Executive Summary

Genesee Power Station Limited Partnership (Genesee Power) retained Apex Companies, LLC (Apex) to conduct air emissions testing from one wood biomass boiler (EU-BOILER) at the Genesee Power facility in Flint, Michigan.

The purpose of the air emission testing was to evaluate compliance with certain emission limits in Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-N3570-2018, effective January 3, 2018.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1, 2, 3A, 4, 5, 18, 19, 25A, 26A, 29, 205, Occupational Safety and Health Administration (OSHA) Method 52, and National Institute for Occupational Safety and Health (NIOSH) Method 5506.

Detailed results are presented in Tables 1 through 6 after the Tables Tab of this report. The following tables summarize the results of the testing conducted on May 20 and 21, 2020.

EU-BOILER Emissions Results

Parameter	Unit	Average Result	Permit Limit
Particulate matter	lb/MMBtu	0.0033	0.03
	lb/hr	1.7	15.7
Mercury	lb/hr	0.00023	0.0047
	lb/MMBtu	4.5×10^{-7}	9×10^{-6}
Lead	lb/hr	0.00046	0.5
Chromium	lb/hr	0.0017	0.0864
Arsenic	lb/hr	0.00070	0.0265
Beryllium	lb/hr	<0.000017	0.006
Acrolein	lb/hr	<0.060	0.053
Benzo(a)pyrene	lb/hr	<0.0037	0.0053
Volatile organic compounds	lb/hr, as C	5.9	15.7
	lb/MMBtu, as C	0.011	0.03
Hydrogen chloride	lb/hr	3.8	47.1
	lb/MMBtu	0.0071	0.09

lb/MMBtu: pound per million British thermal unit
lb/hr: pound per hour

1.0 Introduction

1.1 Summary of Test Program

Genesee Power Station Limited Partnership (Genesee Power) retained Apex Companies, LLC (Apex) to conduct air emissions testing from one wood biomass boiler (EU-BOILER) at the Genesee Power facility in Flint, Michigan.

The purpose of the air emission testing was to evaluate compliance with certain emission limits in Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-N3570-2018, effective January 3, 2018.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1, 2, 3A, 4, 5, 18, 19, 25A, 26A, 29, 205, Occupational Safety and Health Administration (OSHA) Method 52, and National Institute for Occupational Safety and Health (NIOSH) Method 5506.

Table 1-1 lists the emission source tested, parameters, and test dates.

Table 1-1
Source, Parameters, and Test Dates

Source	Parameter	Test Date
EU-BOILER	Particulate matter (PM)	May 20, 2020
	Mercury (Hg)	May 20, 2020
	Lead (Pb)	May 20, 2020
	Chromium (Cr)	May 20, 2020
	Arsenic (As)	May 20, 2020
	Beryllium (Be)	May 20, 2020
	Acrolein	May 20, 2020
	Benzo(a)pyrene (BaP)	May 20 and 21, 2020
	Volatile organic compounds (VOC)	May 21, 2020
	Hydrogen chloride (HCl)	May 21, 2020

1.2 Key Personnel

The key personnel involved in this test program are listed in Table 1-2. Mr. David Kawasaki, Staff Consultant with Apex, led the emission testing program. Ms. Kathryn Cunningham, P.E. with CMS Enterprises, provided process coordination and recorded operating parameters. Mr. David Patterson and Ms. Julie Brunner, with EGLE, witnessed the testing and verified production parameters were recorded.

Table 1-2
Key Contact Information

<table>
<tr><th>Client</th><th>Apex</th></tr>
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</table>

2.0 **Source and Sampling Locations**

2.1 Process Description

Genesee Power operates a renewable energy power plant that can produce approximately 35 megawatts of electricity using (1) an ABB Combustion Engineering VU-40 traveling-grate-spreader-stoker boiler rated at 523 million British thermal units per hour (MMBtu/hr) and (2) an ABB single-flow condensing turbine coupled to an ABB synchronous generator unit. The power plant has been in operation since 1995 and is permitted to fire wood biomass, tire derived fuel (up to 20 tons per day), and natural gas for startup.

During testing, the boiler was fired with wood biomass and tire derived fuel. Based on fuel testing, firing wood biomass and tire derived fuel are the worst-case fuel for emissions.

The wood biomass is transported to Genesee Power via trucks and unloaded into the 7-acre wood yard using a truck tipper. The wood biomass is stored in piles that are rotated using front-end loaders to prevent decay, achieve uniform moisture content, and prevent pile fires. Once the wood has achieved the desired characteristics, front-end loaders load wood into a hopper that conveys the wood to the boiler feeders.

Wood is gravity-fed into the feeders and introduced into the boiler at injection points. As the wood and air enter the boiler, the wood rapidly ignites and is combusted, producing heat.

The heat generated increases the temperature of water-filled tubes inside the boiler and produces steam. The steam in the tubes rises and enters a boiler steam drum, where liquid water and vapor are separated. The liquid in the boiler drum is recycled into the boiler tubes for re-heating, while the steam from the drum is sent through tubes positioned in the location of the boiler with the highest temperature for superheating. The high-pressure, superheated steam rotates the turbines for a turbine-generator unit to generate electricity. After propelling the turning gear, the steam is (1) directed into the boiler or (2) passed through a condenser to be recaptured as liquid and recycled into the boiler.

The ash from the combustion of wood biomass falls to the bottom of the boiler onto a sloped grate. The sloped grate vibrates at set intervals to migrate the ash into a water trough. A screw conveyer moves the ash from the water trough into a storage bin; the ash is sold and/or recycled as fertilizer, concrete mix aggregate, or other applications.

The boiler combustion air (flue gas) that is used to heat the boiler tubes, the boiler drum, and superheater is ducted through an economizer, which pre-heats new boiler feed water that is continually added to the system. The flue gas is also used to pre-heat combustion air (blown in with the wood biomass) prior to being ducted into a mechanical multi-clone separator and electrostatic precipitator (ESP). Fly ash is then disposed of to a landfill.

Operating parameters were measured and recorded by Genesee Power personnel during testing. Table 2-1 summarizes the operating conditions during testing of EU-BOILER. Additional operating parameter data are included in Appendix F.

