Air Emission Testing of EUBOILER3

Lansing Board of Water & Light
Eckert Station
601 Island Avenue
Lansing, Michigan

State Registration No. B2647
MI-ROP-B2647-2012

Prepared for
Lansing Board of Water & Light
Lansing, Michigan

Bureau Veritas Project No. 11013-000258.00
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Executive Summary

Lansing Board of Water & Light (BWL) retained Bureau Veritas North America, Inc. to measure emissions of particulate matter (PM) for the EUBOILER3 source located at the BWL Eckert Station facility in Lansing, Michigan. The purpose of the testing was to evaluate compliance with the PM emission limit of 0.20 pounds per 1,000 pounds of exhaust gases, corrected to 50% excess air within Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2647-2012.

The testing was conducted on May 13, 2014, and followed United States Environmental Protection Agency (USEPA) Reference Methods outlined in 40 CFR 60, Appendix A: 1, 2, 3A, 4, and 5. Bureau Veritas measured emissions as summarized in the table below at high load conditions.

Summary of Emissions Testing

Parameter	EUBOILER3 High Load Condition	USEPA Reference Method
Gas flowrate†	•	1, 2, 3A, and 4
Oxygen (O_2) Carbon dioxide (CO_2)	•	3A
Particulate matter (PM)	•	5

† Gas flowrate procedures include measurement of sampling location, volumetric flowrate, molecular weight, and moisture content.

EUBOILER3 –High-Load Conditions. Three 60-minute test runs were conducted at the outlet of the EUBOILER3 stack during high-load conditions to measure PM emissions. The permit limit for particulate matter is 0.20 pounds per 1,000 pounds of exhaust gases, corrected to 50% excess air.

The results of the testing compared to the permit limits are summarized in the following table.

EUBOILER3 PM Emissions Results

Parameter	Units	Run 1	Run 2	Run 3	Average	Limit
PM	lb/1,000 lb exhaust gas at 50% EA	0.013	0.029	0.046	0.029	0.20

PM: Particulate matter
lb/1,000 lb exhaust gas at 50% EA: pound per 1,000 pounds of exhaust gases, corrected to 50% excess air

The average results of the particulate matter emission testing indicate that EUBOILER3 complied with the applicable permit limit of 0.20 pound per 1,000 pounds of exhaust gases, corrected to 50% excess air.

1.0 Introduction

Lansing Board of Water & Light (BWL) retained Bureau Veritas North America, Inc. to measure emissions of particulate matter (PM) for the EUBOILER3 source located at the BWL Eckert Station facility in Lansing, Michigan. The purpose of the testing was to evaluate compliance with the PM emission limit of 0.20 pound per 1,000 pounds of exhaust gases, corrected to 50% excess air within Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B2647-2012.

The testing was conducted on May 13, 2014, and followed United States Environmental Protection Agency (USEPA) Reference Methods outlined in 40 CFR 60, Appendix A: 1, 2, 3A, 4, and 5.

1.1 Summary of Test Program

BWL operates six boilers at its Eckert Station in Lansing, Michigan. The boilers are referred to as EUBOILER1, EUBOILER2, EUBOILER3, EUBOILER4, EUBOILER5, and EUBOILER6. Air emissions from the EUBOILER3 source were monitored during the high-load condition.

Testing consisted of three 60-minute test runs that were conducted at the outlet of the EUBOILER3 during the high-load condition. The permit limit for particulate matter is 0.20 pounds per 1,000 pounds of exhaust gases, corrected to 50% excess air.

1.2 Purpose of Testing

The purpose of the testing is to measure emissions of PM and evaluate compliance with the PM emission limit of 0.20 pounds per 1,000 pounds of exhaust gases, corrected to 50% excess air within MDEQ ROP MI-ROP-B2647-2012.

1.3 Contact Information

Contact information is listed in Table 1-1. Mr. Thomas Schmelter, Senior Project Manager with Bureau Veritas, led the emission testing program. Ms. Angie Goodman, Environmental Compliance Specialist with BWL, provided process coordination and arranged for facility operating parameters to be recorded. The testing was witnessed by Mr. David Patterson, Environmental Quality Analyst with the MDEQ.

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Table 1-1
Contact Persons

Permitee	Emission Testing Company
Lansing Board of Water & Light 1201 South Washington Avenue Lansing, Michigan 48910 Telephone 517.702.6000	Bureau Veritas North America, Inc. 22345 Roethel Drive Novi, Michigan 48375 Telephone 248.344.1770 Facsimile 248.344.2656
Angie Goodman Environmental Compliance Specialist Telephone 517.702.7059 ame1@LBWL.com	Thomas Schmelter, QSTI Senior Project Manager Telephone 248.344.3003 thomas.schmelter@us.bureauveritas.com
Michigan Department of Environmental Quality	
MDEQ – Air Quality Division Technical Programs Unit 525 West Allegan Street Lansing, Michigan 48909-7760 Telephone 517.335.3082 Facsimile 517.241.3571	
David Patterson Environmental Quality Analyst Telephone 517.284.6782 pattersond2@michigan.gov	

2.0 Source and Sampling Locations

2.1 Process Description

BWL operates six boilers at its Eckert Station in Lansing, Michigan. The boilers are referred to as EUBOILER1, EUBOILER2, EUBOILER3, EUBOILER4, EUBOILER5, and EUBOILER6.

