Air Emission for Fluidized Bed Sewage Sludge Incinerator

YCUA
Wastewater Treatment Plant
2777 State Street
Ypsilanti, Michigan

Permit to Install 68-02A
State Registration No. B6237

Prepared for
Ypsilanti Community Utilities Authority
Ypsilanti, Michigan

Bureau Veritas Project No. 11013-000234.00

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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 the exhaust stack SV-001. The testing was performed to evaluate compliance with applicable emission limits in Michigan Department of Environmental Quality (MDEQ) Permit to Install Permit 68-02A, dated November 21, 2007.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1, 2, 3, 3A, 4, 10, and 29 guidelines. Three, 60-minute test runs were completed for each analyte at the EU-FBSSI exhaust source. Oxygen concentrations of 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), and mercury (Hg). 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 November 21, 2013.

Summary of EU-FBSSI Emissions Test Results

Pollutant	Units	Average Result	EU-FBSSI Permit Limit
Carbon Monoxide	mg/dscm corrected to 7% O_2	44.4	†
	ppmvd corrected to 7% O_2	39.1	100
	lb/dry ton corrected to 7% O_2	1.0	†
	lb/dry ton	1.0	†
Mercury	mg/dscm corrected to 7% O_2	7.9×10^{-3}	†
	ppmvd corrected to 7% O_2	6.2×10^{-3}	†
	lb/dry ton corrected to 7% O_2	1.7×10^{-4}	†
	lb/dry ton	1.7×10^{-4}	6.9×10^{-4}

† No permit limit. Parameter 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 (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) Permit to Install Permit 68-02A, dated November 21, 2007.

1.1 Identification, Location, and Dates of Test

The compliance testing was performed on November 21, 2013. The source and test date for each parameter tested are listed below:

Table 1-1
Source, Parameters, and Test Date

Source	Parameter	Test Date
EU-FBSSI Exhaust	• Oxygen (O_2)	November 21, 2013
	Carbon monoxide (CO)	
	Mercury (Hg)	

1.2 Purpose of Testing

The purpose of the testing was to evaluate compliance with YCUA's Permit to Install 68-02A, issued November 21, 2007, 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 eight 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 bed (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 Identifica
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 stack (SV-001) exhaust where emission testing was performed. Figure 1-3 is a photograph of the EU-FBSSI exhaust sampling location.

