



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
September 2025*

Contents

Preface3

Table 1A. Before Project - Diesel Bus Emission Factors4

Table 1B. After Project - Natural Gas Bus Emission Factors.....5

Table 1C. After Project - Electric Bus Emission Factors.....6

Table 2 Emission Factors for Cleaner Vehicles for Light-Duty and Medium-Duty Trucks/SUVs (Chassis-Certified).....7

Table 3A. Average Auto Emission Factors - Gasoline9

Table 3B. Average Auto Emission Factors - Electric10

Table 3C. Average Auto Emission Factors - Gasoline11

Table 3D. Average Auto Emission Factors - Electric12

Table 4A. Emission Factors (grams per mile) by Speed (mph) - Aggregated13

Table 4B. Emission Factors (grams per mile) by Speed (mph) - Aggregated15

Table 5A. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Gasoline.....17

Table 5A. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Gasoline (Continued)18

Table 5A. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Gasoline (Continued)19

Table 5B. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Diesel20

Table 5B. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Diesel (Continued)21

Table 5B. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Diesel (Continued)22

Table 5C. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Natural Gas.....23

Table 5C. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) -Natural Gas (Continued)24

Table 5C. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Natural Gas (Continued)25

Off-Road Emission Factors for Cleaner Vehicle Projects.....26

Preface

This document contains updated emission factors to be used with the "Methods to Find the Cost-Effectiveness of Funding Air Quality Projects" document published in May 2005 (the Methods document). The emission factors below are the latest available as of the publication date. In most cases, it is based on the California Air Resources Board's on-road emission factor model EMFAC, or in the case of off-road emissions data, the Board's emission rate model OFFROAD.

Please note that even though the emission factors have changed since the original publication of the Methods document, the actual methods to apply the rates in that document remain valid.

Summary of Changes

Table 1	Updated emission rates to reflect EMFAC2021 for Calendar Year 2024.
Table 3	Updated emission rates to reflect EMFAC2021 for Calendar Year 2024.
Table 4	Updated emission rates to reflect EMFAC2021 for Calendar Year 2024.
Table 5	Updated emission rates to reflect EMFAC2021 for Calendar Year 2024.

Table 1A. Before Project - Diesel Bus Emission Factors
(Through Model Year 2024)

Pollutant	Calendar Year	Model Year	Emission Factor (gram/mile) Average	Emission Factor (gram/mile) 45 MPH
ROG	2024	Entire Fleet	0.067	0.055
	2024	2007 - 2011	0.070	0.060
	2024	2012 - 2016	0.070	0.057
	2024	2017 - 2021	0.066	0.056
	2024	2022 - 2024	0.057	0.052
CO	2024	Entire Fleet	0.077	0.066
	2024	2007 - 2011	0.080	0.069
	2024	2012 - 2016	0.081	0.070
	2024	2017 - 2021	0.076	0.069
	2024	2022 - 2024	0.061	0.059
NOx	2024	Entire Fleet	0.377	0.339
	2024	2007 - 2011	0.393	0.382
	2024	2012 - 2016	0.407	0.363
	2024	2017 - 2021	0.360	0.339
	2024	2022 - 2024	0.291	0.302
PM2.5 - Exhaust¹	2024	Entire Fleet	0.007	0.023
	2024	2007 - 2011	0.007	0.023
	2024	2012 - 2016	0.007	0.023
	2024	2017 - 2021	0.007	0.023
	2024	2022 - 2024	0.005	0.022
PM2.5 - Tire Wear	All Years	All Years	0.008	Not Speed Dependent
PM2.5 - Brake Wear	All Years	All Years	0.038	Not Speed Dependent
PM2.5 - Road Dust²	All Years	All Years	0.028	Not Speed Dependent

Source: EMFAC2021 V1.0.2, average annual emissions, statewide vehicle fleet, 50% humidity, temperature 75 °F.

[PM2.5 = 0.15*PM10]

¹ Statewide average annual PM2.5 emission factor, weighted by VMT per road category.

² The PM2.5 road dust emission factor was calculated using *US EPA's Compilation of Air Pollutant Emission Factors, Vol. 5 (AP-42, Chapter 13.2.1, Jan. 2011)*, and *ARB's Miscellaneous Process Methodology 7.9, Entrained Paved Road Travel, Paved Road Dust (updated Jan. 2013)*.

Table 1B. After Project – Natural Gas Bus Emission Factors
(Through Model Year 2024)

Pollutant	Calendar Year	Model Year	Emission Factor (gram/mile) Average	Emission Factor (gram/mile) 45 MPH
ROG	2024	Entire Fleet	0.041	0.036
	2024	2007 - 2011	0.023	0.017
	2024	2012 - 2016	0.025	0.020
	2024	2017 - 2021	0.055	0.046
	2024	2022 - 2024	0.062	0.047
CO	2024	Entire Fleet	37.936	26.287
	2024	2007 - 2011	27.525	17.565
	2024	2012 - 2016	30.481	16.684
	2024	2017 - 2021	44.256	30.645
	2024	2022 - 2024	49.749	33.986
NOx	2024	Entire Fleet	0.480	0.281
	2024	2007 - 2011	0.708	0.510
	2024	2012 - 2016	0.786	0.523
	2024	2017 - 2021	0.171	0.166
	2024	2022 - 2024	0.108	0.090
PM2.5 - Exhaust³	2024	Entire Fleet	0.000	0.020
	2024	2007 - 2011	0.000	0.019
	2024	2012 - 2016	0.000	0.019
	2024	2017 - 2021	0.001	0.020
	2024	2022 - 2024	0.000	0.019
PM2.5 - Tire Wear	All Years	All Years	0.008	Not Speed Dependent
PM2.5 - Brake Wear	All Years	All Years	0.038	Not Speed Dependent
PM2.5 - Road Dust⁴	All Years	All Years	0.028	Not Speed Dependent

Source: EMFAC2021 V1.0.2, average annual emissions, statewide vehicle fleet, 50% humidity, temperature 75 °F.

[PM2.5 = 0.15*PM10]

³ Statewide average annual PM2.5 emission factor, weighted by VMT per road category.

⁴ The PM2.5 road dust emission factor was calculated using *US EPA's Compilation of Air Pollutant Emission Factors, Vol. 5 (AP-42, Chapter 13.2.1, Jan. 2011)*, and *ARB's Miscellaneous Process Methodology 7.9, Entrained Paved Road Travel, Paved Road Dust (updated Jan. 2013)*.

Table 1C. After Project – Electric Bus Emission Factors
(Through Model Year 2024)⁵

Pollutant	Calendar Year	Model Year	Emission Factor (gram/mile) Average	Emission Factor (gram/mile) 45 MPH
PM2.5 – Tire Wear	All Years	All Years	0.008	Not Speed Dependent
PM2.5 – Brake Wear	All Years	All Years	0.019	Not Speed Dependent
PM2.5 – Road Dust**⁶	All Years	All Years	0.028	Not Speed Dependent

Source: EMFAC2021 V1.0.2, average annual emissions, statewide vehicle fleet, 50% humidity, temperature 75 °F.

