77	75	
Moisture	(%)	3.3	3.1	3.3	3.2	
Continuous Emissions Monitoring Systems						
Oxygen	(%)	10.1	10.7	9.1	10.0	
Carbon Dioxide	(%)	8.4	8.2	9.6	8.7	
Oxides of Nitrogen	(PPM)	108.6	108.6	147.9	121.7	
	(PPM@7% O_2)	139.77	147.99	174.22	**154.0**	**220**
	(lb/mmBtu)	0.2186	0.2314	0.2724	0.2408	
	(lb/hr)	11.83	12.28	15.93	13.35	
Carbon Monoxide	(PPM)	1650.2	1056.6	1607.3	1438.0	
	(PPM@7% O_2)	2123.9	1439.9	1893.3	**1819**	**3,800**
	(lb/mmBtu)	2.0219	1.3707	1.8024	1.73	
	(lb/hr)	109.44	72.73	105.36	95.84	
Sulfur Dioxide	(PPM)	0.7	0.2	0.7	0.5	
	(PPM@7% O_2)	0.93	0.27	0.82	**0.68**	**26**
	(lb/mmBtu)	0.0020	0.0006	0.0018	0.0015	
	(lb/hr)	0.11	0.03	0.10	0.08	

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

Table 3-12

Summary of Results
Method 5/26A – PM and HCl
Great Lakes Water Authority @ Detroit WRRF
EU-INC 14

Test Run No. Date Time Start Stop		PM-HCL Run 6 06/15/21 14:32 16:01	PM-HCL Run 7 06/15/21 16:38 18:09	PM-HCL Run 8 06/15/21 18:50 20:18	Average	Facility Permit Limit
Sample Conditions						
Volume	(dscf)[a]	65.186	63.411	63.155	64.299	
Volume	(dscm)[b]	1.846	1.796	1.789	1.821	
Isokinetics	(%)	102	105	103	104	
Stack Conditions						
Flow Rate	(dscfm)[c]	15,779	15,027	15,202	15,403	
Temperature	(°F)	74.5	73.3	77.1	73.9	
Moisture	(%)	3.3	3.1	3.3	3.2	
Oxygen	(%)	10.1	10.7	9.1	10.4	
Carbon Dioxide	(%)	8.4	8.2	9.6	8.3	
Particulate Matter Emissions						
Total PM Catch	Front Half (mg)	29.6	36.0	34.7	32.8	
Emission Rate - Front Half	(mg/dscf)	0.5	0.6	0.5	0.5	
	(mg/dscm@7% O2)	20.6	27.3	22.9	24.0	80
	(lb/hr)	0.9	1.1	1.1	1.0	
Hydrogen Chloride Emissions						
Emission Rate - **HCl**	(PPM)	0.1	0.1	0.1	0.1	
	(PPM @ 7% O2)	0.1	0.1	0.1	0.1	1.2
	(lb/hr)	0.0	0.0	0.0	0.0	

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

Table 3-13
Summary of Results
Method 29 – Multiple Metals
Great Lakes Water Authority @ Detroit WRRF
EU-INC 14

