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Filterable Particulate Matter
40 CFR Part 63 Subpart UUUUU
LEE Demonstration

EUBOILER01 and 02
T.E.S. Filer City Station

T.E.S. Filer City Station
700 Mee Street
Filer City, Michigan 48634
Test Dates: May 9-11, 2016

June 27, 2016
Work Order No. 4101442

Revision 0

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section – Air Emissions Testing Body
GE&S/Environmental & Laboratory Services
Written by: Brian Miska, Senior Engineering Technical Analyst II

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1.0 INTRODUCTION

Consumers Energy Company (CECo) Regulatory Compliance Testing Section (RCTS) performed the Filterable Particulate Matter (FPM) Low Emitting Electric Generating Unit (LEE) demonstration per Subpart UUUUU, 40 CFR Part 63 (commonly referred to as the Mercury and Air Toxics Standard [MATS] Rule) at the stack exhausts associated with emissions units EUBOILER01 (Unit 1) and EUBOILER02 (Unit 2) in operation at the Tondu Energy Systems (TES) Filer City Station, located in Filer City, Michigan.

The FPM test was performed to demonstrate qualification as a LEE for FPM. This was the third test performed of the quarterly testing regimen. The FPM LEE demonstration requires quarterly sampling at each unit over a period of three calendar years. The results of each quarterly test must be less than or equal to 50 percent of the applicable FPM standard listed in Table 2 of the MATS Rule (see Table 1.1 below), equating to 0.015 lb/mmBtu for each of Units 1 and 2. A test protocol was submitted to the Michigan Department of Environmental Quality (MDEQ) on September 9th, 2015 and subsequently approved by Mr. Jeremy Howe, MDEQ Environmental Quality Analyst, in his letter dated October 2nd, 2015. The preceding reflects a standing approval for all quarterly MATS PM tests as long as no modifications from the original protocol are required, as was the case for this test event.

Table 1.1 - UUUUU, 40 CFR Part 63 (MATS Rule) Emission Limit

EGU Subcategory	Pollutant Being Sampled	Emission Limit
Existing Unit, Coal-fired not low rank virgin coal	Filterable Particulate Matter	0.030 lb/mmBtu

1.1 Summary of Test Program

The test program was conducted in accordance with applicable MATS Rule requirements and followed the sampling, calibration and quality assurance procedures specified in U.S. EPA CFR Part 60, Appendix A, Reference Methods (RM) 1, 2, 3A, 4, 5 (MATS Modified) and 19.

1.2 Key Personnel

RCTS representatives Brian Miska and Dillon King conducted the testing on May 9 through 11, 2016. Mr. Todd Guenthardt, TES Filer City Maintenance Supervisor and Environmental Health & Safety Coordinator, coordinated the test program with plant personnel. Mr. Jeremy Howe of the MDEQ observed portions of the testing.

Table 1.2 – Key Personnel Contact Information

Responsible Party	Address	Contact
Test Facility	TES Filer City Station 700 Mee Street Manistee, Michigan 49634	Mr. Todd Guenthardt Office: 231-723-6573, Ext. 104 Cell: 231-357-1169 Maintenance Supervisor Environmental Health & Safety todd.guenthardt@cmsenergy.com
Test Representative & Qualified Individuals	Consumers Energy Company RCTS - AETB 2742 North Weadock Highway ESD Trailer #4 Essexville, Michigan 48732	Mr. Brian Miska, QSTI Senior Engineering Technical Analyst II 989-891-3415 brian.miska@cmsenergy.com
		Mr. Dillon King, QSTI Technical Analyst 989-891-5585 dillon.king@cmsenergy.com
Regulatory Agency Representative	Michigan Department of Environmental Quality 120 W. Chapin Street Cadillac, Michigan 49601	Mr. Jeremy Howe Environmental Quality Analyst 231-876-4416 howej1@michigan.gov

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2.0 SOURCE DESCRIPTION

2.1 Process Description

TES Filer City Station operates a cogeneration power plant with a rated output of 60-megawatts (MW) net and 50,000 pounds of process steam per hour. At full load, each of Units 1 and 2 are capable of producing approximately 320,000 pounds per hour of steam, and this steam is fed to a common steam turbine and electrical generator. The electricity and process steam are sold under contract to public and/or private companies.

