Source Test Report for 2023 Compliance Testing Engines EU-COMPWEST (3), EU-COMPNORTH (1) and EU-COMPEAST (4)
Bluewater Gas Storage, LLC
Bluewater Gas Storage Station
Columbus, Michigan

Prepared For:

Bluewater Gas Storage, LLC
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Prepared By:

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For Submission To:

Michigan Department of Environment, Great Lakes and Energy
525 West Allegan Street
Lansing, MI 48933

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ACCREDITED
TO ASTM D7036 ONLY
CERT #1925.01

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:	Brandon Check	**Date:**	10 / 04 / 2023
Name:	Brandon Check	**Title:**	Client Project Manager

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:	Henry M. Taylor	**Date:**	10 / 04 / 2023
Name:	Henry M. Taylor, QSTO	**Title:**	Senior Reporting QC Specialist

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1.0 Introduction

1.1 Summary of Test Program

Bluewater Gas Storage, LLC (Bluewater) contracted Montrose Air Quality Services, LLC (Montrose) to perform a compliance emissions test program on the sources listed in Table 1-1 at the Bluewater Gas Storage Station facility located in Columbus, MI.

The tests were conducted to determine compliance with the emission limits listed in the Permit to Install (PTI) 77-14C issued by the Michigan Department of Environment, Great Lakes, and Energy (EGLE), and emission limits listed in 40 CFR 63 Subpart ZZZZ.

The specific objectives were to:

- Determine the nitrogen oxides (NO_x), carbon monoxide (CO) and formaldehyde (HCHO) emissions from three natural gas fired, compressor engines at the Bluewater Gas Storage Columbus Facility.
- Conduct the test program with a focus on safety

Montrose performed the tests to measure the emission parameters listed in Table 1-1.

Table 1-1
Summary of Test Program

Test Date(s)	Unit ID/ Source Name	Activity/Parameters	Test Methods	No. of Runs	Duration (Minutes)
9/12/2023-9/13/2023	EU-COMPWEST (3), EU-COMPNORTH (1), EU-COMPEAST (4)	Sampling Locations	EPA 1	--	--
		O_2, CO_2	EPA 3A	3	60
		NO_x	EPA 7E	3	60
		CO	EPA 10	3	60
		CH_2O	EPA 320	3	60

To simplify this report, a list of Units and Abbreviations is included in Appendix C.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 through 1-4. 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 1-5. The tests were conducted according to the test plan (protocol) dated July 6, 2023 that was submitted to the Michigan EGLE.

Table 1-2
Summary of Average Compliance Results – EU-COMPWEST

September 12, 2023

Parameter/Units	Average Results	Emission Limits
Nitrogen Oxides (NO_x)		
lb/hr	3.66 lb/hr	≤ 7.4 lb/hr
Carbon Monoxide (CO)		
ppmvd @ 15% O_2	3.92 ppmvd @ 15% O_2	≤ 47 ppmvd @ 15% O_2
lb/hr	0.252 lb/hr	≤ 1.85 lb/hr
Formaldehyde (HCHO)		
lb/hr	0.195 lb/hr	≤ 0.248 lb/hr

Table 1-3
Summary of Average Compliance Results – EU-COMPNORTH

September 13, 2023

Parameter/Units	Average Results	Emission Limits
Nitrogen Oxides (NO_x)		
lb/hr	3.77 lb/hr	≤ 4.5 lb/hr
Carbon Monoxide (CO)		
ppmvd @ 15% O_2	< 0.006 ppmvd @ 15% O_2	≤ 47 ppmvd @ 15% O_2
lb/hr	< 0.00001 lb/hr	≤ 0.40 lb/hr
Formaldehyde (HCHO)		
lb/hr	0.002 lb/hr	≤ 0.017 lb/hr

Table 1-4
Summary of Average Compliance Results – EU-COMPEAST

September 13, 2023

Parameter/Units	Average Results	Emission Limits
Nitrogen Oxides (NO_x)		
lb/hr	2.72 lb/hr	≤ 7.4 lb/hr
Carbon Monoxide (CO)		
ppmvd @ 15% O_2	1.99 ppmvd @ 15% O_2	≤ 47 ppmvd @ 15% O_2
lb/hr	0.136 lb/hr	≤ 1.85 lb/hr
Formaldehyde (HCHO)		
lb/hr	0.236 lb/hr	≤ 0.248 lb/hr

