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COMPLIANCE TEST REPORT

for

PARTICULATE MATTER AND CONDENSABLE PARTICULATE EMISSIONS (PM 2.5) TESTING

UNITS 1-4

Monroe Power Plant
Monroe, Michigan

May – June 2018

RECEIVED
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AIR QUALITY DIVISION

Prepared By
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EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Resources (EM&R) Field Services Group performed particulate emissions testing on the exhausts of Units 1-4 at the Monroe Power Plant, located in Monroe, Michigan. The testing was required by Michigan Department of Environmental Quality (MDEQ) Permit to Install (PTI) 27-13b. The testing measured combined total filterable particulate emissions and condensable emissions, then reporting the combined total as $PM_{2.5}$. The permit does not specify a limit for the $PM_{2.5}$ emissions.

A summary of the emission test results is shown below:

Emissions Testing Summary
Monroe Power Plant Units 1-4

Source	Date Tested	PM 2.5[1] (lbs/MMbtu)
Unit 1	May 14-15, 2018	0.014
Unit 2	June 11-12, 2018	0.018
Unit 3	May 23-24, 2018	0.009
Unit 4	June 14-15, 2018	0.009

[1] measured as total filterable particulate, plus condensable matter

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1.0 INTRODUCTION

DTE Energy's Environmental Management and Resources (EM&R) Field Services Group performed particulate emissions testing on the exhaust of Units 1-4 at the Monroe Power Plant, located in Monroe, Michigan. The testing was required by MDEQ PTI 27-13b to document $PM_{2.5}$ emissions. Because the test method specific for filterable $PM_{2.5}$ could not be used on the units, a substitute procedure was used. Testing was conducted while the units operated at or near maximum operating conditions. The PTI does not contain an emission limit for $PM_{2.5}$.

Testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Methods 1, 3, 4, 5B, and 202.

The fieldwork was performed in accordance with EPA Reference Methods and DTE Energy Intent to Test, which was approved in a letter by Mr. Tom Gasloli from the Michigan Department of Environmental Quality (MDEQ), dated May 7, 2018. The following DTE Energy personnel participated in the testing program: Mr. Mark Westerberg, Senior Environmental Specialist, Mr. Jason Logan, Environmental Specialist, Mr. Frank Kurta, Senior Environmental Technician, and Mr. Kenneth St. Amant, Senior Environmental Technician. Mr. Westerberg was the project leader. Ms. Kailyn Gerzich, Environmental Engineer at the plant, provided process coordination for the testing program.

The Test Protocol and approval letter are attached in Appendix A of this report.

2.0 SOURCE DESCRIPTION

The Monroe Power Plant 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 1-4 exhaust into their own separate stacks. The exhaust stacks for all units are 580 feet tall with an internal diameter of 28 feet. Figure 1 identifies the sampling location and stack dimensions at each location.

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

The boiler exhausts are equipped with Research Cottrell electrostatic precipitators (ESPs), with particulate removal efficiencies of 99.6%. 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 four units is equipped with sulfuric acid mist control equipment.

Units 1-4 are equipped with Selective Catalytic Reduction (SCR) systems to control 90% of the NO_x emissions prior to their respective ESP's.

All four units are equipped with wet Flue Gas Desulfurization (FGD) Scrubbers to control sulfur dioxide (SO_2), other acid gases, and particulate matter. The typical coal blend for each unit is a 65% low-sulfur western (LSW) / 35% mid-sulfur eastern (MSE). During the emissions testing slight variations to this typical blend occurred with some of the units. All units were operated at normal, full load conditions (>700 GMW) during compliance testing.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

DTE Energy obtained emissions measurements in accordance with procedures specified in the USEPA *Standards of Performance for New Stationary Sources* or listed as an approved *"Other Test Method"*. The sampling and analytical methods used in the testing program are indicated in the table below:

Sampling Method	Parameter	Analysis
USEPA Methods 1-2	Exhaust Gas Flow Rates	Field data analysis and reduction
USEPA Method 3A	Oxygen & CO2	Instrumental Analyzer Method
USEPA Method 4	Moisture Content	Field data analysis and reduction
USEPA Method 5B	Filterable Particulate Matter (Non-Sulfuric Acid)	Gravimetric Analysis
USEPA Method 202	Condensable Particulate Matter	Gravimetric Analysis

3.1 STACK GAS VELOCITY AND FLOWRATES (USEPA Methods 1-2)

3.1.1 Sampling Method

Stack gas velocity traverses were conducted in accordance with the procedures outlined in USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources," and Method 2, "Determination of Stack Gas Velocity and Volumetric Flowrate." Four (4) sampling ports were utilized, sampling at three (3) points per port for a total of

twelve (12) sampling points. See Figure 2 for a diagram of the traverse/sampling points used.

