## 1. PROJECT OVERVIEW

## Test Program Summary

Marathon Petroleum Company LP (MPC) contracted CleanAir Engineering (CleanAir) to perform compliance testing on the B&W Boiler (EU27-B&WBOILER-S1) at the Detroit Refinery. The objective of the test program was to demonstrate compliance with the Michigan Department of Environment, Great Lakes, and Energy (EGLE) 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.

Table 1-1: Summary of Results

Source Constituent	Sampling Method	Average Emission	Permit Limit <sup>1</sup>	
B&W Boiler Stack				
PM (lb/MMBtu) VOC (lb/MMBtu)	USEPA 5 USEPA 25A	0.0014 0.0014	0.0019 0.0055	

<sup>&</sup>lt;sup>1</sup> Permit limits obtained from MDEQ Renew able Operating Permit No. MI-ROP-A9831-2012c.

# TEST PROGRAM DETAILS

#### **PARAMETERS**

The test program included the following measurements:

- particulate matter (PM) assumed equivalent to filterable particulate matter (FPM) only
- volatile organic compounds (VOC) assumed equivalent to total hydrocarbons (THC) less methane ( $CH_4$ ) and ethane ( $C_2H_6$ )
- flue gas composition (e.g., O<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>O)
- flue gas temperature
- flue gas flow rate

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#### SCHEDULE

Testing was performed on March 4, 2021. Table 1-2 outlines the on-site schedule followed during the test program.

Table 1-2: Test Schedule

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	B&W Boiler Stack	USEPA Method 5	FPM	03/04/21	08:33	09:36
1	B&W Boiler Stack	USEPA Method 3A/18/25A	O <sub>2</sub> /CO <sub>2</sub> /VOC	03/04/21	08:33	09:36
2	B&W Boiler Stack	USEPA Method 5	FPM	03/04/21	10:16	11:19
2	B&W Boiler Stack	USEPA Method 3A/18/25A	O <sub>2</sub> /CO <sub>2</sub> /VOC	03/04/21	10:16	11:19
3	B&W Boiler Stack	USEPA Method 5	FPM	03/04/21	11:52	12:54
3	B&W Boiler Stack	USEPA Method 3A/18/25A	O <sub>2</sub> /CO <sub>2</sub> /VOC	03/04/21	11:52	12:54

#### DISCUSSION

## Filterable Particulate Matter Testing

Three (3) 60-minute EPA Method 5 test runs were performed. FPM emission results were calculated in units of pounds per million Btu (lb/MMBtu). The final result was expressed as the average of the three (3) test runs.

## Volatile Organic Compounds Testing

VOC emissions were determined using EPA Method 25A to quantify THC emissions. The results were comprised of three (3) 60-minute test runs. The final result was expressed as the average of the three (3) test runs.

Oxygen concentrations from concurrent Method 3A test runs were utilized to convert VOC results to lb/MMBtu. THC data was converted from an actual (wet) basis to a dry basis using moisture data collected from concurrent Method 5 test runs. VOC emissions are reported on a propane basis.

An integrated gas sample was collected during each test run for follow-up analysis for methane and ethane by Method 18 at CleanAir's Analytical Services in Palatine, Illinois. The methane and ethane results are reported on an as propane basis to facilitate subtraction from the Method 25A THC results.

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#### Fuel F<sub>d</sub> Factor

Emission results in units of dry volume-based concentration (lb/dscf, ppmdv) were converted to units of lb/MMBtu by calculating a combination oxygen-based fuel factor ( $F_d$ ) for natural gas and refinery gas per EPA Method 19 specifications.

- For natural gas, the volume-based gross heat content ( $GCV_V$ ) was obtained from a gas analysis report provided by MPC. The natural gas  $F_d$  factor was calculated from the reported constitute values.
- For refinery gas, the heat content and F<sub>d</sub> factor was calculated from percent volume composition
  analytical data, provided by MPC, and tabulated heating values for each of the measured constituents.

A refinery gas and natural gas combined  $F_d$  factor was calculated for each run based on respective fuel flow during the run.

#### Test Conditions

The unit was operated at the maximum normal operating capacity during each of the emissions compliance test runs. Test run process data is presented in Section 2 results tables. MPC was responsible for logging any relevant process-related data and providing it to CleanAir for inclusion in the test report.