Test Run No. Date Time Start Stop		Metals - Run 4 06/15/21 14:32 16:01	Metals - Run 5 06/15/21 16:38 18:10	Metals - Run 6 06/15/21 18:50 20:18	Average	Facility Permit Limits
Sample Conditions						
Volume	(dscf)[a]	62.26	56.14	54.31	57.57	
	(dscm)[b]	1.76	1.59	1.54	1.63	
Isokinetics	(%)	97	98	96	97	
Stack Conditions						
Flow Rate	(dscfm)[c]	15,785	14,234	13,785	14,601	
Temperature	(°F)	80	74	79	78	
Moisture	(%)	2.8	3.4	3.8	3.3	
Oxygen	(%)	9.9	12.2	10.4	10.8	
Carbon Dioxide	(%)	8.8	6.3	7.8	7.6	
Trace Metals						
Cadmium (Cd) Catch	(mg)	0.0112	0.0112	0.0082	0.0102	
Cd Concentration	(mg/dscm @ 7%O_2)	0.0082	0.0096	0.0097	**0.0092**	**0.095**
Cd Emission Rate	(lb/hr)	3.76E-04	3.76E-04	4.23E-04	3.92E-04	
Lead (Pb) Catch	(mg)	0.0659	0.0862	0.0884	0.0802	
Pb Concentration	(mg/dscm @ 7%O_2)	0.0481	0.0739	0.0677	**0.0632**	**0.30**
Pb Emission Rate	(lb/hr)	2.21E-03	2.89E-03	2.97E-03	2.69E-03	
Mercury (Hg) Catch	(mg)	0.0446	0.0469	0.0501	0.0472	
Hg Concentration	(mg/dscm @ 7%O_2)	0.0326	0.0402	0.0383	**0.0370**	**0.28**
Hg Emission Rate	(lb/hr)	1.49E-03	1.57E-03	1.68E-03	1.58E-03	

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

Table 3-14
Summary of Results
Method 23 – Dioxins & Furans
Great Lakes Water Authority @ Detroit WRRF
EU-INC 14

Test Run No.		D/F - Run 5	D/F - Run 6	D/F - Run 7	Average	Facility Permit Limits
Date		06/16/21	06/16/21	06/16/21		
Time Start		7:55	9:40	13:05		
Stop		9:22	12:35	14:34		
Sample Conditions						
Volume	(dscf)[a]	63.128	62.884	64.778	63.597	
	(dscm)[b]	1.788	1.781	1.835	1.801	
Isokinetics	(%)	103.3	102.3	101.7		
Stack Conditions						
Flow Rate	(dscfm)[c]	14,927	15,164	15,551	15,214	
Temperature	(°F)	71.7	74.5	72.9	73.0	
Moisture	(%)	2.9	2.8	3.0	2.9	
Oxygen	(%)	9.9	12.2	10.4	10.8	
Carbon Dioxide	(%)	8.8	6.3	7.8	7.6	
Total Tetra through Octa Dioxins & Furans Emissions						
Total PCDD/PCDF Catch (TMB)	(pg)	898.3	4147.7	532.6	1859.5	
Total PCDD/PCDF Concentration (TMB)	(ng/dscm@7%O_2)	0.635	3.721	0.384	**1.58**	**5.0**
Total PCDD/PCDF Emission Rate (TMB)	(lb/hr)	2.81E-08	1.32E-07	1.69E-08	5.91E-08	
Total PCDD/PCDF Concentration TEQ (EPA TEF)	(pg)	30.4	190.5	22.6	81.2	
Total PCDD/PCDF Concentration TEQ (EPA TEF)	(ng/dscm@7%O_2)	0.0215	0.1709	0.0163	**0.07**	**0.32**
Total PCDD/PCDF Concentration TEQ (EPA TEF)	(lb/hr)	9.50E-10	6.07E-09	7.17E-10	2.58E-09	

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

4.0 SAMPLING LOCATION

All MHI sampling locations are identical. Outlet flue gas sampling occurred 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 90o 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) took place 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 was 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 5	Determination of Filterable Particulate Emissions from Stationary Sources and Temperature at Filter Exit
US EPA Method 6C	Determination of Sulfur Dioxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)
US EPA Method 7E	Determination of Nitrogen Oxides Emissions from Station Sources (Instrumental Analyzer Procedure)
US EPA Method 10	Determination of Carbon Monoxide Emissions from Stationary Sources
US EPA Method 22	Visual Determination of Fugitive Emissions from Material Sources and Smoke Emission from Flares
US EPA Method 23	Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans from Stationary Sources
US EPA Method 26A	Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources –Isokinetic Method
US EPA Method 29	Determination of Metals Emissions from Stationary Sources

CK calibrated CEMS every 84 minutes, after each compliance testing.

