Source Test Report for
2022 Compliance Emissions Testing

Boiler No. 10 (EUBOILER#10) and
Boiler No. 11 (EUBOILER#11)

Graphic Packaging International, LLC
Kalamazoo, Michigan

Prepared For:

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STAC STACK TESTING ACCREDITATION COUNCIL
ACCREDITED TO ASTM D7036 ONLY CERT #3925.01

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Review and Certification

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature:	Shawn Jaworski	**Date:**	11 / 04 / 2022
Name:	Shawn Jaworski	**Title:**	Senior Field Technician

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature:	robert j lisy jr	**Date:**	11 / 04 / 2022
Name:	Robert J. Lisy, Jr.	**Title:**	Reporting Hub Manager

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1.0 Introduction

1.1 Summary of Test Program

Graphic Packaging International, LLC (Graphic Packaging) (Facility ID: B1678) contracted Montrose Air Quality Services, LLC (Montrose) to perform a compliance test program on Boilers No. 10 (EUBOILER#10) and 11 (EUBOILER#11) at the Graphic Packaging facility located in Kalamazoo, Michigan. Testing was performed on October 17-18, 2022, for the purpose of satisfying the emission testing requirements pursuant to Michigan Department of Environment, Great Lakes, and Energy (EGLE) Permit-to-Install (PTI) No. 133-19A.

The specific objectives were to:

- Verify the emissions of total particulate matter (TPM) under 2.5-µm ($PM_{2.5}$) and PM under 10-µm (PM_{10}) from the exhaust stacks (SVBLR1 and SVBLR2) serving EUBOILER#10 and EUBOILER#11
- Conduct the test program with a focus on safety

Montrose performed the tests to measure the emission parameters listed in Table 1-1. All Total PM (TPM) emissions are to be considered as $PM_{2.5}$ and PM_{10} for compliance determination.

Table 1-1
Summary of Test Program

Test Date(s)	Unit ID/ Source Name	Activity/Parameters	Test Methods	No. of Runs	Duration (Minutes)
10/17/2022	EUBOILER#10	Velocity/Volumetric Flow Rate	EPA 1 & 2	3	120
10/17/2022	EUBOILER#10	O_2, CO_2	EPA 3A	3	120
10/17/2022	EUBOILER#10	Moisture	EPA 4	3	120
10/17/2022	EUBOILER#10	FPM, CPM	EPA 5/202	3	120
10/18/2022	EUBOILER#11	Velocity/Volumetric Flow Rate	EPA 1 & 2	3	120
10/18/2022	EUBOILER#11	O_2, CO_2	EPA 3A	3	120
10/18/2022	EUBOILER#11	Moisture	EPA 4	3	120
10/18/2022	EUBOILER#11	FPM, CPM	EPA 5/202	3	120

To simplify this report, a list of Units and Abbreviations is included in Appendix D.1. Throughout this report, chemical nomenclature, acronyms, and reporting units are not defined. Please refer to the list for specific details.

This report presents the test results and supporting data, descriptions of the testing procedures, descriptions of the facility and sampling locations, and a summary of the quality assurance procedures used by Montrose. The average emission test results are summarized and compared to their respective permit limits in Tables 1-2 and 1-3. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

The testing was conducted by the Montrose personnel listed in Table 1-4. The tests were conducted according to the test plan dated April 4, 2022, and revised April 11, 2022, that was submitted to EGLE.

Table 1-2
Summary of Average Compliance Results – EUBOILER#10

October 17, 2022

Parameter/Units	Average Results	Emission Limits
Total Particulate Matter (TPM) ($PM_{2.5}$ / PM_{10})		
lb/MMBtu	0.0021	0.004

Table 1-3
Summary of Average Compliance Results – EUBOILER#11

October 18, 2022

Parameter/Units	Average Results	Emission Limits
Total Particulate Matter (TPM) ($PM_{2.5}$ / PM_{10})		
lb/MMBtu	0.0018	0.004

1.2 Key Personnel

A list of project participants is included below:

Facility Information

Source Location:	Graphic Packaging International, LLC 1500 North Pitcher Street Kalamazoo, MI 49007
Project Contact:	Steven Smock
Role:	Environmental Manager
Company:	Graphic Packaging
Telephone:	269-383-5453
Email:	steven.smock@graphicpkg.com

Agency Information

Regulatory Agency:	EGLE
Agency Contact:	Lindsey Wells
Telephone:	517-282-2345
Email:	WellsL8@michigan.gov

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC	
Contact:	Robert J. Lisy, Jr.	Shawn Jaworski
Title:	Reporting Hub Manager	Senior Field Technician
Telephone:	440-262-3760	440-262-3760
Email:	rlisy@montrose-env.com	sjaworski@montrose-env.com

Laboratory Information

Laboratory:	Enthalpy Analytical, LLC
City, State:	Durham, NC
Method:	EPA Methods 5 and 202

Test personnel and observers are summarized in Table 1-4.

