AECOM

Particulate Matter Compliance Test 2024

Graphic Packaging International, LLC

Boiler 10 (EUBOILER#10)

Project number: 60725702

June 6, 2024

Graphic Packaging International, LLC
1500 N Pitcher Street
Kalamazoo, Michigan 49007

Delivering a better world

Quality information

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1. Executive Summary

1.1 Background

AECOM was retained to conduct Compliance Emissions Testing of the EUBoiler#10 outlet gas stream to determine the unit's compliance with the emission limit requirements for particulate matter (Total PM). Graphic Packaging International operates EUBoiler#10, a natural gas fired boiler used to heat steam for a dryer and hot water for the paper machine, under Permit to Install (PTI) No. 133-19A.

1.2 Summary of Test Program

The goal of this compliance testing project was to determine that EUBoiler#10 met the emission limit requirements for Total PM. This was accomplished by completing three (3), one-hundred-and-twenty-minute (120) test runs on the unit's outlet. EPA Method 1 was utilized to determine the suitability of sampling locations and the presence of gas stream cyclonic flow. EPA Method 2 was utilized for determining gas stream velocity and volumetric flow rate. EPA Method 3A was utilized to determine gas stream molecular weight, and EPA Method 4 was utilized to determine gas stream moisture content.

AECOM performed emissions compliance testing of EUBoiler#10 outlet gas stream using wet chemistry sampling to determine emissions of total filterable particulate matter (FPM). It will be assumed that all exhaust gas particulate matter from EUBoiler#10 has a diameter of 10 microns or less; therefore, worst-case emissions of PM10 can be determined as the sum of FPM plus condensable particulate matter (CPM). Emissions of FPM and CPM were determined in accordance with EPA Test Methods 5 and 202, respectively. Exhaust gas samples were taken through a wet chemistry sampling apparatus having a heated filter housing followed by glass impingers filled with aqueous adsorbing solution and maintained in an ice bath. Sample filters were analyzed for FPM and impinger solution recovery samples were analyzed for CPM by an offsite gravimetric analysis laboratory.

Table 1-1 summarizes the pertinent data for this compliance event.

Table 1-1 Compliance Summary

Responsible Groups	• Graphic Packaging International, LLC • Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division
Applicable Regulations	• Permit to Install 133-19A • 40 CFR Part 60 PS 2 & 3
Plant Location	• Graphic Packaging International, LLC Kalamazoo, Michigan 49007
Sampling Contractor	• AECOM 564 White Pond Dr Akron, OH 44320
Date of Last Compliance Test	• October 17, 2022
Air Pollution Control Equipment	• Low NO_x Burners and Flue Gas Recirculation
Emission Points	• EUBOILER#10
Pollutants/Diluent Measured	• Total Particulate Matter (FPM, $PM_{2.5}$, PM_{10}) • Oxygen (O_2) • Carbon Dioxide (CO_2)
Test Dates	• May 08, 2024& May 09, 2024

1.3 Key Personnel

The contact for the source and test report is:

Steven Smock
M:269-491-6055
E: steven.smock@graphicpkg.com

Names and affiliations of personnel, including their roles in the test program, are summarized in the following table (**Table 1-2**).

Table 1-2 Key Personnel

Role	Name	Address	Contact Information
Process Focal Point	Steven Smock	Graphic Packaging, International, LLC	269-491-6055 steven.smock@graphicpkg.com
Regulatory Agency	Michael Cox	EGLE	616-240-3607 CoxM9@michigan.gov
Technical Reviewer	Rob Sava	AECOM	234-425-8440 Rob.Sava@aecom.com
Field Team Leader	Chris Trevillian	AECOM	330-815-5016 Chris.Trevillian@aecom.com
Test Project Manager	James Edmister	AECOM	(585) 721-9128 James.Edmister@aecom.com

1.4 Executive Summary

Results summaries for the Compliance Testing are presented in **Table 1-3** and **Table 1-4**

The results indicate that EUBoiler#10 was operating within the required emission limitations, as applicable. Emissions results were calculated for Total PM (assumed as all PM_{10}) in units of pounds per hour (lb/hr) and lb/mmBTU.