Figure 1-1. EU-FBSSI Schematic 1

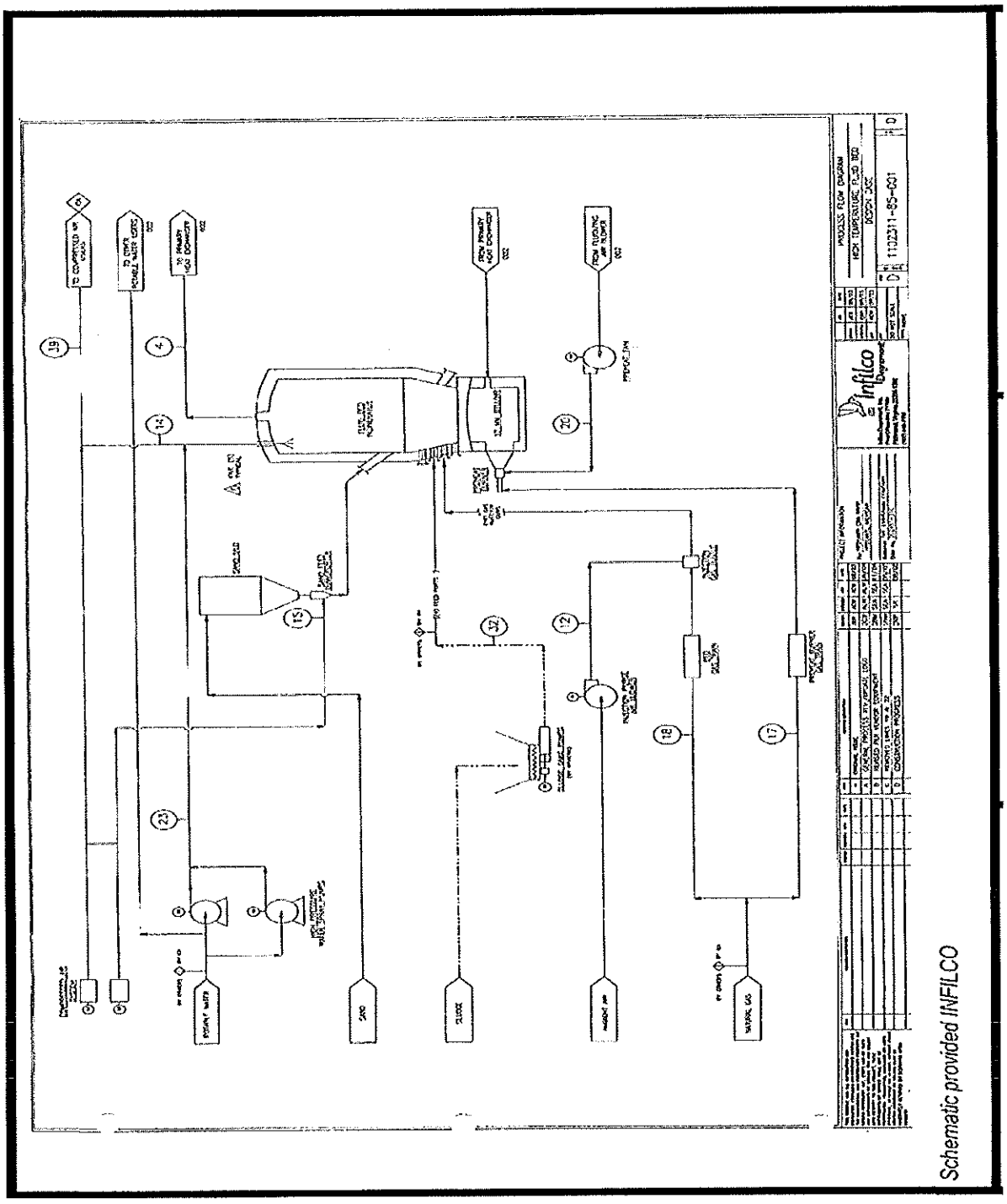


Figure 1-2. EU-FBSSI Schematic 2

