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February 12, 2016

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Bureau Veritas Project No. 11015-000237.00

Subject: **Air Emissions Test Report**
Fluidized Bed Sewage Sludge Incinerator – Wastewater Treatment Plant
Ypsilanti Community Utilities Authority
2777 State Road
Ypsilanti, Michigan

Dear Ms. Kajiya-Mills and Mr. Miller:

On behalf of Ypsilanti Community Utilities Authority, Bureau Veritas North America, Inc. submits this report for the emissions testing of the fluidized bed sewage sludge incinerator (EU-FBSSI) at the Ypsilanti Community Utilities Authority wastewater treatment plant in Ypsilanti, Michigan. The enclosed report summarizes the results of the testing performed on December 15 and 16, 2015.

If you have any questions regarding this report, please contact us.

Sincerely,

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Senior Project Manager
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cc: Luther Blackburn – YCUA
Sara Breneman – USEPA Region V

B6237-TEST_20151215

Air Emission Test for Fluidized Bed Sewage Sludge Incinerator

YCUA
Wastewater Treatment Plant
2777 State Road
Ypsilanti, Michigan

Renewable Operating Permit B6237-2015
State Registration No. B6237

Prepared for
Ypsilanti Community Utilities Authority
Ypsilanti, Michigan

Bureau Veritas Project No. 11015-000237.00
February 12, 2016

Move Forward with Confidence

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DEQ

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

RENEWABLE OPERATING PERMIT REPORT CERTIFICATION

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating (RO) Permit program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as described in General Condition No. 22 in the RO Permit and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name: Ypsilanti Community Utilities Authority   County: Washtenaw

Source Address: 2777 State Street   City: Ypsilanti

AQD Source ID (SRN): B6237   RO Permit No. MI-ROP-B6237-2015   RO Permit Section No. C

Please check the appropriate box(es):

☐ **Annual Compliance Certification** **(General Condition No. 28 and No. 29 of the RO Permit)**

Reporting period (provide inclusive dates): From ____________ To ____________

☐ 1. During the entire reporting period, this source was in compliance with **ALL** terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the RO Permit.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference, **EXCEPT** for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the RO Permit, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification** **(General Condition No. 23 of the RO Permit)**

Reporting period (provide inclusive dates): From ____________ To ____________

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred.

☐ 2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred, **EXCEPT** for the deviations identified on the enclosed deviation report(s).

☒ **Other Report Certification**

Reporting period (provide inclusive dates): From na To na

Additional monitoring reports or other applicable documents required by the RO Permit are attached as described:

Air Emissions Test Report to evaluate compliance with EU-FBSSI emission unit.
This form shall certify that the testing was conducted in accordance with the
submitted test plan and that the facility operated in compliance with pemit
conditions or at the maximum routine operating conditions for the facility.

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete, and that any observed, documented or known instances of noncompliance have been reported as deviations, including situations where a different or no monitoring method is specified by the RO Permit.

Jeff Castro	Director	734-484-4600
Name of Responsible Official (print or type)	Title	Phone Number

[signature] 2/11/2016

Signature of Responsible Official   Date

* Photocopy this form as needed.

EQP 5736 (8/99)

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Executive Summary

Ypsilanti Community Utilities Authority (YCUA) retained Bureau Veritas North America, Inc. to perform emission testing at the YCUA wastewater treatment plant in Ypsilanti, Michigan. Air emissions from the fluidized-bed sewage sludge incinerator (Emission Unit ID: EU-FBSSI) were tested at Exhaust Stack SV-001. The testing was performed to evaluate compliance with applicable emission limits in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B6237-2015, dated March 17, 2015, and Table 2 to Subpart MMMM of CFR 40 Part 60.

Bureau Veritas sampled the EU-FBSSI exhaust for the following analytes:

- Oxygen (O_2)
- Sulfur dioxide (SO_2)
- Oxides of nitrogen (NO_x)
- Carbon monoxide (CO)
- 2,3,7,8-Tetrachlorodibenzo-*para*-dioxin toxic equivalents (2,3,7,8-TCDD TEQ)
- Total dioxins and furans
- Total polychlorinated biphenyls (PCBs)
- Hydrogen chloride (HCl)
- Particulate matter (PM)
- Arsenic (As), beryllium (Be), cadmium (Cd), total chromium (Cr), lead (Pb), and mercury (Hg)

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1, 2, 3A, 4, 5, 6C, 7E, 10, 23, 26A, 29, and 205 guidelines. Three 60-minute test runs were completed for each analyte at the EU-FBSSI source. Concentrations of oxygen in the exhaust gas were measured and averaged over the test period in order to correct the results to 7% oxygen.

Detailed results are presented in Tables 1 through 4 after the Tables Tab of this report. The following table summarizes the results of the testing conducted on December 15 and 16, 2015.

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Summary of EU-FBSSI Air Emission Test Results

Parameter	Units	Average Result	EU-FBSSI Permit Limit	40 CFR Part 60 Subpart MMMM Emission Limits[1,2]
Sulfur dioxide (SO_2)	ppmvd at 7% oxygen	7.4	—	15
Oxides of nitrogen (NO_x)	ppmvd at 7% oxygen	52.2	—	150
Carbon monoxide (CO)	ppmvd at 7% oxygen	45.0	100 [3]	64
2,3,7,8-Tetrachlorodibenzo-*para*-dioxin, toxic equivalents (2,3,7,8-TCDD TEQ)	lb/ton dry sewage sludge	8.9×10^{-12}	1.4×10^{-9} [4]	—
Total dioxins and furans	ng/dscm at 7% oxygen	0.045	—	1.2 Total mass basis
		0.00044	—	0.10 Toxic equivalency basis
Total polychlorinated biphenyls (PCBs)	lb/ton dry sewage sludge	2.7×10^{-7}	1.2×10^{-6} [4]	—
Hydrogen chloride (HCl)[6]	lb/ton dry sewage sludge	<0.038	0.8 [5]	—
	ppmvd at 7% oxygen	<1.473	—	0.51
Particulate matter (PM)	lb/ton dry sewage sludge	0.06	0.35 [3]	—
	mg/dscm at 7% oxygen	3.3	—	18
Arsenic (As)	lb/ton dry sewage sludge	2.0×10^{-5}	1.3×10^{-3} [3]	—
Beryllium (Be)	lb/ton dry sewage sludge	4.3×10^{-6}	2.5×10^{-5} [3]	—
Cadmium (Cd)	lb/ton dry sewage sludge	4.3×10^{-6}	8.5×10^{-3} [3]	—
	mg/dscm at 7% oxygen	2.4×10^{-4}	—	1.6×10^{-3}
Total chromium (Cr)	lb/ton dry sewage sludge	1.1×10^{-4}	4.5×10^{-2} [3]	—
Lead (Pb)	mg/dscm at 7% oxygen	1.8×10^{-3}	—	7.4×10^{-3}
Mercury (Hg)	lb/ton dry sewage sludge	2.8×10^{-4}	6.9×10^{-4} [3]	—
	mg/dscm at 7% oxygen	1.5×10^{-2}	—	3.7×10^{-2}

ppmvd: part per million by volume, dry
lb/ton: pound per ton
mg/dscm: milligram per dry standard cubic meter
ng/dscm: nanogram per dry standard cubic meter

[1] Emission limits from Table 2 to Subpart MMMM of 40 CFR Part 60.
[2] Table 2 to Subpart MMMM of 40 CFR Part 60 indicates that (1) all emission limits shall be measured at 7% oxygen, dry basis at standard conditions and (2) results shall be based on a three-run average collecting a minimum volume of 1 dry standard cubic meter per run with the exception of oxides of nitrogen, sulfur dioxide, and carbon monoxide for which sample duration shall be a minimum of 1 hour per run.
[3] Based on 60-minute averaging time
[4] Based on 240-minute averaging time
[5] Based on 120-minute averaging time
[6] As noted in laboratory report, HCl samples were diluted due to matrix interference; sulfate peak was higher than expected.

1.0 Introduction

1.1 Summary of Test Program

Ypsilanti Community Utilities Authority (YCUA) retained Bureau Veritas North America, Inc. to perform emission testing at the YCUA wastewater treatment plant in Ypsilanti, Michigan. YCUA provides water and wastewater services for the City of Ypsilanti and surrounding communities. YCUA processes over 8 billion gallons of wastewater annually.

The testing was performed to evaluate compliance with applicable emission limits in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B6237-2015, dated March 17, 2015, and Table 2 to Subpart MMMM of CFR 40 Part 60.

Air emissions from the fluidized-bed sewage sludge incinerator (Emission Unit ID: EU-FBSSI) were tested at Exhaust Stack SV-001. Bureau Veritas sampled the EU-FBSSI exhaust for the following analytes:

- Oxygen (O_2)
- Sulfur dioxide (SO_2)
- Oxides of nitrogen (NO_x)
- Carbon monoxide (CO)
- 2,3,7,8-Tetrachlorodibenzo-*para*-dioxin, toxic equivalents (2,3,7,8-TCDD TEQ)
- Total dioxins and furans
- Total polychlorinated biphenyls (PCBs)
- Hydrogen chloride (HCl)
- Particulate matter (PM)
- Arsenic (As), beryllium (Be), cadmium (Cd), total chromium (Cr), lead (Pb), and mercury (Hg)

The term toxic equivalency (TEQ) is referenced in the permit limits and means the product of the concentration of an individual dioxin isomer in an environmental mixture and the corresponding estimate of the compound–specific toxicity relative to tetrachlorinated dibenzo-*para*-dioxin, referred to as the toxic equivalency factor for that compound. Toxic equivalency factors are listed in Table 5 to Subpart MMMM of CFR 40 Part 60.

The air emission testing was conducted December 15 and 16, 2015, as described in the Intent-to-Test plan, which was submitted to MDEQ on October 23, 2015. The testing is summarized in Table 1-1.

Table 1-1
Source Tested, Parameters, and Test Date

Source	Parameter	Test Date
Fluidized bed sewage sludge incinerator (EU-FBSSI Exhaust)	Oxygen (O_2)	December 15 and 16, 2015
	Sulfur dioxide (SO_2)	
	Oxides of nitrogen (NO_X)	
	Carbon monoxide (CO)	
	2,3,7,8-Tetrachlorodibenzo-*para*-dioxin, toxic equivalents (2,3,7,8-TCDD TEQ)	
	Total dioxins and furans	
	Total polychlorinated biphenyls (PCBs)	
	Hydrogen chloride (HCl)	
	Particulate matter (PM)	
	Arsenic (As)	
	Beryllium (Be),	
	Cadmium (Cd),	
	Total chromium (Cr),	
	Lead (Pb),	
	Mercury (Hg)	

1.2 Key Personnel

Key personnel involved in this test program are listed in Table 1-2. Mr. Thomas Schmelter, Senior Project Manager with Bureau Veritas, directed the compliance testing program. Mr. Luther Blackburn, Director of Wastewater Operations and Compliance with YCUA, provided process coordination and arranged for facility operating parameters to be recorded.

The testing was witnessed by Mr. David Patterson, Mr. Scott Miller, and Ms Diane Kavanaugh-Vetort, Environmental Quality Analysts with MDEQ.

Table 1-2
Key Personnel

YCUA	BVNA
Luther Blackburn Director of Wastewater Operations and Compliance **Ypsilanti Community Utilities Authority** 2777 State Road Ypsilanti, Michigan 28198-9112 Telephone: 734.484.4600 Ext. 121 Facsimile: 734.544.7149, 734.484.7344 lblackburn@ycua.org	Thomas R. Schmelter, QSTI Senior Project Manager **Bureau Veritas North America, Inc.** 22345 Roethel Drive Novi, Michigan 48375-4710 Telephone: 248.344.3003 Facsimile: 248.344.2656 thomas.schmelter@us.bureauveritas.com
MDEQ	
David Patterson **Michigan Department of Environmental Quality** Air Quality Division – Technical Programs Unit Constitution Hall, 2nd Floor South 525 West Allegan Street Lansing, Michigan 48933-1502 Telephone: 517. 284.6782 Facsimile: 517.335.3537 pattersond2@michigan.gov Diane Kavanaugh-Vetort **Michigan Department of Environmental Quality** Air Quality Division – Jackson District Office 301 East Louis Glick Highway Jackson, Michigan 49201 Telephone: 517.780.7864 Facsimile: 517.780.7855 kavanaughd@michigan.gov	Scott Miller **Michigan Department of Environmental Quality** Air Quality Division – Jackson District Office 301 East Louis Glick Highway Jackson, Michigan 49201 Telephone: 517.780.7481 Facsimile: 517.780.7855 millers@michigan.gov

2.0 Source and Sampling Locations

2.1 Process Description

YCUA operates a wastewater treatment plant that processes over 8 billion gallons of residential and industrial wastewater per year. As part of the wastewater treatment, biosolids are accumulated and collected prior to discharge of the treated water into the Lower Rouge River. Biosolids are a sludge that is typically brown to black in color, malodorous, and consists of residual organic matter and microbes containing bacteria and pathogens.

Biosolid sludge accumulated at the YCUA wastewater treatment plant is treated using a fluidized bed sewage sludge incinerator. Air emissions from the fluidized bed sewage sludge incinerator are controlled by four pollution control devices: a scrubber, impingement tray, electrostatic precipitator, and carbon bed; the final discharge to the atmosphere is through Stack SV-001. Bureau Veritas performed emissions testing at Exhaust Stack SV-001.

The facility processes residential and industrial wastewater. Biosolids are accumulated as part of the treatment process. These biosolids are treated in the fluidized bed sewage sludge incinerator.

The incinerator is designed to operate continuously. Depending on the amount of available biosolids, the incinerator is operated on an average of 3 to 4 days a week. During the emission testing, biosolids were introduced into the incinerator using conveyors and pumps at an average rate of 5,677 dry pounds per hour (lb/hr) on December 15, 2015, and 5,274 dry pounds per hour on December 16, 2015. The incinerator operated at ≥85% of the permitted capacity during the emission testing.

Two dewatered sewage sludge feed bins are located in the solids building. Dewatered cake from nine belt filter presses is stored in the feed bins before being pumped to the incinerator. Two dewatered biosolid pumps are connected to each of the feed bins. The feed bin extraction screw conveyors feed the pumps, and the pumps transfer dewatered sludge to the incinerator. Sludge is transferred, via high-pressure schedule 80 steel pipe, from the feed bins to the incinerator. High-pressure ball valves installed in the piping system control the flow of sludge to the incinerator.

YCUA personnel recorded operating parameters during the emission testing. The recorded operating parameters are included in Appendix F.

