

Kansas City PM Characterization Study

Final Report

Appendix NN

Round 1 and 2 Average Emission Data

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

Sponsors:

National Renewable Energy Laboratory, U.S. Department of Energy
Federal Highway Administration, U.S. Department of Transportation
STAPPA-ALAPCO Emission Inventory Improvement Program
Coordinating Research Council Inc. (Project No. E-69)

Prepared for EPA by
Eastern Research Group, Incorporated
Austin, TX

Bevilacqua-Knight Incorporated
Oakland, CA

NuStats LLC
Austin, TX

Desert Research Institute
Reno, NV

EPA Contract No. GS 10F-0036K

October 27, 2006
Revised April 2008 by EPA staff



United States
Environmental Protection
Agency

EPA420-R-08-009
April 2008

**Round 1 and 2 Phase and Composite Average Emission Data
Calculated from Second-by-Second Data from the EPA's
Dynamometer Analyzers**

**(EPA modified this data file from the Contractor's submitted
Results after performing additional QA/QC procedures)**

Legend:

avg: average emission rate for the number of vehicles tested
std: standard deviation on the emission rate for the number of vehicles tested
cv: coefficient of variance (standard deviation/average) on the emission rate for the
number of vehicles tested
min: minimum emission value record for the number of vehicles tested
max: maximum emission value record for the number of vehicles tested

Round	Bin	# of vehicles	Composite SBS Phase 1				
			THC g/mile	CO g/mile	CO2 g/mile	NOX g/mile	PM mg/mile
1	1	2					
	avg		17.04	203.52	859.57	2.84	87.80
	std		10.89	69.82	115.85	1.95	107.12
	cv		63.92	34.31	13.48	68.50	122.01
	min		9.34	154.15	777.65	1.47	12.05
	max		24.74	252.90	941.49	4.22	163.54
	2	16					
	avg		8.69	80.01	664.90	4.02	93.80
	std		8.34	80.61	139.01	1.98	166.21
	cv		96.08	100.74	20.91	49.22	177.20
	min		2.96	14.47	415.31	1.79	3.75
	max		33.60	308.17	936.07	7.55	662.78
	3	19					
	avg		4.30	34.66	770.23	4.19	14.48
	std		1.15	19.59	127.26	1.32	24.60
	cv		26.63	56.53	16.52	31.49	169.90
	min		2.39	15.68	558.69	1.76	1.45
	max		5.93	83.91	1048.85	7.02	105.95
	4	41					
	avg		2.05	14.10	815.98	1.99	9.58
	std		1.08	8.95	104.14	1.25	0.99
	cv		52.48	63.47	12.76	62.43	10.37
	min		0.54	2.20	627.39	0.12	0.13
	max		6.00	43.28	1120.21	5.27	4.22
	5	7					
	avg		17.66	250.41	676.00	2.61	160.77
	std		6.34	164.95	158.79	2.60	108.00
	cv		35.91	65.87	23.49	99.77	67.18
	min		9.51	51.84	384.51	0.53	56.76
	max		24.19	460.48	811.22	7.79	326.53
	6	58					
	avg		5.70	43.34	647.44	4.20	35.02
	std		4.10	44.91	124.91	2.09	76.00
	cv		72.01	103.62	19.29	49.91	217.04
	min		1.91	9.97	356.28	0.96	2.38
	max		25.00	271.53	913.64	8.25	461.18
	7	44					
	avg		3.37	25.78	634.01	2.92	11.43
	std		1.19	17.89	128.26	1.04	10.23
	cv		35.22	69.41	20.23	35.59	89.52
	min		1.76	7.34	407.06	0.56	1.65
	max		6.98	84.06	866.92	5.14	38.47
	8	53					
	avg		2.00	12.76	634.13	1.87	7.40
	std		1.05	7.92	112.56	1.16	10.50
	cv		52.27	62.04	17.75	62.34	141.86
	min		0.40	1.22	382.65	0.00	0.17
	max		5.88	50.93	855.73	6.33	61.94