The following sections describe the sampling and analytical methodologies utilized during the emissions compliance testing. Field data sheets are included in the Appendix.

5.1 TEST METHODS

5.1.1 US EPA Method 1, 2 & 4 - Volumetric Flow Rate and Moisture

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).

A 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 were taken and recorded at each of the traverse points in the exhaust stack.

The moisture content was determined in conjunction with the Method 5/26A sampling trains. The trains consisted of a series of impingers and applicable sampling reagents. The impingers was 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 was 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 US EPA Method 3A - Oxygen/Carbon Dioxide

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% 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. It was calibrated before and after each test period using low, mid, or high calibration gases prepared according to EPA Report. Sampling occurred simultaneously with flow measurements in order to obtain volumetric flow data for mass emission calculations.

5.1.3 US EPA Method 5 - Particulate Matter

Filterable Particulate Matter (PM) was 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 26 sampling train. Sampling was conducted isokinetically for a period of 84 minutes per run, collecting a minimum of 60 dry standard cubic feet.

The front-half of the sampling train consisted of a glass button hook nozzle, a heated glass lined sample probe, a tared glass fiber filter in a holder in an oven box, a set of four tared glass impingers connected in series in an ice bath, and a control module consisting of a leak free sampling pump, a calibrated orifice, an inclined manometer, and a calibrated dry gas meter. A system leak check was performed per section 8.4.1 of Method 5. A calibration check with certified weight was performed on the field balance and was noted on the first moisture run. A glass cyclone bypass connected the sampling probe to the filter holder.

All filters were prepared and analyzed by Bureau Veritas. 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 demonstrate a constant weight, + 0.5 milligrams.

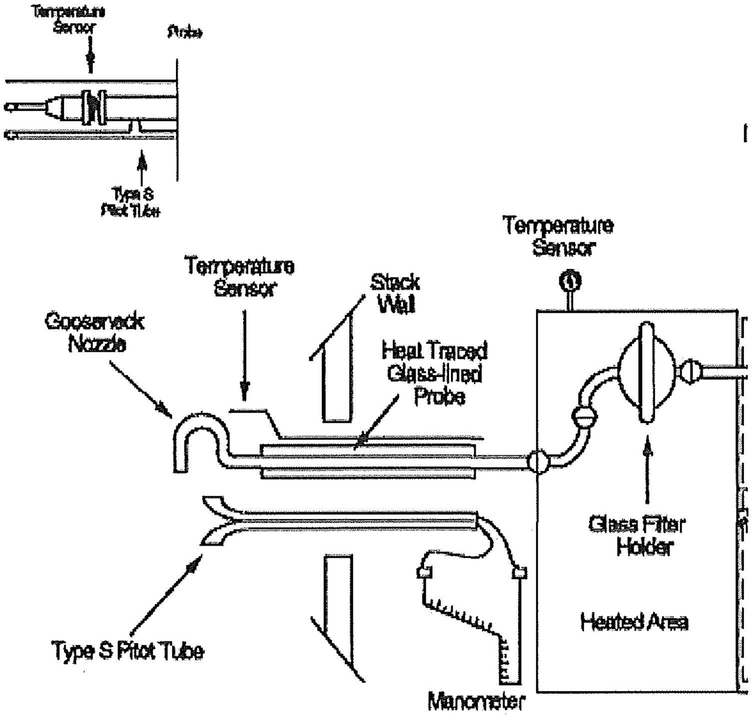
Prior to sampling, the isokinetic correlation was established, the train is carefully assembled, and leak checked. After the probe and filter compartment reach the desired operating temperature (248°F + 25°), the probe is placed in the stack and isokinetic sampling takes place.

At the completion of isokinetic sampling, the train was leak checked, disassembled, and sealed. All train recovery procedures are 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. An acetone field blank was also taken for analysis along with the samples.

