Kansas City PM Characterization Study
Final Report

Appendix F
Dynamometer Calculations

Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

Sponsors:

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Calculations for the Dynamometer Determined Regulated Emissions

Individual phase and weighted regulated emissions rates and fuel economy were determined from both the modal and bag THC, CO, NOx, and CO2 analyses. Emission rates were calculated according to procedures found in the Code of Federal Regulations (CFR) Title 40, Part 86, Paragraph 86.144-90. Methanol, formaldehyde, and methane were not measured, so emission rates for these compounds, as well as Non-Methane Hydrocarbon (NMHC) and Total hydrocarbon equivalent (THCE) were not determined.

Calculations were performed within a Lotus123 spreadsheet , *KC_Regdata.wk4,* designed specifically for this study. The spreadsheet contained macros to import and process the modal data files and bag data files containing user input. The spreadsheet also served as a "log" file to distribute regulated emission results to study participants during the course of the study and is included as two separate files (one for Round 1 and one for Round 2) on the ERG study web site. The spreadsheet contains 203 data fields (including 22 blank fields included to improve readability) as listed in Table F-1. Specific calculations used for all calculated fields are described in the comments column of the Table. In reporting weighted emissions, the same phase weighting factors as used for the Federal Test Procedure were applied to this data set. Included within the spreadsheet are intermediary calculations for the NOx correction factor, Vmix, and dilution factor, as follows:

NOx correction factor = 1 / (1 - 0.0047*(H-75)),

where H = absolute humidity (grains H2O per lb dry air)

= {(43.478)Ra * Psat} / {Pb - (Psat * Ra / 100)}

where Ra = relative humidity (percent)

Pb = barometric pressure (in Hg)

Psat = saturated vapor pressure @ dry bulb temp (in Hg)

= 29.92 * 218.167 / Pw,

where $Log(Pw) = [A(x-t) + B(x-t)^2 + C(x-t)^4] / [t(1 + D(x-t))]$ and

A = 3.244

B = 0.005868

C = 0.0000000117

D = .002188

x = 647.27

t = Tdry, Farenheit.

Vmix = Vo * N * {(Pb - Ppdp) * 528 / (760 * Tpdp)},

where Vo = Volume of gas pumped by the PDP per revolution (cu ft / revolution)

N = number of PDP revolutions per test phase.

Ppdp = PDP inlet pressure depression (mm Hg)

Tpdp = average temperature at PDP inlet (degrees Rankine)

Pb = barometric pressure (mm Hg)

The constant, Vo = 0.306 cu ft/rev, has been previously determined by propane injections. N is also considered a constant, determined from PDP rpm and phase duration.

Dilution Factor = $13.4 / \{CO_2 + (HC + CO)* 10^{-4}\}$

Where CO_2, HC, and CO are the average dilute concentrations.

Emission rates (grams/mile) for each test phase for the regulated emissions were calculated from the following format:

HC (gm/mile) = HC (ppmC) * 10^{-6} * Vmix * 16.33 (gm /cu ft) /Miles

CO (gm/mile) = CO (ppm) * 10^{-6} * Vmix * 32.97 (gm/cu ft) /Miles

CO_2 (gm/mile) = CO_2 (%) * 10^{-4} * Vmix * 51.81 (gm/cu ft) /Miles

NOx (gm/mile) = NOx (ppm) * 10^{-6} * Vmix * 54.16 (gm/cu ft) /Miles

Since the fuel properties of the tested consumer vehicles were unknown, fuel properties for a "generic" fuel were used for fuel economy calculations. The control vehicle, however, was fueled with Indolene, so fuel properties for Indolene were used when performing fuel economy calculations for the control vehicle. Fuel economy was calculated as follows:

Fuel Economy (mpg) = CGAL / {(.429 * CO) + (.273 * CO_2) + (0.8646 *HC},

where CGAL = grams C / gallon fuel = 2350.00 and CO, CO_2, and HC are grams/mile emitted per test phase.

Table F-1. Data Fields for the Regulated Emission Calculation Spreadsheet.

