

Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

*For Evaluating
Motor Vehicle Registration Fee Projects
and
Congestion Mitigation and
Air Quality Improvement (CMAQ) Projects*

**Contains PM2.5 for use by the
South Coast Air Quality Management District**

Emission Factor Tables
December 2009

California Air Resources Board

Table 1 Diesel Bus Emission Factors

(through Model Year 2010)

Pollutant	Calendar Year	Model Year	Emission Factor (g/mi)	
			Average	45 MPH
ROG	2010	Entire Fleet	0.73	0.43
	2010	1973-83	0.83	0.49
	2010	1984-90	0.85	0.49
	2010	1991-93	0.80	0.48
	2010	1994-95	0.87	0.48
	2010	1996-2001	0.81	0.47
	2010	2002	0.86	0.47
	2010	2003 - 2006	0.25	0.14
	2010	2007 - 2009	0.03	0.02
	2010	2010	0.03	0.02
CO	2010	Entire Fleet	3.74	1.97
	2010	1973-83	6.48	3.43
	2010	1984-90	6.03	3.18
	2010	1991-93	3.48	1.83
	2010	1994-95	2.27	1.23
	2010	1996-2001	1.83	0.96
	2010	2002	1.87	0.96
	2010	2003 - 2006	1.31	0.70
	2010	2007 - 2009	1.04	0.55
	2010	2010	0.99	0.53
NOx	2010	Entire Fleet	19.35	17.32
	2010	1973-83	28.73	25.77
	2010	1984-90	26.21	23.43
	2010	1991-93	15.93	14.22
	2010	1994-95	18.51	16.65
	2010	1996-2001	18.40	16.48
	2010	2002	12.68	11.38
	2010	2003 - 2006	4.60	4.13
	2010	2007 - 2009	0.59	0.53
	2010	2010	0.56	0.51
PM2.5 - Exhaust	2010	Entire Fleet	0.30	0.18
	2010	1973-83	0.39	0.22
	2010	1984-90	0.35	0.22
	2010	1991-93	0.34	0.20
	2010	1994-95	0.35	0.24
	2010	1996-2001	0.32	0.19
	2010	2002	0.14	0.10
	2010	2003 - 2006	0.06	0.02
	2010	2007 - 2009	0.04	0.02
	2010	2010	0.03	0.02
PM2.5 - Tire Wear	All Years	All Years	0.002	Not Speed Dependent
PM2.5 - Brake Wear	All Years	All Years	0.005	Not Speed Dependent
PM2.5 - Road Dust*	All Years	All Years	0.028	Not Speed Dependent

Table 1 Diesel Bus Emission Factors (through Model Year 2010) -- Sources

Source: EMFAC2007, V2.3 (Nov 1 2006), average annual emissions, statewide urban diesel bus fleet, running exhaust emissions only, humidity 50%, temperature 75 degrees F.

Average factors for ROG (MY 2007) and PM10 (MY 2007) exhaust were estimated using proportional analysis relative to 45 mph factors because exhaust emissions were too small to show up in EMFAC model output files (csv files).

PM2.5 road dust factor is estimated as, $[PM2.5] = 0.15[PM10]$

PM2.5/PM10 ratio is based on "Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors; prepared by Midwest Research Institute for Western Governors' Association, Western Regional Air Partnership (WRAP); MRI Project No. 110397; finalized November 1, 2006."

<http://www.epa.gov/ttn/chief/ap42/ch13/bgdocs/b13s02.pdf>

(See Table 1. Proposed Particle Size Ratios for AP-42)

PM10 Road Dust (paved) emission factor of 0.184 is based on US EPA's Compilation of Air Pollutant Emission Factors (AP-42, January 1995).