2.2 Control Equipment

The fluidized bed sewage sludge incinerator uses four pollution control devices prior to exhausting emissions to the atmosphere through Exhaust Stack SV-001. These pollution control devices include: a venturi scrubber, a multi-stage impingement tray scrubber, a wet electrostatic precipitator, and a granular activated carbon bed.

The main component of the incinerator is the fluid bed reactor. During static conditions, the fluid bed reactor consists of an inert sand bed supported on an air distributor dome. As air is forced up through the dome and sand bed, the individual particles of the bed will fluidize. At a certain air velocity, the sand becomes suspended in the fluidizing air stream. The fluidized state promotes an intensive mixing of the individual sand particles with the fluidizing air that is used as combustion air for the incineration process.

The fluid bed reactor vessel has three main sections of which two sections are physically separated. The bottom of the reactor is the windbox, which is used to distribute the air evenly to the sand and has a burner for preheating. In the middle sand bed section, natural gas and sludge are injected into the fluidized sand media where most of the combustion takes place. The upper section is the freeboard, which allows additional residence time to completely combust the natural gas and sludge.

Hot gases containing ash from the incineration process exit the top of the fluidized bed incinerator and pass through two shell-and-tube heat exchangers. After the heat exchangers, the gases pass through a venturi scrubber that removes particulate matter from the gases due to water injection and gas velocity increases at the venturi throat. Next, the gases pass through a tray scrubber to remove condensable gas byproducts and lower the exit temperature of the gases.

The gas from the tray scrubber is passed through a wet electrostatic precipitator to remove very fine particulate matter. The final air pollution control device is the granular activated carbon system that contains (1) a conditioner to remove water droplets and heat the gas and (2) an absorber to remove trace mercury in the gas stream. The absorber removes mercury by passing the gas through one cell of porous filter media pellets and two cells of more porous carbon pellets.

2.3 Operating Parameters

Operating parameters for the fluidized bed sewage sludge incinerator pollution control equipment are controlled by programmable logic controller monitoring systems.

Operating parameters for EU-FBSSI include the following:

- Maintain a temperature of 1,200°F within the fluidized sand bed during startup.

- Maintain temperatures above 1,500°F during shutdown while any sludge is still burning.

- Maintain the oxygen content of the exhaust stack gas to be greater than 2% wet or 3% dry based on 15-minute average.

- Ensure the total volumetric flowrate at the fluidized air blower does not exceed 13,061 standard cubic feet per minute (scfm), based on an hourly average.

- Maintain a minimum operating temperature of 1,150°F, based on a 15-minute average, within the fluidized sand bed while in operation.

- Maintain a minimum 2-second retention time while the sewage is in the fluidized sand bed.

- Maintain a temperature of 1,500°F, based on a 15-minute average, at the freeboard.

- Maintain a 6-second retention time while sewage is in the freeboard.

- Maintain a sewage sludge input feed rate of less than 6,300 pounds of dry sewage sludge per hour based on a 24-hour average and less than 16,380 tons of dry sewage sludge per 12-month rolling period.

- Maintain venturi scrubber water flow at a minimum of 300 gallons per minute (gpm).

- Maintain an impingement tray scrubber water flowrate at a minimum of 350 gpm.

- Maintain a venturi scrubber pressure differential between 30 to 40 inches of water (20 to 40 inches of water during startup).

- Maintain an impingement tray scrubber pressure differential of 5 to 15 inches of water.

- Maintain a granular activated carbon bed pressure differential from 1 to 10 inches of water.

The permitted capacity of the FBSSI is 6,300 dry pounds of solids per hour. The rated air pollutant removal efficiency is a minimum of 95%.

Process and control equipment data recorded during testing are included in Appendix F. Table 2-1 summarizes the process and control equipment data.

2.4 Materials Processed During Tests

The facility processes residential and industrial wastewater. Biosolids are accumulated as part of the treatment process. These biosolids are treated in the fluidized bed sewage sludge incinerator. The air emissions from the incineration of the biosolids were tested during this study. In addition, YCUA personnel collected an instantaneous sample of sewage sludge for metal content analysis. The Table 2-1 summarizes the sewage sludge metal content in comparison to permit limits.

Table 2-1
Sewage Sludge Metal Content

Pollutant	Units	Average		Permit Limit
		Dec. 15, 2016	Dec. 16, 2016	
Arsenic	mg/kg dry sewage sludge	6.1	6.4	**13**
Beryllium	mg/kg dry sewage sludge	<0.20†	<0.20†	**0.25**
Cadmium	mg/kg dry sewage sludge	5.4	5.6	**85**
Total Chromium	mg/kg dry sewage sludge	150	150	**450**
Lead	mg/kg dry sewage sludge	11	12	-
Mercury	mg/kg dry sewage sludge	0.20	0.27	**3.7**
Total PCBs	mg/kg dry sewage sludge	1.6	2.0	-

PCBs: polychlorinated biphenyls
mg/kg: milligram/kilogram
† Not detected above reporting limit of 0.20 mg/kg dry sewage sludge

Refer to Appendix F for the metal analytical results of the sewage sludge sample.

2.5 Rated Capacity of Process

Currently the incinerator processes over 5,000 dry tons of biosolids sludge per year. As required under Section C.II. of the permit, no more than 6,300 pounds of dry sewage per hour are to be incinerated on a 24-hour basis.

The average sewage sludge feedrate into the incinerator was monitored as total sludge processed in gallons. The sludge solid content was used to convert the total sludge processed from gallons to total pounds of solids. The measured beltpress transfer efficiency of 89.3% was used with the total time of the test to calculate the dry pounds of sludge processed per hour.

During emission testing, biosolids were introduced into the incinerator using conveyors and pumps at an average rate of 5,677 dry pounds per hour (2.8 dry tons per hour) on December 15, 2015, and 5,274 dry pounds per hour (2.6 dry tons per hour) on December 16, 2015,. Typically YCUA operates the EU-FBSSI at a sewage sludge feed rate of 1.9 to 2.6 dry tons per hour.

The rated air pollution removal efficiency is a minimum of 95%.

2.6 Flue Gas Sampling Locations

YCUA provides water and wastewater services for the City of Ypsilanti and surrounding communities. YCUA processes over 8 billion gallons of wastewater annually. YCUA operates a fluidized bed sewage sludge (biosolids) incinerator. This incinerator incorporates four types of air pollution control; the final control is a granular activated carbon absorber (GACA). A description of the source tested is presented in Table 2-2.

Table 2-2
Emission Unit Identification

Emission Unit ID	Emission Unit Description	Stack Identification
EU-FBSSI	Fluidized bed sewage sludge (biosolids) incinerator controlled with a venturi scrubber, a multi-stage impingement tray scrubber, a wet electrostatic precipitator (WSEP), and a granular activated carbon absorber bed (GACA)	SV-001

A description of the flue gas sampling location is presented in Section 2.6.1.

2.6.1 EU-FBSSI Exhaust

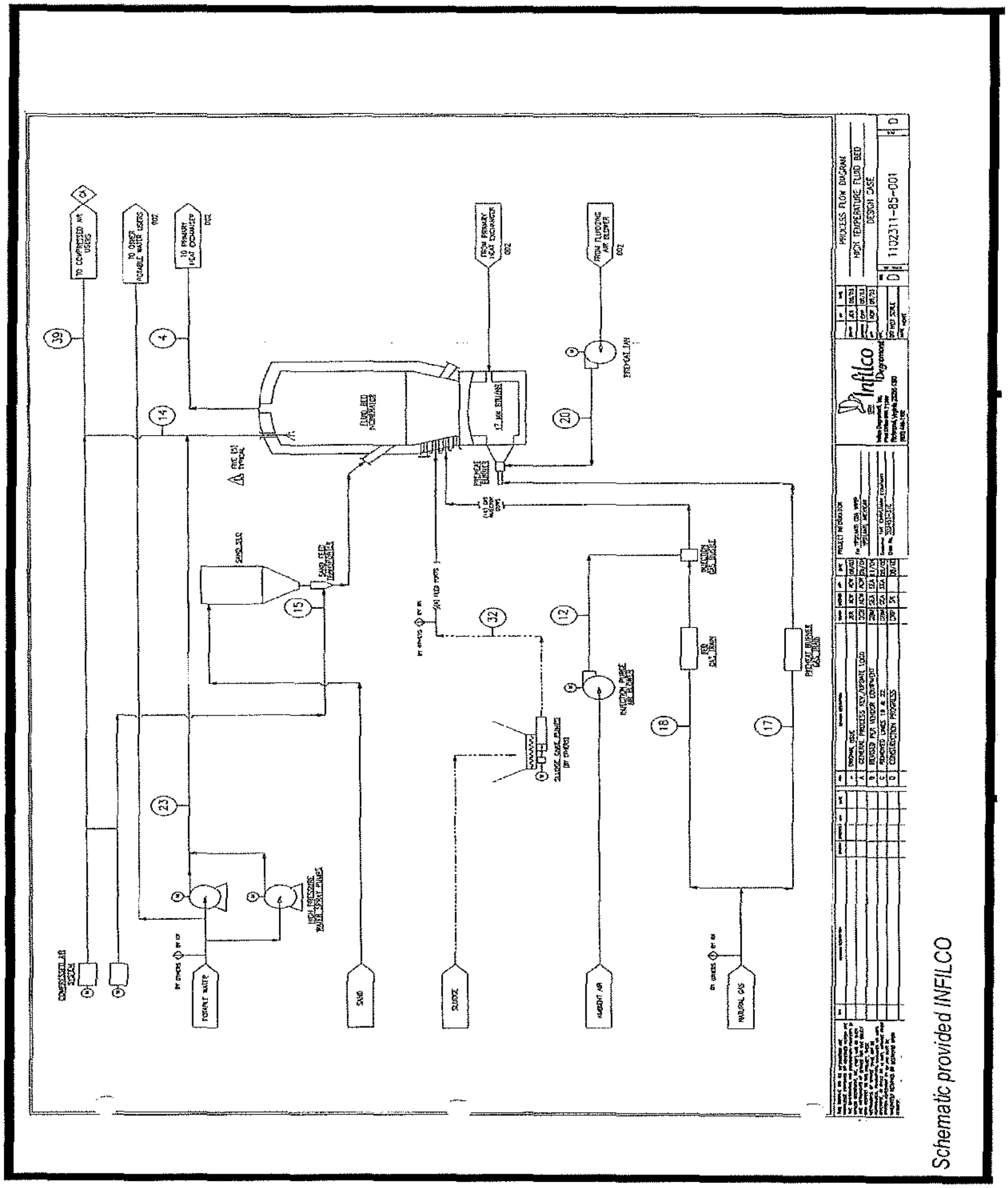
The EU-FBSSI exhaust stack is 42 inches in diameter and has two 4-inch-diameter sampling ports. Six traverse points per sampling port were used to measure stack gas velocity. The ports are located:

- 18 feet (5.1 duct diameters) from the nearest downstream disturbance.
- 56 feet (16 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible via a ladder and a platform on the stack.

Figures 2-1 and 2-2 depict the fluidized bed sewage sludge process flow and sampling location. Point 9 on Figure 2-2 depicts the EU-FBSSI exhaust (SV-001) where emissions testing were performed. Figure 2-3 is a photograph of the EU-FBSSI exhaust sampling location. Figure 1 in the Appendix depicts the EU-FBSSI sampling and traverse point locations.

