

Chapter 4 Criteria Pollutants

Summary Statistics from Tables in this Chapter

Source		
Table 4.1	Transportation's share of U.S. emissions, 1998	
	<i>CO</i>	78.6%
	<i>NO_x</i>	53.4%
	<i>VOC</i>	43.5%
	<i>PM-10</i>	2.1%
	<i>PM-2.5</i>	7.2%
	<i>SO₂</i>	7.2%
	<i>NH₃</i>	5.2%
Table 4.10	Transportation's share of lead emissions	
	<i>1970</i>	82.3%
	<i>1998</i>	13.1%

Table 4.1
Total National Emissions of the Criteria Air Pollutants by Sector, 1998
(millions of short tons/percentage)

Sector	CO	NO _x	VOC	PM-10	PM-2.5	SO ₂	NH ₃
Highway vehicles	50.39	7.77	5.33	0.26	0.20	0.33	0.25
	56.3%	31.8%	29.7%	0.7%	2.4%	1.7%	5.1%
Aircraft	0.96	0.16	0.18	0.04	0.03	0.01	0.00
	1.1%	0.7%	1.0%	0.1%	0.3%	0.1%	0.1%
Railroads	0.12	0.95	0.05	0.03	0.03	0.11	0.00
	0.1%	3.9%	0.3%	0.1%	0.4%	0.6%	0.0%
Vessels	0.14	1.00	0.04	0.04	0.04	0.26	0.00
	0.2%	4.1%	0.2%	0.1%	0.5%	1.3%	0.0%
Other off-highway	18.71	3.17	2.19	0.35	0.31	0.70	0.00
	20.9%	13.0%	12.2%	1.0%	3.7%	3.6%	0.0%
Transportation total	70.30	13.05	7.79	0.72	0.61	1.41	0.26
	78.6%	53.4%	43.5%	2.1%	7.2%	7.2%	5.2%
Stationary source fuel combustion	5.37	10.19	0.89	1.09	0.79	16.72	0.06
	6.0%	41.7%	5.0%	3.1%	9.4%	85.1%	1.2%
Industrial processes	3.71	0.80	8.02	0.71	0.39	1.46	0.25
	4.1%	3.3%	44.8%	2.0%	4.7%	7.4%	5.1%
Waste disposal and recycling total	1.15	0.10	0.43	0.31	0.24	0.04	0.09
	1.3%	0.4%	2.4%	0.9%	2.8%	0.2%	1.7%
Miscellaneous	8.92	0.33	0.79	31.92	6.35	0.01	4.28
	10.0%	1.3%	4.4%	91.9%	75.8%	0.1%	86.6%
Total of all sources	89.45	24.45	17.92	34.74	8.38	19.65	4.94
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0

Source:

All other—U. S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998*, 2000, Appendix A. (Additional resources: www.epa.gov/oar/oaqps)

Note:

CO = Carbon monoxide. NO_x = Nitrogen oxides. PM-10 = Particulate matter less than 10 microns.

PM-2.5 = Particulate matter less than 2.5 microns. SO₂ = Sulfur dioxide. VOC = Volatile organic compounds. NH₃ = Ammonia.

The transportation sector accounted for more than three-fourths of the nation's carbon monoxide (CO) emissions in 1998. Highway vehicles are by far the source of the greatest amount of CO. For details on the highway emissions of CO, see Table 4.3.

Table 4.2
Total National Emissions of Carbon Monoxide, 1970–98^a
(million short tons)

Source category	1970	1980	1990	1995	1997	1998	Percent of total, 1998
Highway vehicles	88.03	78.05	57.85	54.11	51.67	50.39	56.3%
Aircraft	0.51	0.74	0.90	0.94	0.96	0.96	1.1%
Railroads	0.07	0.10	0.12	0.11	0.12	0.12	0.1%
Vessels ^b	0.02	0.06	0.13	0.13	0.14	0.14	0.2%
Other off-highway	11.38	13.59	17.04	19.04	18.71	18.71	20.9%
Transportation total	100.00	92.54	76.04	74.33	70.30	70.30	78.6%
Stationary fuel combustion total	4.63	7.30	5.51	5.93	5.37	5.37	6.0%
Industrial processes total	9.84	6.95	4.77	4.61	3.71	3.71	4.1%
Waste disposal and recycling total	7.06	2.30	1.08	1.19	1.15	1.15	1.3%
Miscellaneous total	7.91	8.34	11.21	7.05	8.92	8.92	10.0%
Total of all sources	129.44	117.43	98.53	93.35	89.45	89.45	100.0%

Source:

U. S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998*, 2000, pp. A-1–A-5, and annual. (Additional resources: www.epa/oar/oaqps)

Note:

Emission estimation methodology changes indicated by shaded areas. Transportation methodologies changed in 1970, while all others changed in 1990.

^aThe sums of subcategories may not equal total due to rounding.

^bRecreational marine vessels.

Table 4.3
Emissions of Carbon Monoxide from Highway Vehicles, 1970–98^a
(million short tons)

Source category	1970	1975	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998	Percent of total, 1998
Gasoline powered													
Light vehicles & motorcycles	64.03	59.28	53.56	49.45	37.41	39.37	39.16	37.51	33.70	28.73	27.04	27.04	53.7%
Light trucks ^b	16.57	15.77	16.14	18.96	13.82	14.57	15.20	17.35	14.83	19.27	18.36	18.73	37.2%
Heavy vehicles	6.71	7.14	7.19	7.72	5.36	4.57	4.48	5.53	4.12	3.77	3.35	3.07	6.1%
Total	87.31	82.19	76.89	76.13	56.58	58.51	58.84	60.38	52.65	51.77	48.75	48.83	96.9%
Diesel powered													
Light vehicles	^c	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.1%
Light trucks ^b	^c	^c	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.0%
Heavy vehicles	0.72	0.92	1.14	1.24	1.23	1.32	1.33	1.41	1.41	1.45	1.47	1.51	3.0%
Total	0.72	0.95	1.16	1.26	1.27	1.35	1.37	1.45	1.45	1.49	1.51	1.55	3.1%
Total													
Highway vehicle total	88.03	83.13	78.05	77.39	57.85	59.86	60.20	61.83	54.11	53.26	50.26	50.39	100.0%
Percent diesel	0.8%	1.1%	1.5%	1.6%	2.2%	2.3%	2.3%	2.3%	2.7%	2.8%	3.0%	3.1%	

Source:

U. S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998*, 2000, p. A-3 and annual.

(Additional resources: www.epa.gov/oar/oaqps)

^aThe sums of subcategories may not equal total due to rounding.

^bLess than 8,500 pounds.

^cData are not available.

The transportation sector accounted for over half of the nation's nitrogen oxide (NO_x) emissions in 1998, with the majority coming from highway vehicles. For details on the highway emissions of NO_x, see Table 4.5.