End of Section

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# 2. RESULTS

This section summarizes the test program results. Additional results are available in the report appendices.

Table 2-1: B&W Boiler Stack – FPM Emissions

Run No	).	1	2	3	Average
Date (2021)		Mar 4	Mar 4	Mar 4	
Start Ti	me (approx.)	08:33	10:16	11:52	
Stop Ti	me (approx.)	09:36	11:19	12:54	
Proces	ss Conditions				
$R_P$	Steam production (mlb/hr)	171	170	170	170
$P_1$	Firing rate (MMBtu/hr)	239	238	243	240
$F_d$	Oxygen-based F-factor (dscf/MMBtu)	8,584	8,585	8,585	8,585
$H_i$	Actual heat input (MMBtu/hr)	214	214	212	213
Сар	Capacity factor (hours/year)	8,760	8,760	8,760	8,760
Gas Co	onditions				
$O_2$	Oxygen (dry volume %)	6.1	6.3	6.2	6.2
$CO_2$	Carbon dioxide (dry volume %)	8.7	8.6	8.7	8.7
$T_s$	Stack temperature (°F)	346	349	349	348
$B_w$	Actual water vapor in gas (% by volume)	16.2	16.4	16.1	16.3
Gas Flo	ow Rate	•			
$Q_a$	Volumetric flow rate, actual (acfm)	90,400	91,700	90,000	90,700
$Q_s$	Volumetric flow rate, standard (scfm)	58,200	58,800	57,700	58,200
$\mathbf{Q}_{\text{std}}$	Volumetric flow rate, dry standard (dscfm)	48,700	49,100	48,400	48,700
Sampli	ing Data				
$V_{mstd}$	Volume metered, standard (dscf)	32.63	33.40	33.29	33.11
%I	Isokinetic sampling (%)	102.2	103.7	105.0	103.6
Labora	itory Data				
$m_{n}$	Total FPM(g)	0.00190	0.00201	0.00130	
FPM Re	esults				
$C_{sd}$	Particulate Concentration (lb/dscf)	1.28E-07	1.33E-07	8.61E-08	1.16E-07
$C_{sd}$	Particulate Concentration (mg/dscm)	2.06	2.12	1.38	1.85
$E_{lb/hr}$	Particulate Rate (lb/hr)	0.38	0.39	0.25	0.34
$E_{Fd}$	Particulate Rate - F <sub>d</sub> -based (lb/MMBtu)	0.0016	0.0016	0.0010	0.0014

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Table 2-2: B&W Boiler Stack – VOC Emissions