Figure 2-1. EU-FBSSI Schematic 1



Schematic provided INFILCO

Figure 2-2. EU-FBSSI Schematic 2

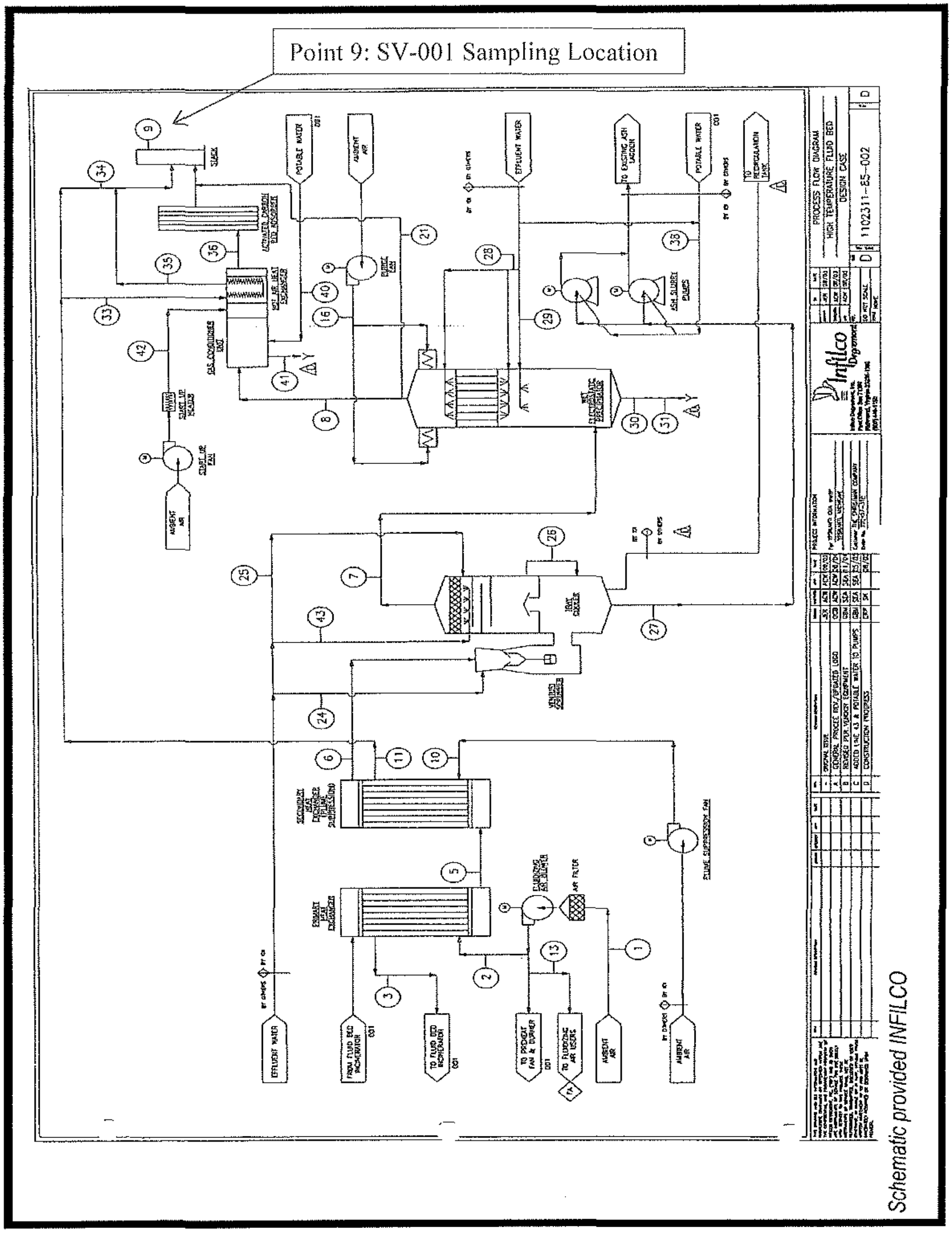
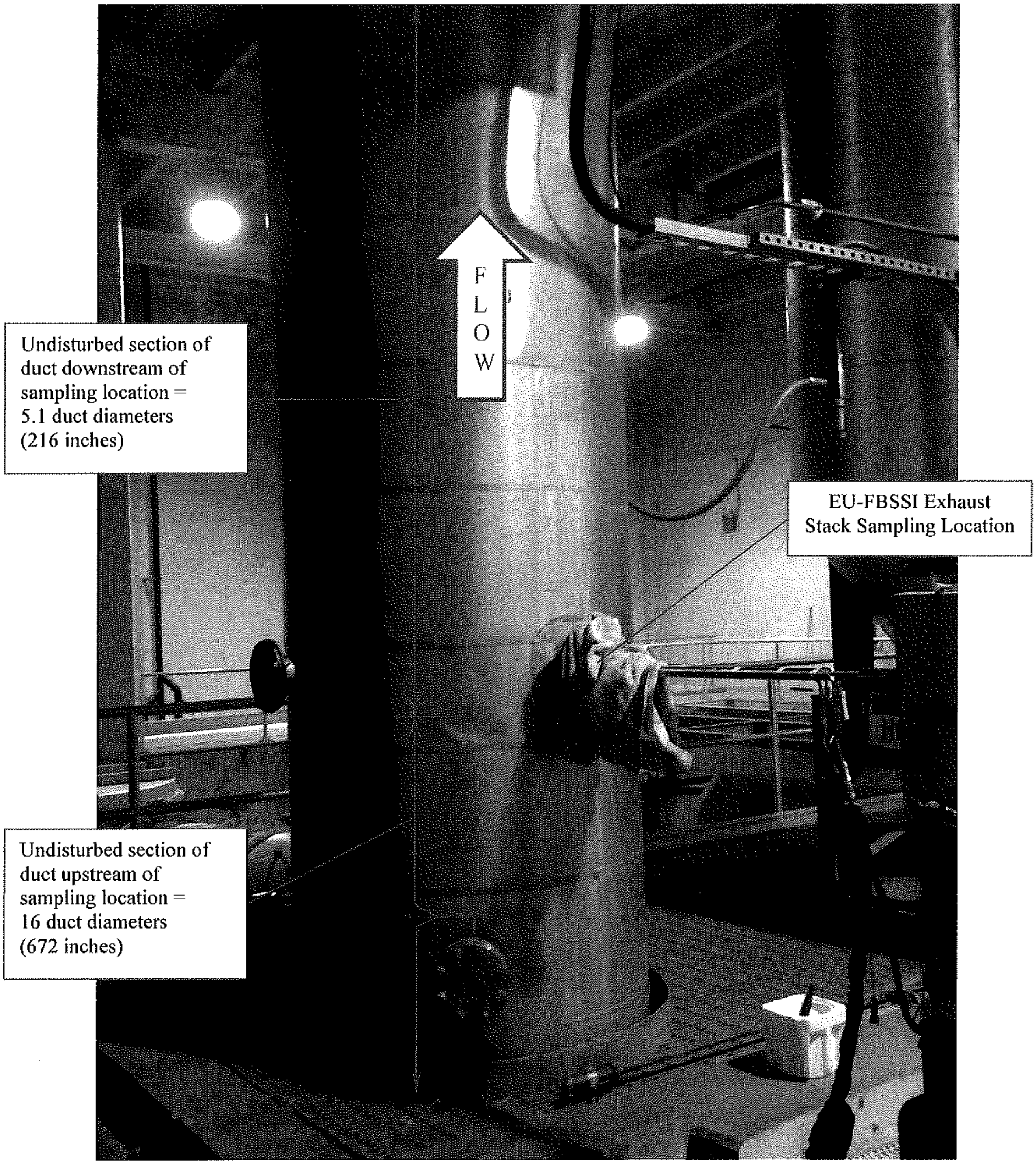


Figure 2-3. EU-FBSSI Photograph



3.0 Summary and Discussion of Results

3.1 Objective and Test Matrix

The objective of the testing was to evaluate compliance with applicable emission limits in MDEQ ROP MI-ROP-B6237-2015, dated March 17, 2015, and Table 2 to Subpart MMMM of CFR 40 Part 60.

Table 3-1 summarizes the sampling and analytical matrix.

Table 3-1
Test Matrix

Sampling Location	Test Date (2015)	Test Run	Start Tine	Stop Tine	Sample/Type of Pollutant	Sampling Method	No. of Test Runs and Duration	Analytical Method	Analytical Laboratory
EU-FBSSI Exhaust	Dec. 15	1	12:15	13:15	O_2, CO_2, CO, NO_x, SO_2	1, 2, 3A, 4, 6C, 7E, 10, and 205	Three 60-minute runs	Field measurement; Instrument paramagnetic, ultraviolet, chemiluminescence, and infrared analysis; gravimetric	Bureau Veritas
		2	13:50	14:50					
		3	16:20	17:20					
	Dec. 15	1	8:30	9:37	O_2, CO_2, PM, metals (As, Be, Cd, Cr, Pb, Hg)	1, 2, 3A, 4, 5, and 29	Three 60-minute runs	Field measurement; Instrument paramagnetic analysis; gravimetric; cold vapor atomic absorption; inductively coupled plasma mass spectrometry	Maxxam Analytics
		2	9:57	11:48					
		3	12:02	13:56					
	Dec. 15	1	15:01	17:19	O_2, CO_2, HCl	1, 2, 3A, 4, and 26A	Three 120-minute runs	Field measurement; Instrument paramagnetic analysis; gravimetric; ion chromatography	Maxxam Analytics
	Dec. 16	2	9:30	11:35					
		3	11:55	14:12					
	Dec. 15	1	9:08	13:20	O_2, CO_2, PCBs, dioxins and furans (2,3,7,8-TCDD TEQ)	1, 2, 3A, 4, and 23	Three 240-minute runs	Field measurement; Instrument paramagnetic analysis; high resolution mass spectrometry	Maxxam Analytics
		2	14:12	18:15					
	Dec. 16	3	8:30	12:35					

3.2 Field Test Changes and Issues

Communication between YCUA, Bureau Veritas, and MDEQ allowed the testing to be completed without field test changes. However the following issue was noted in the analytical laboratory report, which led to elevated detection limits for the HCl samples:

- HCl samples were diluted due to matrix interference; sulfate peak higher than expected.

3.3 Summary of Results

The results of the testing, compared to the applicable emission limits, are summarized in Table 3-2. Detailed results are presented in Tables 1 through 4 after the Table Tab of this report. Graphs of the measured O_2, CO_2, CO, NO_x, and SO_2 concentrations are presented after the Graphs Tab of this report. Sample calculations are presented in Appendix B.

Table 3-2
Summary of EU-FBSSI Air Emission Test Results

Parameter	Units	Average Result	EU-FBSSI Permit Limit	40 CFR Part 60 Subpart MMMM Emission Limits[1, 2]
Sulfur dioxide (SO_2)	ppmvd at 7% oxygen	7.4	—	15
Oxides of nitrogen (NO_x)	ppmvd at 7% oxygen	52.2	—	150
Carbon monoxide (CO)	ppmvd at 7% oxygen	45.0	100 [3]	64
2,3,7,8-Tetrachlorodibenzo-*para*-dioxin, toxic equivalents (2,3,7,8-TCDD TEQ)	lb/ton dry sewage sludge	8.9×10^{-12}	1.4×10^{-9} [4]	—
Total dioxins and furans	ng/dscm at 7% oxygen	0.045	—	1.2 Total mass basis
		0.00044	—	0.10 Toxic equivalency basis
Total polychlorinated biphenyls (PCBs)	lb/ton dry sewage sludge	2.7×10^{-7}	1.2×10^{-6} [4]	—
Hydrogen chloride (HCl)[6]	lb/ton dry sewage sludge	<0.038	0.8 [5]	—
	ppmvd at 7% oxygen	<1.473	—	0.51
Particulate matter (PM)	lb/ton dry sewage sludge	0.06	0.35 [3]	—
	mg/dscm at 7% oxygen	3.3	—	18
Arsenic (As)	lb/ton dry sewage sludge	2.0×10^{-5}	1.3×10^{-3} [3]	—
Beryllium (Be)	lb/ton dry sewage sludge	4.3×10^{-6}	2.5×10^{-5} [3]	—
Cadmium (Cd)	lb/ton dry sewage sludge	4.3×10^{-6}	8.5×10^{-3} [3]	—
	mg/dscm at 7% oxygen	2.4×10^{-4}	—	1.6×10^{-3}
Total chromium (Cr)	lb/ton dry sewage sludge	1.1×10^{-4}	4.5×10^{-2} [3]	—
Lead (Pb)	mg/dscm at 7% oxygen	1.8×10^{-3}	—	7.4×10^{-3}
Mercury (Hg)	lb/ton dry sewage sludge	2.8×10^{-4}	6.9×10^{-4} [3]	—
	mg/dscm at 7% oxygen	1.5×10^{-2}	—	3.7×10^{-2}

ppmvd: part per million by volume, dry
lb/ton: pound per ton
mg/dscm: milligram per dry standard cubic meter
ng/dscm: nanogram per dry standard cubic meter

[1] Emission limits from Table 2 to Subpart MMMM of 40 CFR Part 60.
[2] Table 2 to Subpart MMMM of 40 CFR Part 60 indicates that (1) all emission limits shall be measured at 7% oxygen, dry basis at standard conditions and (2) results shall be based on a three-run average collecting a minimum volume of 1 dry standard cubic meter per run with the exception of oxides of nitrogen, sulfur dioxide, and carbon monoxide for which sample duration shall be a minimum of 1 hour per run.
[3] Based on 60-minute averaging time
[4] Based on 240-minute averaging time
[5] Based on 120-minute averaging time
[6] As noted in laboratory report, HCl samples were diluted due to matrix interference; sulfate peak was higher than expected.

4.0 Sampling and Analytical Procedures

4.1 Test Methods

Bureau Veritas measured emissions in accordance with the procedures specified in the United States Environmental Protection Agency (USEPA) Standards of Performance for New Stationary Sources. Bureau Veritas used methods presented in Table 4-1.

Table 4-1
Sampling Methods

Parameter	EU-FBSSI (SV-001)	Method	USEPA Reference
Sampling ports and traverse points	•	1	Sample and Velocity Traverses for Stationary Sources
Velocity and flowrate	•	2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
Oxygen (O_2), carbon dioxide (CO_2), molecular weight	•	3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (instrument analyzer procedure)
Moisture content	•	4	Determination of Moisture Content in Stack Gases
Particulate matter (PM)	•	5	Determination of Particulate Matter Emissions from Stationary Sources
Sulfur dioxide (SO_2)	•	6C	Determination of Sulfur Dioxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)
Oxides of nitrogen (NO_x)	•	7E	Determination of Nitrogen Oxide Emissions from Stationary Sources (instrument analyzer procedure)
Carbon monoxide (CO)	•	10	Determination of Carbon Monoxide Emissions from Stationary Sources (instrument analyzer procedure)
2,3,7,8- Tetrachlorodibenzo-*para*-dioxin, toxic equivalents (2,3,7,8-TCDD TEQ), total dioxins and furans, total polychlorinated biphenyls (PCBs)	•	23	Determination of Polychlorinated Dibenzo-*p*-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors
Hydrogen chloride (HCl)	•	26A	Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources
Arsenic (As), beryllium (Be), cadmium (Cd), total chromium (Cr), lead (Pb), and mercury (Hg)	•	29	Determination of Metals Emissions from Stationary Sources
Gas dilution	•	205	Verification of Gas Dilution Systems for Field Instrument Calibrations†

• Indicates a test parameter for each test run
† For calibration gases

4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources," from the Code of Federal Regulations, Title 40, Part 60 (40 CFR 60), Appendix A, was used to evaluate the sampling location and the number of traverse points for the measurement of velocity profiles. Figure 1 (see Figures Tab) depicts the sampling location and traverse points.

Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)," was used to measure flue gas velocity and calculate volumetric flowrate. An S-type Pitot tube and thermocouple assembly connected to a digital manometer and thermometer was used. Because the dimensions of Bureau Veritas' Pitot tubes meet the requirements outlined in Method 2, Section 10.0, a baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned.

The digital manometer and thermometer are calibrated using calibration standards, which are traceable to National Institute of Standards (NIST). The Pitot tube inspection and calibration sheets are included in Appendix A.

Cyclonic Flow Check. Bureau Veritas evaluated whether cyclonic flow was present at the EU-FBSSI sampling location in Exhaust Stack SV-001 on November 23, 2009.

Cyclonic flow is defined as a flow condition with an average null angle greater than 20°. The direction of flow can be determined by aligning the Pitot tube to obtain zero (null) velocity head readings—the direction would be parallel to the Pitot tube face openings or perpendicular to the null position. By measuring the angle of the Pitot tube face openings in relation to the stack wall when a null angle is obtained, the direction of flow is measured. If the absolute average of the flow direction angles is greater than 20°, the flue gas flow is considered to be cyclonic at that sampling location and an alternative location should be used.

The average of the measured traverse point flue gas velocity null angle was 4° at the EU-FBSSI exhaust sampling location. The measurements indicate the absence of cyclonic flow at the EU-FBSSI location.

Field data sheets are included in Appendix C. Computer-generated field data sheets are included in Appendix D.

4.1.2 Oxygen, Carbon Dioxide, Sulfur Dioxide, Oxides of Nitrogen, and Carbon Monoxide (USEPA Methods 3A, 6C, 7E, and 10)

USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrument Analyzer Procedure)," was used to measure the oxygen concentration of the flue gas to correct the results to 7% oxygen. Sulfur dioxide concentrations were measured using USEPA Method 6C, "Determination of Sulfur Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure). Oxides of nitrogen concentrations were measured using USEPA Method 7E, "Determination of Nitrogen Oxides

Emissions from Stationary Sources." Carbon monoxide concentrations were measured using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources." Figure 2 depicts the USEPA Methods 3A, 6C, 7E, and 10 sampling train.