A full cyclonic flow check was performed during the initial flow monitor certification RATA on each unit. Testing at the sampling locations demonstrated that no cyclonic flow was present. No changes to the stacks have occurred since the cyclonic flow check was performed. Additionally, static pressure checks performed each day confirmed that the null angles were at 0°.

3.1.2 Method 2 Sampling Equipment

The EPA Method 2 sampling equipment consisted of a 0-10" incline manometer, calibrated S-type pitot tubes (C_p = 0.84) and a type-K calibrated thermocouple.

3.2 OXYGEN AND CARBON DIOXIDE (USEPA Method 3A)

3.2.1 Sampling Method

Stack gas Oxygen (O_2) and Carbon Dioxide (CO_2) emissions were evaluated using USEPA Method 3A, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight (Instrumental Analyzer Method)". The O_2 / CO_2 analyzers utilize paramagnetic sensors.

3.2.2 O_2 / CO_2 Sampling Train

A Servomex 1400 gas analyzer was used to measure exhaust O_2/CO_2. The inlet to the instrument was attached to the exhaust of the dry gas meter (i.e. gas was conditioned prior to entering the instrument). See Figure 3 for a diagram.

3.2.3 Sampling Train Calibration

The O_2 / CO_2 analyzer was calibrated according to procedures outlined in USEPA Method 7E. Zero, span, and mid range calibration gases were introduced directly into the analyzer to verify the instruments linearity. O_2/CO_2 concentrations were recorded on the field data sheets.

3.3 MOISTURE DETERMINATION (USEPA Method 4)

3.3.1 Sampling Method

Determination of the moisture content of the exhaust gas was performed using the chilled impinger method as a component of the isokinetic sampling train in accordance with USEPA Method 4. The moisture was collected in glass impingers and the percentage of moisture was then derived from calculations outlined in USEPA Method 4. Method 4 was incorporated into the Method 5B/202 train.

3.4 PARTICULATE MATTER (USEPA Method 5B)

3.4.1 Filterable Particulate Sampling Method

USEPA Method 5B, "Determination of Non-Sulfuric Acid Particulate Emissions from Stationary Sources" was used to measure the filterable (front-half) particulate emissions (see Figure 3 for a schematic of the sampling train). Triplicate, 120-minute test runs were conducted.

The Method 5B modular isokinetic stack sampling system (Figure 4) consisted of the following:

(1) PTFE coated stainless-steel button-hook nozzle
(2) Heated glass-lined probe
(3) Heated 3" glass filter holder with a quartz filter (maintained at a temperature of 320 ± 25 °F)
(4) USEPA Method 202 impinger train
(5) Length of sample line
(6) Isokinetic metering device equipped with a pump, dry gas meter, calibrated orifice, and temperature sensors.

The quartz filters used in the sampling were initially baked for 3 hours at 320 °F, desiccated for 24 hours and weighed to a constant weight as described in Method 5B to obtain the initial tare weight.

After completion of the final leak test for each test run, the filter was recovered, and the probe, nozzle and the front half of the filter holder assembly were brushed and rinsed with acetone. The acetone rinses were collected in a pre-cleaned sample container. The container was labeled with the test number, test location, test date, and the level of liquid marked on the outside of the container. Immediately after recovery, the sample containers were placed in a cooler for storage.

At the laboratory, the acetone rinses were transferred to clean pre-weighed beakers, and evaporated to dryness at ambient temperature and pressure. The beakers and filters were baked for 6 hours at 320 °F, desiccated for 24 hours and weighed to a constant weight (within 0.5 mg). The data sheets containing the initial and final weights on the filters and beakers can be found in Appendix C.