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Table 2 Cleaner Vehicles Emission Factors (2004+)
For Light-Duty and Medium-Duty Vehicles (Chassis Certified)
Based on LEV II Exhaust Emission Standards

Baseline Vehicles

Low-emission light-duty and medium-duty vehicle (LEV) emission factors in grams per mile with 120,000 mile durability					
Weight (lbs.) ¹	ROG	NOx	PM2.5 ²		CO
			Exhaust	Total ³	
Up to 8500	0.08	0.06	0.009	0.044	3.87
8501-10,000	0.20	0.20	0.110	0.145	6.40
10,001-14,000	0.23	0.40	0.110	0.145	7.30

Cleaner Vehicles

Ultra low-emission light-duty and medium-duty vehicle (ULEV) emission factors in grams per mile with 120,000 mile durability					
Weight (lbs.)	ROG	NOx	PM2.5		CO
			Exhaust	Total	
Up to 8500	0.05	0.06	0.009	0.044	1.93
8501-10,000	0.14	0.20	0.055	0.090	6.40
10,001-14,000	0.17	0.40	0.055	0.090	7.30

Super ultra low-emission vehicle (SULEV) factors in grams per mile with 120,000 mile durability Partial zero emission vehicle (PZEV) with 150,000 mile durability Advanced technology zero emission vehicle (AT-PZEV) with 150,000 mile durability					
Weight (lbs.)	ROG	NOx	PM2.5		CO
			Exhaust	Total	
Up to 8500	0.01	0.02	0.009	0.044	1.00
8501-10,000	0.10	0.10	0.055	0.090	3.20
10,001-14,000	0.12	0.20	0.055	0.090	3.70

Zero-emission light-duty and medium-duty vehicle (ZEV) emission factors in grams per mile					
Weight (lbs.)	ROG	NOx	PM2.5		CO
			Exhaust	Total	
All weights	0	0	0	0.035	0

Source: Based on California Vehicle Exhaust Standards ("LEV II") for chassis certified vehicles. Factors represent a weighted average of emission standards over a 120,000-mile life; the first 50,000 miles are assessed at the 50,000-mile standard, and the remaining 70,000 miles are assessed at the 120,000-mile standard. The SULEVs exhaust standards apply over the full 120,000 mile life. PZEVs and AT-PZEVs must comply to SULEV standards over 150,000 miles and have near zero evaporative emissions. AT-PZEV must also make use of additional "ZEV-enabling" clean technology such as alternative fuel, electric drive, or other advanced technology systems. The PM exhaust factors are based on total PM standards which were multiplied by a factor of 0.92 to convert to PM2.5. Tire wear and brake wear factors are based on EMFAC2007, version 2.3 (Nov 1, 2006). The road dust portion of the PM10 factor is based on U.S. EPA's [Compilation of Air Pollutant Emission Factors](#) (AP-42, January 1995). Silt loading and vehicle weight data used as inputs to EPA's equation are from [Improvement of Specific Emission Factors](#). (BACM Project No. 1), Final Report, Midwest Research Institute, March 1996. Vehicle trip reductions may have little, if any effect on road dust emissions from high volume facilities thought to be in equilibrium, i.e., the dust is fully entrained due to the heavy traffic. The road dust PM10 factor, however, may be multiplied times total VMT reductions as it has been scaled down to reflect emissions from lower-volume local and collector roads only.

¹ Gross vehicle weights can be associated with passenger capacity as follows: 5751-8500, roughly 8 passengers; 8501-10,000, roughly 10-15 passengers; 10,001-14,000, roughly 20 passengers or more.

² PM2.5 factors are based on standards for diesel vehicles only. There is no applicable standard for gasoline vehicles; gasoline vehicles are known to emit significantly less PM2.5.

³ Total PM2.5 factors include motor vehicle exhaust, tire wear (0.002 g/m), brake wear (0.005 g/m), and entrained road dust (0.028 g/m).