[PM2.5 = 0.15*PM10]

⁵ All-electric vehicles and PHEVs running only on electricity have zero tailpipe emissions.

⁶ The PM2.5 road dust emission factor was calculated using *US EPA's Compilation of Air Pollutant Emission Factors, Vol. 5 (AP-42, Chapter 13.2.1, Jan. 2011)*, and *ARB's Miscellaneous Process Methodology 7.9, Entrained Paved Road Travel, Paved Road Dust (updated Jan. 2013)*.

Table 2 Emission Factors for Cleaner Vehicles for Light-Duty and Medium-Duty Trucks/SUVs (Chassis-Certified)

Baseline (Older) Technology Vehicles

Average New Truck in 2010 (note: emission factor units are grams/mile and weight units are pound)

Weight⁷	ROG	NOx	PM2.5 Exhaust	PM2.5 Total⁸	CO
Up to 8,500	0.051	0.060	0.010	0.056	2.1
8,501-10,000	0.148	0.195	0.068	0.132	6.2
10,001-14,000	0.173	0.390	0.068	0.137	7.1

Replacement (Newer) Technology Cleaner Vehicles

Projected Average New Trucks in 2020 (note: emission factor units are grams per mile)

Weight⁷	ROG	NOx	PM2.5 Exhaust	PM2.5 Total⁸	CO
Up to 8,500	0.043	0.054	0.003	0.049	1.8
8,501-10,000	0.104	0.149	0.008	0.072	5.7
10,001-14,000	0.155	0.245	0.010	0.079	6.4

Replacement (Newer) Technology Cleaner Vehicles

Zero-emission light-duty and medium-duty vehicles (ZEV) (note: emission factor units are grams per mile)

Weight⁷	ROG	NOx	PM2.5 Exhaust	PM2.5 Total⁸	CO
Up to 8,500	0	0	0	0.046	0
8,501-10,000	0	0	0	0.064	0
10,001-14,000	0	0	0	0.069	0

See notes on next page.

⁷ Gross vehicle weights can be associated with payload capacity as follows: 5751-8500 lb, roughly 1-ton payload; 8501-10,000 lb, roughly 1.8-ton payload; 10,001-14,000 lb, 2.5-ton payload.

⁸ Total PM2.5 factors include motor vehicle exhaust, tire wear, brake wear, and entrained road dust.

Sources:

The baseline is California Vehicle Exhaust Standards ("LEV II") for average chassis-certified trucks for model year 2010. Factors assume emissions at the 50,000 mile standard for the first 50,000 miles of the car's life (assumed to be 120,000 miles) and emissions at the 120,000 mile standard for the last 70,000 miles of the car's life.

Cleaner Vehicle Emission Factors are from the California Vehicle Exhaust Standards for MYs after 2016 ("LEV III") evaluated for calendar year 2020.

The road dust portion of the PM_{2.5} emission factor was calculated from equation 1 of Chapter 13.2.1.3 of *AP-42 Compilation of Air Pollutant Emission Factors Vol 5*. US EPA Jan 1995. The equation's silt loading and other parameters came from Improvement of Specific Emission Factors (BACM Project No 1) provided by the Midwest Research Institute, 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. However, the road dust PM factor may be multiplied by the total VMT reductions as it has been scaled down to reflect emissions from lower-volume local and collector roads only. The brake wear emission factors came from a review of recent non-asbestos brake emissions (Section 9 of the EMFAC2011 Technical Documentation).

Table 3A. Average Auto Emission Factors - Gasoline

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

Analysis Period or Project Life	1-5 Years (2023- 2027)	6-10 Years (2023- 2032)	11-15 Years (2023- 2037)	16-20 Years (2023- 2042)
ROG				
VMT (g/mile)	0.055	0.050	0.047	0.044
commute trip ends (g/trip end)	0.570	0.499	0.445	0.404
average trip ends (g/trip end)	0.524	0.463	0.416	0.380
NOx				
VMT (g/mile)	0.066	0.055	0.047	0.042
commute trip ends (g/trip end)	0.273	0.243	0.224	0.211
average trip ends (g/trip end)	0.304	0.272	0.252	0.238
PM_{2.5}				
VMT (g/mile)	0.034	0.034	0.034	0.033
running exhaust only (g/mile)	0.001	0.001	0.001	0.001
tire and brake wear (g/mile)	0.005	0.005	0.005	0.005
road dust (g/mile)	0.028	0.028	0.028	0.028
commute trip ends (g/trip end)	0.003	0.003	0.003	0.002
average trip ends (g/trip end)	0.002	0.002	0.002	0.001
CO				
VMT (g/mile)	0.929	0.831	0.769	0.728
commute trip ends (g/trip end)	4.036	3.552	3.205	2.949
average trip ends (g/trip end)	3.505	3.128	2.855	2.654

Source: EMFAC2021 V1.0.2, average annual emissions, statewide vehicle fleet, 50% humidity, temperature 75 °F.

PM_{2.5}, road dust: statewide average annual PM_{2.5} emission factor is based on *US EPA's Compilation of Air Pollutant Emission Factors, Vol. 5 (AP-42, Chapter 13.2.1, Jan. 2011)*, and *CARB's Miscellaneous Process Methodology 7.9, Entrained Paved Road Travel, Paved Road Dust* (updated Nov. 2016).

[PM_{2.5} = 0.15*PM₁₀]

Table 3B. Average Auto Emission Factors – Electric

(Fleet of Light-Duty Passenger Vehicles, Light-Duty Trucks, and Motorcycles)⁹

Analysis Period or Project Life	1-5 Years (2023-2027)	6-10 Years (2023-2032)	11-15 Years (2023-2037)	16-20 Years (2023-2042)
PM_{2.5}				
VTM (g/mile)	0.031	0.031	0.031	0.031
running exhaust only (g/mile)	0.000	0.000	0.000	0.000
tire and brake wear (g/mile)	0.004	0.004	0.004	0.004
road dust (g/mile)	0.028	0.028	0.028	0.028

Source: EMFAC2021 V1.0.2, average annual emissions, statewide vehicle fleet, 50% humidity, temperature 75 °F.

PM_{2.5}, road dust: statewide average annual PM_{2.5} emission factor is based on *US EPA's Compilation of Air Pollutant Emission Factors, Vol. 5 (AP-42, Chapter 13.2.1, Jan. 2011)*, and *CARB's Miscellaneous Process Methodology 7.9, Entrained Paved Road Travel, Paved Road Dust* (updated Nov. 2016).

⁹ All-electric vehicles and PHEVs running only on electricity have zero tailpipe emissions.