The samples were analyzed gravimetrically by Bureau Veritas 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 are within +0.5 mg.

Figure 5-1

Method 5 Front Half Filterable PM Set-up



5.1.4 US EPA Method 6C - Sulfur Dioxide

Method 6C utilizes continuous emissions monitoring instrumentation. CK used a Western Research SO_2 Model 721M ultraviolet (UV), non-dispersive infrared (NDIR) 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 Report. The instrument was calibrated in the 0-100 ppm range. Stability test and interference test data sheets was available on-site and is in the appendix.

5.1.5 US EPA Method 7E - Oxides of Nitrogen

Oxides of Nitrogen (NOx) was measured in accordance with US EPA Method 7E. This method utilizes continuous emissions monitoring instrumentation. CK used a Thermo Electron Model 42C NOx 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 report specifications.

5.1.6 US EPA Method 10 - Carbon Monoxide

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 ppmvd CO. The range used during this emissions test was 0-5,000 ppmvd 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 report specifications.

5.1.7 US EPA Method 23 - Polychlorinated Dibenzo-P-Dioxins and Polychlorinated Dibenzofurans

Semi-volatile organic emissions of Polychlorinated Dibenzo-P-Dioxins and Polychlorinated Dibenzofurans compounds and their congeners (PCDDs/PCDFs) were 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 consisted 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 followed these components. The sorbent resin trap contains pre-cleaned XAD-2 resin.

Prior to mobilization filters, sorbent traps and XAD-2 resin were pre-cleaned in accordance with the method at Bureau Veritas. The filters and traps, containing XAD-2 resin, were packed, and shipped, at 4°C just prior to mobilization.

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

All quartz glass fiber filters were 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 was 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 were also hexane-rinsed. Cotton gloves were worn during all preparation and recovery procedures.

In the field the sampling train was set up in accordance with Method 23 procedures while wearing cotton gloves. The first impinger (a moisture knock-out) was empty in order to collect any condensate that may come through the sorbent trap. The second and third impingers each contained 100 ml of deionized distilled water. The fourth impinger was left empty. The fifth impinger contained a pre-weighed amount of color indicating silica gel. The sorbent trap was wrapped in foil to avoid exposure to direct sunlight. The sorbent trap and condenser coil were 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 included the probe and glass filter assembly were heated and maintained at a temperature of 248°F ± 25°F.

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

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

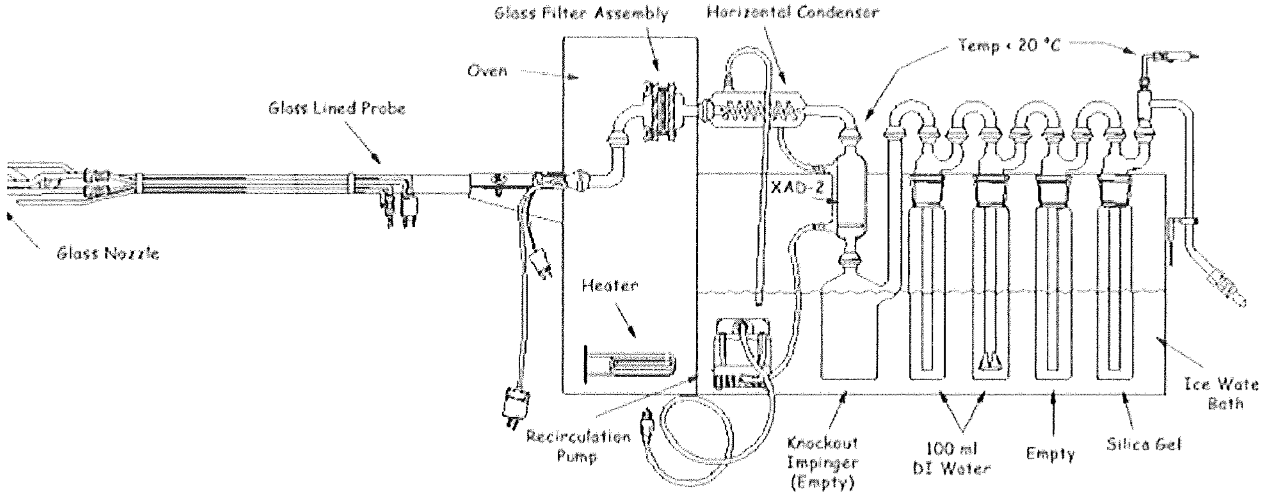
Following recovery, the samples were sealed, labeled, and stored in a cooler or refrigerator until shipment to the analytical laboratory. The samples were overnight shipped to the laboratory in coolers containing a sufficient number of freezer packs to ensure that the sample temperatures did not exceed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