Table 3 Average Auto Emission Factors

(Fleet of Light-Duty Passenger Vehicles, Light-Duty Trucks and Motor Cycles)

Analysis Period or Project Life	1-5 Years (2008-2012)	6-10 Years (2008-2017)	11-15 Years (2008-2022)	16-20 Years (2008-2027)
ROG				
VMT (g/mile)	0.277	0.231	0.200	0.180
commute trip ends (g/trip end)	1.023	0.860	0.738	0.646
average trip ends (g/trip end)	0.762	0.644	0.555	0.488
NOx				
VMT (g/mile)	0.324	0.263	0.220	0.189
commute trip ends (g/trip end)	0.462	0.380	0.315	0.267
average trip ends (g/trip end)	0.444	0.368	0.307	0.260
PM2.5				
VMT (g/mile)	0.050	0.050	0.051	0.051
running exhaust only (g/mile)	0.015	0.015	0.016	0.016
tire and brake wear (g/mile)	0.007	0.007	0.007	0.007
road dust (g/mile)	0.028	0.028	0.028	0.028
commute trip ends (g/trip end)	0.015	0.015	0.016	0.016
average trip ends (g/trip end)	0.008	0.008	0.008	0.008
CO				
VMT (g/mile)	3.365	2.758	2.338	2.044
commute trip ends (g/trip end)	8.784	7.381	6.274	5.427
average trip ends (g/trip end)	6.289	5.270	4.472	3.862

Source: EMFAC2007, V2.3 (Nov 1 2006), statewide average annual emissions

RTS runs use humidity 50%, temperature 75 degrees F.

PM2.5 road dust factor is estimated as, [PM2.5] = 0.15*[PM10]

Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors; prepared by Midwest Research Institute for Western Governors' Association, Western Regional Air Partnership (WRAP); MRI Project No. 110397; finalized November 1, 2006.

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(See Table 1. Proposed Particle Size Ratios for AP-42)

PM10 Road Dust (paved) emission factor of 0.184 is based on US EPA's Compilation of Air Pollutant Emission Factors (AP-42, January 1995).

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Table 3A Average Auto Emission Factors
(Fleet of Light-Duty Passenger Vehicles, Light-Duty Trucks and Motor Cycles)

Analysis Period or Project Life	1 Year 2008	1 Year 2009	1 Year 2010
ROG			
VMT (g/mile)	0.332	0.302	0.273
commute trip ends (g/trip end)	1.189	1.100	1.016
average trip ends (g/trip end)	0.885	0.819	0.756
NOx			
VMT (g/mile)	0.391	0.354	0.320
commute trip ends (g/trip end)	0.535	0.498	0.461
average trip ends (g/trip end)	0.511	0.477	0.444
PM2.5			
VMT (g/mile)	0.049	0.050	0.050
running exhaust only (g/mile)	0.014	0.015	0.015
tire and brake wear (g/mile)	0.007	0.007	0.007
road dust (g/mile)	0.028	0.028	0.028
commute trip ends (g/trip end)	0.014	0.014	0.015
average trip ends (g/trip end)	0.008	0.008	0.008
CO			
VMT (g/mile)	4.032	3.668	3.325
commute trip ends (g/trip end)	10.113	9.422	8.747
average trip ends (g/trip end)	7.259	6.753	6.261

Source: EMFAC2007, V2.3 (Nov 1 2006), statewide average annual emissions

RTS runs use humidity 50%, temperature 75 degrees F.

PM2.5 road dust factor is estimated as, [PM2.5] = 0.15*[PM10]

Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors; prepared by Midwest Research Institute for Western Governors' Association, Western Regional Air Partnership (WRAP); MRI Project No. 110397; finalized November 1, 2006.

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(See Table 1. Proposed Particle Size Ratios for AP-42)

PM10 Road Dust (paved) emission factor of 0.184 is based on US EPA's Compilation of Air Pollutant Emission Factors (AP-42, January 1995).