Table 3C. Average Auto Emission Factors - Gasoline

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

Analysis Period or Project Life	1 Year 2023	1 Year 2024	1 Year 2025
ROG			
VTM (g/mile)	0.060	0.057	0.055
commute trip ends (g/trip end)	0.648	0.605	0.567
average trip ends (g/trip end)	0.587	0.553	0.521
NOx			
VTM (g/mile)	0.081	0.072	0.065
commute trip ends (g/trip end)	0.310	0.289	0.270
average trip ends (g/trip end)	0.342	0.321	0.302
PM_{2.5}			
VTM (g/mile)	0.034	0.034	0.034
running exhaust only (g/mile)	0.001	0.001	0.001
tire and brake wear (g/mile)	0.005	0.005	0.005
road dust (g/mile)	0.028	0.028	0.028
commute trip ends (g/trip end)	0.003	0.003	0.003
average trip ends (g/trip end)	0.002	0.002	0.002
CO			
VTM (g/mile)	1.053	0.980	0.919
commute trip ends (g/trip end)	4.589	4.282	4.003
average trip ends (g/trip end)	3.929	3.693	3.481

Source: EMFAC2021 V1.0.2, average annual emissions, statewide vehicle fleet, 50% humidity, temperature 75 °F.

PM_{2.5}, road dust: statewide average annual PM_{2.5} emission factor is based on *US EPA's Compilation of Air Pollutant Emission Factors, Vol. 5 (AP-42, Chapter 13.2.1, Jan. 2011)*, and *CARB's Miscellaneous Process Methodology 7.9, Entrained Paved Road Travel, Paved Road Dust* (updated Nov. 2016).

[PM_{2.5} = 0.15*PM₁₀]

Table 3D. Average Auto Emission Factors - Electric

(Fleet of Light-Duty Passenger Vehicles, Light-Duty Trucks, and Motorcycles)¹⁰

Analysis Period or Project Life	1 Year 2023	1 Year 2024	1 Year 2025
PM_{2.5}			
VMT (g/mile)	0.031	0.031	0.031
running exhaust only (g/mile)	0.000	0.000	0.000
tire and brake wear (g/mile)	0.004	0.004	0.004
road dust (g/mile)	0.028	0.028	0.028

Source: EMFAC2021 V1.0.2, average annual emissions, statewide vehicle fleet, 50% humidity, temperature 75 °F.

PM_{2.5}, road dust: statewide average annual PM_{2.5} emission factor is based on *US EPA's Compilation of Air Pollutant Emission Factors, Vol. 5 (AP-42, Chapter 13.2.1, Jan. 2011)*, and *CARB's Miscellaneous Process Methodology 7.9, Entrained Paved Road Travel, Paved Road Dust* (updated Nov. 2016).

[PM_{2.5} = 0.15*PM₁₀]

¹⁰ All-electric vehicles and PHEVs running only on electricity have zero tailpipe emissions.

Table 4A. Emission Factors (grams per mile) by Speed (mph) -
Aggregated

Project Life 1-5 years (2023-2027)

Speed	ROG ¹¹	CO	NOx	PM2.5 Ex ¹²	Speed	ROG	CO	NOx	PM2.5 Ex
5	0.1112	2.0468	0.5602	0.0096	48	0.0133	0.8716	0.1091	0.0018
6	0.1020	1.9895	0.5294	0.0089	49	0.0132	0.8604	0.1084	0.0018
7	0.0935	1.9339	0.5004	0.0082	50	0.0131	0.8493	0.1076	0.0018
8	0.0857	1.8797	0.4729	0.0076	51	0.0131	0.8396	0.1083	0.0019
9	0.0786	1.8271	0.4470	0.0070	52	0.0131	0.8300	0.1090	0.0019
10	0.0721	1.7760	0.4225	0.0065	53	0.0131	0.8206	0.1096	0.0019
11	0.0665	1.7289	0.3950	0.0060	54	0.0131	0.8112	0.1103	0.0020
12	0.0614	1.6832	0.3692	0.0056	55	0.0132	0.8020	0.1110	0.0020
13	0.0567	1.6386	0.3452	0.0052	56	0.0133	0.7944	0.1130	0.0021
14	0.0523	1.5952	0.3227	0.0049	57	0.0135	0.7869	0.1151	0.0021
15	0.0483	1.5530	0.3016	0.0045	58	0.0136	0.7794	0.1172	0.0022
16	0.0451	1.5188	0.2890	0.0042	59	0.0138	0.7721	0.1194	0.0023
17	0.0421	1.4854	0.2768	0.0040	60	0.0140	0.7648	0.1215	0.0023
18	0.0394	1.4528	0.2651	0.0037	61	0.0143	0.7591	0.1249	0.0024
19	0.0368	1.4208	0.2540	0.0035	62	0.0146	0.7535	0.1283	0.0025
20	0.0343	1.3895	0.2433	0.0033	63	0.0149	0.7479	0.1318	0.0026
21	0.0325	1.3623	0.2341	0.0031	64	0.0153	0.7424	0.1355	0.0027
22	0.0307	1.3356	0.2253	0.0030	65	0.0156	0.7369	0.1392	0.0027
23	0.0290	1.3094	0.2168	0.0028	66	0.0158	0.7353	0.1397	0.0028
24	0.0275	1.2838	0.2087	0.0027	67	0.0161	0.7337	0.1402	0.0028
25	0.0260	1.2586	0.2008	0.0025	68	0.0163	0.7320	0.1407	0.0028
26	0.0248	1.2358	0.1936	0.0024	69	0.0165	0.7304	0.1412	0.0028
27	0.0237	1.2135	0.1866	0.0024	70	0.0168	0.7288	0.1417	0.0029
28	0.0226	1.1915	0.1799	0.0023	71	0.0168	0.7288	0.1417	0.0029
29	0.0216	1.1699	0.1734	0.0022	72	0.0168	0.7288	0.1417	0.0029
30	0.0206	1.1488	0.1671	0.0021	73	0.0168	0.7288	0.1417	0.0029
31	0.0199	1.1294	0.1615	0.0020	74	0.0168	0.7288	0.1417	0.0029
32	0.0192	1.1103	0.1562	0.0020	75	0.0168	0.7288	0.1417	0.0029
33	0.0185	1.0916	0.1510	0.0019	76	0.0168	0.7288	0.1417	0.0029
34	0.0178	1.0732	0.1460	0.0019	77	0.0168	0.7288	0.1417	0.0029
35	0.0172	1.0550	0.1411	0.0018	78	0.0168	0.7288	0.1417	0.0029
36	0.0167	1.0385	0.1372	0.0018	79	0.0168	0.7288	0.1417	0.0029
37	0.0162	1.0222	0.1334	0.0018	80	0.0168	0.7288	0.1417	0.0029
38	0.0158	1.0061	0.1297	0.0018	81	0.0168	0.7288	0.1417	0.0029
39	0.0154	0.9903	0.1261	0.0017	82	0.0168	0.7288	0.1417	0.0029
40	0.0149	0.9747	0.1226	0.0017	83	0.0168	0.7288	0.1417	0.0029
41	0.0147	0.9606	0.1203	0.0017	84	0.0168	0.7288	0.1417	0.0029
42	0.0144	0.9467	0.1180	0.0017	85	0.0168	0.7288	0.1417	0.0029
43	0.0141	0.9330	0.1158	0.0017	86	0.0168	0.7289	0.1417	0.0029
44	0.0139	0.9194	0.1136	0.0017	87	0.0168	0.7289	0.1417	0.0029

¹¹ ROG includes running exhaust and running evaporative emissions.