Collected field blanks consisted of a blank filter and acetone solution blank. The acetone blank was collected from the rinse bottle used in sample recovery. The blank filter and acetone were collected and analyzed following the same procedures used to recover and analyze the field samples. Field data sheets for the Method 5B sampling can be found in Appendix B.

3.4.2 *Quality Control and Assurance*

All sampling and analytical equipment was calibrated according to the guidelines referenced in EPA Method 5B. All Method 1-4, and 5B calibration data is located in Appendix D.

3.5 CONDENSABLE PARTICULATE MATTER (USEPA M 202)

3.5.1 Condensable Particulate Sampling Method (Method 202)

USEPA Method 202, "Dry Impinger method for Determining Condensable Particulate Emissions from Stationary Sources" was used to measure condensable particulate matter (CPM). This method includes procedures for measuring both organic and inorganic CPM. The Method 202 samples were collected in conjunction with the Method 5B samples.

The Method 202 impinger configuration (Figure 3 – after the Method 5B filter holder assembly,) consisted of the following:

(1) Method 23 type condenser (capable of cooling the stack gas to less than 85 °F
(2) Condensate dropout impinger (dry) without the bubbler tube
(3) Modified Greenburg-Smith impinger (dry) with no taper as a backup impinger
(4) 3" glass filter holder with a PTFE filter (maintained at a temperature of $65\,^{\circ}F \geq T \geq 85\,^{\circ}F$)
(5) Modified Greenburg-Smith impinger containing 100 millimeters (ml) of distilled de-ionized (DDI) water
(6) Modified Greenburg-Smith impinger containing approximately 300 grams of silica gel desiccant.

The condensate dropout impinger and backup impinger were placed in an insulated box with a recirculatory pump to maintain the required CPM filter temperature. The water and silica gel impingers were placed in an ice water bath to maintain the exit gas temperature from the silica gel impinger below 68°F.

All Method 202 glassware was pre-cleaned prior to testing with soap and water, and rinsed using tap water, distilled de-ionized (DDI) water, acetone, and finally, hexane. After cleaning, the glassware was baked at 300 °C for 6 hours. Prior to each sampling run, the train glassware was rinsed thoroughly with distilled deionized ultra-filtered water.

As soon as possible after the post-test leak check was completed, the Method 5B probe and heated filter box was detached from the Method 202 condenser and impinger train. The Method 202 impinger train was then carefully disassembled. The liquid in each impinger was measured gravimetrically and recorded on the field data sheet. The silica gel was re-weighed, and any increase was recorded on the field data sheets. Moisture from the condensate dropout impinger was added to the second impinger. The Method 202 impinger train was purged with ultra-high purity compressed nitrogen at 14 liters per minute for 60 minutes. During the purge the condenser recirculation pump was operated and the first two impingers were heated/cooled to maintain the gas temperature exiting the CPM filter below 85 °F.

Contents from the dropout impinger and the impinger prior to the CPM filter were collected into a pre-cleaned sample container. The condenser, impingers and front-half of the CPM filter holder were rinsed with DDI water and the rinses added to the sample container. The condenser, impingers and front-half of the CPM filter holder were then rinsed with acetone followed by two rinses with hexane. The acetone and hexane rinses were collected into a pre-cleaned sample container. The CPM filter was recovered and placed into a labeled container. All containers were labeled with the test number, test location, test date, and the level of liquid marked on the outside of the container. Immediately after recovery, the sample containers were placed in a cooler for storage.

Collected blanks consisted of an acetone rinse blank, a DDI water rinse blank and a hexane rinse blank taken directly from the bottles used during recovery of the samples. Additionally, one field train recovery blank was collected in accordance with Section 9.10 of Method 202. A field train proof blank was not collected as the glassware was baked prior to field use.

Analysis of the Method 202 samples and blanks were conducted by Maxxam Analytics of Mississauga, Ontario. All analysis followed the procedures listed in Method 202. A complete laboratory report can be found in Appendix C. Blank corrections were applied to the samples following the procedures outlined in Method 202 (correcting the samples by less than or equal to 2.0 mg).

Field data sheets for the Method 202 sampling can be found in Appendix B.

3.5.2 Quality Control and Assurance

All sampling and analytical equipment was calibrated according to the guidelines referenced in Method 202.