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Table 4 Emission Factors by Speed

Project Life 1-5 years (2008-2012)

<i>Speed</i>					<i>Grams per Mile</i>					<i>Speed</i>				
<i>(mph)</i>	<i>ROG</i>	<i>CO</i>	<i>NOx</i>	<i>PM2.5 Ex</i>	<i>(mph)</i>	<i>ROG</i>	<i>CO</i>	<i>NOx</i>	<i>PM2.5 Ex</i>	<i>(mph)</i>	<i>ROG</i>	<i>CO</i>	<i>NOx</i>	<i>PM2.5 Ex</i>
5	1.03	7.32	2.20	0.17	35	0.15	3.22	1.00	0.03					
6	0.95	7.05	2.09	0.16	36	0.14	3.18	1.00	0.03					
7	0.87	6.77	1.98	0.15	37	0.14	3.15	1.00	0.03					
8	0.79	6.50	1.87	0.14	38	0.14	3.11	1.00	0.03					
9	0.71	6.23	1.75	0.13	39	0.14	3.07	0.99	0.03					
10	0.63	5.96	1.64	0.11	40	0.13	3.03	0.99	0.03					
11	0.58	5.77	1.57	0.11	41	0.13	3.01	0.99	0.03					
12	0.54	5.58	1.50	0.10	42	0.13	2.99	0.99	0.03					
13	0.49	5.39	1.43	0.09	43	0.13	2.96	1.00	0.03					
14	0.44	5.20	1.36	0.09	44	0.13	2.94	1.00	0.03					
15	0.39	5.00	1.29	0.08	45	0.13	2.92	1.00	0.03					
16	0.37	4.87	1.26	0.07	46	0.13	2.91	1.00	0.03					
17	0.34	4.73	1.22	0.07	47	0.13	2.90	1.01	0.03					
18	0.32	4.60	1.19	0.06	48	0.13	2.90	1.01	0.03					
19	0.29	4.46	1.16	0.06	49	0.13	2.89	1.02	0.03					
20	0.27	4.33	1.13	0.06	50	0.13	2.88	1.02	0.03					
21	0.25	4.23	1.12	0.05	51	0.13	2.89	1.03	0.03					
22	0.24	4.14	1.11	0.05	52	0.13	2.91	1.04	0.03					
23	0.23	4.04	1.09	0.05	53	0.13	2.92	1.05	0.03					
24	0.22	3.95	1.08	0.05	54	0.14	2.93	1.06	0.03					
25	0.21	3.85	1.07	0.05	55	0.14	2.94	1.07	0.03					
26	0.20	3.78	1.06	0.04	56	0.14	2.98	1.08	0.03					
27	0.19	3.71	1.05	0.04	57	0.14	3.02	1.10	0.04					
28	0.19	3.63	1.04	0.04	58	0.15	3.06	1.11	0.04					
29	0.18	3.56	1.03	0.04	59	0.15	3.09	1.13	0.04					
30	0.17	3.49	1.03	0.04	60	0.16	3.13	1.14	0.04					
31	0.17	3.44	1.02	0.04	61	0.16	3.21	1.16	0.04					
32	0.16	3.38	1.02	0.04	62	0.17	3.28	1.18	0.04					
33	0.16	3.33	1.01	0.04	63	0.17	3.36	1.20	0.04					
34	0.15	3.28	1.01	0.03	64	0.18	3.43	1.22	0.04					
					65	0.19	3.51	1.24	0.05					

Source: EMFAC2007 Version 2.3 (Nov 1, 2006), average annual emissions, statewide vehicle fleet, 50% humidity, temperature 75 degrees F.
 ROG includes running exhaust and running evaporative emissions. PM2.5 Ex includes running exhaust emissions only.

Table 4 Emission Factors by Speed (Continued)

Project Life 6-10 years (2008-2017)