Run Eco   1	DOWN L	Bow Boiler Stack - voc Ellissions						
Stap T::: (approx.)         08:03         10:16         11:52           Stop T::: (approx.)         09:36         11:19         12:54           Process Unitions           Reproduction (mlb/hr)         171         170         170         170           P1         Firing rate (MMBtu/hr)         239         238         243         240           P4         Oxygen-based F-factor (dscffMMBtu)         8,584         8,585         8,585         8,585           H1         Actual heat input (MMBtu/hr)         214         214         212         213           Cay Supper (dry volume %)         6.13         6.31         6.16         6.20           Cy         Caypen (dry volume %)         8.71         8.58         8.66         8.65           T8         Sample temperature (*F)         346         349         349         348         349         348         348         368         8.65         8.65         8.65         8.65         8.65         8.65         8.65         8.65         8.65         8.65         8.65         8.65         8.65         8.65         8.65         9.62         9.00         9.00         9.00         9.00         9.00	Run No	).	1	2	3	Average		
Stop-Type School (Internation of Processed School (Internation of Internation of Internation of Internation (Internation of Internation (Internation of Internation (Internation of Internation (Internation (Internatio	Date (2021)		Mar 4	Mar 4	Mar 4			
Procession (milb/ling)         171         170         170         170           Rp         15team Production (milb/ling)         171         170         170         170           P1         Firing rate (MMBtu/hr)         238         238         243         240           Fd         0xygen-based F-factor (dscf/MMBtu)         214         214         212         213           Cay         0xygen (dry volume %)         6.13         6.31         6.16         6.20           Cay         2 cytoon dioxide (dry volume %)         8.71         8.58         8.66         8.65           Ts         2 cytoon dioxide (dry volume %)         8.71         8.58         8.66         8.65           Ts         2 cytoon dioxide (dry volume %)         8.71         8.58         8.66         8.65           Ts         2 cytoon dioxide (dry volume %)         8.71         8.58         8.66         8.65           Ts         2 cytoon dioxide (dry volume %)         8.71         8.58         8.66         8.65           Ts         2 cytoon dioxide (dry volume %)         8.71         8.58         8.68         8.65           Ts         3 cytoon divation (particle (accounting to gas (%) syolume for faccounting to gas (%) syolu	Start Time (approx.)		08:33	10:16	11:52			
Rpp         Steam Production (mlb/hr)         171         170         170         170           P1         Frining rate (MMBtu/hr)         239         238         243         240           Fd         Oxygen-based F-factor (dscf/MMBtu)         8,584         8,585         8,585         8,585           Him in print (MMBtu/hr)         214         212         212         213           Coval in part (MMBtu/hr)         214         214         212         212         213           Coval in part (MMBtu/hr)         6.13         6.13         6.13         6.16         6.20           Coval in divide (dry volume %)         6.13         6.31         6.16         6.20           Coval color divide (dry volume %)         8.71         8.58         8.66         8.65           Tax divide (dry volume %)         8.71         8.58         8.66         8.65           Tax divide (dry volume %)         6.16         3.49         349         349         349         349         349         349         349         348         348         348         348         348         348         348         348         348         348         349         349	Stop Ti	me (approx.)	09:36	11:19	12:54			
P₁   Firing rate (MMBtu/hr)         239   238   243   248   258   8,585   8,585   8,585   14   212   213   213   213   214   214   212   213	Proces	s Conditions						
Fd black         Oxygen-based F-factor (dsct/MMBtu/hr)         8,584         8,585         8,585         8,585         8,585         8,585         8,585         8,585         8,585         8,585         8,685         2,13         213 <td><math>R_P</math></td> <td>Steam Production (mlb/hr)</td> <td>171</td> <td>170</td> <td>170</td> <td>170</td>	$R_P$	Steam Production (mlb/hr)	171	170	170	170		
H₁	$P_1$	Firing rate (MMBtu/hr)	239	238	243	240		