Round	Bin	Composite SBS Phase 2				
		THC g/mile	CO g/mile	CO2 g/mile	NOX g/mile	PM mg/mile
1	1					
	avg	6.06	64.94	594.34	2.92	45.05
	std	7.13	56.41	57.93	2.50	50.21
	cv	117.68	86.86	9.75	85.79	111.47
	min	1.02	25.05	553.38	1.15	9.54
	max	11.10	104.83	635.31	4.69	80.55
	2					
	avg	2.58	41.25	408.36	2.29	37.65
	std	4.23	60.97	85.89	1.41	65.56
	cv	163.89	147.80	21.03	61.68	174.15
	min	0.13	0.24	264.00	0.32	1.06
	max	16.60	192.37	583.04	5.74	261.52
	3					
	avg	0.47	6.62	476.13	1.89	11.13
	std	0.48	3.84	68.35	1.20	16.73
	cv	101.06	58.09	14.36	63.56	150.35
	min	0.04	0.71	350.33	0.29	0.50
	max	1.77	15.52	621.69	5.59	56.14
	4					
	avg	0.11	2.12	480.59	0.51	4.01
	std	0.19	2.71	60.92	0.68	5.11
	cv	168.13	127.76	12.68	132.60	127.40
	min	0.00	0.07	393.11	0.04	0.36
	max	0.86	12.64	665.09	4.03	30.22
	5					
	avg	7.45	113.63	407.01	2.72	73.09
	std	5.43	88.68	102.90	2.56	99.22
	cv	72.90	78.04	25.28	93.88	135.76
	min	0.77	9.52	257.18	0.23	2.83
	max	14.39	254.04	482.49	7.45	266.15
	6					
	avg	1.25	15.72	388.74	2.61	18.94
	std	1.51	19.20	69.28	1.97	34.58
	cv	120.79	122.11	17.82	75.66	182.54
	min	0.04	0.95	152.96	0.32	0.19
	max	10.01	129.88	521.13	6.78	181.80
	7					
	avg	0.34	8.53	377.44	1.16	7.54
	std	0.51	10.39	65.39	0.83	9.23
	cv	151.76	121.72	17.32	71.93	122.41
	min	0.04	0.19	277.17	0.15	0.24
	max	3.08	48.23	529.87	4.34	41.35
	8					
	avg	0.08	2.81	366.91	0.42	2.48
	std	0.11	3.65	52.77	0.45	5.62
	cv	134.35	130.20	14.38	107.73	226.18
	min	0.00	0.05	240.12	0.02	0.12
	max	0.59	23.92	487.13	3.46	51.12

Round	Bin	Composite SBS Phase 3				
		THC g/mile	CO g/mile	CO2 g/mile	NOX g/mile	PM mg/mile
1	1					
	avg	8.54	68.45	647.32	2.90	9.14
	std	8.63	50.28	155.95	0.73	9.08
	cv	101.02	73.45	24.09	25.32	99.34
	min	2.44	32.90	537.04	2.38	2.72
	max	14.65	104.01	757.59	3.42	15.56
	2					
	avg	5.06	51.87	528.49	2.65	51.05
	std	7.68	74.68	108.59	1.57	98.67
	cv	151.72	143.97	20.55	59.22	193.28
	min	0.47	0.29	378.50	0.26	0.63
	max	31.09	272.67	781.81	6.01	345.61
	3					
	avg	1.33	11.96	636.71	2.54	14.41
	std	2.58	6.96	97.57	1.47	24.99
	cv	194.66	58.23	15.32	58.11	173.43
	min	0.24	3.45	378.50	0.40	1.25
	max	3.05	28.65	858.74	6.19	86.79
	4					
	avg	0.31	3.55	648.30	0.79	2.33
	std	0.59	5.38	83.11	1.24	2.10
	cv	192.23	151.63	12.82	157.40	90.40
	min	0.01	-0.01	502.27	0.00	0.16
	max	3.27	24.85	869.04	6.71	7.59
	5					
	avg	11.85	137.86	515.28	2.87	63.73
	std	9.65	98.89	131.00	2.82	86.50
	cv	81.46	71.73	25.42	98.37	135.73
	min	1.58	10.48	285.12	0.31	3.56
	max	26.65	282.77	611.56	8.19	200.85
	6					
	avg	2.62	21.62	527.28	3.33	8.79
	std	2.60	22.80	105.58	2.43	15.51
	cv	99.09	105.48	20.02	72.93	176.55
	min	0.22	1.82	256.59	0.45	0.35
	max	14.68	118.87	751.57	8.39	87.15
	7					
	avg	0.94	10.01	510.75	1.61	5.08
	std	1.14	13.77	107.70	1.12	7.73
	cv	121.91	137.50	21.09	69.90	152.28
	min	0.03	0.50	339.75	0.09	0.05
	max	5.38	83.61	760.06	4.86	37.95
	8					
	avg	0.20	2.78	492.57	0.60	1.80
	std	0.22	2.47	81.98	0.70	3.34
	cv	107.65	88.71	16.64	116.27	185.69
	min	0.00	0.01	321.70	0.01	0.09
	max	1.15	12.43	688.15	5.76	28.15