Data Field #	Label	Units	Source	Example Value	Comment
1	Run#		Keyboard Input	84101	Test number
2	Veh.Tag #		Keyboard Input	763TTY	Vehicle License Plate number
3	Veh Yr, Make, Model		Keyboard Input	2004 Toyota Camry	Vehicle Make,model, and model year
4	Odometer	*Miles*	Keyboard Input	169043	Vehicle odometer reading, may not be actual miles
5	Inertia	*Lbs*	Keyboard Input	3500	Dynamometer test inertia used
6	Hp@50mph	*Hp*	Keyboard Input	7.2	Dynamometer load used
7	Time		Keyboard Input	1:22 p.m.	Test start time
8	Date		Keyboard Input	07/30/2004	Test date
9	Comments		Keyboard Input		
10	(Blank Field)				
11	Vo	*ACF/Rev*	Keyboard Input	0.306	Positive displacement pump (PDP) volume per revolution
12	PDP_Speed	*Rpm*	Keyboard Input	1770	PDP speed
13	Ph_Length_1	*Seconds*	Constant	300	Phase 1 duration
14	Ph_Length_2	*Seconds*	Constant	1136	Phase 2 duration
15	Ph_Length_3	*Seconds*	Constant	300	Phase 3 duration
16	Pi_pdp	*mmHg*	Keyboard Input	20.46	PDP inlet pressure depression
17	Pbaro.	*mmHg*	Realtime	742.87	Barometric pressure
18	Tpdp_1	*degreesC*	Realtime	46.36	PDP inlet air average temperature for Phase 1
19	Tpdp_2	*degreesC*	Realtime	46.91	PDP inlet air average temperature for Phase 2
20	Tpdp_3	*degreesC*	Realtime	46.23	PDP inlet air average temperature for Phase 3
21	Vmix_1	*Cu. Ft*	Calculated	2361.87	Vo * (PDP_Speed / Ph_Length_1 /60) * {(Pbaro - Pi_pdp)/760} * {528 / ((Tpdp_1 * 9 / 5) + 32 + 460)}
22	Vmix_2	*Cu. Ft*	Calculated	8928.29	Vo * (PDP_Speed / Ph_Length_2 /60) * {(Pbaro - Pi_pdp)/760} * {528 / ((Tpdp_2 * 9 / 5) + 32 + 460)}
23	Vmix_3	*Cu. Ft*	Calculated	2362.83	Vo * (PDP_Speed / Ph_Length_3 /60) * {(Pbaro - Pi_pdp)/760} * {528 / ((Tpdp_3 * 9 / 5) + 32 + 460)}
24	(Blank Field)				

Data Field #	Label	Units	Source	Example Value	Comment
25	Tamb	*F*	Realtime	77.4	Average ambient temperature during all test Phases and hot soak.
26	Rel_Hum	*%*	Realtime	49.9	Average relative humidity during all test Phases and hot soak.
27	DryBulbT	*degrees K*	Calculated	298.4	(Tamb -32)*(5/9)+273.15
28	PsatDry	*inHg*	Calculated	0.94648	29.92 * 218.167 / (@EXP(@LN(10) * (647.27 - DryBulbT) / DryBulbT * (3.2437814 + 0.00586826 * (647.27 - DryBulbT) + 1.1702379E-008 * (647.27 - DryBulbT)^3) / (1 + (0.0021878462 * (647.27-DryBulbT)))))
29	Spec_Humidity	*Grains/lb*	Calculated	71.31191	4347.8 * (Rel_Hum / 100) * PsatDry / {(Pbaro / 25.4) - PsatDry * (Rel_Hum / 100)}
30	NOx_Corr_Fac		Calculated	0.98296	1 / {1 - 0.0047 *(Spec_Humidity - 75)}
31	(Blank Field)				
32	RR_Spd_1	*MPH*	Realtime	14.3732	Average speed for Phase 1 (t=1 to 301seconds)
33	RR_Spd_2	*MPH*	Realtime	27.5901	Average speed for Phase 2 (t=302 to 1437 seconds)
34	RR_Spd_3	*MPH*	Realtime	14.2443	Average speed for Phase 3 (t=2037 to 2337 seconds)
35	RR_Dist_1	*Miles*	Calculated	1.198	Test distance for phase 1= RR_Spd_1 * Ph_Length_1 / 3600
36	RR_Dist_2	*Miles*	Calculated	8.706	Test distance for phase 2= RR_Spd_2 * Ph_Length_2 / 3600
37	RR_Dist_3	*Miles*	Calculated	1.187	Test distance for phase 3= RR_Spd_3 * Ph_Length_3 / 3600
38	(Blank Field)				
39	HC_1_Exh_m	*ppmC*	Realtime	102.562	Avg HC concentration Phase 1 (t = 1 to 301 seconds)
40	HC_1_Bkg_m	*ppmC*	Realtime	2.733	Avg HC concentration Hot Soak Background (t = 1494 to 1994 seconds)
41	HC_2_Exh_m	*ppmC*	Realtime	27.095	Avg HC concentration Phase 2 (t = 317 to 1437 seconds)
42	HC_2_Bkg_m	*ppmC*	Realtime	2.733	Avg HC concentration Hot Soak Background (t = 1494 to 1994 seconds)
43	HC_3_Exh_m	*ppmC*	Realtime	15.615	Avg HC concentration Phase 3 (t = 2037 to 2337 seconds)
44	HC_3_Bkg_m	*ppmC*	Realtime	2.733	Avg HC concentration Hot Soak Background (t = 1494 to 1994 seconds)