EUBOILER3 is a Combustion Engineering pulverized coal-fired boiler, which uses No. 2 fuel oil for startup and flame stabilization. The boiler is rated at 522 MMBtu/hr and equipped with low-nitrogen-oxide-(NO_x) burners and overfire air. Particulate matter emissions are controlled by two electrostatic precipitators. The steam generated by the boiler is used for electrical power generation and to provide backup steam for sale to customers for building heating, cooling, and process operations. The basic processing steps for steam and electrical production are presented below:

- Bituminous coal is conveyed from storage to coal bunkers.
- Pulverized coal and air are introduced into the boiler furnace and combusted to generate heat.
- The coal combustion heats water wall tubes and the steam drum. The steam drum captures steam and directs it to a header pipe where the steam is used to rotate a turbine for power generation or is distributed to the service area.
- Flue gas from the furnace is exhausted through an electrostatic precipitator (ESP) prior to discharge to the atmosphere.

2.2 Control Equipment

As part of the steam and electrical production process, emissions are generated from coal and No. 2 fuel oil combustion. BWL operates pollution control equipment to control the discharge of pollutants to the atmosphere. The EUBOILER3 incorporates the use of low NO_x burners, overfire air, and electrostatic precipitators to control air emissions.

The low-NO_x burners installed in EUBOILER3 reduces NO_x emissions. Low-NO_x burners reduce emissions by staging the combustion process, which delays ignition and results in a lower combustion temperature. The lower combustion temperature reduces thermal NO_x formation.

Overfire air involves diverting a portion of the combustion air from the primary combustion zone. Because the off-stoichiometric air-to-fuel ratio results in a lower combustion temperature, thermal NO_x formation is reduced in the primary oxidization zone. Non-combusted fuel from the primary zone is oxidized in the overfire air. The staged combustion provides more complete combustion of the fuel at lower temperatures.

The ESPs are designed to remove particulate matter from the flue gas prior to discharge to the atmosphere. The ESPs are powered by high-voltage transformers and solid state rectifiers with spark attenuation. As particles enter an ESP, a negative charge is imparted on them. The negatively charged particles migrate towards grounded collector plates having a positive charge. As the particles collect on the plates, a dust layer is created. The accumulated dust layer is removed by rapping the plates. The ESPs have variable intensity controls for the collecting plate rappers and discharge electrode vibrators.

2.3 Flue Gas Sampling Location

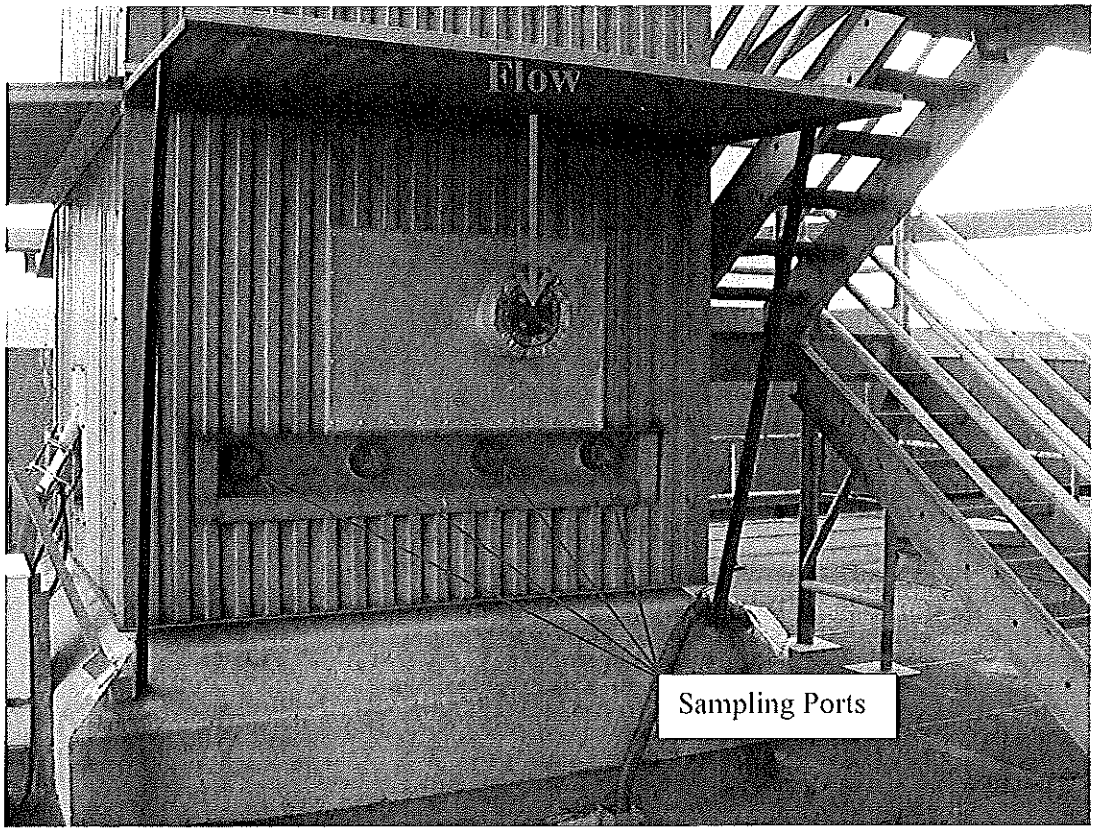
The EUBOILER3 exhausts to atmosphere through stack SVSTACK3. At the sampling location, the ports are positioned within 72-inch-wide by 90-inch-deep rectangular ductwork:

- Approximately 180 inches (2.25 duct diameters) from the nearest upstream disturbance, a bend in the ductwork.
- Approximately 180 inches (2.25 duct diameters) from the nearest downstream disturbance (i.e., duct confluence).