Round	Bin	Composite SBS Total				
		THC g/mile	CO g/mile	CO2 g/mile	NOX g/mile	PM mg/mile
1	1					
	avg	1.89	19.81	136.89	0.60	44.80
	std	1.76	12.24	17.46	0.40	50.34
	cv	92.82	61.76	12.75	66.46	112.38
	min	0.65	11.16	124.55	0.32	9.20
	max	3.14	28.47	149.24	0.88	80.39
	2					
	avg	0.94	10.70	100.75	0.56	48.70
	std	1.22	12.67	20.59	0.30	77.06
	cv	130.78	118.37	20.44	53.50	158.23
	min	0.18	0.66	66.80	0.16	6.55
	max	5.02	44.88	144.23	1.22	287.25
	3					
	avg	0.31	2.88	118.96	0.52	12.37
	std	0.13	1.23	18.01	0.24	17.58
	cv	42.11	42.57	15.14	46.72	142.08
	min	0.14	1.16	88.48	0.13	1.39
	max	0.58	5.54	157.76	1.23	60.76
	4					
	avg	0.12	1.04	121.88	0.18	4.21
	std	0.09	0.84	14.74	0.18	4.66
	cv	75.04	81.57	12.09	99.12	110.81
	min	0.03	0.20	97.84	0.00	0.41
	max	0.51	3.54	166.49	0.90	26.97
	5					
	avg	2.20	30.18	100.38	0.56	77.09
	std	1.34	20.84	24.67	0.54	95.32
	cv	61.12	69.05	24.58	96.53	123.65
	min	0.59	3.84	59.57	0.06	5.75
	max	3.93	60.56	119.36	1.58	261.02
	6					
	avg	0.53	4.76	98.69	0.64	19.24
	std	0.45	4.83	18.68	0.42	32.29
	cv	85.54	101.51	18.93	66.02	167.83
	min	0.12	0.99	45.82	0.12	0.80
	max	2.97	28.97	133.65	1.54	163.74
	7					
	avg	0.24	2.58	95.67	0.34	8.22
	std	0.15	2.29	18.26	0.18	8.97
	cv	62.25	88.93	19.09	52.92	109.17
	min	0.10	0.57	65.77	0.10	0.35
	max	0.90	11.28	136.23	0.95	37.36
	8					
	avg	0.11	1.00	93.51	0.16	2.86
	std	0.06	0.64	14.83	0.12	5.89
	cv	56.61	63.63	15.86	78.51	206.31
	min	0.02	0.09	59.84	0.00	0.40
	max	0.35	3.30	126.04	0.96	49.61

Round	Bin	# of vehicles	Composite SBS Phase 1				
			THC g/mile	CO g/mile	CO2 g/mile	NOX g/mile	PM mg/mile
2	1	9					
	avg		14.14	216.01	800.09	2.80	281.33
	std		8.06	161.81	267.11	1.84	417.87
	cv		56.98	74.91	33.38	65.95	148.53
	min		2.94	6.36	382.11	0.34	4.90
	max		31.57	465.91	1195.00	5.36	1198.94
	2	35					
	avg		12.25	156.37	699.87	3.37	210.94
	std		7.21	96.22	133.91	1.63	297.39
	cv		58.87	61.53	19.13	48.51	140.98
	min		3.71	43.28	454.80	0.47	11.50
	max		32.73	481.45	963.81	7.74	1436.68
	3	34					
	avg		5.92	79.06	776.50	3.56	40.05
	std		2.54	44.49	139.10	1.61	39.71
	cv		42.80	56.28	17.91	45.09	99.14
	min		2.37	19.88	508.91	0.80	3.99
	max		11.55	192.41	1032.15	7.22	152.80
	4	64					
	avg		3.76	35.75	834.76	2.30	40.84
	std		2.50	24.33	115.20	1.40	82.95
	cv		66.46	68.05	13.80	60.93	203.12
	min		0.22	0.72	559.08	0.09	1.88
	max		11.53	103.93	1194.48	7.01	601.42
	5	17					
	avg		16.82	251.28	767.71	2.39	361.73
	std		6.91	126.44	177.28	1.66	436.66
	cv		41.11	50.32	23.09	69.56	120.71
	min		6.51	99.87	490.04	0.69	32.31
	max		31.08	480.88	1242.99	5.86	1652.50
	6	51					
	avg		8.83	113.86	652.62	3.49	114.81
	std		5.67	81.06	135.14	1.78	188.21
	cv		64.19	71.19	20.71	50.92	163.93
	min		2.47	22.33	392.39	0.55	6.83
	max		31.64	356.29	1121.23	6.90	1038.48
	7	48					
	avg		6.37	89.09	701.82	2.77	55.06
	std		4.56	97.47	129.72	1.17	74.73
	cv		71.65	109.40	18.48	42.33	135.73
	min		1.96	16.09	411.83	0.54	4.65
	max		29.10	538.94	967.28	5.99	419.36
	8	40					
	avg		4.11	39.35	700.27	1.79	46.88
	std		2.14	28.60	116.65	0.82	97.71
	cv		52.03	72.69	16.66	45.63	208.40
	min		1.00	3.71	444.64	0.32	0.69
	max		9.99	152.82	903.50	4.23	599.46

