1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

DTE Energy (DTE) contracted Montrose Air Quality Services, LLC (Montrose) to perform a $PM_{2.5}$ emissions test program on the Units 1 and 2 at the Monroe Power Plant facility located in Monroe, MI. The tests were conducted per Michigan Renewable Operating Permit (ROP) No. MI-ROP-B2816-2019 issued by Michigan Department of Environment, Great Lakes, And Energy (EGLE).

The specific objectives were to:

- Determine $PM_{2.5}$ emissions on Unit 1 and 2 stacks.
- 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)
12/14/21 & 12/15/21	Unit 1/Unit 2	Velocity/Volumetric Flow Rate	EPA 1 & 2	3	120
12/14/21 & 12/15/21	Unit 1/Unit 2	O_2, CO_2	EPA 3A	3	120
12/14/21 & 12/15/21	Unit 1/Unit 2	Moisture	EPA 4	3	120
12/14/21 & 12/15/21	Unit 1/Unit 2	TPM	EPA 5B/202	3	120

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 in Table 1-2. 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 1-3. The tests were conducted according to the test plan (protocol) dated April 1, 2021 that was submitted to and approved by the EGLE.

TABLE 1-2
SUMMARY OF AVERAGE $PM_{2.5}$ RESULTS -
UNIT 1
December 14, 2021

Parameter/Units	Average Results
Total Particulate Matter (PM)	
gr/dscf	0.0052
lb/hr	78.24
lb/MMBtu	0.0118

TABLE 1-3
SUMMARY OF AVERAGE $PM_{2.5}$ RESULTS -
UNIT 2
December 15, 2021

Parameter/Units	Average Results
Total Particulate Matter (PM)	
gr/dscf	0.0065
lb/hr	98.65
lb/MMBtu	0.0151

1.2 KEY PERSONNEL

A list of project participants is included below:

Facility Information

Source Location:	DTE Energy Monroe Power Plant 3500 E Front Street Monroe, MI
Project Contact:	Mr. Mark Grigereit
Role:	Principal Engineer, QSTI
Company:	DTE Energy
Telephone:	313-412-0305
Email:	Mark.grigereit@dteenergy.com

Agency Information

Regulatory Agency:	Michigan Department of Environment, Great Lakes, And Energy
Agency Contact:	Mr. Brian Carley
Telephone:	517-416-4631
Email:	CarleyB@michigan.gov

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC
Contact:	Mr. John Hamner
Title:	Account Manager
Telephone:	630-519-5135
Email:	jhamner@montrose-env.com

Laboratory Information

Laboratory:	Enthalpy Analytical
City, State:	Durham, NC
Method:	5B/202

Test personnel and observers are summarized in Table 1-3.

TABLE 1-3
TEST PERSONNEL AND OBSERVERS

Name	Affiliation	Role/Responsibility
John Hamner	Montrose	Field Team Leader/Sample Train Operator/Report Preparation
Justin Merryman	Montrose	Sample Recovery/Field Technician
Mark R Grigereit	DTE	Client Liaison/Test Coordinator

2.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

2.1 PROCESS DESCRIPTION, OPERATION, AND CONTROL EQUIPMENT

The Monroe Power Plant (MONPP) is a DTE Energy facility located at 3500 E. Front Street in Monroe, Michigan. The plant has four (4) coal-fired electric generating units, referred to as Units 1, 2, 3 and 4. These units were placed in service between 1971 and 1974, and have a total electric generating capacity of 3,135 megawatts (gross). The boiler (Babcock & Wilcox) for each unit is a similar supercritical pressure, pulverized coal-fired cell burner boiler. Units 1 through 4 exhaust into their own separate stacks.

Units 1 and 4 have General Electric turbine generators, each with a rated capability of 817 gross megawatts (GMW). Units 2 and 3 have Westinghouse turbine generators, each with a rated capability of 823 GMW.

The boiler exhausts are equipped with Research Cottrell electrostatic precipitators (ESPs) with particulate removal efficiencies greater than 99%. There is a sulfur trioxide flue gas conditioning system on each unit that is used to lower the resistivity of the fly ash for better collection by the ESPs. None of the units are equipped with Sulfuric Acid mist control equipment.

Units 1-4 are equipped with Selective Catalytic Reduction (SCR) systems to control 90% of the NOx emissions prior to their respective ESP's. Each unit has wet Flue Gas Desulfurization (FGD) Scrubbers to control sulfur dioxide (SO2), other acid gases, and particulate matter emissions.

