DTE

EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Resources, Field Services Group (EMR) performed emissions testing on the Unit 4 FGD exhaust stack located at the Monroe Power Plant, in Monroe, Michigan. The testing was required by the Michigan Department of Environment, Great Lakes, & Energy (EGLE) Renewable Operating Permit (ROP) No. MI-ROP-B2816-2019 to document Fine Particulate ($PM_{2.5}$) stack emissions from Unit 4 FGD during normal operating conditions. Testing was conducted July 27, 2020.

A summary of the emission test results is shown below:

Emissions Testing Summary
Unit 4 FGD Stack
Monroe Power Plant
July 27, 2020

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	Unit 4 PM2.5(1) (lb/MMBtu)
Emission Rate	**0.011**

(1) = Measured as Total Filterable PM plus Condensable PM (Per Method 202)

1.0 INTRODUCTION

DTE Energy's Environmental Management and Resources, Field Services Group (EMR) performed emissions testing on the Unit 4 FGD exhaust stack located at the Monroe Power Plant, in Monroe, Michigan. The testing was required by the Michigan Department of Environment, Great Lakes, & Energy (EGLE) Renewable Operating Permit (ROP) No. MI-ROP-B2816-2019 to document Fine Particulate ($PM_{2.5}$) stack emissions from Unit 4 FGD during normal operating conditions. The testing was conducted July 27, 2020.

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

The fieldwork was performed in accordance with EPA Reference Methods and EMR's Intent to Test[1], which was submitted to the Michigan Department of Environment, Great Lakes, & Energy (EGLE), on March 3, 2020. Fine Particulate ($PM_{2.5}$) Emissions were collected using the PM_{10} sampling data, collected as described in the Intent to Test. The following EMR personnel participated in the testing program: Mr. Mark Grigereit, Principal Engineer, Mr. Mark Thom Snyder, Environmental Specialist, and Mr. Fred Meinecke, Senior Engineering Technician. Mr. Grigereit was the project Leader. Ms. Lisa Lockwood, Sr. Environmental Engineer at Monroe Power Plant, provided process coordination for the testing program. Testing was observed by Ms. Regina Angellotti with EGLE.

2.0 SOURCE DESCRIPTION

The Monroe Power Plant is 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. Each boiler exhausts into a dedicated exhaust stack.

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.

Each boiler is equipped with Research Cottrell electrostatic precipitator (ESPs), each with a rated particulate removal efficiency of 99.6%. There is a sulfur trioxide flue gas conditioning

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[1] EGLE, Test Plan, Submitted March 3, 2020. (Attached-Appendix A)

system on each unit that is only used on an "as needed basis" 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 through 4 have Selective Catalytic Reduction (SCR) systems, operated to control at least 90% of the NOx emissions. The SCR's are located upstream of the respective ESP's. Each unit has wet Flue Gas Desulfurization (FGD) Scrubbers to control sulfur dioxide (SO_2), other acid gases, and particulate matter emissions.

The coal blend fired on the test day was 15% high-sulfur eastern (HSE) / 70% low-sulfur western (LSW)/ 15% Petcoke. Testing was performed while the boiler was operated at normal full load conditions (>700 GMW).

The boilers at Monroe Power Plant employ the use of continuous soot-blowing, thus a separate PM test conducted specifically during a soot-blowing period was not necessary.

The exhaust stacks for each of boilers are 580 feet tall with an internal diameter of 28 feet. See Figure 1 for a diagram of the Unit 4 sampling location and stack dimension.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

Emissions measurements were conducted 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

Sampling Method	Parameter	Analysis
USEPA Method 5B	Particulate Matter (Non-Sulfuric Acid)	Gravimetric Analysis
USEPA Method 202	PM Condensables	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." During the emissions testing, four (4) sampling ports were utilized, sampling at three (3) points per port for a total of twelve (12) sampling points. Velocity traverses were conducted in conjunction with all testing method sample collection. See Figure 2 for a diagram of the traverse/sampling points used.

A cyclonic flow check was performed on the Unit 4 FGD Stack during the initial flow monitor certification RATA. Testing at all sampling locations demonstrated that no cyclonic flow was present.

3.1.2 Method 2 Sampling Equipment

The EPA Method 2 sampling equipment consisted of a 0-10.0" incline manometer, S-type pitot tube ($C_p = 0.84$) 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

The Method 3A sampling system consisted of continuously collecting a gas sample from the exhaust of the dry gas meter during each test. The sample was drawn through a Teflon® line into a Universal™ gas conditioner and into a Servomex™ 1400 O_2/CO_2 gas analyzer.