1.2 Key Personnel

A list of project participants is included below:

Facility Information

Source Location:	Bluewater Gas Storage, LLC 333 South Wales Center Columbus, MI 48063
Project Contact:	James Jensen
Company:	Bluewater Gas Storage, LLC
Telephone:	414-221-2530
Email:	James.Jensen@wecenergygroup.com

Agency Information

Regulatory Agency:	Michigan Department of Environment, Great Lakes and Energy
Agency Contact:	Jeremy Howe
Telephone:	231-878-6687
Email:	Howej@michigan.gov

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC
Contact:	Brandon Check
Title:	Client Project Manager
Telephone:	630-860-4740
Email:	bcheck@montrose-env.com

Test personnel and observers are summarized in Table 1-5.

Table 1-5
Test Personnel and Observers

Name	Affiliation	Role/Responsibility
Brandon Check	Montrose	Project Manager/Field Team Leader
Sean Wheeler	Montrose	Project Manager/Qualified Individual (QI)/Trailer operator
Jeremy Devries	Montrose	Field Support
Levi Butler	Montrose	Calculations and report preparation
James Jensen	WEC Energy Group	Client Liaison/Test Coordinator
Regina Angellotti	Michigan EGLE	Observer

2.0 Plant and Sampling Location Descriptions

2.1 Process Description, Operation, and Control Equipment

EU-COMPNORTH is a Caterpillar G3516 natural gas fired, 4 stroke, lean burn, reciprocating internal combustion engine driving compressors and has a rated capacity of 10.1 MMBtu/hr heat input. EU-COMPWEST and EU-COMPEAST are Caterpillar G3616 gas fired, 4-stroke, lean burn, reciprocating internal combustion engines driving compressors and have a rated capacity of 31.9 MMBtu/hr heat input. All three engine emissions are controlled with catalytic oxidation systems.

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.)	
EU-COMPNORTH (1)	12	~ 34 / 2.83	~ 36 / 3.0	Gaseous: 3
EU-COMPWEST (3), EU-COMPEAST (4)	31	~ 84 / 2.71	~ 25 / 0.81	Gaseous: 3

The sample locations were verified in the field to conform to EPA Method 1. See Appendix A.1 for more information.

2.3 Operating Conditions and Process Data

Emission tests were performed while the units and air pollution control devices were operating at the conditions required by the permit.

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.

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 Methods 3A, 7E, and 10, Determination of Oxygen, Nitrogen Oxides, and Carbon Monoxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)

