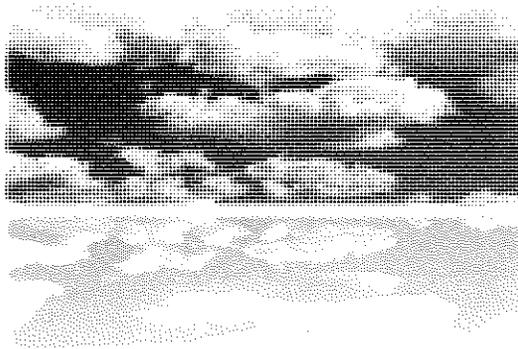




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REPORT ON COMPLIANCE
TESTING

Detroit Refinery

Complex 2 SRU Incinerator Stack

Marathon Petroleum Company LP
1300 South Fort Street
Detroit, MI 48217
Client Reference No. 4101004604

CleanAir Project No. 13375-3
STAC Certificate No. 2007.002.0113.1217
Revision 1, Final Report
November 28, 2017

1. PROJECT OVERVIEW

Test Program Summary

Marathon Petroleum Company LP (MPC) contracted CleanAir Engineering (CleanAir) to successfully complete testing at the Complex 2 SRU Incinerator (EU42-43SULRECOV-S1) at the Detroit Refinery located in Detroit, Michigan. The test program included the following objectives:

- Perform particulate matter (PM), volatile organic compounds (VOCs) and nitrogen oxides (NO_x) testing to demonstrate compliance with the Michigan Department of Environmental Quality (DEQ) Permit No. MI-ROP-A9831-2012c.

A summary of the test program results is presented below. Section 2 Results provides a more detailed account of the test conditions and data analysis. Test program information, including the test parameters, on-site schedule and a project discussion, begins on page 2.

**Table 1-1:
Summary of Compliance Results**

Source Constituent	Sampling Method	Average Emission	Permit Limit¹
Complex 2 SRU Incinerator			
PM (lb/hr)	USEPA 5	0.17	1.75
PM ₁₀ (lb/hr)	USEPA 5 / 202	0.51	1.75
VOC (lb/MMBtu)	USEPA 18 / 25A	< 0.0030	0.0055
NO _x (lb/hr)	USEPA 7E	1.4	7.5

¹ Permit limits obtained from MDEQ Renewable Operation Permit No. MI-ROP-A9831-2012c.

Test Program Details

Parameters

The test program included the following emissions measurements:

- particulate matter (PM) assumed equivalent to filterable particulate matter (FPM)
- total particulate matter less than 10 microns in diameter (PM₁₀), assumed equivalent to the sum of the following constituents:
 - filterable particulate matter (FPM)
 - condensable particulate matter (CPM)
- nitrogen oxides (NO_x)
- volatile organic compounds (VOCs), assumed equivalent to total hydrocarbons (THCs) minus the following constituents
 - methane (CH₄)
 - ethane (C₂H₆)
- flue gas composition (e.g., O₂, CO₂, H₂O)
- flue gas temperature
- flue gas flow rate

Schedule

Testing was performed on October 19, 2017. The on-site schedule followed during the test program is outlined in Table 1-2.

**Table 1-2:
Test Schedule**

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	C2 SRU Incinerator	USEPA Method 5/202	FPM/CPM	9/26/17	N/A ¹	N/A ¹
2	C2 SRU Incinerator	USEPA Method 5/202	FPM/CPM	10/19/17	09:10	12:00
3	C2 SRU Incinerator	USEPA Method 5/202	FPM/CPM	10/19/17	12:47	N/A ²
4	C2 SRU Incinerator	USEPA Method 5/202	FPM/CPM	10/19/17	15:20	17:40
5	C2 SRU Incinerator	USEPA Method 5/202	FPM/CPM	10/19/17	18:10	20:26
1	C2 SRU Incinerator	USEPA Method 3A/7E	O ₂ /CO ₂ /NO _x	10/19/17	10:44	11:44
2	C2 SRU Incinerator	USEPA Method 3A/7E	O ₂ /CO ₂ /NO _x	10/19/17	12:02	13:02
3	C2 SRU Incinerator	USEPA Method 3A/7E	O ₂ /CO ₂ /NO _x	10/19/17	13:22	14:22
1	C2 SRU Incinerator	USEPA Method 25A/18	VOC	10/19/17	10:44	11:44
2	C2 SRU Incinerator	USEPA Method 25A/18	VOC	10/19/17	12:02	13:02
3	C2 SRU Incinerator	USEPA Method 25A/18	VOC	10/19/17	13:22	14:22

¹ Run 1 was attempted on 9/26/17 but was not completed. See discussion on next page.