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. The O_2/CO_2 concentrations are 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 method described in USEPA Method 4, "Determination of Moisture Content in Stack Gases". The exhaust gas condensate was collected in glass impingers and the percentage of moisture was derived from calculations outlined in USEPA Method 4.

3.4 PARTICULATE MATTER INCLUDING CONDENSABLES (USEPA Method 5B/202)

3.4.1 Filterable Particulate Sampling

USEPA Method 5B, "Determination of Non-Sulfuric Acid Particulate Matter 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 3) consisted of the following:

(1) Teflon® coated stainless-steel button-hook nozzle
(2) Heated glass-lined probe (maintained at a temperature of 320 ± 25 °F)
(3) Heated 3" glass filter holder with a quartz filter (maintained at a temperature of 320 ± 25 °F)
(4) Set of impingers (Method 202) for the collection condensable particulates and condensate for moisture determination (see section 3.4.2, below)
(5) Length of sample line
(6) Environmental Supply® control case equipped with a pump, dry gas meter, and calibrated orifice.

The quartz filters used in the sampling were initially 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 then placed in a desiccator for 24 hours and weighed to a constant weight (within 0.5 mg). The data sheets containing the initial and final weights of 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/202 sampling are in Appendix B.

3.4.2 Condensable Particulate Sampling Method (Method 202)

USEPA Method 202, "Dry Impinger method for Determining Condensable Particulate Emissions from Stationary Sources" was used to measure the condensable particulate matter (CPM) (see Figure 3 for a schematic of the sampling train). This method includes procedures for measuring both organic and inorganic CPM. The Method 202 samples were collected in conjunction with the Method 5B samples as part of the sampling train. Triplicate, 120-minute test runs were conducted.

The Method 202 impinger configuration (Figure 3) consisted of the following:

(1) Method 23 type condenser (capable of cooling the stack gas to less than 85 °F)
(2) Condensate dropout pot belly impinger (dry)
(3) Modified Greenburg-Smith impinger (dry) with no taper as a backup impinger
(4) 83mm glass filter holder with a Teflon® filter (maintained at a temperature $\leq$ 85 °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 water at ≤ 85 °F. 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 water, and acetone. After cleaning, the glassware was baked at 300 °C for 3 hours. Prior to each sampling run, the train glassware was rinsed thoroughly with distilled de-ionized ultra-filtered water.

As soon as possible after the post-test leak check was completed, the Method 5B filter and probe were detached from the Method 202 condenser and impinger train. The Method 202 impinger train was then carefully disassembled. The liquid volume of each impinger was measured (by weight) and recorded on the field data sheet. 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 one hour. 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. If insufficient water was collected in the dry impinger to allow the modified insert tip to extend below the water level, 50-100 ml of de-gassed, DDI water was added to the impinger and noted on the sampling data sheet.

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 reagent blanks consisted of an acetone blank, a DDI water blank and a hexane blank taken directly from the bottles used during recovery of the samples. Additionally, a field train recovery blank was assembled and recovered following the same procedures used to prepare and recover the test samples.

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 is in Appendix C.

Field data sheets for the Method 5B/202 sampling can be found in Appendix B.

3.4.3 Quality Control and Assurance

All sampling and analytical equipment was calibrated according to the guidelines referenced in EPA Method 5B (see Appendix E for equipment calibration). Maxxam Analytics followed all the appropriate Method 202 analytical QA/QC (see Appendix C).

3.4.4 Data Reduction

$PM_{2.5}$ emissions were calculated by adding the total filterable PM emissions and the condensable PM emissions. The $PM_{2.5}$ emissions were calculated and reported as pounds per hour (lbs/hr) and pounds per million Btu (lbs/MMBtu).

Emissions calculations were based on calculations located in USEPA Method 5 and Method 19. Example calculations are presented in Appendix E.

4.0 OPERATING PARAMETERS

The test program included the collection of boiler operating data, CEMs emission data, precipitator operating data, SCR operating data, sulfur control system operating data, and FGD scrubber operating data during each emission test.

During each day of emissions sampling, a representative coal sample was collected from the unit and analyzed for ultimate and proximate analysis, including % Sulfur, % Ash, and heat content.

CEMs data, operational data and control equipment data collected during the testing are presented in Appendix F. Results from the coal analysis are in Appendix F.