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3.5.3 Data Reduction

Results from the total filterable (Method 5B) and condensable (Method 202) were combined and reported as $PM_{2.5}$. Emissions data was reduced to pounds per million btu (lb/MMbtu) as requested in the Test Plan Approval Letter issued on May 7, 2018.

4.0 OPERATING PARAMETERS

The test program included the collection of boiler load and stack emissions CEMs data during each test run. Parameters recorded included gross Megawatts (MW) and CEMs data (SO_2, NO_x, CO_2, and Opacity).

Process data collected from each Unit's digital control system included load in gross megawatts (MW), main steam flow in thousand pounds per hour (Klbs/hr), fuel usage in tons per hour (Tons/hr), and total precipitator power in kilowatts (kW).

Coal samples were collected during each day of sampling and subject to proximate and ultimate analysis.

Operational data and results of the fuel analysis can be referred to in Appendix F.

5.0 DISCUSSION OF RESULTS

Tables 1-4 present individual PM emissions test results. An Executive Summary was provided on Page IV of this report for the three-test average emission rate for each unit. Total PM plus condensable particulate matter was calculated as $PM_{2.5}$ and data was reduced to lb/MMbtu as requested in the Test Plan Approval Letter.

The testing was conducted as proposed and subsequently approved by MDEQ. A couple items of note are as follows:

1. Test number 3 on Unit 3 was unexpectedly halted for a short period of time when the unit experienced a coal mill problem, which caused a temporary decrease in unit load. The mill was fixed with a couple of hours. The load was then increased and the remainder of test 3 was completed.
2. Test number 3 on Unit was voided when it was discovered at the end of the test that the impinge train had been assembled incorrectly. Although both pre and post test leak checks were passed, the decision was made to void the test and to run a 4^{th} test. The run 3 samples were not analyzed.

The laboratory report for filterable and condensable PM is presented in Appendix C. Process operational data is presented in Appendix F.

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6.0 CERTIFICATION STATEMENT

"I certify that I believe the information provided in this document is true, accurate, and complete. Results of testing are based on the good faith application of sound professional judgment, using techniques, factors, or standards approved by the Local, State, or Federal Governing body, or generally accepted in the trade."

for Mr. Mark R. Grigereit, QSTI

This report prepared by: _____

for Mr. Jason Logan, QSTI
Environmental Specialist, Field Services Group
Environmental Management and Resources
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This report reviewed by: _____

Mr. Thomas Durham
Manager, Field Services Group
Environmental Management and Resources
DTE Energy Corporate Services, LLC

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TABLE NO. 1
PM 2.5 PARTICULATE EMISSION TESTING RESULTS
Monroe Power Plant - Unit 1
May 14-15, 2018

Test	Test Date	Test Time	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	(SCFM)	(DSCFM)	PM 2.5 Emissions[1] (lbs/MMBtu)[2]
PM-1	14-May-18	10:01-12:17	780	123	15.7	4,194	2,582,658	2,247,570	1,893,752	0.018
PM-2	15-May-18	6:57-9:09	757	124	15.1	4,029	2,481,087	2,141,110	1,818,319	0.012
PM-3	15-May-18	9:54-12:06	756	123	15.3	4,044	2,490,407	2,168,837	1,836,790	0.013
	Average:		***764***	***123***	***15.4***	***4,089***	***2,518,051***	***2,185,839***	***1,849,620***	***0.014***

(1) Measured as Total Filterable Particulate + Condensible Particulate

(2) No Limit Specified in Permit

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TABLE NO. 2
PM 2.5 PARTICULATE EMISSION TESTING RESULTS
Monroe Power Plant - Unit 2
June 11-12 2018

Test	Test Date	Test Time	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	(SCFM)	(DSCFM)	PM 2.5 Emissions[1] (lbs/MMBtu)[2]
PM-1	**11-Jun-18**	8:35-11:21	712	122	14.7	3,582	2,205,519	1,936,995	1,652,556	0.016
PM-2	**11-Jun-18**	12:00-14:34	717	122	14.7	3,558	2,190,910	1,927,223	1,644,835	0.015
PM-3	**12-Jun-18**	7:17-9:26	714	123	16.4	3,693	2,273,977	1,996,321	1,669,859	0.024
	Average:		***714***	***122***	***15.3***	***3,611***	***2,223,469***	***1,953,513***	***1,655,750***	***0.018***