The remainder of this document is organized as follows. **Section 2** of this document provides a summary and discussion of results for the compliance emissions test, and flue gas sample locations; **Section 3** describes the sampling and analysis procedures; **Section 4** describes the test procedures that were followed and a description of AECOM's portable instrumental analyzer laboratory; **Section 5** describes the Quality Assurance/Quality control measures for the test program; and **Section 6** describes how the data reduction was performed.

Test program participants included: Christopher Trevillian, Jonathan Grech, and Matt Collins from AECOM; as well as Steven Smock from Graphic Packaging International.

Additional information is contained in the Appendices as follows: **Appendix A** provides Reference Method (RM) Emissions Data from AECOM's test activities during the test program, and example calculations **Appendix B** contains Facility Data and supporting documentation, **Appendix C** contains RM Quality Assurance Data, including Manual Equipment Calibrations and instrumental analyzer Calibration Error Tests, System Bias and Drift Checks, System Response Times, Gas Cylinder Certification Sheets, and **Appendix D** contains the Laboratory Report.

Table 1-3 Emissions Summary of Results – EUBoiler#10

Test Run Number	1	2	3		
Date	05/08/24	05/08/24	05/09/24		
Run Time	11:40-13:43	14:40-16:43	07:40-09:42	**Average**	**Emission Limit**
PM_{10} Emission Rate (lb/MMbtu)	0.0018	0.0015	0.0007	**0.0013**	**0.004**

Table 1-4 Run Summary - EUBoiler#10

Project Name Graphic Packaging International
Project Number 60725702
Facility Kalamazoo, Michigan

Sample Type	5/202	5/202	5/202	Averages
Source	EUBoiler#10	EUBoiler#10	EUBoiler#10	
Condition	TPM	TPM	TPM	
Run	1	2	3	
Date	5/8/2024	5/8/2024	5/9/2024	
Time Start	11:40	14:40	7:40	
Time Stop	13:43	16:43	9:42	
Sampling Times	11:40-13:43	14:40-16:43	07:40-09:42	
Duct Diameter (ft) *(equivalent if square duct)*	5.19	5.19	5.19	
Pitot Tube Correction Factor	0.84	0.84	0.84	
Nozzle Diameter (inches)	0.275	0.275	0.275	
DGMCF (Y_d)	1.022	1.022	1.022	
Orifice Factor ("wc) ($\Delta H_@$)	1.776	1.776	1.776	
Console Identification	AKR-MTB-001	AKR-MTB-001	AKR-MTB-001	
Standard Temperature (°F) (T_{std})	68	68	68	
Barometric Pressure Measured ("Hg)	28.90	28.92	28.96	
Stack Elevation (ft) (relative to Barometer)	0	0	0	
Barometric Pressure ("Hg) (P_{bar})	28.9	28.92	28.96	
Average Stack Temperature (°F) (T_S)	263.2	262.8	251.5	259.2
Average DGM Temp (°F) (T_m)	96.7	100.7	90.8	
Average Delta H ("wc) (ΔH_{avg})	2.49	2.52	2.57	
Condensed Water (g)	411.8	414.4	424.4	
Test Duration (minutes) (Θ)	120	120	120	
Static Pressure ("wc) (P_g)	-0.50	-0.94	-0.62	
Carbon Dioxide Content (%) ($\%CO_2$)	9.80	9.81	9.76	
Oxygen Content (%) ($\%O_2$)	3.66	3.70	3.75	
Meter Volume (dcf) (V_m)	104.307	104.699	105.103	
Average square root of ΔP ($(\sqrt{\Delta P})_{avg}$)	0.839	0.839	0.841	
Absolute Stack Pressure ("Hg) (P_S)	28.86	28.85	28.91	
Absolute Stack Temperature (°R) (T_S)	722.9	722.4	711.2	718.8
Flue Gas Moisture (%) (B_{WS})	16.50	16.62	16.63	16.59
Gas Molecular Wt (Wet) (g/g-mole) (M_S)	27.78	27.77	27.76	
Corrected Vol of Gas Sample (dcf) ($V_{m(actual)}$)	106.602	107.002	107.415	
Volume at Meter (dscf) (V_M)	98.273	98.020	100.313	
Average Gas Velocity (ft/sec) (V_S)	57.23	57.22	56.87	57.11
Avg Flow Rate (acfh)	4,361,155	4,360,970	4,333,843	4,351,990
Avg Flow Rate (acfm)	72,686	72,683	72,231	72,533
Avg Flow Rate (scfh)	3,071,017	3,071,520	3,107,345	3,083,294
Avg Flow Rate (scfm)	51,184	51,192	51,789	51,388
Avg Flow Rate (dscfh) (Q_{sd})	2,564,297	2,560,950	2,590,513	2,571,920
Avg Flow Rate (dscfm) (Q_{sd})	42,738	42,682	43,175	42,865
Isokinetic Sampling Rate (%) (I)	**98.34**	**98.22**	**99.37**	