Table 4.4
Total National Emissions of Nitrogen Oxides, 1970–98^a
(million short tons)

Source category	1970	1980	1990	1995	1997	1998	Percent of total, 1998
Highway vehicles	7.39	8.62	7.09	7.83	7.88	7.77	31.8%
Railroads	0.50	0.73	0.93	0.99	0.95	0.95	3.9%
Other off-highway	1.44	2.80	3.88	4.14	4.30	4.33	17.7%
Transportation total	9.32	12.15	11.89	12.95	13.13	13.05	53.3%
Stationary fuel combustion total	10.06	11.32	10.89	10.83	10.40	10.19	41.7%
Industrial processes total	0.78	0.56	0.80	0.77	0.79	0.80	3.3%
Waste disposal and recycling total	0.44	0.11	0.09	0.10	0.10	0.10	0.4%
Miscellaneous total	0.33	0.25	0.37	0.27	0.41	0.33	1.3%
Total of all sources	20.93	24.38	24.05	24.92	24.82	24.45	100.0%

Source:

U. S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998*, 2000, pp. A-6–A-10, and annual. (Additional resources: www.epa/oar/oaqps)

Note:

Emission estimation methodology changes indicated by shaded areas. Transportation methodologies changed in 1970, while all others changed in 1990.

^aThe sums of subcategories may not equal total due to rounding.

Table 4.5
Emissions of Nitrogen Oxides from Highway Vehicles, 1970–98^a
(million short tons)

Source category	1970	1975	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998	Percent of total, 1998
Gasoline powered													
Light vehicles & motorcycles	4.16	4.73	4.42	3.81	3.22	3.61	3.68	3.57	3.44	2.98	2.93	2.85	36.7%
Light trucks ^b	1.28	1.46	1.41	1.53	1.26	1.36	1.42	1.66	1.52	1.95	1.96	1.95	24.7%
Heavy vehicles	0.28	0.32	0.30	0.33	0.33	0.31	0.32	0.35	0.33	0.33	0.33	0.32	4.2%
Total	5.71	6.51	6.13	5.67	4.80	5.28	5.42	5.58	5.30	5.26	5.22	5.09	65.5%
Diesel powered													
Light vehicles	^c	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.4%
Light trucks ^b	^c	^c	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.2%
Heavy vehicles	1.68	2.12	2.46	2.39	2.24	2.30	2.34	2.45	2.48	2.54	2.61	2.63	33.9%
Total	1.68	2.14	2.49	2.42	2.29	2.35	2.39	2.49	2.53	2.59	2.66	2.68	34.5%
Total													
Highway vehicle total	7.39	8.65	8.62	8.09	7.09	7.62	7.81	8.08	7.83	7.85	7.87	7.77	100.0%
Percent diesel	22.7%	24.8%	28.9%	30.0%	32.3%	30.8%	30.6%	30.9%	32.3%	33.0%	33.7%	34.5%	

Source:

U. S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998*, 2000, p. A-9 and annual.

(Additional resources: www.epa.gov/oar/oaqps)

^aThe sums of subcategories may not equal total due to rounding.

^bLess than 8,500 pounds.

^cData are not available.

The transportation sector accounted for over 40% of the nation's volatile organic compound (VOC) emissions in 1998, with the majority coming from highway vehicles. For details on the highway emissions of VOC, see Table 4.7.

Table 4.6
Total National Emissions of Volatile Organic Compounds, 1970–98^a
(million short tons)

Source category	1970	1980	1990	1995	1997	1998	Percent of total, 1998
Highway vehicles	12.97	8.98	6.31	5.70	5.33	5.33	29.7%
Off-highway	1.71	2.14	2.55	2.70	2.46	2.46	13.7%
Transportation total	14.69	11.12	8.86	8.40	7.79	7.79	43.5%
Stationary fuel combustion total	0.72	1.05	1.01	1.07	0.89	0.89	5.0%
Industrial processes total	12.33	12.10	9.01	9.71	8.02	8.02	44.8%
Waste disposal and recycling total	1.98	0.76	0.99	1.07	0.43	0.43	2.4%
Miscellaneous total	1.10	1.13	1.07	0.57	1.26	0.79	4.4%
Total of all sources	30.82	26.17	20.94	20.82	18.88	17.92	100.0%

Source:

U. S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998*, 2000, pp. A-11–A-17, and annual. (Additional resources: www.epa.gov/oar/oaqps)

Note:

Emission estimation methodology changes indicated by shaded areas. Transportation methodologies changed in 1970, while all others changed in 1990.

^aThe sum of subcategories may not equal total due to rounding. The EPA's definition of volatile organic compounds excludes methane, ethane, and certain other nonphotochemically reactive organic compounds.

Table 4.7
Emissions of Volatile Organic Compounds from Highway Vehicles, 1970–98^a
(thousand short tons)

Source category	1970	1975	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998	Percent of total, 1998
Gasoline powered													
Light vehicles & motorcycles	9,193	7,248	5,907	5,864	3,947	3,832	3,812	3,748	3,426	2,875	2,796	2,832	47.6%
Light trucks ^b	2,770	2,289	2,059	2,425	1,622	1,588	1,647	1,909	1,629	2,060	2,017	2,015	33.9%
Heavy vehicles	1,206	1,038	830	988	662	739	772	906	735	917	889	877	14.7%
Total	13,169	10,575	8,796	9,277	6,231	6,159	6,231	6,563	5,790	5,852	5,702	5,724	96.3%
Diesel powered													
Light vehicles	^c	15	8	8	13	13	13	13	14	12	12	12	0.2%
Light trucks ^b	^c	^c	2	2	3	3	3	4	4	5	5	5	0.1%
Heavy vehicles	266	335	392	360	297	302	301	313	302	245	227	205	3.4%
Total	266	350	402	370	313	318	317	330	320	262	244	222	3.7%
Total													
Highway vehicle total	13,435	10,925	9,198	9,647	6,544	6,477	6,548	6,893	6,110	6,114	5,946	5,946	100.0%
Percent diesel	2.0%	3.2%	4.4%	3.8%	4.8%	4.9%	4.8%	4.8%	5.2%	4.3%	4.1%	3.7%	

Source:

U. S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998*, 2000, p. A-16 and annual.

(Additional resources: www.epa.gov/oar/oaqps)

^aThe sums of subcategories may not equal total due to rounding.

^bLess than 8,500 pounds.

^cData are not available.

The transportation sector accounted for only 2% of the nation's particulate matter (PM-10) emissions in 1998. For details on the highway emissions of PM-10, see Table 4.9.