² Run 3 was aborted approximately halfway through. See discussion on next page.

Discussion

Test Scope Synopsis

PM & PM₁₀ Testing

A total of three (3) valid 120-minute EPA Method 5/202 test runs (Runs 2, 4, and 5) were performed. Run 1 was attempted during a prior mobilization on September 26, 2017; however, it was unable to be completed because of facility process issues. Run 3 was aborted approximately halfway through the test because the sample probe liner was compromised during the traversing process.

FPM/CPM emission results were calculated in units of pounds per hour (lb/hr). The final result was expressed as the average of the three (3) valid runs (Runs 2, 4, and 5).

PM is assumed equivalent to FPM, and PM₁₀ is assumed equivalent to the sum of FPM less than 10 micrometers (µm) in diameter (FPM₁₀) and CPM. The Method 5/202 sample train yields a front-half, FPM result and a back-half, CPM result. The total PM result (FPM plus CPM) from Method 5/202 can be used as a worst-case estimation of total PM₁₀ since Method 5 collects all FPM present in the flue gas (regardless of particle size).

NO_x Testing

NO_x emissions were determined using EPA Method 7E. NO_x emission results were calculated in units of pounds per hour (lb/hr).

Three (3) 60-minute Method 7E test runs were performed concurrently with VOC compliance testing utilizing the same sample system. The final result for each NO_x compliance run was expressed as the average of three (3) consecutive 60-minute runs.

VOC Testing

VOC emissions were determined using EPA Method 25A to quantify THC emissions, and EPA Method 18 to quantify methane (CH₄) and ethane (C₂H₆) emissions. VOC emissions are assumed equivalent to THC emissions minus CH₄ and C₂H₆.

Three (3) 60-minute Method 25A test runs were performed concurrently with three (3) 60-minute Method 18 bag collections. The final result for each VOC run was expressed as the average of three (3) consecutive 60-minute runs. Other CEMS methods referencing Method 3A and 7E were performed simultaneously using the same sampling system. Data was collected from all of the required Method 7E points rather than from the centroid of the duct, as specified by Method 25A.

THC, CH₄, and C₂H₆ emission results were calculated in units of heat input-based lb/MMBtu as propane. THC data was converted from an actual (wet) basis to a dry basis using moisture data collected from averaging overlapping Method 5/202 runs.

For all Method 25A runs, the measured concentrations of THC were below the detection limit defined as 'less than 1%' of the calibration span of THC instrument. For all runs, C₂H₆ was below analytical detection limits. For runs resulting in non-detects, the final result is treated as 'less than' the entire value of the detection limit. Assuming worst-case scenario, if the resultant VOC emissions were less than the defined THC detection limit, then they were reported as 'less than' the defined THC detection limit corrected to dry conditions.

Test Conditions

The unit was operated at the maximum normal operating capacity during each of the emissions compliance test. MPC was responsible for logging any relevant process-related data and providing it to CleanAir for inclusion in the test reports.

End of Section

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2. RESULTS

This section summarizes the test program results. Additional results are available in the report appendices, specifically Appendix C Parameters.