2. Plant and Sample Location Description

2.1 Facility Description

The Boiler 10 is a natural gas fired boiler equipped with low NOx burners and flue gas recirculation with a maximum heat input of approximately 311 MMBtu/hr. This natural gas fired boiler is used to heat steam for the dryer and hot water to be used on the paper machine.

2.2 Applicable Regulations and Performance Requirements

Applicable Regulations

- Permit to Install 133-19A

Pollutants/Diluents Measured

- Traverse Point Determination – EPA Method 1
- Velocity – EPA Method 2
- O_2 and CO_2 – EPA Method 3A
- Moisture Content – EPA Method 4
- PM10 (Total Particulate Matter) – EPA Methods 5 and 202

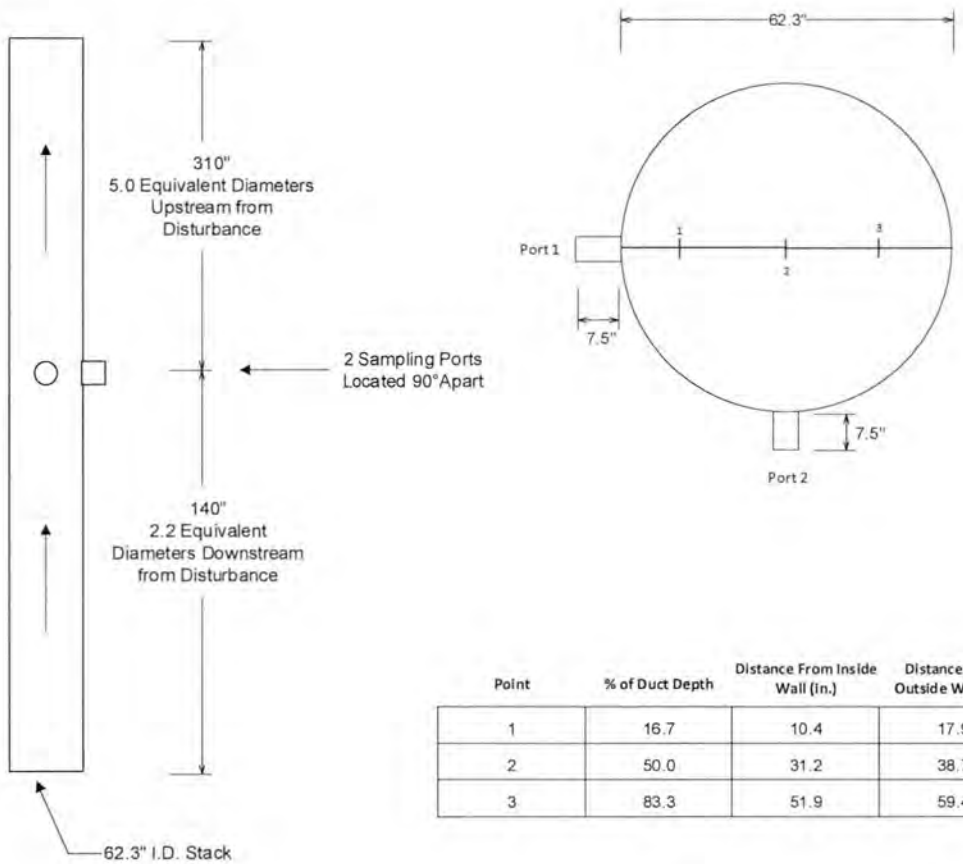
2.3 Process Emissions Control Description