<i>Speed</i>					<i>Grams per Mile</i>					<i>Speed</i>				
<i>(mph)</i>	<i>ROG</i>	<i>CO</i>	<i>NOx</i>	<i>PM2.5 Ex</i>	<i>(mph)</i>	<i>ROG</i>	<i>CO</i>	<i>NOx</i>	<i>PM2.5 Ex</i>	<i>(mph)</i>	<i>ROG</i>	<i>CO</i>	<i>NOx</i>	<i>PM2.5 Ex</i>
5	0.84	6.00	1.81	0.15	35	0.12	2.69	0.81	0.03					
6	0.78	5.78	1.71	0.14	36	0.12	2.66	0.81	0.03					
7	0.71	5.57	1.62	0.13	37	0.12	2.63	0.81	0.03					
8	0.65	5.35	1.53	0.12	38	0.11	2.59	0.81	0.03					
9	0.58	5.13	1.44	0.11	39	0.11	2.56	0.81	0.03					
10	0.52	4.91	1.35	0.10	40	0.11	2.53	0.80	0.03					
11	0.48	4.76	1.29	0.09	41	0.11	2.51	0.81	0.03					
12	0.44	4.60	1.24	0.09	42	0.11	2.49	0.81	0.03					
13	0.40	4.45	1.18	0.08	43	0.11	2.47	0.81	0.03					
14	0.36	4.29	1.12	0.07	44	0.10	2.45	0.81	0.03					
15	0.32	4.14	1.06	0.07	45	0.10	2.43	0.81	0.03					
16	0.30	4.03	1.04	0.06	46	0.10	2.42	0.81	0.03					
17	0.28	3.92	1.01	0.06	47	0.10	2.41	0.82	0.03					
18	0.26	3.81	0.98	0.06	48	0.10	2.41	0.82	0.03					
19	0.24	3.70	0.96	0.05	49	0.10	2.40	0.82	0.03					
20	0.22	3.59	0.93	0.05	50	0.11	2.39	0.83	0.03					
21	0.21	3.51	0.92	0.05	51	0.11	2.40	0.84	0.03					
22	0.20	3.44	0.91	0.05	52	0.11	2.41	0.84	0.03					
23	0.19	3.36	0.90	0.04	53	0.11	2.41	0.85	0.03					
24	0.18	3.28	0.89	0.04	54	0.11	2.42	0.86	0.03					
25	0.17	3.21	0.88	0.04	55	0.11	2.43	0.87	0.03					
26	0.16	3.15	0.87	0.04	56	0.12	2.45	0.88	0.03					
27	0.16	3.09	0.86	0.04	57	0.12	2.48	0.89	0.03					
28	0.15	3.03	0.85	0.04	58	0.12	2.51	0.90	0.03					
29	0.15	2.97	0.85	0.04	59	0.12	2.54	0.91	0.03					
30	0.14	2.91	0.84	0.03	60	0.13	2.56	0.92	0.03					
31	0.14	2.87	0.83	0.03	61	0.13	2.62	0.94	0.04					
32	0.13	2.82	0.83	0.03	62	0.14	2.68	0.96	0.04					
33	0.13	2.78	0.82	0.03	63	0.14	2.73	0.98	0.04					
34	0.12	2.73	0.82	0.03	64	0.15	2.79	0.99	0.04					
					65	0.15	2.85	1.01	0.04					

Source: EMFAC2007 Version 2.3 (Nov 1, 2006), average annual emissions, statewide vehicle fleet, 50% humidity, temperature 75 degrees F.
 ROG includes running exhaust and running evaporative emissions. PM2.5 Ex includes running exhaust emissions only.

Table 5 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (2010+)

**BEFORE PROJECT Baseline Emission Factors
New Diesel Vehicles**

Vehicle Type	Gross Vehicle Weight Rating (lbs)	Model Year	Emission Factors (g/mi)	
			NOx	PM2.5*
Urban transit buses	> 33,000	2007-2009	4.8	0.037
		2010+	0.8	0.037
Transit buses, School buses and trucks	14,001 – 33,000	2007-2009	2.79	0.022
		2010+	0.51	0.022
Class 8 trucks	> 33,000	2007-2009	6.36	0.026
		2010+	1.06	0.026

Source: Carl Moyer Program Guidelines April 22 2008 Air Resources Board. Table B-4, Table B-5 and Table B-6.

