Air Emission Test for Fluidized Bed Sewage Sludge Incinerator

YCUA
Wastewater Treatment Plant
2777 State Road
Ypsilanti, Michigan

YPSILANTI COMMUNITY UTILITIES AUTHORITY
YCUA
www.ycua.org

Renewable Operating Permit B6237-2015
State Registration No. B6237

Prepared for
Ypsilanti Community Utilities Authority
Ypsilanti, Michigan

Bureau Veritas Project No. 11014-000217.00

June 29, 2015

BUREAU VERITAS 1828

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Bureau Veritas North America, Inc.
22345 Roethel Drive
Novi, Michigan 48375
248.344.2661
www.us.bureauveritas.com/hse

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 Ext. 116
Name of Responsible Official (print or type)	Title	Phone Number

[signature]	JUNE 29, 2015
Signature of Responsible Official	Date

* Photocopy this form as needed.

EQP 5736 (8/99)

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 the 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.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1, 2, 3A, 4, 5, 7E, 10, 29, and 205 guidelines. Three 60-minute test runs were completed 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.

The EU-FBSSI exhaust was sampled for oxygen (O_2), carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter (PM), mercury (Hg), and lead (Pb). Detailed results are presented in Tables 1 and 2 after the Tables Tab of this report. The following table summarizes the results of the testing conducted on May 6, 2015.

Summary of EU-FBSSI Emissions Test Results

Pollutant	Units	Average Result	EU-FBSSI Permit Limit
Carbon Monoxide (CO)	mg/dscm corrected to 7% O_2	15.7	†
	ppmvd corrected to 7% O_2	13.5	100
	lb/dry ton corrected to 7% O_2	0.33	†
	lb/dry ton	0.29	†
Nitrogen Oxides (NO_x)	mg/dscm corrected to 7% O_2	110.5	†
	ppmvd corrected to 7% O_2	58.4	†
	lb/dry ton corrected to 7% O_2	2.4	†
	lb/dry ton	3.6	†
Particulate Matter (PM)	mg/dscm corrected to 7% O_2	8.3	†
	ppmvd corrected to 7% O_2	6.7	†
	lb/dry ton corrected to 7% O_2	0.18	†
	lb/dry ton	0.16	0.35
Mercury (Hg)	mg/dscm corrected to 7% O_2	1.5×10^{-3}	†
	ppmvd corrected to 7% O_2	1.2×10^{-3}	†
	lb/dry ton corrected to 7% O_2	3.2×10^{-5}	†
	lb/dry ton	2.9×10^{-5}	6.9×10^{-4}
Lead (Pb)	mg/dscm corrected to 7% O_2	2.5×10^{-3}	†
	ppmvd corrected to 7% O_2	2.0×10^{-3}	†
	lb/dry ton corrected to 7% O_2	5.4×10^{-5}	†
	lb/dry ton	4.7×10^{-5}	†

mg/dscm = milligram per dry standard cubic meter
ppmvd = part per million by volume, dry
lb = pound
† = Limits for pollutant are not listed in the facility's permit – parameters were measured for YCUA's internal purposes.

The results of the testing indicate compliance with EU-FBSSI permit limits.

1.0 Introduction

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 (EU-FBSSI) were tested at the 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.

1.1 Identification, Location, and Date of Test

The emission testing was performed on May 6, 2015. The source, parameters, and test date are listed below:

Table 1-1
Source, Parameters, and Test Date

Source	Parameter	Test Date
Fluidized bed sewage sludge incinerator (EU-FBSSI Exhaust)	Oxygen (O_2)	May 6, 2015
	Carbon monoxide (CO)	
	Nitrogen oxides (NO_x)	
	Particulate matter (PM)	
	Mercury (Hg)	
	Lead (Pb)	

1.2 Purpose of Testing

The purpose of the testing was to evaluate compliance with emission limits specified in YCUA's ROP MI-ROP-B6237-2015, issued March 17, 2015, for the EU-FBSSI emissions source.