Table 2-1
Summary of EU-BOILER Operating Data

Parameter	Unit	Run 1	Run 2	Run 3	Average
Metals, Particulate Matter, Acrolein					
Steam Flow	kscf	282.3	282.8	282.7	**282.6**
Power	MW	35	35	35	**35**
Fuel (wood)	ton	76.42	74.22	73.20	**74.61**
Fuel (TDF)	ton	1.15	1.18	1.04	**1.12**
Benzo(a)pyrene (Runs 2, 3, and 4)					
Steam Flow	kscf	282.8	282.7	281.8	**282.4**
Power	MW	35	35	35	**35**
Fuel (wood)	ton	74.22	73.20	71.80	**73.07**
Fuel (TDF)	ton	1.18	1.04	0.84	**1.02**
Hydrogen Chloride, Volatile Organic Compounds					
Steam Flow	kscf	281.9	281.7	282.1	**281.9**
Power	MW	35	35	35	**35**
Fuel (wood)	ton	38.43	41.79	38.68	**39.63**
Fuel (TDF)	ton	0.49	0.49	0.46	**0.48**

2.2 Control Equipment Description

A selective non-catalytic reduction (SNCR) system is used to reduce nitrogen oxide emissions. The SNCR system injects a mist of blended urea and water into the upper sections of the boiler furnace to reduce nitrogen oxide emissions to nitrogen, carbon dioxide, and water. As the flue gas exits the furnace, particles are captured in a series of multi-cyclones.

Cyclones use centrifugal force to remove particles from the gas stream. Particles enter at a high velocity and travel along the cyclone body where the centrifugal force and gravity cause the particles to travel down tapered walls and into a hopper at the bottom. The treated gas exits a tube at the top of the cyclone. Multi-cyclones are used in series to improve particle collection efficiency. Additional particulate matter removal occurs in the ESP.

The ESP applies a voltage to generate an electrostatic charge on rows of vertically hung collection plates, which attract particulate matter in the flue. By removing the charge from the collection plates and using a series of plate rappers, the particulate matter is released from the plates and collected at the bottom of the ESP in a hopper. The collected fly ash is pneumatically conveyed to a storage bin; the ash is hauled to a landfill. After the air passes through the ESP it is ducted through an induced draft fan that exhaust the flue gas through a 94-inch-diameter, 220-foot-tall stack.

2.3 Flue Gas Sampling Location

Two sampling ports oriented at 90° to one another are located in a straight section of a 94 inch-internal-diameter duct. The sampling ports are located:

- Approximately 158 feet (20 duct diameters) from the nearest downstream disturbance.
- Approximately 48 feet (6 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible via ladder. A photograph of the EU-BOILER sampling location is presented in Figure 2-1. Figure 1 in the Appendix depicts the EU-BOILER sampling ports and traverse point locations.

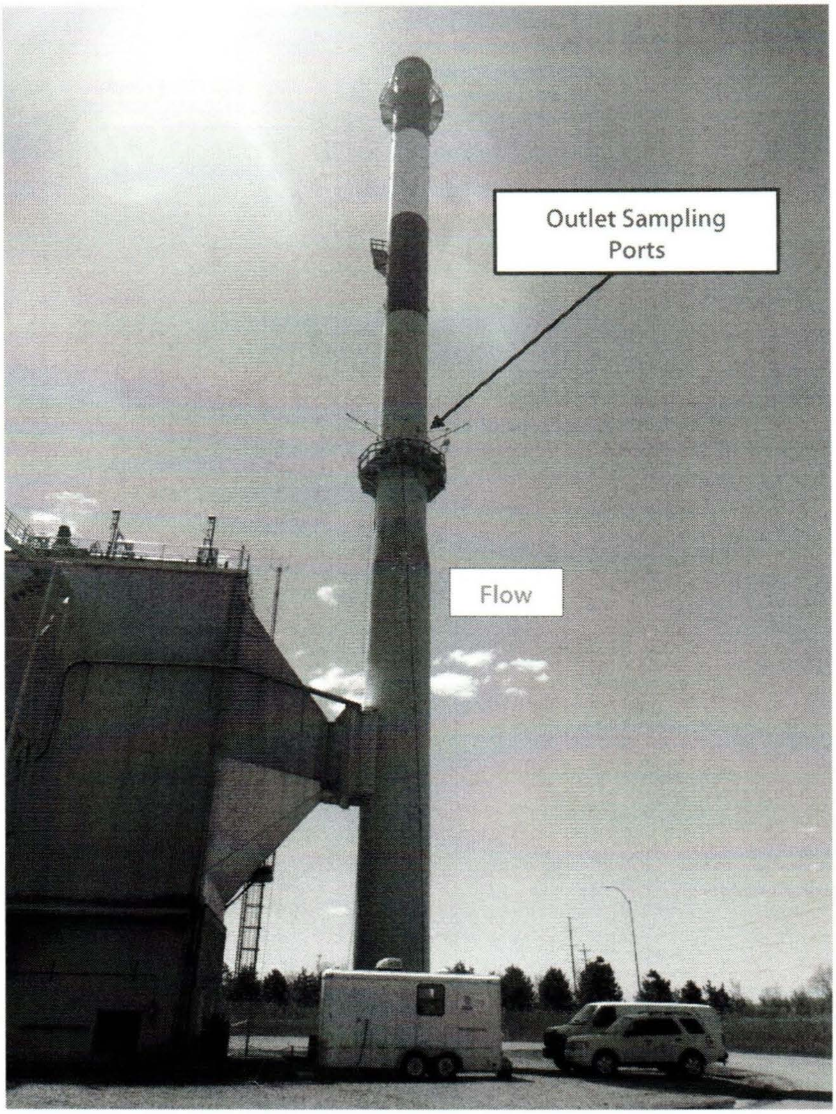


Figure 2-1. EU-BOILER Outlet Sampling Location

2.4 Process Sampling Locations

Process sampling was not required during this test program. A process sample is a sample that is analyzed for operational parameters, such as calorific value of a fuel (e.g., natural gas, coal), organic compound content (e.g., paint coatings), or composition (e.g., polymers). Standard F-factors, as provided in USEPA Method 19, were used for emissions calculations for this test program.

3.0 Summary and Discussion of Results

3.1 Objectives and Test Matrix

The objective of the testing was to evaluate compliance of EU-BOILER with certain emission limits and requirements in EGLE ROP MI-ROP-N3570-2018, effective January 3, 2018.

Table 3-1 summarizes the sampling and analytical matrix.