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.)	
Unit 1	336	~2,805.6 / 8.35	~2,419.2 / 7.2	Isokinetic: 12 (4/port)
Unit 2	336	~2,805.6 / 8.35	~2,419.2 / 7.2	Isokinetic: 12 (4/port)

See Appendix A.1 for more information.

2.3 OPERATING CONDITIONS AND PROCESS DATA

Emission tests were performed while the units were operating at the conditions required by the permit. The units were tested when operating normally at Base load.

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:

- Load, MW
- NO_x, ppm & lb/MMBtu
- SO_2, ppm
- CO, ppm
- CO_2, %

3.0 SAMPLING AND ANALYTICAL PROCEDURES

3.1 TEST METHODS

The test methods for this test program were presented previously 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.

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

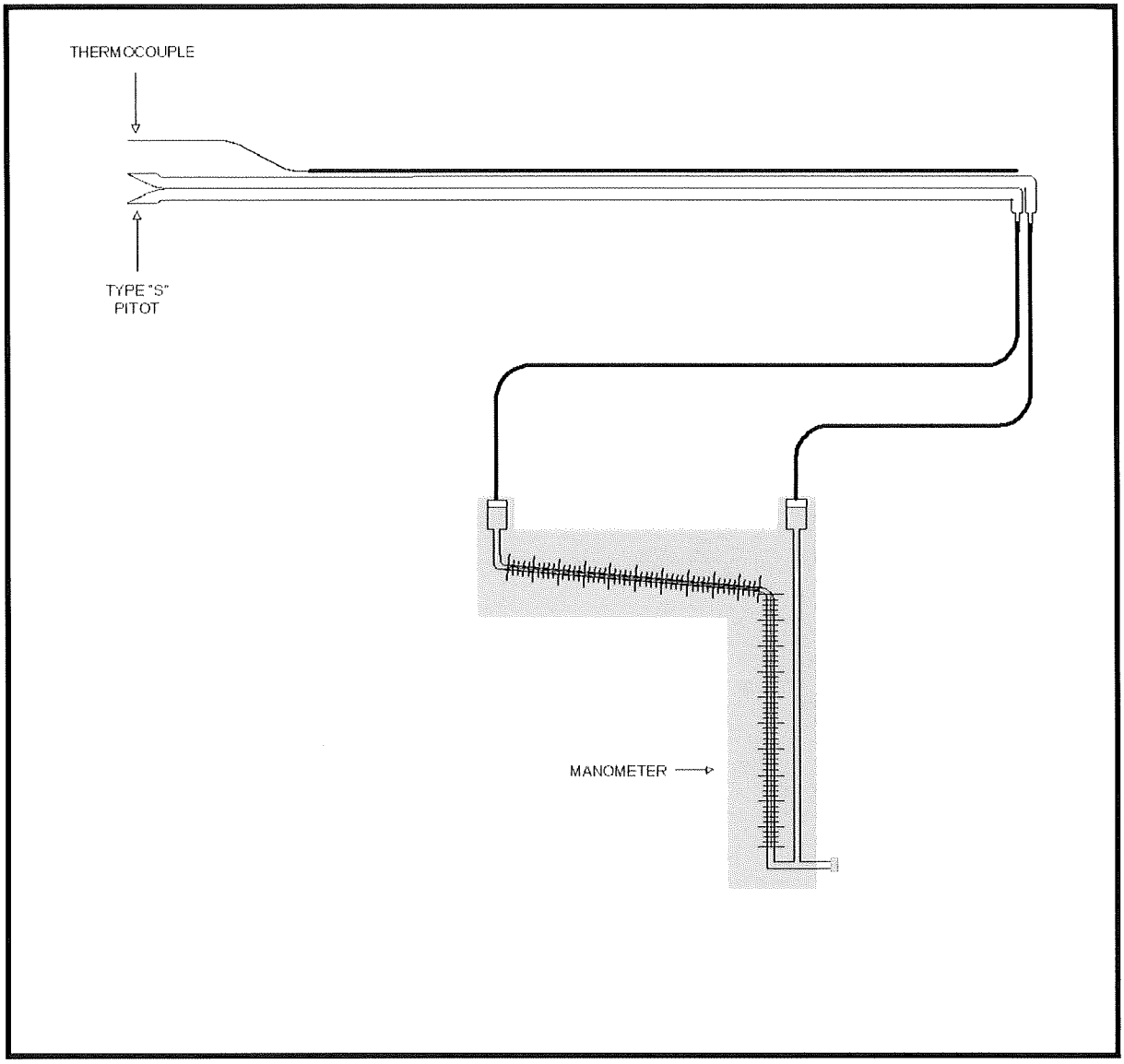
EPA Method 2 is used to measure the gas velocity using an S-type pitot tube connected to a pressure measurement device, and to measure the gas temperature using a calibrated thermocouple connected to a thermocouple indicator. Typically, Type S (Stausscheibe) pitot tubes conforming to the geometric specifications in the test method are used, along with an inclined manometer. The measurements are made at traverse points specified by EPA Method 1. The molecular weight of the gas stream is determined from independent measurements of O_2, CO_2, and moisture. The stack gas volumetric flow rate is calculated using the measured average velocity head, the area of the duct at the measurement plane, the measured average temperature, the measured duct static pressure, the molecular weight of the gas stream, and the measured moisture.