Table 1-4
Test Personnel and Observers

Name	Affiliation	Role/Responsibility
Shawn Jaworski	Montrose	Field Project Manager, QI
Jason Fawks	Montrose	Field Technician
Steven Smock	Graphic Packaging	Test Coordinator
Lindsey Wells	EGLE	Observer

2.0 Plant and Sampling Location Descriptions

2.1 Process Description, Operation, and Control Equipment

Graphic Packaging International operates two 311 MMBtu/hr natural gas-fired boilers (EUBOILER#10 and EUBOILER#11) (FGBOILERS10-11) to generate steam and hot water for use in facility operations. EUBOILER#10 and EUBOILER#11 are equipped with low NO_x burners and flue gas recirculation. They have maximum heat input rates of 311 MMBtu/hr and were in operation for this test event.

2.2 Flue Gas Sampling Locations

Information regarding the sampling locations is presented in Table 2-1.

Table 2-1
Sampling Locations

Sampling Location	Stack Inside Diameter (in.)	Distance from Nearest Disturbance		Number of Traverse Points
		Downstream EPA "B" (in./dia.)	Upstream EPA "A" (in./dia.)	
EUBOILER#10 Exhaust Stack (SVBLR10)	62.3	140.0 / 2.2	310.0 / 5.0	Isokinetic: 24 (12/port) Gaseous: 1
EUBOILER#11 Exhaust Stack (SVBLR11)	62.3	140.0 / 2.2	310.0 / 5.0	Isokinetic: 24 (12/port) Gaseous: 1

Sample locations were verified in the field to conform to EPA Method 1. Acceptable cyclonic flow conditions were confirmed prior to testing using EPA Method 1, Section 11.4. See Appendix A.1 for more information.

2.3 Operating Conditions and Process Data

Emission tests were performed while the boilers operated at greater than 90% of its rated capacity.

Plant personnel were responsible for establishing the test conditions and collecting all applicable unit-operating data. The process data that was provided is presented in Appendix B. Data collected includes the following parameters:

- Gas flow rate, kscfh
- Steam Load, lb/hr

3.0 Sampling and Analytical Procedures

3.1 Test Methods

The test methods for this test program have been presented in Table 1-1. Additional information regarding specific applications or modifications to standard procedures is presented below.

3.1.1 EPA Method 1, Sample and Velocity Traverses for Stationary Sources

EPA Method 1 is used to assure that representative measurements of volumetric flow rate are obtained by dividing the cross-section of the stack or duct into equal areas, and then locating a traverse point within each of the equal areas. Acceptable sample locations must be located at least two stack or duct equivalent diameters downstream from a flow disturbance and one-half equivalent diameter upstream from a flow disturbance.

The sample port and traverse point locations are detailed in Appendix A.

3.1.2 EPA Method 2, Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

EPA Method 2 is used to measure the gas velocity using an S-type pitot tube connected to a pressure measurement device, and to measure the gas temperature using a calibrated thermocouple connected to a thermocouple indicator. Typically, Type S (Staußcheibe) pitot tubes conforming to the geometric specifications in the test method are used, along with an inclined manometer. The measurements are made at traverse points specified by EPA Method 1.