Table 3-1
Sampling and Analytical Matrix

Sampling Location	Sample/Type of Pollutant	Sample Method	Date (2020)	Run	Start Time	End Time	Analytical Laboratory
EU-BOILER	Flowrate, molecular weight, moisture content, particulate matter, metals, acrolein, benzo(a)pyrene	USEPA 1, 2, 3A, 4, 5, 18, 19, 29, 205, OSHA 52, NIOSH 5506	May 20	1	8:30	10:40	Bureau Veritas Laboratories
				2	11:15	13:22	
				3	14:17	16:22	
	Benzo(a)pyrene	USEPA 18, NIOSH 5506	May 21	4	7:20	9:20	
	Flowrate, molecular weight, moisture content, volatile organic compounds, hydrogen chloride	USEPA 1, 2, 3A, 4, 19, 25A, 26A, 205	May 21	1	7:20	8:25	
				2	8:40	9:45	
				3	10:00	11:05	

3.2 Field Test Changes and Issues

Communication between Genesee Power, Apex, and EGLE allowed the testing to be completed as proposed in the Intent-to-Test Plan, dated April 7, 2020, with the following exceptions:

- Test Run 1, for benzo(a)pyrene, was voided due to an issue with the sample media. A fourth run was conducted.
- On May 20, 2020, the data acquisition system for oxygen and carbon dioxide stopped recording from 8:55 to 8:59, during Test Run 1, and from 15:04 to 15:26, during Test Run 3. The analyzers were ran for additional time at the end of the test runs to accommodate this loss in data.

3.3 Summary of Results

The results of testing are presented in Table 3-2. Detailed results are presented in the Appendix Tables 1 through 6 after the Tables Tab of this report. Graphs are presented after the Graphs Tab of this report. Sample calculations are presented in Appendix B.

Table 3-2
EU-BOILER Emissions Results

Parameter	Unit	Run 1	Run 2	Run 3	Average Result	Permit Limit
Particulate matter	lb/MMBtu	0.0033	0.0034	0.0033	**0.0033**	**0.03**
	lb/hr	1.7	1.7	1.7	**1.7**	**15.7**
Mercury	lb/hr	0.00027	0.00020	0.00022	**0.00023**	**0.0047**
	lb/MMBtu	5.3 x 10^{-7}	3.9 x 10^{-7}	4.2 x 10^{-7}	**4.5 x 10^{-7}**	**9 x 10^{-6}**
Lead	lb/hr	0.00052	0.00048	0.00039	**0.00046**	**0.5**
Chromium	lb/hr	0.0016	0.0021	0.0015	**0.0017**	**0.0864**
Arsenic	lb/hr	0.00062	0.00066	0.00081	**0.00070**	**0.0265**
Beryllium	lb/hr	<0.000017	<0.000017	<0.000016	**<0.000017**	**0.006**
Acrolein	lb/hr	<0.060	<0.063	<0.058	**<0.060**	**0.053**
Benzo(a)pyrene	lb/hr	<0.0035	<0.0037	<0.0038	**<0.0037**	**0.0053**
Volatile organic compounds	lb/hr, as C	2.8	5.4	9.4	**5.9**	**15.7**
	lb/MMBtu, as C	0.0053	0.010	0.018	**0.011**	**0.03**
Hydrogen chloride	lb/hr	7.3	1.7	2.3	**3.8**	**47.1**
	lb/MMBtu	0.0139	0.0033	0.0042	**0.0071**	**0.09**

lb/MMBtu: pound per million British thermal unit
lb/hr: pound per hour

4.0 Sampling and Analytical Procedures

Apex measured emissions in accordance with USEPA sampling methods. Table 4-1 presents the emissions test parameters and sampling methods.

Table 4-1
Emission Testing Methods

Parameter	EU-BOILER	USEPA and OSHA Reference	
	EGLE ROP	Method	Title
Sampling ports and traverse points	●	1	Sample and Velocity Traverses for Stationary Sources
Velocity and flowrate	●	2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
Molecular weight	●	3A	Determination of Oxygen and Carbon Dioxide Emissions from Stationary Sources (Instrument Analyzer Procedure)
Moisture content	●	4	Determination of Moisture Content in Stack Gases
Particulate matter	●	5	Determination of Particulate Matter from Stationary Sources
Acrolein, benzo(a)pyrene [B(a)p]	●	18	Measurement of Gaseous Organic Compound Emissions by Gas Chromatography
Emission rate	●	19	Determine of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates
Volatile organic compound (VOC)	●	25A	Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer
Hydrogen chloride (HCl)	●	26A	Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources Isokinetic Method
Mercury (Hg)	●	29	Determination of Metals Emissions from Stationary Sources
Metals (beryllium, arsenic, chromium, lead)	●	29	Determination of Metals Emissions from Stationary Sources
Gas dilution	●	205	Verification of Gas Dilution Systems for Field Instrument Calibrations
Acrolein	●	OSHA 52†	Volatile Organic Compounds by Gas Chromatography: Acrolein and/or Formaldehyde
B(a)p	●	NIOSH 5506†	Polynuclear Aromatic Hydrocarbons by HPLC

† Method analytical procedures were used in conjunction with USEPA Method 18 sampling.

4.1 Emission Test Methods

4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources," was used to evaluate the sampling location and the number of traverse points for sampling and the measurement of velocity profiles. Figure 1 in the Appendix depicts the source locations and traverse points.

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 flowrates. S-type Pitot tubes and thermocouple assemblies, calibrated in accordance with Method 2, Section 10.0, were used during testing. Because the dimensions of the Pitot tubes met the requirements outlined in Method 2, Section 10.1, and are within the specified limits, the baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned. The digital manometer and thermometer are calibrated using calibration standards that are traceable to National Institute of Standards and Technology (NIST). Pitot tube inspection sheets are included in Appendix A.

Cyclonic Flow Check. Apex evaluated whether cyclonic flow was present at the sampling locations. 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°, the flue gas is considered to be cyclonic at that sampling location and an alternative location should be selected.

The average of the measured traverse point flue gas velocity null angles were less than 20° at the sampling location. The measurements indicate the absence of cyclonic flow.