Retrofit Diesel Vehicles

Vehicle Type	Gross Vehicle Weight Rating (lbs)	Model Year	Emission Factors (g/mi)	
			NOx	PM2.5*
Urban transit buses	> 33,000	1994-1997	18.60	0.18
		1998-2002	14.88	0.13
Transit buses, School buses and trucks	14,001 – 33,000	1994-1997	10.7	0.19
		1998-2002	9.77	0.13
Class 8 trucks	> 33,000	1994-1997	17.95	0.33
		1998-2002	17.58	0.37

Source: Carl Moyer Program Guidelines April 22 2008 Air Resources Board. Table B-4, Table B-5 and Table B-6.

AFTER PROJECT Emission Factors

New Cleaner Vehicle Purchases or Re-powers (Typically Alternative-Fueled Vehicles)

Vehicle Type	Gross Vehicle Weight Rating (lbs)	MY	Engine Certified Emission Rate (g/bhp-hr)		Conversion Factors+ (bhp-hr/mi)	Emission Factors (g/mi)	
			NOx	PM		NOx	PM2.5
Urban transit buses	> 33,000	<=200	1.2	0	4.0	4.8	0.037
		2010	0.2	0	4.0	0.8	0.037
Buses and trucks	14,001 – 33,000	<=200	1.2	0	1.8	2.1	0.018
		2010	0.2	0	1.8	0.4	0.018
Class 8 trucks	> 33,000	<=200	1.2	0	2.9	3.5	0.028
		2010	0.2	0	2.9	0.6	0.028

Source: Carl Moyer Program Guidelines April 22 2008 Air Resources Board. Table B-4, Table B-5 and Table B-6.

† Carl Moyer Program Guidelines April 22 2008 Air Resources Board. Table B-8.

*To convert to PM2.5, the PM10 emission rate is multiplied by a factor of 0.92.

Cleaner vehicles could be compressed natural gas (CNG), liquefied natural gas (LNG), or cleaner diesel with after-treatment technology to reduce NOx and PM. The “After Project” emission factors are based on typical CNG vehicles; however, after-treatment applied to CNG vehicles has been shown to reduce even more PM and also, formaldehyde.

If the project's NOx engine certification rate is not shown in the table, multiply the appropriate rate times the conversion factor corresponding to the vehicle class to get grams per mile. For refuse vehicles or retrofit projects, see Carl Moyer Program Guidelines for emission rates.

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**Table 6 Off-Road Emission Factors
for Cleaner Vehicle Projects (through 2010)**

Find the horsepower (hp) and model year for the engine that best describes the engine being replaced to determine the “before project” baseline emission factors. Find the hp and model year for the newer engine. These factors represent the “after project” cleaner engine emission factors.

		(g/hp-hr)	(g/hp-hr)	(g/hp-hr)	(g/hp-hr)	(g/hp-hr)
HP	Model Year	ROG	CO	NOX	PM	PM2.5
51 - 120	1987 or older	1.44	4.80	13.00	0.84	0.77
51 - 120	1988 - 1997	0.99	3.49	8.75	0.69	0.63
51 - 120	1998 - 2003	0.99	3.49	6.90	0.69	0.63
51 - 120	2004	0.46	3.23	5.64	0.39	0.36
51 - 120	2005	0.28	3.14	5.22	0.29	0.27
51 - 120	2006 - 2007	0.19	3.09	5.01	0.24	0.22
51 - 120	2008 - 2011	0.10	3.05	2.89	0.20	0.18
121 - 175	1969 or older	1.32	4.40	14.00	0.77	0.71
121 - 175	1970 - 1971	1.10	4.40	13.00	0.66	0.61
121 - 175	1972 - 1979	1.00	4.40	12.00	0.55	0.51
121 - 175	1980 - 1984	0.94	4.30	11.00	0.55	0.51
121 - 175	1985 - 1987	0.88	4.20	11.00	0.55	0.51
121 - 175	1988 - 1996	0.68	2.70	8.17	0.38	0.35
121 - 175	1997 - 2002	0.68	2.70	6.90	0.38	0.35
121 - 175	2003	0.33	2.70	5.26	0.24	0.22
121 - 175	2004	0.22	2.70	4.72	0.19	0.17
121 - 175	2005 - 2006	0.16	2.70	4.44	0.16	0.15
121 - 175	2007 - 2011	0.10	2.70	2.45	0.14	0.13
176 - 250	1969 or older	1.32	4.40	14.00	0.77	0.71
176 - 250	1970 - 1971	1.10	4.40	13.00	0.66	0.61
176 - 250	1972 - 1979	1.00	4.40	12.00	0.55	0.51
176 - 250	1980 - 1984	0.94	4.30	11.00	0.55	0.51
176 - 250	1985 - 1987	0.88	4.20	11.00	0.55	0.51
176 - 250	1988 - 1995	0.68	2.70	8.17	0.38	0.35
176 - 250	1996 - 2002	0.32	0.92	6.25	0.15	0.14
176 - 250	2003	0.19	0.92	5.00	0.12	0.11
176 - 250	2004	0.14	0.92	4.58	0.11	0.10
176 - 250	2005 - 2006	0.12	0.92	4.38	0.11	0.10
176 - 250	2007 - 2010	0.10	0.92	2.45	0.11	0.10