5.0 DISCUSSION OF RESULTS

Table 1 presents the Unit 4 Fine Particulate Matter ($PM_{2.5}$) emission testing results. Particulate emissions are presented in pounds per hour (lbs/hr) and pounds per Million British thermal units (lbs/MMBtu). Unit 4 does not have a Permit Limit for PM less than 2.5 micron ($PM_{2.5}$). cannot be measured per Method 201 because of the FGD and potential water droplets in the exhaust gas, therefore all PM measured (Method 5B and 202) were combined to represent the PM2.5 emissions. The average $PM_{2.5}$ emissions are 0.011 lbs/MMBtu.

The Auxiliary test data presented in each Table for each test includes the Unit Load in gross megawatts (GMW), stack temperature in degrees Fahrenheit (°F), stack gas moisture in percent (%), stack gas velocity in feet per minute (ft/min), and stack gas flow rate in actual cubic feet per minute (ACFM), standard cubic feet per minute (SCFM) and dry standard cubic feet per minute (DSCFM).

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."

Mark R. Grigereit, QSTI

This report prepared by:

Mr. Mark R. Grigereit, QSTI
Principal Engineer, Environmental Field Services
Environmental Management and Resources
DTE Energy Corporate Services, LLC

This report reviewed by: Th Snyder

Mr. Thom Snyder
Environmental Specialist, Environmental Field Services
Environmental Management and Resources
DTE Energy Corporate Services, LLC