(1) Measured as Total Filterable Particulate + Condensible Particulate

(2) No Limit Specified in Permit

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TABLE NO. 3
PM 2.5 PARTICULATE EMISSION TESTING RESULTS
Monroe Power Plant - Unit 3
May 23-24, 2018

Test	Test Date	Test Time	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	(SCFM)	(DSCFM)	PM 2.5 Emissions[1] (lbs/MMBtu)[2]
PM-1	23-May-18	6:57-9:13	751	123	14.6	3,816	2,349,798	2,065,591	1,764,877	0.008
PM-2	23-May-18	9:45-11:58	747	125	15.3	3,905	2,404,518	2,109,775	1,786,291	0.008
PM-3	24-May-18	7:00-12:23	744	122	13.9	3,786	2,331,083	2,057,643	1,770,855	0.010
	Average:		***747***	***123***	***14.6***	***3,836***	***2,361,800***	***2,077,670***	***1,774,008***	***0.009***

(1) Measured as Total Filterable Particulate + Condensible Particulate

(2) No Limit Specified in Permit

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TABLE NO. 4
FILTERABLE PARTICULATE EMISSION TESTING RESULTS
Monroe Power Plant - Unit 4
June 14-15, 2018

Test	Test Date	Test Time	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	(SCFM)	(DSCFM)	PM 2.5 Emissions[1] (lbs/MMBtu)[2]
PM-1	**14-Jun-18**	8:15-10:28	766	120	13.8	3,908	2,406,429	2,153,591	1,856,388	0.010
PM-2	**14-Jun-18**	11:03-13:19	766	119	13.7	3,902	2,402,497	2,153,475	1,857,852	0.009
PM-4	**15-Jun-18**	10:47-13:05	765	121	14.3	3,870	2,382,841	2,133,553	1,829,459	0.009
	Average:		***766***	***120***	***13.9***	***3,893***	***2,397,256***	***2,146,873***	***1,847,900***	***0.009***

(1) Measured as Total Filterable Particulate + Condensible Particulate

(2) No Limit Specified in Permit

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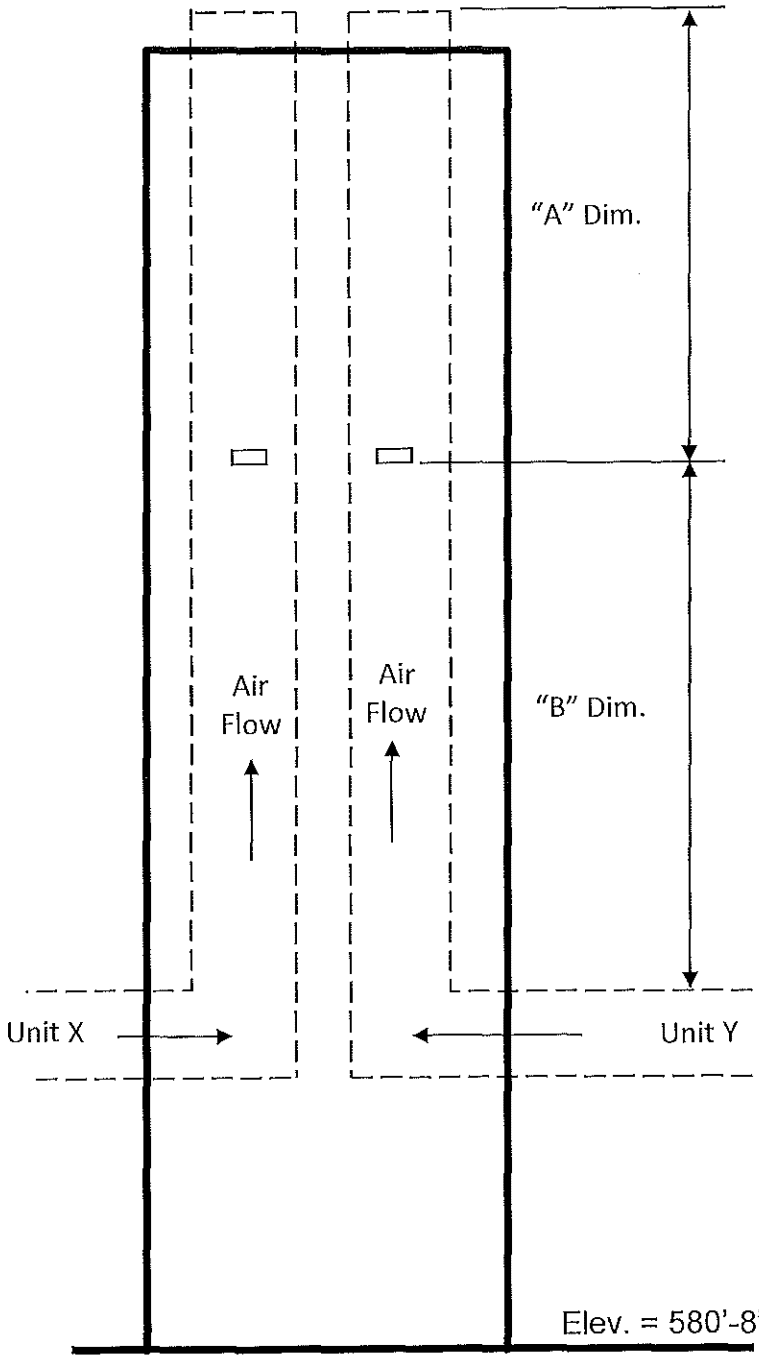
Figure 1 – Sampling Location
Monroe Power Plant – Units 1, 2, 3 & 4
May – June 2018