Table 6 (cont.)

HP	Model Year	(g/hp-hr)	(g/hp-hr)	(g/hp-hr)	(g/hp-hr)	(g/hp-hr)
		ROG	CO	NOX	PM	PM2.5
251 - 500	1969 or older	1.26	4.20	14.00	0.74	0.68
251 - 500	1970 - 1971	1.05	4.20	13.00	0.63	0.58
251 - 500	1972 - 1979	0.95	4.20	12.00	0.53	0.49
251 - 500	1980 - 1984	0.90	4.20	11.00	0.53	0.49
251 - 500	1985 - 1987	0.84	4.10	11.00	0.53	0.49
251 - 500	1988 - 1995	0.68	2.70	8.17	0.38	0.35
251 - 500	1996 - 2000	0.32	0.92	6.25	0.15	0.14
251 - 500	2001	0.19	0.92	4.95	0.12	0.11
251 - 500	2002	0.14	0.92	4.51	0.11	0.10
251 - 500	2003 - 2004	0.12	0.92	4.29	0.11	0.10
251 - 500	2005	0.10	0.92	4.00	0.11	0.10
251 - 500	2006 - 2010	0.10	0.92	2.45	0.11	0.10
501 - 750	1969 or older	1.26	4.20	14.00	0.74	0.68
501 - 750	1970 - 1971	1.05	4.20	13.00	0.63	0.58
501 - 750	1972 - 1979	0.95	4.20	12.00	0.53	0.49
501 - 750	1980 - 1984	0.90	4.20	11.00	0.53	0.49
501 - 750	1985 - 1987	0.84	4.10	11.00	0.53	0.49
501 - 750	1988 - 1995	0.68	2.70	8.17	0.38	0.35
501 - 750	1996 - 2001	0.32	0.92	6.25	0.15	0.14
501 - 750	2002	0.19	0.92	4.95	0.12	0.11
501 - 750	2003	0.14	0.92	4.51	0.11	0.10
501 - 750	2004 - 2005	0.12	0.92	4.29	0.11	0.10
501 - 750	2006 - 2010	0.10	0.92	2.45	0.11	0.10
> 750	1969 or older	1.26	4.20	14.00	0.74	0.68
> 750	1970 - 1971	1.05	4.20	13.00	0.63	0.58
> 750	1972 - 1979	0.95	4.20	12.00	0.53	0.49
> 750	1980 - 1984	0.90	4.20	11.00	0.53	0.49
> 750	1985 - 1987	0.84	4.10	11.00	0.53	0.49
> 750	1988 - 1999	0.68	2.70	8.17	0.38	0.35
> 750	2000 - 2005	0.32	0.92	6.25	0.15	0.14
> 750	2006	0.19	0.92	4.95	0.12	0.11
> 750	2007	0.14	0.92	4.51	0.11	0.10
> 750	2008 - 2009	0.12	0.92	4.29	0.11	0.10
> 750	2010	0.10	0.92	4.08	0.11	0.10