Cas Usigen (dry volume %)         6.13         6.31         6.16         6.20           CO₂         Coxygen (dry volume %)         8.71         8.58         8.66         8.65           T₃         Sample temperature (*F)         346         349         349         348           B₀         Actual water vapor in gas (% by volume)¹         16.2         16.4         16.1         16.3           Cas Texate²           Q₃         Volumetric flow rate, actual (acfm)         99,400         58,800         57,700         58,200           Q₃         Volumetric flow rate, standard (scfm)         58,200         55,800         57,700         58,200           Q₃         Volumetric flow rate, dry standard (dscfm)         48,700         49,100         48,400         48,700           Colspan="6">Concentration (ppmdv)         16.6         16.2         16.1         16.3           Concentration (lb/dscf)         1.90E-06         1.86E-06         1.84E-06         1.87E-06           E <sub>Fd</sub> Mass Rate (lb/MMBtu) - Fd         0.023         0.023         0.022         22.9         23.7           Metase Issuits (as C <sub>3</sub> H <sub>6</sub> )         2.2         2.2         2.2         2.2         2.2	$F_d$	Oxygen-based F-factor (dscf/MMBtu)	8,584	8,585	8,585	8,585		
O₂         Cxygen (dry volume %)         6.13         6.31         6.16         6.20           CO₂         Carbon dioxide (dry volume %)         8.71         8.58         8.66         8.65           T₃         Sample temperature (°F)         346         349         349         348           B₀         Actual water vapor in gas (% by volume)¹         16.2         16.4         16.1         16.3           Cas Pate²           Q₃         Volumetric flow rate, actual (acfm)         90,400         91,700         90,000         90,700           Q₃         Volumetric flow rate, standard (scfm)         58,200         58,800         57,700         58,200           Q₃         Volumetric flow rate, standard (scfm)         48,700         49,100         48,400         48,700           Cast Sc3-H₀         Volumetric flow rate, standard (scfm)         48,700         49,100         48,400         48,700           Cast Sc3-H₀         Volumetric flow rate, standard (scfm)         18,200         58,800         57,700         58,200           C₃d         Concentration (lpmdv)         16.6         16.2         16.1         16.3         16.2         18,41         16.3         18,72         23.2         23.2         23	$H_{i}$	Actual heat input (MMBtu/hr)	214	214	212	213		
CO₂ Draw to dioxide (dry volume %)         8.71 mode of the process of the pro	Gas Co	onditions						
T₂ s ample temperature (°F)         346 and a sign of sign o	$O_2$	Oxygen (dry volume %)	6.13	6.31	6.16	6.20		
Bw         Actual water vapor in gas (% by volume)¹         16.2         16.4         16.1         16.1         16.2         16.4         16.1         16.2         16.4         16.1         16.2         16.4         16.1         16.2         99,000         99,000         99,000         99,000         99,000         99,000         99,000         99,000         99,000         99,000         99,000         99,000         48,000 <th col<="" td=""><td><math>CO_2</math></td><td>Carbon dioxide (dry volume %)</td><td>8.71</td><td>8.58</td><td>8.66</td><td>8.65</td></th>	<td><math>CO_2</math></td> <td>Carbon dioxide (dry volume %)</td> <td>8.71</td> <td>8.58</td> <td>8.66</td> <td>8.65</td>	$CO_2$	Carbon dioxide (dry volume %)	8.71	8.58	8.66	8.65	
Cas Fac²           Q <sub>8</sub> Volumetric flow rate, actual (acfm)         90,400         91,700         90,000         90,700           Q <sub>8</sub> Volumetric flow rate, standard (scfm)         58,200         58,800         57,700         58,200           Q <sub>8td</sub> Volumetric flow rate, dry standard (dscfm)         48,700         49,100         48,400         48,700           THC Results (as C <sub>3</sub> H <sub>8</sub> )           C <sub>8d</sub> Concentration (ppmdv)         16.6         16.2         16.1         16.3           C <sub>8d</sub> Concentration (lb/dscf)         1.90E-06         1.86E-06         1.84E-06         1.87E-06           E <sub>Fd</sub> Mass Rate (lb/MMBtu) - Fd         0.023         0.023         0.022         0.023           Methan         Results           C <sub>8d</sub> Concentration (ppmdv)         25.6         22.6         22.9         23.7           Methan         Results (as C <sub>3</sub> H <sub>8</sub> )           C <sub>8d</sub> Concentration (lb/dscf)         1.1E-06         9.4E-07         9.5E-07         9.9E-07           E <sub>Fd</sub> Mass Rate (lb/MMBtu) - Fd         0.013         0.012         0.012         0.012           C <sub>8d</sub> Concentration (ppmdv)	$T_s$	Sample temperature (°F)	346	349	349	348		