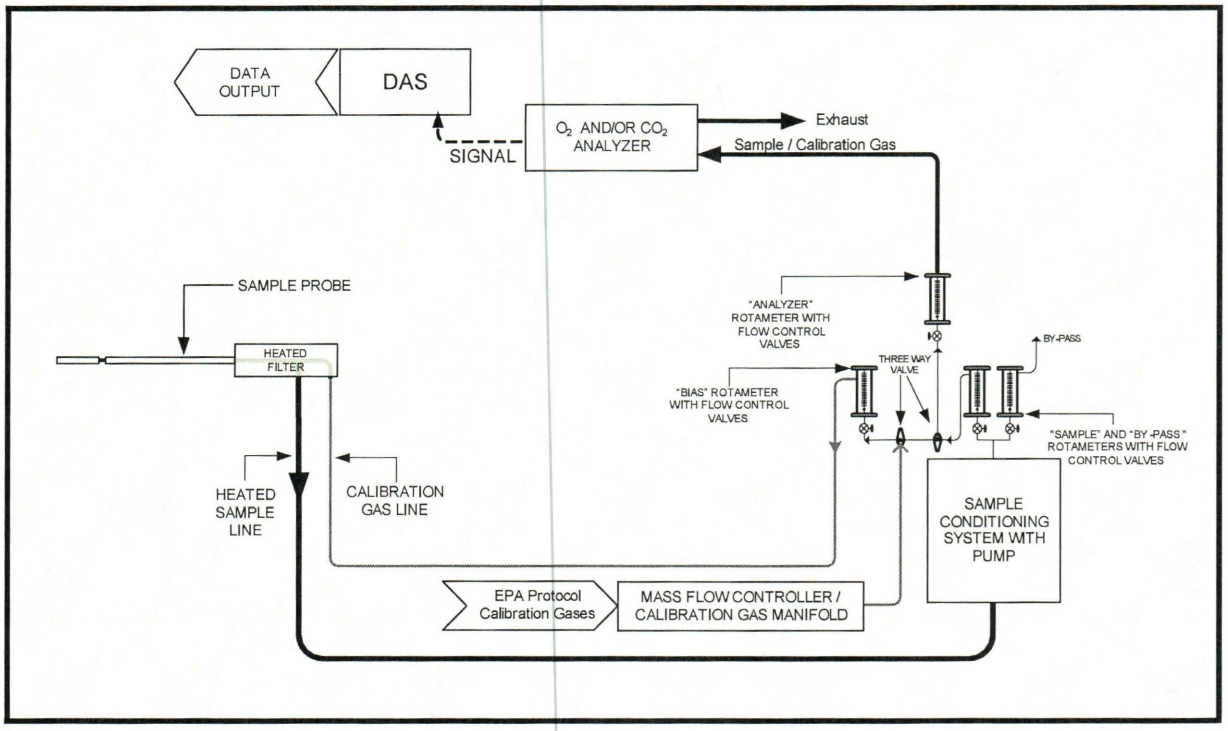
The typical sampling system is detailed in Figure 3-2.

3.1.3 EPA Method 3A, Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)

EPA Method 3A is an instrumental test method used to measure the concentration of O_2 and CO_2 in stack gas. The effluent gas is continuously or intermittently sampled and conveyed to analyzers that measure the concentration of O_2 and CO_2. The performance requirements of the method must be met to validate data.

The typical sampling system is detailed in Figure 3-1.

Figure 3-1
EPA Method 3A Sampling Train



3.1.4 EPA Method 4, Determination of Moisture Content in Stack Gas

EPA Method 4 is a manual, non-isokinetic method used to measure the moisture content of gas streams. Gas is sampled at a constant sampling rate through a probe and impinger train. Moisture is removed using a series of pre-weighed impingers containing methodology-specific liquids and silica gel immersed in an ice water bath. The impingers are weighed after each run to determine the percent moisture.