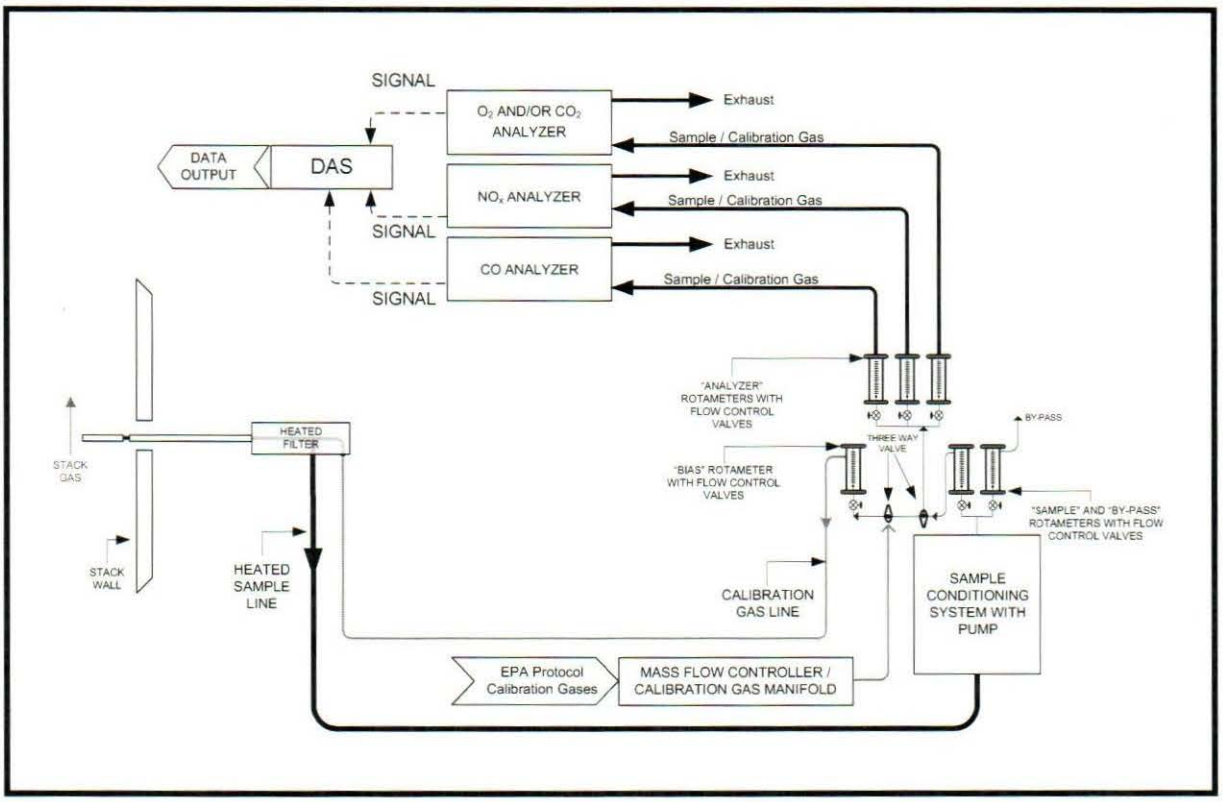
Concentrations of O_2, NO_X, and CO are measured simultaneously using EPA Methods 3A, 7E, and 10, which are instrumental test methods. Conditioned gas is sent to a series of analyzers to measure the gaseous emission concentrations. The performance requirements of the method must be met to validate the data.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - A dry extractive sampling system is used to report emissions on a dry basis
  - A paramagnetic analyzer is used to measure O_2
  - A chemiluminescent analyzer is used to measure NO_x
  - A gas filter correlation nondispersive infrared analyzer is used to measure CO
- Method Exceptions:
  - For gaseous emissions sampling, MDL are calculated for each analyzer. The ISDL is equal to the sensitivity of the instrumentation, which is 2% of the span value.
- Target and/or Minimum Required Sample Duration: 60 minutes
- Target Analytes: O_2, NO_X, and CO

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

Figure 3-1
US EPA Method 3A, 7E, and 10 Sampling Train



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

EPA Method 19 is a manual method used to determine (a) PM, SO_2, and NO_x emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions. This method provides data reduction procedures, but does not include any sample collection or analysis procedures.

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.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - F factor is the oxygen-based F factor, dry basis (F_d)
  - F factor is provided by Bluewater's DAS
  - Heat input data is calculated based on the fuel flow rate and higher heating value
  - Heat input data is provided by Bluewater's DAS
  - Higher Heating Value is provided by Bluewater's DAS
- Method Exceptions:
  - None