Table 4.8
Total National Emissions of Particulate Matter (PM-10), 1970–98^a
(million short tons)

Source category	1970	1980	1990	1995	1996	1997	1998	Percent of total, 1998
Highway vehicles	0.44	0.40	0.34	0.29	0.28	0.27	0.26	0.7%
Off-highway	0.22	0.40	0.49	0.46	0.46	0.46	0.46	1.3%
Transportation total	0.66	0.80	0.83	0.75	0.74	0.73	0.72	2.1%
Stationary fuel combustion total	2.87	2.45	1.20	1.18	1.17	1.09	1.09	3.1%
Industrial processes total	7.67	2.75	1.04	0.95	0.68	0.70	0.71	2.0%
Waste disposal and recycling total	1.00	0.27	0.27	0.29	0.30	0.31	0.31	0.9%
Miscellaneous total	0.84	0.85	26.63	23.91	30.14	31.40	31.40	91.9%
Total of all sources	13.04	7.12	29.96	27.07	33.04	34.23	34.74	100.0%

Source:

U. S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998*, 2000, pp. A-22–A-26, and annual. (Additional resources: <http://www.epa.gov/oar/oaqps>)

Note:

Emission estimation methodology changes indicated by shaded areas. Transportation methodologies changed in 1970, while all others changed in 1990.

^aFine particle matter less than 10 microns. The sums of subcategories may not equal total due to rounding.

Table 4.9
Emissions of Particulate Matter (PM-10) from Highway Vehicles, 1970–98^a
 (thousand short tons)

Source category	1970	1975	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998	Percent of total, 1998
Gasoline powered													
Light vehicles & motorcycles	225	207	120	77	61	64	65	62	62	55	56	56	21.8%
Light trucks ^b	70	72	55	43	30	31	31	35	32	41	41	40	15.6%
Heavy vehicles	13	15	15	14	10	9	10	10	9	9	9	8	3.1%
Total	308	294	190	134	101	104	106	107	103	105	106	104	40.5%
Diesel powered													
Light vehicles	^c	10	12	8	9	9	8	8	8	7	6	6	2.3%
Light trucks ^b	^c	^c	2	1	1	2	2	2	2	2	2	2	0.8%
Heavy vehicles	136	166	194	219	224	228	205	204	181	168	158	144	56.0%
Total	136	177	209	228	235	239	215	213	190	177	167	152	59.1%
Total													
Highway vehicle total	443	471	397	363	336	343	321	320	293	282	272	257	100.0%
Percent diesel	30.7%	37.6%	52.6%	62.8%	69.9%	69.7%	67.0%	66.6%	64.8%	62.8%	61.4%	59.1%	

Source:

U. S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998*, 2000, p. A-25 and annual.
 (Additional resources: www.epa.gov/oar/oaqps)

^aThe sums of subcategories may not equal total due to rounding.

^bLess than 8,500 pounds.

^cData are not available.

The transportation sector accounted for only 7% of the nation's particulate matter (PM-2.5) emissions in 1998. For details on the highway emissions of PM-2.5, see Table 4.11.

Table 4.10
Total National Emissions of Particulate Matter (PM-2.5), 1990–98
 (million short tons)

Source category	1990	1991	1992	1993	1994	1995	1996	1997	1998	Percent of total, 1998
Highway vehicles	0.28	0.29	0.28	0.26	0.26	0.23	0.22	0.21	0.20	2.4%
Off-highway	0.44	0.43	0.43	0.43	0.42	0.40	0.41	0.41	0.41	4.9%
Transportation total	0.71	0.72	0.71	0.68	0.68	0.63	0.63	0.62	0.61	7.3%
Stationary fuel combustion total	0.91	0.89	0.93	0.85	0.84	0.90	0.86	0.79	0.79	9.4%
Industrial processes total	0.56	0.57	0.58	0.50	0.50	0.50	0.38	0.39	0.39	4.7%
Waste disposal and recycling total	0.23	0.24	0.24	0.29	0.27	0.25	0.23	0.24	0.24	2.8%
Miscellaneous total	5.55	5.31	5.19	5.00	5.68	4.90	6.09	6.45	6.35	75.7%
Total of all sources	7.96	7.74	7.65	7.33	7.98	7.18	8.20	8.48	8.38	100.0%

Source:

U.S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998, 2000*, pp. A-27–A-31, and annual.

(Additional resources: www.epa.gov/oar/oaqps)

Diesel vehicles are responsible for the majority of highway vehicle PM-2.5 emissions. Nearly two-thirds of the PM-2.5 emissions are from heavy diesel trucks.

Table 4.11
Emissions of Particulate Matter (PM-2.5) from Highway Vehicles, 1990–98^a
(thousand short tons)

Source category	1990	1991	1992	1993	1994	1995	1996	1997	1998	Percent of total, 1998
Gasoline powered										
Light vehicles & motorcycles	37	38	38	38	36	36	32	32	33	16.8%
Light trucks ^b	19	21	20	20	23	20	25	25	25	12.7%
Heavy vehicles	7	6	6	7	7	6	6	6	5	2.5%
Total	63	65	64	65	66	62	63	63	63	32.0%
Diesel powered										
Light vehicles	8	8	8	7	7	7	6	6	5	2.5%
Light trucks ^b	1	1	2	1	2	2	2	2	2	1.0%
Heavy vehicles	203	212	206	183	182	161	149	140	127	64.5%
Total	212	221	216	192	190	169	157	147	134	68.0%
Total										
Highway vehicle total	275	286	280	257	256	231	221	211	197	100.0%
Percent diesel	77.1%	77.3%	77.1%	74.7%	74.2%	73.2%	71.0%	69.7%	68.0%	

Source:

U.S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998, 2000*, p. A-30 and annual.

(Additional resources: www.epa.gov/oar/oaqps)

^a The sums of subcategories may not equal total due to rounding.

^b Less than 8,500 pounds.

Historically the transportation sector, highway vehicles in particular, have been a major source of lead emissions in the U.S. Regulatory action in 1978 required a gradual reduction of the lead content of all gasoline over a period of many years. The transportation sector accounts for only 13% of lead emissions in 1998.

Table 4.12
National Lead Emission Estimates, 1970–98^a
(thousand short tons per year)

Source category	1970	1975	1980	1985	1990	1995	1996	1997	1998	Percent of total, 1998
Highway vehicles	171.96	130.21	60.50	18.05	0.42	0.02	0.02	0.02	0.02	0.5%
Off-highway	9.74	6.13	4.21	0.92	0.78	0.54	0.51	0.50	0.50	12.7%
Transportation total	181.70	136.34	64.71	18.97	1.20	0.56	0.52	0.52	0.52	13.1%
Stationary source fuel combustion	10.62	10.35	4.30	0.52	0.50	0.49	0.49	0.49	0.50	12.7%
Industrial processes	26.36	11.38	3.94	2.53	2.47	2.27	2.27	2.32	2.33	58.6%
Waste disposal and recycling total	2.20	1.60	1.21	0.87	0.80	0.60	0.61	0.62	0.62	15.6%
Total of all sources	220.87	159.66	74.15	22.89	4.98	3.93	3.90	3.95	3.97	100.0%

Source:

U. S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900-1998*, 2000, pp. A-34–A-35, and annual.
 (Additional resources: www.epa.gov/oar/oaqps)

^aThe sums of subcategories may not equal due to rounding.