At the time of testing, Units 1 and 2 were capable of firing mixtures of coal (bituminous and subbituminous), wood and wood waste, construction/demolition (C/D) material, tire-derived-fuel (TDF) and natural gas. Units 1 and 2 are classified as "coal-fired unit not low rank virgin coal" in Item 1 of Table 2 Subpart UUUUU. During the tests, bituminous coal and TDF were fired during each run while wood was fired during 1 or more runs.

In March of 2016, installation of natural gas-fired burners in Units 1 and 2 was completed. Natural gas is utilized as a clean startup fuel under MATS, as well as at other times for flame stabilization and other purposes. However during this test event, Units 1 and 2 did not fire natural gas. Further, TES executed an Administrative Consent Order with the EPA which resulted in all petroleum coke having been removed from the site by March 31, 2016, and TES does not anticipate firing petroleum coke in the near future. Each unit has a nominal heat input rating of approximately 384 mmBtu/hour.

2.2 Control Device Description

The exhaust gas from each boiler is vented to an individual baghouse for PM control and a spray dryer absorber (SDA) flue gas desulfurization (FGD) system for sulfur dioxide (SO_2) and acid gas control. The abated exhaust gases are discharged through separate circular flues housed within a single exhaust stack; the separate flues discharge approximately 250 feet above grade.

3.0 SUMMARY OF TEST RESULTS

During the test program, Units 1 and 2 burned a mixture of coal, tire-derived fuel, and wood. The fuel blend firing rate and composite fuel factor data for each of the runs is included in Attachment 4. Testing was conducted at as close to full load as possible. The Unit 1 average steam flow was 304 klbs/hr (95% of full load), while the Unit 2 average steam flow was 302 klbs/hr (94% of full load).

3.1 Objectives

The objective of this test was to demonstrate qualification as a LEE for FPM. This was the third test performed of the three-year duration, quarterly testing regimen. The results of each quarterly test must be less than or equal to 50% the particulate matter emission limit of 0.030 lb/mmBtu to demonstrate qualification for LEE.

3.2 Test Results and Discussion

As shown in Table 3.1 below, the results of each individual run, as well as the average of the three runs for each unit were below the 40 CFR Part 63 Subpart UUUUU limit of 0.030 lb/mmBtu for Units 1 and 2. Both units demonstrated eligibility for Low Emitting EGU qualification as emission rates were below 0.015 lb/mmBtu (i.e., 50% of the FPM limit). This test program was the third of a series of 12 filterable particulate matter tests that will take place over a period of approximately three years to qualify Units 1 and 2 for LEE status.

Table 3.1 - TES Filer City
Summary of Filterable PM Emission Test Results

Source	Run	PM Concentration (gr/dscf)	PM Emission Rate (lb/hr)	PM Concentration (lb/1,000 lbs Gas Flow*)	PM Emission Rate (lb/mmBtu)	
				Result	Result	LEE Qualification
Filterable Particulate Matter						
UNIT 1	1	0.0019	1.53	0.0029	0.0038	-
	2	0.0019	1.50	0.0029	0.0038	-
	3	0.0019	1.55	0.0030	0.0039	-
	Average	**0.0019**	**1.53**	**0.0030**	**0.0039**	**0.015**
UNIT 2	1	0.0009	0.80	0.0014	0.0017	-

Source	Run	PM Concentration (gr/dscf)	PM Emission Rate (lb/hr)	PM Concentration (lb/1,000 lbs Gas Flow*)	PM Emission Rate (lb/mmBtu)	
				Result	Result	LEE Qualifi-cation
	2	0.0006	0.55	0.0010	0.0012	-
	3	0.0010	0.80	0.0016	0.0020	-
	Average	**0.0008**	**0.72**	**0.0013**	**0.0016**	**0.015**

* Emissions in pounds of particulate per 1000 pounds gas flow corrected to 50 % excess air.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

PM test runs were performed on the Unit 1 Stack May 9 and 10, 2016 and the Unit 2 stack May 10 and 11, 2016. During the testing, each boiler was operating under routine operating conditions as close to full load as possible. Operating data collected at 1-minute intervals during the test runs included CO_2 concentrations, fuel feed rates (coal, natural gas, TDF and wood), steam flow and pressure, stack opacity readings and CEMS derived heat input and composite fuel factor. It should be noted that the run start and stop times for the CEMS data were adjusted by the difference between local time and CEMS time, as well as the response time of the respective CEMS (i.e., 3 minutes for Unit 1 and 4 minutes for Unit 2). In addition, unit specific SDA slurry and recycle flow rates were logged manually; all process data is presented in Attachment 4.