The sampling trains for USEPA Methods 3A, 6C, 7E, and 10 are similar and the flue gas was extracted from the stack through:

- A stainless-steel probe.
- Heated (248 ±25°F) Teflon sample line to prevent condensation.
- A chilled Teflon impinger train with peristaltic pump to remove moisture from the sampled gas stream prior to entering the analyzers via separate sampling lines.
- Oxygen, carbon dioxide, sulfur dioxide, oxides of nitrogen, and carbon monoxide gas analyzers.

The flue gas was extracted and continuously introduced into the paramagnetic (O_2 and CO_2), ultraviolet (SO_2), chemiluminescence (NO_x), and infrared (CO) gas analyzers to measure pollutant concentrations. Data were recorded at 1-second intervals on a computer equipped with data acquisition software. Recorded concentrations were reported in 1-minute averages over the duration of each test run.

In lieu of conducting a pre-test stratification test, Bureau Veritas connected the heated Teflon sample line to the Method 29 sample probe and traversed the stack in accordance with USEPA Method 29 requirements during each test. Twelve traverse points were used at the EU-FBSSI sampling location.

A calibration error check was performed on each analyzer by introducing zero-, mid-, and high-level calibration gases directly into the analyzer. The calibration error check was performed to evaluate if an analyzer responds to within ±2% of the calibration span.

Prior to each test run, a system-bias test was performed in which known concentrations of calibration gases were introduced at the probe tip to measure if the analyzer's response was within ±5% of the calibration span. At the conclusion of the each test run, an additional system-bias check was performed to evaluate the potential drift from pre- and post-test system-bias checks. The acceptable analyzer drift tolerance is ±3% of the calibration span.

Calibration data along with the USEPA Protocol 1 certification sheets for the calibration gases used are included in Appendix A.

4.1.3 Moisture Content (USEPA Method 4)

Prior to testing, the moisture content was estimated using measurements from previous testing, psychrometric charts and/or water saturation vapor pressure tables. These data were used in conjunction with preliminary velocity head pressure and temperature data to calculate flue gas velocity, ideal nozzle size, and to establish the isokinetic sampling rate for the USEPA Methods 23, 26A, 5, and 29 sampling. For each sampling run, moisture content of the flue gases was measured using the reference method outlined in Section 2 of USEPA Method 4, "Determination of Moisture Content in Stack Gases" in conjunction with the performance of USEPA Methods 23, 26A, and 5/29.

4.1.4 Dioxins, Furans, and Polychlorinated Biphenyls (USEPA Method 23)

USEPA Method 23, "Determination of Polychlorinated Dibenzo-*p*-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors" was used to measure dioxin, furan, and PCB concentrations. Triplicate 240-minute test runs were performed at the EU-FBSSI sampling location. Figure 3 depicts the USEPA Method 23 sampling train.

Bureau Veritas' modular isokinetic stack sampling system consists of:

- A borosilicate glass button-hook nozzle.
- A heated (248±25°F) borosilicate glass-lined probe.
- A pre-cleaned glass fiber filter (manufactured to at least 99.95% efficiency (<0.05 % penetration) for 0.3-micron dioctyl phthalate smoke particles) in a heated (248±25°F) filter box.
- A glass recirculating ice water condenser system.
- An XAD-2 sorbent trap.
- A set of five impingers: one Greenburg-Smith (GS) impingers, three modified GS impingers, and one water "knock-out" impinger with the configuration shown in Table 4-2.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-2
Method 23 Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Amount
1	"Knock-out"	Empty	0 ml
2	Greenburg-Smith	HPLC water	100 ml
3	Modified	HPLC water	100 ml
4	Modified	Empty	0 ml
5	Modified	Silica gel desiccant	~200-300 g

HPLC: high-performance liquid chromatography

Before testing, a preliminary velocity traverse was performed and an "ideal" nozzle size was calculated; a nozzle size was selected to enable isokinetic sampling at an average rate of 0.75 cubic feet per minute (cfm). Bureau Veritas selected a pre-cleaned borosilicate glass nozzle that had an inner diameter that approximated the calculated ideal value. The nozzle was (1) measured with calipers across three cross-sectional chords to evaluate the inside diameter, (2) rinsed and brushed with acetone, methylene chloride, and toluene, and (3) connected to the borosilicate glass-lined sampling probe.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a pressure head of 3.0 inches of water for more than 15 seconds. The sampling train was leak-checked by capping the nozzle tip and applying a vacuum of approximately 15 inches of mercury to the sampling train. The dry-gas meter was monitored for approximately 1 minute to measure that the sample train leakage rate was less than 0.02 cfm. The sampling probe was inserted into the sampling port.

Ice was placed around the impingers and the probe, and filter temperatures were allowed to stabilize at 248±25°F before each test run. After the desired operating conditions were coordinated with the facility, testing began.

Stack parameters (e.g., flue velocity, temperature) were monitored to establish the isokinetic sampling rate within ±10 % for the duration of the test. Each of the 12 traverse points were sampled at 20-minute intervals.

At the conclusion of a test run and the post-test leak check, the sampling train was disassembled and the condenser, XAD-2 sorbent trap, impingers, and filter were transported to the recovery trailer. The XAD-2 sorbent trap was removed from the sampling train, capped at both ends, labeled, covered with aluminum foil, and stored in an iced cooler for transport to the laboratory.

The filter was recovered using Teflon-lined tweezers and placed in a Petri dish. The Petri dish was immediately labeled and sealed. The nozzle, probe, filter housing, and condenser were brushed and triple-rinsed with acetone and then methylene chloride; these solvents were collected in a pre-cleaned sample container. The nozzle, probe, filter housing, and condenser were triple-rinsed with toluene, which was collected in a separate sample container.

At the end of a test run, the liquid collected in each impinger, including the silica gel, was weighed. These weights were used to calculate the moisture content of the flue gas.

Bureau Veritas labeled each container with the test number, test location, and test date, and marked the level of liquid on the outside of the container. In addition, blank samples of the high performance liquid chromatography (HPLC) water, acetone, methylene chloride, toluene, adsorbent module, and filter were collected. Samples were transported by courier to Maxxam Analytics, a Bureau Veritas laboratory, located in Mississauga, Ontario, Canada for analysis.

4.1.5 Hydrogen Chloride (USEPA Method 26A)

USEPA Method 26A, "Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources," was used to measure hydrogen chloride emissions. Triplicate 120-minute test runs were performed at the EU-FBSSI sampling location. Figure 4 depicts the USEPA Method 26A sampling train.

Bureau Veritas' modular isokinetic stack sampling system consists of:

- A borosilicate glass button-hook nozzle.
- A heated borosilicate glass-lined probe, heated above 248°F.
- A desiccated and untared Teflon fiber filter in a filter box heated above 248°F.
- A set of five pre-cleaned GS impingers with the configuration shown in Table 4-3.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Before testing, a preliminary velocity traverse was performed and an "ideal" nozzle size was calculated; a nozzle size was selected to enable isokinetic sampling at an average rate of 0.75 cfm. Bureau Veritas selected a pre-cleaned borosilicate glass nozzle that has an inner diameter that approximates the calculated ideal value. The nozzle was (1) measured with calipers across three cross-sectional chords to evaluate the inside diameter, (2) rinsed and brushed with Type 3 deionized water and proof-rinsed with 0.1 N sulfuric acid (H_2SO_4), and (3) connected to the borosilicate glass-lined sampling probe.

Table 4-3
Method 26A Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Amount
1	Modified	0.1 N H_2SO_4	100 ml
2	Modified	0.1 N H_2SO_4	100 ml
3	Modified	0.1 N NaOH	100 ml
4	Modified	0.1 N NaOH	100 ml
5	Modified	Silica gel desiccant	~200-300 g

Before testing, a preliminary velocity traverse was performed and an "ideal" nozzle size was calculated that would enable isokinetic sampling at an average rate of 0.75 cfm. Bureau Veritas selected a pre-cleaned borosilicate glass nozzle that has an inner diameter that approximated the calculated ideal value. The nozzle was (1) measured with calipers across three cross-sectional chords to evaluate the inside diameter, (2) rinsed and brushed with Type 3 deionized water and proof-rinsed with 0.1 N H_2SO_4, and (3) connected to the borosilicate glass-lined sampling probe.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a pressure head of 3.0 inches of water for more than 15 seconds. The sampling train was leak-checked by capping the nozzle tip and applying a vacuum of approximately 15 inches of mercury to the sampling train. The dry-gas meter was monitored for approximately 1 minute to measure that the sample train leakage rate was less than 0.02 cfm. The sampling probe was inserted into the sampling port.

Ice was placed around the impingers and the probe, and filter temperatures were allowed to stabilize to a temperature above 248°F before each test run. After the desired operating conditions were coordinated with the facility, testing was initiated.

Stack parameters (e.g., flue velocity, temperature) were monitored to establish the isokinetic sampling rate within ±10 % for the duration of the test. Each of the 12 traverse points were sampled at 10-minute intervals.

At the conclusion of a test run and the post-test leak check, the sampling train was disassembled and the impingers and filter housing were transported to the recovery area. The filter was removed from the filter housing and discarded. The nozzle and probe liner, and the front half of the filter housing were rinsed with deionized water to remove particulate matter. The deionized water rinses were discarded.

At the end of a test run, the liquid collected in each impinger, including the silica gel impinger, was measured using an electronic scale; these weights were used to calculate the moisture content of the flue gas.

The contents of Impingers 1 and 2, back-half of the filter housing, and connecting glassware were placed in a 500-ml polyethylene container with a Teflon cap screw liner. The glassware was rinsed three times with deionized water and the rinsate was placed in the polyethylene container. The sample container was labeled as "0.1 N H_2SO_4/DI," marked at the liquid level, and sealed.

The contents of Impinger 4 and 5, and all connecting glassware were placed into a polyethylene container with a Teflon screw cap liner. The glassware was rinsed three times with deionized water and the rinsate was placed in the polyethylene bottle. This sample container was labeled as "0.1N NaOH/DI," marked at the liquid level, and sealed.

All sample containers, including blanks of Type 3 deionized water, 0.1 N H_2SO_4, and 0.1 N NaOH were transported by courier to Maxxam Analytics, a Bureau Veritas laboratory, located in Mississauga, Ontario, Canada for analysis.

4.1.6 Particulate Matter and Metals (USEPA Method 5 and 29)

USEPA Method 5, "Determination of Particulate Matter Emissions from Stationary Sources," and Method 29, "Determination of Metals Emissions from Stationary Sources," were used to measure particulate matter and metals (arsenic, beryllium, cadmium, total chromium, lead, and mercury) emissions. Figure 5 depicts the USEPA Method 5 and 29 sampling train.

Bureau Veritas' modular isokinetic stack sampling system consists of:

- A borosilicate glass button-hook nozzle.
- A heated (248±25°F) borosilicate glass-lined probe.
- A desiccated and pre-weighed 110- or 83-millimeter-diameter quartz fiber filter (manufactured to at least 99.95% efficiency (<0.05 % penetration) for 0.3-micron dioctyl phthalate smoke particles) in a heated (248±25°F) filter box.
- A set of six pre-cleaned GS impingers in an ice bath with the configuration shown in Table 4-4.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-4
USEPA Method 5 and 29 Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Amount
1	Modified	5% HNO_3,10% H_2O_2	100 ml
2	Greenburg-Smith	5% HNO_3,10% H_2O_2	100 ml
3	Modified	Empty	0 ml
4	Modified	Acidified $KMnO_4$	100 ml
5	Modified	Acidified $KMnO_4$	100 ml
6	Modified	Silica gel desiccant	~200-300 g

Before testing, a preliminary velocity traverse was performed and an ideal nozzle size was calculated. The calculated nozzle size allowed isokinetic sampling at an average rate of 0.75 cfm. Bureau Veritas selected a pre-cleaned borosilicate glass nozzle with an inner diameter that approximates the calculated ideal value. The nozzle inside diameter was measured with calipers across three cross-sectional chords. The nozzle was rinsed and connected to the borosilicate glass-lined sample probe.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a pressure of 3 inches of water for more than 15 seconds. The sampling train was leak-checked by capping the nozzle tip and applying a vacuum of approximately 15 inches of mercury to the sampling train. The dry-gas meter was monitored to measure whether the sample train leak rate was less than 0.02 cfm. If the pre-test leak failed, the sampling train was adjusted until the leak rate was <0.02 cfm. Next, the sampling probe was inserted into the stack through the sampling port to begin sampling.

Ice and water was placed around the impingers and the probe and filter temperatures were allowed to stabilize at ≥248±25°F before each test run. After the desired operating conditions were coordinated with the facility, testing was initiated.

Stack parameters (e.g., flue velocity, temperature) were monitored to establish the isokinetic sampling rate to within ±10 % for the duration of the test.

At the conclusion of a test run and the post-test leak check, the sampling train was disassembled and the impingers and filter were transported to the recovery area. The filter was recovered using Teflon-lined tweezers and placed in a Petri dish. The Petri dish was immediately labeled and sealed with Teflon tape. The nozzle, probe, and the front half of the filter holder assembly was brushed and, at a minimum, triple-rinsed with acetone to recover particulate matter. The acetone rinses were collected in pre-cleaned sample containers.

Next, the probe nozzle, fittings, probe liner, and front-half of the filter holder were washed and brushed (using a nylon bristle brush) three times with 100 ml of 0.1-N nitric acid (HNO_3). This rinsate was collected in a 500-ml glass sample container. Following the HNO_3 rinse, the probe nozzle, fittings, probe liner, and front-half of the filter holder were rinsed with HPLC water followed by acetone. The HPLC water and acetone rinses were discarded.

The contents of Impingers 1 and 2 were transferred to two glass sample containers. Impingers 1 and 2, the filter support, the back half of the filter housing, and connecting glassware were thoroughly rinsed with 100 ml of 0.1-N HNO_3, and the rinsates were added to the sample containers in which the contents of the first two impingers were stored.

The weight of the contents of Impinger 3 was measured and the contents transferred to a glass sample container. This impinger was rinsed with 100 ml of 0.1-N HNO_3, and the rinsate was added to the glass sample container.