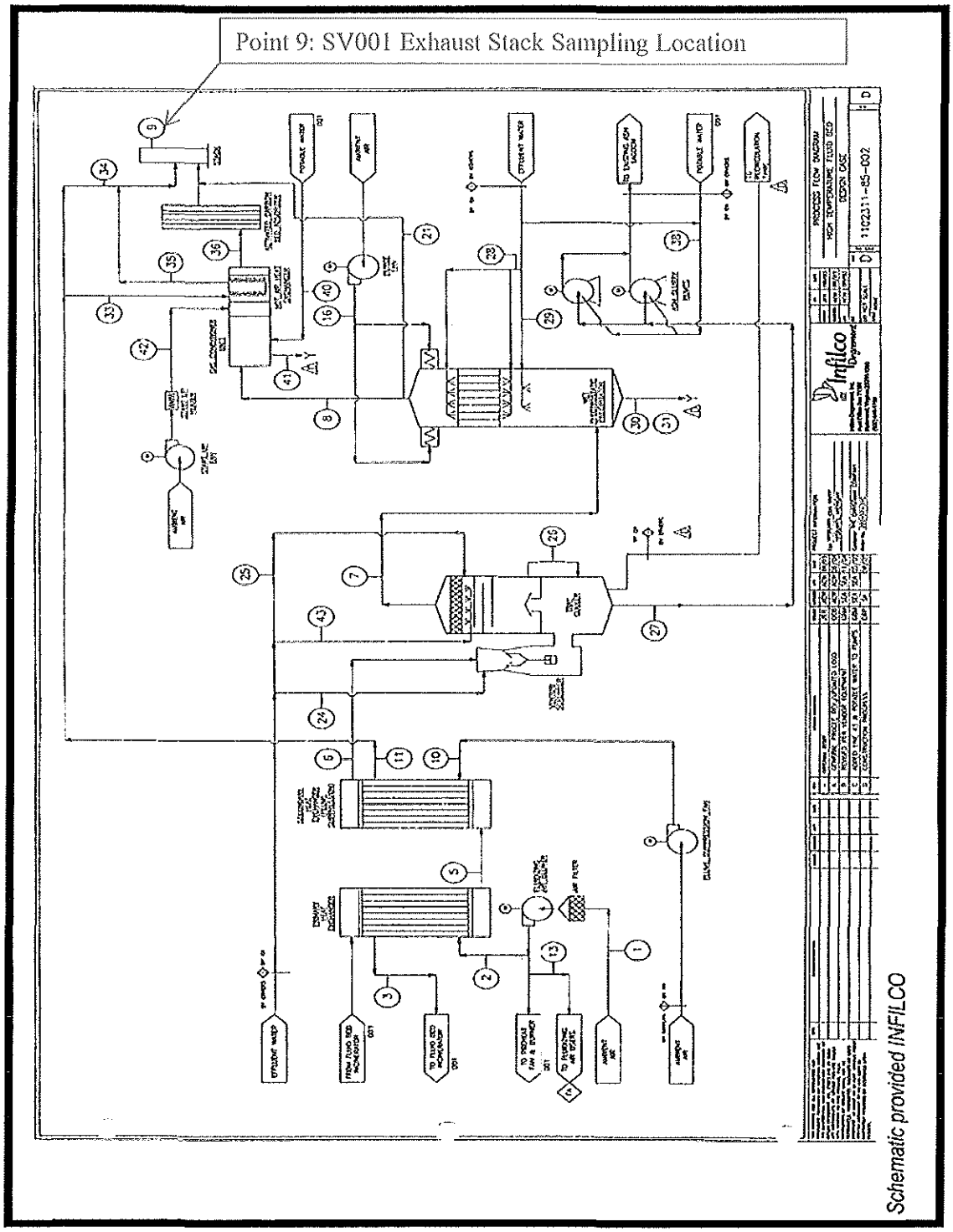
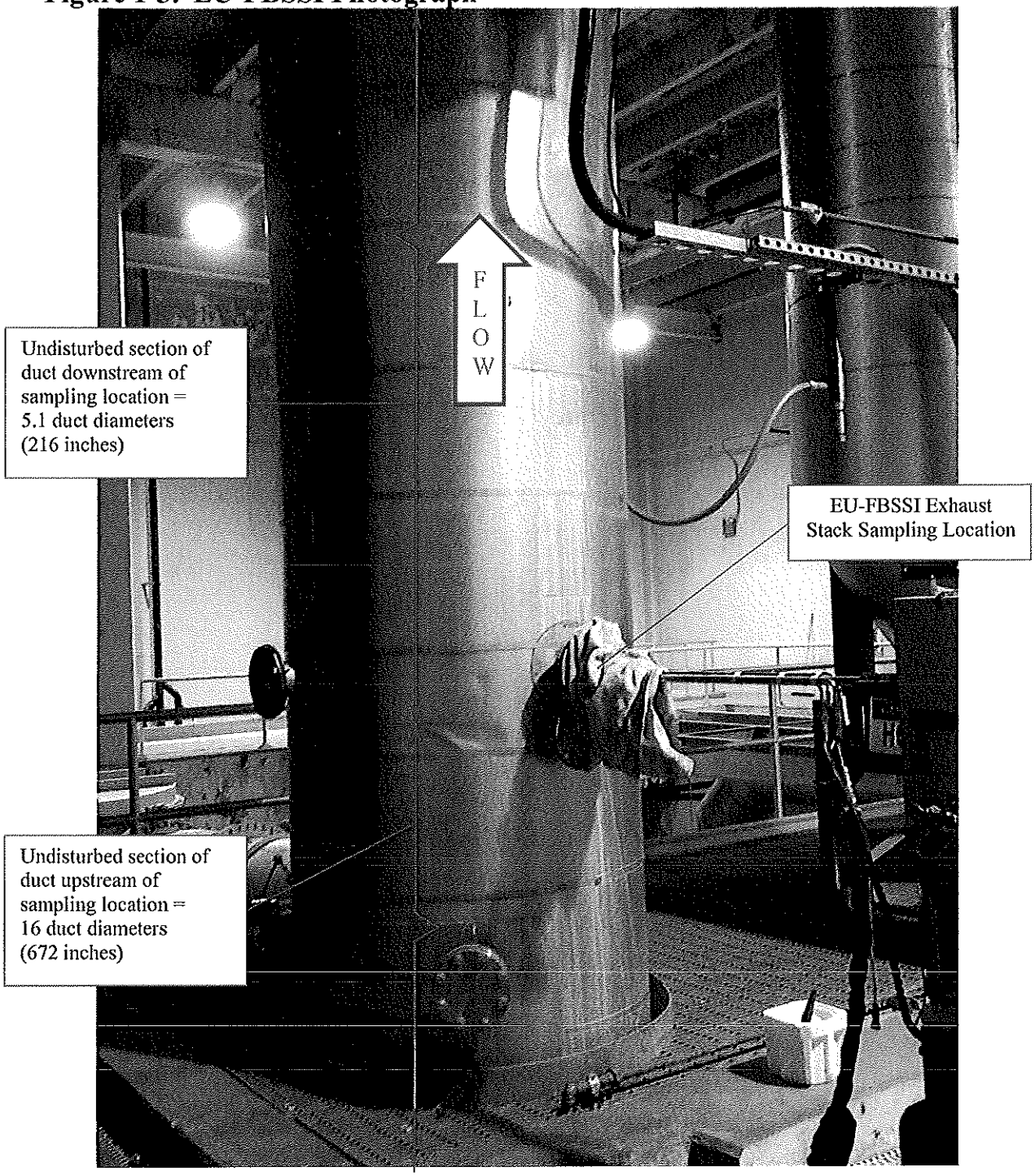