3.1.3 EPA Method 320, Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive FTIR Spectroscopy

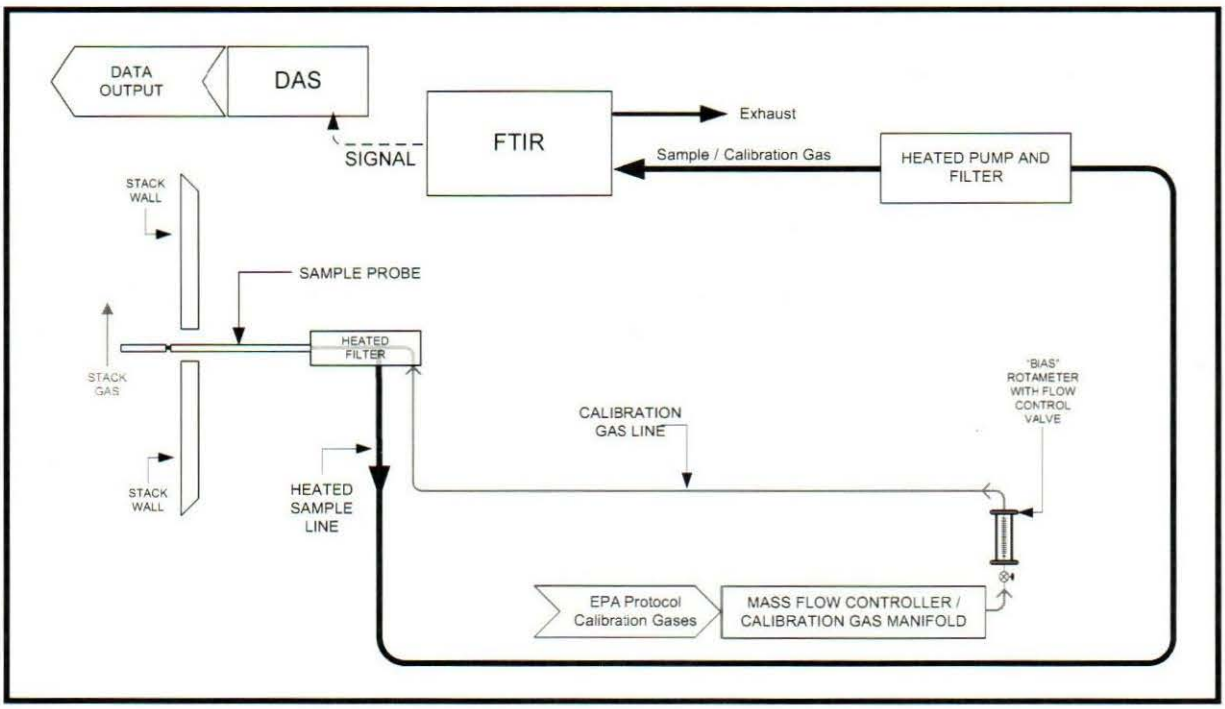
EPA Method 320 is an instrumental test method used to measure specific analyte concentrations for which EPA reference spectra have been developed or prepared. Extractive emission measurements are performed using FTIR spectroscopy. The FTIR analyzer is composed of a spectrometer and detector, a high optical throughput sampling cell, analysis software, and a quantitative spectral library. The analyzer collects high resolution spectra in the mid infrared spectral region (400 to 4,000 cm^{-1}), which are analyzed using the quantitative spectral library. This provides an accurate, highly sensitive measurement of gases and vapors.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - The specific analyte concentrations include H_2O and formaldehyde
  - Continuous static sampling is performed at a flow rate of approximately 5 liters per minute
  - A dynamic matrix spike is performed using formaldehyde and SF_6 as a tracer gas
- Method Exceptions:
  - To calculate the MDL for the target analytes, the guidelines in Appendix B of 40 CFR 136 are followed using the Student t-test to calculate the MDL for each analyte at a 99% confidence level. This follows EPA guidelines for reporting of zeroes or non-detects and also meets the NELAC requirements for determination of MDL values.
  - Independent calculations of optical path length are not performed because the instrument has a fixed path of 5.11 meters
- Target and/or Minimum Required Sample Duration: 60 minutes

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

Figure 3-2
EPA Method 320 Sampling Train



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

No field deviations or exceptions from the test plan or test methods occurred during this test program.