Round	Bin	Composite SBS Phase 2				
		THC g/mile	CO g/mile	CO2 g/mile	NOX g/mile	PM mg/mile
2	1					
	avg	4.46	51.12	530.98	2.94	101.70
	std	4.70	27.96	143.42	1.53	129.89
	cv	105.51	54.70	27.01	52.19	127.72
	min	0.30	2.43	235.50	1.33	6.78
	max	15.38	91.67	675.24	5.29	397.78
	2					
	avg	1.78	23.64	456.72	2.40	31.43
	std	3.10	39.48	84.56	1.07	48.98
	cv	174.31	167.01	18.52	44.69	155.85
	min	0.09	0.27	331.07	0.60	1.30
	max	13.26	209.20	644.21	4.98	242.55
	3					
	avg	0.49	7.48	465.33	1.60	19.13
	std	0.71	8.17	77.29	1.24	36.41
	cv	144.55	109.14	16.61	77.70	190.32
	min	0.03	0.33	289.13	0.14	0.58
	max	2.59	40.47	620.15	5.33	213.10
	4					
	avg	0.14	2.89	468.84	0.64	6.02
	std	0.23	3.84	58.94	0.76	6.79
	cv	160.09	132.89	12.57	118.15	112.90
	min	0.01	0.08	340.74	0.01	0.56
	max	1.18	20.25	672.35	5.10	30.16
	5					
	avg	3.00	48.03	492.37	2.89	42.34
	std	3.29	46.80	83.30	1.74	73.47
	cv	109.74	97.44	16.92	60.09	173.53
	min	0.46	5.49	293.65	0.73	3.19
	max	14.75	185.39	637.23	7.12	315.45
	6					
	avg	1.61	21.60	386.61	2.26	23.86
	std	2.50	33.19	56.67	1.68	40.46
	cv	155.02	153.65	14.66	74.27	169.60
	min	0.06	1.77	256.26	0.11	0.82
	max	16.45	169.89	496.80	5.20	177.64
	7					
	avg	0.46	9.37	399.91	1.03	16.25
	std	1.60	33.41	63.41	0.65	27.44
	cv	351.78	356.53	15.86	63.46	168.90
	min	0.03	0.20	261.51	0.17	0.00
	max	11.19	234.74	545.62	3.60	143.30
	8					
	avg	0.08	2.24	379.66	0.38	6.20
	std	0.06	2.02	60.06	0.33	12.89
	cv	74.07	90.19	15.82	86.34	207.91
	min	0.02	0.09	265.67	0.03	0.58
	max	0.25	6.63	503.37	1.29	81.41