The ports are accessible by elevator to the 10th floor of the building and stairs to the sampling location.

Figure 1 in the Appendix depicts the EUBOILER3 sampling port and traverse point locations. Figure 2-1 is a photograph of the EUBOILER3 sampling location.

Figure 2-1. EUBOILER3 Sampling Location



3.0 Summary and Discussion of Results

3.1 Objectives

The testing was performed to evaluate compliance with certain limits of the facility's Renewable Operating Permit MDEQ ROP MI-ROP-B2647-2012, effective May 17, 2012. The specific objectives are to:

- Measure particulate matter emissions at high load conditions from the EUBOILER3 source to evaluate compliance with the particulate matter permit limit. The permit limit for particulate matter is 0.20 pounds per 1,000 pounds of exhaust gases, corrected to 50% excess air.

3.2 Test Matrix

The emission testing was conducted to evaluate the objectives in Section 3.1. Table 3-1 presents the sampling and analytical test matrix.

Table 3-1
Test Matrix

Date (2014)	Source	Condition	Sample / Type of Pollutant	USEPA Sampling Method	Run	Sampling Time†	Test Duration (min)
May 13	EUBOILER3	High Load	PM	1, 2, 3A, 4, 5	1 2 3	7:45-8:55 9:20-10:33 11:00-12:09	60

† Times are for particulate matter emission measurements and include sampling port changes.

3.3 Field Test Changes and Issues

Field test changes were not required to complete the emission testing. Testing was paused during Run 2 from 9:35 to 9:41 to ensure the boiler was providing the minimum electricity output required. No other field test changes or issues were encountered.

3.4 Results

The results of the testing compared to the permit limits are summarized in Table 3-2. Detailed results are presented in Tables 1 and 2 after the Tables Tab of this report. Graphs of the oxygen (O_2) and carbon dioxide (CO_2) concentrations are presented after the Graphs Tab of this report. Sample calculations are presented in Appendix B.

Table 3-2
EUBOILER3 PM Emissions Results

Parameter	Units	Run 1	Run 2	Run 3	Average	Limit
PM	lb/1000 lb exhaust gas at 50% EA	0.013	0.029	0.046	0.029	0.20

PM: Particulate matter
lb/1000 lb exhaust gas at 50% EA: pound per 1,000 pounds of exhaust gases, corrected to 50% excess air

The average results of the particulate matter emission testing indicate that EUBOILER3 complied with the applicable permit limit of 0.20 pound per 1,000 pounds of exhaust gases, corrected to 50% excess air.

4.0 Sampling and Analytical Procedures

Bureau Veritas measured emissions in accordance with the procedures specified in 40 CFR 60, Appendix A, "Standards of Performance for New Stationary Sources," and State of Michigan Part 10 Rules, Intermittent Testing and Sampling." The sampling and analytical methods used during this test program are listed in the following table.

Table 4-1
Sampling and Analytical Test Methods

USEPA Sampling Method	Parameter	Analysis
1 and 2	Gas stream volumetric flowrate	Field measurement, S-type Pitot tube differential pressure
3A	Oxygen (O_2), carbon dioxide (CO_2), molecular weight	Paramagnetic and single wavelength infrared technology gas analyzers
4	Moisture content	Gravimetric
5	Particulate matter (PM)	Gravimetric

4.1 Test Methods

4.1.1 Flowrate (USEPA Methods 1 and 2)

Method 1, "Sample and Velocity Traverses for Stationary Sources," from 40 CFR 60, Appendix A, was used to evaluate the sampling location and the number of traverse points for sampling and the measurement of velocity profiles. Details of the sampling location and number of velocity traverse points are presented in the Table 4-2.

Table 4-2
Sampling Location and Number of Traverse Points

Sampling Locations	Equivalent Duct Diameter (inch)	Distance from Ports to Upstream Flow Disturbance (diameter)	Distance from Ports to Downstream Flow Disturbances (diameter)	Number of Ports	Traverse Points per Port	Total Points
EUBOILER3	80	2.25	2.25	4	6	24

Figure 1 in the Appendix depicts the EUBOILER3 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 tubes and thermocouple assembly, calibrated in accordance with Method 2, Section 10.0, was used during testing. The default S-Type Pitot tube coefficient of 0.84 (dimensionless) was used in flow rate calculations. Refer to Appendix A for the calibration and inspection sheets.