**Table 2-1:
C2 SRU Incinerator – PM & PM₁₀ Emissions**

Run No.	2	4	5	Average
Date (2017)	Oct 19	Oct 19	Oct 19	
Start Time (approx.)	09:10	15:20	18:10	
Stop Time (approx.)	12:00	17:40	20:26	
Process Conditions				
H _i Actual heat input (MMBtu/hr)	12.2	12.4	12.5	12.4
Gas Conditions				
O ₂ Oxygen (dry volume %)	7.3	8.0	6.7	7.3
CO ₂ Carbon dioxide (dry volume %)	4.2	3.9	4.3	4.1
T _s Sample temperature (°F)	1286	1273	1285	1281
B _w Actual water vapor in gas (% by volume)	9.2	9.0	9.0	9.0
Gas Flow Rate				
Q _a Volumetric flow rate, actual (acfm)	39,000	39,700	42,500	40,400
Q _s Volumetric flow rate, standard (scfm)	11,800	12,100	12,900	12,300
Q _{std} Volumetric flow rate, dry standard (dscfm)	10,700	11,000	11,700	11,100
Sampling Data				
V _{metd} Volume metered, standard (dscf)	47.56	49.43	52.61	49.87
%I Isokinetic sampling (%)	100.3	101.5	101.7	101.2
Laboratory Data				
m _{FPM} Total FPM (g)	0.00827	0.00486	0.00453	
m _{CPM} Total CPM (g)	0.01164	0.01018	0.01172	
m _{Part} Total particulate matter (as PM ₁₀) (g)	0.01991	0.01504	0.01625	
FPM Results				
C _{sd} Particulate Concentration (lb/dscf)	3.83E-07	2.17E-07	1.90E-07	2.63E-07
E _{lb/hr} Particulate Rate (lb/hr)	0.247	0.143	0.133	0.174
CPM Results				
C _{sd} Particulate Concentration (lb/dscf)	5.40E-07	4.54E-07	4.91E-07	4.95E-07
E _{lb/hr} Particulate Rate (lb/hr)	0.347	0.300	0.345	0.331
Total Particulate Matter (as PM₁₀) Results				
C _{sd} Particulate Concentration (lb/dscf)	9.23E-07	6.71E-07	6.81E-07	7.58E-07
E _{lb/hr} Particulate Rate (lb/hr)	0.594	0.444	0.478	0.505

Average includes 3 runs.

**Table 2-2:
C2 SRU Incinerator – VOCs & NO_x Emissions**

Run No.		1	2	3	Average
Date (2017)		Oct 19	Oct 19	Oct 19	
Start Time (approx.)		10:44	12:02	13:22	
Stop Time (approx.)		11:44	13:02	14:22	
Process Conditions					
H _i	Actual heat input (MMBtu/hr)	12.3	12.3	12.4	12.3
Gas Conditions					
O ₂	Oxygen (dry volume %)	5.7	5.6	5.6	5.6
CO ₂	Carbon dioxide (dry volume %)	4.8	4.8	4.8	4.8
B _w	Actual water vapor in gas (% by volume) ¹	9.2	9.2	9.0	9.1
Gas Flow Rate²					
Q _a	Volumetric flow rate, actual (acfm)	38,975	38,975	39,658	39,200
Q _s	Volumetric flow rate, standard (scfm)	11,801	11,801	12,103	11,900
Q _{std}	Volumetric flow rate, dry standard (dscfm)	10,721	10,721	11,019	10,800
THC Results³					
C _{sd}	Concentration (ppmdv as C ₃ H ₈)	<0.499	<0.499	<0.498	<0.498
C _{sd}	Concentration (lb/dscf)	<5.71E-08	<5.71E-08	<5.69E-08	<5.70E-08
E _{Hi}	Emission Rate - Heat input-based (lb/MMBtu)	< 0.00299	< 0.00298	< 0.00305	< 0.00301
Methane Results⁴					
C _{sd}	Concentration (ppmdv)	<0.12	<0.12	<0.12	<0.12
C _{sd}	Concentration (lb/dscf)	<5.0E-09	<5.0E-09	<5.0E-09	<5.0E-09
E _{l/hr}	Emission Rate (lb/hr)	< 0.0032	< 0.0032	< 0.0033	< 0.0032
E _{Hi}	Emission Rate - Heat input-based (lb/MMBtu)	< 0.00026	< 0.00026	< 0.00027	< 0.00026
Ethane Results⁴					
C _{sd}	Concentration (ppmdv)	<0.22	<0.22	<0.22	<0.22
C _{sd}	Concentration (lb/dscf)	<1.7E-08	<1.7E-08	<1.7E-08	<1.7E-08
E _{l/hr}	Emission Rate (lb/hr)	< 0.011	< 0.011	< 0.011	< 0.011
E _{Hi}	Emission Rate - Heat input-based (lb/MMBtu)	< 0.00090	< 0.00090	< 0.00092	< 0.00090
VOC Results⁵					
C _{sd}	Concentration (ppmdv as C ₃ H ₈)	<0.499	<0.499	<0.498	<0.498
E _{Hi}	Emission Rate - Heat input-based (lb/MMBtu)	< 0.00299	< 0.00298	< 0.00305	< 0.00301
Nitrogen Oxides Results					
C _{sd}	Concentration (ppmdv)	17.8	17.5	17.9	17.8
C _{sd}	Concentration (lb/dscf)	2.13E-06	2.09E-06	2.14E-06	2.12E-06
E _{l/hr}	Emission Rate (lb/hr)	1.37	1.35	1.41	1.38

¹ Moisture data used for ppmw v to ppmdv correction obtained from nearly-concurrent M-5/202 runs.