4.2 Presentation of Results

The average results are compared to the permit limits in Tables 1-2 through 1-4. The results of individual compliance test runs performed are presented in Tables 4-1 through 4-3. 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
NO_x, CO, and Formaldehyde Emissions Results -
EU-COMPWEST

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	9/12/2023	9/12/2023	9/12/2023	--
Time	9:56-10:56	11:15-12:15	12:32-13:32	--
Process Data				
fuel factor, Fd	8612	8612	8612	8612
fuel flow, MSCFH	27.0	28.0	27.0	27.3
heating value, BTU	1068	1059	1059	1062.0
heat input, MMBtu/hr	28.8	29.7	28.6	29.0
Sampling & Flue Gas Parameters				
sample duration, minutes	60	60	60	--
O_2, % volume dry	11.36	11.39	11.39	11.38
moisture content, % volume	11.0	11.0	10.9	11.0
Nitrogen Oxides (NO_x)				
ppmvd	55.0	56.3	56.4	55.9
ppmvd @ 15% O_2	34.0	34.9	35.0	34.7
lb/hr	3.57	3.78	3.64	3.66
Carbon Monoxide (CO)				
ppmvd	6.29	6.35	6.33	6.32
ppmvd @ 15% O_2	3.89	3.94	3.92	3.92
lb/hr	0.249	0.259	0.249	0.252
Formaldehyde				
ppmvw	3.98	4.09	4.13	4.07
ppmvd	4.47	4.60	4.64	4.57
ppmvd @ 15% O_2	2.76	2.85	2.88	2.83
lb/hr	0.189	0.201	0.196	0.195

Table 4-2
NO_x, CO, and Formaldehyde Emissions Results - EU-COMPNORTH

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	9/13/2023	9/13/2023	9/13/2023	--
Time	11:02-12:02	12:19-13:20	13:45-14:45	--
Process Data				
fuel factor, Fd	8612	8612	8612	8612
fuel flow, MSCFH	5.55	5.50	5.46	5.50
heating value, BTU	1069	1069	1069	1069.0
heat input, MMBtu/hr	5.9	5.9	5.8	5.9
Sampling & Flue Gas Parameters				
sample duration, minutes	60	60	60	--
O_2, % volume dry	7.47	7.44	7.43	7.45
moisture content, % volume	13.6	13.7	13.8	13.7
Nitrogen Oxides (NO_x)				
ppmvd	399.3	395.7	407.2	400.7
ppmvd @ 15% O_2	175.4	173.4	178.4	175.7
lb/hr	3.79	3.71	3.79	3.77
Carbon Monoxide (CO)				
ppmvd	< 0.005	< 0.005	0.021	< 0.010
ppmvd @ 15% O_2	< 0.002	< 0.008	0.009	< 0.006
lb/hr	< 0.00003	< 0.00003	0.00012	< 0.00006
Formaldehyde				
ppmvw	0.363	0.363	0.324	0.350
ppmvd	0.420	0.421	0.376	0.406
ppmvd @ 15% O_2	0.184	0.185	0.165	0.178
lb/hr	0.003	0.003	0.002	0.002

Table 4-3
NO_x, CO, and Formaldehyde Emissions Results -
EU-COMPEAST

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	9/13/2023	9/13/2023	9/13/2023	--
Time	15:45-16:45	17:00-18:00	18:12-19:12	--
Process Data				
fuel factor, Fd	8612	8612	8612	8612
fuel flow, MSCFH	29.0	29.0	29.0	29.0
heating value, BTU	1062	1062	1062	1062.0
heat input, MMBtu/hr	30.8	30.8	30.8	30.8
Sampling & Flue Gas Parameters				
sample duration, minutes	60	60	60	--
O_2, % volume dry	12.07	12.08	12.05	12.07
moisture content, % volume	9.8	9.8	9.9	9.9
Nitrogen Oxides (NO_x)				
ppmvd	32.9	37.7	38.2	36.3
ppmvd @ 15% O_2	22.0	25.2	25.5	24.2
lb/hr	2.47	2.83	2.86	2.72
Carbon Monoxide (CO)				
ppmvd	2.91	2.99	3.06	2.98
ppmvd @ 15% O_2	1.94	2.00	2.04	1.99
lb/hr	0.133	0.137	0.139	0.136
Formaldehyde				
ppmvw	4.30	4.34	4.40	4.35
ppmvd	4.77	4.82	4.89	4.82
ppmvd @ 15% O_2	3.18	3.22	3.26	3.22
lb/hr	0.233	0.236	0.239	0.236

5.0 Internal QA/QC Activities

5.1 QA/QC Audits

EPA Method 3A, 7E, and 10 calibration audits were all within the measurement system performance specifications for the calibration drift checks, system calibration bias checks, and calibration error checks.