Cyclonic Flow Check. Bureau Veritas evaluated whether cyclonic flow was present at the sampling location. Cyclonic flow is defined as a flow condition with an average null angle greater than 20 degrees. 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 angles for EUBOILER3 indicated the absence of cyclonic flow at this sampling location. The average null angle was 5° measured on November 18, 2013.

4.1.2 O_2 and CO_2 Concentrations (USEPA Method 3A)

USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrument Analyzer Procedure)," was used to measure the oxygen (O_2) and carbon dioxide (CO_2) concentrations of the flue gas. The flue gas oxygen (O_2) concentration was measured in order to calculate an emission rate in pounds per 1,000 pounds of exhaust gases, corrected to 50% excess air.

Figure 2 depicts the USEPA Method 3A sampling train.

Sampling for O_2 and CO_2 consisted of extracting the flue gas from the stack through:

- A stainless-steel probe.
- Heated Teflon® sample line to prevent condensation.
- A chilled Teflon condenser with peristaltic pump to remove moisture from the sampled gas stream prior to entering the analyzer.
- A Teledyne® paramagnetic O_2 and CO_2 gas analyzer

Data were recorded at 1-second intervals on a computer equipped with data acquisition software. Recorded concentrations are reported in 1-minute averages over the duration of each test run and included in Appendix D Computer-Generated Data Sheets.

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 analyzers respond 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 response is within ±5% of the analyzer calibration span.

Prior to testing, a three-point stratification test was conducted with the sampling probe located along a traverse line passing through the stack cross section's centroid and at points corresponding to 17, 50, and 83% of the stack diameter. The stack gas was sampled for at least twice the response time. If the concentration at each traverse point differs from the mean for all traverse points by no more than ±0.3% of the mean concentration, the gas stream can be considered unstratified. Based on the measurements, the gas stream was considered to be unstratified and a single sampling point located near the centroid of the duct was used (all points had a percent difference less than 0.3%). The stratification test results are presented in Table 4-3.

Table 4-3
O_2 Three-Point Stratification Test Results

Point	Distance From Stack Wall (inch)	Average O_2 Concentration (%)†	Difference from Mean (%)†	% Difference from Mean
3	12.0	7.7	0.1	1.9%
2	36.0	7.8	0.04	0.6%
1	60.0	8.1	0.2	2.5%
	Mean	7.9	**All points < 0.3%**	

† Concentration expressed as a percentage (1% = 10,000 ppmv).

At the conclusion of the each test run, an additional system-bias check was performed to evaluate the analyzer drift from pre- and post-test system-bias checks. The acceptable analyzer drift tolerance is ±3% of the calibration span. The results of the pre- and post-test system bias checks were used to correct the measured pollutant concentrations for analyzer drift.

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)

The moisture content at the outlet of the flue gas was measured using USEPA Method 4, "Determination of Moisture Content in Stack Gases," in conjunction with the performance of USEPA Method 5.

4.1.4 Particulate Matter (USEPA Method 5)

USEPA Method 5, "Determination of Particulate Emissions from Stationary Sources," was used to measure the filterable "front-half" particulate matter emissions. The "front half" refers to the filterable particulate mass collected from the nozzle, probe, and filter. Triplicate 60-minute test runs were performed at the outlet of the EUBOILER3. Bureau Veritas' modular isokinetic stack sampling system consists of the following:

- A stainless steel button-hook nozzle.
- A heated (248±25°F) stainless steel 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 four pre-cleaned GS impingers with the configuration shown in Table 4-4.
- A sample line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-4
Method 5 Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Amount of Contents
1	Modified	Water	100 grams
2	Greenburg Smith	Water	100 grams
3	Modified	Empty	0 grams
4	Modified	Silica desiccant	~300 grams

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 cfm. Bureau Veritas selected a pre-cleaned stainless steel nozzle that had an inner diameter that approximates 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; and connected to the stainless steel-lined sample probe.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a velocity head of three 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 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. Data were recorded at each of the traverse points.

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 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.

At the end of a test run, the mass of liquid collected in each impinger was measured using a scale to within ±0.5 grams; these masses were used to calculate moisture content of the flue gas. The contents of the impinger train were discarded after the mass is measured.

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. Immediately after recovery, the sample containers were stored. Bureau Veritas personnel transported the samples to Bureau Veritas' laboratory in Novi, Michigan, for analysis. Figure 3 in the Appendix depicts the USEPA Method 5 sampling train.

4.2 Procedures for Obtaining Process Data

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

4.3 Sampling Identification and Custody

Sample identification and chain of custody procedures were applicable to the sampling methods used in this test program. Applicable 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) 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.

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

5.0 QA/QC Activities

Equipment used in this emissions test program passed quality assurance/quality control (QA/QC) procedures. Refer to Appendix A for equipment calibration 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 methods 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. Calibration and inspection sheets for dry-gas meters (DGM), thermocouples, nozzles, and Pitot tubes are presented in Appendix A.

5.2.1 Method 5 QA/QC Audits

The sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The Table 5-1 summarizes the Method 5 QA/QC audits conducted on each sampling train.