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

4.1.2 Oxygen and Carbon Dioxide (USEPA Method 3A)

USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations from Stationary Sources (Instrumental Analyzer Procedure)," was used to measure oxygen and carbon dioxide concentrations in the flue gas. Flue gas was continuously sampled in the stack and conveyed to an analyzer for concentration measurements. Flue gas was extracted from the stack through:

- A stainless-steel probe.
- Heated Teflon sample line to prevent condensation.
- A chilled Teflon impinger train (equipped with a peristaltic pump) to remove moisture from the sampled gas stream prior to entering the analyzer.
- O_2 and CO_2 analyzers.

Figure 4-1 depicts the USEPA Method 3A sampling train. Data was recorded at 1-second intervals on a computer equipped with data acquisition software. Recorded concentrations were averaged over the duration of each test run.

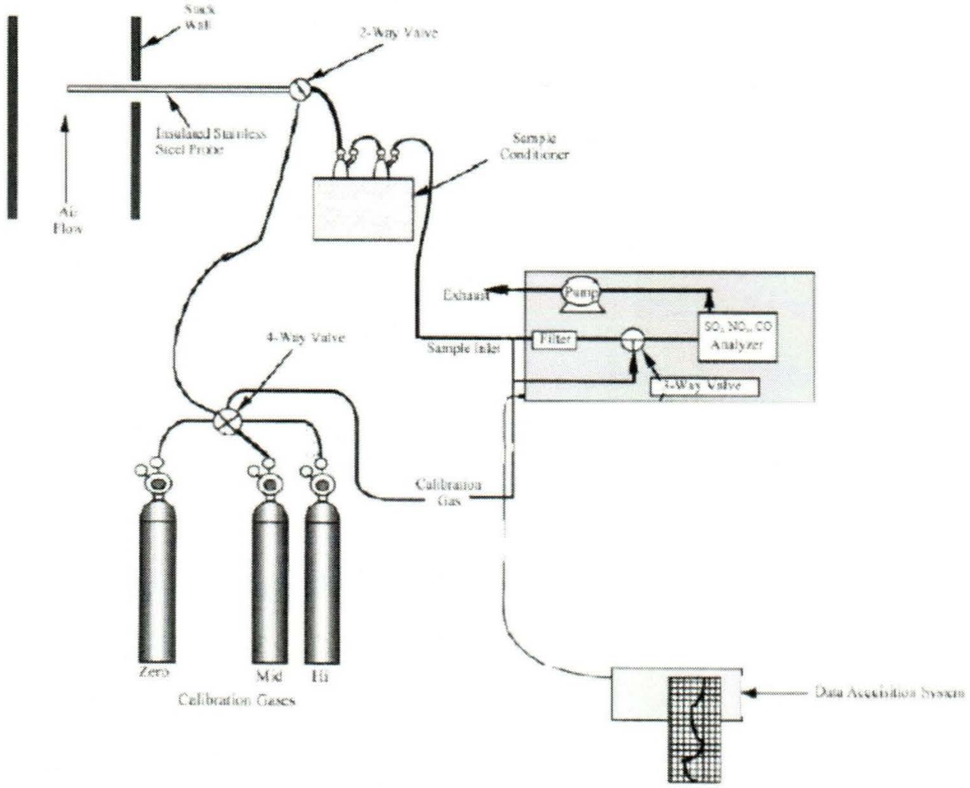


Figure 4-1. USEPA Method 3A Sampling Train

Prior to testing, a 3-point stratification test was conducted at 17, 50, and 83% of the stack diameter for at least twice the response time to determine the minimum number of traverse points to be sampled.

The pollutant concentrations were measured using an analyzer calibrated with zero-, mid-, and high-USEPA-Traceability-Protocol-certified calibration gases. The mid-level gas was 40 to 60% of the high-level (also referred to as span) gas.

Calibration Error Check. A calibration error check was performed by introducing zero-, mid-, and high-level calibration gases directly into the analyzer. The calibration error check was performed to verify the analyzer response was within ±2% of the certified calibration gas introduced.

System Bias Test. 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 an analyzer's response was within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run, an additional system-bias check was performed to evaluate the analyzer drift from pre- and post-test system-bias checks. The system-bias check evaluates the analyzer drift against the ±3% quality assurance/quality control (QA/QC) requirement.

The analyzer drift data was used to correct the measured flue gas concentrations. Recorded concentrations were averaged over the duration of each test run.

4.1.3 Moisture Content (USEPA Method 4)

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

4.1.4 Particulate Matter and Metals (USEPA Methods 5 and 29)

USEPA Methods 5, "Determination of Particulate Matter Emissions from Stationary Sources," and 29, "Determination of Metals Emissions from Stationary Sources," were used to measure particulate matter and metals emissions. Figure 4-2 depicts the USEPA Methods 5 and 29 sampling train.

Apex's modular isokinetic stack sampling system consists of:

- A borosilicate glass button-hook nozzle.
- A heated (248±25°F) borosilicate glass-lined probe.
- A desiccated and pre-weighed 83-millimeter-diameter quartz fiber filter (manufactured to at least 99.95% efficiency (<0.05 % penetration) for 0.3-micron dioctyl phthalate smoke particles) in a heated (248±25°F) filter box.
- A set of seven pre-cleaned impingers with the configuration shown in Table 4-2.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-2
USEPA Methods 5 and 29 Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Contents
1	Modified	Empty	0 ml
2	Modified	5% HNO3/10% H2O2	100 ml
3	Greenburg-Smith	5% HNO3/10% H2O2	100 ml
4	Modified	Empty	0 ml
5	Modified	Acidified KMnO4	100 ml
6	Modified	Acidified KMnO4	100 ml
7	Modified	Silica gel desiccant	~300 grams

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 approximately 1 cubic foot per minute (cfm). Apex selected a pre-cleaned borosilicate glass nozzle with an inner diameter that approximated 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 10 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 cfm. The sample probe was then inserted into the stack through the sampling port to begin sampling.

Ice and water were 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 were 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 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 collected in each impinger was measured using a scale to within ±0.5 grams; these measurements 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 container 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 may still be visible 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. The sample containers were stored and transported to Bureau Veritas Laboratories in Mississauga, Ontario, Canada for analysis. The laboratory analytical results are included in Appendix E.