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

- Method Options:
  - S-type pitot tube coefficient is 0.84
- Method Exceptions:
  - None

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

FIGURE 3-1
US EPA METHOD 2 SAMPLING TRAIN



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.

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

- Method Options:
- Multi-point sampling was performed for O_2 and CO_2 measurements in conjunction with the Method 5B/202 sample points.
- O_2 and CO_2 measurements are for molecular weight calculations only
- Method Exceptions:
- None

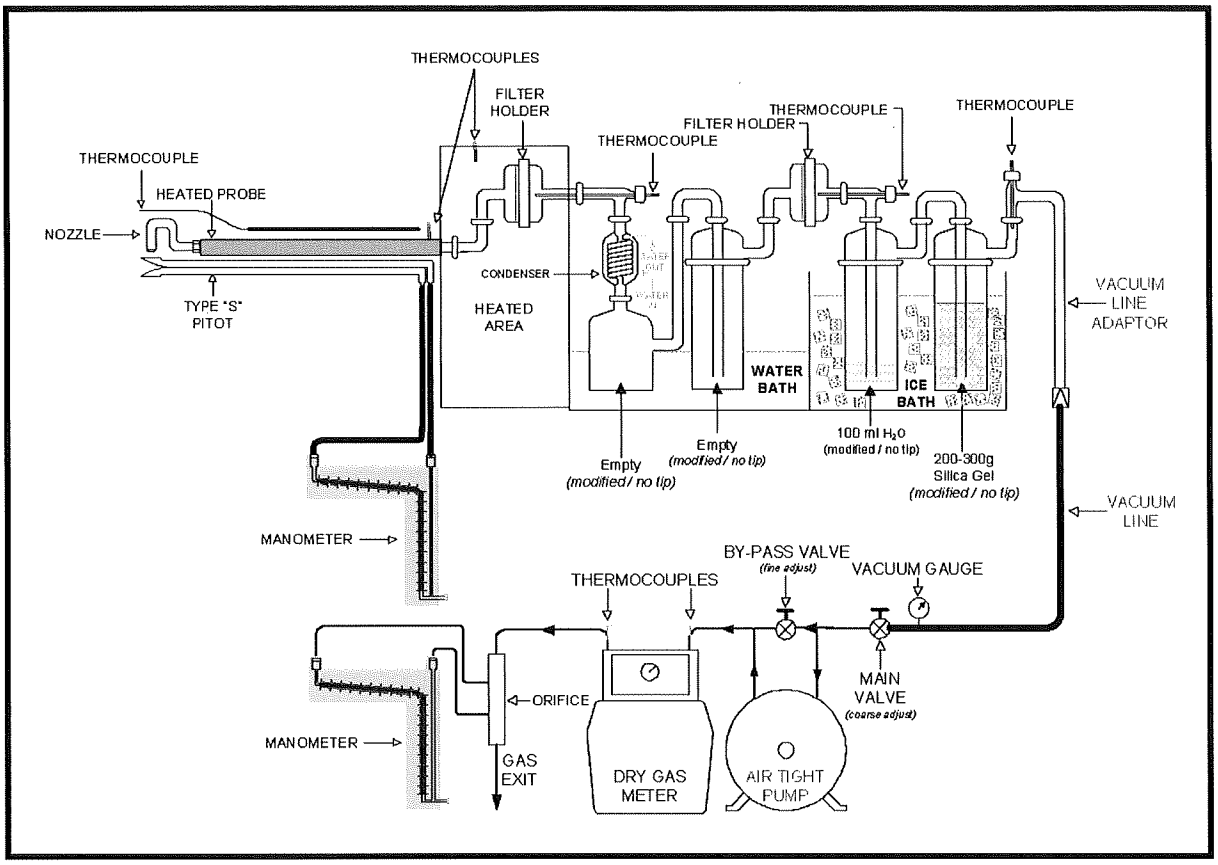
3.1.4 EPA Methods 5B and 202, Determination of Particulate Matter from Stationary Sources and Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources

EPA Methods 5B and 202 are manual, isokinetic methods used to measure FPM and CPM emissions. The methods are performed in conjunction with EPA Methods 1 through 4. The stack gas is sampled through a nozzle, probe, heated filter, unheated CPM filter, condenser, and impinger train. FPM is collected from the probe and heater filter. CPM is collected from the unheated CPM filter and the impinger train. The samples are analyzed gravimetrically. The sum of FPM and CPM represents TPM. The FPM, CPM, and TPM results are reported in emission concentration and emission rate units. Pertinent information regarding the performance of the method is presented below:

- Method Options:
- Stainless steel sample nozzles and glass probe liners are used
- Condensed water is measured gravimetrically
- The post-test nitrogen purge is performed by passing nitrogen through the train under pressure
- Method Exceptions:
- None
- Target and/or Minimum Required Sample Duration: 120 minutes
- Target and/or Minimum Required Sample Volume: 80 dscf
- Analytical Laboratory: Enthalpy Analytical, Durham, NC

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

FIGURE 3-2
US EPA METHOD 5B/202 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 in Tables 1-2 and 1-3. The results of individual $PM_{2.5}$ 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.

TABLE4-1
$PM_{2.5}$ EMISSIONS RESULTS - UNIT 1

Client				DTE Energy
Unit / Location				Unit 1 Monroe
A (stack area), ft^2				615.750
T_{std} (reference temperature), °F				68
F_d (fuel °F" factor @ 68°F), dscf/MMBtu				10,108
F_d (fuel °F" factor @ T_{std}), dscf/MMBtu				10,108
Test number	Test 1	Test 2	Test 3	Average
Date	12-14-21	12-14-21	12-14-21	--
Start / Stop time	7:08-9:16	9:33-11:42	11:56-14:03	--
Meter box number	CS4	CS4	CS4	--
C_p (pitot coefficient), dimensionless	0.8400	0.8400	0.8400	0.8400
Y (meter calibration factor), dimensionless	1.000	1.000	1.000	1.000
Θ (sample time), min	120.00	120.00	120.00	120.00
Nozzle diameter, in.	0.205	0.205	0.205	0.205
P_{bar} (barometric pressure), in Hg	29.68	29.68	29.68	29.68
V_m (meter box volume), acf	81.575	81.646	78.533	80.585
V_{lc} (impinger liquid volume), ml	277.5	281.3	270.4	276.4
T_m (meter temperature), °F	73.5	69.4	68.7	70.5
ΔH (meter pressure), in. H_2O	1.610	1.646	1.646	1.634
ΔP (velocity head), in. H2O	1.0805	1.1225	1.0494	1.0841
P_g (static pressure), in. Hg	-0.95	-1.00	-0.98	-0.98
T_s (stack temperature), °F	124.9	125.1	125.5	125.2
$\%O_2$ (oxygen stack gas), % volume dry	7.66	7.64	7.63	7.64
$\%CO_2$ (carbon dioxide stack gas), % volume dry	12.01	12.05	12.06	12.04
m_f (F½ particulate matter catch - filter), mg	6.8000	2.6000	9.1000	6.1667
m_a (F½ particulate matter catch - acetone rinse), mg	4.8000	9.9000	9.7000	8.1333
m_{cpb} (B½ particulate matter catch - total condensible, blank correct	12.50	19.60	5.40	12.50
m_n (total particulate matter catch), mg	24.10	32.10	24.20	26.80
$V_{m(std)}$ (standard sample volume), dscf	80.406	81.104	78.122	79.877
$V_{w(std)}$ (water vapor volume), scf	13.059	13.238	12.725	13.007
B_{ws} (moisture fraction), non-dimensional	0.1397	0.1403	0.1401	0.1400
Moisture, %	13.97	14.03	14.01	14.00
MW_{dry} (stack gas molecular weight), dry	30.228	30.234	30.235	30.232
MW_{wet} (stack gas molecular weight), wet	28.519	28.517	28.521	28.519
P_s (absolute stack pressure), in Hg	29.610	29.606	29.608	29.608
V_s (stack gas velocity), ft/sec	62.024	63.232	61.155	62.137
Q (stack flow rate), acfm	2,291,472	2,336,104	2,259,364	2,295,647
Q_{ws} (stack flow rate), wscfm	2,047,073	2,086,092	2,016,229	2,049,798
Q_{ds} (stack flow rate), dscfm	1,761,052	1,793,372	1,733,814	1,762,746
I (isokinetic ratio), %	102.24	101.26	100.89	101.46
G (total grain loading), gr/dscf	0.0046	0.0061	0.0048	0.0052
M (total mass emissions), lb/hr	69.81	93.88	71.03	78.24
E (total mass emissions), lb/MMBtu	0.0105	0.0139	0.0109	0.0118