² Flow data used in lb/hr calculations was obtained from nearly-concurrent M-5/202 runs.

³ For THC, '<' indicates a measured response below the detection limit (assumed to be 1% of the instrument calibration span).

⁴ For methane and ethane, '<' indicates a measured response below the analytical detection limit determined by the laboratory.

⁵ For VOCs, '<' indicates at least one non-detectable fraction was used in the calculations.

3. DESCRIPTION OF INSTALLATION

Process Description

MPC's facility in Detroit, Michigan, produces refined petroleum products from crude oil. MPC must continue to demonstrate that select process units are in compliance with permitted emission limits.

The Sulfur Recovery Unit (EU42-43SULRECOV-S1) removes hydrogen sulfide (H₂S) from acid gas and converts it to elemental sulfur using the Claus Process (Trains A, B, and C), the SCOT Tail Gas Treating Unit process (Trains No. 1 and No. 2), and associated amine treating equipment. Tail gas is routed to a thermal oxidizer, or incinerator, which oxidizes the remaining H₂S in the tail gas to SO₂ before exhausting to the atmosphere via the SRU Incinerator Stack (SV43-H2). The emission group also consists of process vessels (including thermal reactors, an absorbing tower, and a stripping tower), heaters, tanks, containers, compressors, seals, process valves, flanges, connectors, etc.).

The testing reported in this document was performed at Complex 2 SRU Incinerator Stack.

Test Location

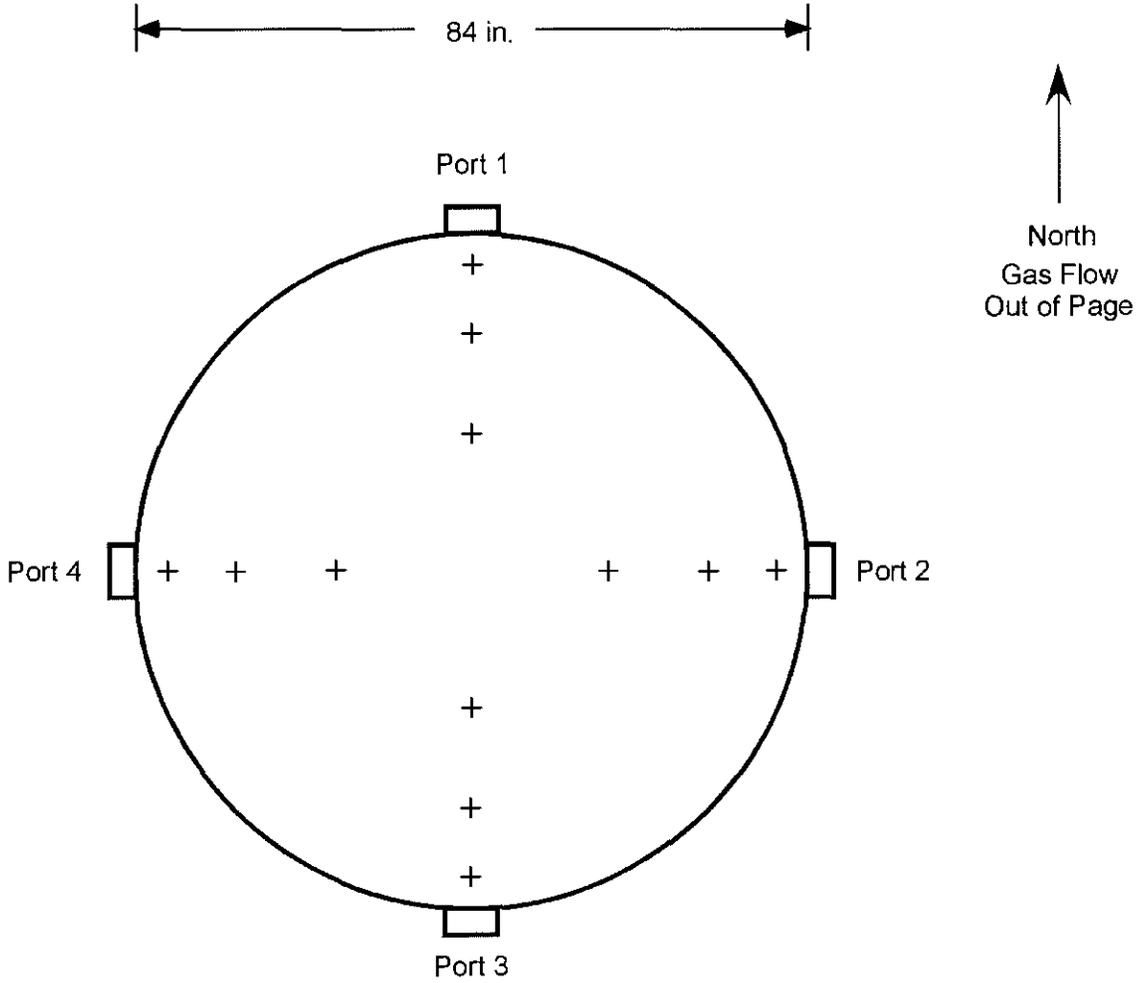
The sample point locations were determined by EPA Methods 1 and 7E specifications. Table 3-1 presents the sampling information for the test location described in this report. The figures shown on pages 8 and 9 represent the layout of the test location.