Qa Solumetric flow rate, actual (acfm)         90,400         91,700         90,000         90,700           Qs Volumetric flow rate, standard (scfm)         58,200         58,800         57,700         58,200           Qstd Volumetric flow rate, dry standard (dscfm)         48,700         49,100         48,400         48,700           THC Results (as C₃H₀)           Csd Concentration (ppmdv)         16.6         16.2         16.1         16.3           Csd Concentration (lb/dscf)         1.90E-06         1.86E-06         1.84E-06         1.87E-06           Efd Mass Rate (lb/MMBtu) - Fd         0.023         0.023         0.022         0.023           Methanse Results (as C₃H₀)           Csd Concentration (ppmdv)         25.6         22.6         22.9         23.7           Methanse Results (as C₃H₀)           Csd Concentration (ppmdv)         9.3         8.2         8.3         8.6           Csd Concentration (lb/dscf)         1.1E-06         9.4E-07         9.5E-07         9.9E-07           Efd Mass Rate (lb/MMBtu) - Fd         0.013         0.012         0.012         0.012           Csd Concentration (ppmdv)         7.3         5.6         7.2         6.7           Csd Cad         Concentration	$B_w$	Actual water vapor in gas (% by volume) <sup>1</sup>	16.2	16.4	16.1	16.3		
Qa Solumetric flow rate, actual (acfm)         90,400         91,700         90,000         90,700           Qs Volumetric flow rate, standard (scfm)         58,200         58,800         57,700         58,200           Qstd Volumetric flow rate, dry standard (dscfm)         48,700         49,100         48,400         48,700           THC Results (as C₃H₀)           Csd Concentration (ppmdv)         16.6         16.2         16.1         16.3           Csd Concentration (lb/dscf)         1.90E-06         1.86E-06         1.84E-06         1.87E-06           Efd Mass Rate (lb/MMBtu) - Fd         0.023         0.023         0.022         0.023           Methanse Results (as C₃H₀)           Csd Concentration (ppmdv)         25.6         22.6         22.9         23.7           Methanse Results (as C₃H₀)           Csd Concentration (ppmdv)         9.3         8.2         8.3         8.6           Csd Concentration (lb/dscf)         1.1E-06         9.4E-07         9.5E-07         9.9E-07           Efd Mass Rate (lb/MMBtu) - Fd         0.013         0.012         0.012         0.012           Csd Concentration (ppmdv)         7.3         5.6         7.2         6.7           Csd Cad         Concentration	Gas Flo	ow Rate <sup>2</sup>						
Q₂ state         Volumetric flow rate, standard (scfm)         58,200         58,800         57,700         58,200           Q₃td         Volumetric flow rate, dry standard (dscfm)         48,700         49,100         48,400         48,700           THC Results (as C₃H₀)           C₃d         Concentration (ppmdv)         16.6         16.2         16.1         16.3           C₃d         Concentration (lb/dscf)         1.90E-06         1.86E-06         1.84E-06         1.87E-06           E₂d         Mass Rate (lb/MMBtu) - Fd         0.023         0.023         0.023         0.022         0.023           Methans           C₃d         Concentration (ppmdv)         25.6         22.6         22.9         23.7           Methans         Results (as C₃H₀)         22.6         22.9         23.7           Methans         Results (as C₃H₀)         3.8         8.6         6.2         2.0         9.9E-07         9.9E-07           C₃d         Concentration (ppmdv)         9.3         8.2         8.3         8.6         9.9E-07         9.9E-07         9.9E-07         9.9E-07         9.9E-07         9.9E-07         9.9E-07         9.9E-07         9.8E-07         9.8E-07 <t< td=""><td></td><td></td><td>90,400</td><td>91,700</td><td>90,000</td><td>90,700</td></t<>			90,400	91,700	90,000	90,700		
Qulum etric flow rate, dry standard (dscfm)         48,700         49,100         48,400         48,700           THC Re>ults (as C₃H₀)           C₃d         Concentration (ppmdv)         16.6         16.2         16.1         16.3           C₃d         Concentration (lb/dscf)         1.90E-06         1.86E-06         1.84E-06         1.87E-06           E₂d         Mass Rate (lb/MMBtu) - Fd         0.023         0.023         0.022         0.023           Methan         Results (as C₃H₀)         25.6         22.6         22.9         23.7           Methan         Results (as C₃H₀)         25.6         22.6         22.9         23.7           Methan         Results (as C₃H₀)         2.8         2.8         3.8.6           C₃d         Concentration (ppmdv)         9.3         8.2         8.3         8.6           C₃d         Concentration (lb/dscf)         1.1E-06         9.4E-07         9.5E-07         9.9E-07           E₂d         Mass Rate (lb/MMBtu) - Fd         0.013         0.012         0.012         0.012           C₃d         Concentration (ppmdv)         7.3         5.6         7.2         6.7           C₃d         Concentration (lb/dscf)						•		