EUBoiler#10 is equipped with Low NOx Burners and Flue Gas Recirculation

2.4 Flue Gas Sampling Locations

Sampling was conducted on the EUBOILER#10 outlet stack. The Total Particulate Matter (TPM) sampling ports on the stack are 2.2 equivalent diameters downstream from the nearest disturbance, and 5.0 equivalent diameters upstream from the effluent exhaust or control device. The cross-sectional diagrams for EUBoiler#10 is represented in **Figure 2-1** and **Figure 2-2**. The emissions compliance test (3 test runs) were performed on May 8th, 2024 and May 9th, 2024. The manual methods train samples were drawn from the stack for sampling runs of one-hundred-and-twenty (120) minutes each.

Figure 2-1 CEMS Three-Point Traverse Diagram



Point	% of Duct Depth	Distance From Inside Wall (in.)	Distance From Outside Wall (in.)
1	16.7	10.4	17.9
2	50.0	31.2	38.7
3	83.3	51.9	59.4

NOTES:
1. Not to scale
2. Dimensions subject to change upon verification.

No.	Revisions	Date	By
1	0	03/08/23	RS

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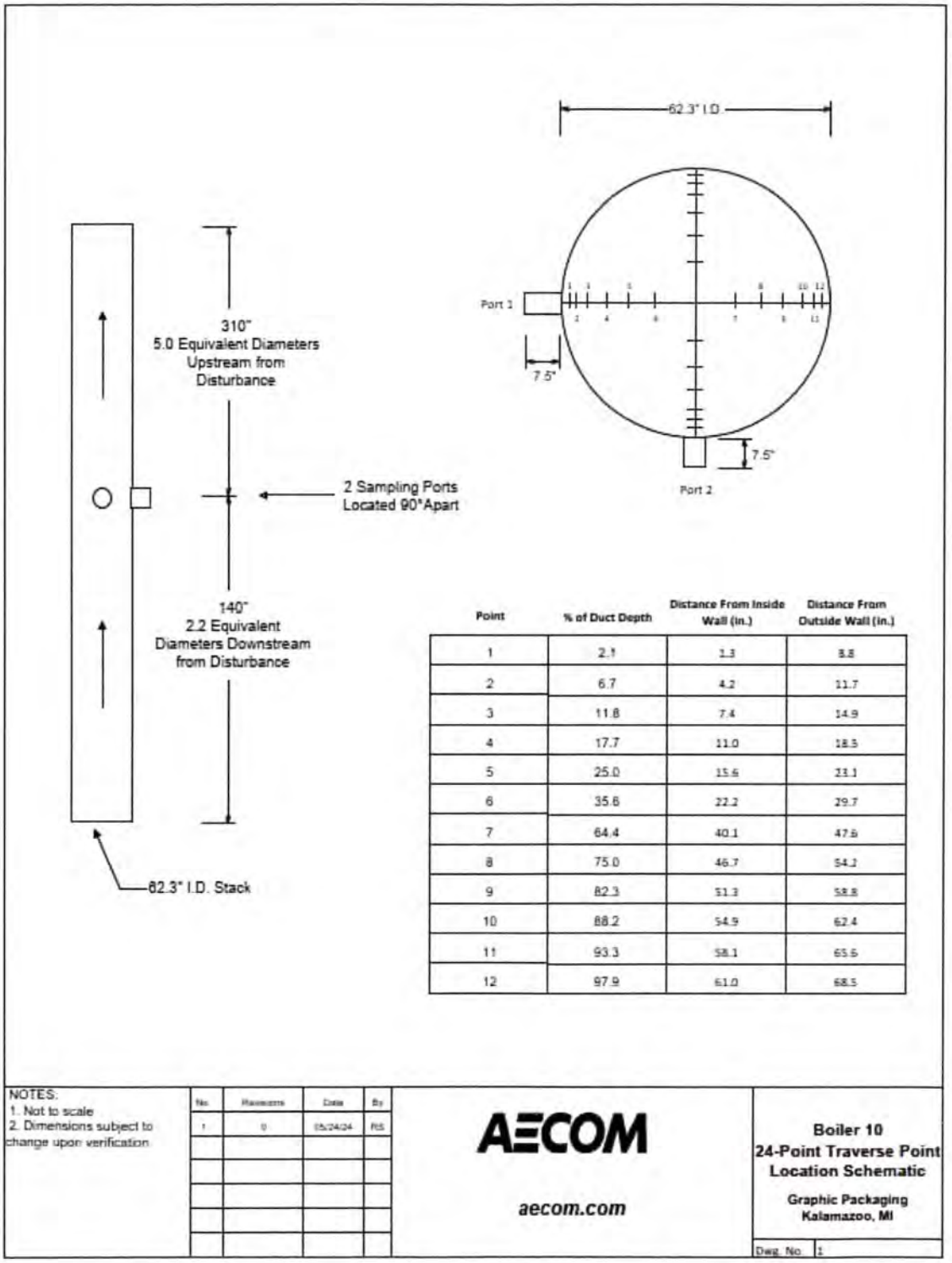
Boiler 10
3-Point Traverse Point Location Schematic