Data Field #	Label	Units	Source	Example Value	Comment
45	(Blank Field)				
46	NOx_1_Exh_m	*Ppm*	Realtime	42.574	Avg NOx concentration Phase 1 (t = 1 to 301 seconds)
47	NOx_1_Bkg_m	*Ppm*	Realtime	0.008	Avg NOx concentration Hot Soak Background (t = 1494 to 1994 seconds)
48	NOx_2_Exh_m	*Ppm*	Realtime	36.455	Avg NOx concentration Phase 2 (t = 317 to 1437 seconds)
49	NOx_2_Bkg_m	*Ppm*	Realtime	0.008	Avg NOx concentration Hot Soak Background (t = 1494 to 1994 seconds)
50	NOx_3_Exh_m	*Ppm*	Realtime	24.800	Avg NOx concentration Phase 3 (t = 2037 to 2337 seconds)
51	NOx_3_Bkg_m	*Ppm*	Realtime	0.008	Avg NOx concentration Hot Soak Background (t = 1494 to 1994 seconds)
52	(Blank Field)				
53	CO_1_Exh_m	*Ppm*	Realtime	613.094	Avg CO concentration Phase 1 (t = 1 to 301 seconds)
54	CO_1_Bkg_m	*Ppm*	Realtime	0.379	Avg CO concentration Hot Soak Background (t = 1494 to 1994 seconds)
55	CO_2_Exh_m	*Ppm*	Realtime	675.482	Avg CO concentration Phase 2 (t = 317 to 1437 seconds)
56	CO_2_Bkg_m	*Ppm*	Realtime	0.379	Avg CO concentration Hot Soak Background (t = 1494 to 1994 seconds)
57	CO_3_Exh_m	*Ppm*	Realtime	181.040	Avg CO concentration Phase 3 (t = 2037 to 2337 seconds)
58	CO_3_Bkg_m	*Ppm*	Realtime	0.379	Avg CO concentration Hot Soak Background (t = 1494 to 1994 seconds)
59	(Blank Field)				
60	CO2_1_Exh_m	*%*	Realtime	0.631	Avg CO2 concentration Phase 1 (t = 1 to 301 seconds)
61	CO2_1_Bkg_m	*%*	Realtime	0.044	Avg CO2 concentration Hot Soak Background (t = 1494 to 1994 seconds)
62	CO2_2_Exh_m	*%*	Realtime	0.723	Avg CO2 concentration Phase 2 (t = 317 to 1437 seconds)
63	CO2_2_Bkg_m	*%*	Realtime	0.044	Avg CO2 concentration Hot Soak Background (t = 1494 to 1994 seconds)
64	CO2_3_Exh_m	*%*	Realtime	0.515	Avg CO2 concentration Phase 3 (t = 2037 to 2337 seconds)
65	CO2_3_Bkg_m	*%*	Realtime	0.044	Avg CO2 concentration Hot Soak Background (t = 1494 to 1994 seconds)
66	(Blank Field)				

Data Field #	Label	Units	Source	Example Value	Comment
67	SPCO2	*%*	Constant	13.40	Engine out CO2 (%) emitted at Stochiometry = 13.4 for both INDOLENE and UNKNOWN fuels.
68	DilFac_1_m		Calculated	19.07	Dilution Factor Phase 1 = SPCO2 / {CO2_1_Exh_m + (CO_1_Exh_m * 0.0001) +(HC_1_Exh_m * 0.0001)}
69	DilFac_2_m		Calculated	16.90	Dilution Factor Phase 2 = SPCO2 / {CO2_2_Exh_m + (CO_2_Exh_m * 0.0001) +(HC_2_Exh_m * 0.0001)}
70	DilFac_3_m		Calculated	25.08	Dilution Factor Phase 3 = SPCO2 / {CO2_3_Exh_m + (CO_3_Exh_m * 0.0001) +(HC_3_Exh_m * 0.0001)}
71	(Blank Field)				
72	HC_Density	*gm/cuft*	Constant	16.33	Density of HC
73	NOx_ Density	*gm/cuft*	Constant	54.16	Density of NOx
74	CO_Density	*gm/cuft*	Constant	32.97	Density of CO
75	CO2_Density	*gm/cuft*	Constant	51.81	Density of CO2
76	HC_1_mass_m	*Gm*	Calculated	3.856	HC mass for Phase 1 = 'Vmix_1 * HC_Density * {HC_Exh_1_m - HC_Bkg_1_m * (1 - 1/ DilFac_1_m)} / 1,000,000
77	HC_2_mass_m	*Gm*	Calculated	3.576	HC mass for Phase 2 = 'Vmix_2 * HC_Density * {HC_Exh_2_m - HC_Bkg_2_m * (1 - 1/ DilFac_2_m)} / 1,000,000
78	HC_3_mass_m	*Gm*	Calculated	0.501	HC mass for Phase 3 = 'Vmix_3 * HC_Density * {HC_Exh_3_m - HC_Bkg_3_m * (1 - 1/ DilFac_3_m)} / 1,000,000
79	NOx_1_mass_m	*Gm*	Calculated	5.445	NOx mass for Phase 1 = 'Vmix_1 * NOx_Density * {NOx_Exh_1_m - NOx_Bkg_1_m * (1 - 1/ DilFac_1_m)} / 1,000,000
80	NOx_2_mass_m	*Gm*	Calculated	17.625	NOx mass for Phase 2 = 'Vmix_2 * NOx_Density * {NOx_Exh_2_m - NOx_Bkg_2_m * (1 - 1/ DilFac_2_m)} / 1,000,000
81	NOx_3_mass_m	*Gm*	Calculated	3.173	NOx mass for Phase 3 = 'Vmix_3 * NOx_Density * {NOx_Exh_3_m - NOx_Bkg_3_m * (1 - 1/ DilFac_3_m)} / 1,000,000
82	NOx_1_mass_mc	*Gm*	Calculated	5.352	NOx (corrected) mass for Phase 1 = 'Vmix_1 * NOx_Density * NOx_Corr_Fac * {NOx_Exh_1_m - NOx_Bkg_1_m * (1 - 1/ DilFac_1_m)} / 1,000,000
83	NOx_2_mass_mc	*Gm*	Calculated	17.324	NOx (corrected) mass for Phase 2 = 'Vmix_2 *