¹² PM2.5 Ex includes running exhaust emissions only.

Speed	ROG ¹¹	CO	NOx	PM2.5 Ex ¹²		Speed	ROG	CO	NOx	PM2.5 Ex
45	0.0136	0.9061	0.1115	0.0017		88	0.0168	0.7289	0.1417	0.0029
46	0.0135	0.8945	0.1107	0.0017		89	0.0168	0.7289	0.1417	0.0029
47	0.0134	0.8829	0.1099	0.0018		90	0.0168	0.7289	0.1417	0.0029

Table 4B. Emission Factors (grams per mile) by Speed (mph) -
Aggregated

Project Life 6-10 years (2023-2032)

Speed	ROG ¹³	CO	NOx	PM2.5 Ex ¹⁴	Speed	ROG	CO	NOx	PM2.5 Ex
5	0.0938	1.8019	0.5305	0.0083	48	0.0111	0.7755	0.0921	0.0016
6	0.0859	1.7527	0.5002	0.0077	49	0.0110	0.7654	0.0913	0.0016
7	0.0787	1.7049	0.4717	0.0071	50	0.0109	0.7554	0.0905	0.0016
8	0.0722	1.6583	0.4447	0.0066	51	0.0109	0.7466	0.0911	0.0017
9	0.0661	1.6130	0.4194	0.0061	52	0.0109	0.7378	0.0916	0.0017
10	0.0606	1.5690	0.3954	0.0056	53	0.0109	0.7292	0.0922	0.0018
11	0.0559	1.5284	0.3685	0.0052	54	0.0110	0.7207	0.0928	0.0018
12	0.0516	1.4889	0.3433	0.0049	55	0.0110	0.7123	0.0934	0.0019
13	0.0476	1.4503	0.3199	0.0045	56	0.0111	0.7053	0.0953	0.0019
14	0.0439	1.4128	0.2981	0.0042	57	0.0112	0.6983	0.0972	0.0020
15	0.0405	1.3763	0.2778	0.0039	58	0.0114	0.6914	0.0992	0.0020
16	0.0378	1.3465	0.2655	0.0037	59	0.0115	0.6846	0.1012	0.0021
17	0.0353	1.3174	0.2538	0.0035	60	0.0116	0.6779	0.1032	0.0022
18	0.0330	1.2890	0.2427	0.0032	61	0.0119	0.6725	0.1063	0.0022
19	0.0308	1.2611	0.2320	0.0030	62	0.0122	0.6671	0.1096	0.0023
20	0.0288	1.2339	0.2217	0.0029	63	0.0124	0.6617	0.1129	0.0024
21	0.0272	1.2100	0.2129	0.0027	64	0.0127	0.6564	0.1163	0.0025
22	0.0257	1.1867	0.2045	0.0026	65	0.0130	0.6512	0.1198	0.0026
23	0.0243	1.1637	0.1963	0.0025	66	0.0132	0.6495	0.1202	0.0026
24	0.0230	1.1412	0.1885	0.0023	67	0.0134	0.6478	0.1206	0.0026
25	0.0218	1.1192	0.1810	0.0022	68	0.0136	0.6461	0.1211	0.0026
26	0.0208	1.0991	0.1740	0.0021	69	0.0137	0.6444	0.1215	0.0026
27	0.0198	1.0794	0.1673	0.0020	70	0.0139	0.6427	0.1219	0.0027
28	0.0190	1.0601	0.1608	0.0020	71	0.0139	0.6427	0.1219	0.0027
29	0.0181	1.0411	0.1546	0.0019	72	0.0139	0.6427	0.1219	0.0027
30	0.0173	1.0224	0.1486	0.0018	73	0.0139	0.6427	0.1219	0.0027
31	0.0167	1.0053	0.1432	0.0018	74	0.0139	0.6427	0.1219	0.0027
32	0.0161	0.9884	0.1380	0.0017	75	0.0139	0.6427	0.1219	0.0027
33	0.0155	0.9718	0.1329	0.0017	76	0.0139	0.6427	0.1219	0.0027
34	0.0149	0.9555	0.1281	0.0016	77	0.0139	0.6427	0.1219	0.0027
35	0.0144	0.9394	0.1234	0.0016	78	0.0139	0.6427	0.1219	0.0027
36	0.0140	0.9247	0.1196	0.0016	79	0.0139	0.6427	0.1219	0.0027
37	0.0136	0.9102	0.1159	0.0016	80	0.0139	0.6427	0.1219	0.0027
38	0.0132	0.8959	0.1123	0.0015	81	0.0139	0.6427	0.1219	0.0027
39	0.0129	0.8819	0.1088	0.0015	82	0.0139	0.6427	0.1219	0.0027
40	0.0125	0.8680	0.1055	0.0015	83	0.0139	0.6427	0.1219	0.0027
41	0.0123	0.8554	0.1032	0.0015	84	0.0139	0.6427	0.1219	0.0027
42	0.0120	0.8430	0.1009	0.0015	85	0.0139	0.6427	0.1219	0.0027
43	0.0118	0.8307	0.0987	0.0015	86	0.0139	0.6427	0.1219	0.0027
44	0.0116	0.8186	0.0966	0.0015	87	0.0139	0.6427	0.1219	0.0027

¹³ ROG includes running exhaust and running evaporative emissions.

¹⁴ PM2.5 Ex includes running exhaust emissions only.