4.1 Sampling Location

The number and location of traverse points for determining exhaust gas velocity/volumetric air-flow and particulate concentrations were determined in accordance with U.S. EPA Reference Method 1, Sample and Velocity Traverses for Stationary Sources. The area of the stack was determined and the cross-section divided into a number of equal areas based on existing air flow disturbances. The test location for Units 1 and 2 is on the stack at an elevation approximately 100 feet above stack grade. Each exhaust gas flue is 76 inches in diameter with two 6-inch internal diameter ports apiece that extend 20 inches from the flue interior wall. At this sample location, USEPA Reference Method 1 required a minimum of 12 traverse points for isokinetic particulate sampling. A schematic depicting the Unit 1 and 2 flues and test port locations is shown in Figures 1 through 3.

4.2 Velocity and Temperature

The exhaust gas velocity and temperature were determined using U.S. EPA Reference Method 2, *Determination of Stack Gas Temperature and Velocity (Type S Pitot Tube)*. The exhaust gas pressure differential (delta P) was measured at each traverse point during PM testing using an "S Type" Pitot tube connected to a manometer. Exhaust gas temperatures were also measured in conjunction with delta P determinations using a "Type K" thermocouple and a temperature indicator.

Attachment 3 of this report includes cyclonic flow test data as verification of the absence of cyclonic flow at the Units 1 and 2 stack test locations. Method 1, § 11.4.2 indicates *if the average* (null angle) *is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology...must be used.* The average null yaw angle measured at the Unit 1 exhaust on August 20, 2012 was observed to be 3° and the average null yaw angle measured at the Unit 2 exhaust on August 20, 2012 was observed to be 8°, thus meeting the less than 20° requirement. There have been no ductwork and/or stack configuration changes since the preceding cyclonic flow tests, so the

preceding null angle information is considered to be valid and additional cyclonic flow verification was not performed prior to the PM test.

4.3 Molecular Weight

The exhaust gas composition was determined using U.S. EPA Reference Method 3A, Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure). Integrated bag samples were obtained by sampling at each traverse point for purposes of determining flue gas molecular weight. The bag samples were analyzed for oxygen and carbon dioxide using paramagnetic (O_2) and gas filter correlation wheel (CO_2) analyzers. The reference method monitor was calibrated with certified gas standards at three levels and operated following the guidelines of Method 3A.

4.4 Moisture

The exhaust gas moisture content was determined using U.S. EPA Reference Method 4, *Determination of Moisture in Stack Gases* in conjunction with the Method 5 sample apparatus. Exhaust gas was drawn through a series of: one modified Greenburg-Smith (GS) impinger filled with 100 mL of water, one standard GS impinger filled with 100 mL of water, an empty modified Greenburg-Smith (GS) impinger, and one modified GS impinger containing approximately 300 g of silica gel. The impingers were immersed in an ice bath to ensure condensation of exhaust gas moisture, and the amount of water vapor collected was determined gravimetrically to calculate exhaust gas percent moisture.

4.5 Filterable Particulate Matter

Filterable PM was collected utilizing 40 CFR Part 60, U.S. EPA Method 5, *Determination of Particulate Matter Emissions from Stationary Sources* with the necessary modifications specified in the MATS Rule for qualifying for low emitting EGU (LEE) status. Specifically, the Method 5 front half temperature was maintained at 320 °F, ±25 °F, throughout the duration of each test run. A minimum of 2 dry standard cubic meters (dscm) or 70.629 dry standard cubic feet (dscf) of sample volume was drawn through a stainless steel nozzle, a heated stainless steel probe, and a heated glass filter holder containing an 83 millimeter (mm) quartz glass fiber filter followed by a Teflon frit filter support. After each run, filterable PM collected in the nozzle and probe was brushed and rinsed into an appropriately labeled sample bottle using acetone and a Teflon brush. After recovering the quartz FPM filter into a Petri dish labeled "Container #1, Filter", the front half filter holder was recovered with acetone rinses and combined with the probe and nozzle rinse in the sample bottle labeled "Container #2, Probe and Nozzle Rinse". At the laboratory, Method 5 gravimetric analytical procedures were followed to analyze the filters and rinses. All filters and rinses were weighed

multiple times (to ensure a constant weight) in a weighing room maintained at less than 50% relative humidity.