The NO_2 to NO converter efficiency check of the analyzer was conducted per the procedures in EPA Method 7E, Section 8.2.4. The conversion efficiency met the criteria.

The EPA Method 320 performance parameters measured included signal to noise tests, noise equivalent absorbance (NEA), detector linearity, background spectra, potential interferents, and cell and system leakage. Quality assurance procedures included baseline measurement with ultra-high purity nitrogen, measurement of a calibration transfer standard (~100 ppm ethylene), direct analyte calibration measurements, and measurements to determine baseline shift. SF_6 was also used as a tracer gas in the calibration gases to verify the sample delivery system integrity. A dynamic matrix spike was performed using SF_6 as a tracer gas. The method QA/QC criteria were met.

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

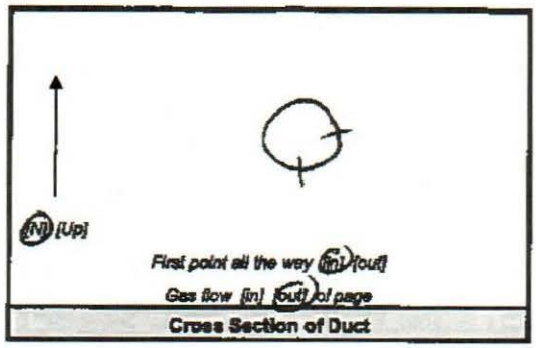
MONTROSE AIR QUALITY SERVICES INC.

EPA Method 1

Sample and Velocity Traverses Datasheet

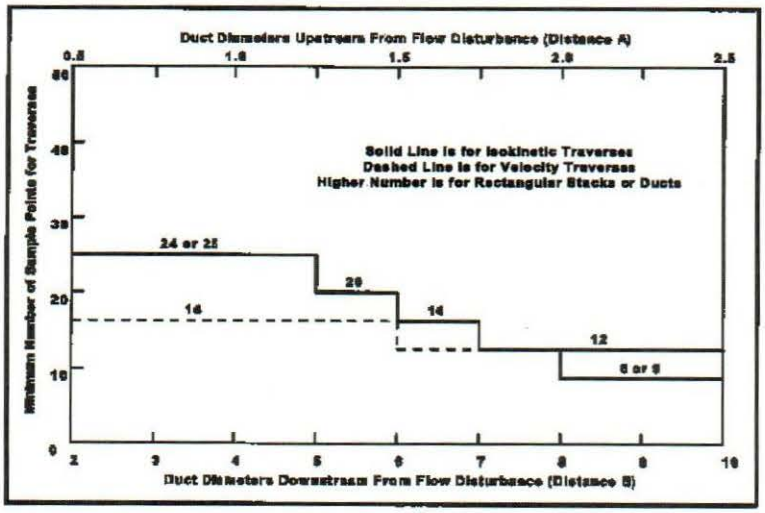
LOCATION NORTH (1)

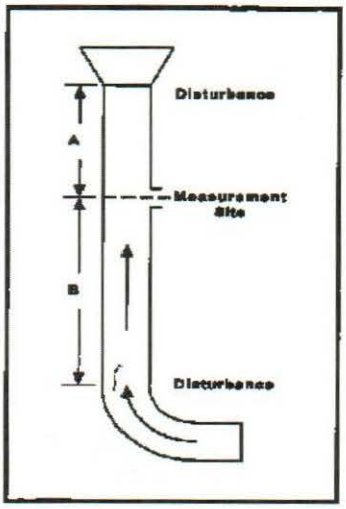
Client	WPS
Project No:	024983
Plant	COLUMBUS, MI
Date	9.13.23
Technician	JD
Duct Diameter (in.)	12"
Port Diameter (in.)	2"
Port Length (in.)	2"
Port Type	M. NIPPLE
Distance A (ft)	3'-36"
Distance B (ft)	2'10"-34"
Distance A (Duct Diameters)	3.0
Distance B (Duct Diameters)	2.83