Table 4.13
State-level Emissions for Criteria Pollutants, 1998
(thousand short tons)

State	Carbon monoxide	Nitrogen oxides ¹	Volatile organic compounds ^a	Sulfur dioxide	Particulate matter (PM-10)	Particulate matter (PM-2.5)
Alabama	2,361	619	419	764	619	184
Alaska	2,249	99	457	12	274	155
Arizona	1,370	450	281	225	336	145
Arkansas	1,147	267	223	125	529	132
California	8,072	1,456	1,215	182	1,973	535
Colorado	1,200	400	274	137	518	126
Connecticut	793	153	156	66	119	30
District of Columbia	100	23	22	11	6	2
Delaware	216	77	51	96	39	14
Florida	5,203	1,059	891	1,008	822	260
Georgia	3,998	730	576	660	1,103	320
Hawaii	321	59	53	35	35	11
Idaho	956	116	115	39	678	161
Illinois	2,890	1,076	748	1,153	1,028	261
Indiana	2,526	848	518	1,164	641	154
Iowa	1,045	343	239	283	602	130
Kansas	1,230	479	257	163	1,570	299
Kentucky	1,389	682	330	753	345	103
Louisiana	2,184	825	425	405	441	149
Maine	488	94	109	53	158	102
Maryland	1,107	344	183	339	227	57
Massachusetts	1,188	304	264	264	290	72
Michigan	3,309	880	765	628	569	153
Minnesota	1,552	476	381	162	1,011	222
Mississippi	1,414	353	304	305	458	130
Missouri	1,816	546	360	482	1,286	252
Montana	703	176	105	60	1,137	216
Nebraska	681	239	154	94	632	125
Nevada	520	157	98	66	143	39
New Hampshire	355	82	74	148	54	17
New Jersey	1,454	466	408	257	313	96
New Mexico	855	279	140	199	4,987	781
New York	3,337	723	753	688	767	222
N. Carolina	2,773	745	605	729	501	172
N. Dakota	380	235	105	327	430	92
Ohio	3,934	1,198	706	1,921	658	195
Oklahoma	1,518	440	295	157	1,033	193
Oregon	1,988	271	272	58	686	224
Pennsylvania	2,909	840	575	1,221	547	156
Rhode Island	221	35	49	12	25	8
S. Carolina	1,638	367	334	290	410	112
S. Dakota	333	119	78	53	349	73
Tennessee	2,037	761	528	789	375	130
Texas	5,644	2,140	1,388	1,096	3,655	733
Utah	942	233	161	79	238	69
Vermont	240	46	44	16	75	18
Virginia	2,149	532	471	373	409	118
Washington	2,035	364	347	155	430	149
W. Virginia	721	500	141	787	152	50
Wisconsin	1,600	480	400	378	391	112
Wyoming	361	270	68	179	663	122
Total	89,454	24,454	17,917	19,647	34,741	8,379

Source:

U.S. Environmental Protection Agency, *National Air Pollutant Emission Trends, 1900–1998*, 2000, p. 2-8.

(Additional resources: www.epa.gov/oar/oaqps)

Note:

The sums of the States may not equal national totals due to rounding.

¹ Excluding biogenics.

The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model

The energy and criteria pollutant estimates of the most recent version (Version 1.5a) of the GREET model are displayed in the next two tables. The model estimates the full fuel-cycle emissions and energy use associated with various transportation fuels and advanced transportation technologies for light vehicles. It calculates fuel-cycle emissions of **five criteria pollutants** (volatile organic compounds, carbon monoxide, nitrogen oxides, sulfur oxides, and particulate matter measuring 10 microns or less) and three greenhouse gases (carbon dioxide, methane, and nitrous oxide). **See Chapter 3 for the greenhouse gas data from GREET.** The model also calculates the total fuel-cycle energy consumption, fossil fuel consumption, and petroleum consumption using various transportation fuels. The fuel cycles that are included in the GREET model are:

- petroleum to conventional gasoline, reformulated gasoline, conventional diesel, reformulated diesel, liquefied petroleum gas, and electricity via residual oil;
- natural gas to compressed natural gas, liquefied natural gas, liquefied petroleum gas, methanol, Fischer-Tropsch diesel, dimethyl ether, hydrogen, and electricity;
- coal to electricity;
- uranium to electricity;
- renewable energy (hydropower, solar energy, and wind) to electricity;
- corn, woody biomass, and herbaceous biomass to ethanol;
- soybeans to biodiesel; and
- landfill gases to methanol.

Near-term technologies are ones which may be applied to 2000 model-year cars and *long-term* technologies are ones which may be applied to 2010 model-year cars.

For additional information about the GREET model, see *GREET 1.5 – Transportation Fuel-Cycle Model, Volume 1: Methodology, Development, Use and Results*, ANL/ESD-39, Vol. 1, August 1999, or contact:

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GREET Web Site:
<http://www.transportation.anl.gov/ttrdc/greet/>

Acronyms Used on Tables 4.14 and 4.15

Emissions acronyms

CO	carbon monoxide
NO _x	nitrogen oxides
PM ₁₀	particulate matter measuring 10 microns or less
SO _x	sulfur oxides
VOC	volatile organic compounds

Geographical acronyms

CA	California
NE	northeast
US	United States

Technologies acronyms

BD20	mixture of 20% biodiesel and 80% conventional diesel (by volume)
CARFG2	California Phase 2 reformulated gasoline
CD	conventional diesel
CIDI	compression ignition, direct injection
CNG	compressed natural gas
CNGV	compressed natural gas vehicle
Dedi.	dedicated
DME	dimethyl ether
E10	mixture of 10% ethanol and 90% gasoline (by volume)
E85	mixture of 85% ethanol and 15% gasoline (by volume)
E90	mixture of 90% ethanol and 10% gasoline (by volume)
ETBE	ethyl tertiary butyl ether
EtOH	ethanol
EtOHV	ethanol vehicle
EV	electric vehicle
FCV	fuel-cell vehicle
FFV	flexible fuel vehicle
FRFG2	federal Phase 2 reformulated gasoline
FG	flared gas
FT50	mixture of 50% Fischer-Tropsch diesel and 50% conventional diesel (by volume)
FT100	100% Fischer-Tropsch diesel
GC	grid-connected
GI	grid-independent
GHGs	greenhouse gases
GV	gasoline vehicle
H ₂	hydrogen
HB	herbaceous biomass
HEV	hybrid electric vehicle
LFG	land-fill gas
LNG	liquefied natural gas
LNGV	liquefied natural gas vehicle
LPG	liquefied petroleum gas
LPGV	liquefied petroleum gas vehicle
M85	mixture of 85% methanol and 15% gasoline by volume
M90	mixture of 90% methanol and 10% gasoline by volume
MeOH	methanol
MeOHV	methanol vehicle
MTBE	methyl tertiary butyl ether
NG	natural gas
RFD	reformulated diesel
SI	spark ignition
SIDI	spark-ignition, direct-injection
WB	woody biomass