**Table 3-1:
Sampling Point Information**

Source	Constituent	Method	Run No.	Ports	Points per Port	Minutes per Point	Total Minutes	Figure
<u>Complex 2 SRU Incinerator</u>								
	FPM / CPM	5 / 202	2, 4, 5	4	3	10	120	3-1
	O ₂ / CO ₂ / NO _x / CH ₄ / C ₂ H ₆ / THC	3A / 7E / 18 / 25A	1 ¹	1	3	20	60	3-2
	O ₂ / CO ₂ / NO _x / CH ₄ / C ₂ H ₆ / THC	3A / 7E / 18 / 25A	2, 3	1	1	60	60	3-2

¹Stratification check conducted during Run 1. Per Method 7E specifications, Runs 2 and 3 were allowed to be sampled at a single point.

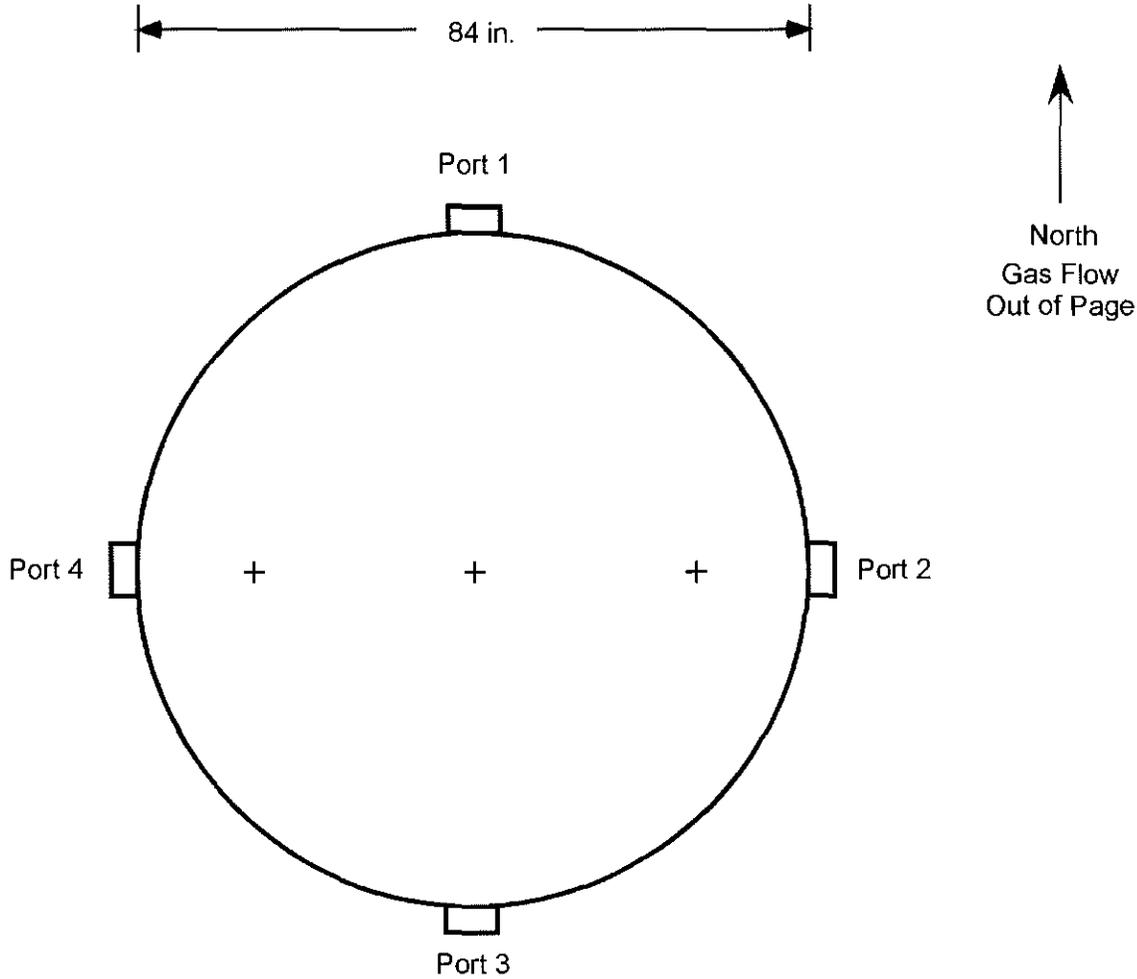
**Figure 3-1:
 PM & PM₁₀ Sample Point Layout (EPA Method 1)**