Speed	ROG ¹³	CO	NOx	PM2.5 Ex ¹⁴		Speed	ROG	CO	NOx	PM2.5 Ex
45	0.0114	0.8067	0.0945	0.0015		88	0.0139	0.6427	0.1219	0.0027
46	0.0113	0.7962	0.0937	0.0016		89	0.0139	0.6428	0.1219	0.0027
47	0.0112	0.7858	0.0929	0.0016		90	0.0139	0.6428	0.1219	0.0027

Table 5A. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Gasoline

BEFORE PROJECT Baseline Emission Factors

Vehicle Type	GVWR ¹⁵ (lbs)	Model Year	ROG (g/mi)	CO (g/mi)	NOx (g/mi)	PM2.5 (g/mi)	Conversion Factors	ROG (g/bhp- hr)	CO (g/bhp- hr ¹⁶)	NOx (g/bhp- hr)	PM2.5 (g/bhp- hr)
Urban Transit Buses	> 33,000	2010-2012	0.087	0.961	0.547	0.042	4.0	0.022	0.240	0.137	0.0105
		2013-2015	0.048	0.819	0.186	0.038	4.0	0.0120	0.205	0.046	0.0094
		2016-2018	0.037	0.778	0.157	0.038	4.0	0.0092	0.194	0.039	0.0094
		2019-2021	0.047	0.932	0.172	0.039	4.0	0.0118	0.233	0.043	0.0098
		2022-2024	0.032	0.766	0.114	0.039	4.0	0.0079	0.191	0.029	0.0098
Transit Buses,¹⁷ School Buses, and Trucks¹⁸	14,001- 33,000	2007-2009	0.281	2.006	0.328	0.019	1.8	0.156	1.115	0.182	0.010
		2010-2012	0.162	1.647	0.208	0.019	1.8	0.090	0.915	0.115	0.010
		2013-2015	0.134	1.514	0.192	0.019	1.8	0.074	0.841	0.106	0.011
		2016-2018	0.109	1.375	0.170	0.020	1.8	0.060	0.764	0.095	0.011
		2019-2021	0.081	1.158	0.158	0.020	1.8	0.045	0.643	0.088	0.011
		2022-2024	0.081	1.209	0.188	0.020	1.8	0.045	0.671	0.104	0.011
Class 8 Trucks¹⁹	> 33,000	2007-2009	0.497	33.70	3.623	0.044	2.9	0.172	11.621	1.249	0.015
		2010-2012	0.528	34.97	3.705	0.036	2.9	0.182	12.057	1.277	0.012
		2013-2015	0.364	29.06	3.093	0.033	2.9	0.125	10.021	1.067	0.011
		2016-2018	0.386	29.45	3.004	0.036	2.9	0.133	10.154	1.036	0.012
		2019-2021	0.269	22.76	2.480	0.036	2.9	0.093	7.850	0.855	0.012
		2022-2024	0.215	18.81	2.304	0.036	2.9	0.074	6.486	0.795	0.012

Source: EMFAC2021 v1.0.2, Annual, Statewide (No pre-2003 Urban Transit Buses)

¹⁵ Gross vehicle weight rating

¹⁶ Grams per brake horsepower-hour

¹⁷ Other buses

¹⁸ Medium heavy-duty trucks

¹⁹ Heavy heavy-duty trucks

Table 5A. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Gasoline (Continued)

Retrofit Gasoline Vehicles

Vehicle Type	GVWR ²⁰ (lbs)	Model Year	ROG (g/mi)	CO (g/mi)	NOx (g/mi)	PM2.5 (g/mi)	Conversion Factors	ROG (g/bhp- hr ²¹)	CO (g/bhp- hr)	NOx (g/bhp- hr)	PM2.5 (g/bhp- hr)
Urban Transit Buses	> 33,000	2010-2012	0.087	0.961	0.547	0.042	4.0	0.022	0.240	0.137	0.010
Transit Buses²², School Buses, and Trucks²³	14,001- 33,000	1994-1997	2.863	26.44	4.648	0.025	1.8	1.591	14.689	2.582	0.014
		1998-2002	1.706	23.81	4.521	0.021	1.8	0.948	13.229	2.512	0.011
		2003-2006	0.579	5.227	1.091	0.019	1.8	0.322	2.904	0.606	0.010
		2007-2009	0.281	2.006	0.328	0.019	1.8	0.156	1.115	0.182	0.010
		2010-2012	0.162	1.647	0.208	0.019	1.8	0.090	0.915	0.115	0.010
Class 8 Trucks²⁴	>33,000	1994-1997	3.589	38.80	15.00	0.048	2.9	1.238	13.379	5.172	0.017
		1998-2002	2.968	38.31	9.303	0.047	2.9	1.023	13.210	3.208	0.016
		2003-2006	1.152	37.78	4.764	0.045	2.9	0.397	13.026	1.643	0.016
		2007-2009	0.497	33.70	3.623	0.044	2.9	0.172	11.621	1.249	0.015
		2010-2012	0.528	34.97	3.705	0.036	2.9	0.182	12.057	1.277	0.012

Source: EMFAC2021 v1.0.2, Annual, Statewide (No pre-2003 Urban Transit Buses)

²⁰ Gross vehicle weight rating

²¹ Grams per brake horsepower-hour

²² Other buses

²³ Medium heavy-duty trucks

²⁴ Heavy heavy-duty trucks

Table 5A. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Gasoline (Continued)

AFTER PROJECT Emission Factors - New Cleaner Gasoline Vehicle Purchase or Repowers

Vehicle Type	GVWR ²⁵ (lbs)	Model Year	ROG (g/mi)	CO (g/mi)	NOx (g/mi)	PM2.5 (g/mi)	Conversion Factors	ROG (g/bhp- hr ²⁶)	CO (g/bhp- hr)	NOx (g/bhp- hr)	PM2.5 (g/bhp- hr)
Urban Transit Buses	> 33,000	2013-2015	0.048	0.82	0.19	0.04	4.0	0.0120	0.205	0.046	0.0094
		2016-2018	0.037	0.78	0.16	0.04	4.0	0.0092	0.194	0.039	0.0094
		2019-2021	0.047	0.93	0.17	0.04	4.0	0.0118	0.233	0.043	0.0098
		2022-2024	0.032	0.77	0.11	0.04	4.0	0.0079	0.191	0.029	0.0098
Transit Buses²⁷, School Buses, and Trucks²⁸	14,001 - 33,000	2013-2015	0.134	1.51	0.19	0.02	1.8	0.074	0.841	0.106	0.011
		2016-2018	0.109	1.38	0.17	0.20	1.8	0.060	0.764	0.095	0.011
		2019-2021	0.081	1.16	0.16	0.02	1.8	0.045	0.643	0.088	0.011
		2022-2024	0.081	1.21	0.19	0.02	1.8	0.045	0.671	0.104	0.011
Class 8 Trucks²⁹	> 33,000	2013-2015	0.364	29.1	3.09	0.03	2.9	0.125	10.021	1.067	0.011
		2016-2018	0.386	29.4	3.00	0.04	2.9	0.133	10.154	1.036	0.012
		2019-2021	0.269	22.8	2.48	0.04	2.9	0.093	7.850	0.855	0.012
		2022-2024	0.215	18.8	2.30	0.04	2.9	0.074	6.486	0.795	0.012

Source: EMFAC2021 v1.0.2, Annual, Statewide (No pre-2003 Urban Transit Buses)

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 formaldehyde.