All samples were extracted, combined, and analyzed for Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans and their congeners by High-Resolution Chromatography / High Resolution Mass Spectrometry. Bureau Veritas performed the analysis in accordance with the Method. The samples were 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 was added to each sample. A 2 µl aliquot of the extract was injected into the GC. Sample extracts were 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 were detected in this analysis, another aliquot of the sample was 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, was added to every sample prior to extraction. The role of the internal standards was 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 were added to the resin in the adsorbent sampling cartridge before the sample is collected. The surrogate recoveries were measured relative to the internal standards and were a measure of collection efficiency. They were 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 5-2
Method 23 Sampling Train Schematic



5.1.8 US EPA Method 26A - Hydrogen Chloride

Hydrogen chloride (HCl) emissions was measured in accordance with EPA Method 26A. This method utilizes a Method 5 type sampling train. The Method 5 front half train was combined with the method 26A back half of train.

Prior to mobilization, all glass and Teflon train components was thoroughly cleaned in hot soapy water, thoroughly rinsed with DI water, allowed to dry, and sealed with parafilm.

The first and second impinger contained 100 mL of 0.1N H_2SO_4. The third was an empty knockout impinger. The last impinger contained a known amount of silica gel.

The sample was collected through a heated glass probe liner, then through a heated filter assembly containing a quartz glass or Teflon membrane filter and finally through the impingers containing appropriate reagents. In accordance with the method, all six impingers were weighed before and after sampling and the data recorded. The first, second and third impingers was quantitatively recovered from the train and transferred to a Nalgene bottle (Container 1). The impingers and connecting glassware were rinsed three times with deionized water in the same sample bottle with a Teflon-lined lid (Container 1). The silica gel was weighed before and after sampling and the weights were recorded on the field data sheets.

An aliquot of all stock impinger solutions was retained and analyzed as a reagent/train blank. Bureau Veritas conducted the sample analysis.

The sulfuric acid impinger solution was analyzed using ion chromatography techniques for chloride ions (Cl-). Duplicate analysis was performed on the samples and the reagent blank. Precision was demonstrated by duplicate injection of each sample; the results of each individual analysis must be within 5% of their mean to be acceptable. If the precision criteria wasnot met, analysis of the sample was repeated until consecutive injections meet the criteria.

5.1.9 US EPA Method 29 - Multiple Metals

Metals' emissions were determined according to procedures outlined in the EPA Multi-Metals Procedure - 40 CFR 60, EPA Method 29. Emissions of mercury, cadmium, and lead was quantified in accordance with the method. Sampling was conducted isokinetically for a period of 120 minutes per run, collecting a minimum of 60 dry standard cubic feet. The following is a description of the sampling train and the procedures to be used to quantify multi-metals during the emissions compliance testing.

The multi-metals sampling train consisted of a glass button hook nozzle, a heated glass lined sample probe, a quartz fiber filter in a holder in an oven box, a set of seven tared glass impingers connected in series in an ice bath, a control module consisting of a leak free sampling pump, a calibrated critical orifice, an inclined manometer, and a calibrated dry gas meter. A Teflon® lined fitting connected the nozzle to the probe liner. A glass cyclone bypass connected the sampling probe to the filter holder. All of the sampling train glassware underwent the cleaning and nitric acid soaking procedure described in US EPA Method 29 prior to testing. Silicone grease was not used as a sealant on the ground glass fittings, to prevent potential sample contamination.