1.3 Description of Source

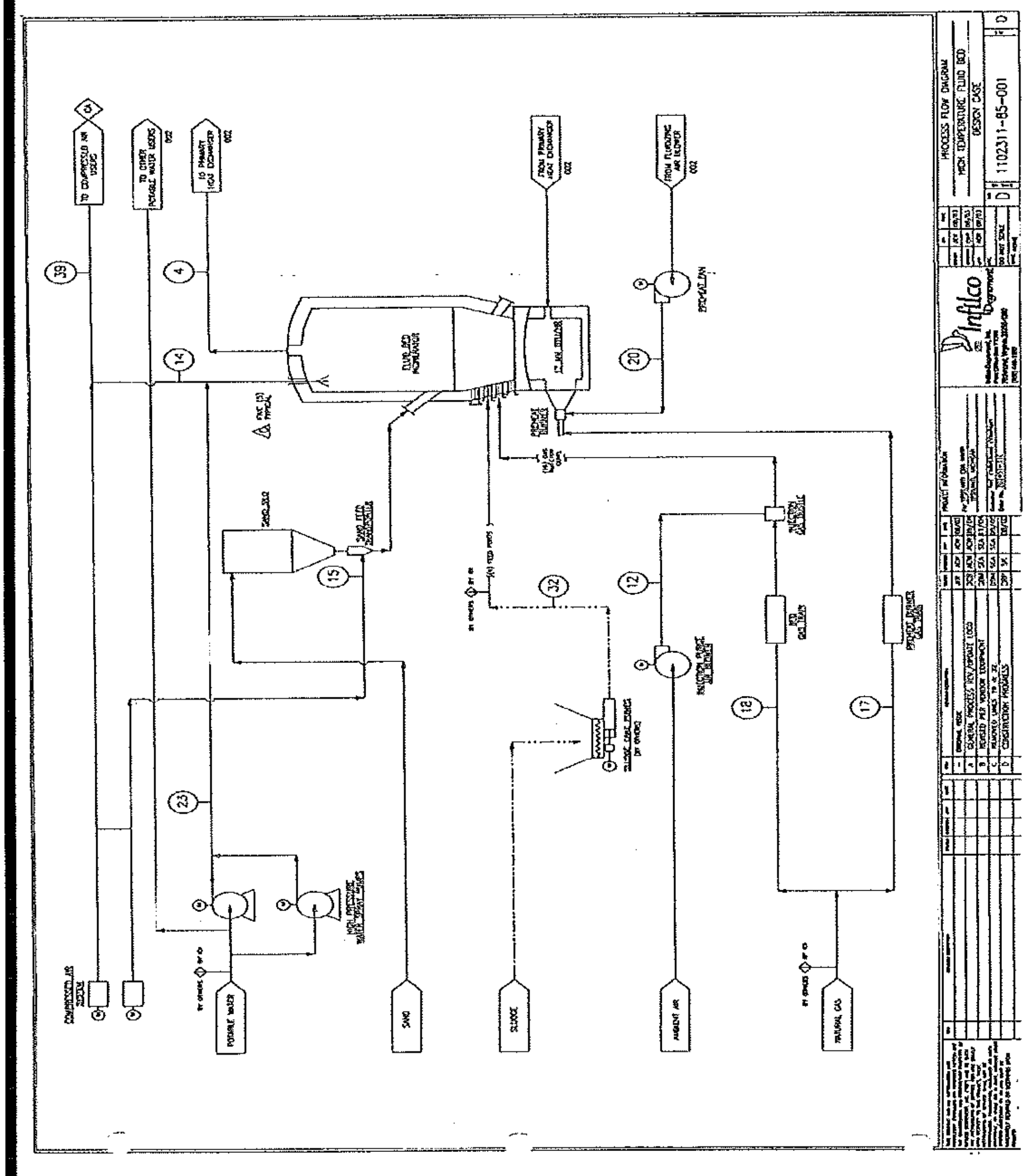
YCUA provides water and wastewater services for the City of Ypsilanti and surrounding communities. YCUA processes over 8 billion gallons of wastewater annually. YCUA operates a fluidized bed sewage sludge (biosolids) incinerator. This incinerator incorporates four types of air pollution control; the final control is a granular activated carbon absorber (GACA). Figure 1 in the Appendix depicts the EU-FBSSI sampling and traverse point locations. A description of the source tested is presented in Table 1-2.