Figure 1-3. EU-FBSSI Photograph



1.4 Contact Information

Mr. Thomas Schmelter, Senior Project Manager with Bureau Veritas, directed the compliance testing event with the assistance of Messrs. Brian Young and Dillon King, both with Bureau Veritas. Mr. Perry M. Thomas with YCUA provided process coordination during the test program. Mr. Nathan Hude with MDEQ witnessed the test program. Contact information for these individuals is listed on the following page.

Table 1-3
Contact Personnel

Facility Contact	Emission Testing Project Manager
Perry M. Thomas Chief Compliance Officer **Ypsilanti Community Utilities Authority** 2777 State Road Ypsilanti, Michigan 28198-9112 Telephone: 734.484.4600 x 121 Facsimile: 734.544.7149, 734.484.7344 pthomas@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
Regulatory Agency	
Nathan Hude **Michigan Department of Environmental Quality** Air Quality Division – Technical Programs Unit Constitution Hall, 2nd Floor South Tower 525 West Allegan Street Lansing, Michigan 48933-1502 Telephone: 517. 284.6779 Facsimile: 517.335.3122 huden@michigan.gov	

2.0 Summary of Results

2.1 Operating Data

YCUA personnel recorded operating parameters during the emissions testing. Mr. Hude of MDEQ verified that 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 Permit to Install No. 68-02A, issued November 21, 2007, for the EU-FBSSI emission equipment. Figure 2-1 depicts the Permit cover page.

Figure 2-1. Applicable Permit

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

November 21, 2007

PERMIT TO INSTALL
68-02A

ISSUED TO
Ypsilanti Community Utilities Authority

LOCATED AT
2777 State Street
Ypsilanti, Michigan

IN THE COUNTY OF
Washtenaw

STATE REGISTRATION NUMBER
B6237

2.3 Comparison to Emission Regulations

The average measured concentrations and emission rates are compared to the applicable emission limits in Table 2-1. Detailed results are presented in Tables 1 and 2 after the Tables Tab of this report. Graphs of the O_2 and CO concentrations are presented after the Graphs Tab of this report. Sample calculations are presented in Appendix B.