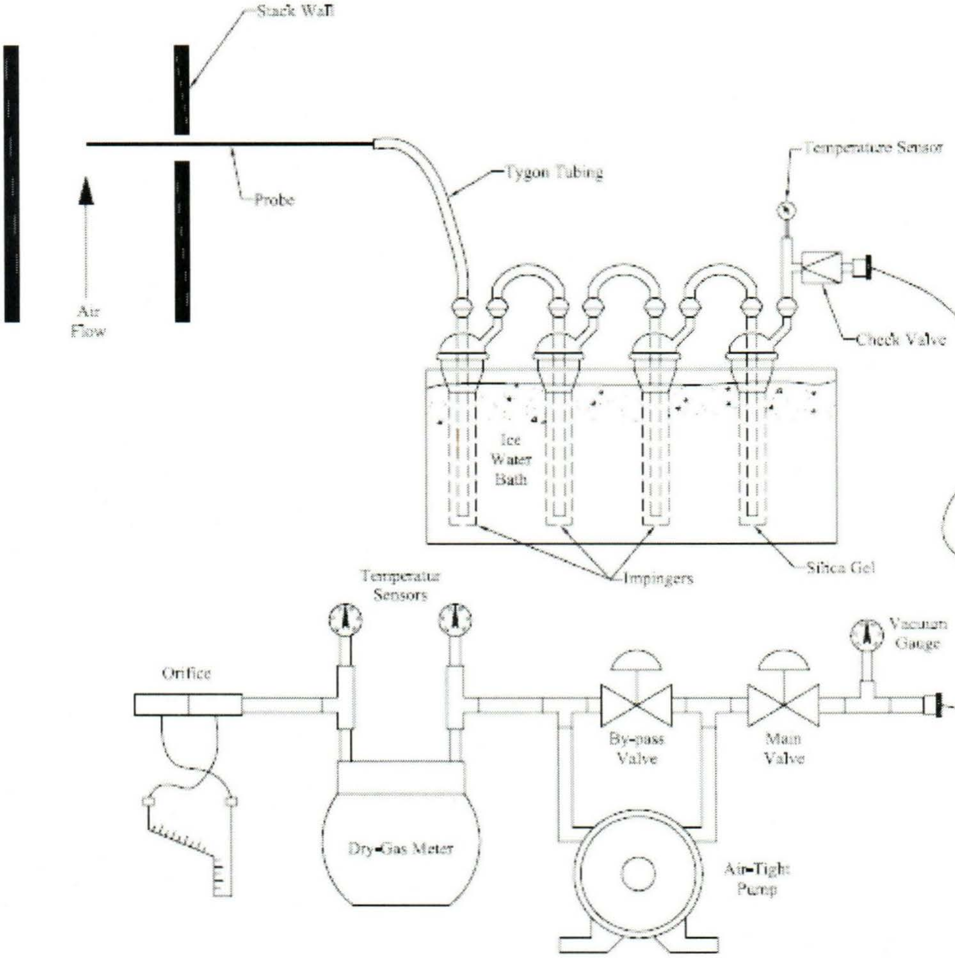


Figure 4-2. USEPA Methods 5 and 29 Sampling Train

4.1.5 Volatile Organic Compounds (USEPA Method 18, OSHA 52, and NIOSH 5506)

USEPA Method 18, "Measurement of Gaseous Organic Compound Emissions by Gas Chromatography," was used to measure select volatile organic compound concentrations. The sampling and analytical procedures followed guidelines in OSHA 52 for acrolein and NIOSH 5506 for benzo(a)pyrene.

Treated sorbent tubes were used to sample the compound of interest. The mass collected on the sampling media was measured using gas chromatography with flame ionization detector.

The sampling trains consisted of flue gas at the exhaust duct being drawn through charcoal containing sorbent tubes. The sorbent tubes were inserted into critical orifices (Gemini® twin-port sampler), which controlled the flowrate, and were connected to a sampling pump.

The USEPA Method 18 sampling train was setup at a constant flow rate for a 120-minute test run. The flowrate varied depending on the analytical method, detection limit, and compound of interest.

Prior to testing, the flowrate through each sorbent tube was measured using a BIOS International DryCal® calibrator. The critical orifices were adjusted to ensure the sample flowrate was within ±20% of the target sampling rate. The pre-test flowrates were recorded on a test run data sheet. After the sampling rate was verified, the sampling train was positioned to sample the flue gas.

Flue gas was sampled into the sorbent tubes for 120 minutes per test run. At the conclusion of each test run, the sample train flowrate was measured using the BIOS International DryCal® calibrator. The average of the pre-and post-test flowrates was used to calculate total sample volume for the test duration. The sample media was then capped and placed in a chilled cooler for storage. The samples were transported to Bureau Veritas Laboratories in Novi, Michigan for analysis.

Spiked sorbent tubes were used in this test program. The spike recovery calculation compares the concentration measured by the unspiked and spiked sorbent tubes and corrects the results based on the fraction of spiked compound recovered. The spike recovery must be between 70 and 130 percent of the expected spike mass.

Figure 4-3 depicts the USEPA Method 18 sampling train.

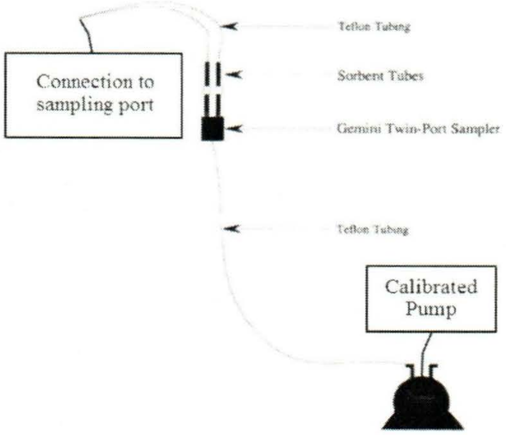


Figure 4-3. USEPA Method 18 Sampling Train

4.1.6 Emission Rate (USEPA Method 19)

USEPA Method 19, "Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates," was used to calculate emission rates of PM, VOC, HCl, and Hg in pounds per million British thermal units. Oxygen concentrations and standard F-factors from USEPA Method 19, Table 19-2 were used to calculate emission rates using USEPA Method 19 Equation 19-1:

$$E = C_d F_d \left(\frac{20.9}{20.9 - \%O_{2d}}\right)$$

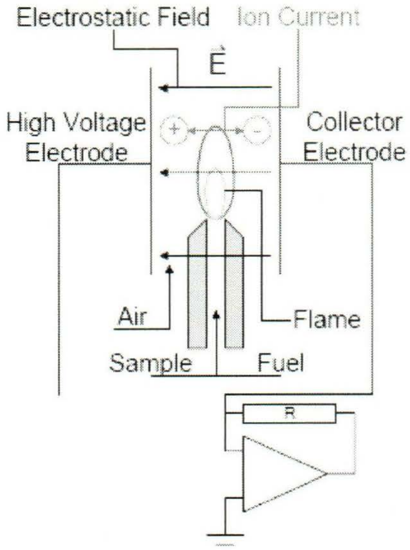
Where:

E = Pollutant emission rate (lb/MMBtu)
C_d = Pollutant concentration, dry basis (lb/dscf)
F_d = F factor (dscf/MMBtu)
$\%O_{2d}$ = Oxygen concentration, dry basis (%, dry)

4.1.7 Total Hydrocarbons (USEPA Method 25A)

USEPA Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer," was used to measure volatile organic compound concentrations in the flue gas. Samples were collected through a stainless steel probe and heated sample line into an analyzer.