The weight of liquid in Impingers 4 and 5 were measured and the contents transferred to a glass sample container. The impingers and connecting glassware were triple-rinsed with acidified $KMnO_4$ solution and the rinsate was added to the Impinger 4 and 5 sample containers. Subsequently, these impingers were rinsed with 100 ml of HPLC water, and the rinsate was added to the sample container. Because deposits may still be visible on the impinger surfaces after the water rinse, 25 ml of 8-N hydrochloric acid were used to wash these impingers and connecting glassware. This 8-N hydrochloric acid rinsate was collected in a separate sample container containing 200 ml of water.

The silica gel impinger was weighed as part of the measurement of the flue gas moisture content. All sample containers containing the acetone, 0.1-HNO_3, HPLC water, 5% HNO_3/10% H_2O_2, acidified $KMnO_4$, 8-N hydrochloric acid, and filter blanks were transported by courier to Maxxam Analytics, a Bureau Veritas laboratory, located in Mississauga, Ontario, Canada for analysis.

4.1.7 Gas Dilution (USEPA Method 205)

A gas dilution system was used to introduce known values of calibration gases into the analyzers. The gas dilution system consists of calibrated orifices or mass flow controls and dilutes a high-level calibration gas to within ±2% of predicted values. The gas divider is capable of diluting gases at set increments and was evaluated for accuracy in the field in accordance with USEPA Method 205, "Verification of Gas Dilution Systems for Field Instrument Calibrations."

Before testing, the gas divider dilutions were measured to evaluate that they were within ±2% of predicted values. Three sets of three dilutions of the high-level calibration gas were performed. In addition, a certified mid-level calibration gas was introduced into an analyzer; this calibration gas concentration was within ± 10% of a gas divider dilution concentration.

4.2 Procedures for Obtaining Process Data

Process data were recorded by YCUA personnel. Refer to Section 2.1 and 2.2 for discussions of process and control device data and Appendix F for the operating parameters recorded during testing.

4.3 Sampling Identification and Custody

Thomas Schmelter, with Bureau Veritas, was responsible for the handling and procurement of the data collected in the field. Mr. Schmelter ensured the data sheets were accounted for and completed.

Recovery and analytical procedures were applicable to the sampling methods used in this test program. Sampling and recovery procedures were described previously Section 4.0.

Applicable Chain of Custody procedures followed guidelines outlined within ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures."

For each sample collected (i.e., impinger) sample identification and custody procedures were completed as follows:

- Containers were sealed to prevent contamination.
- Containers were labeled with test number, location, and test date.
- Containers were stored in a cooler.
- Samples were logged using guidelines outlined in ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures."
- Samples were delivered to the laboratory.

Chains of custody and laboratory analytical results are included in Appendix E.

5.0 QA/QC Activities

Equipment used in this test program passed quality assurance/quality control (QA/QC) procedures. Refer to Appendix A for equipment calibrations and inspection sheets. Field data sheets are presented in Appendix C. Computer-generated data sheets are presented within Appendix D.

5.1 Pretest QA/QC Activities

Before testing, the sampling equipment was cleaned, inspected, and calibrated according to procedures outlined in the applicable USEPA sampling method and USEPA's "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III, Stationary Source-Specific Methods."

5.2 QA/QC Audits

The results of select sampling and equipment QA/QC audits and the acceptable tolerance are presented in the following sections. Analyzer calibration and gas certification sheets are presented in Appendix A.

5.2.1 Results of Audit Samples

Audit samples, supplied by Environmental Resource Associates (ERA), were analyzed as part of this test program. The purpose of ERA's Stationary Source Audit Sample Program is to evaluate accuracy and data reliability. The audit samples were analyzed by Maxxam Analytics. The audit sample results were within the acceptance limits. The results of the audit samples are presented in Table 5-1. ERA's Audit Evaluation Report is included in Appendix E.

Table 5-1
Stationary Source Audit Program QA/QC Audit Sample Results

Sample Catalog Number	Analyte	Units	Maxxam Analytics Reported Value	ERA Assigned Value	Difference	Acceptable Limits	Performance Evaluation
1425	Metal on glass filter filters (beryllium)	µg/filter	9.29	10	0.71	7.50-12.5	Acceptable
1426	Metal in impinger solution (beryllium)	µg/mL	0.507	0.507	0	0.355-0.659	Acceptable
1427	Mercury on filter	µg/filter	30.4	30.4	0	22.8-38.0	Acceptable
1428	Mercury in impinger solution	ng/mL	148	150	2	112-188	Acceptable

5.2.2 Sampling Train QA/QC Audits

The sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. Table 5-2 summarizes the QA/QC audits conducted for the Methods 23, 26A, and 5 and 29 sampling train.

Table 5-2
Methods 23, 26A, and 5/29 Sampling Train QA/QC Audits

Parameter	Run 1	Run 2	Run 3	Method Requirement	Comment
Method 23					
Sampling train leak check Post–test	0 ft^3 for 1 min at 15 in Hg	0 ft^3 for 1 min at 15 in Hg	0 ft^3 for 1 min at 12 in Hg	<0.020 ft^3 for 1 minute at $\geq$ sample vacuum recorded during test	Valid
Sampling vacuum (in Hg)	9 to 14	6 to 10	6 to 8		
Method 26A					
Sampling train leak check Post–test	0 ft^3 for 1 min at 10 in Hg	0 ft^3 for 1 min at 10 in Hg	0 ft^3 for 1 min at 10 in Hg	<0.020 ft^3 for 1 minute at $\geq$ sample vacuum recorded during test	Valid
Sampling vacuum (in Hg)	5 to 6	3 to 6	4 to 5		
Methods 5 and 29					
Sampling train leak check Post–test	0 ft^3 for 1 min at 20 in Hg	0 ft^3 for 1 min at 15 in Hg	0 ft^3 for 1 min at 15 in Hg	<0.020 ft^3 for 1 minute at $\geq$ sample vacuum recorded during test	Valid
Sampling vacuum (in Hg)	2 to 5	2	3		

5.2.3 Instrument Analyzer QA/QC Audits

The instrument sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The analyzers passed the applicable calibration criteria. The following table summarizes gas cylinders used during this test program. Refer to Appendix A for additional calibration data.

Table 5-3
Calibration Gas Cylinder Information

Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
Carbon dioxide (CO_2) Oxygen (O_2) Nitrogen (N)	Airgas	XC018136B	19.94% (CO_2) 20.09% (O_2) Balance (N)	2/26/23
		CC307809	11.20% (CO_2) 10.91% (O_2) Balance (N)	2/17/23
		CC13924	19.93% (CO_2) 20.11% (O_2) Balance (N)	2/26/23
Carbon monoxide (CO) Nitrogen (N)	Pangaea Gases, LLC	EB0033503	503.0 ppm (CO) Balance (N)	11/12/21
	Airgas	XC014125B	81.49 ppm Balance (N)	1/6/23
Nitrogen (N)	Airgas	CC183736	99.9995%	11/2/23
Nitrogen dioxide (NO_2) Oxygen (O_2) Nitrogen (N)	Airgas	CC500773	50.18 ppm (NO_2) 1,000 ppm (O_2) Balance (N)	11/11/17
Nitric oxide (NO) Oxides of nitrogen (NO_x) Nitrogen (N)	Airgas	XC033685B	491.1 ppm (NO) 491.7 ppm (NO_x) Balance (N)	12/2/21
Sulfur dioxide (SO_2)	Airgas	CC259138	499.5 ppm (SO_2) Balance (N)	11/22/19

5.2.4 Dry-Gas Meter QA/QC Audits

Table 5-4 summarizes the dry-gas meter calibration checks in comparison to the acceptable USEPA tolerance. Refer to Appendix A for DGM calibrations.

Table 5-4
Dry-gas Meter Calibration QA/QC Audit

Dry-Gas Meter	Pre-test DGM Calibration Factor (Y) (dimensionless)	Post-Test DGM Calibration Factor (Y) (dimensionless)	Difference Between Pre- and Post-test DGM Calibrations	Acceptable Tolerance	Comment
2	0.974 October 12, 2015	0.984 December 17, 2015	0.01	±0.05	Valid
8	1.004 June 11, 2015	0.977 December 17, 2015	0.027	±0.05	Valid

5.2.5 Thermocouple QA/QC Audits

Temperature measured using thermocouples and digital pyrometers were compared to a reference temperature (i.e., ice water bath, boiling water) before and after testing to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperature within ±1.5% of the reference temperatures and were within USEPA acceptance criteria. Thermocouple calibration sheets are presented in Appendix A.

5.3 QA/QC Checks for Data Reduction and Validation

Bureau Veritas validated the computer spreadsheets onsite. The computer spreadsheets were used to evaluate the accuracy of field calculations. The field data sheets were reviewed to evaluate whether data had been recorded appropriately. The computer data sheets were checked against the field data sheets for accuracy. Sample calculations were performed to check computer spreadsheet computations.

5.4 QA/QC Problems

Equipment audits and QA/QC procedures demonstrate sample collection accuracy for the test runs.

6.0 Limitations

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Tables

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Table 1
EU-FBSSI Exhaust O_2, CO, NO_x, and SO_2 Emission Results
Ypsilanti Community Utilities Authority
Ypsilanti, Michigan
Bureau Veritas Project No. 11015-000237.00
Sampling Date: December 15, 2015

Parameter	Run 1	Run 2	Run 3		Average
Sample Start Time	12:15	13:50	16:20		
Test Duration (min)	60	60	60		60
Ton of dry sewage sludge (dry ton/hr)	2.84	2.84	2.84		2.84
Exhaust Gas Stream Volumetric Flowrate (dscfm)†	**13,469**	**13,951**	**13,919**		**13,780**
O_2 Concentration (C_{Avg}, %)	6.8	6.8	5.9		6.5
Corrected O_2 Concentration (C_{Gas}, %)	**7.0**	**7.1**	**6.1**		**6.7**
CO Concentration (C_{Avg}, ppmvd)	28.3	25.0	82.0		45.1
Corrected CO Concentration (C_{Gas}, ppmvd)	**29.0**	**25.6**	**85.3**		**46.6**
CO Concentration (mg/dscm)	**33.8**	**29.9**	**99.4**		**54.3**
CO Concentration (mg/dscm, @ 7% O_2)	**33.7**	**30.1**	**93.5**		**52.4**
CO Concentration (ppmvd, @ 7% O_2)	**28.9**	**25.8**	**80.2**		**45.0**
CO Emission Rate (lb/hr)	**1.70**	**1.6**	**5.18**		**2.82**
CO Emission Rate (lb/hr, @ 7% O_2)	**1.70**	**1.6**	**4.87**		**2.72**
CO Emission Rate (lb/ton of dry sewage sludge)	**0.60**	**0.55**	**1.83**		**0.99**
CO Emission Rate (lb/ton of dry sewage sludge, @ 7% O_2)	**0.60**	**0.55**	**1.72**		**0.96**
NO_x Concentration (C_{Avg}, ppmvd)	45.8	44.3	62.8		51.0
Corrected NO_x Concentration (C_{Gas}, ppmvd)	**47.9**	**46.4**	**65.9**		**53.4**
NO_x Concentration (mg/dscm)	**87.6**	**84.9**	**120.2**		**97.5**
NO_x Concentration (mg/dscm, @ 7% O_2)	**87.5**	**85.4**	**113.0**		**95.3**
NO_x Concentration (ppmvd, @ 7% O_2)	**47.9**	**46.7**	**62.0**		**52.2**
NO_x Emission Rate (lb/hr)	**4.6**	**4.6**	**6.6**		**5.3**
NO_x Emission Rate (lb/hr, @ 7% O_2)	**4.4**	**4.5**	**5.9**		**4.9**
NO_x Emission Rate (lb/ton of dry sewage sludge)	**1.6**	**1.6**	**2.3**		**1.9**
NO_x Emission Rate (lb/ton of dry sewage sludge, @ 7% O_2)	**1.6**	**1.6**	**2.1**		**1.7**
SO_2 Concentration (C_{Avg}, ppmvd)	7.2	8.0	10.9		8.7
Corrected SO_2 Concentration (C_{Gas}, ppmvd)	**6.0**	**6.8**	**9.9**		**7.6**
SO_2 Concentration (mg/dscm)	**13.7**	**15.4**	**20.8**		**16.6**
SO_2 Concentration (mg/dscm, @ 7% O_2)	**13.7**	**15.5**	**19.6**		**16.3**
SO_2 Concentration (ppmvd, @ 7% O_2)	**6.0**	**6.8**	**9.3**		**7.4**
SO_2 Emission Rate (lb/hr)	**0.80**	**0.95**	**1.4**		**1.0**
SO_2 Emission Rate (lb/hr, @ 7% O_2)	**0.69**	**0.81**	**1.0**		**0.84**
SO_2 Emission Rate (lb/ton of dry sewage sludge)	**0.28**	**0.33**	**0.48**		**0.37**
SO_2 Emission Rate (lb/ton of dry sewage sludge, @ 7% O_2)	**0.24**	**0.28**	**0.36**		**0.30**

ppmvd = part per million by volume, dry basis
dscfm = dry standard cubic foot per minute
mg/dscm = milligram per dry standard cubic meter
lb/hr = pound per hour
† Flowrates from Run 3 Method 29, Run 2 Method 23, and Run 1 Method 26A sampling trains