Table 2-1
Comparison of FBSSI Emissions to Permit Limits

Pollutant	Units	Average Result	EU-FBSSI Permit Limit
Carbon Monoxide	mg/dscm corrected to 7% O_2	44.4	†
	ppmvd corrected to 7% O_2	39.1	100
	lb/dry ton corrected to 7% O_2	1.0	†
	lb/dry ton	1.0	†
Mercury	mg/dscm corrected to 7% O_2	7.9×10^{-03}	†
	ppmvd corrected to 7% O_2	6.2×10^{-03}	†
	lb/dry ton corrected to 7% O_2	1.7×10^{-04}	†
	lb/dry ton	1.7×10^{-04}	6.9E-04
† No permit limit. Parameter 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 is controlled by four pollution control devices: a scrubber, impingement tray, electrostatic precipitator, and carbon bed; the final discharge to the atmosphere is from Stack SV-001. Bureau Veritas performed compliance emissions testing at the stack.

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 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 completely 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 the gas velocity increase 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 in the gas stream. The absorber removes mercury 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 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 6,930 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 and submitted it to a laboratory 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	5.1	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	52	450
Mercury	mg/kg dry sewage sludge	0.32	3.7
mg/kg = milligram/kilogram			

The sewage sludge sample results indicate compliance with metal content permit limits. 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 6,000 dry tons of biosolids sludge per year.

As required under Section 1.5 of the permit, no more than 6,930 pounds of dry sewage per hour are to be incinerated on a 24-hour basis. The permitted capacity of the FBSSI is 6,930 dry pounds of solids per hour.

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 beltpress transfer efficiency of 80% 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 2.2 dry tons per hour or 4,480 dry pounds of solids per hour. Typically YCUA operates the 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. Mr. Hude of MDEQ was 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
3 and 3A	Oxygen (O_2), carbon dioxide (CO_2), molecular weight	Fyrite® chemical absorption and paramagnetic gas analyzers
4	Moisture content	Gravimetric
10	Carbon monoxide (CO)	Non-dispersive infrared
29	Mercury (Hg)	Cold-vapor atomic absorption spectrophotometry

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 Methods 1, "Sample and Velocity Traverses for Stationary Sources" and 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. The velocity sampling location and number of velocity traverse points are presented in the following table:

Table 4-2
Sampling Location and Number of Traverse Points

Sampling Locations	Duct Diameter (inches)	Upstream Distance from Flow Disturbance (diameters)	Downstream Distance from Flow Disturbances (diameters)	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 depicting the sampling and traverse point locations.

USEPA 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, calibrated in accordance with USEPA Method 2, Section 10.0, 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 10.1, and were within the specified limits, the baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned. Appendix A includes calibration and inspection sheets.

Cyclonic Flow Check. Bureau Veritas previously evaluated whether cyclonic flow was present at the sampling EU-FBSSI location in the SV-001 stack. 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 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 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.

4.1.2 Molecular Weight (USEPA Methods 3)

Molecular weight measured using Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." Grab samples of flue gas were extracted from the stack through a probe positioned near the centroid of the duct and directed into a Fyrite® gas analyzer. The

concentration of carbon dioxide (CO_2) was measured by chemical absorption with a Fyrite® gas analyzer to within ±0.5%. The average CO_2 result of the grab samples were used to calculate molecular weight.

4.1.3 Oxygen and Carbon Monoxide (USEPA Methods 3A and 10)

USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrument Analyzer Procedure)," was followed to measure the oxygen concentration of the flue gas to correct the results to 7% oxygen. Carbon monoxide concentrations were measured following USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources." Figure 2 depicts the USEPA Methods 3A and 10 sampling train.

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

- A stainless-steel probe.
- Heated 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 and carbon monoxide gas analyzers.

The flue gas was extracted and continuously introduced into the paramagnetic (O_2) and infrared (CO) gas analyzers to measure pollutant concentrations. Data were recorded at 1-second intervals on a computer equipped with data acquisition software and reported as 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 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 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 is included in Appendix A.

4.1.4 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 Method 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 Method 29.

4.1.5 Mercury (USEPA Method 29)

USEPA Method 29, "Determination of Metals Emissions from Stationary Sources," was used to measure mercury emissions Figure 3 depicts the USEPA Method 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 GS impingers situated in a chilled ice bath with the configuration shown in Table 4-3.
- A length of sample 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 a nozzle size was calculated that would allow 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 measured with calipers across three cross-sectional chords to evaluate the inside diameter; rinsed and brushed with acetone, nitric acid, and water; and connected to the borosilicate glass-lined sample probe. Refer to Appendix A for the nozzle diameter measurement sheet.

Table 4-3
USEPA Method 29 Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Amount of Contents
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 grams

The impact and static pressure openings of the Pitot tube were leak-checked at or above a velocity 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 then monitored for approximately 1-minute to measure that the sample train leak rate was less than 0.02 cfm. The sample probe was then inserted into the sampling port to begin sampling.