A flame ionization detector (FID) determines the average hydrocarbon concentration in part per million by volume (ppmv) of VOC as the calibration gas (i.e., propane). The FID is fueled by 100% hydrogen, which generates a flame with a negligible number of ions. Flue gas is introduced into the FID and enters the flame chamber. The combustion of flue gas generates electrically charged ions. The analyzer applies a polarizing voltage between two electrodes around the flame, producing an electrostatic field. Negatively charged ions, anions, migrate to a collector electrode, while positive charged ions, cations, migrate to a high-voltage electrode. The current between the electrodes is directly proportional to the hydrocarbon concentration in the sample. The flame chamber is depicted at right.



Using the voltage analog signal, measured by the FID, the concentration of VOCs was recorded by a data acquisition system (DAS). The average concentration of VOCs is reported as the calibration gas (i.e., propane) in equivalent units.

Before testing, the analyzer was calibrated by introducing a zero-calibration range gas (<1% of span value) and high-calibration range gas (80-90% span value) to the tip of the sampling probe. The span value was set to 1.5 to 2.5 times the expected concentration (e.g., 0-100 ppmv). Next, a low-calibration range gas (25-35% of span value) and mid-calibration range gas (45-55% of span value) were introduced. The analyzers are considered to be calibrated when the analyzer response is ±5% of the calibration gas value.

At the conclusion of a test run, a calibration drift test was performed by introducing the zero- and mid-calibration gas to the tip of the sampling probe. The test run data was considered valid if the calibration drift test demonstrated the analyzers are responding within 3% of the calibration span from pre-test to post-test calibrations.

Figure 4-4 depicts the USEPA Method 25A sampling train.

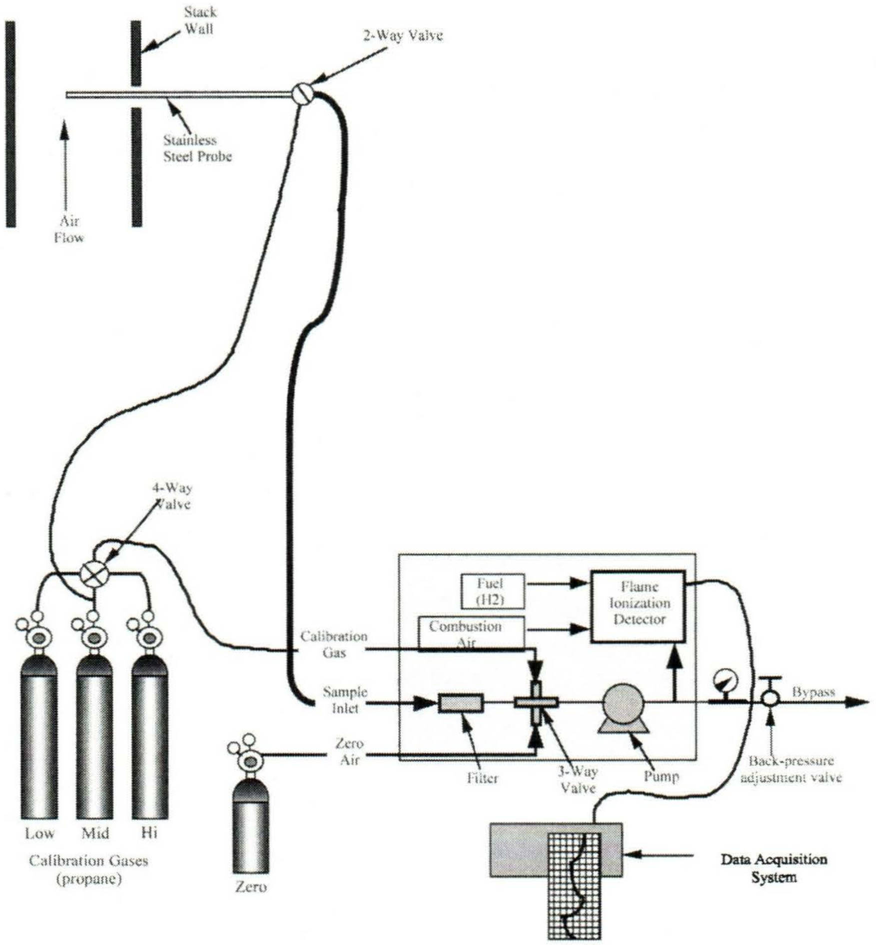


Figure 4-4. USEPA Method 25A Sampling Train

4.1.8 Hydrogen Chloride (USEPA Method 26A)

USEPA Method 26A, "Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources," was used to measure hydrogen chloride emissions. Figure 4-5 depicts the USEPA Method 26A sampling train.

Apex's modular isokinetic stack sampling system consists of:

- A borosilicate glass button-hook nozzle.
- A heated borosilicate glass-lined probe maintained at a temperature greater than 248°F.
- A desiccated and untared 83-millimeter-diameter Teflon fiber filter in a filter box maintained at a temperature above 248°F.
- A set of six pre-cleaned impingers with the configuration shown in Table 4-3.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-3
USEPA Method 26A Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Contents
1	Modified	Empty	0 ml
2	Greenburg-Smith	0.1N H_2SO_4	100 ml
3	Greenburg-Smith	0.1N H_2SO_4	100 ml
4	Modified	0.1N NaOH	100 ml
5	Modified	0.1N NaOH	100 ml
6	Modified	Silica gel desiccant	~300 grams

Before testing, a preliminary velocity traverse was performed and a nozzle size was calculated that allowed isokinetic sampling. Apex selected a pre-cleaned borosilicate glass nozzle that had an inner diameter that approximated the calculated value. The nozzle was measured with calipers across three cross-sectional chords; rinsed and brushed with Type 3 deionized water and proof-rinsed with 0.1-N $H2SO_4$; 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 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 10 inches of mercury to the sampling train. The dry-gas meter was monitored for approximately 1 minute to measure that the sample train leakage rate was less than 0.02 cfm. The 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 to a temperature above 248°F before sampling. After the desired operating conditions were coordinated with the facility, testing was initiated.