TABLE 4-1
$PM_{2.5}$ EMISSIONS RESULTS - UNIT 2

Client				DTE Energy
Unit / Location				Unit 2 Monroe
A (stack area), ft^2				615.750
T_{std} (reference temperature), °F				68
F_o (fuel 'F' factor @ 68°F), dscf/MMBtu				10,108
F_o (fuel 'F' factor @ T_{std}), dscf/MMBtu				10,108
Test number	Test 1	Test 2	Test 3	Average
Date	12-15-21	12-15-21	12-15-21	--
Start / Stop time	7:28-9:40	9:54-12:05	12:29-14:35	--
Meter box number	CS4	CS4	CS4	--
C_p (pitot coefficient), dimensionless	0.8400	0.8400	0.8400	0.8400
Y (meter calibration factor), dimensionless	1.000	1.000	1.000	1.000
Θ (sample time), min	120.00	120.00	120.00	120.00
Nozzle diameter, in	0.205	0.205	0.205	0.205
P_{bar} (barometric pressure), in Hg	29.16	29.16	29.16	29.16
V_m (meter box volume), acf	84.639	80.798	82.522	82.653
V_{lc} (impinger liquid volume), ml	262.7	244.9	261.5	256.4
T_m (meter temperature), °F	73.2	69.6	57.3	66.7
ΔH (meter pressure), in. H_2O	1.607	1.583	1.614	1.601
ΔP (velocity head), in. H2O	1.0943	1.0776	1.0954	1.0891
P_g (static pressure), in. Hg	-0.91	-0.95	-0.96	-0.94
T_s (stack temperature), °F	123.1	123.0	123.1	123.1
$\%O_2$ (oxygen stack gas), % volume dry	8.01	7.78	7.89	7.89
$\%CO_2$ (carbon dioxide stack gas), % volume dry	11.73	11.96	11.84	11.84
m_f (F½ particulate matter catch - filter), mg	10.6000	8.7000	9.0000	9.4333
m_a (F½ particulate matter catch - acetone rinse), mg	14.5000	17.1000	16.8000	16.1333
m_{cpb} (B½ particulate matter catch - total condensible, blank correct	7.40	9.10	9.10	8.53
m_n (total particulate matter catch), mg	32.50	34.90	34.90	34.10
$V_{m(std)}$ (standard sample volume), dscf	82.021	78.824	82.431	81.092
$V_{w(std)}$ (water vapor volume), scf	12.363	11.525	12.306	12.065
B_{ws} (moisture fraction), non-dimensional	0.1310	0.1276	0.1299	0.1295
Moisture, %	13.10	12.76	12.99	12.95
MW_{dry} (stack gas molecular weight), dry	30.197	30.225	30.210	30.211
MW_{wet} (stack gas molecular weight), wet	28.600	28.665	28.624	28.630
P_s (absolute stack pressure), in Hg	29.093	29.090	29.089	29.091
V_s (stack gas velocity), ft/sec	62.783	62.228	62.793	62.601
Q (stack flow rate), acfm	2,319,517	2,299,005	2,319,879	2,312,800
Q_{ws} (stack flow rate), wscfm	2,042,345	2,024,369	2,042,405	2,036,373
Q_{ds} (stack flow rate), dscfm	1,774,831	1,766,137	1,777,102	1,772,690
I (isokinetic ratio), %	103.48	99.94	103.86	102.43
G (total grain loading), gr/dscf	0.0061	0.0068	0.0065	0.0065
M (total mass emissions), lb/hr	93.01	103.42	99.51	98.65
E (total mass emissions), lb/MMBtu	0.0143	0.0157	0.0152	0.0151