Table 2 - EU-FBSSI Exhaust Particulate Matter and Metals Results

Facility		Ypsilanti Community Utilities Authority			
Source Designation		EU-FBSSI Exhaust			
Test Date		Dec 15, 2015	Dec 15, 2015	Dec 15, 2015	
Meter/Nozzle Information		**Run 1 - M29**	**Run 2 - M29**	**Run 3 - M29**	**Average**
Meter Temperature, T_m	°F	115	120	121	119
Meter Pressure, P_m	in Hg	29.00	29.00	28.31	28.77
Measured Sample Volume, V_m	ft^3	42.01	41.40	40.86	41.42
Sample Volume, V_m	std ft^3	37.42	36.56	35.17	36.38
Sample Volume, V_m	std m^3	1.06	1.04	1.00	1.03
Condensate Volume, V_w	std ft^3	3.07	2.88	2.71	2.89
Gas Density, ρ_s	std lb/ft^3	0.0758	0.0757	0.0758	0.0758
Total weight of sampled gas	lb	3.068	2.986	2.742	2.932
Nozzle Size, A_n	ft^2	0.0004276	0.0004276	0.0004276	0.0004276
Isokinetic Variation, I	%	104	102	98	101
Stack Data					
Average Stack Temperature, T_s	°F	143	140	140	141
Molecular Weight Stack Gas-dry, M_d	lb/lb-mole	30.10	30.05	30.06	30.07
Molecular Weight Stack Gas-wet, M_s	lb/lb-mole	29.19	29.17	29.20	29.19
Stack Gas Specific Gravity, G_s		1.01	1.01	1.01	1.01
Percent Moisture, B_{ws}	%	7.59	7.30	7.14	7.35
Water Vapor Volume (fraction)		0.076	0.073	0.071	0.073
Pressure, P_s	in Hg	28.92	28.92	28.22	28.68
Average Stack Velocity, V_s	ft/sec	29.97	29.57	30.28	29.94
Area of Stack	ft^2	9.62	9.62	9.62	9.62
Exhaust Gas Flowrate					
Flowrate	ft^3/min, actual	17,298	17,068	17,481	17,283
Flowrate	ft^3/min, standard wet	14,630	14,511	14,505	14,549
Flowrate	ft^3/min, standard dry	13,519	13,451	13,469	13,480
Flowrate	m^3/min, standard dry	383	381	381	382
Collected Mass					
Particulate Matter (PM)	mg	2.7	4.6	3.2	3.5
Mercury (Hg)	mg	0.017	0.015	0.017	0.016
Lead (Pb)	mg	0.00219	0.00209	0.00155	0.00194
Arsenic (As)	mg	0.0011	0.0011	0.0012	0.0011
Beryllium (Be)	mg	<0.00025	<0.00025	<0.00025	<0.00025
Cadmium (Cd)	mg	<0.00025	<0.00025	<0.00025	<0.00025
Total Chromium (Cr)	mg	0.00465	0.00887	0.00641	0.00664
Concentration					
Particulate Matter (PM)	mg/dscf	0.072	0.13	0.091	0.10
Particulate Matter (PM)	mg/dscm @ 7% Oxygen	2.4	4.4	3.2	3.3
Particulate Matter (PM)	ppmvd @ 7% Oxygen	1.9	3.5	2.5	2.7
Mercury (Hg)	mg/dscf	4.6E-04	4.0E-04	4.8E-04	4.4E-04
Mercury (Hg)	mg/dscm @ 7% Oxygen	1.5E-02	1.4E-02	1.7E-02	1.5E-02
Mercury (Hg)	ppmvd @ 7% Oxygen	1.2E-02	1.1E-02	1.3E-02	1.2E-02
Lead (Pb)	mg/dscf	5.9E-05	5.7E-05	4.4E-05	5.3E-05
Lead (Pb)	mg/dscm @ 7% Oxygen	2.0E-03	2.0E-03	1.5E-03	1.8E-03
Lead (Pb)	ppmvd @ 7% Oxygen	1.6E-03	1.6E-03	1.2E-03	1.5E-03
Arsenic (As)	mg/dscf	3.0E-05	3.1E-05	3.3E-05	3.1E-05
Arsenic (As)	mg/dscm @ 7% Oxygen	1.0E-03	1.1E-03	1.1E-03	1.1E-03
Arsenic (As)	ppmvd @ 7% Oxygen	8.0E-04	8.7E-04	9.1E-04	8.6E-04
Beryllium (Be)	mg/dscf	6.7E-06	6.8E-06	7.1E-06	6.9E-06
Beryllium (Be)	mg/dscm @ 7% Oxygen	2.2E-04	2.4E-04	2.5E-04	2.4E-04
Beryllium (Be)	ppmvd @ 7% Oxygen	1.8E-04	1.9E-04	2.0E-04	1.9E-04
Cadmium (Cd)	mg/dscf	6.7E-06	6.8E-06	7.1E-06	6.9E-06
Cadmium (Cd)	mg/dscm @ 7% Oxygen	2.2E-04	2.4E-04	2.5E-04	2.4E-04
Cadmium (Cd)	ppmvd @ 7% Oxygen	1.8E-04	1.9E-04	2.0E-04	1.9E-04
Total Chromium (Cr)	mg/dscf	1.2E-04	2.4E-04	1.8E-04	1.8E-04
Total Chromium (Cr)	mg/dscm @ 7% Oxygen	4.1E-03	8.5E-03	6.3E-03	6.3E-03
Total Chromium (Cr)	ppmvd @ 7% Oxygen	3.3E-03	6.8E-03	5.1E-03	5.1E-03
Mass Emission Rate					
Dry sewage sludge feedrate	ton/hr	2.8	2.8	2.8	2.8
Particulate Matter (PM)	lb/hr	0.13	0.22	0.16	0.17
Particulate Matter (PM)	lb/ton of dry sewage sludge	0.05	0.08	0.06	0.06
Particulate Matter (PM)	lb/ton of dry sewage sludge @ 7% O	0.04	0.08	0.06	0.06
Mercury (Hg)	lb/hr	8.2E-04	7.1E-04	8.5E-04	7.9E-04
Mercury (Hg)	lb/ton of dry sewage sludge	2.9E-04	2.5E-04	3.0E-04	2.8E-04
Mercury (Hg)	lb/ton of dry sewage sludge @ 7% O	2.7E-04	2.5E-04	2.9E-04	2.7E-04
Lead (Pb)	lb/hr	1.0E-04	1.0E-04	7.9E-05	9.5E-05
Lead (Pb)	lb/ton of dry sewage sludge	3.7E-05	3.6E-05	2.8E-05	3.3E-05
Lead (Pb)	lb/ton of dry sewage sludge @ 7% O	3.5E-05	3.6E-05	2.7E-05	3.3E-05
Arsenic (As)	lb/hr	5.4E-05	5.5E-05	5.8E-05	5.6E-05
Arsenic (As)	lb/ton of dry sewage sludge	1.9E-05	2.0E-05	2.1E-05	2.0E-05
Arsenic (As)	lb/ton of dry sewage sludge @ 7% O	1.8E-05	1.9E-05	2.0E-05	1.9E-05
Beryllium (Be)	lb/hr	1.2E-05	1.2E-05	1.3E-05	1.2E-05
Beryllium (Be)	lb/ton of dry sewage sludge	4.2E-06	4.3E-06	4.5E-06	4.3E-06
Beryllium (Be)	lb/ton of dry sewage sludge @ 7% O	4.0E-06	4.3E-06	4.4E-06	4.2E-06
Cadmium (Cd)	lb/hr	1.2E-05	1.2E-05	1.3E-05	1.2E-05
Cadmium (Cd)	lb/ton of dry sewage sludge	4.2E-06	4.3E-06	4.5E-06	4.3E-06
Cadmium (Cd)	lb/ton of dry sewage sludge @ 7% O	4.0E-06	4.3E-06	4.4E-06	4.2E-06
Total Chromium (Cr)	lb/hr	2.2E-04	4.3E-04	3.2E-04	3.3E-04
Total Chromium (Cr)	lb/ton of dry sewage sludge	7.8E-05	1.5E-04	1.1E-04	1.1E-04
Total Chromium (Cr)	lb/ton of dry sewage sludge @ 7% O	7.4E-05	1.5E-04	1.1E-04	1.1E-04

Table 3 - EU-FBSSI Exhaust Hydrogen Chloride Results

Facility		**Ypsilanti Community Utilities Authority**			
Source Designation		**EU-FBSSI Exhaust**			
Test Date		**Dec 15, 2015**	**Dec 16, 2015**	**Dec 16, 2015**	
Meter/Nozzle Information		**Run 1 - M26A**	**Run 2 - M26A**	**Run 3 - M26A**	**Average**
Meter Temperature, T_m	°F	124	124	129	126
Meter Pressure, P_m	in Hg	29.01	29.31	29.31	29.21
Measured Sample Volume, V_m	ft^3	80.76	83.04	83.50	82.43
Sample Volume, V_m	std ft^3	70.82	73.64	73.34	72.60
Sample Volume, V_m	std m^3	2.01	2.09	2.08	2.06
Condensate Volume, V_w	std ft^3	5.26	4.80	4.95	5.00
Gas Density, ρ_s	std lb/ft^3	0.0761	0.0762	0.0761	0.0761
Total weight of sampled gas	lb	5.789	5.976	5.741	5.835
Nozzle Size, A_n	ft^2	0.0004276	0.0004276	0.0004276	0.0004276
Isokinetic Variation, I	%	95	98	98	97
Stack Data					
Average Stack Temperature, T_s	°F	140	143	145	143
Molecular Weight Stack Gas-dry, M_d	lb/lb-mole	30.15	30.09	30.09	30.11
Molecular Weight Stack Gas-wet, M_s	lb/lb-mole	29.31	29.35	29.33	29.33
Stack Gas Specific Gravity, G_s		1.01	1.01	1.01	1.01
Percent Moisture, B_{ws}	%	6.91	6.12	6.32	6.45
Water Vapor Volume (fraction)		0.069	0.061	0.063	0.065
Pressure, P_s	in Hg	28.92	29.22	29.22	29.12
Average Stack Velocity, V_s	ft/sec	30.48	30.51	30.38	30.45
Area of Stack	ft^2	9.62	9.62	9.62	9.62
Exhaust Gas Flowrate					
Flowrate	ft^3/min, actual	17,594	17,611	17,537	17,580
Flowrate	ft^3/min, standard wet	14,952	15,070	14,946	14,990
Flowrate	ft^3/min, standard dry	13,919	14,148	14,001	14,023
Flowrate	m^3/min, standard dry	394	401	396	397
Collected Mass					
Hydrogen chloride	mg	<4.000	<4.000	<4.000	<4.000
Concentration					
Hydrogen chloride	mg/dscf	<0.056	<0.054	<0.055	<0.055
Hydrogen chloride	mg/dscm @ 7% Oxygen	<1.886	<1.814	<1.834	<1.845
Hydrogen chloride	ppmvd @ 7% Oxygen	<1.504	<1.449	<1.465	<1.473
Mass Emission Rate					
Dry sewage sludge feedrate	ton/hr	2.8	2.6	2.6	2.7
Hydrogen chloride	lb/hr	<0.1040	<0.1017	<0.1010	<0.1022
Hydrogen chloride	lb/ton of dry sewage sludge	<0.0366	<0.0385	<0.0383	<0.0378
Hydrogen chloride	lb/ton of dry sewage sludge @ 7% O_2	<0.0346	<0.0365	<0.0365	<0.0359

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Table 4 - EU-FBSSI Exhaust Dioxin, Furan, and PCB Results

Facility		**Ypsilanti Community Utilities Authority**			
Source Designation		**EU-FBSSI Exhaust**			
Test Date		**Dec 15, 2015**	**Dec 15, 2015**	**Dec 16, 2015**	
Meter/Nozzle Information		**Run 1 - M23**	**Run 2 - M23**	**Run 3 - M23**	**Average**
Meter Temperature, T_m	°F	113	118	119	117
Meter Pressure, P_m	in Hg	29.09	29.01	29.31	29.14
Measured Sample Volume, V_m	ft^3	216.32	165.19	170.91	184.14
Sample Volume, V_m	std ft^3	188.74	142.56	148.76	160.02
Sample Volume, V_m	std m^3	5.34	4.04	4.21	4.53
Condensate Volume, V_w	std ft^3	12.57	9.37	9.73	10.56
Gas Density, ρ_s	std lb/ft^3	0.0761	0.0763	0.0761	0.0762
Total weight of sampled gas	lb	15.315	11.596	11.641	12.851
Nozzle Size, A_n	ft^2	0.0005275	0.0004276	0.0004276	0.0004609
Isokinetic Variation, I	%	103	96	97	99
Stack Data					
Average Stack Temperature, T_s	°F	139	138	142	140
Molecular Weight Stack Gas-dry, M_d	lb/lb-mole	30.06	30.15	30.06	30.09
Molecular Weight Stack Gas-wet, M_s	lb/lb-mole	29.31	29.40	29.32	29.34
Stack Gas Specific Gravity, G_s		1.01	1.02	1.01	1.01
Percent Moisture, B_{ws}	%	6.25	6.17	6.14	6.19
Water Vapor Volume (fraction)		0.062	0.062	0.061	0.062
Pressure, P_s	in Hg	28.92	28.92	29.22	29.02
Average Stack Velocity, V_s	ft/sec	30.23	30.17	30.88	30.43
Area of Stack	ft^2	9.62	9.62	9.62	9.62
Exhaust Gas Flowrate					
Flowrate	ft^3/min, actual	17,450	17,418	17,827	17,565
Flowrate	ft^3/min, standard wet	14,865	14,869	15,269	15,001
Flowrate	ft^3/min, standard dry	13,937	13,951	14,332	14,073
Flowrate	m^3/min, standard dry	395	395	406	399
Collected Mass					
Dioxins					
2,3,7,8-Tetra CDD	pg	<3.1	<3.2	<3.0	<3.1
1,2,3,7,8-Penta CDD	pg	<3.1	<4.7	<7.1	<5.0
1,2,3,4,7,8-Hexa CDD	pg	<3.2	<4.5	9.8	5.8
1,2,3,6,7,8-Hexa CDD	pg	<3.4	5.3	<8.8	5.8
1,2,3,7,8,9-Hexa CDD	pg	6.8	11.2	12.6	10.2
1,2,3,4,6,7,8-Hepta CDD	pg	23.0	39.9	63.8	42.2
1,2,3,4,6,7,8,9-Octa CDD	pg	45.1	68.8	114	76
Total Tetra CDD	pg	<3.1	<3.2	<3.0	<3.1
Total Penta CDD	pg	<3.1	<4.7	<7.1	<5.0
Total Hexa CDD	pg	15.6	32.6	59.7	36.0
Total Hepta CDD	pg	36.2	39.9	98.0	58.0
Total Dioxins	pg	103.1	149.2	281.8	178.0
Furans					
2,3,7,8-Tetra CDF	pg	<7.8	<4.7	<4.5	<5.7
1,2,3,7,8-Penta CDF	pg	<3.1	<4.5	<6.9	<4.8
2,3,4,7,8-Penta CDF	pg	<3.1	<4.5	<6.9	<4.8
1,2,3,4,7,8-Hexa CDF	pg	<3.4	<3.6	<6.2	<4.4
1,2,3,6,7,8-Hexa CDF	pg	<3.3	<3.5	<5.9	<4.2
2,3,4,6,7,8-Hexa CDF	pg	<3.5	<3.7	<6.3	<4.5
1,2,3,7,8,9-Hexa CDF	pg	<3.8	<4.0	<6.9	<4.9
1,2,3,4,6,7,8-Hepta CDF	pg	<3.2	<3.4	<5.4	<4.0
1,2,3,4,7,8,9-Hepta CDF	pg	<3.9	<4.1	<6.6	<4.9
1,2,3,4,6,7,8,9-Octa CDF	pg	<3.6	3.5	5.1	4.1
Total Tetra CDF	pg	<7.8	<4.7	<4.5	<5.7
Total Penta CDF	pg	<3.1	<4.5	<6.9	<4.8
Total Hexa CDF	pg	<3.5	<3.7	<6.3	<4.5
Total Hepta CDF	pg	<3.5	<3.7	<6.0	<4.4
Total Furans	pg	21.5	20.1	28.8	23.5
Total Dioxin + Furan	pg	125	169	311	202
2,3,7,8-TCDD TEQ	pg	0.924	2.07	2.91	1.97
PCBs					
Total PCBs	ng	66	49	74	63