Cross Section of Duct

For rectangular ducts $$ED = \frac{2LW}{(L+W)}$$





Location Schematic and Notes	Traverse Point	Distance (in.)
	1	4.004
	2	8.0
	3	11.996
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	
	16	

Indicate sample ports, height from grade, types of disturbances, access, unistrut configuration, etc.
Distance to point must include length of port

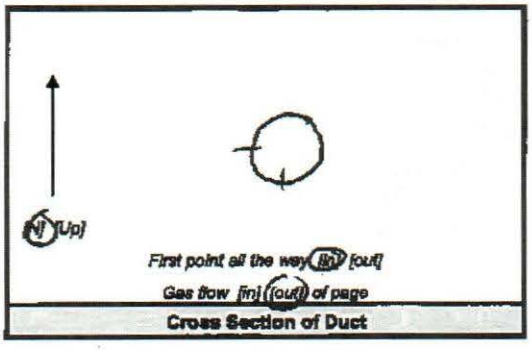
MONTROSE AIR QUALITY SERVICES INC.

EPA Method 1

Sample and Velocity Traverses Datasheet

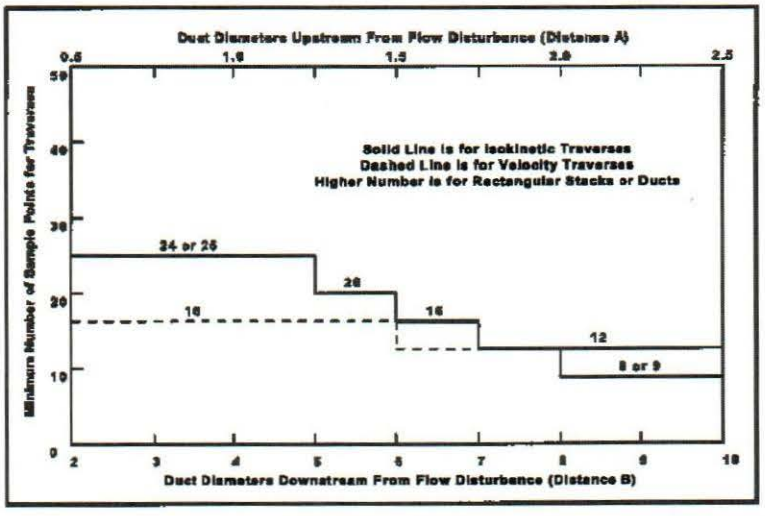
LOCATION (3) WEST / (4) EAST

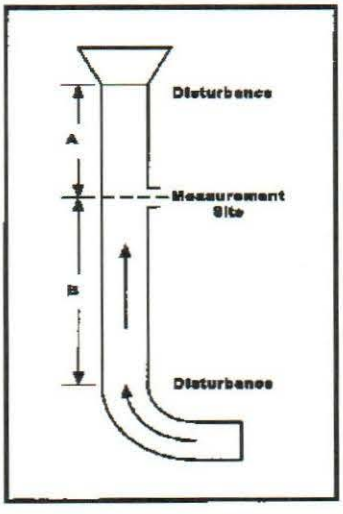
Client	MDU
Project No:	024983
Plant	Columbus, MI
Date	9.12.23
Technician	JD
Duct Diameter (in.)	~~31~~ 31"
Port Diameter (in.)	3"
Port Length (in.)	4"
Port Type	M. FLANGE
Distance A (ft)	2'1" — 25"
Distance B (ft)	7' — 84"
Distance A (Duct Diameters)	.81
Distance B (Duct Diameters)	2.71



Cross Section of Duct

For rectangular ducts $$ED = \frac{2LW}{(L+W)}$$





Location Schematic and Notes	Traverse Point	Distance (in.)
	~~1~~	~~4.~~
	~~2~~	~~20.00~~
	~~3~~	~~29.823~~
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	
	16	

9.177
19.50
29.823

Indicate sample ports, height from grade, types of disturbances, access, unistrut configuration, etc.

Distance to point must include length of port