Round	Bin	Composite SBS Phase 3				
		THC g/mile	CO g/mile	CO2 g/mile	NOX g/mile	PM mg/mile
2	1					
	avg	7.17	57.96	618.29	2.93	28.12
	std	8.18	39.25	167.67	1.30	34.39
	cv	113.96	67.72	27.12	44.36	122.31
	min	0.77	1.50	290.82	1.22	0.89
	max	26.28	98.82	798.96	5.17	95.79
	2					
	avg	3.67	20.91	566.51	2.93	22.16
	std	6.43	25.31	107.10	1.41	38.91
	cv	175.24	121.07	18.90	48.06	175.60
	min	0.49	0.17	392.64	1.07	0.92
	max	27.94	115.07	879.91	7.96	140.20
	3					
	avg	1.18	10.54	587.15	2.03	5.22
	std	1.18	7.44	97.84	1.50	6.08
	cv	100.22	70.55	16.66	74.13	116.49
	min	0.18	2.18	388.94	0.31	0.39
	max	4.12	31.35	793.56	5.87	26.44
	4					
	avg	0.30	3.48	609.72	0.75	3.26
	std	0.46	3.97	84.50	0.88	3.67
	cv	155.28	114.11	13.86	117.66	112.34
	min	0.00	-0.01	400.05	0.00	0.05
	max	2.70	18.98	878.59	5.80	26.31
	5					
	avg	4.73	57.55	609.40	3.12	14.31
	std	4.89	76.10	112.65	1.96	17.96
	cv	103.36	132.23	18.49	62.78	125.45
	min	0.97	3.06	351.11	0.70	2.66
	max	22.73	319.06	781.44	8.04	73.58
	6					
	avg	2.81	26.61	493.37	2.79	13.68
	std	3.98	39.54	79.21	2.12	24.97
	cv	141.99	148.58	16.06	75.78	182.52
	min	0.16	2.02	299.20	0.23	1.48
	max	27.33	184.04	658.33	7.21	116.82
	7					
	avg	1.00	10.32	525.38	1.41	6.70
	std	2.28	24.94	100.37	0.83	10.81
	cv	228.58	241.62	19.10	59.13	161.50
	min	0.11	0.26	334.68	0.24	0.15
	max	15.87	174.57	762.26	4.57	60.50
	8					
	avg	0.12	2.00	494.48	0.45	4.21
	std	0.11	1.94	88.92	0.37	4.86
	cv	90.87	97.07	17.98	83.42	115.33
	min	0.00	0.02	342.29	0.05	0.09
	max	0.42	6.63	658.48	1.23	25.13

Round	Bin	Composite SBS Total				
		THC g/mile	CO g/mile	CO2 g/mile	NOX g/mile	PM mg/mile
2	1					
	avg	1.47	17.82	123.74	0.59	106.13
	std	1.26	10.22	34.37	0.25	134.87
	cv	85.69	57.33	27.78	42.65	127.08
	min	0.20	0.61	57.02	0.32	6.38
	max	4.39	34.72	163.09	0.93	416.66
	2					
	avg	0.92	10.39	108.71	0.55	39.69
	std	0.94	8.53	20.21	0.21	51.77
	cv	102.37	82.12	18.59	38.56	130.45
	min	0.25	2.22	75.32	0.17	2.85
	max	4.31	47.11	161.75	1.28	231.92
	3					
	avg	0.37	4.78	114.33	0.43	20.65
	std	0.22	2.67	19.07	0.26	33.50
	cv	58.72	55.84	16.68	61.24	162.20
	min	0.14	1.37	73.80	0.13	1.00
	max	0.91	12.31	150.26	1.18	188.57
	4					
	avg	0.19	2.04	118.81	0.21	7.92
	std	0.13	1.34	15.09	0.18	8.30
	cv	65.90	65.33	12.70	85.16	104.77
	min	0.02	0.16	84.74	0.01	0.75
	max	0.54	6.20	168.82	1.15	36.05
	5					
	avg	1.30	18.90	117.49	0.57	57.47
	std	0.83	12.65	20.97	0.33	79.56
	cv	63.79	66.92	17.85	58.09	138.43
	min	0.58	6.34	73.77	0.20	7.46
	max	4.11	57.43	162.82	1.38	332.43
	6					
	avg	0.71	8.68	95.86	0.54	28.17
	std	0.67	7.77	15.20	0.35	43.99
	cv	94.61	89.50	15.85	64.42	156.13
	min	0.13	1.72	61.17	0.12	1.24
	max	4.50	41.07	134.62	1.19	181.59
	7					
	avg	0.38	5.41	101.08	0.31	18.51
	std	0.46	8.35	16.95	0.14	26.52
	cv	121.77	154.44	16.77	47.42	145.60
	min	0.10	0.91	64.05	0.10	1.05
	max	3.31	57.12	133.20	0.82	132.98
	8					
	avg	0.19	2.06	97.47	0.14	8.23
	std	0.10	1.29	15.90	0.08	14.19
	cv	50.62	62.85	16.31	55.18	172.33
	min	0.06	0.28	67.81	0.02	1.19
	max	0.44	6.81	124.68	0.28	83.25