Data Field #	Label	Units	Source	Example Value	Comment
					NOx_Density * NOx_Corr_Fac * {NOx_Exh_2_m - NOx_Bkg_2_m * (1 - 1/ DilFac_2_m)} / 1,000,000
84	NOx_3_mass_ mc	*Gm*	Calculated	3.119	NOx (corrected) mass for Phase 3 = 'Vmix_3 * NOx_Density * NOx_Corr_Fac * {NOx_Exh_3_m - NOx_Bkg_3_m * (1 - 1/ DilFac_3_m)} / 1,000,000
85	CO_1_mass_m	*Gm*	Calculated	47.714	CO mass for Phase 1 = 'Vmix_1 * CO_Density * {CO_Exh_1_m - CO_Bkg_1_m * (1 - 1/ DilFac_1_m)} / 1,000,000
86	CO_2_mass_m	*Gm*	Calculated	198.734	CO mass for Phase 2 = 'Vmix_2 * CO_Density * {CO_Exh_2_m - CO_Bkg_2_m * (1 - 1/ DilFac_2_m)} / 1,000,000
87	CO_3_mass_m	*Gm*	Calculated	14.075	CO mass for Phase 3 = 'Vmix_3 * CO_Density * {CO_Exh_3_m - CO_Bkg_3_m * (1 - 1/ DilFac_3_m)} / 1,000,000
88	CO2_1_mass_m	*Gm*	Calculated	721.378	CO2 mass for Phase 1 = 'Vmix_1 * CO2_Density * {CO2_Exh_1_m - CO2_Bkg_1_m * (1 - 1/ DilFac_1_m)} / 100
89	CO2_2_mass_m	*Gm*	Calculated	3152.989	CO2 mass for Phase 2 = 'Vmix_2 * CO2_Density * {CO2_Exh_2_m - CO2_Bkg_2 _m* (1 - 1/ DilFac_2_m)} / 100
90	C2O_3_mass_m	*Gm*	Calculated	578.488	CO2 mass for Phase 3 = 'Vmix_3 * CO2_Density * {CO2_Exh_3_m - CO2_Bkg_3_m * (1 - 1/ DilFac_3_m)} / 100
91	(Blank Field)				
92	HC_1_ER_m	*gm/mile*	Calculated	3.219	HC Emission Rate for Phase 1 = HC_1_mass_m / RR_Dist_1
93	HC_2_ER_m	*gm/mile*	Calculated	0.411	HC Emission Rate for Phase 2 = HC_2_mass_m / RR_Dist_2
94	HC_3_ER_m	*gm/mile*	Calculated	0.422	HC Emission Rate for Phase 3 = HC_3_mass_m / RR_Dist_3
95	NOx_1_ER_m	*gm/mile*	Calculated	4.546	NOx Emission Rate for Phase 1 = NOx_1_mass_m / RR_Dist_1
96	NOx_2_ER_m	*gm/mile*	Calculated	2.024	NOx Emission Rate for Phase 2 = NOx_2_mass_m / RR_Dist_2
97	NOx_3_ER_m	*gm/mile*	Calculated	2.673	NOx Emission Rate for Phase 2 = NOx_2_mass_m / RR_Dist_2