Table 4.14
NEAR-TERM Technology (for MY 2000 vehicles)

**Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to conventional gasoline vehicles fueled with conventional gasoline)**

	GV: FRFG2, MTBE	GV: FRFG2, EtOH	CIDI: CD	Bi-Fuel CNGV on CNG	Dedi. CNGV	Dedi. LPGV: NG	Dedi. LPGV: Crude	M85 FFV: NG	E85 FFV: Corn
Total Emissions:									
Total Energy	0.0%	0.4%	-29.7%	8.6%	5.1%	-9.6%	-8.6%	15.3%	17.8%
Fossil fuels	0.0%	-3.5%	-29.6%	6.9%	3.4%	-9.2%	-8.6%	16.0%	-41.9%
Petroleum	-11.0%	-3.6%	-26.7%	-99.3%	-99.4%	-98.2%	-3.4%	-72.6%	-74.3%
VOC	-15.6%	-11.1%	-61.5%	-52.0%	-75.0%	-64.2%	-59.3%	-19.3%	55.6%
CO	-19.1%	-19.5%	-79.4%	-19.0%	-19.0%	-25.0%	-24.6%	-22.7%	-37.4%
NOx	0.7%	2.8%	55.8%	35.0%	26.6%	-20.5%	-15.4%	1.4%	103.3%
PM10	-1.6%	38.9%	158.8%	-33.0%	-34.9%	-42.2%	-32.8%	-26.5%	619.9%
SOx	-28.8%	-16.2%	-31.3%	-28.3%	-30.6%	-77.3%	-57.3%	-58.7%	168.7%
Urban Emissions:									
VOC	-19.7%	-20.2%	-62.8%	-47.7%	-76.6%	-60.3%	-63.2%	-20.2%	-19.1%
CO	-20.0%	-20.0%	-80.5%	-19.5%	-19.5%	-24.9%	-24.9%	-25.0%	-39.9%
NOx	-4.2%	-4.6%	111.5%	29.8%	19.1%	-9.3%	-9.1%	-12.0%	-7.6%
PM10	-1.4%	-1.7%	258.6%	-29.8%	-31.7%	-31.3%	-31.3%	-22.8%	-20.7%
SOx	-82.7%	-82.9%	-4.0%	-96.0%	-96.1%	-98.1%	-98.0%	-73.7%	-79.0%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.14 (continued)
NEAR-TERM Technology (for MY 2000 vehicles)

Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to conventional gasoline vehicles fueled with conventional gasoline)

	E10 GV:		EV: NE US		GC SIDI		GI SIDI	GI SIDI	
	Corn	EV: US Mix	Mix	EV: CA Mix	HEV:	HEV:	HEV:	HEV:	GI CIDI
					CARFG2,	FRFG2,	FRFG2,	FRFG2,	HEV: CD
					EtOH, CA	MTBE	EtOH		
					Mix				
Total Emissions:									
Total Energy	2.0%	-13.7%	-14.2%	-17.0%	-35.8%	-47.4%	-47.2%	-47.2%	-52.5%
Fossil fuels	-3.4%	-39.1%	-46.4%	-69.0%	-52.6%	-47.4%	-49.2%	-49.2%	-52.5%
Petroleum	-6.3%	-98.2%	-96.8%	-99.6%	-61.7%	-53.2%	-49.3%	-49.3%	-50.6%
VOC	14.7%	-88.7%	-91.5%	-96.1%	-50.6%	-34.1%	-31.7%	-31.7%	-65.2%
CO	-42.8%	-98.1%	-98.0%	-98.7%	-44.0%	-20.4%	-20.6%	-20.6%	-80.0%
NOx	10.1%	64.3%	14.3%	-50.5%	-24.5%	-17.2%	-16.1%	-16.1%	47.4%
PM10	57.7%	48.9%	12.3%	-30.3%	-3.0%	-12.2%	9.1%	9.1%	151.8%
SOx	15.7%	464.9%	242.4%	-5.9%	-40.1%	-62.6%	-55.9%	-55.9%	-53.7%
Urban Emissions:									
VOC	10.5%	-99.8%	-99.5%	-99.6%	-51.1%	-30.4%	-30.6%	-30.6%	-63.7%
CO	-43.9%	-99.9%	-99.9%	-99.9%	-44.0%	-20.0%	-20.0%	-20.0%	-80.6%
NOx	0.2%	-95.8%	-90.8%	-93.2%	-29.3%	-1.8%	-2.0%	-2.0%	110.6%
PM10	0.1%	-35.9%	-33.3%	-34.7%	-6.3%	6.0%	5.8%	5.8%	258.0%
SOx	-6.7%	-96.2%	-90.4%	-99.1%	-93.2%	-90.9%	-91.0%	-91.0%	-35.2%

Source:

Wang, Michael Q., GREET 1.5a Model Results, Argonne National Laboratory, Argonne, IL, April 2000.

Note: See page preceding Table 4.14 for acronym definitions.