Table 5-1
Method 5 Sampling Train QA/QC Audits

Parameter	Run 1	Run 2	Run 3	Method Requirement	Comment
EUBOILER3					
Average velocity pressure head (in H_2O)	1.03	1.15	1.20	>0.05 in H_2O†	Valid
Sampling train leak check Post–test	0.000 ft^3 for 1 min at 5 in Hg	0.000 ft^3 for 1 min at 5 in Hg	0.000 ft^3 for 1 min at 5 in Hg	<0.020 ft^3 for 1 minute at ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1 to 2	2 to 3	1 to 3		

† Manometer capable of reading 0 to 10 in H_2O acceptable for measuring differential pressure head above 0.05 in H_2O

5.2.2 Isokinetic Sampling

Isokinetic sampling, which means collecting flue gas into the sampling nozzle at the velocity equal to that of the flue gas velocity, is a requirement of USEPA Method 5. Maintaining isokinetic sampling is important because under anisokinetic conditions, sample concentrations may be biased depending on the inertial effects of the particles.

When flue gas containing small and large particles are collected isokinetically, the small and large particle concentrations are consistent with the flue gas composition. However, in over-isokinetic conditions (200% high sampling flowrate into nozzle) the particulate matter concentrations are biased low, because a greater number of smaller, lighter particles and fewer larger, heavier particles will be collected compared to isokinetic conditions. Under-isokinetic sampling (50% low sampling flowrate into nozzle) will bias the results high because a greater number of larger, heavy particles will be collected.

The USEPA Method 5 isokinetic sampling rate for each test run is presented in Table 5-2.

Table 5-2
Summary of Isokinetic Sampling Rates

Source	Run	Actual % Isokinetic Sampling Rate	Allowable % Isokinetic Sampling Rate
EUBOILER3	1	102	100±10%
	2	103	
	3	101	

The isokinetic sampling rates were within the isokinetic requirement of 100±10% percent.

5.2.3 Instrument Analyzer QA/QC Audits

The instrument analyzer sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The analyzers passed the applicable calibration criteria. Calibration gas selection, error, bias, and drift checks are included in Appendix A.

5.2.4 Dry-Gas Meter QA/QC Audits

Table 5-3 summarizes the DGM calibration checks compared to the acceptable USEPA tolerance. Refer to Appendix A for complete DGM calibrations.

Table 5-3
Dry-Gas Meter Calibration QA/QC Audit

Meter Box	Pre-test DGM Calibration Factor (Y) (dimensionless)	Post-test DGM Calibration Check Value (Y_{qa}) (dimensionless)	Absolute Difference Between Pre- and Post-test DGM Calibrations	Acceptable Tolerance	Calibration Result
2	1.008 March 28, 2014	0.999 June 3, 2014	0.009	≤0.05	Valid

5.2.5 Thermocouple QA/QC Audits

Temperature measurements using thermocouples and digital pyrometers were compared to reference temperatures (i.e., ice water bath, boiling water) to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperatures within ±1.5% (i.e., the USEPA acceptance criterion) of the reference temperatures. Thermocouple and pyrometer calibration results are presented in the Appendix A.

5.3 QA/QC Blanks

Field blanks were analyzed for the constituent of interest. The results of the blanks are presented in Table 5-4. The blank results do not indicate significant contamination occurred in the field. Blank corrections were not applied.

Table 5-4
QA/QC Blanks

Sample Identification	Result (mg)	Comment
M5 Acetone Blank	<0.5	Reporting limit is 0.5 milligrams. Acetone blank corrections not applied.
M5 Filter Blank	<0.5	Reporting limit is 0.5 milligrams. Filter blank corrections not applied

5.4 QA/QC Problems

No QA/QC problems were encountered during this test program.

Limitations

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Tables

Table 1 - EUBOILER3 Oxygen and Carbon Dioxide Results
Lansing BWL Eckert Station Particulate Matter Testing

Lansing, Michigan

Bureau Veritas Project No. 11013-000258.00

Sampling Date: May 13, 2014

Parameter	Units	Run 1	Run 2	Run 3	Average
Sample Time	hr:min	7:45-8:55	9:20-10:33	11:00-12:09	
O_2 Concentration (C_{avg})	%	6.4	6.4	6.7	6.5
Pre-test system calibration, zero gas (C_O)	%	0.20	0.20	0.30	0.23
Post-test system calibration, zero gas (C_O)	%	0.20	0.30	0.20	0.23
Certified low bracket gas concentration (C_{MA})	%	11.0	11.0	11.0	11.0
Pre-test system calibration, low bracket gas (C_M)	%	11.0	10.9	10.9	10.9
Post-test system calibration, low bracket gas (C_M)	%	10.9	10.9	10.9	10.9
Average Corrected O_2 Concentration (C_{gas})†	%	**6.4**	**6.4**	**6.7**	**6.5**
CO_2 Concentration (C_{avg})	%	13.2	13.2	12.8	13.1
Pre-test system calibration, zero gas (C_O)	%	0.00	0.20	0.20	0.13
Post-test system calibration, zero gas (C_O)	%	0.20	0.20	0.10	0.17
Certified low bracket gas concentration (C_{MA})	%	11.0	11.0	11.0	11.0
Pre-test system calibration, low bracket gas (C_M)	%	10.9	10.9	10.9	10.9
Post-test system calibration, low bracket gas (C_M)	%	10.9	10.9	10.9	10.9
Average Corrected CO_2 Concentration (C_{gas})†	%	**13.3**	**13.3**	**12.9**	**13.2**