Ice 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 within ±10 % for the duration of the test. Each of the traverse points were sampled at 5-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 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 were brushed and, at a minimum, triple-rinsed with acetone to recover particulate matter. The acetone rinses were collected in pre-cleaned sample containers.

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 a total of 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 and then acetone. The HPLC water and acetone rinses were discarded.

The mass collected in each impinger was measured using an electronic scale to within ±0.5 gram; the impinger mass and the mass of water collected by the silica gel were used to calculate the moisture content of the flue gas. The contents of Impingers 1 and 2 were transferred to a glass sample container. 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 placed.

The mass of the contents of Impinger 3 was measured and 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 mass of liquid in Impingers 4 and 5 were measured and the contents were transferred to a glass sample container. The impingers and connecting glassware were then triple-rinsed with acidified $KMnO_4$ solution and the rinsate was added to the Impinger 4 and 5 sample container. Subsequently, these impingers were rinsed with 100 ml of HPLC water, and the rinsate was added to the sample container. Because deposits were still visible on the impinger surfaces after the water rinse, 25 ml of 8-N hydrochloric acid (HCl) were 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 to measure the moisture content. The 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 shipped to a laboratory in Mississauga, Ontario, Canada, for analysis. Refer to Appendix E for the Method 29 analytical results.

4.2 Recovery and Analytical Procedures

USEPA Methods 4 and 29 recovery and analytical procedures were applicable to this test program. These recovery procedures are described in Section 4.1. Applicable Chain of Custody procedures followed guidelines outlined within ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sampling 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 the outside of the sample containers to identify if leakage occurred prior to receipt of the samples by 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 transported to the laboratory under chain of custody.
- Chains of custody and laboratory analytical results are included in Appendix E.

The sample recovery procedures for these methods are outlined above.

4.3 Cross-Sectional View

Figure 1 provides a cross-sectional view of the EU-FBSSI sampling location with the sampling ports and the 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.

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

No sampling variations or deviations on operating conditions were encountered during this test program.

5.4 Upset Conditions

No upset conditions were encountered during this test program.

5.5 Air Pollution Control Device Maintenance

The YUCA facility has been in operation since 1982; however the FBSSI was installed in 2003. No significant air pollution control device maintenance has occurred since the FBSSI was installed.

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 Identification	Analyte	Units	Maxxam Analytics Reported Value	ERA Assigned Value	Difference	Acceptable Limits	Performance Evaluation
111413M	Mercury	ng/mL	26.2	25.1	1.1	18.8 to 31.4	Acceptable
111413N	Mercury	ng/mL	181.3	170	11.3	128 to 212	Acceptable

5.7 Calibration and Inspection Sheets

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

The information and opinions rendered in this report are exclusively for use by Ypsilanti Community Utilities Authority. Bureau Veritas North America, Inc. will not distribute or publish this report without Ypsilanti Community Utilities Authority's consent except as required by law or court order. The information and opinions are given in response to a limited assignment and should be implemented only in light of that assignment. Bureau Veritas North America, Inc. accepts responsibility for the competent performance of its duties in executing the assignment and preparing reports in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

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January 16, 2014

Tables

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Table 1
EU-FBSSI O_2 and CO Emissions Results
Ypsilanti Community Utilities Authority
Ypsilanti, Michigan
Bureau Veritas Project No. 11013-000234.00
Sampling Date: November 21, 2013

Parameter	Run 1	Run 2	Run 3	Average
Sample Start Time	9:20	11:45	13:35	
Test Duration (min)	60	60	60	60
Ton of dry sewage sludge (dry ton/hr)	2.3	2.1	2.4	2.2
EU-FBSSI Exhaust Gas Stream Volumetric Flowrate (dscfm)*	**12,963**	**13,134**	**12,902**	**13,000**
EU-FBSSI O_2 Concentration (C_{Avg}, %)	6.9	6.9	6.8	6.9
Pre-test system calibration, zero gas (C_O)	-0.1	-0.1	-0.1	-0.1
Post-test system calibration, zero gas (C_O)	-0.1	-0.1	-0.1	-0.1
Certified low bracket gas concentration (C_{MA})	11.0	11.0	11.0	11.0
Pre-test system calibration, low bracket gas (C_M)	10.8	10.8	10.7	10.8
Post-test system calibration, low bracket gas (C_M)	10.8	10.7	10.7	10.7
EU-FBSSI Average Corrected O_2 Concentration (C_{Gas}, %)	**7.1**	**7.2**	**7.0**	**7.1**
EU-FBSSI CO Concentration (C_{Avg}, ppmvd)	42.4	37.1	34.3	37.9
Pre-test system calibration, zero gas (C_O)	0.5	-0.9	-1.0	-0.5
Post-test system calibration, zero gas (C_O)	-0.1	-1.0	-1.6	-0.9
Certified low bracket gas concentration (C_{MA})	26.0	45.2	45.2	38.8
Pre-test system calibration, low bracket gas (C_M)	25.7	44.2	44.2	38.0
Post-test system calibration, low bracket gas (C_M)	25.3	44.2	44.4	38.0
EU-FBSSI Average Corrected CO Concentration (C_{Gas}, ppmvd)	**43.3**	**38.1**	**35.2**	**38.9**
EU-FBSSI CO Concentration (mg/dscm)	**49.4**	**43.2**	**39.9**	**44.2**
EU-FBSSI CO Concentration (mg/dscm, @ 7% O_2)	**49.7**	**43.7**	**40.0**	**44.4**
EU-FBSSI CO Concentration (ppmvd, @ 7% O_2)	**43.6**	**38.5**	**35.3**	**39.1**
EU-FBSSI CO Emission Rate (lb/hr)	**2.5**	**2.2**	**2.0**	**2.2**
EU-FBSSI CO Emission Rate (lb/hr, @ 7% O_2)	**2.4**	**2.2**	**1.9**	**2.2**
EU-FBSSI CO Emission Rate (lb/ton of dry sewage sludge)	**1.1**	**1.0**	**0.8**	**1.0**
EU-FBSSI CO Emission Rate (lb/ton of dry sewage sludge, @ 7% O_2)	**1.1**	**1.0**	**0.8**	**1.0**