Table 4 (continued) - EU-FBSSI Exhaust Dioxin, Furan, and PCB Results

Facility		Ypsilanti Community Utilities Authority			
Source Designation		EU-FBSSI Exhaust			
Test Date		Dec 15, 2015	Dec 15, 2015	Dec 16, 2015	
Run		Run 1 - M23	Run 2 - M23	Run 3 - M23	Average
Concentration					
Dioxins					
2,3,7,8-Tetra CDD	mg/dscf	<1.6E-11	<2.2E-11	<2.0E-11	<2.0E-11
1,2,3,7,8-Penta CDD	mg/dscf	<1.6E-11	<3.3E-11	<4.8E-11	<3.2E-11
1,2,3,4,7,8-Hexa CDD	mg/dscf	<1.7E-11	<3.2E-11	6.6E-11	3.8E-11
1,2,3,6,7,8-Hexa CDD	mg/dscf	<1.8E-11	3.7E-11	<5.9E-11	3.8E-11
1,2,3,7,8,9-Hexa CDD	mg/dscf	3.6E-11	7.9E-11	8.5E-11	6.6E-11
1,2,3,4,6,7,8-Hepta CDD	mg/dscf	1.2E-10	2.8E-10	4.3E-10	2.8E-10
1,2,3,4,6,7,8,9-Octa CDD	mg/dscf	2.4E-10	4.8E-10	7.7E-10	5.0E-10
Total Tetra CDD	mg/dscf	<1.6E-11	<2.2E-11	<2.0E-11	<2.0E-11
Total Penta CDD	mg/dscf	<1.6E-11	<3.3E-11	<4.8E-11	<3.2E-11
Total Hexa CDD	mg/dscf	8.3E-11	2.3E-10	4.0E-10	2.4E-10
Total Hepta CDD	mg/dscf	1.9E-10	2.8E-10	6.6E-10	3.8E-10
Total Dioxins	mg/dscf	5.5E-10	1.0E-09	1.9E-09	1.2E-09
Furans					
2,3,7,8-Tetra CDF	mg/dscf	<4.1E-11	<3.3E-11	<3.0E-11	<3.5E-11
1,2,3,7,8-Penta CDF	mg/dscf	<1.6E-11	<3.2E-11	<4.6E-11	<3.1E-11
2,3,4,7,8-Penta CDF	mg/dscf	<1.6E-11	<3.2E-11	<4.6E-11	<3.1E-11
1,2,3,4,7,8-Hexa CDF	mg/dscf	<1.8E-11	<2.5E-11	<4.2E-11	<2.8E-11
1,2,3,6,7,8-Hexa CDF	mg/dscf	<1.7E-11	<2.5E-11	<4.0E-11	<2.7E-11
2,3,4,6,7,8-Hexa CDF	mg/dscf	<1.9E-11	<2.6E-11	<4.2E-11	<2.9E-11
1,2,3,7,8,9-Hexa CDF	mg/dscf	<2.0E-11	<2.8E-11	<4.6E-11	<3.2E-11
1,2,3,4,6,7,8-Hepta CDF	mg/dscf	<1.7E-11	<2.4E-11	<3.6E-11	<2.6E-11
1,2,3,4,7,8,9-Hepta CDF	mg/dscf	<2.1E-11	<2.9E-11	<4.4E-11	<3.1E-11
1,2,3,4,6,7,8,9-Octa CDF	mg/dscf	<1.9E-11	2.5E-11	3.4E-11	2.6E-11
Total Tetra CDF	mg/dscf	<4.1E-11	<3.3E-11	<3.0E-11	<3.5E-11
Total Penta CDF	mg/dscf	<1.6E-11	<3.2E-11	<4.6E-11	<3.1E-11
Total Hexa CDF	mg/dscf	<1.9E-11	<2.6E-11	<4.2E-11	<2.9E-11
Total Hepta CDF	mg/dscf	<1.9E-11	<2.6E-11	<4.0E-11	<2.8E-11
Total Furans	mg/dscf	1.1E-10	1.4E-10	1.9E-10	1.5E-10
Total Dioxin + Furan	mg/dscf	6.6E-10	1.2E-09	2.1E-09	1.3E-09
2,3,7,8-TCDD TEQ	mg/dscf	4.9E-12	1.5E-11	2.0E-11	1.3E-11
PCBs					
Total PCBs	mg/dscf	3.5E-07	3.4E-07	5.0E-07	4.0E-07

Table 4 (continued) - EU-FBSSI Exhaust Dioxin, Furan, and PCB Results

Facility		Ypsilanti Community Utilities Authority			
Source Designation		EU-FBSSI Exhaust			
Test Date		Dec 15, 2015	Dec 15, 2015	Dec 16, 2015	
Run		Run 1 - M23	Run 2 - M23	Run 3 - M23	Average
Concentration					
Dioxins					
2,3,7,8-Tetra CDD	ng/dscm @ 7% Oxygen	<5.7E-04	<7.5E-04	<6.9E-04	<6.7E-04
1,2,3,7,8-Penta CDD	ng/dscm @ 7% Oxygen	<5.7E-04	<1.1E-03	<1.6E-03	<1.1E-03
1,2,3,4,7,8-Hexa CDD	ng/dscm @ 7% Oxygen	<5.9E-04	<1.1E-03	2.3E-03	1.3E-03
1,2,3,6,7,8-Hexa CDD	ng/dscm @ 7% Oxygen	<6.2E-04	1.2E-03	2.0E-03	1.3E-03
1,2,3,7,8,9-Hexa CDD	ng/dscm @ 7% Oxygen	1.2E-03	2.6E-03	2.9E-03	2.3E-03
1,2,3,4,6,7,8-Hepta CDD	ng/dscm @ 7% Oxygen	4.2E-03	9.3E-03	1.5E-02	9.4E-03
1,2,3,4,6,7,8,9-Octa CDD	ng/dscm @ 7% Oxygen	8.3E-03	1.6E-02	2.6E-02	1.7E-02
Total Tetra CDD	ng/dscm @ 7% Oxygen	<5.7E-04	<7.5E-04	<6.9E-04	<6.7E-04
Total Penta CDD	ng/dscm @ 7% Oxygen	<5.7E-04	<1.1E-03	<1.6E-03	<1.1E-03
Total Hexa CDD	ng/dscm @ 7% Oxygen	2.9E-03	7.6E-03	1.4E-02	8.1E-03
Total Hepta CDD	ng/dscm @ 7% Oxygen	6.6E-03	9.3E-03	2.3E-02	1.3E-02
Total Dioxins	ng/dscm @ 7% Oxygen	1.9E-02	3.5E-02	6.5E-02	4.0E-02
Furans					
2,3,7,8-Tetra CDF	ng/dscm @ 7% Oxygen	<1.4E-03	<1.1E-03	<1.0E-03	<1.2E-03
1,2,3,7,8-Penta CDF	ng/dscm @ 7% Oxygen	<5.7E-04	<1.1E-03	<1.6E-03	<1.1E-03
2,3,4,7,8-Penta CDF	ng/dscm @ 7% Oxygen	<5.7E-04	<1.1E-03	<1.6E-03	<1.1E-03
1,2,3,4,7,8-Hexa CDF	ng/dscm @ 7% Oxygen	<6.2E-04	<8.4E-04	<1.4E-03	<9.7E-04
1,2,3,6,7,8-Hexa CDF	ng/dscm @ 7% Oxygen	<6.0E-04	<8.2E-04	<1.4E-03	<9.3E-04
2,3,4,6,7,8-Hexa CDF	ng/dscm @ 7% Oxygen	<6.4E-04	<8.7E-04	<1.5E-03	<9.9E-04
1,2,3,7,8,9-Hexa CDF	ng/dscm @ 7% Oxygen	<7.0E-04	<9.4E-04	<1.6E-03	<1.1E-03
1,2,3,4,6,7,8-Hepta CDF	ng/dscm @ 7% Oxygen	<5.9E-04	<8.0E-04	<1.2E-03	<8.8E-04
1,2,3,4,7,8,9-Hepta CDF	ng/dscm @ 7% Oxygen	<7.1E-04	<9.6E-04	<1.5E-03	<1.1E-03
1,2,3,4,6,7,8,9-Octa CDF	ng/dscm @ 7% Oxygen	<6.6E-04	8.2E-04	1.2E-03	8.9E-04
Total Tetra CDF	ng/dscm @ 7% Oxygen	<1.4E-03	<1.1E-03	<1.0E-03	<1.2E-03
Total Penta CDF	ng/dscm @ 7% Oxygen	<5.7E-04	<1.1E-03	<1.6E-03	<1.1E-03
Total Hexa CDF	ng/dscm @ 7% Oxygen	<6.4E-04	<8.7E-04	<1.5E-03	<9.9E-04
Total Hepta CDF	ng/dscm @ 7% Oxygen	<6.4E-04	<8.7E-04	<1.4E-03	<9.6E-04
Total Furans	ng/dscm @ 7% Oxygen	3.9E-03	4.7E-03	6.6E-03	5.1E-03
Total Dioxin + Furan	ng/dscm @ 7% Oxygen	2.3E-02	4.0E-02	7.2E-02	4.5E-02
2,3,7,8-TCDD TEQ	ng/dscm @ 7% Oxygen	1.7E-04	4.8E-04	6.7E-04	4.4E-04
PCBs					
Total PCBs	mg/dscm @ 7% Oxygen	1.2E-05	1.1E-05	1.7E-05	1.4E-05

Table 4 (continued) - EU-FBSSI Exhaust Dioxin, Furan, and PCB Results					
Facility		Ypsilanti Community Utilities Authority			
Source Designation		EU-FBSSI Exhaust			
Test Date		Dec 7, 2011	Dec 7, 2011	Dec 8, 2011	
Run		Run 1 - M23	Run 2 - M23	Run 3 - M23	Average
Concentration					
Dioxins					
2,3,7,8-Tetra CDD	ppmvd @ 7% Oxygen	<4.5E-10	<6.0E-10	<5.5E-10	<5.4E-10
1,2,3,7,8-Penta CDD	ppmvd @ 7% Oxygen	<4.5E-10	<8.8E-10	<1.3E-09	<8.8E-10
1,2,3,4,7,8-Hexa CDD	ppmvd @ 7% Oxygen	<4.7E-10	<8.4E-10	1.8E-09	1.0E-09
1,2,3,6,7,8-Hexa CDD	ppmvd @ 7% Oxygen	<5.0E-10	9.9E-10	<1.6E-09	1.0E-09
1,2,3,7,8,9-Hexa CDD	ppmvd @ 7% Oxygen	1.0E-09	2.1E-09	2.3E-09	1.8E-09
1,2,3,4,6,7,8-Hepta CDD	ppmvd @ 7% Oxygen	3.4E-09	7.5E-09	1.2E-08	7.5E-09
1,2,3,4,6,7,8,9-Octa CDD	ppmvd @ 7% Oxygen	6.6E-09	1.3E-08	2.1E-08	1.3E-08
Total Tetra CDD	ppmvd @ 7% Oxygen	<4.5E-10	<6.0E-10	<5.5E-10	<5.4E-10
Total Penta CDD	ppmvd @ 7% Oxygen	<4.5E-10	<8.8E-10	<1.3E-09	<8.8E-10
Total Hexa CDD	ppmvd @ 7% Oxygen	2.3E-09	6.1E-09	1.1E-08	6.5E-09
Total Hepta CDD	ppmvd @ 7% Oxygen	5.3E-09	7.5E-09	1.8E-08	1.0E-08
Total Dioxins	ppmvd @ 7% Oxygen	1.5E-08	2.8E-08	5.2E-08	3.2E-08
Furans					
2,3,7,8-Tetra CDF	ppmvd @ 7% Oxygen	<1.1E-09	<8.8E-10	<8.3E-10	<9.5E-10
1,2,3,7,8-Penta CDF	ppmvd @ 7% Oxygen	<4.5E-10	<8.4E-10	<1.3E-09	<8.6E-10
2,3,4,7,8-Penta CDF	ppmvd @ 7% Oxygen	<4.5E-10	<8.4E-10	<1.3E-09	<8.6E-10
1,2,3,4,7,8-Hexa CDF	ppmvd @ 7% Oxygen	<5.0E-10	<6.7E-10	<1.1E-09	<7.7E-10
1,2,3,6,7,8-Hexa CDF	ppmvd @ 7% Oxygen	<4.8E-10	<6.5E-10	<1.1E-09	<7.4E-10
2,3,4,6,7,8-Hexa CDF	ppmvd @ 7% Oxygen	<5.1E-10	<6.9E-10	1.2E-09	<7.9E-10
1,2,3,7,8,9-Hexa CDF	ppmvd @ 7% Oxygen	<5.6E-10	<7.5E-10	<1.3E-09	<8.6E-10
1,2,3,4,6,7,8-Hepta CDF	ppmvd @ 7% Oxygen	<4.7E-10	<6.3E-10	<1.0E-09	<7.0E-10
1,2,3,4,7,8,9-Hepta CDF	ppmvd @ 7% Oxygen	<5.7E-10	<7.7E-10	<1.2E-09	<8.5E-10
1,2,3,4,6,7,8,9-Octa CDF	ppmvd @ 7% Oxygen	<5.3E-10	6.5E-10	9.4E-10	7.1E-10
Total Tetra CDF	ppmvd @ 7% Oxygen	<1.1E-09	<8.8E-10	<8.3E-10	<9.5E-10
Total Penta CDF	ppmvd @ 7% Oxygen	<4.5E-10	<8.4E-10	<1.3E-09	<8.6E-10
Total Hexa CDF	ppmvd @ 7% Oxygen	<5.1E-10	<6.9E-10	<1.2E-09	<7.9E-10
Total Hepta CDF	ppmvd @ 7% Oxygen	<5.1E-10	<6.9E-10	<1.1E-09	<7.7E-10
Total Furans	ppmvd @ 7% Oxygen	3.1E-09	3.8E-09	5.3E-09	4.1E-09
Total Dioxin + Furan	ppmvd @ 7% Oxygen	1.8E-08	3.2E-08	5.7E-08	3.6E-08
2,3,7,8-TCDD TEQ	ppmvd @ 7% Oxygen	1.4E-10	3.9E-10	5.4E-10	3.5E-10
PCBs					
Total PCBs	ppmvd @ 7% Oxygen	9.7E-06	9.2E-06	1.4E-05	1.1E-05