Data Field #	Label	Units	Source	Example Value	Comment
98	NOx_1_ER_mc	*gm/mile*	Calculated	4.469	Corrected NOx Emission Rate for Phase 1 = NOx_1_mass_mc / RR_Dist_1
99	NOx_2_ER_mc	*gm/mile*	Calculated	1.990	Corrected NOx Emission Rate for Phase 2 = NOx_2_mass_mc / RR_Dist_2
100	NOx_3_ER_mc	*gm/mile*	Calculated	2.627	Corrected NOx Emission Rate for Phase 3 = NOx_3_mass_mc / RR_Dist_3
101	CO_1_ER_m	*gm/mile*	Calculated	39.836	CO Emission Rate for Phase 1 = CO_1_mass_m / RR_Dist_1
102	CO_2_ER_m	*gm/mile*	Calculated	22.827	CO Emission Rate for Phase 2 = CO_2_mass_m / RR_Dist_2
103	CO_3_ER_m	*gm/mile*	Calculated	11.857	CO Emission Rate for Phase 3 = CO_3_mass_m / RR_Dist_3
104	CO2_1_ER_m	*gm/mile*	Calculated	602.271	CO2 Emission Rate for Phase 1 = CO2_1_mass_m / RR_Dist_1
105	CO2_2_ER_m	*gm/mile*	Calculated	362.153	CO2 Emission Rate for Phase 2 = CO2_2_mass_m / RR_Dist_2
106	CO2_3_ER_m	*gm/mile*	Calculated	487.342	CO2 Emission Rate for Phase 3 = CO2_3_mass_m / RR_Dist_3
107	(Blank Field)				
108	HC_wt_ER_m	*gm/mile*	Calculated	0.558	Weighted HC emission rate = 0.43 *{(HC_1_mass_m +HC_2_mass_m)/ (RR_Dist_1 + RR_Dist_2)} + 0.57 * {(HC_3_mass_m + HC_2_mass_m) / (RR_Dist_3 + RR_Dist_2)}
109	NOx_wt_ER_m	*gm/mile*	Calculated	2.200	Weighted NOx emission rate = 0.43 *{(NOx_1_mass_m +NOx_2_mass_m)/ (RR_Dist_1 + RR_Dist_2)} + 0.57 * {(NOx_3_mass_m + NOx_2_mass_m) / (RR_Dist_3 + RR_Dist_2)}
110	NOx_wt_ER_mc	*gm/mile*	Calculated	2.162	Weighted NOx (corrected) emission rate = 0.43 *{(NOx_1_mass_mc +NOx_2_mass_mc)/ (RR_Dist_1 + RR_Dist_2)} + 0.57 * {(NOx_3_mass_mc + NOx_2_mass_mc) / (RR_Dist_3 + RR_Dist_2)}
111	CO_wt_ER_m	*gm/mile*	Calculated	22.961	Weighted CO emission rate = 0.43 *{(CO_1_mass_m +CO_2_mass_m)/ (RR_Dist_1 + RR_Dist_2)} + 0.57 * {(CO_3_mass_m + CO_2_mass_m) / (RR_Dist_3 + RR_Dist_2)}
112	CO2_wt_ER_m	*gm/mile*	Calculated	383.202	Weighted CO2 emission rate = 0.43 *{(CO2_1_mass_m +CO2_2_mass_m)/ (RR_Dist_1 + RR_Dist_2)} + 0.57 *

Data Field #	Label	Units	Source	Example Value	Comment
					{(CO2_3_mass_m + CO2_2_mass_m) / (RR_Dist_3 + RR_Dist_2)}
113	(Blank Field)				
114	CRHC	*Fuel Wt% C*	Constant	0.840	Weight percent carbon in fuel / 100 = 0.867 for INDOLENE and 0.840 for UNKNOWN fuels.
115	CGAL	*gmC/galFuel*	Constant	2350.000	Carbon density in fuel = 2434 for INDOLENE and 2350 for UNKNOWN fuels.
116	FE_1_m	*mpg*	Calculated	12.76	Fuel Economy for Phase 1 = GGAL / (CRHC * HC_1_ER_m + 0.429 * CO_1_ER_m + 0.273 * CO2_1_ER_m)
117	FE_2_m	*mpg*	Calculated	21.56	Fuel Economy for Phase 2 = GGAL / (CRHC * HC_2_ER_m + 0.429 * CO_2_ER_m + 0.273 * CO2_2_ER_m)
118	FE_3_m	*mpg*	Calculated	16.97	Fuel Economy for Phase 3 = GGAL / (CRHC * HC_3_ER_m + 0.429 * CO_3_ER_m + 0.273 * CO2_3_ER_m)
119	FE_wt_m	*mpg*	Calculated	20.45	Weighted Fuel Economy = GGAL / (CRHC * HC_wt_ER_m + 0.429 * CO_wt_ER_m + 0.273 * CO2_wt_ER_m)
120	(Blank Field)				
121	HC_1_Exh_b	*ppmC*	Keyboard Input	93.0	Bag HC diluted exhaust concentration for Phase 1
122	HC_1_Bkg_b	*ppmC*	Keyboard Input	4.0	Bag HC background concentration for Phase 1
123	HC_2_Exh_b	*ppmC*	Keyboard Input	30.0	Bag HC diluted exhaust concentration for Phase 2
124	HC_2_Bkg_b	*ppmC*	Keyboard Input	4.0	Bag HC background concentration for Phase 2
125	HC_3_Exh_b	*ppmC*	Keyboard Input	18.0	Bag HC diluted exhaust concentration for Phase 3
126	HC_3_Bkg_b	*ppmC*	Keyboard Input	5.0	Bag HC background concentration for Phase 3
127	(Blank Field)				
128	NOx_1_Exh_b	*Ppm*	Keyboard Input	27.7	Bag NOx diluted exhaust concentration for Phase 1
129	NOx_1_Bkg_b	*Ppm*	Keyboard Input	0.0	Bag NOx background concentration for Phase 1
130	NOx_2_Exh_b	*Ppm*	Keyboard Input	25.1	Bag NOx diluted exhaust concentration for Phase 2
131	NOx_2_Bkg_b	*Ppm*	Keyboard Input	0.1	Bag NOx background concentration for Phase 2
132	NOx_3_Exh_b	*Ppm*	Keyboard Input	23.4	Bag NOx diluted exhaust concentration for Phase 3