Table 1-2
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

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

Figure 1-1. EU-FBSSI Schematic 1



Schematic provided INFILCO

Figure 1-2. EU-FBSSI Schematic 2

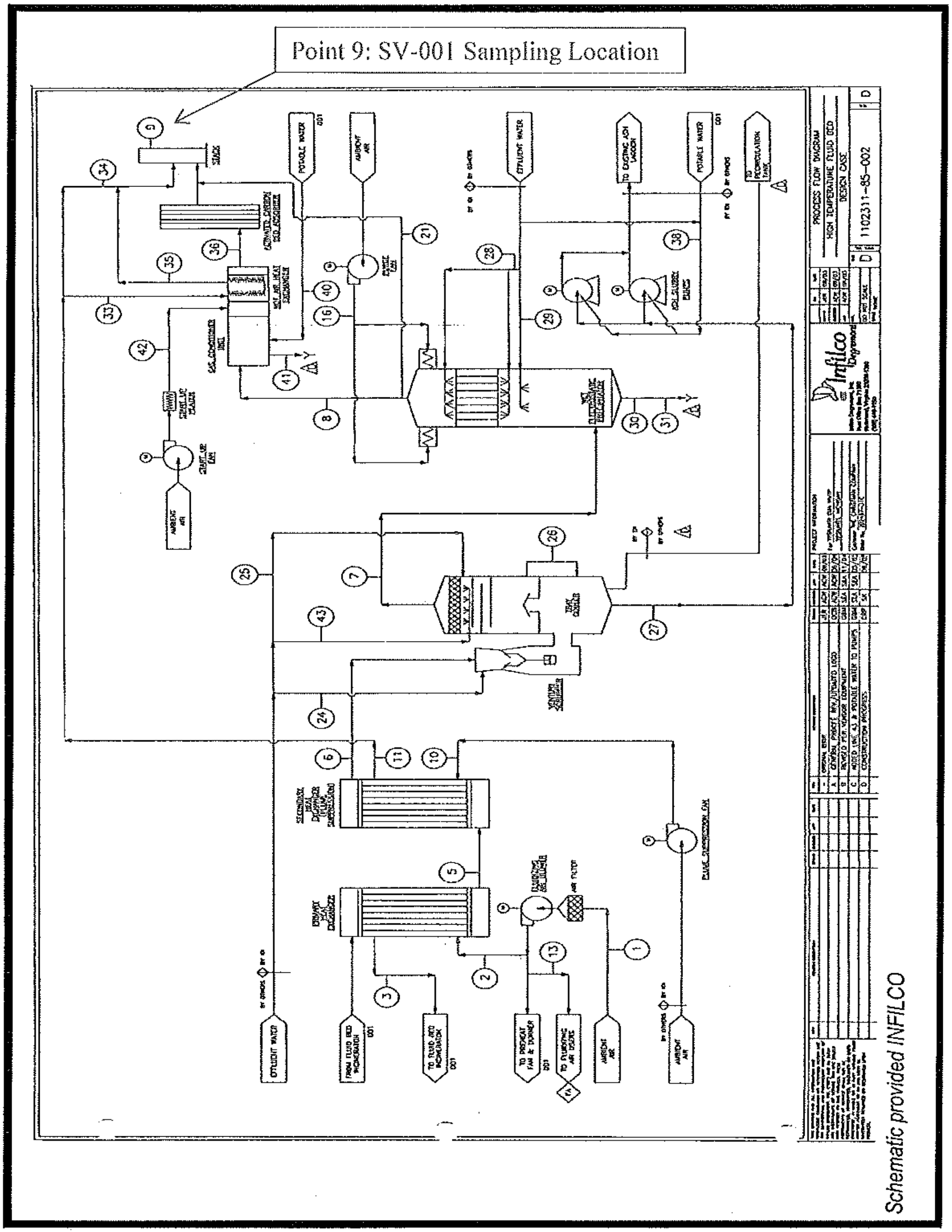
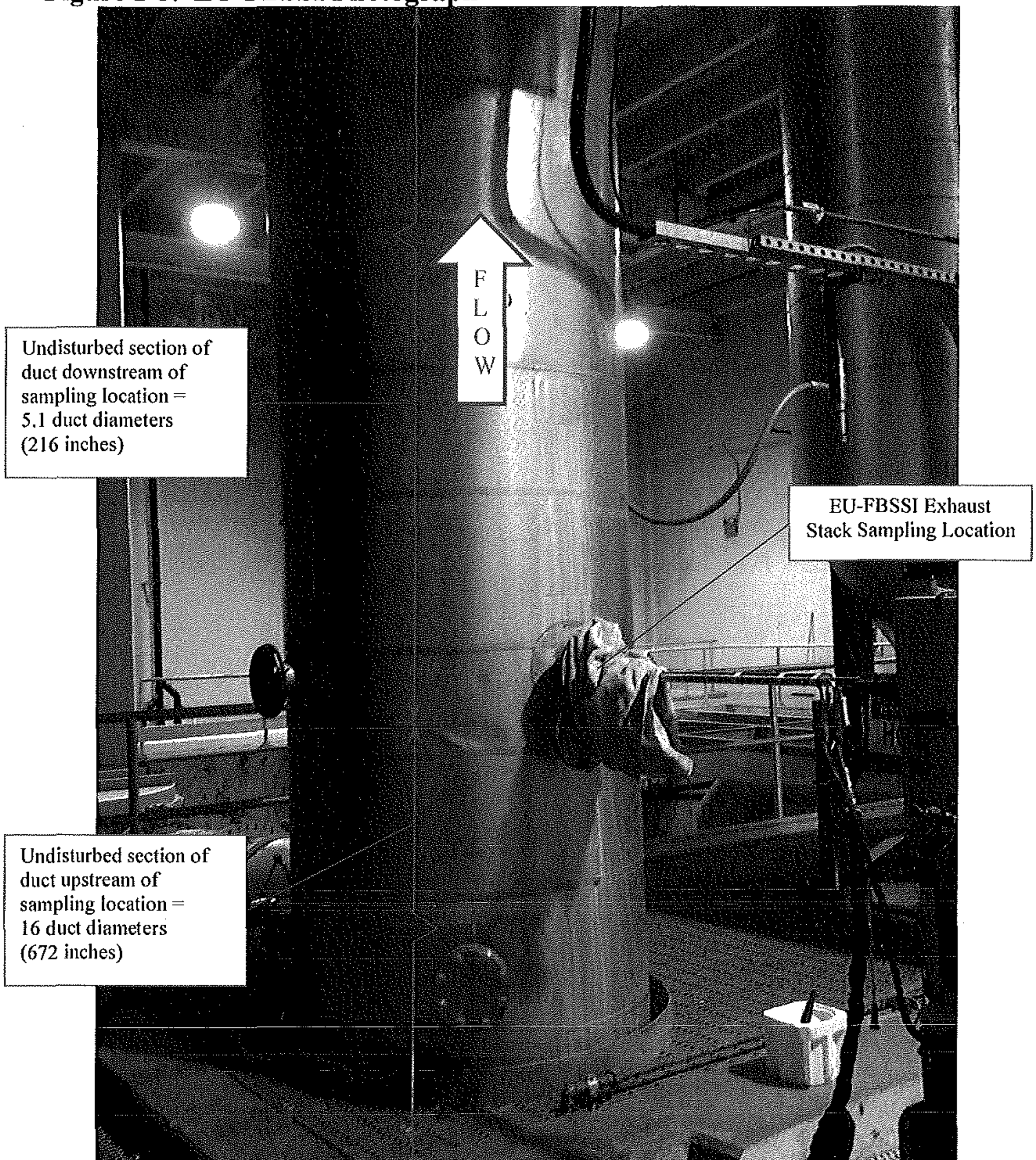


Figure 1-3. EU-FBSSI Photograph



1.4 Contact Information

Mr. Thomas Schmelter, Senior Project Manager with Bureau Veritas, directed the emissions testing event with the assistance of Messrs. Brian Young and Dillon King, both with Bureau Veritas. Mr. Luther Blackburn with YCUA provided process coordination during the test program. Mr. Tom Gasloli, with MDEQ, witnessed the test program. Mr. Scott Miller, Environmental Manager, Mr. Glen Erickson, Environmental Quality Analyst, and Ms. Diane Kavanaugh-Vetort, Environmental Quality Analyst with the MDEQ Jackson District Office witnessed portions of the testing. Contact information for the key individuals is listed below.