In accordance with §63.10007(e)(2) of the MATS Rule, particulate matter emission rates were calculated in units of lb/mmBtu using the PM concentrations (as lb/dscf) determined in accordance with Method 5, the CO_2 concentrations determined in accordance with Method 3A and composite CO_2 based fuel factors (F_c) determined in accordance with Section 3.3.6 of 40 CFR Part 75, Appendix A, as well as the applicable equations from Method 19. Specific equations include the following:

$$E = C_d F_c \frac{100}{\%CO_{2d}} \quad \text{Eq. 19-6}$$

The CEMS uses fuel feed rate data and the default F_c factors for bituminous coal, natural gas, TDF, and wood residue from 40 CFR Part 75, Appendix F Table 1 to calculate a composite F_c factor on a minute basis via Equation F-8 from Section 3.3.6 of 40 CFR Part 75, Appendix A.

$$F_c = \sum_{i=1}^{n} X_i (F_c)_i \quad \text{Eq. 19-6}$$

The default F_c factors for bituminous coal, natural gas, TDF and wood residue can be found below in 40 CFR Part 75, Appendix F, Table 1.

TABLE 1—F- AND F_c-FACTORS [1]

Fuel	F-factor (dscf/mmBtu)	F_c-factor (scf CO_2/ mmBtu)
Coal (as defined by ASTM D388–99 [2]):		
Anthracite	10,100	1,970
Bituminous	9,780	1,800
Subbituminous	9,820	1,840
Lignite	9,860	1,910
Petroleum Coke	9,830	1,850
Tire Derived Fuel	10,260	1,800
Oil	9,190	1,420
Gas:		
Natural gas	8,710	1,040
Propane	8,710	1,190
Butane	8,710	1,250
Wood:		
Bark	9,600	1,920
Wood residue	9,240	1,830

[1] Determined at standard conditions: 20 °C (68 °F) and 29.92 inches of mercury.

5.0 QUALITY ASSURANCE PROCEDURES

Each U.S. EPA reference method performed contains specific language stating reliable results are obtained by persons equipped with a thorough knowledge of the techniques associated with each method. To that end, factors which could potentially cause sampling errors were minimized by implementing quality assurance (QA) programs into every applicable component of field testing possible. The following QA components were included in this test program.

While not directly required, each PM sample apparatus was leak-checked before each test run as well as immediately after. Extreme care was exercised to minimize effects of stray or ambient particulate at the sampling site, such as ensuring the sample ports are cleaned thoroughly, maintaining enough distance from duct walls and/or other sources of PM so that bias was not introduced artificially. Time, meter box temperature, sample rate, barometric pressure, source temperature and total sample volume was documented for each run. Isokinetic variation was verified to be within Method 5 requirements. Field recovery of the impingers and nozzle/filter particulate catch were carefully performed in an enclosed laboratory area, prior to analysis.

All manual test equipment was calibrated before the test program in accordance with appropriate U.S. EPA procedures. Pitot tubes and thermocouples used to measure the exhaust gas were calibrated following the handbook requirements outlined in Stationary Source-Specific Methods, Method 2, Type S Pitot Tube Inspection, and in ALT – 011, Alternative Method 2 Thermocouple Calibration Procedure. Dry test meters used for moisture determination were calibrated using ALT – 009 as described in Method 5, § 16.1, using the procedures in Method 5, § 10.3.2. All applicable equipment calibration documents are included in Attachment 5.

All RM instruments measuring gaseous concentrations were calibrated and operated following applicable methodology based in part on specific quality assurance and quality control requirements contained in Method 7E. Although not required for MATS testing, U.S. EPA Protocol gas standards used by RCTS were purchased from an outside vendor participating in the U.S. EPA Protocol Gas Verification Program (PGVP) calibration gas audit program described 40 CFR Part 75 § 75.21(g). The standards are certified to have a total relative uncertainty of ±2 percent according to the U.S. EPA Traceability Protocol for Assay & Certification of Gaseous Calibration Standards; EPA – 600/R-97/121; September, 1997 or EPA Traceability Protocol for Assay & Certification of Gaseous Calibration Standards; EPA – 600/R-12/531; May, 2012.

Before beginning the sampling, a three-point analyzer calibration error check was conducted on the RM analyzer by injecting zero, mid and high-level calibration gases directly into the instrument and measuring the response. The instrument response must be within ± 2.0% of the respective analyzer

span or within 0.5 ppmv absolute difference to be acceptable. Zero and upscale gases were also introduced to the RM analyzer after each test run in order to determine analyzer drift, which must be within 3.0% of span or within 0.5 ppmv absolute difference to be acceptable. The results of the drift test were used to drift correct the average CO_2 and O_2 concentrations according the RM 7E, Equation 7E-5b.