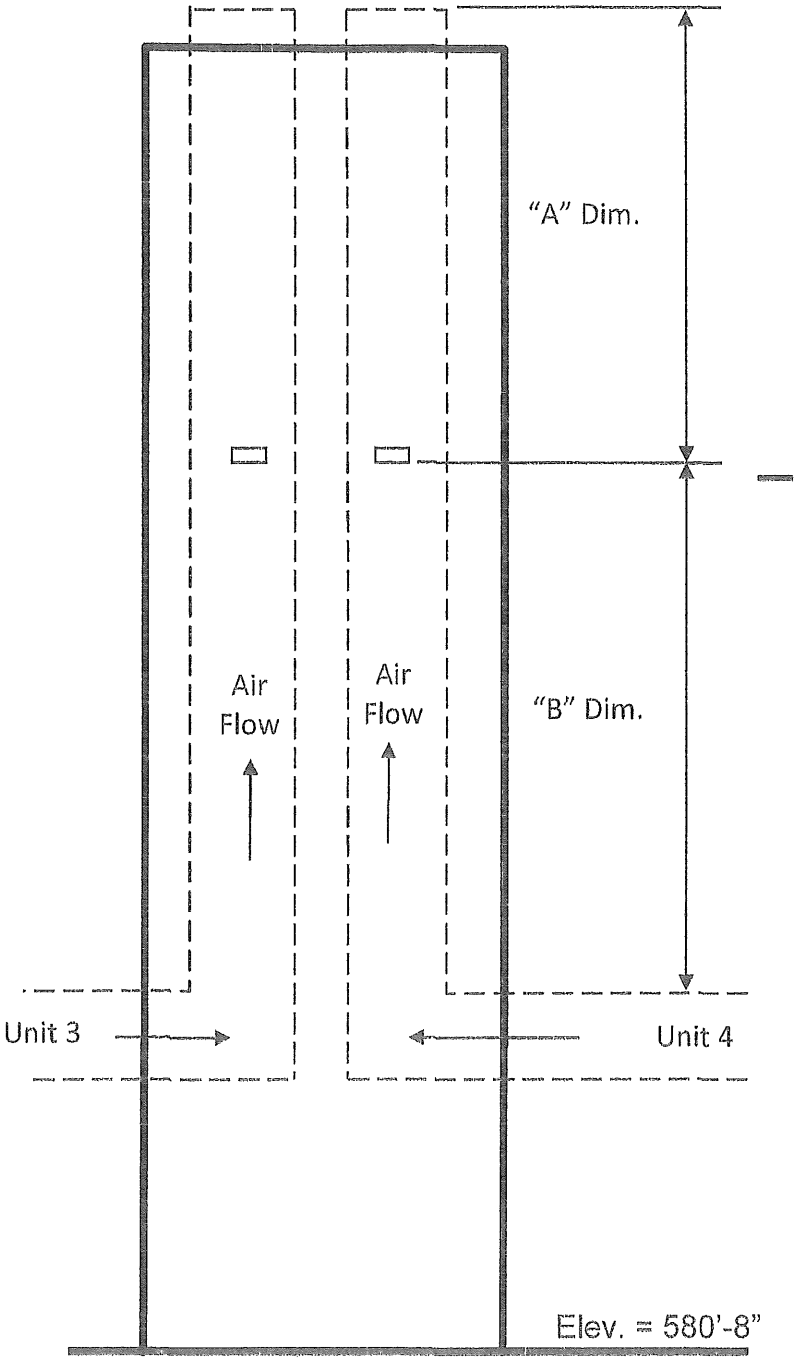
RESULTS TABLES

TABLE NO. 1
FINE PARTICULATE EMISSION TESTING RESULTS
Monroe Power Plant - Unit 4 FGD Stack
July 27, 2020

Test	Test Date	Test Time	Unit Load (GMW)	Stack Temperature (°F)	Stack Moisture (%)	Stack Velocity (ft/min)	Exhaust Gas Flowrates (ACFM)	Exhaust Gas Flowrates (SCFM)	Exhaust Gas Flowrates (DSCFM)	$PM_{2.5}$ Emissions (lbs/hr)	$PM_{2.5}$ Emissions (lbs/MMBtu)
PM-1	**27-Jul-20**	6:24-8:30	746.2	125.8	15.0	4,011	2,469,860	2,226,430	1,891,594	88.90	0.012
PM-2	**27-Jul-20**	8:47-11:36	746.3	125.9	15.5	4,105	2,527,393	2,277,969	1,925,054	97.79	0.011
PM-3	**27-Jul-20**	11:52-14:00	746.4	126.1	15.2	4,097	2,522,524	2,272,934	1,927,595	74.67	0.010
	Average:		*746.3*	*125.9*	*15.2*	*4,071*	*2,506,593*	*2,259,111*	*1,914,748*	*87.12*	*0.011*

FIGURES

Figure 1 – Sampling Location
Monroe Power Plant – Unit 3-4
July 27, 2020

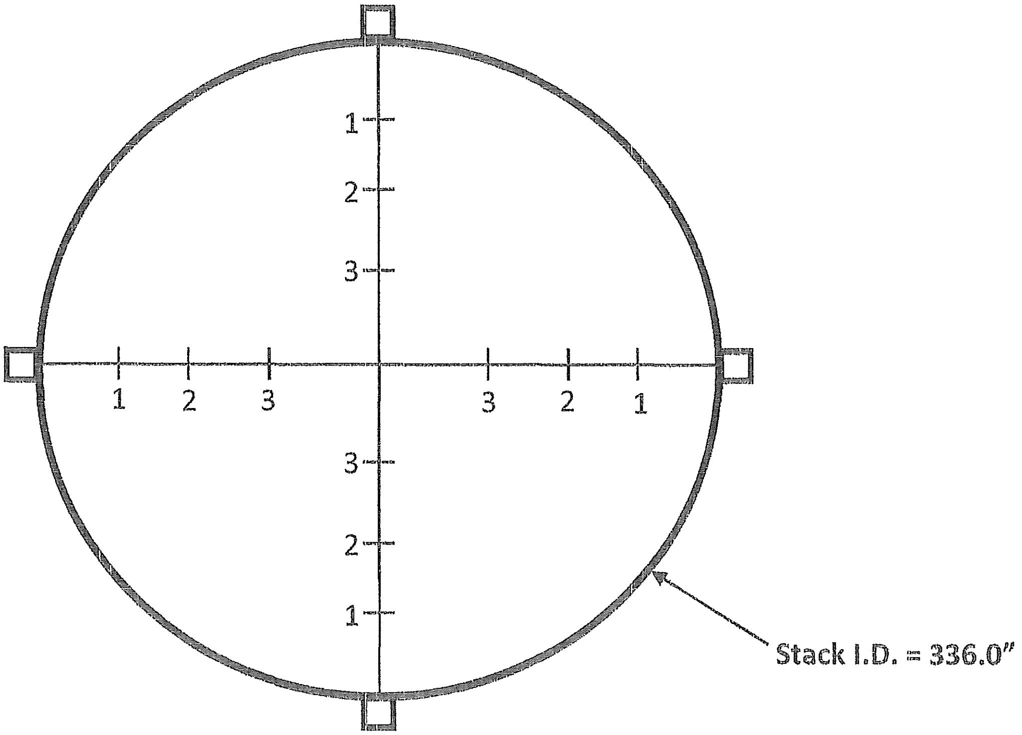


Details

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

Dia. @ Sample Location = 28'-0"