Data Field #	Label	Units	Source	Example Value	Comment
133	NOx_3_Bkg_b	*Ppm*	Keyboard Input	0.2	Bag NOx background concentration for Phase 3
134	(Blank Field)				
135	CO_1_Exh_b	*Ppm*	Keyboard Input	601.0	Bag CO diluted exhaust concentration for Phase 1
136	CO_1_Bkg_b	*Ppm*	Keyboard Input	0.0	Bag CO background concentration for Phase 1
137	CO_2_Exh_b	*Ppm*	Keyboard Input	661.0	Bag CO diluted exhaust concentration for Phase 2
138	CO_2_Bkg_b	*Ppm*	Keyboard Input	0.0	Bag CO background concentration for Phase 2
139	CO_3_Exh_b	*Ppm*	Keyboard Input	183.0	Bag CO diluted exhaust concentration for Phase 3
140	CO_3_Bkg_b	*Ppm*	Keyboard Input	0.0	Bag CO background concentration for Phase 3
141	(Blank Field)				
142	CO2_1_Exh_b	*%*	Keyboard Input	0.6319	Bag CO2 diluted exhaust concentration for Phase 1
143	CO2_1_Bkg_b	*%*	Keyboard Input	0.0419	Bag CO2 background concentration for Phase 1
144	CO2_2_Exh_b	*%*	Keyboard Input	0.7136	Bag CO2 diluted exhaust concentration for Phase 2
145	CO2_2_Bkg_b	*%*	Keyboard Input	0.0404	Bag CO2 background concentration for Phase 2
146	CO2_3_Exh_b	*%*	Keyboard Input	0.5300	Bag CO2 diluted exhaust concentration for Phase 3
147	CO2_3_Bkg_b	*%*	Keyboard Input	0.0449	Bag CO2 background concentration for Phase 3
148	(Blank Field)				
149	DilFac_1_b		Calculated	19.11	Dilution Factor Phase 1 = SPCO2 / {CO2_1_Exh_b + (CO_1_Exh_b * 0.0001) +(HC_1_Exh_b * 0.0001)}
150	DilFac_2_b		Calculated	17.12	Dilution Factor Phase 2 = SPCO2 / {CO2_2_Exh_b + (CO_2_Exh_b * 0.0001) +(HC_2_Exh_b * 0.0001)}
151	DilFac_3_b		Calculated	24.36	Dilution Factor Phase 3 = SPCO2 / {CO2_3_Exh_m + (CO_3_Exh_m * 0.0001) +(HC_3_Exh_m * 0.0001)}
152	(Blank Field)				
153	HC_1_mass_b	*Gm*	Calculated	3.441	HC mass for Phase 1 = 'Vmix_1 * HC_Density * {HC_Exh_1_b - HC_Bkg_1_b * (1 - 1/ DilFac_1_b)} / 1,000,000
154	HC_2_mass_b	*Gm*	Calculated	3.825	HC mass for Phase 2 = 'Vmix_2 * HC_Density * {HC_Exh_2_b - HC_Bkg_2_b * (1 - 1/ DilFac_2_b)} / 1,000,000
155	HC_3_mass_b	*Gm*	Calculated	0.509	HC mass for Phase 3 = 'Vmix_3 * HC_Density * {HC_Exh_3_b - HC_Bkg_3_b * (1 - 1/ DilFac_3_b)} /