6.0 CERTIFICATION

I hereby certify that the statements and information in this test report and supporting enclosures are true, accurate, and complete, and that the test program was performed in accordance with test methods specified in this report.

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Environmental Services – Air Quality Section

T.E.S. Filer City
Unit 1
Particulate Matter Emission Test

Summary Table

Filterable Particulate Matter

Date	Source	Run	Unit 1 Steam Flow (klbs/hr)	Volumetric Flowrate (DSCFM)	Particulate Concentration (gr/dscf)	Particulate Concentration (lb/1,000 lbs exhaust gas)†	Particulate Emission Rate (lb/hr)	Particulate Emission Rate (lb/mmBtu)	Average Stack Opacity (%)	Flue Gas Temperature (F°)	Flue Gas Velocity (fps)	Excess Air (%)	Flue Gas Moisture (%)	Isokinetic Variation (%)
5/9/16	Unit 1	1	304.8	93,236	0.0019	0.0029	1.53	0.0038	1.51	174.5	69.9	37.77	13.74	99.41
5/9/16	Unit 1	2	303.1	92,694	0.0019	0.0029	1.50	0.0038	1.64	173.5	69.6	39.66	14.04	98.41
5/10/16	Unit 1	3	305.4	96,613	0.0019	0.0030	1.55	0.0039	1.92	172.6	71.6	44.52	12.85	98.97
		Average	304.4	94,181	0.0019	0.0030	1.53	0.0039	1.69	173.5	70.4	40.65	13.54	98.93

* Emissions in pounds of particulate per 1000 pounds gas flow corrected to 50 % excess air.

Notes:
1. The particulate emission rate limit for 40CFR63 Subpart UUUUU Low Emitting EGU status is 0.015 lb/mmBtu. (One half the permissable limit of 0.030 lb/mmBtu)
2. Oxygen and carbon dioxide is measured via integrated bag sampling at the point of particulate sampling.
3. Flue gas moisture is determined by USEPA Method 4 in conjunction with USEPA Method 5
4. Flue gas temperature is the average temperature at the point of particulate sampling.

T.E.S. Filer City
Unit 2
Particulate Matter Emission Test

Summary Table

Filterable Particulate Matter

Date	Source	Run	Unit 1 Steam Flow (klbs/hr)	Volumetric Flowrate (DSCFM)	Particulate Concentration (gr/dscf)	Particulate Concentration (lb/1,000 lbs exhaust gas)*	Particulate Emission Rate (lb/hr)	Particulate Emission Rate (lb/mmBtu)	Average Stack Opacity (%)	Flue Gas Temperature (F°)	Flue Gas Velocity (fps)	Excess Air (%)	Flue Gas Moisture (%)	Isokinetic Variation (%)
5/10/16	Unit 1	1	304.3	102,656	0.0009	0.0014	0.80	0.0017	2.23	180.9	77.2	38.58	13.00	98.46
5/10/16	Unit 1	2	302.3	101,668	0.0006	0.0010	0.55	0.0012	2.15	179.8	76.7	40.07	13.43	98.82
5/11/16	Unit 1	3	298.9	98,123	0.0010	0.0016	0.80	0.0020	2.17	181.0	74.2	49.31	13.58	99.06
		Average	301.8	100,816	0.0008	0.0013	0.72	0.0016	2.18	180.6	76.0	42.65	13.33	98.78

* Emissions in pounds of particulate per 1000 pounds gas flow corrected to 50 % excess air.

Notes:
1. The particulate emission rate limit for 40CFR63 Subpart UUUUU Low Emitting EGU status is 0.015 lb/mmBtu. (One half the permissable limit of 0.030 lb/mmBtu)
2. Oxygen and carbon dioxide is measured via integrated bag sampling at the point of particulate sampling.
3. Flue gas moisture is determined by USEPA Method 4 in conjunction with USEPA Method 5
4. Flue gas temperature is the average temperature at the point of particulate sampling.