Stack parameters (e.g., flue velocity, temperature) were monitored to establish an isokinetic sampling rate 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 housing were transported to the recovery trailer. The filter was removed from the filter housing and discarded. The nozzle and probe liner, and the front half of the filter housing were rinsed with deionized water to remove any existing particulate matter. The deionized water rinses were discarded.

At the end of a test run, the liquid weight collected in each impinger, including the silica gel impinger, were measured using an electronic scale; these weights were used to calculate the moisture content of the flue gas. The contents of Impingers 1 through 3, back half of the filter housing, and connecting glassware were placed in a container with a Teflon cap screw liner. The described glassware was rinsed three times with deionized water and the rinsate was placed in the sample container. The sample container was labeled as 0.1-N H_2SO_4, marked at the liquid level, and sealed. The contents of Impingers 4 and 5 were placed in a container with a separate Teflon cap screw liner. The described glassware was rinsed three times with deionized water and the rinsate was placed in the sample container. The sample container was labeled as 0.1-N NaOH, marked at the liquid level, and sealed. The sample containers were transported to Bureau Veritas Laboratories in Mississauga, Ontario, Canada for analysis. The laboratory analytical results are included in Appendix E.

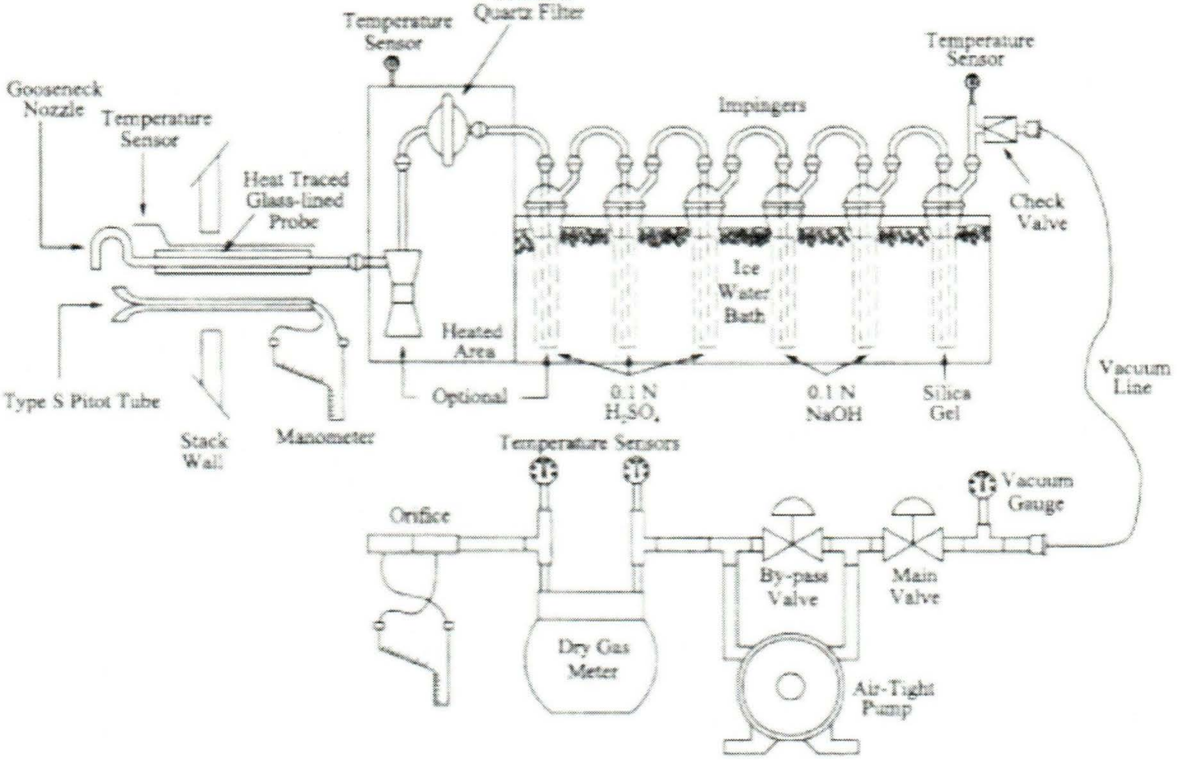


Figure 4-5. USEPA Method 26A Sampling Train

4.1.9 Gas Dilution (USEPA Method 205)

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

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

4.2 Process Data

Genesee Power recorded process data during testing. EGLE personnel verified the requested operating and process data were recorded. Process data are included in Appendix F.

5.0 Quality Assurance and Quality Control

5.1 QA/QC Procedures

Equipment used in this emissions test program passed Quality Assurance (QA) and Quality Control (QC) procedures. Refer to Appendix A for equipment calibrations. Before testing, the sampling equipment was cleaned, inspected, and calibrated according to procedures outlined in the applicable USEPA sampling method and USEPA's "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III, Stationary Source-Specific Methods."

5.2 QA/QC Audits

Onsite QA/QC procedures (i.e., Pitot tube inspections, nozzle size verifications, leak check, calculation of isokinetic sampling rates, calibrations) were performed in accordance with the respective USEPA sampling methods. Equipment inspection and calibration measurements are presented in Appendix A.

Offsite QA audits include dry-gas meter and thermocouple calibrations.