Graphic Packaging
Kalamazoo, MI

Dwg. No. 1

Figure 2-2 Twenty-Four-Point Isokinetic Traverse Diagram



Point	% of Duct Depth	Distance From Inside Wall (in.)	Distance From Outside Wall (in.)
1	2.1	1.3	8.8
2	6.7	4.2	11.7
3	11.8	7.4	14.9
4	17.7	11.0	18.5
5	25.0	15.6	23.1
6	35.6	22.2	29.7
7	64.4	40.1	47.6
8	75.0	46.7	54.2
9	82.3	51.3	58.8
10	88.2	54.9	62.4
11	93.3	58.1	65.6
12	97.9	61.0	68.5

NOTES:
1. Not to scale
2. Dimensions subject to change upon verification

No.	Revisions	Date	By
1	0	05/24/24	RS

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Boiler 10
24-Point Traverse Point Location Schematic
Graphic Packaging
Kalamazoo, MI

Dwg. No. 1

3. Sampling and Analysis Procedures

3.1 Objectives and Test Matrix

This testing was performed to meet the requirements of 40 CFR Part 60, Appendix A. The specific objectives of this test were:

- Determine the Total Particulate Emissions (FPM and CPM) in the EUBOILER#10 outlet stack.

3.2 Facility Operations

During the relative accuracy test, the plant operated EUBoiler#10 at the max, or near maximum operating load. The operating rate for this unit is determined based on the steam lb/hr rate presented in **Table 3-1**.

3.3 Comments / Exceptions

As allowed by 40 CFR Part 60, this Performance Test consisted of three (3) one-hundred-and-twenty minute (120) test runs. Test runs 1 and 2 were completed on May 8th 2024, and test run 3 was completed on May 9th 2024 due to weather delays. All three compliance runs had no issues.

Table 3-1 Boiler 10 Steam Flow

EUBOILER#10	
PM Compliance Run #	Run Average Steam (lb/hr)
Run 1	136,527.9
Run 2	136,845.3
Run 3	182,478.6
Average	151,950.6

4. Test Procedures

The following is a description of the testing that was completed on the EUBoiler#10 exhaust stack to fulfill permit emission limitation requirements.