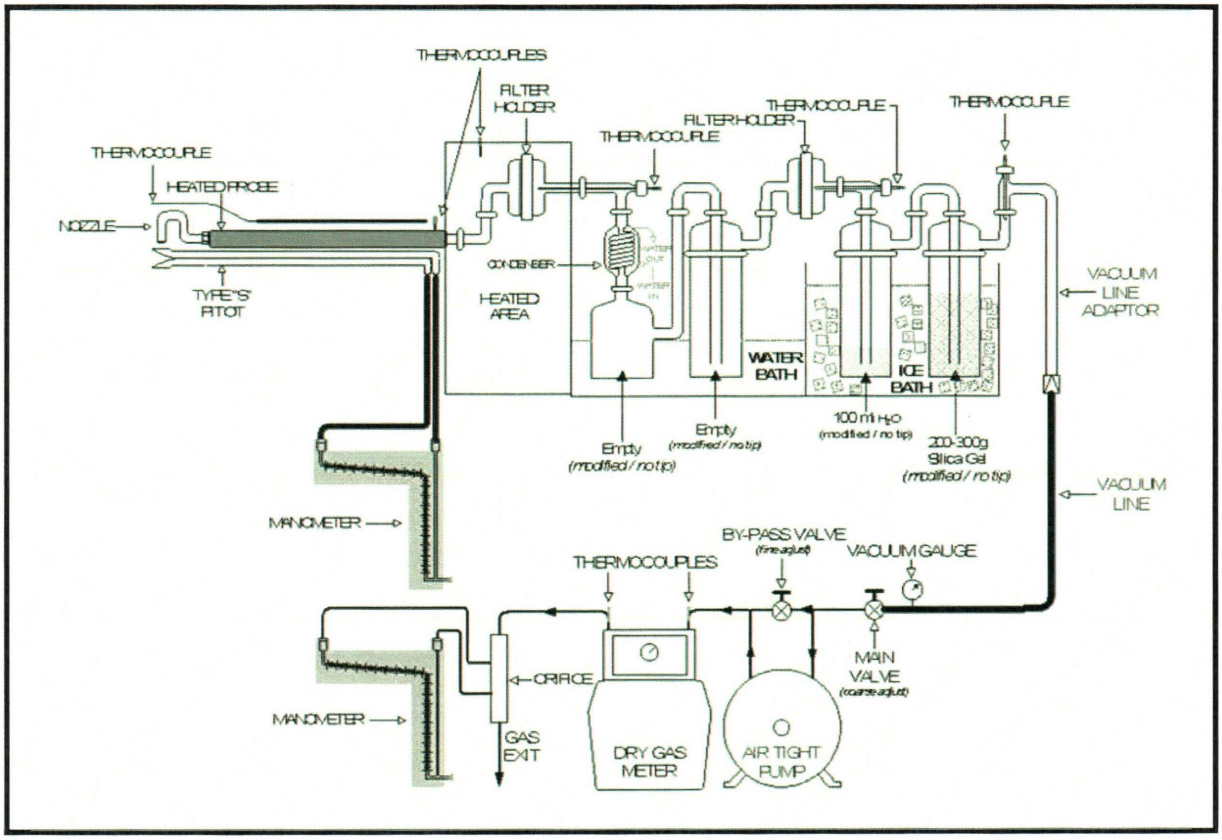
The typical sampling system is detailed in Figure 3-2.

3.1.5 EPA Method 5, Determination of Particulate Matter from Stationary Sources

EPA Method 5 is a manual, isokinetic method used to measure FPM emissions. The samples are analyzed gravimetrically. This method is performed in conjunction with EPA Methods 1 through 4. The stack gas is sampled through a nozzle, probe, filter, and impinger train. FPM results are reported in emission concentration and emission rate units.

The typical sampling system is detailed in Figure 3-2.

Figure 3-2
EPA Method 5/202 Sampling Train



3.1.6 EPA Method 19, Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates

EPA Method 19 is used to calculate mass emission rates in units of lb/MMBtu. EPA Method 19, Table 19-2 contains a list of assigned fuel factors for different types of fuels, which can be used for these calculations.

3.1.7 EPA Method 202, Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources

The CPM is collected in dry impingers after filterable PM has been collected on a filter maintained as specified in either Method 5 of Appendix A-3 to 40 CFR 60, Method 17 of Appendix A-6 to 40 CFR 60, or Method 201A of Appendix M to 40 CFR 51. The organic and aqueous fractions of the impingers and an out-of-stack CPM filter are then taken to dryness and weighed. The total of the impinger fractions and the CPM filter represents the CPM. Compared to the version of Method 202 that was promulgated on December 17, 1991, this method eliminates the use of water as the collection media in impingers and includes the addition of a condenser followed by a water dropout impinger immediately after the final in-stack or heated filter. This method also includes the addition of one modified Greenburg Smith impinger (backup impinger) and a CPM filter following the water dropout impinger.

CPM is collected in the water dropout impinger, the modified Greenburg Smith impinger, and the CPM filter of the sampling train as described in this method. The impinger contents are purged with nitrogen immediately after sample collection to remove dissolved SO_2 gases from the impinger. The CPM filter is extracted with water and hexane. The impinger solution is then extracted with hexane. The organic and aqueous fractions are dried and the residues are weighed. The total of the aqueous and organic fractions represents the CPM.

The potential artifacts from SO_2 are reduced using a condenser and water dropout impinger to separate CPM from reactive gases. No water is added to the impingers prior to the start of sampling. To improve the collection efficiency of CPM, an additional filter (the "CPM filter") is placed between the second and third impingers

The typical sampling system is detailed in Figure 3-2.

3.2 Process Test Methods

The test plan did not require that process samples be collected during this test program; therefore, no process sample data are presented in this test report.