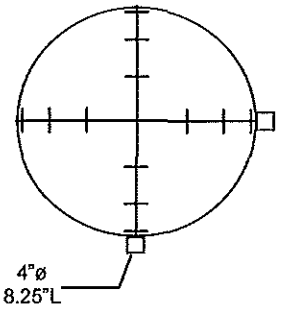
ppmvd = part per million by volume, dry basis
dscfm = dry standard cubic feet per minute
* = flowrate measured from Method 29 sampling train

Table 2 - EU-FBSSI Exhaust Mercury Results

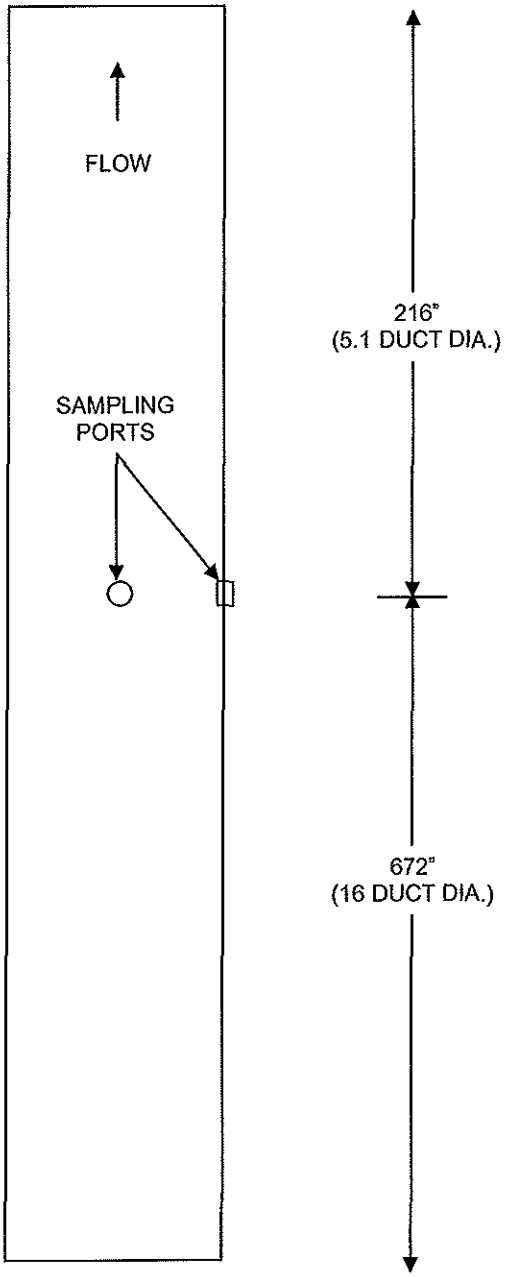
Facility		Ypsilanti Community Utilities Authority			
Source Designation		EU-FBSSI Exhaust			
Test Date		Nov 21, 2013	Nov 21, 2013	Nov 21, 2013	
Meter/Nozzle Information		**Run 1 - M29**	**Run 2 - M29**	**Run 3 - M29**	**Average**
Meter Temperature, T_m	°F	91	93	95	93
Meter Pressure, P_m	in Hg	30.38	30.38	30.38	30.38
Measured Sample Volume, V_m	ft^3	42.99	44.43	43.40	43.61
Sample Volume, V_m	std ft^3	42.02	43.28	42.16	42.49
Sample Volume, V_m	std m^3	1.19	1.23	1.19	1.20
Condensate Volume, V_w	std ft^3	1.90	2.08	1.81	1.93
Gas Density, ρ_s	std lb/ft^3	0.0778	0.0777	0.0779	0.0778
Total weight of sampled gas	lb	3.417	3.524	3.377	3.439
Nozzle Size, A_n	ft^2	0.0005309	0.0005309	0.0005309	0.0005309
Isokinetic Variation, I	%	98	100	99	99
Stack Data					
Average Stack Temperature, T_s	°F	138	135	133	135
Molecular Weight Stack Gas-dry, M_d	lb/lb-mole	30.51	30.50	30.52	30.51
Molecular Weight Stack Gas-wet, M_s	lb/lb-mole	29.97	29.92	30.01	29.96
Stack Gas Specific Gravity, G_s		1.03	1.03	1.04	1.03
Percent Moisture, B_{ws}	%	4.33	4.59	4.11	4.34
Water Vapor Volume (fraction)		0.043	0.046	0.041	0.043
Pressure, P_s	in Hg	30.26	30.26	30.26	30.26
Average Stack Velocity, V_s	ft/sec	26.29	26.57	25.86	26.24
Area of Stack	ft^2	9.62	9.62	9.62	9.62
Exhaust Gas Flowrate					
Flowrate	ft^3/min, actual	15,174	15,340	14,930	15,148
Flowrate	ft^3/min, standard wet	13,549	13,765	13,454	13,589
Flowrate	ft^3/min, standard dry	12,963	13,133	12,901	12,999
Flowrate	m^3/min, standard dry	367	372	365	368
Collected Mass					
Mercury (Hg)	mg	0.0095	0.0091	0.0098	0.0095
Concentration					
Mercury (Hg)	mg/dscf	2.3E-04	2.1E-04	2.3E-04	2.2E-04
Mercury (Hg)	mg/dscm @ 7% Oxygen	8.0E-03	7.5E-03	8.2E-03	7.9E-03
Mercury (Hg)	ppmvd @ 7% Oxygen	6.3E-03	5.9E-03	6.4E-03	6.2E-03
Mass Emission Rate					
Dry sewage sludge feedrate	ton/hr	2.3	2.1	2.4	2.2
Mercury (Hg)	lb/hr	3.9E-04	3.7E-04	4.0E-04	3.8E-04
Mercury (Hg)	lb/ton of dry sewage sludge	1.7E-04	1.7E-04	1.7E-04	1.7E-04
Mercury (Hg)	lb/ton of dry sewage sludge @ 7% O_2	1.7E-04	1.8E-04	1.7E-04	1.7E-04