Data Field #	Label	Units	Source	Example Value	Comment
					1,000,000
156	NOx_1_mass_b	*Gm*	Calculated	3.548	NOx mass for Phase 1 = 'Vmix_1 * NOx_Density * {NOx_Exh_1_b - NOx_Bkg_1_b * (1 - 1/ DilFac_1_b)} / 1,000,000
157	NOx_2_mass_b	*Gm*	Calculated	12.091	NOx mass for Phase 2 = 'Vmix_2 * NOx_Density * {NOx_Exh_2_b - NOx_Bkg_2_b * (1 - 1/ DilFac_2_b)} / 1,000,000
158	NOx_3_mass_b	*Gm*	Calculated	2.966	NOx mass for Phase 3 = 'Vmix_3 * NOx_Density * {NOx_Exh_3_b - NOx_Bkg_3_b * (1 - 1/ DilFac_3_b)} / 1,000,000
159	NOx_1_mass_bc	*Gm*	Calculated	3.488	NOx (corrected) mass for Phase 1 = 'Vmix_1 * NOx_Density * NOx_Corr_Fac * {NOx_Exh_1_b - NOx_Bkg_1_b * (1 - 1/ DilFac_1_b)} / 1,000,000
160	NOx_2_mass_bc	*Gm*	Calculated	11.885	NOx (corrected) mass for Phase 2 = 'Vmix_2 * NOx_Density * NOx_Corr_Fac * {NOx_Exh_2_b - NOx_Bkg_2_b * (1 - 1/ DilFac_2_b)} / 1,000,000
161	NOx_3_mass_ bc	*Gm*	Calculated	2.915	NOx (corrected) mass for Phase 3 = 'Vmix_3 * NOx_Density * NOx_Corr_Fac * {NOx_Exh_3_b - NOx_Bkg_3_b * (1 - 1/ DilFac_3_b)} / 1,000,000
162	CO_1_mass_b	*Gm*	Calculated	46.800	CO mass for Phase 1 = 'Vmix_1 * CO_Density * {CO_Exh_1_b - CO_Bkg_1_b * (1 - 1/ DilFac_1_b)} / 1,000,000
163	CO_2_mass_b	*Gm*	Calculated	194.576	CO mass for Phase 2 = 'Vmix_2 * CO_Density * {CO_Exh_2_b - CO_Bkg_2_b * (1 - 1/ DilFac_2_b)} / 1,000,000
164	CO_3_mass_b	*Gm*	Calculated	14.256	CO mass for Phase 3 = 'Vmix_3 * CO_Density * {CO_Exh_3_b - CO_Bkg_3_b * (1 - 1/ DilFac_3_b)} / 1,000,000
165	CO2_1_mass_b	*Gm*	Calculated	724.662	CO2 mass for Phase 1 = 'Vmix_1 * CO2_Density * {CO2_Exh_1_b - CO2_Bkg_1_b * (1 - 1/ DilFac_1_b)} / 100
166	CO2_2_mass_b	*Gm*	Calculated	3125.115	CO2 mass for Phase 2 = 'Vmix_2 * CO2_Density * {CO2_Exh_2_b - CO2_Bkg_2_b * (1 - 1/ DilFac_2_b)} / 100
167	C2O_3_mass_b	*Gm*	Calculated	596.042	CO2 mass for Phase 3 = 'Vmix_3 * CO2_Density * {CO2_Exh_3_b - CO2_Bkg_3_b * (1 - 1/ DilFac_3_b)} / 100

Data Field #	Label	Units	Source	Example Value	Comment
168	(Blank Field)				
169	HC_1_ER_b	*gm/mile*	Calculated	2.873	HC Emission Rate for Phase 1 = HC_1_mass_b / RR_Dist_1
170	HC_2_ER_b	*gm/mile*	Calculated	0.439	HC Emission Rate for Phase 2 = HC_2_mass_b / RR_Dist_2
171	HC_3_ER_b	*gm/mile*	Calculated	0.429	HC Emission Rate for Phase 3 = HC_3_mass_b / RR_Dist_3
172	NOx_1_ER_b	*gm/mile*	Calculated	2.963	NOx Emission Rate for Phase 1 = NOx_1_mass_b / RR_Dist_1
173	NOx_2_ER_b	*gm/mile*	Calculated	1.389	NOx Emission Rate for Phase 2 = NOx_2_mass_b / RR_Dist_2
174	NOx_3_ER_b	*gm/mile*	Calculated	2.499	NOx Emission Rate for Phase 2 = NOx_2_mass_b / RR_Dist_2
175	NOx_1_ER_bc	*gm/mile*	Calculated	2.912	Corrected NOx Emission Rate for Phase 1 = NOx_1_mass_bc / RR_Dist_1
176	NOx_2_ER_bc	*gm/mile*	Calculated	1.365	Corrected NOx Emission Rate for Phase 2 = NOx_2_mass_bc / RR_Dist_2
177	NOx_3_ER_bc	*gm/mile*	Calculated	2.456	Corrected NOx Emission Rate for Phase 3 = NOx_3_mass_bc / RR_Dist_3
178	CO_1_ER_b	*gm/mile*	Calculated	39.073	CO Emission Rate for Phase 1 = CO_1_mass_b / RR_Dist_1
179	CO_2_ER_b	*gm/mile*	Calculated	22.349	CO Emission Rate for Phase 2 = CO_2_mass_b / RR_Dist_2
180	CO_3_ER_b	*gm/mile*	Calculated	12.010	CO Emission Rate for Phase 3 = CO_3_mass_b / RR_Dist_3
181	CO2_1_ER_b	*gm/mile*	Calculated	605.013	CO2 Emission Rate for Phase 1 = CO2_1_mass_b / RR_Dist_1
182	CO2_2_ER_b	*gm/mile*	Calculated	358.952	CO2 Emission Rate for Phase 2 = CO2_2_mass_b / RR_Dist_2
183	CO2_3_ER_b	*gm/mile*	Calculated	502.130	CO2 Emission Rate for Phase 3 = CO2_3_mass_b / RR_Dist_3
184	(Blank Field)				
185	HC_wt_ER_b	*gm/mile*	Calculated	0.565	Weighted HC emission rate = 0.43 *{(HC_1_mass_b +HC_2_mass_b)/ (RR_Dist_1 + RR_Dist_2)} + 0.57 * {(HC_3_mass_b + HC_2_mass_b) / (RR_Dist_3 + RR_Dist_2)}