Table 1-3
Contact 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 x 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	
Tom Gasloli **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. 284.6778 Facsimile: 517.335.3122 gaslolit@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
Glen Erickson **Michigan Department of Environmental Quality** Air Quality Division – Jackson District Office 301 East Louis Glick Highway Jackson, Michigan 49201 Telephone: 517.780.7851 Facsimile: 517.780.7855 ericksong@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

2.0 Summary of Results

2.1 Operating Data

YCUA personnel recorded operating parameters during the emissions testing. MDEQ personnel verified the operating parameters were recorded appropriately. The operating parameters used to regulate the process are mostly computer-operated and recorded. For example, the incinerator temperature, pressure, and water supply were continuously monitored to verify proper operation. The operating parameters recorded during the testing are included in Appendix F.

2.2 Applicable Permit or Source Designation

The purpose of this test program was to evaluate compliance with MI-ROP-B6237-2015, issued March 17, 2015, for the EU-FBSSI emission equipment. Figure 2-1 depicts the Permit cover page.

Figure 2-1. Permit Information

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

EFFECTIVE DATE: March 17, 2015
ISSUED TO

Ypsilanti Community Utilities Authority

State Registration Number (SRN): B6237

LOCATED AT
2777 State Street, Ypsilanti, Michigan 48197

RENEWABLE OPERATING PERMIT

Permit Number: MI-ROP-B6237-2015

Expiration Date: March 17, 2020

Administratively Complete ROP Renewal Application Due Between September 17, 2019 to September 17, 2018

This Renewable Operating Permit (ROP) is issued in accordance with and subject to Section 5506(3) of Part 55, Air Pollution Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Act 451). Pursuant to Michigan Air Pollution Control Rule 210(1), this ROP constitutes the permittee's authority to operate the stationary source identified above in accordance with the general conditions, special conditions and attachments contained herein. Operation of the stationary source and all emission units listed in the permit are subject to all applicable future or amended rules and regulations pursuant to Act 451 and the federal Clean Air Act.

SOURCE-WIDE PERMIT TO INSTALL

Permit Number: MI-PTI-B6237-2015

This Permit to Install (PTI) is issued in accordance with and subject to Section 5505(5) of Act 451. Pursuant to Michigan Air Pollution Control Rule 214a, the terms and conditions herein, identified by the underlying applicable requirement citation of Rule 201(1)(a), constitute a federally enforceable PTI. The PTI terms and conditions do not expire and remain in effect unless the criteria of Rule 201(6) are met. Operation of all emission units identified in the PTI is subject to all applicable future or amended rules and regulations pursuant to Act 451 and the federal Clean Air Act.

Michigan Department of Environmental Quality

Scott Miller, Jackson District Supervisor

2.3 Comparison to Emission Regulations

The average measured concentrations and emission rates are summarized in Table 2-1. Detailed results are presented in Table 1 and Table 2 after the Table Tab of this report. Graphs of the O_2, CO, and NO_x concentrations are presented after the Graphs Tab of this report. Sample calculations are presented in Appendix B.