4.0 Test Discussion and Results

4.1 Field Test Deviations and Exceptions

The post-test sampling train leak check performed after Run 3 at the EUBOILER#11 Exhaust Stack yielded a leakage rate which was greater than the allowable leakage rate of 0.020 cfm as specified within EPA Method 5, Section 8.4.4. Therefore, Run 3 was voided, and an additional run (Run 4) was performed. Results from Run 3 are not included in this test report.

Prior to Run 1 sampling at the EUBOILER#10 Exhaust Stack, an initial system bias test was not performed following the recalibration of the EPA Method 3A CO_2 analyzer. As a result, the zero and mid-level direct calibration gas responses were utilized as the initial system bias in order to determine the bias corrected CO_2 concentration for Run 1. It is the opinion of Montrose that this substitution had little to no effect on the overall results of this test.

4.2 Presentation of Results

The average results are compared to the permit limits in Tables 1-2 and 1-3. The results of individual compliance test runs performed are presented in Tables 4-1 and 4-2. Emissions are reported in units consistent with those in the applicable regulations or requirements. Additional information is included in the appendices as presented in the Table of Contents.

Table 4-1
TPM ($PM_{2.5}/PM_{10}$) Emissions Results - EUBOILER#10

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	10/18/2022	10/18/2022	10/18/2022	--
Time	8:43-10:49	11:28-13:32	13:59-16:04	--
Process Data				
Gas flow rate, kscfh *				
Steam load, klb/hr *				
Fc-based heat input rate, MMBtu/hr	269.2	264.0	265.5	266.2
Sampling & Flue Gas Parameters				
O_2, % volume dry	3.62	3.74	3.72	3.69
CO_2, % volume dry	10.43	10.12	10.26	10.27
flue gas temperature, °F	252.7	256.9	256.1	255.2
moisture content, % volume	16.42	16.31	16.31	16.35
volumetric flow rate, dscfm	44,753	45,206	44,858	44,939
Filterable Particulate Matter (FPM)				
gr/dscf	0.00015	0.00016	0.00020	0.00017
lb/hr	0.056	0.063	0.078	0.066
lb/MMBtu	0.00021	0.00024	0.00029	0.00025
Condensable Particulate Matter (CPM)				
gr/dscf	0.0011	0.0011	0.0017	0.0013
lb/hr	0.42	0.42	0.65	0.50
lb/MMBtu	0.0016	0.0016	0.0025	0.0019
Total Particulate Matter (TPM) ($PM_{2.5}/PM_{10}$)				
lb/hr	0.47	0.49	0.73	0.56
lb/MMBtu	0.0018	0.0018	0.0028	0.0021

* Process data was provided by Graphic Packaging personnel.

Table 4-2
TPM ($PM_{2.5}/PM_{10}$) Emissions Results -
EUBOILER#11

Parameter/Units	Run 1	Run 2	Run 4	Average
Date	10/17/2022	10/17/2022	10/17/2022	--
Time	9:28-11:37	12:29-14:37	18:15-20:20	--
Process Data				
Gas flow rate, kscfh *				
Steam load, klb/hr *				
Fc-based heat input rate, MMBtu/hr	240.4	240.6	248.1	243.0
Sampling & Flue Gas Parameters				
O_2, % volume dry	4.30	4.35	4.43	4.36
CO_2, % volume dry	9.73	9.70	9.77	9.73
flue gas temperature, °F	253.4	255.1	257.8	255.4
moisture content, % volume	15.17	15.81	15.94	15.64
volumetric flow rate, dscfm	42,829	43,002	44,012	43,281
Filterable Particulate Matter (FPM)				
gr/dscf	0.00018	0.00051	0.00027	0.00032
lb/hr	0.067	0.190	0.100	0.119
lb/MMBtu	0.00028	0.00079	0.00040	0.00049
Condensable Particulate Matter (CPM)				
gr/dscf	0.00073	0.00099	0.00080	0.00084
lb/hr	0.27	0.37	0.30	0.31
lb/MMBtu	0.0011	0.0015	0.0012	0.0012
Total Particulate Matter (TPM) ($PM_{2.5}/PM_{10}$)				
lb/hr	0.33	0.56	0.40	0.43
lb/MMBtu	0.0014	0.0023	0.0016	0.0018

* Process data was provided by Graphic Packaging personnel.

5.0 Internal QA/QC Activities

5.1 QA/QC Audits

The meter boxes and sampling trains used during sampling performed within the requirements of their respective methods. All post-test leak checks, minimum metered volumes, minimum sample durations, and percent isokinetics met the applicable QA/QC criteria.