The sample probe and oven box were maintained at a temperature of 248+/-25°F during sampling to prevent moisture condensation. The first impinger was initially empty. The second and third impingers each contained 100 ml of 5% nitric acid / 10% hydrogen peroxide ($5\%HNO_3/10\%H_2O_2$). The fourth impinger was initially empty. The fifth and sixth impingers each contained 100 ml of 4% potassium permanganate / 10% sulfuric acid ($4\%KMnO_4/10\%H_2SO_4$). The acidic permanganate solution was prepared fresh on-site daily, in accordance with US EPA Method 29. The seventh impinger contained a known quantity of indicating silica gel. The third impinger was a Greenburg-Smith impinger with a standard tip, while the other impingers had modified tips. The temperature at the outlet of the seventh impinger was maintained below 68°F during sampling by adding ice to the ice bath. A vacuum line connected the outlet of the seventh impinger to the control module.

Before each test, the sampling train was leak checked to ensure a leakage rate no greater than 0.02 cfm at 15 in. Hg sample 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 differential pressure, critical orifice differential pressure, dry gas meter volume, dry gas meter temperature, probe temperature, stack temperature, oven box temperature, impinger outlet temperature, and sample vacuum was recorded at five minute intervals during sampling. Before port changes and at the completion of each test, the sampling train was leak checked to ensure a leakage rate no greater than 0.02 cfm at the highest recorded test vacuum.

After the post-test leak check, the sampling train was disassembled, all open ends were sealed, and the sampling train components were moved to the cleanup area for recovery. The recovery procedure for the multi-metals sampling train was as follows:

The filter was carefully removed from the filter holder with Teflon® coated forceps and placed in a labeled plastic petri dish (Container 1). Any particulate matter or filter fragments that adhere to the filter holder gasket was transferred to the petri dish using a dry, acid cleaned nylon bristle brush. The petri dish was then sealed for transport to the laboratory.

The nozzle, probe liner, cyclone bypass, and filter holder front half was then rinsed thoroughly with 100 ml of 0.1 N HNO_3. These rinses were collected in a labeled Nalgene® sample jar (Container 2). The sample jar was sealed, and the liquid level was marked. The nozzle, probe liner, cyclone bypass, and filter holder front half were rinsed with water followed by acetone. These rinses were discarded.

The moisture gain in the first three impingers was measured gravimetrically and their contents was transferred to a labeled Nalgene® sample jar (Container 3). The first three impingers, the filter support, the back half of the filter holder, and the connecting glassware between the back half of the filter holder and the third impinger was then rinsed with 100 ml of 0.1 N HNO_3. These rinses were combined with the impinger contents, and the sample jar was sealed, and the liquid level was marked.

The moisture gain in the fourth impinger was measured gravimetrically, and its contents were transferred to a labeled Nalgene® sample jar (Container 4). This impinger was then rinsed with 100 ml of 0.1 N HNO_3. The rinses were combined with the impinger contents, and the sample jar was sealed, and the liquid level was marked.

The moisture gain in the permanganate impingers (Impingers 5 & 6) was measured gravimetrically and their contents were transferred to a labeled glass sample jar (Container 5). These impingers and their connecting glassware was then rinsed with 100 ml of fresh $4\%KMnO_4/10\%H_2SO_4$ followed by a rinse with 100 ml of water. The permanganate and deionized water rinses was combined with the impinger contents, and the sample jar was sealed, and the liquid level was marked. This sample jar was not completely filled and was vented to relieve excess pressure.