THC Results (as C₃H₀)           C₃d C₃d Concentration (ppmdv)         16.6         16.2         16.1         16.3           C₃d C₃d Concentration (lb/dscf)         1.90E-06         1.86E-06         1.84E-06         1.87E-06           E₂d Concentration (lb/dscf)         0.023         0.023         0.022         0.023           Methare Results           C₃d Concentration (ppmdv)         25.6         22.6         22.9         23.7           Methare Results (as C₃H₀)           C₃d Concentration (ppmdv)         9.3         8.2         8.3         8.6           C₃d Concentration (lb/dscf)         1.1E-06         9.4E-07         9.5E-07         9.9E-07           E₂d Concentration (ppmdv)         0.013         0.012         0.012         0.012           Ethane Results (as C₃H₀)           C₃d Concentration (ppmdv)         10.7         8.2         10.5         9.8           Ethane Results (as C₃H₀)           C₃d Concentration (ppmdv)         7.3         5.6         7.2         6.7           C₃d Concentration (ppmdv)         7.3         5.6         7.2         6.7           C₃d Concentration (lb/dscf)         8.3E-07         6.4E-07         8.2E-07         7.6E-07			48,700		48,400	· ·		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		esults (as C <sub>2</sub> H <sub>6</sub> )						
$ \begin{array}{c ccccccc} C_{sd} & \text{Concentration (lb/dscf)} & 1.90E-06 & 1.86E-06 & 1.84E-06 & 1.87E-06 \\ E_{Fd} & \text{Mass Rate (lb/MMBtu) - Fd} & 0.023 & 0.023 & 0.022 & 0.023 \\ \hline \textbf{Methassits} & & & & & & & & & & & & & & & & & & &$		, , ,	16.6	16.2	16.1	16.3		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$								
Methar Results           C₂₃ detail         Concentration (ppmdv)         25.6         22.6         22.9         23.7           Methar Results (as C₃H₀)           C₃₃ detail (as C₃detail (ppmdv)         9.3         8.2         8.3         8.6           C₃₃ detail (bl/MMBtu) - Fd         0.013         0.012         0.012         0.012           Ethane Results           C₃₃ detail (as C₃H₀)         10.7         8.2         10.5         9.8           Ethane Results (as C₃H₀)         7.3         5.6         7.2         6.7           C₃₃ detail (bl/Mbgtu) - Fd         8.3E-07         6.4E-07         8.2E-07         7.6E-07           C₃₃ detail (bl/Mbgtu) - Fd         0.010         0.0078         0.010         0.0093           VOC Results (as C₃H₀)           C₃₃ detail (bl/Mbgtu) - Fd         0.010         0.0078         0.010         0.0093           VOC Results (as C₃H₀)           C₃₃ detail (bl/Mbgtu) - Fd         0.010         0.0078         0.010         0.0093           VOC Results (as C₃H₀)         0.004         2.4         0.58         1.0           C₃ detail (bl/Mbgtu) - Fd         0.004         2.4         0.58		, -						
$ \begin{array}{c ccccc} C_{sd} & Concentration (ppmdv) & 25.6 & 22.6 & 22.9 & 23.7 \\ \hline \textbf{Methassalts (as $C_3$H_8$)} & & & & & & & & & \\ \hline C_{sd} & Concentration (ppmdv) & 9.3 & 8.2 & 8.3 & 8.6 \\ \hline C_{sd} & Concentration (lb/dscf) & 1.1E-06 & 9.4E-07 & 9.5E-07 & 9.9E-07 \\ \hline E_{Fd} & Mass Rate (lb/MMBtu) - Fd & 0.013 & 0.012 & 0.012 & 0.012 \\ \hline \textbf{Ethassalts} & & & & & & & \\ \hline C_{sd} & Concentration (ppmdv) & 10.7 & 8.2 & 10.5 & 9.8 \\ \hline \textbf{Ethassalts (as $C_3$H_8$)} & & & & & \\ \hline C_{sd} & Concentration (ppmdv) & 7.3 & 5.6 & 7.2 & 6.7 \\ \hline C_{sd} & Concentration (ppmdv) & 7.3 & 5.6 & 7.2 & 6.7 \\ \hline C_{sd} & Concentration (lb/dscf) & 8.3E-07 & 6.4E-07 & 8.2E-07 & 7.6E-07 \\ \hline E_{Fd} & Mass Rate (lb/MMBtu) - Fd & 0.010 & 0.0078 & 0.010 & 0.0093 \\ \hline \textbf{VOC } \textbf{RSSalts (as $C_3$H_8$)} & & & & & & \\ \hline C_{sd} & Concentration (ppmdvas $C_3$H_8$) & 0.04 & 2.4 & 0.58 & 1.0 \\ \hline C_{sd} & Concentration (ppmdvas $C_3$H_8$) & 0.04 & 2.4 & 0.58 & 1.0 \\ \hline C_{sd} & Concentration (ppmdvas $C_3$H_8$) & 0.04 & 2.4 & 0.58 & 1.0 \\ \hline C_{sd} & Concentration (ppmdvas $C_3$H_8$) & 0.04 & 2.4 & 0.58 & 1.0 \\ \hline C_{sd} & Concentration (ppmdvas $C_3$H_8$) & 0.04 & 2.8E-07 & 6.7E-08 & 1.2E-07 \\ \hline \end{array} $								
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$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			0.2	9.2	0.2	0.0		
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$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		·	0.013	0.012	0.012	0.012		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		., ,	10.7	8.2	10.5	9.8		
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$ \begin{array}{cccccccccccccccccccccccccccccccccccc$								
VOC Results (as $C_3H_8$ ) $C_{sd}$ Concentration (ppmdv as $C_3H_8$ )       0.04       2.4       0.58       1.0 $C_{sd}$ Concentration (lb/dscf)       4.5E-09       2.8E-07       6.7E-08       1.2E-07								
$C_{sd}$ Concentration (ppmdv as $C_3H_8$ ) 0.04 2.4 0.58 1.0 $C_{sd}$ Concentration (lb/dscf) 4.5E-09 2.8E-07 6.7E-08 1.2E-07	$E_{Fd}$	Mass Rate (lb/MMBtu) - Fd	0.010	0.0078	0.010	0.0093		
C <sub>sd</sub> Concentration (lb/dscf) 4.5E-09 2.8E-07 6.7E-08 <b>1.2E-07</b>	VOC Results (as C <sub>3</sub> H <sub>8</sub> )							
••	$C_{sd}$	Concentration (ppmdv as C <sub>3</sub> H <sub>8</sub> )			0.58	1.0		
E <sub>Fd</sub> Mass Rate (lb/MMBtu) - Fd 0.000055 0.0034 0.00081 <b>0.0014</b>	$C_{sd}$	, ,	4.5E-09		6.7E-08	1.2E-07		
	$E_{Fd}$	Mass Rate (lb/MMBtu) - Fd	0.000055	0.0034	0.00081	0.0014		