²⁵ Gross vehicle weight rating

²⁶ Grams per brake horsepower-hour

²⁷ Other buses

²⁸ Medium heavy-duty trucks

²⁹ Heavy heavy-duty trucks

Table 5B. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Diesel

BEFORE PROJECT Baseline Emission Factors

Vehicle Type	GVWR ³⁰ (lbs)	Model Year	ROG (g/mi)	CO (g/mi)	NOx (g/mi)	PM2.5 (g/mi)	Conversion Factors	ROG (g/bhp- hr)	CO (g/bhp- hr ³¹)	NOx (g/bhp- hr)	PM2.5 (g/bhp- hr)
Urban Transit Buses	> 33,000	2010-2012	0.074	0.087	0.443	0.054	4.0	0.019	0.022	0.111	0.0135
		2013-2015	0.069	0.080	0.397	0.053	4.0	0.0173	0.020	0.099	0.0133
		2016-2018	0.068	0.077	0.376	0.053	4.0	0.0169	0.019	0.094	0.0133
		2019-2021	0.066	0.077	0.351	0.052	4.0	0.0164	0.019	0.088	0.0131
		2022-2024	0.057	0.061	0.291	0.050	4.0	0.0142	0.015	0.073	0.0126
Transit Buses³², School Buses, and Trucks³³	14,001- 33,000	2007-2009	0.155	0.452	6.824	0.050	1.8	0.086	0.251	3.791	0.028
		2010-2012	0.029	0.308	2.971	0.030	1.8	0.016	0.171	1.650	0.016
		2013-2015	0.012	0.241	1.494	0.024	1.8	0.007	0.134	0.830	0.014
		2016-2018	0.010	0.208	1.020	0.022	1.8	0.005	0.116	0.566	0.012
		2019-2021	0.009	0.187	0.896	0.022	1.8	0.005	0.104	0.498	0.012
		2022-2024	0.008	0.173	0.778	0.022	1.8	0.005	0.096	0.432	0.012
Class 8 Trucks³⁴	> 33,000	2007-2009	0.150	0.457	9.571	0.089	2.9	0.052	0.158	3.300	0.031
		2010-2012	0.100	0.907	5.133	0.073	2.9	0.034	0.313	1.770	0.025
		2013-2015	0.060	0.793	2.929	0.069	2.9	0.021	0.274	1.010	0.024
		2016-2018	0.057	0.742	2.329	0.067	2.9	0.020	0.256	0.803	0.023
		2019-2021	0.055	0.697	2.128	0.060	2.9	0.019	0.240	0.734	0.021
		2022-2024	0.050	0.633	1.795	0.054	2.9	0.017	0.218	0.619	0.019

Source: EMFAC2021 v1.0.2, Annual, Statewide (No pre-2003 Urban Transit Buses)

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.

³⁰ Gross vehicle weight rating

³¹ Grams per brake horsepower-hour

³² Other buses

³³ Medium heavy-duty trucks

³⁴ Heavy heavy-duty trucks

Table 5B. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Diesel (Continued)

Retrofit Diesel Vehicles

Vehicle Type	GVWR ³⁵ (lbs)	Model Year	ROG (g/mi)	CO (g/mi)	NOx (g/mi)	PM2.5 (g/mi)	Conversion Factors	ROG (g/bhp- hr ³⁶)	CO (g/bhp- hr)	NOx (g/bhp- hr)	PM2.5 (g/bhp- hr)
Urban Transit Buses	> 33,000	2010-2012	0.074	0.087	0.443	0.054	4.0	0.019	0.022	0.111	0.014
Transit Buses³⁷, School Buses, and Trucks³⁸	14,001- 33,000	1994-1997	0.530	1.649	15.24	0.227	1.8	0.294	0.916	8.464	0.126
		1998-2002	0.426	1.322	15.43	0.188	1.8	0.237	0.734	8.570	0.105
		2003-2006	0.164	0.540	9.727	0.092	1.8	0.091	0.300	5.404	0.051
		2007-2009	0.155	0.452	6.824	0.050	1.8	0.086	0.251	3.791	0.028
		2010-2012	0.029	0.308	2.971	0.030	1.8	0.016	0.171	1.650	0.016
Class 8 Trucks³⁹	>33,000	1994-1997	0.144	0.455	18.99	0.111	2.9	0.050	0.157	6.549	0.038
		1998-2002	0.117	0.346	21.74	0.105	2.9	0.040	0.119	7.498	0.036
		2003-2006	0.070	0.251	12.57	0.110	2.9	0.024	0.087	4.333	0.038
		2007-2009	0.150	0.457	9.571	0.089	2.9	0.052	0.158	3.300	0.031
		2010-2012	0.100	0.907	5.133	0.073	2.9	0.034	0.313	1.770	0.025

Source: EMFAC2021 v1.0.2, Annual, Statewide (No pre-2003 Urban Transit Buses)

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.

³⁵ Gross vehicle weight rating

³⁶ Grams per brake horsepower-hour

³⁷ Other buses

³⁸ Medium heavy-duty trucks

³⁹ Heavy heavy-duty trucks

Table 5B. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) - Diesel (Continued)

AFTER PROJECT Emission Factors - New Cleaner Diesel Vehicle Purchase or Repowers

Vehicle Type	GVWR ⁴⁰ (lbs)	Model Year	ROG (g/mi)	CO (g/mi)	NOx (g/mi)	PM2.5 (g/mi)	Conversion Factors	ROG (g/bhp- hr ⁴¹)	CO (g/bhp- hr)	NOx (g/bhp- hr)	PM2.5 (g/bhp- hr)
Urban Transit Buses	> 33,000	2013-2015	0.069	0.08	0.40	0.05	4.0	0.0173	0.020	0.099	0.0133
		2016-2018	0.068	0.08	0.38	0.05	4.0	0.0169	0.019	0.094	0.0133
		2019-2021	0.066	0.08	0.35	0.05	4.0	0.0164	0.019	0.088	0.0131
		2022-2024	0.057	0.06	0.29	0.05	4.0	0.0142	0.015	0.073	0.0126
Transit Buses⁴², School Buses, and Trucks⁴³	14,001 - 33,000	2013-2015	0.012	0.24	1.49	0.02	1.8	0.007	0.134	0.830	0.014
		2016-2018	0.010	0.21	1.02	0.02	1.8	0.005	0.116	0.566	0.012
		2019-2021	0.009	0.19	0.90	0.02	1.8	0.005	0.104	0.498	0.012
		2022-2024	0.008	0.17	0.78	0.02	1.8	0.005	0.096	0.432	0.012
Class 8 Trucks⁴⁴	> 33,000	2013-2015	0.060	0.79	2.93	0.07	2.9	0.021	0.274	1.010	0.024
		2016-2018	0.057	0.74	2.33	0.07	2.9	0.020	0.256	0.803	0.023
		2019-2021	0.055	0.70	2.13	0.06	2.9	0.019	0.240	0.734	0.021
		2022-2024	0.050	0.63	1.80	0.05	2.9	0.017	0.218	0.619	0.019

Source: EMFAC2021 v1.0.2, Annual, Statewide (No pre-2003 Urban Transit Buses)

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.