Source: Air Resources Board Technical Memo 'Addition of Tier 4 Emission Factors to Off-road Large Compression-Ignited Engines (>25 hp).' Appendix B, pages 6-7 titled 'OFFROAD Model Diesel Emission Factors (g/hp-hr) Highlighting the Tier 4 Standards.' (July 24, 2006)

Other information needed to estimate emissions are operating hours and load factor. Operating hours for construction equipment can range from 535 to 1641 hours per year and the load factor can vary between 0.43 and 0.78. Operating hours for agricultural equipment can range from 90 to 790 hours per year and the load factor can vary between 0.43 to 0.70.

**Table 7 Medium-Duty Vehicle Emission Factors
For Vanpool and Shuttle Evaluations
(Model Years 1995 - 2003)**

Low-emission medium-duty vehicle (LEV) emission factors in grams per mile					
Weight (lbs.)*	ROG	NOx	PM2.5		CO
			Exhaust	Total**	
5751-8500	0.24	0.77	0.110	0.146	6.34
8501-10,000	0.29	0.88	0.110	0.146	7.02
10,001-14,000	0.38	1.29	0.110	0.146	8.93

Ultra low-emission medium-duty vehicle (ULEV) emission factors in grams per mile					
Weight (lbs.)*	ROG	NOx	PM2.5		CO
			Exhaust	Total**	
5751-8500	0.15	0.77	0.055	0.090	6.34
8501-10,000	0.17	0.88	0.055	0.090	7.02
10,001-14,000	0.23	1.29	0.055	0.090	8.93

Super ultra low-emission medium-duty vehicle (SULEV) emission factors in grams per mile					
Weight (lbs.)*	ROG	NOx	PM2.5		CO
			Exhaust	Total**	
5751-8500	0.07	0.39	0.055	0.090	3.20
8501-10,000	0.09	0.44	0.055	0.090	3.56
10,001-14,000	0.11	0.62	0.055	0.090	4.49

Zero-emission medium-duty vehicle (ZEV) emission factors in grams per mile					
Weight (lbs.)*	ROG	NOx	PM2.5		CO
			Exhaust	Total**	
All weights	0	0	0	0.035	0

If vanpool/shuttle project is using 2004+ model year vehicles, refer to Table 2.

Source: Based on California Vehicle Exhaust Standards ("LEV I"), January 1999. (LEV II went into effect in 2004.) Factors represent a weighted average of emission standards over a 120,000-mile life; the first 50,000 miles are assessed at the 50,000-mile standard, and the remaining 70,000 miles are assessed at the 120,000-mile standard.

*Gross vehicle weights can be associated with passenger capacity as follows: 5751-8500, roughly 8 passengers; 8501-10,000, roughly 10-15 passengers; 10,001-14,000, roughly 20 passengers or more.

** Total PM2.5 factors include motor vehicle exhaust, tire wear (0.002 g/m for all), brake wear (0.005 g/m for all), and entrained road dust (0.028 g/m for all). The PM exhaust factors are based on total PM standards which were multiplied by a factor of 0.92 to convert to PM2.5 (Source: http://www.arb.ca.gov/msei/onroad/downloads/tsd/TotalPM_Emfac00.pdf); tire wear and brake wear factors are based on EMFAC2007, version 2.3 (Nov 1, 2006). The road dust portion of the PM10 factor is based on U.S. EPA's Compilation of Air Pollutant Emission Factors (AP-42, January 1995). Silt loading and vehicle weight data used as inputs to EPA's equation are from Improvement of Specific Emission Factors (BACM Project No. 1), Final Report, Midwest Research Institute, March 1996. Vehicle trip reductions may have little, if any, effect on road dust emissions from high volume facilities thought to be in equilibrium, i.e., the dust is fully entrained due to the heavy traffic. The road dust PM10 factor, however, may be multiplied times total VMT reductions as it has been scaled down to reflect emissions from lower-volume local and collector roads only.