Sampling Point	% of Stack Diameter	Port to Point Distance (inches)
1	29.6	24.9
2	14.6	12.3
3	4.4	3.7

Duct diameters upstream from flow disturbance (A): 20 Limit: 0.5
 Duct diameters downstream from flow disturbance (B): 15 Limit: 2.0

Figure 3-2:
O₂, NO_x & THC Sample Point Layout (EPA Method 7E)



Sampling Point	% of Stack Diameter	Port to Point Distance (inches)
1	83.3	70.0
2	50.0	42.0
3	16.7	14.0

Duct diameters upstream from flow disturbance (A): 14.5 Limit: 0.5
 Duct diameters downstream from flow disturbance (B): 14.5 Limit: 2.0

4. METHODOLOGY

Procedures and Regulations

The test program sampling measurements followed procedures and regulations outlined by the United States Environmental Protection Agency (USEPA) and the DEQ. These methods appear in detail in Title 40 of the CFR and at <https://www.epa.gov/emc>. Appendix A includes diagrams of the sampling apparatus, as well as specifications for sampling, recovery and analytical procedures.

CleanAir follows specific QA/QC procedures outlined in the individual methods and in USEPA "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III Stationary Source-Specific Methods," EPA/600/R-94/038C. Appendix D contains additional QA/QC measures, as outlined in CleanAir's internal Quality Manual.

Title 40 CFR Part 60, Appendix A

- Method 1 "Sample and Velocity Traverses for Stationary Sources"
- Method 2 "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)"
- Method 3 "Gas Analysis for the Determination of Dry Molecular Weight"
- Method 3A "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
- Method 3B "Gas Analysis for the Determination of Emission Rate Correction Factor or Excess Air"
- Method 4 "Determination of Moisture Content in Stack Gases"
- Method 5 "Determination of Particulate Matter Emissions from Stationary Sources"
- Method 7E "Determination of Nitrogen Oxide Emissions from Stationary Sources (Instrumental Analyzer)"
- Method 18 "Measurement of Gaseous Organic Compound Emissions by Gas Chromatography"
- Method 25A "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer"

Title 40 CFR Part 60, Appendix B Performance Specifications

- PS2 "Specifications and Test Procedures for SO₂ and NO_x Continuous Emission Monitoring Systems in Stationary Sources"
- PS3 "Specifications and Test Procedures for O₂ and CO₂ Continuous Emission Monitoring Systems in Stationary Sources"

Title 40 CFR Part 51, Appendix M

- Method 202 "Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources"

Methodology Discussion

PM and PM₁₀ Testing – USEPA Method 5/202

The front-half (Method 5 portion) of the sampling train consisted of a glass nozzle, glass liner and filter holder heated to 248°F ± 25°F and a quartz fiber filter. Flue gas samples were extracted isokinetically per Method 5 requirements.