Data Field #	Label	Units	Source	Example Value	Comment
186	NOx_wt_ER_b	*gm/mile*	Calculated	1.547	Weighted NOx emission rate = 0.43 *{(NOx_1_mass_b +NOx_2_mass_b)/ (RR_Dist_1 + RR_Dist_2)} + 0.57 * {(NOx_3_mass_b + NOx_2_mass_b) / (RR_Dist_3 + RR_Dist_2)}
187	NOx_wt_ER_mb	*gm/mile*	Calculated	1.520	Weighted NOx (corrected) emission rate = 0.43 *{(NOx_1_mass_bc +NOx_2_mass_bc)/ (RR_Dist_1 + RR_Dist_2)} + 0.57 * {(NOx_3_mass_bc + NOx_2_mass_bc) / (RR_Dist_3 + RR_Dist_2)}
188	CO_wt_ER_b	*gm/mile*	Calculated	22.512	Weighted CO emission rate = 0.43 *{(CO_1_mass_b +CO_2_mass_b)/ (RR_Dist_1 + RR_Dist_2)} + 0.57 * {(CO_3_mass_b + CO_2_mass_b) / (RR_Dist_3 + RR_Dist_2)}
189	CO2_wt_ER_b	*gm/mile*	Calculated	381.540	Weighted CO2 emission rate = 0.43 *{(CO2_1_mass_b +CO2_2_mass_b)/ (RR_Dist_1 + RR_Dist_2)} + 0.57 * {(CO2_3_mass_b + CO2_2_mass_b) / (RR_Dist_3 + RR_Dist_2)}
190	(Blank Field)				
191	FE_1_b	*mpg*	Calculated	12.748	Fuel Economy for Phase 1 = GGAL / (CRHC * HC_1_ER_b + 0.429 * CO_1_ER_b + 0.273 * CO2_1_ER_b)
192	FE_2_b	*mpg*	Calculated	21.769	Fuel Economy for Phase 2 = GGAL / (CRHC * HC_2_ER_b + 0.429 * CO_2_ER_b + 0.273 * CO2_2_ER_b)
193	FE_3_b	*mpg*	Calculated	16.480	Fuel Economy for Phase 3 = GGAL / (CRHC * HC_3_ER_b + 0.429 * CO_3_ER_b + 0.273 * CO2_3_ER_b)
194	FE_wt_b	*mpg*	Calculated	20.561	Weighted Fuel Economy = GGAL / (CRHC * HC_wt_ER_b + 0.429 * CO_wt_ER_b + 0.273 * CO2_wt_ER_b)
195	(Blank Field)				
196	FR_Dist_1	*Miles*	Realtime	1.196	Not used - Front roll Distance Phase 1
197	FR_Dist_2	*Miles*	Realtime	8.615	Not used - Front roll Distance Phase 2
198	FR_Dist_3	*Miles*	Realtime	1.172	Not used - Front roll Distance Phase 3
199	Avg_Tork_1	*Ft-lbs*	Realtime	2.235	Not used - Average torque Phase 1
200	Avg_Tork_2	*Ft-lbs*	Realtime	6.363	Not used - Average torque Phase 2

Data Field #	Label	Units	Source	Example Value	Comment
201	Avg_Tork_3	*Ft-lbs*	Realtime	2.111	Not used - Average torque Phase 3
202	PAU Temp.	*C*	Realtime	29.78	Not used - Average dynamometer PAU temperature over entire test cycle
203	Amb. HC	*ppmC*	Realtime	2.07	Not used - Average HC concentration inside test facility over entire test cycle.