4.1 Manual Test Methods

4.1.1 Flow Rate, Gas Composition, Moisture, and Total Particulate Matter (PM_{10})

Concurrent with the performance of the compliance test runs, measurements were made to determine stack gas volumetric flow rate from measurements of gas velocity and temperature (EPA Method 2), gas molecular weight composition (EPA Method 3A), gas moisture (EPA Method 4), and Total Particulate Matter (EPA Methods 5 and 202, reported as PM_{10}).

A schematic of the Total Particulate Matter sampling train is shown in **Figure 4-1.**

4.2 Instrumental Analyzer Test Method

AECOM followed the instrumental analyzer procedures specified in EPA Methods 3A (40 CFR Part 60, Appendix A) for the determination of O_2/CO_2, concentrations. Exhaust gas volumetric flow rates were calculated using measurements made following the source testing procedures specified in EPA Methods 2 and 4 (40 CFR Part 60, Appendix A) for the determination of gas velocity and moisture, respectively. The following subsections describe the sample procedures in more detail.

AECOM conducted three 120-minute test runs for the compliance testing using the AECOM transportable instrumental analyzer laboratory, which is described later in this section. Average undiluted dry concentrations by volume of O_2 and CO_2 were determined for each test run. During each test run, the sample probe extracted a continuous sample along a traverse line through the center of the stack cross section. Prior to sampling, a stratification test was completed where the sample probe was traversed across the stack at three points (16.7%, 50.0%, and 83.3%) of a measurement line passing through the stack centroid. The results of the Stratification Test are presented in **Appendix A**. The O_2/CO_2 and flow rate test run data and calculation results are presented in **Appendix A**.

A schematic of the O_2/CO_2 sampling train is shown in **Figure 4-2.**

4.3 Transportable Instrumental Analyzer Laboratory

A transportable instrumental analyzer laboratory (i.e., Mobile Lab) was used to provide an environmentally controlled shelter to house RM analyzers and the sample delivery and conditioning system to measure O_2, CO_2, by volume on a dry basis. The AECOM monitoring system was contained in a temperature controlled portable shelter that was delivered to the site and set up prior to the start of the test program. The sample delivery and conditioning system consists of a stainless-steel sample probe, a heated particulate filter assembly, a heat-traced Teflon sample line, a refrigerated gas conditioning system (for moisture and condensable particulate removal), a sample gas manifold, and a sample pump. The clean dry sample was then delivered to the gas analyzers for the determination of undiluted O_2 and CO_2 concentrations.

The analog output signals from each analyzer were connected to a data acquisition system (DAS) using a software package to perform the test calculations. The DAS then stored the data in engineering units and provided 1-minute and 10-second averages based upon a minimum of 60 readings per minute.

4.4 Instrumental Analyzer Calibration Procedures

The initial phase of the instrumental analyzer methods (e.g., Methods 3A) requires initial measurement system performance tests to be performed, including calibration error tests, system bias checks, response-time tests, and interference checks, as applicable.

Prior to performing test runs with the dry-measurement analyzers (i.e., Methods 3A), AECOM conducted direct instrument calibration error tests using zero and two upscale gases each for the O_2/CO_2 analyzers prior to initiation of testing. Following these direct calibrations, an initial system bias check was performed by sending zero and one upscale gas, from one gas cylinder at a time, up to the sample probe and back down through the components of the sampling system. Following the initial system bias checks, response-time data was obtained for each analyzer. Subsequently, system bias and drift checks were performed both prior to and following each test run set of up to three consecutive runs using zero and one upscale calibration gas. These system checks allowed for the determination of initial and final system bias, as well as system drift for each test run set.

The test runs were performed during a for a period of 120 minutes followed by a system bias and drift check. The calibration gases used during this program were prepared in accordance with EPA Protocol G1 procedures as specified by the National Institute of Standards and Technology (NIST).

