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

Emission Factor Tables
March 2010

California Air Resources Board

Table 1 Diesel Bus Emission Factors

(through Model Year 2010)

Pollutant	Model Year	Emission Factor (g/mi) Average	45 MPH
ROG	Entire Fleet	0.73	0.43
	1973-83	0.83	0.49
	1984-90	0.85	0.49
	1991-93	0.80	0.48
	1994-95	0.87	0.48
	1996-2001	0.81	0.47
	2002	0.86	0.47
	2003 - 2006	0.25	0.14
	2007 - 2009	0.03	0.02
	2010	0.03	0.02
CO	Entire Fleet	3.74	1.97
	1973-83	6.48	3.43
	1984-90	6.03	3.18
	1991-93	3.48	1.83
	1994-95	2.27	1.23
	1996-2001	1.83	0.96
	2002	1.87	0.96
	2003 - 2006	1.31	0.70
	2007 - 2009	1.04	0.55
	2010	0.99	0.53
NOx	Entire Fleet	19.35	17.32
	1973-83	28.73	25.77
	1984-90	26.21	23.43
	1991-93	15.93	14.22
	1994-95	18.51	16.65
	1996-2001	18.40	16.48
	2002	12.68	11.38
	2003 - 2006	4.60	4.13
	2007 - 2009	0.59	0.53
	2010	0.56	0.51
PM10 - Exhaust	Entire Fleet	0.33	0.19
	1973-83	0.39	0.24
	1984-90	0.39	0.23
	1991-93	0.40	0.22
	1994-95	0.52	0.27
	1996-2001	0.35	0.21
	2002	0.14	0.11
	2003 - 2006	0.06	0.02
	2007 - 2009	0.04	0.02
	2010	0.03	0.02
PM10 - Tire Wear	All Years	0.008	Not Speed Dependent
PM10 - Brake Wear	All Years	0.013	Not Speed Dependent
PM10 - Road Dust	All Years	0.184	Not Speed Dependent

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.

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).

Table 2 Cleaner Vehicles Emission Factors (2004 - 2008)
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**	**PM10[2]**		**CO**
			Exhaust	Total[3]	
Up to 8500	0.08	0.06	0.01	0.21	3.87
8501-10,000	0.20	0.20	0.12	0.32	6.40
10,001-14,000	0.23	0.40	0.12	0.32	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**	**PM10**		**CO**
			Exhaust	Total	
Up to 8500	0.05	0.06	0.01	0.21	1.93
8501-10,000	0.14	0.20	0.06	0.26	6.40
10,001-14,000	0.17	0.40	0.06	0.26	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**	**PM10**		**CO**
			Exhaust	Total	
Up to 8500	0.01	0.02	0.01	0.21	1.00
8501-10,000	0.10	0.10	0.06	0.26	3.20
10,001-14,000	0.12	0.20	0.06	0.26	3.70

Zero-emission light-duty and medium-duty vehicle (ZEV) emission factors in grams per mile					
Weight (lbs.)	**ROG**	**NOx**	**PM10**		**CO**
			Exhaust	Total	
All weights	0	0	0	0.20	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 with 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. 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.

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[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] PM10 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 PM10.

[3] Total PM10 factors include motor vehicle exhaust, tire wear (0.008 g/m), brake wear (0.013 g/m), and entrained road dust (0.184 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
PM10				
VMT (g/mile)	0.221	0.221	0.221	0.222
running exhaust only (g/mile)	0.016	0.017	0.017	0.017
tire and brake wear (g/mile)	0.020	0.020	0.020	0.020
road dust (g/mile)	0.184	0.184	0.184	0.184
commute trip ends (g/trip end)	0.016	0.017	0.017	0.017
average trip ends (g/trip end)	0.009	0.009	0.009	0.009
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.

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).