Table 4.15
LONG-TERM Technology (for MY 2010 vehicles)
Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	Dedi. CNGV	Dedi. LNGV: NG	Dedi. LNGV: FG	Dedi. LPGV: NG	Dedi. LPGV: Crude	Dedi. MeOHV: M90, NG	Dedi. MeOHV: M90, FG	Dedi. EtOHV: E90, Corn	Dedi. EtOHV: E90, WB
Total Emissions:									
Total Energy	-8.5%	-5.7%	-89.8%	-17.8%	-16.9%	10.5%	-77.5%	10.1%	90.7%
Fossil fuels	-9.4%	-5.2%	-90.0%	-17.5%	-16.9%	11.1%	-77.7%	-52.0%	-88.7%
Petroleum	-99.4%	-97.8%	-95.9%	-98.2%	-1.3%	-78.1%	-78.1%	-80.1%	-76.1%
VOC	-63.3%	-54.1%	-59.8%	-56.8%	-50.8%	-13.8%	-20.0%	87.4%	20.2%
CO	-38.8%	-36.7%	-40.8%	-40.1%	-39.5%	2.4%	-2.2%	1.7%	15.1%
NOx	31.0%	77.6%	-23.3%	-38.4%	-29.8%	4.5%	-115.6%	156.9%	287.7%
PM10	-33.4%	-29.5%	-68.5%	-38.4%	-30.1%	-22.4%	-62.5%	601.2%	147.6%
SOx	-32.6%	-76.9%	-77.1%	-71.8%	-48.4%	-59.1%	-60.6%	140.8%	-159.8%
Urban Emissions:									
VOC	-57.1%	-58.2%	-58.6%	-47.4%	-51.1%	-11.1%	-11.1%	-9.4%	-9.4%
CO	-39.3%	-39.9%	-40.0%	-39.9%	-39.9%	-0.2%	-0.2%	0.0%	-0.1%
NOx	106.3%	-8.3%	-11.0%	-3.7%	-2.8%	-17.2%	-17.2%	7.4%	0.4%
PM10	-24.5%	-25.9%	-26.1%	-25.2%	-25.1%	-14.5%	-14.5%	-12.4%	-12.9%
SOx	-80.6%	-98.1%	-98.3%	-91.5%	-91.3%	-77.9%	-77.9%	-83.0%	-85.4%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)
Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	Dedi. EtOHV: E90, HB	SIDI: FRFG2, EtOH	Dedi. MeOH SIDI: M90, NG	Dedi. MeOH SIDI: M90, FG	Dedi. EtOH SIDI: E90, Corn	Dedi. EtOH SIDI: E90, WB	Dedi. EtOH SIDI: E90, HB	GI SIDI HEV: FRFG2, EtOH	GI SI HEV: CNG
Total Emissions:									
Total Energy	77.6%	-20.0%	-5.2%	-82.7%	-3.1%	67.8%	56.3%	-47.4%	-43.5%
Fossil fuels	-80.5%	-20.0%	-4.7%	-135.5%	-57.8%	-90.1%	-82.8%	-47.4%	-44.0%
Petroleum	-78.5%	-20.0%	-82.1%	-82.1%	-82.5%	-78.9%	-81.1%	-47.4%	-99.6%
VOC	13.9%	-11.4%	-22.8%	-28.3%	69.1%	10.0%	4.5%	-28.7%	-66.3%
CO	12.4%	-0.8%	1.2%	-2.9%	0.9%	12.7%	10.4%	-2.0%	-40.4%
NOx	307.8%	-16.6%	-14.0%	-119.6%	128.2%	243.2%	261.0%	-39.2%	-12.4%
PM10	129.9%	-4.2%	-20.2%	-55.4%	532.5%	133.3%	117.7%	-21.5%	-33.7%
SOx	-97.5%	-20.0%	-75.6%	-76.8%	111.9%	-152.6%	-97.8%	-47.4%	-58.3%
Urban Emissions:									
VOC	-9.5%	-7.3%	-15.8%	-15.8%	-14.4%	-14.4%	-14.5%	-32.1%	-58.3%
CO	0.0%	-0.1%	-0.2%	-0.2%	0.0%	-0.1%	-0.1%	-0.1%	-39.6%
NOx	3.3%	-4.9%	-18.3%	-18.3%	3.4%	-2.8%	-0.2%	-11.7%	55.7%
PM10	-12.7%	12.0%	-2.1%	-2.1%	-0.3%	-0.7%	-0.5%	5.0%	-16.5%
SOx	-84.0%	-20.0%	-80.6%	-80.6%	-85.0%	-87.1%	-85.9%	-47.4%	-88.0%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)

Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	GI SI HEV: LNG, NG	GI SI HEV: LNG, FG	GI SI HEV: LPG, NG	GI SI HEV: LPG, Crude	GI SIDI HEV: M90, NG	GI SIDI HEV: M90, FG	GI SIDI HEV: E90, Corn	GI SIDI HEV: E90, WB	GI SIDI HEV: E90, HB
Total Emissions:									
Total Energy	-41.8%	-93.7%	-46.8%	-46.2%	-54.0%	-54.1%	-36.3%	10.4%	2.8%
Fossil fuels	-41.4%	-93.8%	-46.6%	-46.3%	-35.7%	-121.7%	-72.2%	-93.5%	-88.7%
Petroleum	-98.7%	-97.5%	-98.8%	-36.1%	-87.3%	-87.3%	-88.5%	-86.1%	-87.5%
VOC	-60.6%	-64.1%	-60.5%	-56.6%	-33.5%	-37.1%	25.0%	-13.9%	-17.6%
CO	-39.1%	-41.6%	-41.1%	-40.7%	-0.7%	-3.3%	-1.1%	6.7%	5.1%
NOx	16.3%	-46.0%	-54.0%	-48.4%	-32.2%	-101.7%	56.1%	131.8%	143.5%
PM10	-31.3%	-55.4%	-36.5%	-31.1%	-25.6%	-48.7%	335.5%	72.9%	62.6%
SOx	-85.8%	-85.9%	-81.7%	-66.6%	-76.3%	-77.2%	39.4%	-134.6%	-98.6%
Urban Emissions:									
VOC	-58.9%	-59.2%	-50.0%	-52.4%	-25.7%	-25.7%	-24.7%	-24.7%	-24.8%
CO	-40.0%	-40.1%	-40.0%	-40.0%	-0.2%	-0.2%	-0.1%	-0.2%	-0.1%
NOx	-15.2%	-16.8%	-11.6%	-11.1%	-21.0%	-21.0%	-6.7%	-10.8%	-9.1%
PM10	-17.3%	-17.5%	-16.8%	-16.8%	-7.1%	-7.1%	-5.9%	-6.2%	-6.0%
SOx	-98.8%	-98.9%	-94.5%	-94.4%	-87.2%	-87.2%	-90.1%	-91.5%	-90.7%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)
Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	GC SIDI HEV: RFG2, EtOH, US Mix	GC SIDI HEV: RFG2, EtOH, NE US Mix	GC SIDI HEV: RFG2, EtOH, CA Mix	GC SI HEV: CNG, US Mix	GC SI HEV: CNG, NE US Mix	GC SI HEV: CNG, CA Mix	GC SI HEV: LNG, NG, US Mix	GC SI HEV: LNG, FG, US Mix	GC SI HEV: LNG, NG, NE US Mix
Total Emissions:									
Total Energy	-43.9%	-44.4%	-44.1%	-40.9%	-41.5%	-41.2%	-39.7%	-77.2%	-40.2%
Fossil fuels	-47.5%	-48.8%	-55.3%	-45.9%	-47.3%	-54.0%	-44.0%	-81.8%	-45.2%
Petroleum	-61.4%	-61.3%	-61.7%	-99.3%	-99.2%	-99.7%	-98.7%	-97.8%	-98.5%
VOC	-46.7%	-47.6%	-48.8%	-72.0%	-73.1%	-74.5%	-67.9%	-70.5%	-68.8%
CO	-30.6%	-30.6%	-30.9%	-44.2%	-44.1%	-44.5%	-43.2%	-45.0%	-43.2%
NOx	4.9%	-12.3%	-37.0%	25.1%	6.9%	-19.5%	45.8%	0.9%	31.2%
PM10	-18.7%	-24.2%	-30.3%	-17.8%	-26.1%	-35.3%	-16.1%	-33.5%	-23.2%
SOx	68.1%	11.4%	-40.4%	73.3%	5.1%	-61.3%	53.5%	53.4%	-6.2%
Urban Emissions:									
VOC	-43.7%	-43.6%	-43.7%	-69.2%	-69.1%	-69.2%	-69.7%	-69.8%	-69.6%
CO	-30.1%	-30.0%	-30.0%	-43.7%	-43.7%	-43.7%	-44.0%	-44.0%	-44.0%
NOx	-32.2%	-26.4%	-30.8%	16.3%	21.9%	17.7%	-34.8%	-36.0%	-29.4%
PM10	-6.1%	-5.6%	-6.0%	-21.2%	-20.6%	-21.1%	-21.8%	-21.9%	-21.3%
SOx	-59.2%	-55.9%	-61.4%	-88.1%	-84.4%	-90.7%	-95.9%	-96.0%	-92.7%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)

Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	GC SI HEV: LNG, FG, NE US Mix	GC SI HEV: LNG, NG, CA Mix	GC SI HEV: LNG, FG, CA Mix	GC SI HEV: LPG, NG, U.S. Mix	GC SI HEV: LPG, Crude, U.S. Mix	GC SI HEV: LPG, NG, NE US Mix	GC SI HEV: LPG, Crude, NE US Mix	GC SI HEV: LPG, NG, CA Mix	GC SI HEV: LPG, Crude, CA Mix
Total Emissions:									
Total Energy	-77.7%	-40.0%	-77.4%	-43.3%	-42.9%	-43.9%	-43.5%	-43.6%	-43.2%
Fossil fuels	-83.1%	-51.0%	-89.4%	-47.7%	-47.5%	-49.0%	-48.8%	-55.0%	-55.0%
Petroleum	-97.6%	-98.9%	-98.1%	-98.8%	-53.6%	-98.6%	-53.4%	-99.1%	-53.8%
VOC	-71.4%	-70.1%	-72.7%	-68.2%	-65.3%	-69.1%	-66.3%	-70.4%	-67.6%
CO	-45.0%	-43.5%	-45.3%	-44.7%	-44.4%	-44.6%	-44.3%	-45.0%	-44.7%
NOx	-15.5%	10.0%	-39.3%	-4.9%	-0.9%	-21.9%	-18.2%	-46.5%	-43.5%
PM10	-40.9%	-31.1%	-49.1%	-19.8%	-15.9%	-27.1%	-23.4%	-35.3%	-31.7%
SOx	-6.5%	-64.3%	-65.0%	56.4%	67.3%	-4.6%	5.8%	-64.0%	-54.1%
Urban Emissions:									
VOC	-69.8%	-69.6%	-69.8%	-63.6%	-65.3%	-63.5%	-65.2%	-63.6%	-65.3%
CO	-44.0%	-44.0%	-44.0%	-44.0%	-44.0%	-44.0%	-44.0%	-44.0%	-44.0%
NOx	-30.6%	-33.5%	-34.7%	-32.3%	-31.9%	-26.8%	-26.2%	-30.9%	-30.4%
PM10	-21.4%	-21.7%	-21.8%	-21.5%	-21.4%	-20.9%	-20.9%	-21.3%	-21.3%
SOx	-92.7%	-98.2%	-98.3%	-92.8%	-92.7%	-89.5%	-89.3%	-95.1%	-95.1%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)
Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	GC SIDI HEV: M90, NG, US Mix	GC SIDI HEV: M90, FG, US Mix	GC SIDI HEV: M90, NG, NE US Mix	GC SIDI HEV: M90, FG, NE US Mix	GC SIDI HEV: M90, NG, CA Mix	GC SIDI HEV: M90, FG, CA Mix	GC SIDI HEV: E90, Corn, US Mix	GC SIDI HEV: E90, WB, US Mix	GC SIDI HEV: E90, HB, US Mix
Total Emissions:									
Total Energy	-35.7%	-72.3%	-36.2%	-72.9%	-35.9%	-72.6%	-35.9%	-2.3%	-7.8%
Fossil fuels	-40.0%	-101.8%	-41.2%	-103.2%	-47.1%	-109.7%	-66.2%	-81.5%	-78.1%
Petroleum	-90.5%	-90.5%	-90.3%	-90.3%	-90.8%	-90.8%	-91.3%	-89.7%	-90.7%
VOC	-50.0%	-52.6%	-50.9%	-53.5%	-52.1%	-54.7%	-7.9%	-35.9%	-38.5%
CO	-29.7%	-31.6%	-29.6%	-31.5%	-29.9%	-31.8%	-30.0%	-24.4%	-25.5%
NOx	10.7%	-39.2%	-5.5%	-57.3%	-29.0%	-83.6%	74.2%	128.6%	137.0%
PM10	-12.1%	-28.8%	-19.2%	-36.2%	-27.1%	-44.4%	247.5%	58.7%	51.3%
SOx	60.2%	59.6%	0.7%	0.0%	-57.3%	-58.2%	143.4%	18.3%	44.3%
Urban Emissions:									
VOC	-47.9%	-47.9%	-47.8%	-47.8%	-47.8%	-47.8%	-47.2%	-47.2%	-47.2%
CO	-30.1%	-30.1%	-30.1%	-30.1%	-30.1%	-30.1%	-30.1%	-30.1%	-30.1%
NOx	-39.0%	-39.0%	-33.5%	-33.5%	-37.7%	-37.7%	-28.8%	-31.7%	-30.5%
PM10	-14.7%	-14.7%	-14.2%	-14.2%	-14.6%	-14.6%	-13.8%	-14.0%	-13.9%
SOx	-87.6%	-87.6%	-84.3%	-84.3%	-89.8%	-89.8%	-89.7%	-90.7%	-90.1%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)

**Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
 (percentage relative to gasoline vehicles fueled with reformulated gasoline)**