⁴⁰ Gross vehicle weight rating

⁴¹ Grams per brake horsepower-hour

⁴² Other buses

⁴³ Medium heavy-duty trucks

⁴⁴ Heavy heavy-duty trucks

Table 5C. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) – Natural Gas

BEFORE PROJECT Baseline Emission Factors - New Natural Gas Vehicles

Vehicle Type	GVWR ⁴⁵ (lbs)	Model Year	ROG (g/mi)	CO (g/mi)	NOx (g/mi)	PM2.5 (g/mi)	Conversion Factors	ROG (g/bhp- hr)	CO (g/bhp- hr ⁴⁶)	NOx (g/bhp- hr)	PM2.5 (g/bhp- hr)
Urban Transit Buses	> 33,000	2010-2012	0.023	27.83	0.709	0.047	4.0	0.006	6.957	0.177	0.0117
		2013-2015	0.025	29.92	0.771	0.047	4.0	0.0062	7.481	0.193	0.0118
		2016-2018	0.031	31.53	0.667	0.047	4.0	0.0077	7.881	0.167	0.0117
		2019-2021	0.062	50.32	0.110	0.047	4.0	0.0156	12.580	0.028	0.0118
		2022-2024	0.062	49.75	0.108	0.047	4.0	0.0154	12.437	0.027	0.0118
Transit Buses⁴⁷, School Buses, and Trucks⁴⁸	14,001- 33,000	2007-2009	0.058	13.25	0.957	0.022	1.8	0.032	7.360	0.532	0.012
		2010-2012	0.055	12.92	0.926	0.022	1.8	0.031	7.175	0.514	0.012
		2013-2015	0.042	9.892	0.729	0.021	1.8	0.023	5.495	0.405	0.012
		2016-2018	0.026	5.832	0.376	0.021	1.8	0.015	3.240	0.209	0.012
		2019-2021	0.023	5.038	0.218	0.021	1.8	0.013	2.799	0.121	0.012
		2022-2024	0.023	4.914	0.218	0.021	1.8	0.013	2.730	0.121	0.012
Class 8 Trucks⁴⁹	> 33,000	2007-2009	0.065	19.85	1.620	0.080	2.9	0.023	6.844	0.559	0.027
		2010-2012	0.055	18.00	1.443	0.066	2.9	0.019	6.205	0.498	0.023
		2013-2015	0.053	17.95	1.428	0.062	2.9	0.018	6.189	0.492	0.021
		2016-2018	0.032	11.76	0.861	0.058	2.9	0.011	4.055	0.297	0.020
		2019-2021	0.010	6.293	0.200	0.064	2.9	0.003	2.170	0.069	0.022
		2022-2024	0.010	6.319	0.198	0.062	2.9	0.004	2.179	0.068	0.021

Source: EMFAC2021 v1.0.2, Annual, Statewide (No pre-2003 Urban Transit Buses)

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.

⁴⁵ Gross vehicle weight rating

⁴⁶ Grams per brake horsepower-hour

⁴⁷ Other buses

⁴⁸ Medium heavy-duty trucks

⁴⁹ Heavy heavy-duty trucks

Table 5C. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) -Natural Gas (Continued)

Retrofit Natural Gas Vehicles

Vehicle Type	GVWR ⁵⁰ (lbs)	Model Year	ROG (g/mi)	CO (g/mi)	NOx (g/mi)	PM2.5 (g/mi)	Conversion Factors	ROG (g/bhp- hr ⁵¹)	CO (g/bhp- hr)	NOx (g/bhp- hr)	PM2.5 (g/bhp- hr)
Urban Transit Buses	> 33,000	2010-2012	0.023	27.83	0.709	0.047	4.0	0.006	6.957	0.177	0.012
Transit Buses⁵², School Buses, and Trucks⁵³	14,001- 33,000	2007-2009	0.058	13.25	0.957	0.022	1.8	0.032	7.360	0.532	0.012
		2010-2012	0.055	12.92	0.926	0.022	1.8	0.031	7.175	0.514	0.012
Class 8 Trucks⁵⁴	>33,000	1994-1997	1.402	1.794	33.74	0.120	2.9	0.484	0.619	11.635	0.041
		1998-2002	1.516	1.826	33.99	0.122	2.9	0.523	0.630	11.721	0.042
		2003-2006	1.492	2.435	23.58	0.164	2.9	0.514	0.840	8.132	0.056
		2007-2009	0.065	19.85	1.620	0.080	2.9	0.023	6.844	0.559	0.027
		2010-2012	0.055	18.00	1.443	0.066	2.9	0.019	6.205	0.498	0.023

Source: EMFAC2021 v1.0.2, Annual, Statewide (No pre-2003 Urban Transit Buses)

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.

⁵⁰ Gross vehicle weight rating

⁵¹ Grams per brake horsepower-hour

⁵² Other buses

⁵³ Medium heavy-duty trucks

⁵⁴ Heavy heavy-duty trucks

Table 5C. Statewide Calendar Year 2024 On-Road Emission Factors for Heavy-Duty Cleaner Vehicle Projects (grams per mile) – Natural Gas (Continued)

AFTER PROJECT Emission Factors – New Cleaner Natural Gas Vehicle Purchase or Repowers

Vehicle Type	GVWR ⁵⁵ (lbs)	Model Year	ROG (g/mi)	CO (g/mi)	NOx (g/mi)	PM2.5 (g/mi)	Conversion Factors	ROG (g/bhp- hr ⁵⁶)	CO (g/bhp- hr)	NOx (g/bhp- hr)	PM2.5 (g/bhp- hr)
Urban Transit Buses	> 33,000	2013-2015	0.025	29.9	0.77	0.05	4.0	0.0062	7.481	0.193	0.0118
		2016-2018	0.031	31.5	0.67	0.05	4.0	0.0077	7.881	0.167	0.0117
		2019-2021	0.062	50.3	0.11	0.05	4.0	0.0156	12.580	0.028	0.0118
		2022-2024	0.062	49.7	0.11	0.05	4.0	0.0154	12.437	0.027	0.0118
Transit Buses⁵⁷, School Buses, and Trucks⁵⁸	14,001 - 33,000	2013-2015	0.042	9.89	0.73	0.02	1.8	0.023	5.495	0.405	0.012
		2016-2018	0.026	5.83	0.38	0.02	1.8	0.015	3.240	0.209	0.012
		2019-2021	0.023	5.04	0.22	0.02	1.8	0.013	2.799	0.121	0.012
		2022-2024	0.023	4.91	0.22	0.02	1.8	0.013	2.730	0.121	0.012
Class 8 Trucks⁵⁹	> 33,000	2013-2015	0.053	17.9	1.43	0.06	2.9	0.018	6.189	0.492	0.021
		2016-2018	0.032	11.8	0.86	0.06	2.9	0.011	4.055	0.297	0.020
		2019-2021	0.010	6.29	0.20	0.06	2.9	0.003	2.170	0.069	0.022
		2022-2024	0.010	6.32	0.20	0.06	2.9	0.004	2.179	0.068	0.021

Source: EMFAC2021 v1.0.2, Annual, Statewide (No pre-2003 Urban Transit Buses)

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.

