Sample Calculations

Marathon Oil Company
Tsubaki Hills 08-62-34-4H
6/10/2013
Run #1 Sample Calculations

EPA Method 3A: Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources
(Instrumental Analyzer Procedure)
(40 CFR Part 60, Appendix A-2)

Variable	Value	Definition	Unit of Measurement
O_2 C_{avg}	4.8	Average Unadjusted Gas Concentration	%vd
O_2 C_0	0.1	Average Pre/Post Zero Gas Response	%vd
O_2 C_{ma}	10.5	Concentration of Upscale Calibration Gas	%
O_2 C_m	10.7	Average Pre/Post Upscale Gas Reponse	%vd
O_2 C_{gas}	4.7	Average Gas Concentration Adjusted for Bias	%vd
CO_2 C_{avg}	9.8	Average Unadjusted Gas Concentration	%vd
CO_2 C_0	0.1	Average Pre/Post Zero Gas Response	%vd
CO_2 C_{ma}	8.0	Concentration of Upscale Calibration Gas	%
CO_2 C_m	7.9	Average Pre/Post Upscale Gas Reponse	%vd
CO_2 C_{gas}	10.0	Average Gas Concentration Adjusted for Bias	%vd

$$O_2\ C_{gas} = \frac{(C_{avg} - C_0) \times C_{ma}}{(C_m - C_0)}$$

$$= \frac{(4.75 - (0.05)) \times 10.5}{(10.65 - (0.05))}$$

= **4.7 %vd** *(Eq. 7E-5b)*

$$CO_2\ C_{gas} = \frac{(C_{avg} - C_0) \times C_{ma}}{(C_m - C_0)}$$

$$= \frac{(9.77 - 0.05) \times 8.04}{(7.85 - 0.05)}$$

= **10.0 %vd** *(Eq. 7E-5b)*

Marathon Oil Company
Tsubaki Hills 08-62-34-4H
6/10/2013
Run #1 Sample Calculations

EPA Method 7E: Determination of Nitrogen Oxides Emissions from Stationary Sources
(Instrumental Analyzer Procedure)
(40 CFR Part 60, Appendix A-4)

Variable	Value	Definition	Unit of Measurement
C_{avg}	121.8	Average Unadjusted Gas Concentration	ppmvd
C_0	0.0	Average Pre/Post Zero Gas Response	ppmvd
C_{ma}	145.0	Concentration of Upscale Calibration Gas	ppm
C_m	147.5	Average Pre/Post Upscale Gas Reponse	ppmvd
C_{gas}	119.7	Average Gas Concentration Adjusted for Bias	ppmvd
MW	46.01	Molecular Weight	lb/lb-mole
385.3	385.3	Volume of One Pound of Ideal Gas at Standard Conditions	scf/lb-mole
F_d	8710	F Factor from EPA Method 19	dscf/mmBtu
C_d	1.43E-05	Pollutant Concentration, Dry Basis	pounds per standard cubic foot
O_2 %vd	4.7	O_2 Concentration (From EPA Method 3A)	dry volume percent
$F_d\ E_{lb/mmBtu}$	0.160	Emission Rate	pounds per million British thermal units
HI	0.7	Heat Input (site rating)	millions of British thermal units per hour
HP	68	Engine Load (site rating)	horsepower

$$C_{gas} = \frac{(C_{avg} - C_0) \times C_{ma}}{(C_m - C_0)}$$

$$= \frac{(121.8 - (0)) \times 145}{(147.5 - (0))}$$

= **119.7 ppmvd** *(Eq. 7E-5b)*

$$C_d = \frac{(C_{gas})\ (MW)}{(10^6)\ (385.3)}$$

$$= \frac{(119.7)\ (46.01)}{(10^6)\ (385.3)}$$

= **1.43E-05 lb/scf**

$$F_d\ E_{lb/mmBtu} = \frac{(C_d)\ (F_d)\ (20.9)}{(20.9 - O_2\%)}$$

$$= \frac{(1.43E\text{-}05)\ (8710)\ (20.9)}{(20.9 - 4.7)}$$

= **0.160 lb/mmBtu** *(Eq. 19-1)*

$$E_{lb/hr} = (E_{lb/mmBtu})\ (HI)$$

$$= (0.160)\ (0.7)$$

= **0.11 lb/hr**

$$E_{g/HP\text{-}hr} = \frac{(E_{lb/hr})\ (453.59)}{(HP)}$$

$$= \frac{(0.11)\ (453.59)}{(68)}$$

= **0.7 g/HP-hr**

Marathon Oil Company
Tsubaki Hills 08-62-34-4H
6/10/2013
Run #1 Sample Calculations