EPA Method 3A calibration audits were all within the measurement system performance specifications for the calibration drift checks, system calibration bias checks, and calibration error checks.

EPA Method 5 analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met, except if noted in Section 5.2. An EPA Method 5 reagent blank was analyzed. The maximum allowable amount that can be subtracted is 0.001% of the weight of the acetone used. The blank did not exceed the maximum residue allowed.

EPA Method 202 analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met. An EPA Method 202 Field Train Recovery Blank (FTRB) was performed for each source category. The maximum allowable amount that can be subtracted is 0.002 g (2.0 mg). For this project, the FTRB had a mass of 5.37 mg, and 2.00 mg was subtracted.

5.2 QA/QC Discussion

All QA/QC criteria were met during this test program.

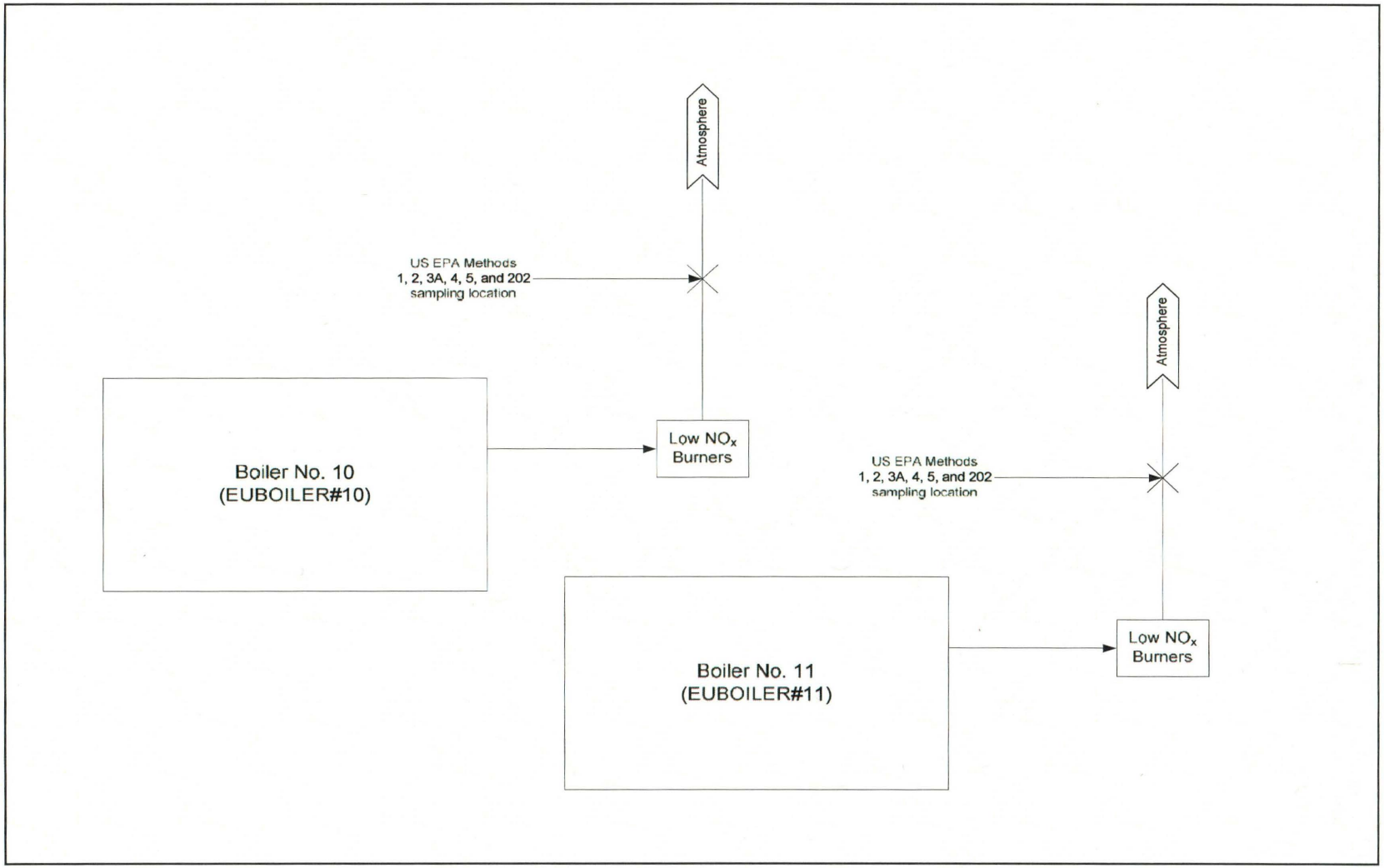
5.3 Quality Statement

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the report appendices. The content of this report is modeled after the EPA Emission Measurement Center Guideline Document (GD-043).