March 2010

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
PM10			
VMT (g/mile)	0.220	0.220	0.221
running exhaust only (g/mile)	0.016	0.016	0.016
tire and brake wear (g/mile)	0.020	0.020	0.020
road dust (g/mile)	0.184	0.184	0.184
commute trip ends (g/trip end)	0.015	0.016	0.016
average trip ends (g/trip end)	0.008	0.008	0.009
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.

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)

				Grams per Mile					
Speed (mph)	**ROG**	**CO**	**NOx**	**PM10 Ex**	***Speed (mph)***	**ROG**	**CO**	**NOx**	**PM10 Ex**
5	**1.0269**	**7.3166**	**2.2034**	**0.1834**	**35**	**0.1477**	**3.2218**	**1.0006**	**0.0364**
6	0.9481	7.0451	2.0910	0.1716	36	0.1448	3.1839	0.9988	0.0358
7	0.8692	6.7736	1.9787	0.1598	37	0.1419	3.1460	0.9970	0.0352
8	0.7903	6.5022	1.8663	0.1480	38	0.1390	3.1080	0.9952	0.0346
9	0.7114	6.2307	1.7540	0.1362	39	0.1360	3.0701	0.9934	0.0340
10	**0.6326**	**5.9592**	**1.6416**	**0.1244**	**40**	**0.1331**	**3.0322**	**0.9916**	**0.0334**
11	0.5842	5.7683	1.5708	0.1164	41	0.1319	3.0092	0.9931	0.0333
12	0.5357	5.5774	1.4999	0.1085	42	0.1307	2.9862	0.9946	0.0332
13	0.4873	5.3864	1.4291	0.1005	43	0.1294	2.9632	0.9960	0.0330
14	0.4389	5.1955	1.3582	0.0926	44	0.1282	2.9402	0.9975	0.0329
15	**0.3905**	**5.0046**	**1.2874**	**0.0846**	**45**	**0.1270**	**2.9172**	**0.9990**	**0.0328**
16	0.3655	4.8691	1.2559	0.0799	46	0.1273	2.9102	1.0041	0.0330
17	0.3404	4.7336	1.2244	0.0752	47	0.1276	2.9032	1.0092	0.0332
18	0.3154	4.5982	1.1930	0.0706	48	0.1279	2.8962	1.0144	0.0334
19	0.2903	4.4627	1.1615	0.0659	49	0.1282	2.8892	1.0195	0.0336
20	**0.2653**	**4.3272**	**1.1300**	**0.0612**	**50**	**0.1285**	**2.8822**	**1.0246**	**0.0338**
21	0.2541	4.2319	1.1176	0.0588	51	0.1303	2.8942	1.0337	0.0344
22	0.2429	4.1366	1.1053	0.0565	52	0.1321	2.9063	1.0428	0.0349
23	0.2318	4.0412	1.0929	0.0541	53	0.1339	2.9183	1.0518	0.0355
24	0.2206	3.9459	1.0806	0.0518	54	0.1357	2.9304	1.0609	0.0360
25	**0.2094**	**3.8506**	**1.0682**	**0.0494**	**55**	**0.1375**	**2.9424**	**1.0700**	**0.0366**
26	0.2020	3.7786	1.0598	0.0478	56	0.1412	2.9802	1.0841	0.0376
27	0.1945	3.7065	1.0513	0.0463	57	0.1449	3.0180	1.0982	0.0386
28	0.1870	3.6345	1.0429	0.0447	58	0.1486	3.0558	1.1122	0.0396
29	0.1795	3.5624	1.0344	0.0432	59	0.1523	3.0936	1.1263	0.0406
30	**0.1721**	**3.4904**	**1.0260**	**0.0416**	**60**	**0.1560**	**3.1314**	**1.1404**	**0.0416**
31	0.1672	3.4367	1.0209	0.0406	61	0.1621	3.2069	1.1611	0.0430
32	0.1623	3.3830	1.0158	0.0395	62	0.1681	3.2824	1.1818	0.0444
33	0.1574	3.3292	1.0108	0.0385	63	0.1741	3.3580	1.2024	0.0458
34	0.1526	3.2755	1.0057	0.0374	64	0.1801	3.4335	1.2231	0.0472
					65	**0.1862**	**3.5090**	**1.2438**	**0.0486**

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. PM10 Ex includes running exhaust emissions only.