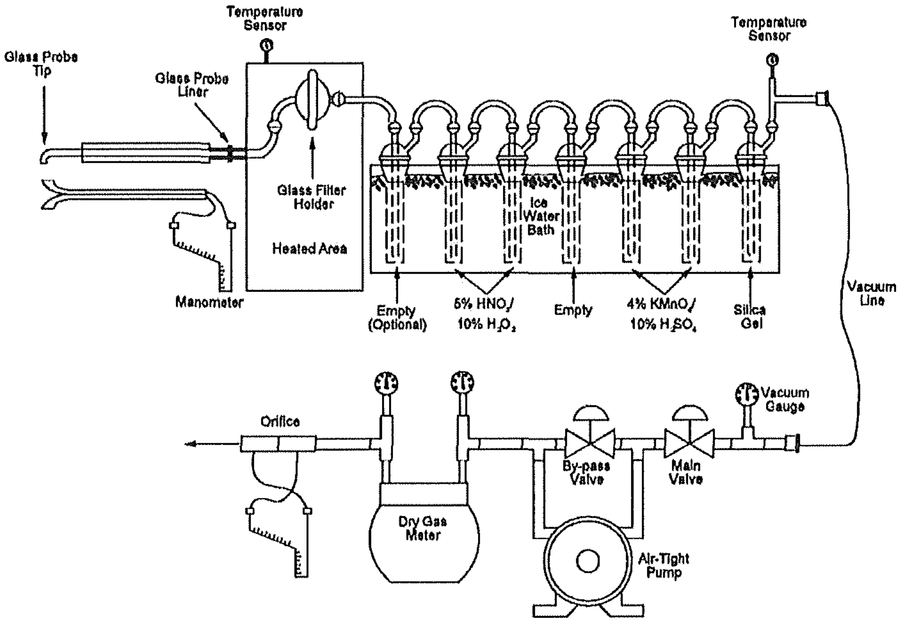
If any visible permanganate deposits remained after the water rinses, the permanganate impingers was rinsed with a total of 25 ml of 8N HCl. The walls and stem of the first permanganate impinger was rinsed, and the rinse was poured into the second permanganate impinger, which will then be rinsed with the remaining 8N HCl. These rinses were collected in a labeled glass sample jar containing 200 ml of water (Container 6). The sample jar was sealed, and the liquid level was marked.

The silica gel impinger was weighed for moisture gain. The silica gel was returned to its original storage container to be dried for reuse.

The multi-metals samples were submitted to the CK sub-contract laboratory, Bureau Veritas Inc., for analysis. Containers 1 through 4 were digested in concentrated acid solutions before being analyzed for the target metals by inductively coupled argon plasma emission spectroscopy (ICAP) or graphite furnace atomic absorption spectroscopy (GFAAS) if lower detection limits were required. All samples were labeled, logged, and stored in a cool, dark area until delivery to the laboratory. A set of reagent blanks were also taken for analysis along with the samples.

Figure 5-3

Method 29 Sampling Train



5.2 EMISSIONS SAMPLING PROCEDURES

5.2.1 Isokinetic Sampling Procedures

All sampling procedures was 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 and Cyclonic Flow Check- A preliminary traverse was conducted. Readings include the velocity pressure, angle of flow, gas temperature and static pressure. The average angle of flow was used to determine whether the exhaust gas is considered "cyclonic" (≥20°).

Stratification Check- Before any gaseous reference method test runs were performed, a stratification check was conducted to ensure that there is no stratification at the sampling location. Stratification is defined as a difference greater than 10 percent between the average concentration of the stack and the concentration at any other point. Once the traverse was completed, each point was 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 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 from the Weather Channel application

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 were 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 are 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 must be 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 exceeds 0.02 cfm the run was suspect and was repeated to get an exact leak rate.

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

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

5.2.2 CEMS Sampling System and Procedures (O2, CO2, SO_2, NOx, CO)

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) 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 is split. One portion of the sample stream was passed through the sample conditioning system before being delivered to the O_2, CO_2, SO_2, CO and NOx 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.

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.