Table 4 (continued) - EU-FBSSI Exhaust Dioxin, Furan, and PCB Results					
Facility		Ypsilanti Community Utilities Authority			
Source Designation		EU-FBSSI Exhaust			
Test Date		Dec 15, 2015	Dec 15, 2015	Dec 16, 2015	
Run		Run 1 - M23	Run 2 - M23	Run 3 - M23	Average
Mass Emission Rate					
Dry Sewage Sludge Feedrate	ton/hr	2.8	2.8	2.6	2.8
Dioxins					
2,3,7,8-Tetra CDD	lb/hr	<3.0E-11	<4.1E-11	<3.8E-11	<3.7E-11
1,2,3,7,8-Penta CDD	lb/hr	<3.0E-11	<6.1E-11	<9.0E-11	<6.1E-11
1,2,3,4,7,8-Hexa CDD	lb/hr	<3.1E-11	<5.8E-11	1.2E-10	7.1E-11
1,2,3,6,7,8-Hexa CDD	lb/hr	<3.3E-11	6.9E-11	<1.1E-10	7.1E-11
1,2,3,7,8,9-Hexa CDD	lb/hr	6.6E-11	1.4E-10	1.6E-10	1.2E-10
1,2,3,4,6,7,8-Hepta CDD	lb/hr	2.2E-10	5.2E-10	8.1E-10	5.2E-10
1,2,3,4,6,7,8,9-Octa CDD	lb/hr	4.4E-10	8.9E-10	1.5E-09	9.3E-10
Total Tetra CDD	lb/hr	<3.0E-11	<4.1E-11	<3.8E-11	<3.7E-11
Total Penta CDD	lb/hr	<3.0E-11	<6.1E-11	<9.0E-11	<6.1E-11
Total Hexa CDD	lb/hr	1.5E-10	4.2E-10	7.6E-10	4.5E-10
Total Hepta CDD	lb/hr	3.5E-10	5.2E-10	1.2E-09	7.1E-10
Total Dioxins	lb/hr	1.0E-09	1.9E-09	3.6E-09	2.2E-09
Furans					
2,3,7,8-Tetra CDF	lb/hr	<7.6E-11	<6.1E-11	<5.7E-11	<6.5E-11
1,2,3,7,8-Penta CDF	lb/hr	<3.0E-11	<5.8E-11	<8.8E-11	<5.9E-11
2,3,4,7,8-Penta CDF	lb/hr	<3.0E-11	<5.8E-11	<8.8E-11	<5.9E-11
1,2,3,4,7,8-Hexa CDF	lb/hr	<3.3E-11	<4.7E-11	<7.9E-11	<5.3E-11
1,2,3,6,7,8-Hexa CDF	lb/hr	<3.2E-11	<4.5E-11	<7.5E-11	<5.1E-11
2,3,4,6,7,8-Hexa CDF	lb/hr	<3.4E-11	<4.8E-11	<8.0E-11	<5.4E-11
1,2,3,7,8,9-Hexa CDF	lb/hr	<3.7E-11	<5.2E-11	<8.8E-11	<5.9E-11
1,2,3,4,6,7,8-Hepta CDF	lb/hr	<3.1E-11	<4.4E-11	<6.9E-11	<4.8E-11
1,2,3,4,7,8,9-Hepta CDF	lb/hr	<3.8E-11	<5.3E-11	<8.4E-11	<5.8E-11
1,2,3,4,6,7,8,9-Octa CDF	lb/hr	<3.5E-11	4.5E-11	6.5E-11	4.8E-11
Total Tetra CDF	lb/hr	<7.6E-11	<6.1E-11	<5.7E-11	<6.5E-11
Total Penta CDF	lb/hr	<3.0E-11	<5.8E-11	<8.8E-11	<5.9E-11
Total Hexa CDF	lb/hr	<3.4E-11	<4.8E-11	<8.0E-11	<5.4E-11
Total Hepta CDF	lb/hr	<3.4E-11	<4.8E-11	<7.6E-11	<5.3E-11
Total Furans	lb/hr	2.1E-10	2.6E-10	3.7E-10	2.8E-10
Total Dioxin + Furan	lb/hr	1.2E-09	2.2E-09	4.0E-09	2.5E-09
2,3,7,8-TCDD TEQ	lb/hr	9.0E-12	2.7E-11	3.7E-11	2.4E-11
PCBs					
Total PCBs	lb/hr	6.4E-07	6.3E-07	9.4E-07	7.4E-07

Table 4 (continued) - EU-FBSSI Exhaust Dioxin, Furan, and PCB Results

Facility		**Ypsilanti Community Utilities Authority**			
Source Designation		**EU-FBSSI Exhaust**			
Test Date		**Dec 15, 2015**	**Dec 15, 2015**	**Dec 16, 2015**	
Run		**Run 1 - M23**	**Run 2 - M23**	**Run 3 - M23**	**Average**
Mass Emission Rate					
Dioxins					
2,3,7,8-Tetra CDD	lb/ton of dry sewage sludge	<1.1E-11	<1.5E-11	<1.4E-11	<1.3E-11
1,2,3,7,8-Penta CDD	lb/ton of dry sewage sludge	<1.1E-11	<2.1E-11	<3.4E-11	<2.2E-11
1,2,3,4,7,8-Hexa CDD	lb/ton of dry sewage sludge	<1.1E-11	<2.1E-11	4.7E-11	2.6E-11
1,2,3,6,7,8-Hexa CDD	lb/ton of dry sewage sludge	<1.2E-11	2.4E-11	<4.3E-11	2.6E-11
1,2,3,7,8,9-Hexa CDD	lb/ton of dry sewage sludge	2.3E-11	5.1E-11	6.1E-11	4.5E-11
1,2,3,4,6,7,8-Hepta CDD	lb/ton of dry sewage sludge	7.9E-11	1.8E-10	3.1E-10	1.9E-10
1,2,3,4,6,7,8,9-Octa CDD	lb/ton of dry sewage sludge	1.6E-10	3.1E-10	5.5E-10	3.4E-10
Total Tetra CDD	lb/ton of dry sewage sludge	<1.1E-11	<1.5E-11	<1.4E-11	<1.3E-11
Total Penta CDD	lb/ton of dry sewage sludge	<1.1E-11	<2.1E-11	<3.4E-11	<2.2E-11
Total Hexa CDD	lb/ton of dry sewage sludge	5.4E-11	1.5E-10	2.9E-10	1.6E-10
Total Hepta CDD	lb/ton of dry sewage sludge	1.2E-10	1.8E-10	4.7E-10	2.6E-10
Total Dioxins	lb/ton of dry sewage sludge	3.5E-10	6.8E-10	1.4E-09	8.0E-10
Furans					
2,3,7,8-Tetra CDF	lb/ton of dry sewage sludge	<2.7E-11	<2.1E-11	<2.2E-11	<2.3E-11
1,2,3,7,8-Penta CDF	lb/ton of dry sewage sludge	<1.1E-11	<2.1E-11	<3.3E-11	<2.2E-11
2,3,4,7,8-Penta CDF	lb/ton of dry sewage sludge	<1.1E-11	<2.1E-11	<3.3E-11	<2.2E-11
1,2,3,4,7,8-Hexa CDF	lb/ton of dry sewage sludge	<1.2E-11	<1.6E-11	<3.0E-11	<1.9E-11
1,2,3,6,7,8-Hexa CDF	lb/ton of dry sewage sludge	<1.1E-11	<1.6E-11	<2.9E-11	<1.9E-11
2,3,4,6,7,8-Hexa CDF	lb/ton of dry sewage sludge	<1.2E-11	<1.7E-11	<3.0E-11	<2.0E-11
1,2,3,7,8,9-Hexa CDF	lb/ton of dry sewage sludge	<1.3E-11	<1.8E-11	<3.3E-11	<2.2E-11
1,2,3,4,6,7,8-Hepta CDF	lb/ton of dry sewage sludge	<1.1E-11	<1.6E-11	<2.6E-11	<1.8E-11
1,2,3,4,7,8,9-Hepta CDF	lb/ton of dry sewage sludge	<1.3E-11	<1.9E-11	<3.2E-11	<2.1E-11
1,2,3,4,6,7,8,9-Octa CDF	lb/ton of dry sewage sludge	<1.2E-11	1.6E-11	2.5E-11	1.8E-11
Total Tetra CDF	lb/ton of dry sewage sludge	<2.7E-11	<2.1E-11	<2.2E-11	<2.3E-11
Total Penta CDF	lb/ton of dry sewage sludge	<1.1E-11	<2.1E-11	<3.3E-11	<2.2E-11
Total Hexa CDF	lb/ton of dry sewage sludge	<1.2E-11	<1.7E-11	<3.0E-11	<2.0E-11
Total Hepta CDF	lb/ton of dry sewage sludge	<1.2E-11	<1.7E-11	<2.9E-11	<1.9E-11
Total Furans	lb/ton of dry sewage sludge	7.4E-11	9.2E-11	1.4E-10	1.0E-10
Total Dioxin + Furan	lb/ton of dry sewage sludge	4.3E-10	7.7E-10	1.5E-09	9.0E-10
2,3,7,8-TCDD TEQ	lb/ton of dry sewage sludge	3.2E-12	9.4E-12	1.4E-11	8.9E-12
PCBs					
Total PCBs	lb/ton of dry sewage sludge	2.3E-07	2.2E-07	3.6E-07	2.7E-07

BUREAU VERITAS

Table 4 (continued) - EU-FBSSI Exhaust Dioxin, Furan, and PCB Results

Facility		Ypsilanti Community Utilities Authority			
Source Designation		EU-FBSSI Exhaust			
Test Date		Dec 15, 2015	Dec 15, 2015	Dec 16, 2015	
Run		Run 1 - M23	Run 2 - M23	Run 3 - M23	Average
Mass Emission Rate					
Dioxins					
2,3,7,8-Tetra CDD	lb/ton of dry sewage sludge @ 7% O_2	<1.0E-11	<1.4E-11	<1.4E-11	<1.3E-11
1,2,3,7,8-Penta CDD	lb/ton of dry sewage sludge @ 7% O_2	<1.0E-11	<2.0E-11	<3.3E-11	<2.1E-11
1,2,3,4,7,8-Hexa CDD	lb/ton of dry sewage sludge @ 7% O_2	<1.1E-11	<1.9E-11	4.6E-11	2.5E-11
1,2,3,6,7,8-Hexa CDD	lb/ton of dry sewage sludge @ 7% O_2	<1.1E-11	2.3E-11	<4.1E-11	2.5E-11
1,2,3,7,8,9-Hexa CDD	lb/ton of dry sewage sludge @ 7% O_2	2.3E-11	4.8E-11	5.9E-11	4.3E-11
1,2,3,4,6,7,8-Hepta CDD	lb/ton of dry sewage sludge @ 7% O_2	7.7E-11	1.7E-10	3.0E-10	1.8E-10
1,2,3,4,6,7,8,9-Octa CDD	lb/ton of dry sewage sludge @ 7% O_2	1.5E-10	3.0E-10	5.4E-10	3.3E-10
Total Tetra CDD	lb/ton of dry sewage sludge @ 7% O_2	<1.0E-11	<1.4E-11	<1.4E-11	<1.3E-11
Total Penta CDD	lb/ton of dry sewage sludge @ 7% O_2	<1.0E-11	<2.0E-11	<3.3E-11	<2.1E-11
Total Hexa CDD	lb/ton of dry sewage sludge @ 7% O_2	5.3E-11	1.4E-10	2.8E-10	1.6E-10
Total Hepta CDD	lb/ton of dry sewage sludge @ 7% O_2	1.2E-10	1.7E-10	4.6E-10	2.5E-10
Total Dioxins	lb/ton of dry sewage sludge @ 7% O_2	3.5E-10	6.4E-10	1.3E-09	7.7E-10
Furans					
2,3,7,8-Tetra CDF	lb/ton of dry sewage sludge @ 7% O_2	<2.6E-11	<2.0E-11	<2.1E-11	<2.3E-11
1,2,3,7,8-Penta CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.0E-11	<1.9E-11	<3.2E-11	<2.1E-11
2,3,4,7,8-Penta CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.0E-11	<1.9E-11	<3.2E-11	<2.1E-11
1,2,3,4,7,8-Hexa CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.1E-11	<1.6E-11	<2.9E-11	<1.9E-11
1,2,3,6,7,8-Hexa CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.1E-11	<1.5E-11	<2.8E-11	<1.8E-11
2,3,4,6,7,8-Hexa CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.2E-11	<1.6E-11	<3.0E-11	<1.9E-11
1,2,3,7,8,9-Hexa CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.3E-11	<1.7E-11	<3.2E-11	<2.1E-11
1,2,3,4,6,7,8-Hepta CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.1E-11	<1.5E-11	<2.5E-11	<1.7E-11
1,2,3,4,7,8,9-Hepta CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.3E-11	<1.8E-11	<3.1E-11	<2.1E-11
1,2,3,4,6,7,8,9-Octa CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.2E-11	1.5E-11	2.4E-11	1.7E-11
Total Tetra CDF	lb/ton of dry sewage sludge @ 7% O_2	<2.6E-11	<2.0E-11	<2.1E-11	<2.3E-11
Total Penta CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.0E-11	<1.9E-11	<3.2E-11	<2.1E-11
Total Hexa CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.2E-11	<1.6E-11	<3.0E-11	<1.9E-11
Total Hepta CDF	lb/ton of dry sewage sludge @ 7% O_2	<1.2E-11	<1.6E-11	<2.8E-11	<1.9E-11
Total Furans	lb/ton of dry sewage sludge @ 7% O_2	7.2E-11	8.7E-11	1.4E-10	9.8E-11
Total Dioxin + Furan	lb/ton of dry sewage sludge @ 7% O_2	4.2E-10	7.3E-10	1.5E-09	8.7E-10
2,3,7,8-TCDD TEQ	lb/ton of dry sewage sludge @ 7% O_2	3.1E-12	8.9E-12	1.4E-11	8.6E-12
PCBs					
Total PCBs	lb/ton of dry sewage sludge @ 7% O_2	2.2E-07	2.1E-07	3.5E-07	2.6E-07