Table 4 Emission Factors by Speed (Continued)

Project Life 6-10 years (2008-2017)

				Grams per Mile					
Speed					***Speed***				
(mph)	**ROG**	**CO**	**NOx**	**PM10 Ex**	***(mph)***	**ROG**	**CO**	**NOx**	**PM10 Ex**
5	**0.8418**	**6.0025**	**1.8050**	**0.1599**	**35**	**0.1207**	**2.6905**	**0.8138**	**0.0321**
6	0.7766	5.7842	1.7144	0.1496	36	0.1184	2.6585	0.8119	0.0316
7	0.7114	5.5659	1.6239	0.1393	37	0.1160	2.6266	0.8100	0.0312
8	0.6462	5.3475	1.5333	0.1289	38	0.1137	2.5946	0.8081	0.0307
9	0.5809	5.1292	1.4428	0.1186	39	0.1114	2.5627	0.8062	0.0303
10	**0.5157**	**4.9109**	**1.3522**	**0.1083**	**40**	**0.1090**	**2.5307**	**0.8043**	**0.0298**
11	0.4759	4.7565	1.2944	0.1015	41	0.1080	2.5105	0.8052	0.0297
12	0.4362	4.6021	1.2367	0.0946	42	0.1070	2.4902	0.8060	0.0295
13	0.3964	4.4476	1.1789	0.0878	43	0.1059	2.4700	0.8069	0.0294
14	0.3566	4.2932	1.1212	0.0809	44	0.1049	2.4497	0.8077	0.0292
15	**0.3168**	**4.1388**	**1.0634**	**0.0741**	**45**	**0.1039**	**2.4295**	**0.8086**	**0.0291**
16	0.2965	4.0294	1.0367	0.0701	46	0.1042	2.4218	0.8126	0.0293
17	0.2762	3.9200	1.0100	0.0660	47	0.1044	2.4141	0.8166	0.0295
18	0.2560	3.8105	0.9834	0.0620	48	0.1047	2.4065	0.8206	0.0297
19	0.2357	3.7011	0.9567	0.0579	49	0.1049	2.3988	0.8246	0.0299
20	**0.2154**	**3.5917**	**0.9300**	**0.0539**	**50**	**0.1052**	**2.3911**	**0.8286**	**0.0301**
21	0.2064	3.5147	0.9191	0.0518	51	0.1067	2.3984	0.8360	0.0306
22	0.1974	3.4377	0.9082	0.0497	52	0.1081	2.4056	0.8434	0.0311
23	0.1885	3.3607	0.8972	0.0477	53	0.1096	2.4129	0.8508	0.0317
24	0.1795	3.2837	0.8863	0.0456	54	0.1110	2.4201	0.8582	0.0322
25	**0.1705**	**3.2067**	**0.8754**	**0.0435**	**55**	**0.1125**	**2.4274**	**0.8656**	**0.0327**
26	0.1645	3.1479	0.8678	0.0421	56	0.1155	2.4547	0.8772	0.0336
27	0.1585	3.0891	0.8602	0.0407	57	0.1185	2.4820	0.8889	0.0344
28	0.1524	3.0302	0.8526	0.0394	58	0.1215	2.5092	0.9005	0.0353
29	0.1464	2.9714	0.8450	0.0380	59	0.1245	2.5365	0.9122	0.0361
30	**0.1404**	**2.9126**	**0.8374**	**0.0366**	**60**	**0.1275**	**2.5638**	**0.9238**	**0.0370**
31	0.1365	2.8682	0.8327	0.0357	61	0.1325	2.6205	0.9411	0.0383
32	0.1325	2.8238	0.8280	0.0348	62	0.1374	2.6772	0.9584	0.0395
33	0.1286	2.7793	0.8232	0.0339	63	0.1424	2.7339	0.9756	0.0408
34	0.1247	2.7349	0.8185	0.0330	64	0.1473	2.7906	0.9929	0.0420
					65	**0.1523**	**2.8473**	**1.0102**	**0.0433**