†: corrected for analyzer drift

C_O: average of the initial and final system calibration bias check responses from the low-level (or zero) calibration gas, ppmv

C_{MA}: actual concentration of the upscale calibration gas, ppmv

C_M: Average of initial and final system calibration bias check responses for the upscale calibration gas, ppmv

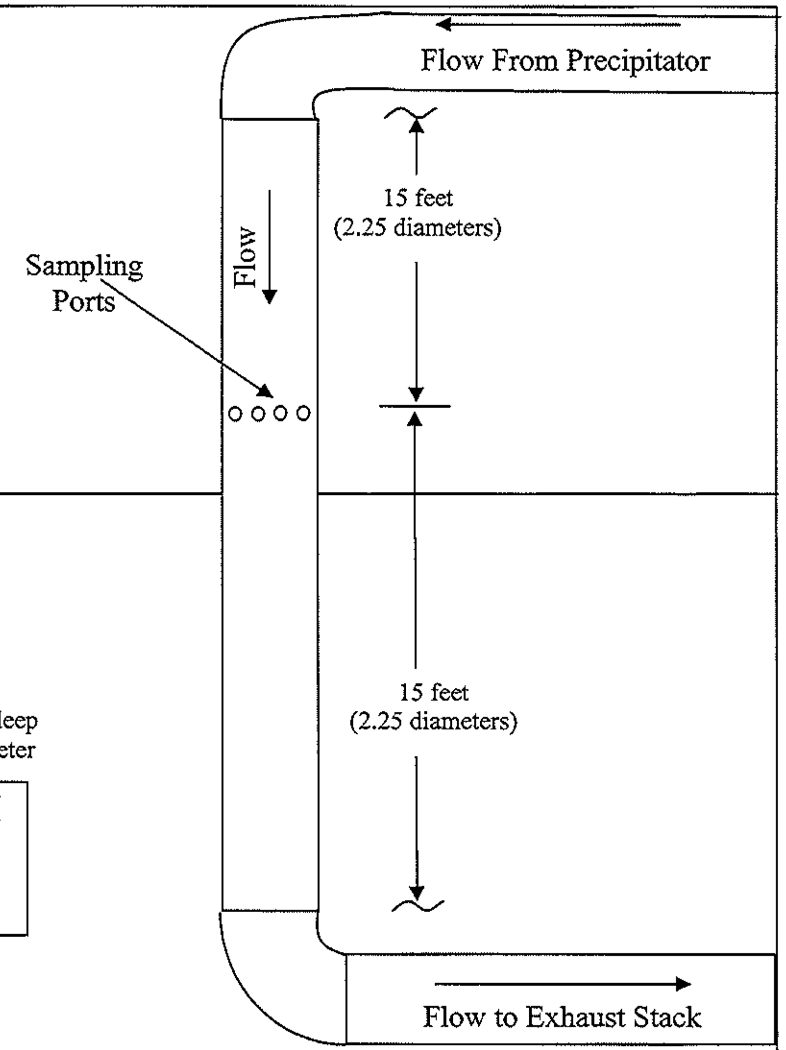
C_{gas}: Average effluent gas concentration adjusted for bias, ppmv

Table 2 - EUBOILER3 Particulate Matter Results

Facility		Lansing Board of Water and Light - Eckert Station			
Source Designation		EUBOILER3			
Test Date		May 13, 2014	May 13, 2014	May 13, 2014	
Meter/Nozzle Information		**Run 1**	**Run 2**	**Run 3**	**Average**
Meter Temperature, T_m	°F	79	84	88	84
Meter Pressure, P_m	in Hg	30.05	30.06	30.06	30.06
Measured Sample Volume, V_m	ft^3	45.74	48.23	48.50	47.49
Sample Volume, V_m	std ft^3	45.36	47.37	47.36	46.69
Sample Volume, V_m	std m^3	1.28	1.34	1.34	1.32
Condensate Volume, V_w	std ft^3	6.64	7.51	7.41	7.18
Gas Density, ρ_s	std lb/ft^3	0.0747	0.0745	0.0744	0.0745
Total weight of sampled gas	lb	3.887	4.086	3.624	3.866
Nozzle Size, A_n	ft^2	0.0003221	0.0003221	0.0003221	0.0003221
Isokinetic Variation, I	%	102	103	101	102
Stack Data					
Average Stack Temperature, T_s	°F	420	439	447	435
Molecular Weight Stack Gas-dry, M_d	lb/lb-mole	30.38	30.38	30.34	30.37
Molecular Weight Stack Gas-wet, M_s	lb/lb-mole	28.80	28.69	28.67	28.72
Stack Gas Specific Gravity, G_s		0.99	0.99	0.99	0.99
Percent Moisture, B_{ws}	%	12.77	13.68	13.53	13.32
Water Vapor Volume (fraction)		0.128	0.137	0.135	0.133
Pressure, P_s	in Hg	29.57	29.57	29.57	29.57
Average Stack Velocity, V_s	ft/sec	73.86	79.12	81.18	78.05
Area of Stack	ft^2	45.00	45.00	45.00	45.00
Exhaust Gas Flowrate					
Flowrate	ft^3/min, actual	199,421	213,622	219,180	210,741
Flowrate	ft^3/min, standard wet	118,283	123,941	126,149	122,791
Flowrate	ft^3/min, standard dry	103,180	106,988	109,086	106,418
Flowrate	m^3/min, standard dry	2,922	3,030	3,089	3,013
Collected Mass					
Particulate Matter Acetone Wash	mg	23	25	40	29
Particulate Matter Filter	mg	22	26	40	29
Total Filterable Particulate Matter (FPM)	mg	23	51	80	51
Concentration					
Particulate Matter (FPM)	mg/dscf	0.51	1.1	1.7	1.1
Particulate Matter (FPM)	grain/dscf	0.0078	0.017	0.026	0.017
Particulate Matter (FPM)	lb/1000 lb exhaust gas at 50% EA	0.013	0.029	0.046	0.029
Mass Emission Rate					
Particulate Matter (FPM)	lb/hr	6.9	15	24	16