Details

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

Dia. @ Sample Location = 28'-0"

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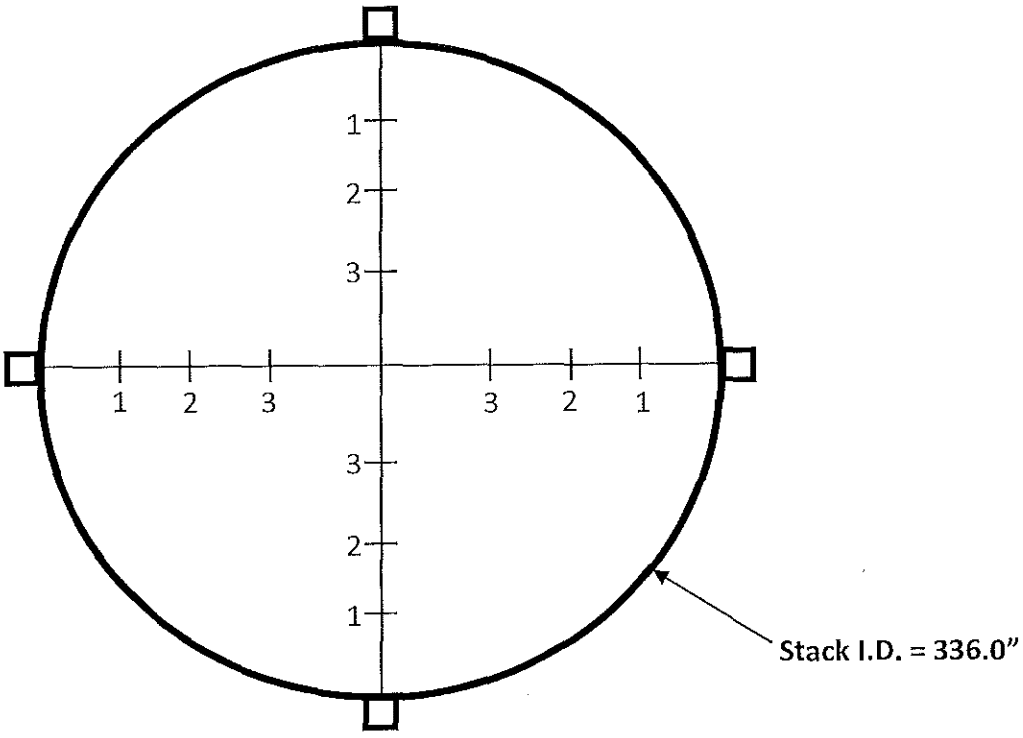
Figure 2 – Sampling Points
Monroe Power Plant – Units 1, 2, 3 & 4
May – June 2018