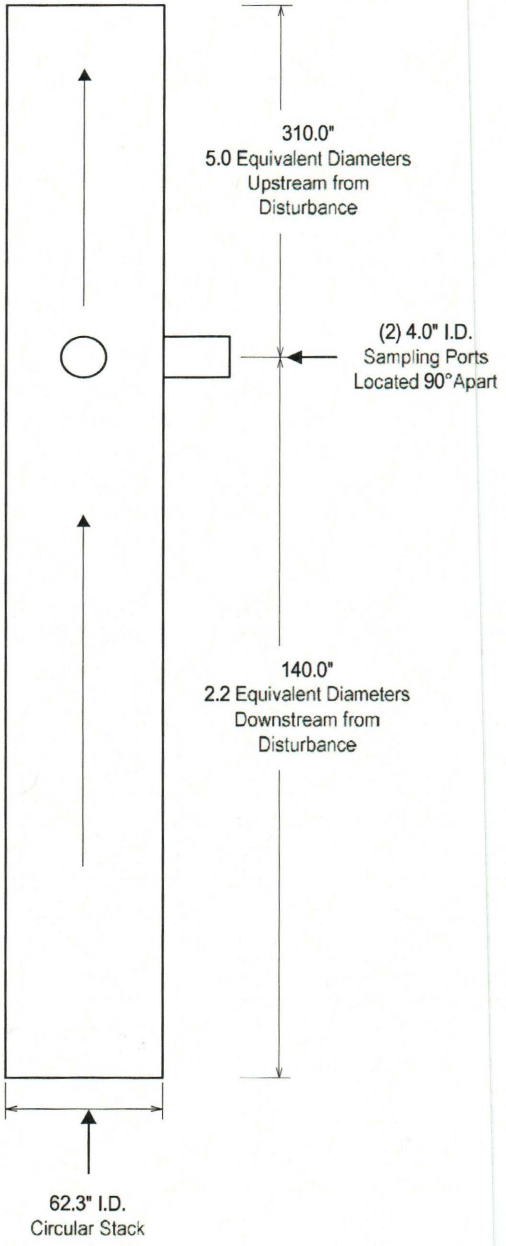
Appendix A
Field Data and Calculations

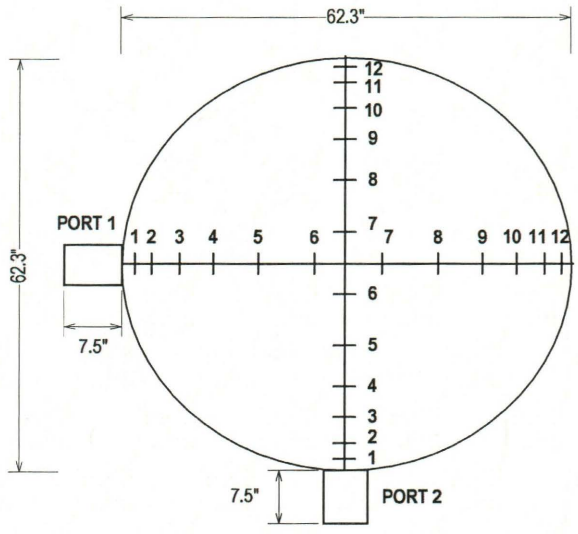
Appendix A.1
Sampling Locations

EUBOILER#10 AND EUBOILER#11 SAMPLING LOCATION SCHEMATIC



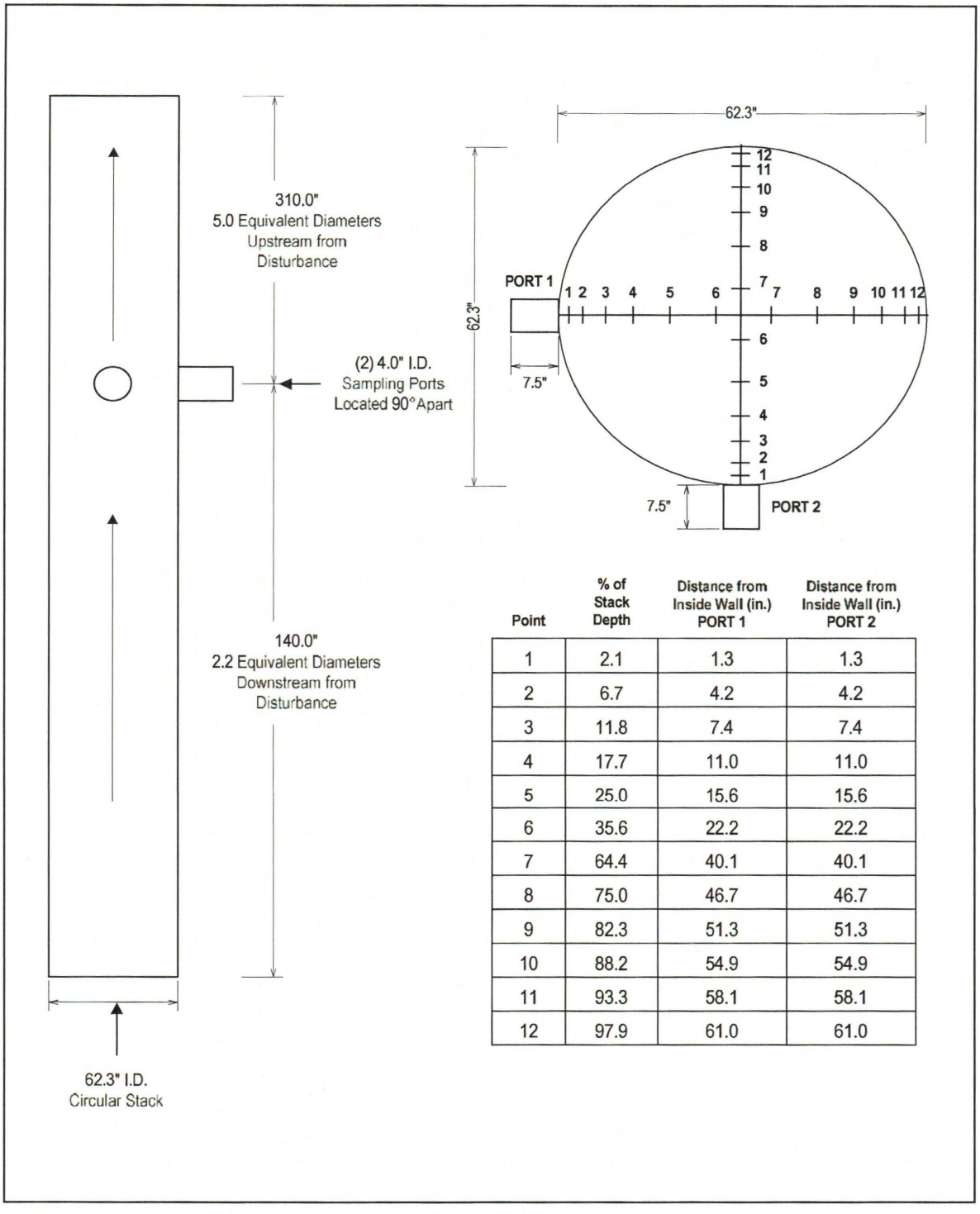
EUBOILER#10 EXHAUST ISOKINETIC TRAVERSE POINT LOCATION DRAWING





Point	% of Stack Depth	Distance from Inside Wall (in.) PORT 1	Distance from Inside Wall (in.) PORT 2
1	2.1	1.3	1.3
2	6.7	4.2	4.2
3	11.8	7.4	7.4
4	17.7	11.0	11.0
5	25.0	15.6	15.6
6	35.6	22.2	22.2
7	64.4	40.1	40.1
8	75.0	46.7	46.7
9	82.3	51.3	51.3
10	88.2	54.9	54.9
11	93.3	58.1	58.1
12	97.9	61.0	61.0

EUBOILER#11 EXHAUST ISOKINETIC TRAVERSE POINT LOCATION DRAWING



Point	% of Stack Depth	Distance from Inside Wall (in.) PORT 1	Distance from Inside Wall (in.) PORT 2
1	2.1	1.3	1.3
2	6.7	4.2	4.2
3	11.8	7.4	7.4
4	17.7	11.0	11.0
5	25.0	15.6	15.6
6	35.6	22.2	22.2
7	64.4	40.1	40.1
8	75.0	46.7	46.7
9	82.3	51.3	51.3
10	88.2	54.9	54.9
11	93.3	58.1	58.1
12	97.9	61.0	61.0