5.0 INTERNAL QA/QC ACTIVITIES

5.1 QA/QC AUDITS

The meter box and sampling train 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 5B analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met. An EPA Method 5B reagent blank was analyzed. The maximum allowable amount that can be subtracted is 0.001% of the weight of the acetone blank. 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 1.75 mg, and 1.75 mg was subtracted.

5.2 QA/QC DISCUSSION

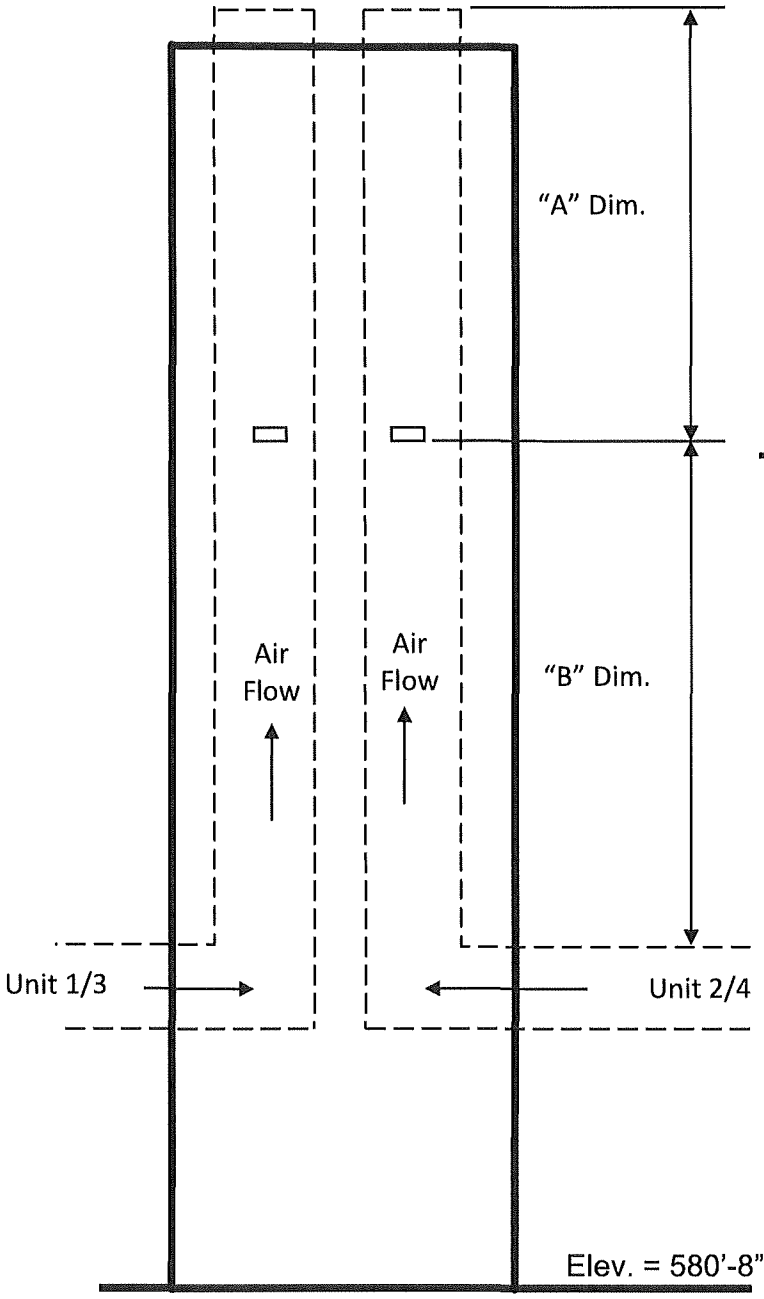
All QA/QC criteria were met during this test program.

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

Figure 1 – Sampling Location
Monroe Power Plant – Units 1-4



Details

"A" Dim = Upstream Distance
"A" Dim = 201.6'
"B" Dim = Downstream Distance
"B" Dim = 233.8'

Dia. @ Sample Location = 28'-0"

DTE