The calibration data, including initial calibration error tests, pre-run and post-run system bias and drift checks, system response time tests, and certificates of analysis for the RM test calibration gases, are provided in **Appendix A**.

Figure 4-1 EPA Methods 5 and 202 Sampling System Schematic

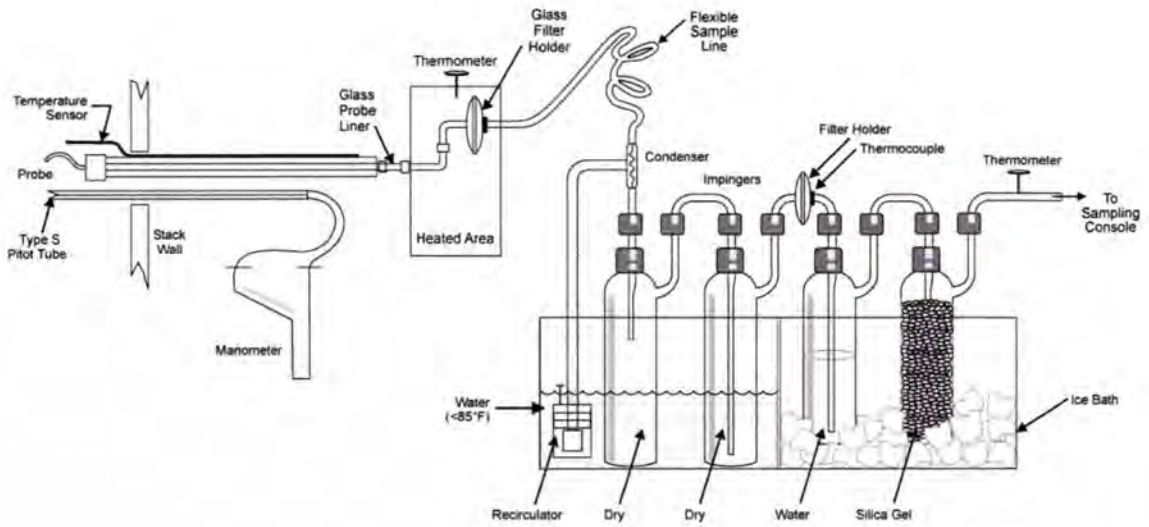
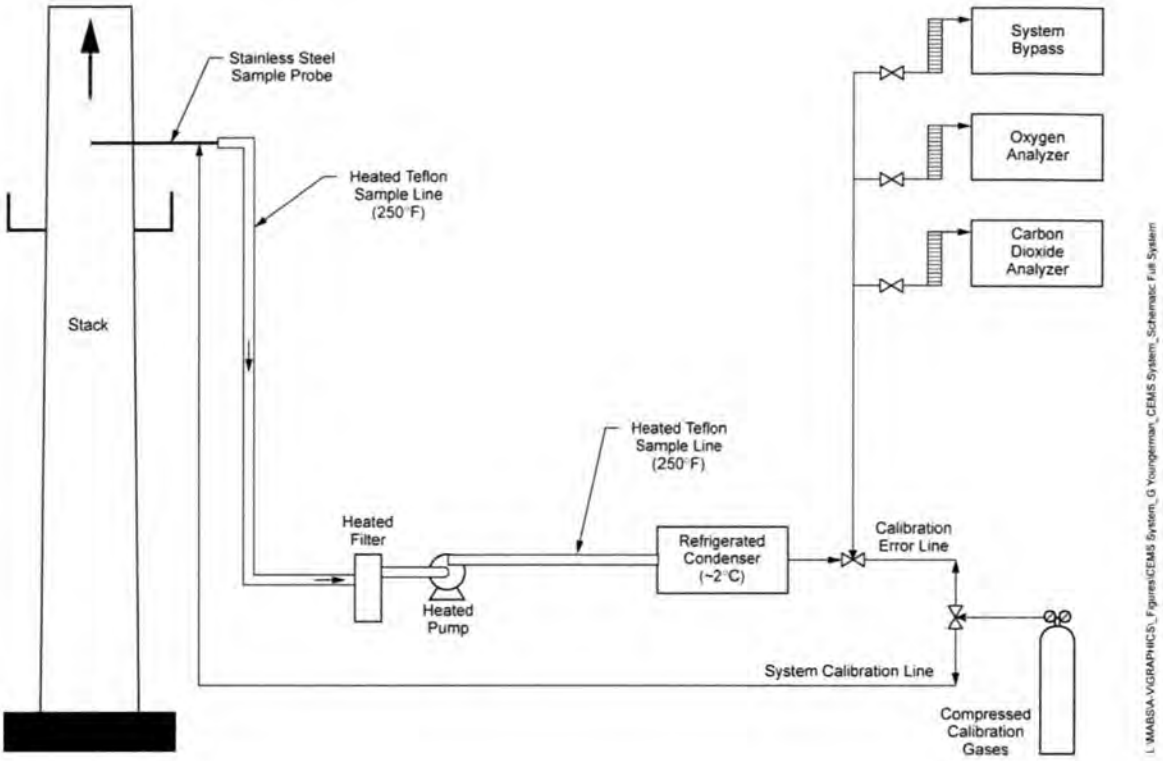