Figures

	DISTANCE FROM PORTS TO NEAREST UPSTREAM BEND/ DISTURBANCE	DISTANCE FROM PORTS TO NEAREST DOWNSTREAM BEND/DISTURBANCE
Unit 3	~15 FEET (~2.25 DIAMETERS)	~15 FEET (~2.25 DIAMETERS)



TRAVERSE POINT	DISTANCE FROM STACK WALL (INCHES)
6	82.5
5	67.5
4	52.5
3	37.5
2	22.5
1	7.5

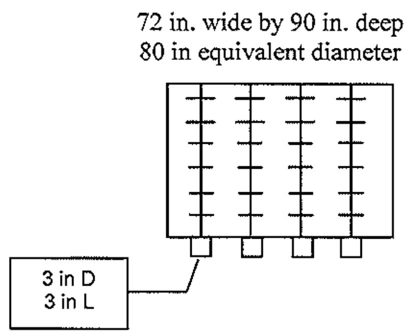


Figure 1
EUBOILER3 Sampling Ports and
Traverse Point Locations

BUREAU VERITAS

Lansing Board of Water & Light
Eckert Station
Lansing, Michigan

Project No. 11013-000258.00

Last Revision:
May 29, 2014

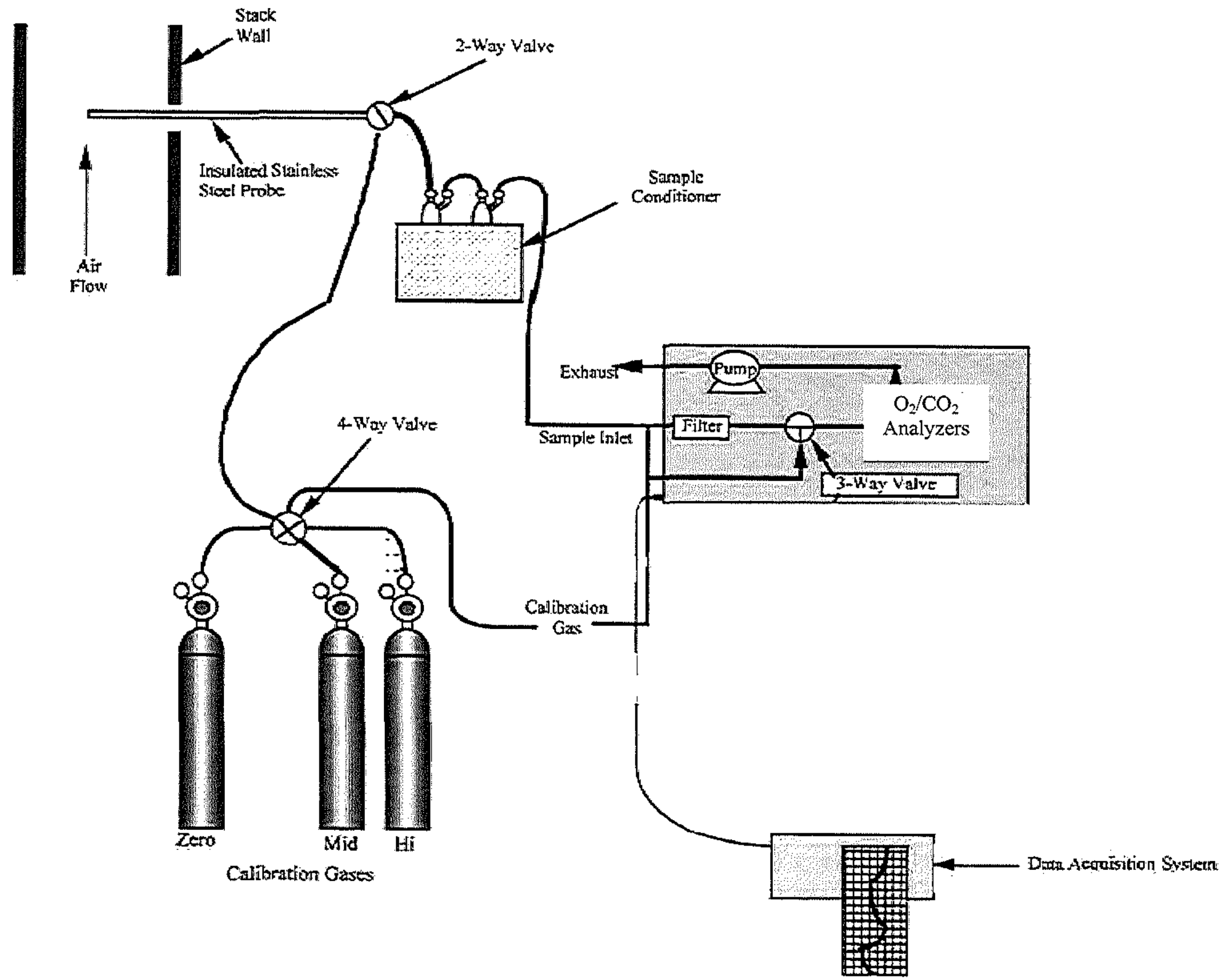


Figure 2 USEPA Method 3A Sampling Train	BUREAU VERITAS	Lansing Board of Water & Light Eckert Station Lansing, Michigan	
		Project No. 11013-000258.00	Last Revision: May 29, 2014

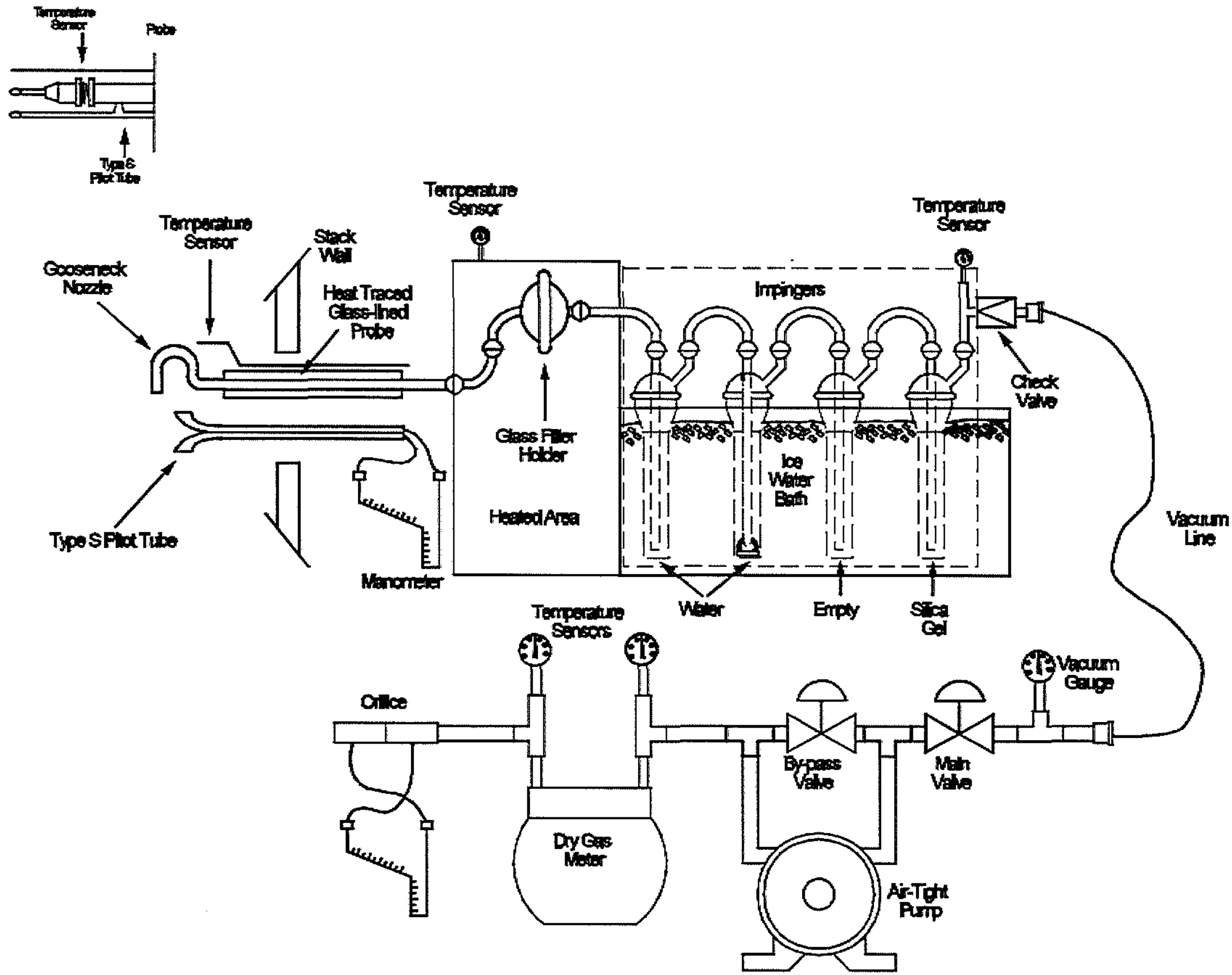


Figure 3
USEPA Method 5 Sampling Train

BUREAU VERITAS

Lansing Board of Water & Light
Eckert Station
Lansing, Michigan

Project No. 11013-000258.00

Last Revision:
May 29, 2014