5.2.1 Audit Sample Results QA/QC

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 Bureau Veritas Laboratories. 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
Audit Sample Results QA/QC

Sample Catalog Number	Analyte	Unit	Laboratory Reported Value	Sample Assigned Value	Acceptable Range	Performance Evaluation
1425	Metals on filter paper (lead)	µg/filter	35.6	36.7	29.4 – 44.0	Acceptable
1425	Metals on filter paper (chromium)	µg/filter	26.7	27.1	21.7 – 32.5	Acceptable
1425	Metals on filter paper (arsenic)	µg/filter	41.2	43.0	32.2 – 53.8	Acceptable
1425	Metals on filter paper (beryllium)	µg/filter	24.5	23.8	17.8 – 29.8	Acceptable
1426	Metals in impinger solution (lead)	µg/mL	0.464	0.461	0.346 – 0.576	Acceptable
1426	Metals in impinger solution (chromium)	µg/mL	1.36	1.30	1.04 – 1.56	Acceptable
1426	Metals in impinger solution (arsenic)	µg/mL	2.77	2.79	2.09 – 3.49	Acceptable
1426	Metals in impinger solution (beryllium)	µg/mL	2.04	1.98	1.48 – 2.48	Acceptable
1427	Mercury on filter paper	µg/filter	53.0	54.2	40.6 – 67.8	Acceptable

Table 5-1
Audit Sample Results QA/QC

Sample Catalog Number	Analyte	Unit	Laboratory Reported Value	Sample Assigned Value	Acceptable Range	Performance Evaluation
1428	Mercury in impinger solution	ng/mL	22.4	22.6	17.0 – 28.2	Acceptable
1440	Hydrogen chloride in impinger solution	mg/L	150	157	141 – 173	Acceptable

5.2.2 Sampling Train QA/QC

The sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. Table 5-2 summarizes the QA/QC audits conducted on each sampling train.

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

Parameter	Run 1	Run 2	Run 3	Method Requirement	Comment
Methods 5 and 29					
Average velocity pressure head (in H_2O)	0.86	0.85	0.84	>0.05 in H_2O	Valid
Sampling train post-test leak check	0.003 ft^3 for 1 min at 9 in Hg	0.003 ft^3 for 1 min at 10 in Hg	0 ft^3 for 1 min at 9 in Hg	<0.020 ft^3 for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	6 to 8	8 to 9	7 to 8		
Method 26A					
Average velocity pressure head (in H_2O)	0.92	0.95	0.93	>0.05 in H_2O	Valid
Sampling train post-test leak check	0.001 ft^3 for 1 min at 5 in Hg	0 ft^3 for 1 min at 5 in Hg	0 ft^3 for 1 min at 5 in Hg	<0.020 ft^3 for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	4	4	3		

5.2.3 Instrument Analyzer QA/QC

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. Table 5-3 summarizes the gas cylinders used during this test program. Analyzer calibration, bias, and drift data are included in Appendix A.

Table 5-3
Calibration Gas Cylinder Information

Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
Nitrogen	Airgas	CC183736	99.9995%	11/2/2023
Oxygen, Carbon dioxide	Airgas	XC035409B	22.05% 22.59%	3/13/2028
Oxygen, Carbon dioxide	Airgas	SG9161438BAL	11.04% 11.10%	6/8/2024
Air	Airgas	CC139694	--	4/5/2026
Propane	Airgas	CC18627	1,098 ppm	11/30/2026
Propane	Airgas	SG9150203BAL	109.6 ppm	3/2/2028

5.2.4 Dry-Gas Meter QA/QC

Table 5-4 summarizes the dry-gas meter calibration checks in comparison to the acceptable USEPA tolerance. Complete dry-gas meter calibrations are included in Appendix A.

Table 5-4
Dry-Gas Meter Calibration QA/QC

Dry-Gas Meter	Pre-test DGM Calibration Factor	Post-test DGM Calibration Factor	Difference Between Pre- and Post-test Calibrations	Acceptable Tolerance	Comment
1	0.970 (5/13/2020)	0.989 (6/18/2020)	0.019	±0.05	Valid

5.2.5 Thermocouple QA/QC

Temperature measurements using thermocouples and digital pyrometers were compared to a reference temperature prior to testing to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperature within ±1.5% of the reference temperatures and were within USEPA acceptance criteria. Thermocouple calibration sheets are included in Appendix A.

5.2.6 Laboratory Blanks QA/QC

QA/QC blanks were analyzed for the parameters of interest. The results are presented in Table 5-5. Blank corrections were not applied to the sample results. Blank and sample laboratory results are included in Appendix E.

Table 5-5
Laboratory Blanks QA/QC

Sample Identification	Result	Comment
Method 5 Reagent Blank – Filter	1.30 mg	Reporting limit is 0.30 milligrams.
Method 5 Reagent Blank – Acetone	0.5 mg	Reporting limit is 0.5 milligrams. Sample volume was 110 milliliters.
Method 29 Blank - Mercury	<0.20 µg	Reporting limit is 0.20 micrograms.
Method 29 Blank - Arsenic	2.01 µg	Reporting limit is 0.80 micrograms.
Method 29 Blank - Beryllium	<0.18 µg	Reporting limit is 0.18 micrograms.
Method 29 Blank - Chromium	13.2 µg	Reporting limit is 3.0 micrograms.
Method 29 Blank - Lead	0.86 µg	Reporting limit is 0.60 micrograms.
Method 26A Reagent Blank – H_2O	<200 µg	Reporting limit is 200 micrograms. Sample volume was 106 milliliters.
Method 26A Reagent Blank – H_2SO_4	<200 µg	Reporting limit is 200 milligrams. Sample volume was 98 milliliters.

5.3 Data Reduction and Validation

The emissions testing Project Manager and/or the QA/QC Officer validated computer spreadsheets. The computer spreadsheets were used to ensure that field calculations were accurate. Random inspection of the field data sheets was conducted to verify data have been recorded appropriately. At the completion of a test, the raw field data were entered into computer spreadsheets to provide applicable onsite emissions calculations. The computer data were checked against the raw field sheets for accuracy during review of the report.

5.4 Sample Identification and Custody

The Apex project manager was responsible for the handling and procurement of the data collected in the field. The project manager ensured the data sheets are accounted for and completed in their entirety. 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 4.1. For each sample collected (i.e., impinger), sample identification and custody procedures were completed as follows:

- Containers were sealed to prevent contamination.
- Containers were labeled with test number, location, and test date.
- The level of fluid was marked on the outside of the sample containers to indicate if leakage occurred prior to receipt of the samples by the laboratory.
- Containers were placed in a cooler for storage, if necessary.
- Samples were logged using guidelines outlined in ASTM D4840-99(Reapproved 2010).
- Samples were transported to the laboratory under chain of custody.

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

5.5 QA/QC Problems

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

6.0 **Limitations**

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