FIGURES

FIGURE 1

TES FILER CITY UNIT 1 & 2 TEST PORT ELEVATION

IN-STACK TEST PORT LOCATION
(elevation looking east)

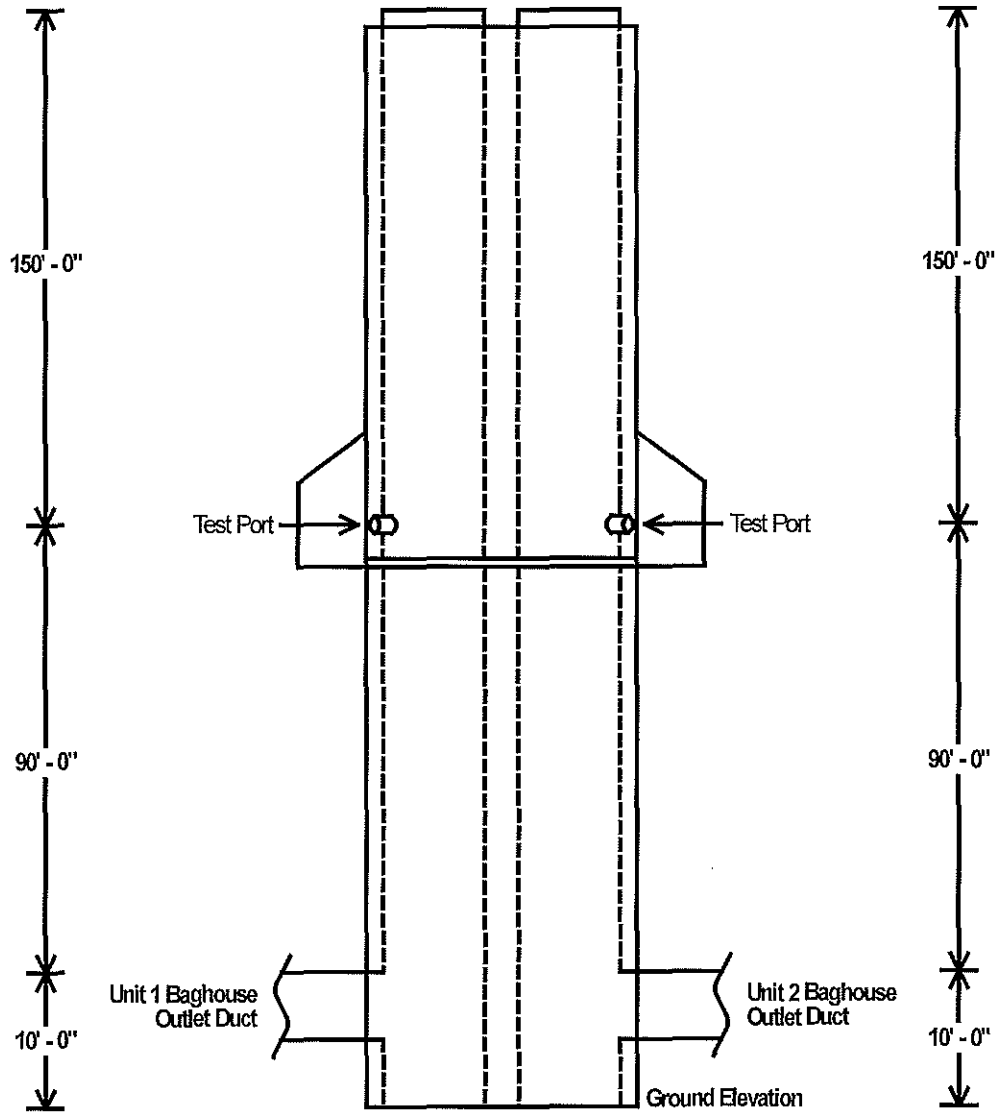
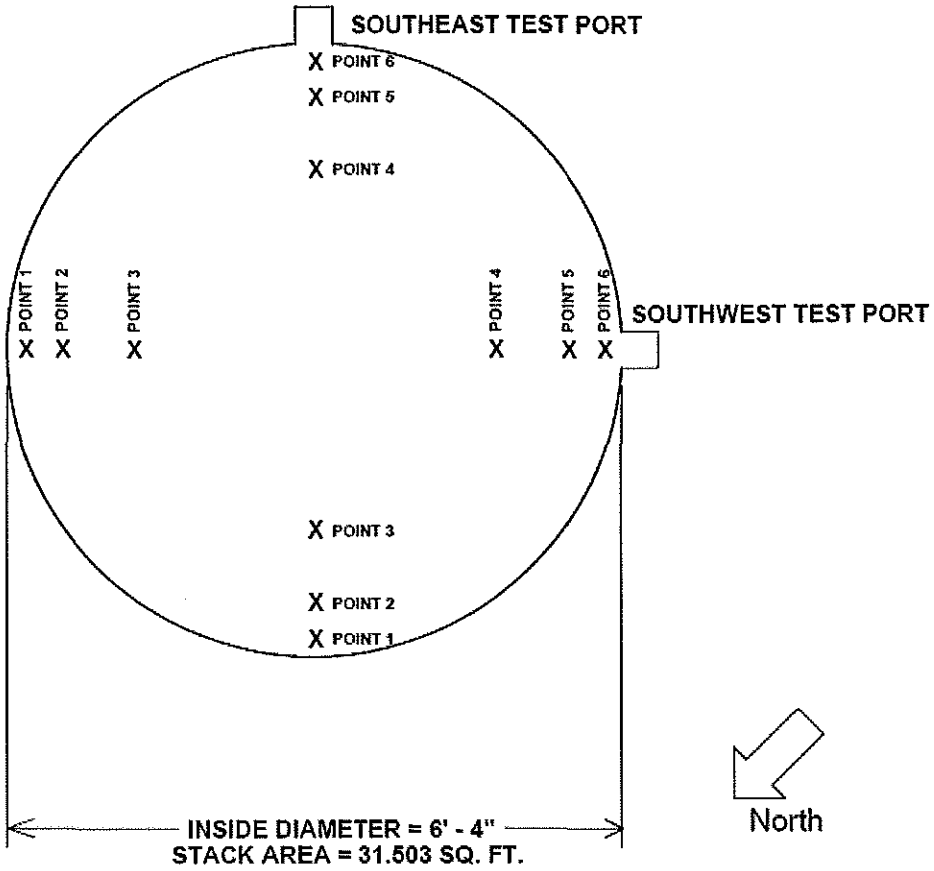