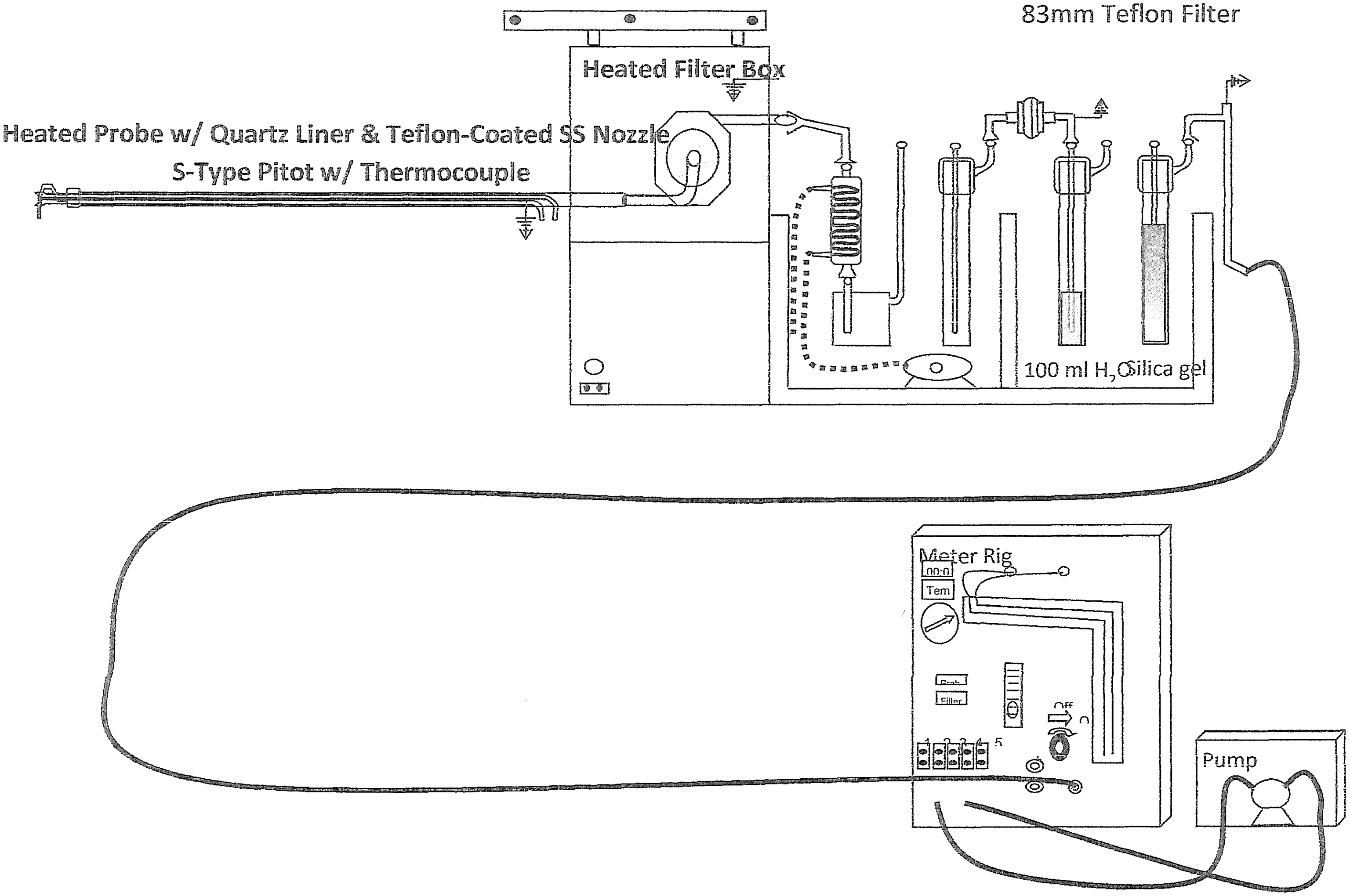
Figure 2 – Sampling Points
Monroe Power Plant – Units 3-4
July 27, 2020



VELOCITY / MEASUREMENT POINTS

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

Figure 3 – EPA Method 5B / 202
Monroe Power Plant – Units 3-4
July 27, 2020



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APPENDIX A

EGLE TEST PLAN & ACCEPTANCE LETTER