Table 2-1
Summary of EU-FBSSI Emissions Test Results

Pollutant	Units	Average Result	EU-FBSSI Permit Limit
Carbon Monoxide (CO)	mg/dscm corrected to 7% O_2	15.7	†
	ppmvd corrected to 7% O_2	13.5	100
	lb/dry ton corrected to 7% O_2	0.33	†
	lb/dry ton	0.29	†
Nitrogen Oxides (NO_x)	mg/dscm corrected to 7% O_2	110.5	†
	ppmvd corrected to 7% O_2	58.4	†
	lb/dry ton corrected to 7% O_2	2.4	†
	lb/dry ton	3.6	†
Particulate Matter (PM)	mg/dscm corrected to 7% O_2	8.3	†
	ppmvd corrected to 7% O_2	6.7	†
	lb/dry ton corrected to 7% O_2	0.18	†
	lb/dry ton	0.16	0.35
Mercury (Hg)	mg/dscm corrected to 7% O_2	1.5×10^{-3}	†
	ppmvd corrected to 7% O_2	1.2×10^{-3}	†
	lb/dry ton corrected to 7% O_2	3.2×10^{-5}	†
	lb/dry ton	2.9×10^{-5}	6.9×10^{-4}
Lead (Pb)	mg/dscm corrected to 7% O_2	2.5×10^{-3}	†
	ppmvd corrected to 7% O_2	2.0×10^{-3}	†
	lb/dry ton corrected to 7% O_2	5.4×10^{-5}	†
	lb/dry ton	4.7×10^{-5}	†

mg/dscm = milligram per dry standard cubic meter
ppmvd = part per million by volume, dry
lb = pound
† = Limits for pollutant are not listed in the facility's permit – parameters were measured for YCUA's internal purposes.

The results of the testing indicate compliance with EU-FBSSI permit limits.

3.0 Source Description

3.1 Process Description

YCUA operates a wastewater treatment facility 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 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.

The 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 the exhaust Stack SV-001.

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; this is where most of the combustion takes place. The upper section is the freeboard, which allows additional time to 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 via water injection. The gas velocity increases at the Venturi throat. 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 small 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 and impurities in the gas stream. The absorber removes the impurities by passing the gas through one cell of porous filter media pellets and two cells of carbon pellets.

3.2 Operating Parameters

The basic operating parameters used to regulate the process include:

- Tons of biosolids processed per hour.
- Incinerator temperature.
- Oxygen content of the flue gas.
- Volumetric flowrate through the incinerator.

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

These operating parameters for the EU-FBSSI source were recorded by YCUA personnel and are provided in Appendix F.

3.3 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 below summarizes the sewage sludge metal content in comparison to permit limits.

Table 3-1
Sewage Sludge Metal Content

Pollutant	Units	Average Result	Permit Limit
Arsenic	mg/kg dry sewage sludge	4.8	**13**
Beryllium	mg/kg dry sewage sludge	<0.20†	**0.25**
Cadmium	mg/kg dry sewage sludge	4.2	**85**
Total chromium	mg/kg dry sewage sludge	71	**450**
Mercury	mg/kg dry sewage sludge	0.34	**3.7**

mg/kg = milligram/kilogram
† Not detected above reporting limit of 0.20 mg/kg dry sewage sludge

Refer to Appendix F for the laboratory analysis of the instantaneous sewage sludge sample.

3.4 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 86.8% was used with the total time of the test to calculate the dry pounds of sludge processed per hour.

The average sewage sludge feedrate into the incinerator during the three runs of testing was 2.23 dry tons per hour or 4,460 dry pounds of solids per hour. 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%.

3.5 Process Monitoring

YCUA personnel recorded process monitoring data during the emissions testing. MDEQ representatives were onsite during the test program and verified that the process was operating within permitted requirements.

Prior to initiating a test, YCUA personnel verified the process was operating in accordance with designated specifications. No process shutdowns or disruptions were encountered that would have prompted a discontinuation of testing.

The process parameters recorded during the testing are included in Appendix F.

4.0 Sampling and Analytical Procedures

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. The sampling and analytical methods used are indicated in the following table.

Table 4-1
Sampling and Analytical Methods

USEPA Sampling Method	Parameter	Analysis
1 and 2	Gas stream volumetric flow rate	Field measurement, S-type Pitot tube, differential pressure
3A	Oxygen (O_2), carbon dioxide (CO_2), molecular weight	Paramagnetic and gas filter correlation gas analyzers
4	Moisture content	Gravimetric
5	Particulate matter (PM)	Gravimetric
7E	Oxides of nitrogen (NO_x)	Chemiluminescence
10	Carbon monoxide (CO)	Non-dispersive infrared
29	Lead (Pb) and mercury (Hg)	Inductively coupled plasma mass spectrometry (ICP/MS), cold vapor atomic absorption spectrometry (CV/AA)
205	Calibration gas dilution	Field verification

4.1 Sampling Train and Procedures

The following sections describe the USEPA source sampling methods used during this test program.