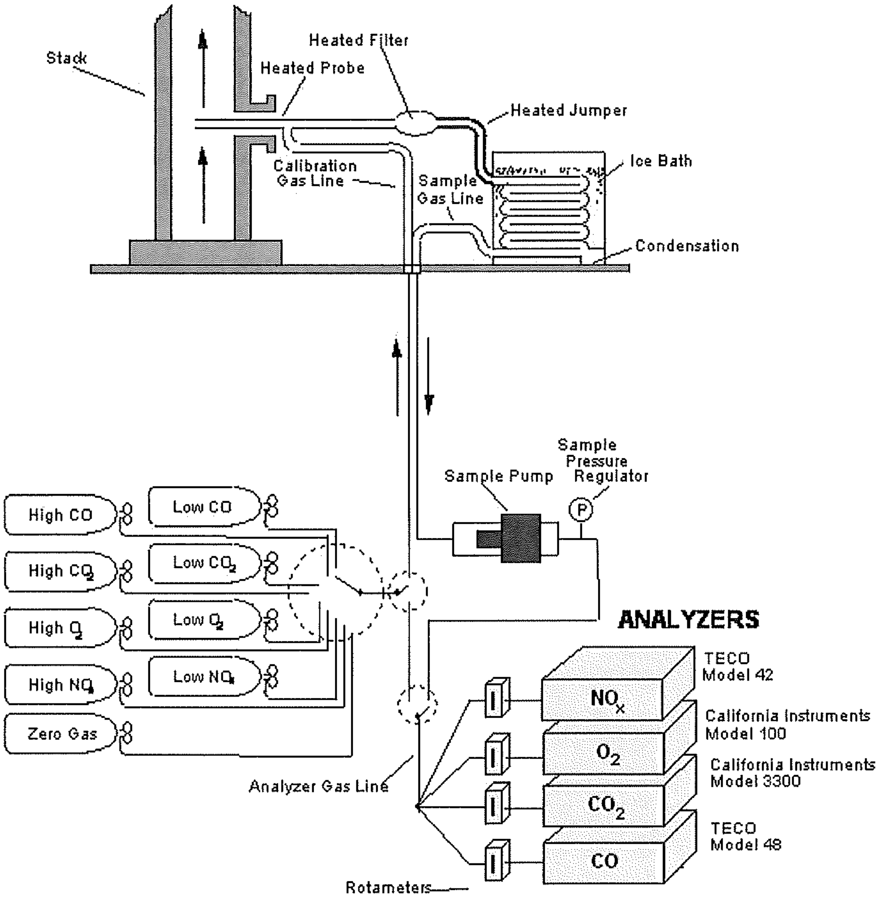
Gas Analyzers - capable of the continuous determination of O_2, CO_2, SO_2, CO, and NO_x concentrations in a sample gas stream. They each meet or exceed the following specifications:

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 was used to record analyzer response to the sample and calibration gas streams. The data logger records at 15-second intervals and the data was 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 were 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 were 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:

Figure 5-4
Schematic of Reference Method CEMS



Selection of Sampling Traverse Point Locations - Sampling point locations were determined prior to testing in accordance with EPA Methods 3A, 6C, 7E, 10.

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, 7E, 10.

Determination of Sampling System Bias - Sampling system bias was 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 were determined. The pre-and post-test analyzer responses were compared to determine drift. The results were evaluated based upon specifications defined in EPA Methods 3A, 6C, 7E, 10.

NO_2 to NO Converter Check- A NO_2 to NO converter check was conducted on the NOx analyzer in accordance with Section 8.2.4 of Method 7E. A calibration gas of $\approx$50 ppm NO_2 was introduced into the analyzer in direct calibration mode. The NOx 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 (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 was available on site during testing and is 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 Report certified calibration gas standards was used. The Certificates of Analysis for all Report standards was available on site during the testing. The Certificates of Analysis is 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 was included in the report to verify the review process was completed.