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. PM10 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	PM10
Urban transit buses	> 33,000	2007-2009	**4.8**	**0.04**
		2010+	**0.8**	**0.04**
Transit buses, School buses, and trucks	14,001 – 33,000	2007-2009	**2.79**	**0.024**
		2010+	**0.51**	**0.024**
Class 8 trucks	> 33,000	2007-2009	**6.36**	**0.028**
		2010+	**1.06**	**0.028**

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	PM10
Urban transit buses	> 33,000	1994-1997	**18.60**	**0.2**
		1998-2002	**14.88**	**0.144**
Transit buses, School buses, and trucks	14,001 – 33,000	1994-1997	**10.7**	**0.216**
		1998-2002	**9.77**	**0.144**
Class 8 trucks	> 33,000	1994-1997	**17.95**	**0.367**
		1998-2002	**17.58**	**0.403**

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 (lb	MY	Engine Certificatior Emission Rates (g/bhp-hr) NOx	PM10	Conversion Factors+ (bhp-hr/mi)	Emission Factors (g/mi) NOx	PM10
Urban transit buses	> 33,000	<=2009	1.2	0.01	4.0	**4.8**	**0.04**
		2010+	0.2	0.01	4.0	**0.8**	**0.04**
Buses and trucks	14,001 – 33,000	<=2009	1.2	0.01	1.8	**2.1**	**0.018**
		2010+	0.2	0.01	1.8	**0.4**	**0.018**
Class 8 trucks	> 33,000	<=2009	1.2	0.01	2.9	**3.5**	**0.029**
		2010+	0.2	0.01	2.9	**0.6**	**0.029**

Source: Carl Moyer Program Guidelines April 22 2008 Air Resources Board. Table B-4, Table B-5, Table B-6 and Table B-8.

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.

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.

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

Table 6 (cont.)

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

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**	**PM10**		**CO**
			Exhaust	Total**	
5751-8500	0.24	0.77	0.110	0.33	6.34
8501-10,000	0.29	0.88	0.110	0.33	7.02
10,001-14,000	0.38	1.29	0.110	0.33	8.93

Ultra low-emission medium-duty vehicle (ULEV) emission factors in grams per mile					
Weight (lbs.)*	**ROG**	**NOx**	**PM10**		**CO**
			Exhaust	Total**	
5751-8500	0.15	0.77	0.055	0.27	6.34
8501-10,000	0.17	0.88	0.055	0.27	7.02
10,001-14,000	0.23	1.29	0.055	0.27	8.93

Super ultra low-emission medium-duty vehicle (SULEV) emission factors in grams per mile					
Weight (lbs.)*	**ROG**	**NOx**	**PM10**		**CO**
			Exhaust	Total**	
5751-8500	0.07	0.39	0.055	0.27	3.20
8501-10,000	0.09	0.44	0.055	0.27	3.56
10,001-14,000	0.11	0.62	0.055	0.27	4.49

Zero-emission medium-duty vehicle (ZEV) emission factors in grams per mile					
Weight (lbs.)*	**ROG**	**NOx**	**PM10**		**CO**
			Exhaust	Total**	
All weights	0	0	0	0.21	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 PM10 factors include motor vehicle exhaust, tire wear (0.009 g/m for all), brake wear (0.013 g/m for all), and entrained road dust (0.184 g/m for all). The PM exhaust factors are based on total PM standards; 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.

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