FIGURE 2

TES FILER CITY UNIT 1 PM TEST

IN-STACK TEST PORTS AND TRAVERSE POINT DETAIL



Probe Depths From Inside Stack Wall

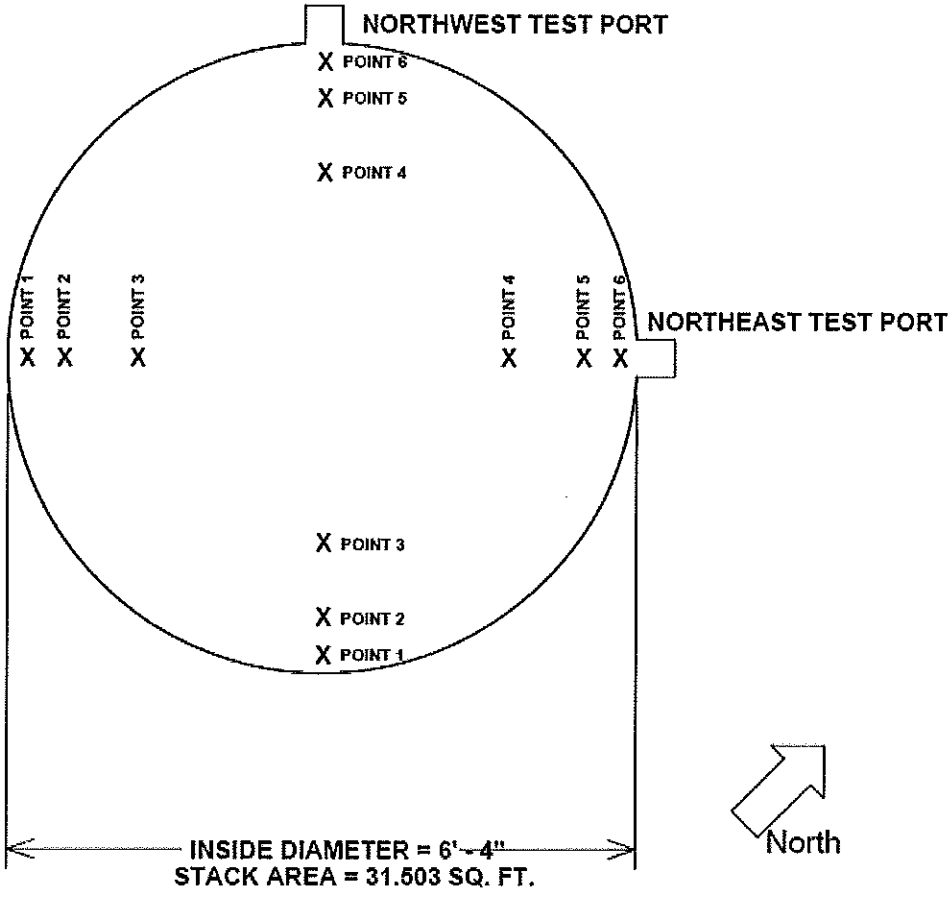
Flow Port Length = 20"