VELOCITY / PM MEASUREMENT POINTS

Point	Distance from Inside Wall
1	14.78"
2	49.06"
3	99.46"

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Figure 3 – EPA Method 3A
Monroe Power Plant – Units 1, 2, 3 & 4
May – June 2018

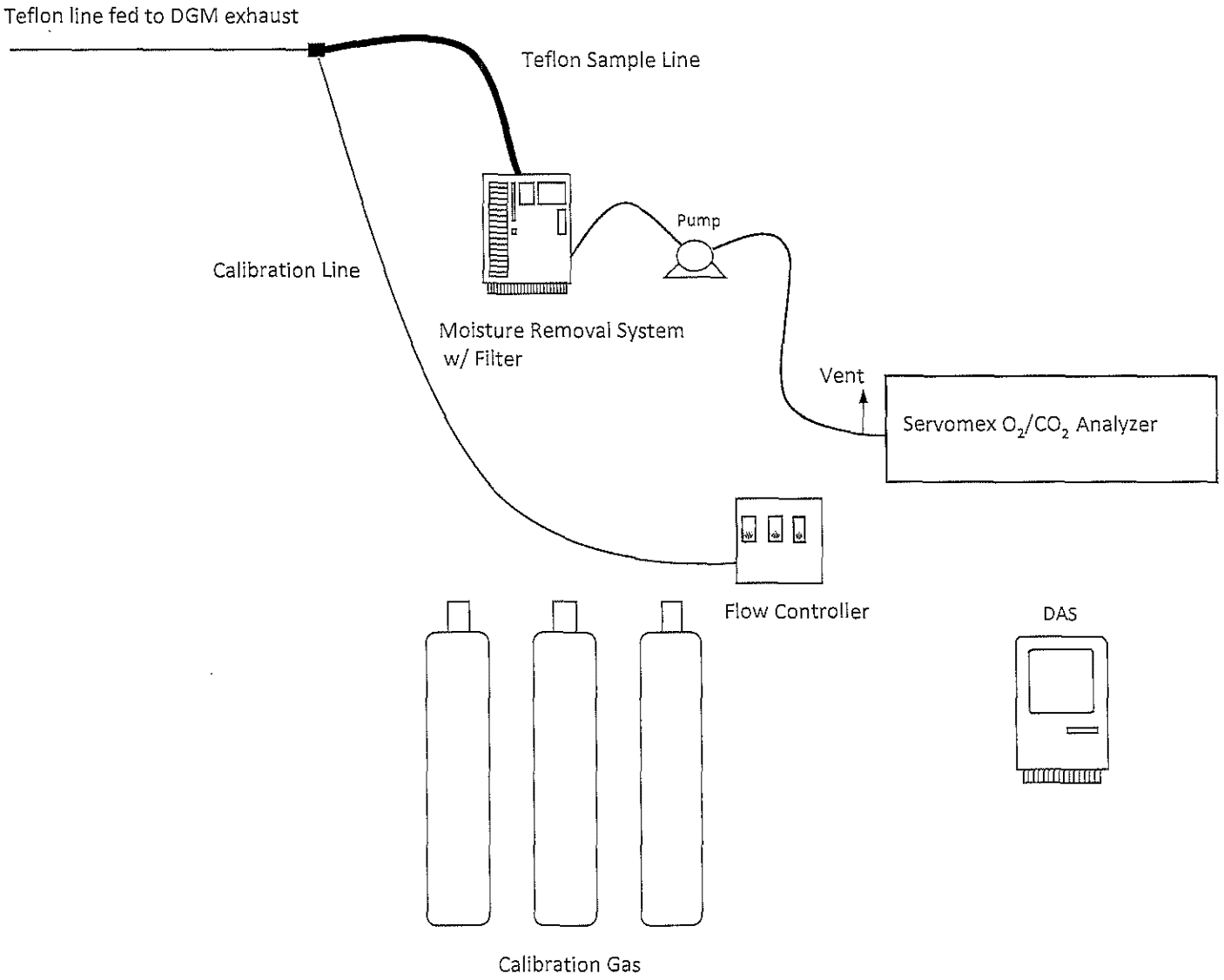

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Figure 4 – EPA Methods 5B/202
Monroe Power Plant – Units 1, 2, 3 & 4
May – June 2018