<sup>1</sup> Moisture data used for ppmw v to ppmdv correction obtained from concurrent M-5 runs.

<sup>&</sup>lt;sup>2</sup> Flow data used in lb/hr calculations was obtained from concurrent M-5 runs.

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# 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 B&W Boiler (EU27-B&WBOILER1-S1) generates steam required by other refinery process components. The unit is fired by natural gas and refinery fuel gas. Emissions are vented to the atmosphere via the B&W Boiler Stack (SV-B&WBOILER1), where testing was conducted.

#### **TEST LOCATION**

The sample point placement was determined by EPA Method 1 specifications. Table 3-1 presents the sampling information for the test location. The figure represents the layout of the test location.

Table 3-1: Sampling Information

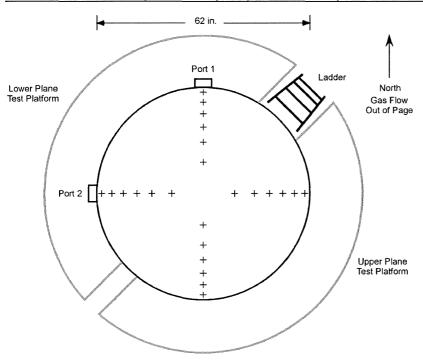
Source Constituent	Method (USEPA)	Run No.	Ports	Points per Port	Minutes per Point	Total Minutes	Figure
B&W Boiler Stack							
PM	5	1-3	2	12	2.5	60	3-1
$O_2$ / $CO_2$ / THC	3A / 18 / 25A	1-3	1	1	60	60	N/A <sup>1</sup>

<sup>&</sup>lt;sup>1</sup> Method 25A sampling was conducted from a single point near the center of the duct.