Figure 4-2 EPA Method 3A Sampling System Schematic



5. Quality Assurance/ Quality Control Measures

5.1 Overview

During the sampling and measurements phase of the program, a strict quality assurance/quality control (QA/QC) program was adhered to. The QA/QC aspects of the program are discussed below.

5.2 Leak Check Procedure

Prior to conducting the instrumental analyzer testing, AECOM's manual and instrumental measurements Systems were leak checked and verified to be leak free. Following the initial leak check, the system bias and drift criteria (as referenced in EPA Method 3A, 40 CFR Part 60, Appendix A) served as a continuous sample integrity check for the instrumental measurement system. Prior to and following each manual method test run, the sample train was leak checked per the procedures in EPA Methods 4, 5, and 202.

5.3 Instrumental Measurements System Calibrations

During the test program, AECOM used EPA instrumental analyzer methods (i.e., 3A as applicable, in 40 CFR Part 60, Appendix A) for the measurement of O_2 and CO_2. The initial phase of instrumental analysis requires calibration of the involved monitors. Prior to performing test runs, AECOM conducted direct instrument calibration error tests using zero and two upscale gases each for the O_2/CO_2 instruments prior to initiation of testing. Following these direct calibrations, an initial system bias check was performed by sending zero and one upscale gas, from one gas cylinder at a time, up to the sample probe and back down through the relevant components of the sampling system. During the initial system bias checks, response-time data was obtained for each analyzer. Subsequently, system bias checks were performed both prior to and following each test run using zero and one upscale calibration gas. These system checks allowed for the determination of initial and final system bias, as well as system drift for each test run. The calibration gases used during this program were prepared to EPA Protocol G1/G2 standards. Certificates of analysis for the calibration gases are presented in **Appendix B**. The measurement system performance criteria in 40 CFR Part 60, Appendix A, Methods 3A are listed below and were the performance criteria for the reference method instruments during this program.

Procedure – Methods 3A, 7E, and 10	Performance Criterion
Calibration error	<±2% of the calibration span
System bias	<±5% of the calibration span
System drift	<±3% of the calibration span

The instrumental analysis methods also require correction of data for calibration drift and/or bias. The values used for the determination of concentration were corrected for system drift and bias observed during each test run. System bias and drift as well as response-time data are presented in **Appendix A** of this report.

6. Data Reduction

6.1 Overview

The objective of the monitoring program was to determine the mass emission rates of the PM_{10}. The results have been reported on an individual analyzer basis (concentrations) and for exhaust gas volumetric flow rate. Photocopies of the raw field data sheets and data printouts are also presented in the appendices. Equations and example calculations from the data reduction process are presented in **Appendix A**.