EPA Method 10: Determination of Carbon Monoxide Emissions from Stationary Sources
(Instrumental Analyzer Procedure)
(40 CFR Part 60, Appendix A-4)

Variable	Value	Definition	Unit of Measurement
C_{avg}	851.9	Average Unadjusted Gas Concentration	ppmvd
C_0	-0.5	Average Pre/Post Zero Gas Response	ppmvd
C_{ma}	776.0	Concentration of Upscale Calibration Gas	ppm
C_m	779.0	Average Pre/Post Upscale Gas Reponse	ppmvd
C_{gas}	848.6	Average Gas Concentration Adjusted for Bias	ppmvd
MW	28.01	Molecular Weight	lb/lb-mole
385.3	385.3	Volume of One Pound of Ideal Gas at Standard Conditions	scf/lb-mole
F_d	8710	F Factor from EPA Method 19	dscf/mmBtu
C_d	6.17E-05	Pollutant Concentration, Dry Basis	pounds per standard cubic foot
O_2 %vd	4.7	O_2 Concentration	dry volume percent
$F_d\ E_{lb/mmBtu}$	0.691	Emission Rate	pounds per million British thermal units
HI	0.7	Heat Input (site rating)	million British themal units per hour
HP	68	Engine Load (site rating)	horsepower

$$C_{gas} = \frac{(C_{avg} - C_0) \times C_{ma}}{(C_m - C_0)}$$

$$= \frac{(851.90 - (-0.5)) \times 776}{(779 - (-0.5))}$$

= **848.6 ppmvd** *(Eq. 7E-5b)*

$$C_d = \frac{(C_{gas})\ (MW)}{(10^6)\ (385.3)}$$

$$= \frac{(848.6)\ (28.01)}{(10^6)\ (385.3)}$$

= **6.17E-05 lb/scf**

$$F_d\ E_{lb/mmBtu} = \frac{(C_d)\ (F_d)\ (20.9)}{(20.9 - O_2\%)}$$

$$= \frac{(6.17E\text{-}05)\ (8710)\ (20.9)}{(20.9 - 4.7)}$$

= **0.691 lb/mmBtu** *(Eq. 19-1)*

$$E_{lb/hr} = (E_{lb/mmBtu})\ (HI)$$

= (0.691) (0.7)

= **0.46 lb/hr**

$$E_{g/HP\text{-}hr} = \frac{(E_{lb/hr})\ (453.59)}{(HP)}$$

$$= \frac{(0.46)\ (453.59)}{(68)}$$

= **3.1 g/HP-hr**

EMCO

EMISSIONS MEASUREMENT COMPANY

Project GA13-0045

Appendix B: Field Data

Engine Operating Data

Field Datasheets

Tsubaki Hills
08-62-34-4H

EMCO
EMISSIONS MEASUREMENT COMPANY

Engine Parameter Data Sheet

Date GA13-45
Client Golder / Marathon
Facility Tsubaki Hills
Elevation
Unit ID 08-62-34-414.
Serial Number 1'
Technician Recording Data AB

	R1	R2	R3	Avg
Ambient Temperature (°F)	89	88	88	
Barometric Pressure ("Hg)	25.07	25.07	25.07	
Engine Speed (RPM)	1800	1800	1800	1800
Suction Pressure (psi)				
Discharge Pressure (psi)				
Intake Manifold Pressure (psi)				
Intake Manifold Temperature (°F)	180	180	180	180
Exhaust Temperature (°F)				
AFR Manufacturer / Type				
AFR Setting (Units:_____)				
Catalyst Manufacturer				
Catalyst Element Installation Date				
Catalyst Inlet Temperature (°F)	570	571	573	572
Catalyst Outlet Temperature (°F)	595	597	598	597
Catalyst Pressure Drop ("H_2O)				
Fuel Flow Rate (Units:_____)				
Engine Load (HP)				

Facility Personnel Certification:

"I certify that the above data are representative of facility operations during testing."