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Figure 3-1:
B&W Boiler Stack Sample Point Layout (EPA Method 1)



Sampling Point	% of Stack Diameter	Port to Point Distance (in)
1	97.9	60.7
2	93.3	57.8
3	88.2	54.7
4	82.3	51.0
5	75.0	46.5
6	64.4	39.9
7	35.6	22.1
8	25.0	15.5
9	17.7	11.0
10	11.8	7.3
11	6.7	4.2
12	2.1	1.3

Duct diameters upstream from flow disturbance (A): 9.5 Duct diameters downstream from flow disturbance (B): 2.3

Limit: 0.5 Limit: 2.0

# 4. METHODOLOGY

#### PROCEDURES AND REGULATIONS

The test program sampling measurements followed procedures and regulations outlined by the USEPA and Michigan Department of Environment, Great Lakes, and Energy (EGLE) 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. Any modifications to standard test methods are explicitly indicated in this appendix. In accordance with ASTM D7036 requirements, CleanAir included a description of any such modifications along with the full context of the objectives and requirements of the test program in the test protocol submitted prior to the measurement portion of this project. Modifications to standard methods are not covered by the ISO 17025 and TNI portions of CleanAir's A2LA accreditation.

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 2F	"Determination of Stack Gas Velocity and Volumetric Flow Rate with Three-Dimensional Probes"
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 18	"Measurement of Gaseous Organic Compound Emissions by Gas Chromatography"
Method 19	"Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide and Nitrogen Oxide Emission Rates"
Method 25A	"Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer"

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## METHODOLOGY DISCUSSION

#### FILTERABLE PARTICULATE MATTER TESTING — USEPA METHOD 5

FPM emissions were determined using EPA Method 5. The front-half (Method 5 portion) of the sampling train consisted of a glass nozzle, glass liner and filter holder heated to  $248^{\circ}F \pm 25^{\circ}F$ , and a quartz fiber filter. Flue gas samples were extracted isokinetically per Method 5 requirements.

The back-half of the sampling train consisted of a series of four (4) glass knock-out jars: two (2) containing water, one (1) empty and one (1) containing silica gel for residual moisture removal. The moisture collected in the knock-out jars was measured to determine the flue gas moisture. 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. After measuring the moisture gain in the back-half portion of the sample train, the contents were discarded.

Reagent blanks were collected to quantify background contamination. All samples and blanks were returned to CleanAir Analytical Services in Palatine, Illinois, for gravimetric analysis.

## VOC TESTING - USEPA METHODS 3A, 18 AND 25A

Oxygen  $(O_2)$  and carbon dioxide  $(CO_2)$  emissions were determined using a paramagnetic/non-dispersive infrared (NDIR) analyzer per EPA Method 3A. VOC emissions were determined using EPA Method 25A to quantify THC emissions.

The Method 3A/25A sampling system consisted of a heated probe, heated filter, and heated sample line. Flue gas was extracted at a constant rate and delivered at approximately 250°F to a tee at the end of the heated sample line.

- One leg of the tee was connected to a flame ionization analyzer (FIA), which continuously measured minute-average THC concentration expressed in terms of propane ( $C_3H_8$ ) on an actual (wet) basis.
- The other leg of the tee was connected to a gas conditioner which removed moisture before delivering the gas to a flow panel, and the O<sub>2</sub>/CO<sub>2</sub> analyzers which measured concentration on a dry basis (units of %dv).
- The Method 18 gas sample was collected by pulling a slipstream from the flow panel and delivered it into a FlexFoil bag at a constant rate. The moisture condensate was not collected for analysis as  $CH_4$  and  $C_2H_6$  are insoluble in water. Each bag was filled over a period of approximately one hour for each test run.

THC analyzer calibration was performed by introducing zero air, high, mid-, and low range  $C_3H_8$  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.

 $O_2/CO_2$  calibration error checks were performed by introducing zero  $N_2$ , high 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 Method 3A, the average results for each run were drift corrected.

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## GENERAL CONSIDERATIONS

A traditional verification of the absence of cyclonic flow following EPA Method 1 specifications was not performed. However, absence of cyclonic flow was demonstrated by measuring the resultant angle of flow using an EPA Method 2F flow traverse. The resultant angle of flow was less than 20°. Data is included in Appendix F of this report.

 $H_2O$  data used for moisture correction of VOC concentration data was obtained from the concurrent Method 5 test runs. Method 4 measurements are incorporated into the sampling and recovery procedures.  $O_2$  and  $CO_2$ , data used for Method 5 flow calculations were obtained from the concurrently operated CEM sample runs.

End of Section