Figures

42" INTERNAL DIAMETER



TRAVERSE POINT	DISTANCE FROM STACK WALL (INCHES)
1	1.848
2	6.132
3	12.432
4	29.568
5	35.868
6	40.152



	DISTANCE FROM PORTS TO NEAREST UPSTREAM BEND/ DISTURBANCE	DISTANCE FROM PORTS TO NEAREST DOWNSTREAM BEND/DISTURBANCE
EU-FBSSI Exhaust Stack	672 INCHES 16 DIAMETERS	216 INCHES 5.1 DIAMETERS

SCALE	NOT TO SCALE
DATE	DECEMBER 5, 2013
PRJ NO.	11013-000234.00

EU-FBSSI Exhaust
Sampling Ports and Traverse Point Locations
Ypsilanti Community Utilities Authority
Ypsilanti, Michigan

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FIGURE
1

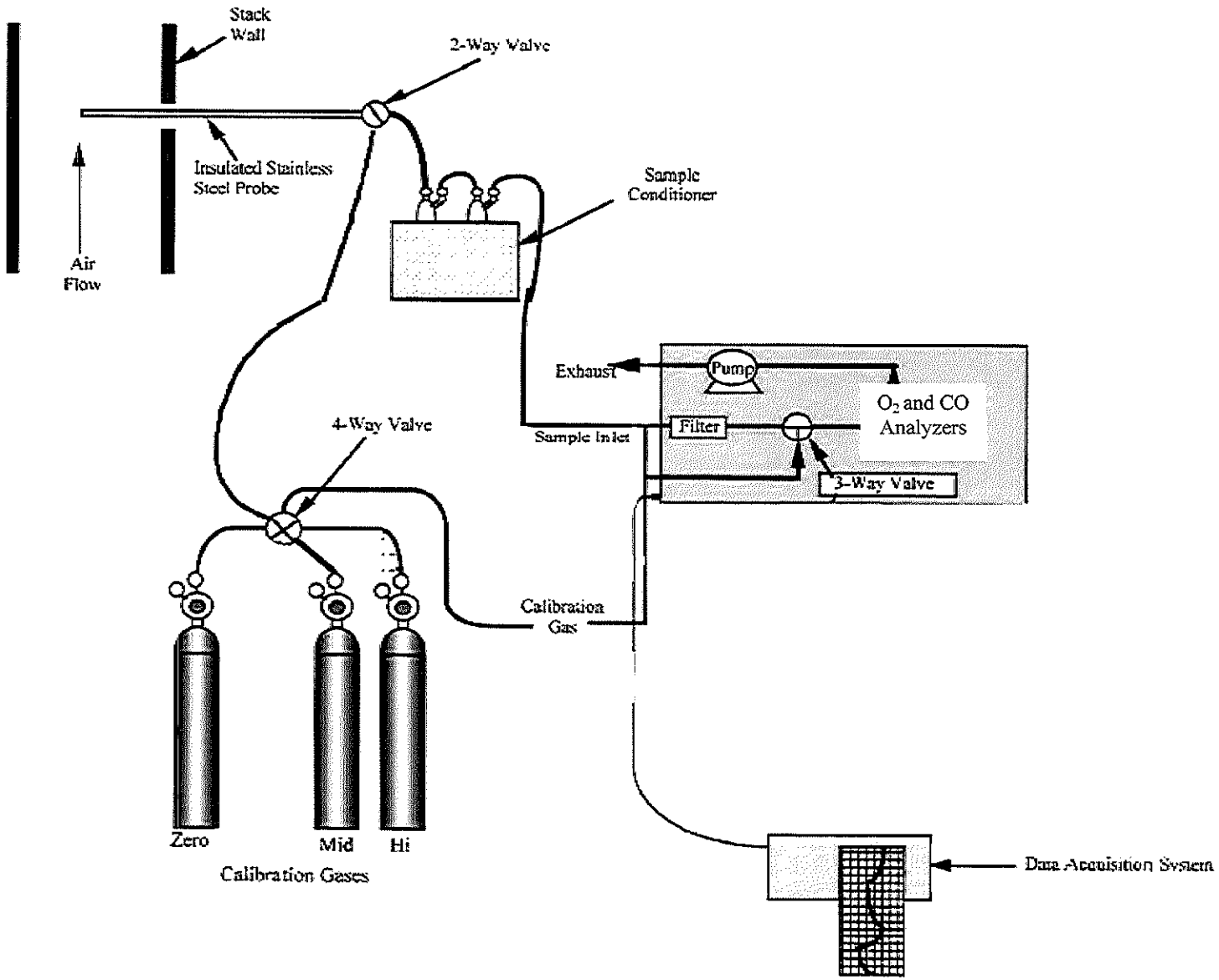

Figure 2
USEPA Methods 3A and 10
Sampling Train

BUREAU VERITAS

Ypsilanti Community Utilities Authority
Ypsilanti, Michigan

Project No. 11013-000234.00

Last Revision:
December 5, 2013

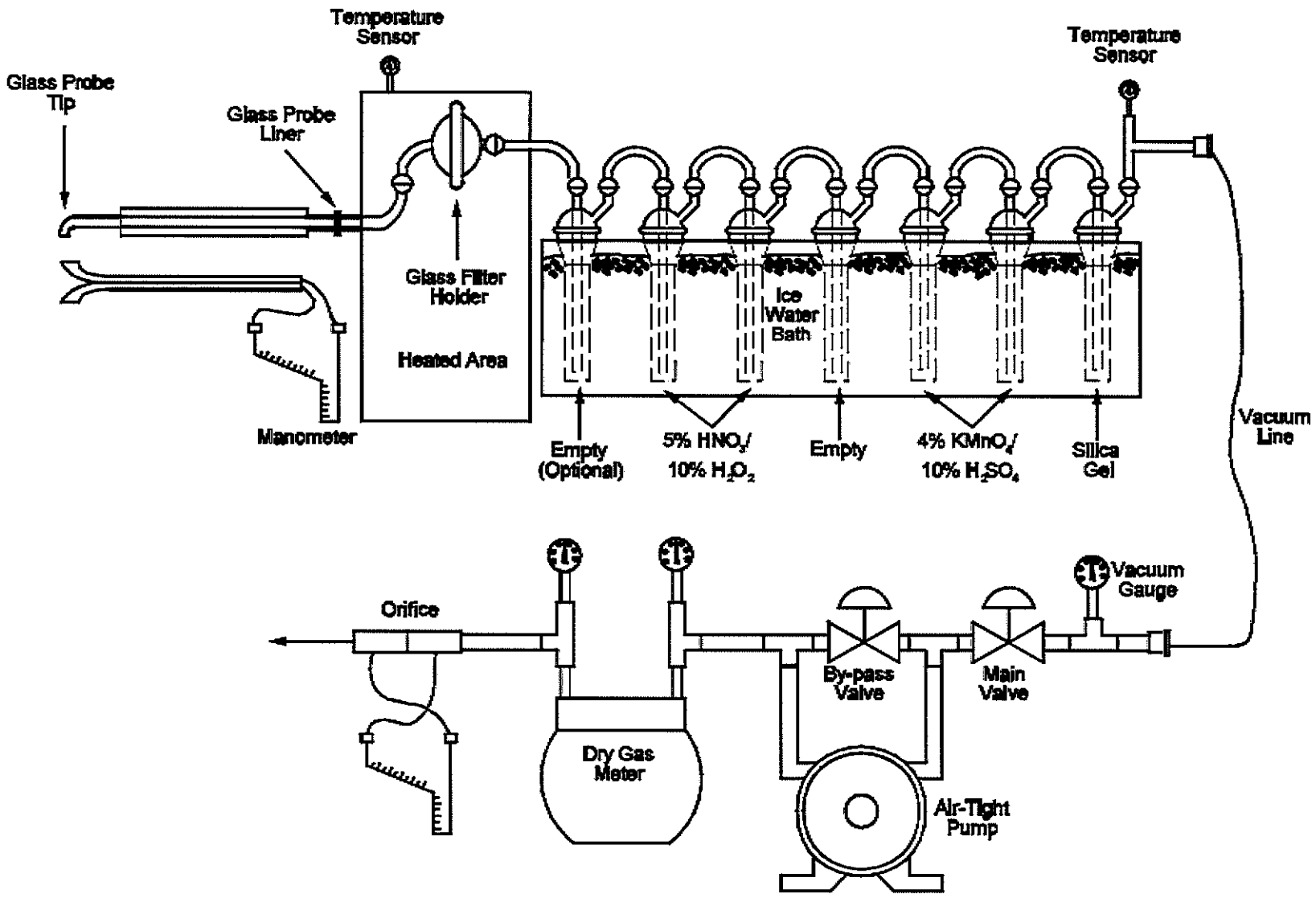

Figure 3
USEPA Method 29 Sampling Train

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Ypsilanti Community Utilities Authority
Ypsilanti, Michigan

Project No. 11013-000234.00

Last Revision:
December 5, 2013