4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources" and Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)," from the Code of Federal Regulations, Title 40, Part 60 (40 CFR 60), Appendix A, were used to determine the number of traverse points and to measure velocity profiles at the EU-FBSSI sampling location. The velocity measurement location and number of velocity traverse points are presented in the following table:

Table 4-2
Velocity Measurement Location and Number of Traverse Points

Sampling Location	Duct Diameter (inch)	Upstream Distance from Flow Disturbance (diameter)	Downstream Distance from Flow Disturbance (diameter)	Number of Ports Used	Traverse Points per Port	Total Points	Cyclonic Flow Check Average Null Angle
EU-FBSSI Exhaust	42	16	5.1	2	6	12	4°

Figure 1 in the Appendix depicts the EU-FBSSI exhaust source and sampling and traverse point locations.

An S-type Pitot tube and thermocouple assembly, calibrated in accordance with USEPA Method 2, Section 10, was used to measure exhaust gas velocity head pressures and temperatures during testing. Because the dimensions of the Pitot tube met the requirements outlined in USEPA Method 2, Section 10, and were within the specified limits, the baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned. Refer to Appendix A for the calibration and inspection sheets.

Cyclonic Flow Check. Bureau Veritas evaluated whether cyclonic flow was present at the EU-FBSSI exhaust sampling location in the SV-001 stack 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 a zero (null) velocity head reading—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 walls 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 degrees, the flue gas flow is considered to be cyclonic at that sampling location and an alternative location should be found.

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

Field data sheets are included in Appendix C.

4.1.2 Oxygen, Nitrogen Oxides and Carbon Monoxide (USEPA Methods 3A, 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. Nitrogen oxides 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, 7E, and 10 sampling train.

The sampling trains for USEPA Methods 3A, 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, nitrogen oxides, and carbon monoxide gas analyzers.

The flue gas was extracted and continuously introduced into the paramagnetic (O_2), chemiluminescence (NO_x), and infrared (CO) gas analyzers to measure pollutant concentrations. Data was 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 traverse the stack in accordance with USEPA Method 29 requirements over the duration of 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 where known concentrations of calibration gases were introduced at the probe tip to measure if the analyzer's response is 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, are included in Appendix A.

4.1.3 Moisture Content (USEPA Method 4)

Prior to testing, moisture content was estimated using historic test data, psychrometric chart, and/or 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 Methods 5/29 sampling. For each sampling run, actual 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 5/29.

4.1.4 Particulate Matter, Lead, and Mercury (USEPA Methods 5/29)

USEPA Methods 5, "Determination of Particulate Matter Emissions from Stationary Sources," and 29, "Determination of Metals Emissions from Stationary Sources," was used to measure particulate matter, lead, and mercury emissions. Figure 3 depicts the USEPA Methods 5/29 sampling train.

Bureau Veritas' modular isokinetic stack sampling system consisted of:

- A borosilicate glass button-hook nozzle.
- A heated (248±25°F) borosilicate glass-lined probe.
- A desiccated and pre-weighed 110-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 impingers situated in a chilled ice bath with the configuration shown in Table 4-3.

- A sample line.

- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-3
USEPA Methods 5/29 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 cubic feet per minute. 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 then monitored to verify the sample train leakage rate was less than 0.02 cubic feet per minute (cfm). If the pre-test leak failed, the sample train would have been adjusted until the leak rate was <0.02 cfm. The sample probe was then 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 sample 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 high performance liquid chromatography (HPLC) water followed by acetone. The HPLC water and acetone rinses were discarded.

At the end of a test run, the liquid volume collected in each impinger was measured using a graduated cylinder to within ±0.5 milliliters; these volume measurements were used to calculate the moisture content of the flue gas.