Point 1 = 72.656"
Point 2 = 64.904"
Point 3 = 53.504"
Point 4 = 22.496"
Point 5 = 11.096"
Point 6 = 3.344"

FIGURE 3

TES FILER CITY UNIT 2 PM TEST

IN-STACK TEST PORTS AND TRAVERSE POINT DETAIL

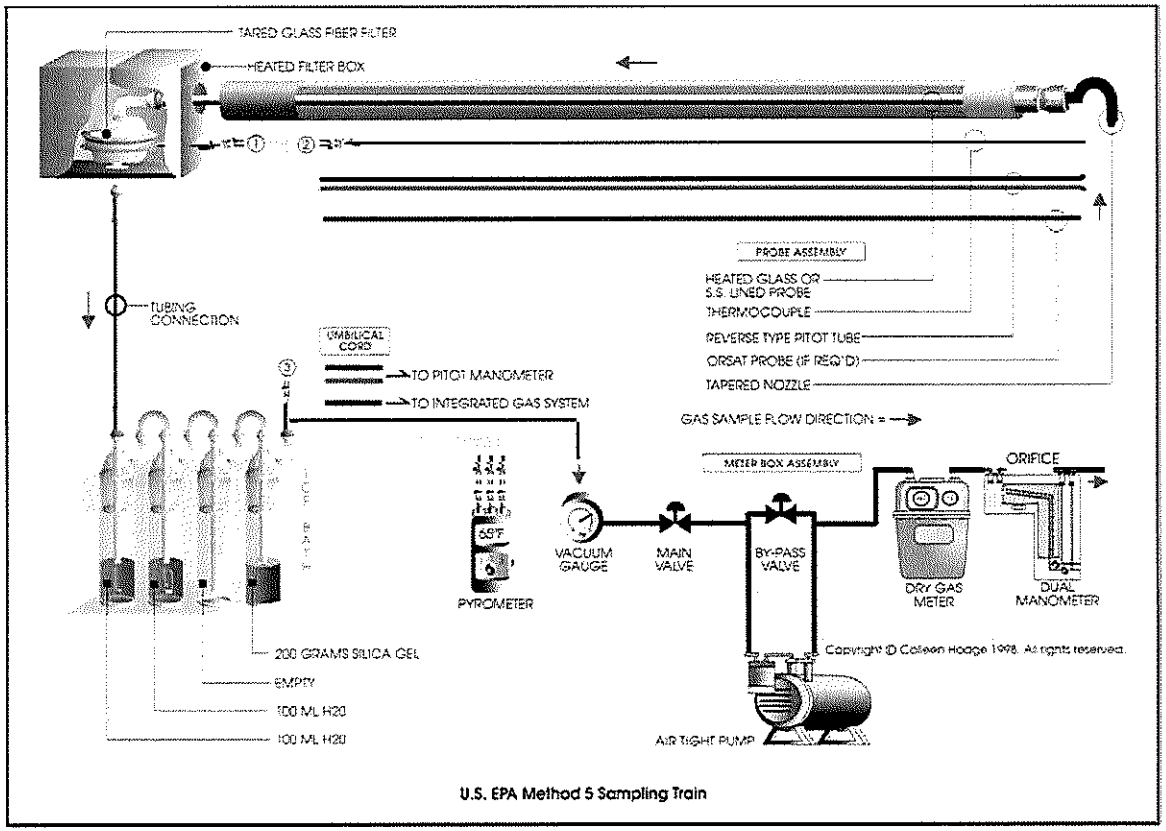


Probe Depths From Inside Stack Wall
Flow Port Length = 20"

Point 1 = 72.656"
Point 2 = 64.904"
Point 3 = 53.504"
Point 4 = 22.496"
Point 5 = 11.096"
Point 6 = 3.344"

FIGURE 4

Method 5 Filterable Particulate Matter Sample Apparatus



U.S. EPA Method 5 Sampling Train