Signature _____ Date _____

Printed Name / Title _____

EMCo Job Code: GA13-45

Client: BOLDER

Source: TSUBAKI HILLS

Date: 6/10/13

Operator: AB

Page 1 of 2

Analyzer Initial Calibration Data Sheet						
Gas	Level	Cylinder #	Concentration		Initial Linearity	Initial Bias
O_2	L	—	0	%	0.1 ✓	0.1
	M	18897	10.5	%	10.7 ✓	10.7
	H	5309	21.1	%	21.1 ✓	
CO_2	L	—	0	%	-0.1 ✓	-0.1
	M	18897	8.04	%	7.8 ✓	7.8
	H	5309	19.1	%	19.1 ✓	
NO_x	L	—	0	ppm	~~-0.6~~ -1 ✓	-1
	M	47091	145	ppm	144	144
	H	4034	332	ppm	332 ✓	
CO	L	—	0	ppm	-1 ✓	-1
	M	5046	7786	ppm	780 ✓	780
	H	5148	1510	ppm	1510 ✓	

EMCo Job Code: GA13-45

Client: Golder

Source: Isabella Hills / Crow Valley

Date: 6/10/13

Operator: AB

Analyzer Calibration Data Sheet

Gas	Level	Concentration		Initial Bias						
				Run Start Time	1010	1120	1230			
				Run Stop Time	1110	1220	1330			
				Initial Bias	R1	R2	R3			
O_2	0	0	%	0.1	0 ✓	0 ✓	0.0 ✓			
	Span	10.5	%	10.7	10.6 ✓	10.6 ✓	10.5 ✓			
CO_2	0	0	%	-0.1	0.2 ✓	0.1 ✓	0.2 ✓			
	Span	8.04	%	7.8	7.9 ✓	8.0 ✓	7.9 ✓			
NO_x	0	0	ppm	-0.6	1 ✓	1.6 ✓	1 ✓			
	Span	145	ppm	144	151 ✓	149 ✓	144 ✓			
CO	0	0	ppm	-1	0 ✓	4 ✓	2 ✓			
	Span	776	ppm	780	778 ✓	783 ✓	776 ✓			
	0		ppm							
	Span		ppm							
	0		ppm							
	Span		ppm							
	0		ppm							
	Span		ppm							

Pawnee Creek
9-57-18-1H

EMCO
EMISSIONS MEASUREMENT COMPANY

Engine Parameter Data Sheet

Date 6-11-13
Client GOLDER
Facility PAWNEE CREEK
Elevation
Unit ID Pump
Serial Number 11447
Technician Recording Data CK

	R1	R2	R3	Avg
Ambient Temperature (°F)				
Barometric Pressure ("Hg)	25.1			
Engine Speed (RPM)	1800	1800	1800	1800
Suction Pressure (psi)	N/A			
Discharge Pressure (psi)	N/A			
Intake Manifold Pressure (psi)	N/A			
Intake Manifold Temperature (°F)	155	165	165	162
Exhaust Temperature (°F)	602	622	600	608
AFR Manufacturer / Type	N/A			
AFR Setting (Units:_____)	N/A			
Catalyst ~~Manufacturer~~ S/N	76046-0002-00158			
Catalyst Element Installation Date				
Catalyst Inlet Temperature (°F)	568	592	560	573
Catalyst Outlet Temperature (°F)	602	622	600	608
Catalyst Pressure Drop ("H_2O)	N/A			
Fuel Flow Rate (Units:_____)	N/A			
Engine Load (HP)	68			

Facility Personnel Certification:

"I certify that the above data are representative of facility operations during testing."

Signature

Date

Printed Name / Title

EMCo Job Code: GA13-45

Client: Golder & Ass.

Source: Pawnee Creek

Date: 6/11/13

Operator: CK

Page 1 of 2

Analyzer Initial Calibration Data Sheet								
Gas	Level	Cylinder #	Concentration		Initial Linearity		Initial Bias	
O_2	L	—	0.0	%	0.1	✓	0.1	✓
	M	13897	10.5	%	10.6	✓	10.5	✓
	H	5309	21.1	%	21.1	✓		
CO_2	L	—	0.0	%	0.0	✓	0.2	✓
	M	13897	8.04	%	7.8	✓	7.8	✓
	H	5309	19.1	%	19.1	✓		
NO_x	L	—	0.0	ppm	-.3	✓	3.0	✓
	M	4034	332	ppm	330	✓	331	✓
	H	5046	778	ppm	781	✓		
CO	L	—	0.0	ppm	8.5	✓	1.0	✓
	M	5046	776	ppm	789	✓	785	✓
	H	5148	1510	ppm	1510	✓		

EMCo Job Code: GA13-45
Client: Golder & Ass
Source: Pawnee Creek
Date: 6/11/13
Operator: CK