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 was 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 Impingers 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 could still be present on the impinger surfaces after the water rinse, 25 ml of 8-N hydrochloric acid (HCl) was used to wash these impingers and connecting glassware. This 8-N HCl 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 HCl, and filter blanks were sent, by courier, to Maxxam Analytics, a Bureau Veritas laboratory, located in Mississauga, Ontario, Canada for analysis. Refer to Appendix E for the Methods 5/29 analytical results.

4.1.5 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 mass flow controllers and dilutes a high-level calibration gas to within ±2% of predicted values. The gas dilution system is capable of diluting gases at various concentrations and was evaluated for accuracy in the field in accordance with USEPA Method 205, "Verification of Gas Dilution Systems for Field Instrument Calibrations."

Prior to testing, three gas dilutions were evaluated against the acceptance tolerance of ±2% of predicted values. Three sets of each high-level calibration gas dilutions 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 dilution system concentration. Refer to Appendix A for the Method 205 field evaluation calibration verification data.

4.2 Recovery and Analytical Procedures

Chain of Custody Procedures followed guidelines outlined within ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures." Detailed sampling and recovery procedures are described in Section 4.0. For each sample collected (i.e. filter, probe rinse, impinger contents) sample identification and custody procedures were completed as follows:

- Containers were sealed with Teflon tape to prevent contamination.
- Containers were labeled with test number, location, and test date.
- The level of fluid was marked on outside of sample containers to identify if leakage had occurred before delivery of the samples to the laboratory.
- Containers were placed in a cooler for storage.
- 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 under chain of custody.

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

4.3 Cross-Sectional View

Figure 1 in the Appendix provides a cross-sectional view of the EU-FBSSI sampling and traverse point locations.

5.0 Test Results and Discussion

5.1 Results

The results of this testing program are summarized in Section 2.0 and presented in Tables 1 and 2 after the Table Tab of this report.

5.2 Significance of Results to Emission Regulations

A comparison of the results to air emissions limits in the applicable permit is presented in Section 2.3. Metal concentrations of the sewage sludge are compared to permit limits in Section 3.3. The results of the testing indicate compliance with EU-FBSSI permit limits.

5.3 Sampling Variations or Operating Conditions

Sampling variations or deviations on operating conditions were not encountered during this test program.

5.4 Upset Conditions

Upset conditions were not encountered during this test program.

5.5 Air Pollution Control Device Maintenance

The YUCA facility has been in operation since 1982; however the EU-FBSSI was installed in 2003. Significant air pollution control device maintenance has occurred from circa November 2014 through April 2015.

5.6 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 Inc. in Mississauga, Ontario. 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
1125	Lead on filter paper	µg/Filter	56.8	56.7	0.1	45.4-68.0	Acceptable
1126	Lead in impinger solution	µg/ml	0.226	0.218	0.008	0.164-0.272	Acceptable
1127	Mercury on filter paper	µg/Filter	12.1	11.4	0.7	8.55-14.2	Acceptable
1128	Mercury in impinger solution	ng/mL	24	24.9	0.9	18.7-31.1	Acceptable

5.7 Calibration and Inspection Sheets

No significant quality assurance/quality control (QA/QC) issues were encountered during testing. Although, the pre- to post-test carbon monoxide calibration drift check for the low-level and upscale calibration gases was <4% and exceeded the criterion of 3% for Runs 1 and 3. Based on the magnitude of the drift, the results in comparison to permit limits, and because the results were corrected for analyzer drift using equation 7E-5b of EPA Method 7E the excess analyzer drift did not affect the conclusions of this report.

Calibration and inspection sheets, including Pitot tube, nozzle, dry-gas meter, calibration gas protocol sheets, and analyzer calibrations, are presented in Appendix A.

5.8 Sample Calculations

Sample calculations are presented in Appendix B.

5.9 Field Data Sheets

Field data sheets are presented in Appendix C. Computer-generated Data Sheets are presented within Appendix D.

5.10 Laboratory Data

Laboratory data are included in Appendix E.

Limitations

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This report prepared by: Thomas R. Schmelter

Thomas R. Schmelter, QSTI
Senior Project Manager
Health, Safety, and Environmental Services

This report approved by:

Derek R. Wong, Ph.D., P.E.
Director and Vice President
Health, Safety, and Environmental Services