⁵⁵ Gross vehicle weight rating

⁵⁶ Grams per brake horsepower-hour

⁵⁷ Other buses

⁵⁸ Medium heavy-duty trucks

⁵⁹ Heavy heavy-duty trucks

Off-Road Emission Factors for Cleaner Vehicle Projects

CARB offers a user-friendly Excel-based tool designed⁶⁰ to estimate fuel consumption and emissions for equipment in a specific year, CARB's 2017 Emission Factors for Off-road Diesel Equipment. This tool employs a methodology that averages engine certification values within a particular horsepower range and model year. This average encompasses a wide spectrum, ranging from engines surpassing the standards for that year to those utilizing various flexibility provisions (such as emission credits) to meet standards from previous years.⁶¹

How to Use the Tool

To utilize this tool effectively, users need to input specific parameters, including horsepower, model year, calendar year, activity measured in annual hours, and accumulated hours on the equipment. If the user only knows the age of the equipment, they can calculate accumulated hours by multiplying annual hours by the age (annual-hours × age). Additionally, users require the load factor, available in the lookup tables provided below. Exhibit 1 shows a screenshot of the input box.

Exhibit 1: Input Box (Example Numbers)

Input	Input Engine Here
Horsepower (hp)	150
Model year	1985
Calendar year	2015
Activity (annual hours)	200
Accumulated hours on equipment (estimate using annual-hours*age if you only know the age of the equipment)	(2015-1985)*200 = 6000 hours
Load factor (check the lookup table)	0.48

⁶⁰ The tool is available here: [ordas_ef_fcf_2017_v8.xlsx \(live.com\)](https://live.com/ordas_ef_fcf_2017_v8.xlsx)

⁶¹ For more information, please see: [ordas_emsfactors_2017.docx \(ca.gov\)](https://ca.gov/ordas_emsfactors_2017.docx)

Look up tables for load factor

Equipment Category	Equipment Type	Load Factor
Agriculture equipment	Agricultural tractors	0.48
	Combine harvesters	0.44
	Forage & silage harvesters	0.44
	Cotton pickers	0.44
	Nut harvester	0.44
	Other harvesters	0.44
	Balers (self propelled)	0.50
	Bale wagons (self propelled)	0.50
	Swathers/windrowers/hay conditioners	0.48
	Hay Squeeze/Stack retriever	0.42
	Sprayers/Spray rigs	0.42
	Construction equipment	0.40
	Other non-mobile	0.48
	Forklifts	0.40
	Atvs	0.40
	Others	0.40
Portable equipment	All portable equipment	0.31
Cargo Handling Equipment	Construction equipment	0.55
	Container handling equipment	0.59
	Forklift	0.30
	Other general industrial equipment	0.51
	Rtg crane	0.20
	Yard tractor	0.39

Equipment Category	Equipment Type	Details	Load Factor
Transport Refrigeration Units (TRU)	TRU on trailers	25 HP and over, MY2012 and Older	0.46
	TRU on trailers	25 HP and over, MY2013 and Newer	0.38
	TRU on trailers	23 HP and Over, below 25 HP, All years	0.46
	TRU on trucks	Below 23 HP, All Model years	0.56
	TRU on railcars	25 HP and over, MY2012 and Older	0.33
	TRU on railcars	25 HP and over, MY2013 and Newer	0.27
	TRU on railcars	Below 25 HP, All Model years	0.33
	TRU with generators	25 HP and over, MY2012 and Older	0.46
	TRU with generators	25 HP and Over, MY2013 and Newer	0.38
	TRU with generators	23 HP and Over, below 25 HP, All Model Years	0.46

Equipment Category	Equipment Type	Load Factor
Construction and Industrial Equipment	Cranes	0.29
	Crawler Tractors	0.43
	Excavators	0.38
	Graders	0.41
	Off-Highway Tractors	0.44
	Off-Highway Trucks	0.38
	Other Construction Equipment	0.42
	Pavers	0.42
	Paving Equipment	0.36
	Rollers	0.38
	Rough Terrain Forklifts	0.40
	Rubber Tired Dozers	0.40
	Rubber Tired Loaders	0.36
	Scrapers	0.48
	Skid Steer Loaders	0.37
	Surfacing Equipment	0.30
	Tractors/Loaders/Backhoes	0.37
	Trenchers	0.50
	Aerial Lifts	0.31
	Forklifts	0.20
	Other General Industrial Equipment	0.34
	Other Material Handling Equipment	0.40
	Sweepers/Scrubbers	0.46
Oil and Drill Rigs	Drill Rig (Mobile)	0.50
	Workover Rig (Mobile)	0.50
	Bore/Drill Rigs	0.50

The Output Box provides a summary of the estimated fuel usage, NO_x (Nitrogen Oxides), PM (Particulate Matter), and THC (Total Hydrocarbons) emissions for the user's equipment. Exhibit 2 shows a screenshot of the output box in the table. Upon completing the analysis, the tool provides the following results based on the input parameters provided by the user:

- Fuel Used (gallon): The total amount of fuel consumed by the equipment, measured in gallons.
- NO_x Emissions (kg): The total Nitrogen Oxides emitted by the equipment, measured in kilograms.
- PM Emissions (kg): The total Particulate Matter emissions from the equipment, measured in kilograms.

- THC Emissions (kg): The total emissions of Total Hydrocarbons from the equipment, measured in kilograms.
- CO2 Emissions (kg): The total Carbon Dioxide emissions resulting from the equipment's fuel consumption, measured in kilograms.
- NOx Emission Factor (including deterioration and fuel correction factor): The emission rate of Nitrogen Oxides per brake horsepower-hour (bhp-hr) of the equipment, accounting for deterioration and fuel correction factors, measured in grams per bhp-hr.
- PM Emission Factor (including deterioration and fuel correction factor): The emission rate of Particulate Matter per brake horsepower-hour (bhp-hr) of the equipment, considering deterioration and fuel correction factors, measured in grams per bhp-hr.
- THC Emission Factor (including deterioration and fuel correction factor): The emission rate of Total Hydrocarbons per brake horsepower-hour (bhp-hr) of the equipment, factoring in deterioration and fuel correction factors, measured in grams per bhp-hr.

Exhibit 2: Output Box (Example Numbers)

Results	
Fuel Used (gallon)	743
NOx Emissions (kg)	150.7
PM Emissions (kg)	6.0
THC Emissions (kg)	11.9
CO2 Emissions (kg)	7590.2
NOx Emission Factor (including deterioration and fuel correction factor): gram/bhp-hr	10.47
PM Emission Factor (including deterioration and fuel correction factor): gram/bhp-hr	0.42
THC Emission Factor (including deterioration and fuel correction factor): gram/bhp-hr	0.83