Analyzer Calibration Data Sheet

			Run Start Time	1016	1125	1233			
			Run Stop Time	1115	1225	1333			
Gas	Level	Concentration	Initial Bias	1	2	3			
O_2	0	0.0 %		0.1 ✓	0.0 ✓	0.6 ✓			
	Span	10.5 %		10.5 ✓	10.5 ✓	10.5 ✓			
CO_2	0	0.0 %		0.3 ✓	0.3 ✓	0.3 ✓			
	Span	8.04 %		8.1 ✓	8.0 ✓	8.1			
NOx	0	0.0 ppm		4 ✓	2 ✓	9 ✓			
	Span	332 ppm		334 ✓	347 ✓	351 ✓			
CO	0	0.0 ppm		-1 ✓	-1 ✓	-1 ✓			
	Span	776 ppm		761 ✓	763 ✓	767 ✓			
	0	ppm							
	Span	ppm							
	0	ppm							
	Span	ppm							
	0	ppm							
	Span	ppm							

Crow Valley
7-62-32-1H

EMCO
EMISSIONS MEASUREMENT COMPANY

Engine Parameter Data Sheet

Date 6-14-13
Client FOULGER
Facility CROW VALLEY
Elevation
Unit ID Pump
Serial Number
Technician Recording Data CK

	R1	R2	R3	Avg
Ambient Temperature (°F)				
Barometric Pressure ("Hg)				
Engine Speed (RPM)	1800	1800	1800	1800
Suction Pressure (psi)	N/A			
Discharge Pressure (psi)	N/A			
Intake Manifold Pressure (psi)	N/A			
Intake Manifold Temperature (°F)	155	165	170	163
Exhaust Temperature (°F)	631	622	590	614
AFR Manufacturer / Type	N/A			
AFR Setting (Units:_____)	N/A			
Catalyst ~~Manufacturer~~ S/N	76046-0001-00045			
Catalyst Element Installation Date				
Catalyst Inlet Temperature (°F)	572	560	546	559
Catalyst Outlet Temperature (°F)	631	622	590	614
Catalyst Pressure Drop ("H_2O)	N/A			
Fuel Flow Rate (Units:_____)	N/A			
Engine Load (HP)	68			

Facility Personnel Certification:

"I certify that the above data are representative of facility operations during testing."

Signature

Date

Printed Name / Title

EMCo Job Code: GA13-45
Client: Golder & Ass.
Source: Crow Valley
Date: 6/14/13
Operator: CK

Analyzer Initial Calibration Data Sheet						
Gas	Level	Cylinder #	Concentration		Initial Linearity	Initial Bias
O_2	L	—	0.0	%	0.0 ✓	0.0 ✓
	M	13897	10.5	%	10.3 ✓	10.3 ✓
	H	5309	21.1	%	21.1 ✓	
CO_2	L	—	0.0	%	-.1 ✓	-.1 ✓
	M	13897	8.01	%	7.7 ✓	7.7 ✓
	H	5309	19.1	%	19.1 ✓	
NO_x	L	—	0.0	ppm	-.2 ✓	1.2 ✓
	M	4034	332	ppm	337 ✓	342.1 ✓
	H	5046	778	ppm	783.2 ✓	
CO	L	—	0.0	ppm	2.0 ✓	-3 ✓
	M	5046	776	ppm	772 ✓	787 ✓
	H	5148	1510	ppm	1506 ✓	
	L			ppm		
	M			ppm		
	H			ppm		
	0			ppm		
	L			ppm		
	M			ppm		
	H			ppm		
	0			ppm		
	L			ppm		
	M			ppm		
	H			ppm		

EMCo Job Code: GA13-45
Client: Golder & Ass
Source: Crow Valley
Date: 6/14/13
Operator: CK

Analyzer Calibration Data Sheet

			Run Start Time	827	938	1049				
			Run Stop Time	927	1038	1149				
Gas	Level	Concentration	Initial Bias	1	2	3				
O_2	0	0.0 %		-.1 ✓	~~0.0~~ -.1 ✓	-.2 ✓				
	Span	10.5 %		10.2 ✓	10.2 ✓	10.2 ✓				
CO_2	0	0.0 %		0.0 ✓	0.1 ✓	0.1 ✓				
	Span	8.04 %		7.9 ✓	8.1 ✓	8.1 ✓				
NO_x	0	0.0 ppm		3 ✓	9 ✓	7.0 ✓				
	Span	332 ppm		328 ✓	340 ✓	333 ✓				
CO	0	0.0 ppm		1.4 ✓	3 ✓	1.0 ✓				
	Span	776 ppm		784 ✓	799 ✓	808 ✓				
	0	ppm								
	Span	ppm								
	0	ppm								
	Span	ppm								
	0	ppm								
	Span	ppm								