The back-half (Method 202 portion) of the sampling train is designed to mimic ambient conditions and collect only the particles that would truly form CPM in the atmosphere by minimizing the SO₂ and NO_x interferences observed with earlier versions of the method, in which flue gas was bubbled through cold water, and SO₂ and NO_x were absorbed and partially oxidized before they could be purged out with nitrogen (N₂).

Flue gas exiting the front-half heated filter passed through a coiled condenser and dry impinger system jacketed by water continually circulated at ambient temperature. Moisture was removed from the flue gas without bubbling through the condensed water. Flue gas then passed through a tetrafluoroethane (TFE) membrane filter at ambient temperature. The temperature of the flue gas at the exit of the filter was directly measured with an in-line thermocouple and maintained in the temperature range of 65°F to 85°F.

After exiting the ambient filter, the flue gas passed through two (2) additional impingers surrounded by ice in a "cold" section of the impinger bucket. The moisture collected in these impingers were not analyzed for CPM and was only collected to determine the flue gas moisture and thoroughly dry the gas. The sample gas then flowed into a calibrated dry gas meter where the collected sample gas volume was determined.

The front-half portion of the sample train (nozzle, probe and heated filter) was recovered per Method 5 requirements, using acetone as the recovery solvent. The back-half of the sample train (heated filter outlet, condenser, dry impingers and TFE membrane filter) was recovered per Method 202 requirements. The impinger train was purged with N₂ at a rate of 14 liters per minute (lpm) for one (1) hour following each test run and prior to recovery.

A field train blank was assembled, purged and recovered as if it were an actual test sample; analysis of the field train blank was used to blank-correct the test run results. Reagent blanks were also collected to quantify background contamination. All samples and blanks were returned to CleanAir Analytical Services for gravimetric analysis. Method 202 samples were maintained at a temperature < 85°F during transport to the laboratory.

O₂, CO₂, and NO_x Testing – USEPA Methods 3A and 7E

Reference method O₂ and CO₂ emissions were determined using a paramagnetic/NDIR analyzer per EPA Method 3A. Reference method NO_x emissions were determined using a chemiluminescent analyzer per EPA Method 7E.

Sample gas was extracted at a constant rate, conditioned to remove moisture and delivered to an analyzer bank which measured the concentration of each pollutant on a dry basis (units of %dv or ppm_{dv}).

Calibration error checks were performed by introducing zero N₂, high range and mid-range calibration gases to the inlet of each analyzer during calibration error checks. Bias checks were performed before and after each sampling run by introducing calibration gas to the inlet of the sampling system's heated filter. Per Methods 3A and 7E, the average results for each run were drift-corrected.

The mid-level gas (approximately 5% O₂) utilized for the calibration error and bias checks on the O₂ analyzer was approximately 25% of the calibration span as opposed to the 40% to 60% range outlined in the methodology. The results are believed to be just as accurate since the measured O₂ during every test set was less than 5%.

VOCs Testing – USEPA Methods 25A and 18

The Method 25A sampling system consists of a heated probe, heated filter and heated sample line. Flue gas was delivered at 250°F to a flame ionization analyzer (FIA), which continuously measures minute-average THC concentration expressed in terms of propane (C₃H₈) on an actual (wet) basis. FIA calibration was performed by introducing zero air, high, mid- and low range C₃H₈ calibration gases to the inlet of the sampling system's heated filter. Bias checks were performed before and after each sampling run in a similar manner.

The Method 18 sampling system consists of a gas conditioner (for moisture removal), TFE sample lines, TFE-coated diaphragm pump and a mass flow meter ("Direct Pump Sampling Procedure"). This system pulled a slipstream of the flue gas from the Method 25A sample delivery system and delivered it into a FlexFoil bag at a constant rate. The moisture condensate was not collected for analysis as CH₄ and C₂H₆ are insoluble in water.

Analysis for CH₄ and C₂H₆ was performed off-site by CleanAir Analytical Services using gas chromatography (GC). Since moisture was removed from the sample prior to collection, the GC analyzer measured concentration on a dry basis. At least five (5) sample injections were analyzed for each run.

Analyzer calibration was performed by generating a calibration curve from triplicate injections of three (3) distinct CH₄ and C₂H₆ concentrations introduced directly into the GC. Upon completion of calibration, a recovery study was performed by spiking one of the bag samples with a known concentration of CH₄ and C₂H₆, storing the bags for the same period of time prior to analysis as the field samples, and analyzing the bags to determine percent recovery.

End of Section