	GC SIDI HEV: E90, Corn, NE US Mix	GC SIDI HEV: E90, WB, NE US Mix	GC SIDI HEV: E90, HB, NE US Mix	GC SIDI HEV: E90, Corn, CA Mix	GC SIDI HEV: E90, WB, CA Mix	GC SIDI HEV: E90, HB, CA Mix	CIDI: RFD	CIDI: DME, NG	CIDI: DME, FG
Total Emissions:									
Total Energy	-36.4%	-2.6%	-8.2%	-36.1%	-2.5%	-8.0%	-35.1%	-17.1%	-94.8%
Fossil fuels	-67.5%	-82.4%	-79.2%	-73.7%	-86.6%	-84.6%	-35.1%	-16.6%	-148.4%
Petroleum	-91.2%	-89.5%	-90.5%	-91.6%	-89.8%	-90.9%	-25.0%	-97.9%	-97.9%
VOC	-8.7%	-36.4%	-39.3%	-9.9%	-37.2%	-40.3%	-62.4%	-73.5%	-83.9%
CO	-29.9%	-24.3%	-25.4%	-30.2%	-24.5%	-25.7%	-2.2%	-0.1%	-4.1%
NOx	60.4%	123.6%	128.5%	40.4%	116.4%	116.1%	-22.1%	-18.3%	-124.2%
PM10	244.5%	55.5%	46.4%	241.1%	51.9%	40.9%	-12.7%	-34.5%	-69.7%
SOx	97.1%	-19.9%	-6.0%	52.0%	-57.2%	-55.0%	-34.1%	-81.9%	-83.4%
Urban Emissions:									
VOC	-47.1%	-47.1%	-47.1%	-47.2%	-47.2%	-47.2%	-63.4%	-76.0%	-76.0%
CO	-30.0%	-30.1%	-30.0%	-30.0%	-30.1%	-30.1%	-0.1%	-0.3%	-0.3%
NOx	-23.4%	-28.3%	-25.9%	-27.4%	-30.9%	-29.3%	43.1%	32.7%	32.7%
PM10	-13.3%	-13.7%	-13.5%	-13.7%	-14.0%	-13.8%	-1.4%	-12.0%	-12.0%
SOx	-86.4%	-88.5%	-87.3%	-92.0%	-92.2%	-92.1%	6.8%	-95.7%	-95.7%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)
Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	CIDI: FT100, NG	CIDI: FT100, FG	CIDI: BD20	GI CIDI HEV: RFD	GI CIDI HEV: DME, NG	GI CIDI HEV: DME, FG	GI CIDI HEV: FT100, NG	GI CIDI HEV: FT100, FG	GI CIDI HEV: BD20
Total Emissions:									
Total Energy	4.0%	-92.0%	-31.5%	-57.7%	-45.9%	-96.6%	-32.2%	-94.8%	-55.3%
Fossil fuels	4.7%	-145.6%	-31.7%	-57.7%	-45.6%	-131.6%	-31.7%	-129.8%	-55.5%
Petroleum	-97.5%	-97.5%	-36.7%	-51.1%	-98.6%	-98.6%	-98.4%	-98.4%	-58.7%
VOC	-71.5%	-77.8%	-37.8%	-67.1%	-76.9%	-83.7%	-73.1%	-77.2%	-51.1%
CO	-0.2%	-4.9%	0.0%	-3.1%	-1.7%	-4.4%	-1.8%	-4.9%	-1.7%
NOx	-24.4%	-145.8%	20.9%	-38.6%	-36.1%	-105.2%	-40.1%	-119.3%	-10.6%
PM10	-34.3%	-74.9%	-5.9%	-20.1%	-36.5%	-59.5%	-35.7%	-62.2%	-16.4%
SOx	-82.6%	-83.5%	-32.6%	-57.0%	-88.2%	-89.2%	-88.6%	-89.3%	-56.1%
Urban Emissions:									
VOC	-66.7%	-66.7%	-61.3%	-64.6%	-76.3%	-76.3%	-66.8%	-66.8%	-63.2%
CO	-0.3%	-0.3%	0.5%	-0.2%	-0.3%	-0.3%	-0.3%	-0.3%	0.2%
NOx	33.0%	33.0%	78.6%	38.3%	31.5%	31.5%	31.7%	31.7%	61.4%
PM10	-8.9%	-8.9%	-0.8%	-2.0%	-12.1%	-12.1%	-9.0%	-9.0%	-2.7%
SOx	-94.9%	-94.9%	-9.6%	-30.4%	-97.2%	-97.2%	-96.7%	-96.7%	-41.1%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)

**Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
 (percentage relative to gasoline vehicles fueled with reformulated gasoline)**

	GC CIDI HEV: RFD, US Mix	GC CIDI HEV: RFD, NE US Mix	GC CIDI HEV: RFD, CA Mix	GC CIDI HEV: DME, NG, US Mix	GC CIDI HEV: DME, FG, US Mix	GC CIDI HEV: DME, NG, NE US Mix	GC CIDI HEV: DME, FG, NE US Mix	GC CIDI HEV: DME, NG, CA Mix	GC CIDI HEV: DME, FG, CA Mix
Total Emissions:									
Total Energy	-50.7%	-51.3%	-51.0%	-42.1%	-79.2%	-42.7%	-79.8%	-42.4%	-79.5%
Fossil fuels	-55.2%	-56.6%	-62.7%	-46.4%	-109.3%	-47.7%	-110.7%	-53.5%	-117.3%
Petroleum	-63.8%	-63.6%	-64.1%	-98.6%	-98.6%	-98.5%	-98.5%	-98.9%	-98.9%
VOC	-73.5%	-74.5%	-75.8%	-80.5%	-85.4%	-81.4%	-86.3%	-82.7%	-87.6%
CO	-31.4%	-31.3%	-31.7%	-30.4%	-32.3%	-30.3%	-32.3%	-30.6%	-32.6%
NOx	6.3%	-10.4%	-34.7%	8.1%	-42.5%	-7.9%	-60.4%	-31.1%	-86.4%
PM10	-8.0%	-15.2%	-23.3%	-19.9%	-36.7%	-27.0%	-44.1%	-34.9%	-52.3%
SOx	74.7%	16.0%	-41.3%	51.9%	51.2%	-7.7%	-8.5%	-65.8%	-66.7%
Urban Emissions:									
VOC	-75.1%	-75.0%	-75.0%	-83.3%	-83.3%	-83.2%	-83.2%	-83.3%	-83.3%
CO	-30.2%	-30.1%	-30.2%	-30.2%	-30.2%	-30.1%	-30.1%	-30.1%	-30.1%
NOx	-3.8%	1.2%	-2.6%	-2.4%	-2.4%	2.6%	2.6%	-1.1%	-1.1%
PM10	-11.8%	-11.3%	-11.7%	-18.2%	-18.2%	-17.7%	-17.7%	-18.1%	-18.1%
SOx	-48.3%	-45.3%	-50.4%	-94.7%	-94.7%	-91.5%	-91.5%	-97.0%	-97.0%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)
Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	GC CIDI HEV: FT100, NG, US Mix	GC CIDI HEV: FT100, FG, US Mix	GC CIDI HEV: FT100, NG, NE US Mix	GC CIDI HEV: FT100, FG, NE US Mix	GC CIDI HEV: FT100, NG, CA Mix	GC CIDI HEV: FT100, FG, CA Mix	GC CIDI HEV: BD20, US Mix	GC CIDI HEV: BD20, NE US Mix	GC CIDI HEV: BD20, CA Mix
Total Emissions:									
Total Energy	-32.1%	-77.9%	-32.6%	-78.5%	-32.3%	-78.2%	-49.0%	-49.6%	-49.3%
Fossil fuels	-36.2%	-108.0%	-37.5%	-109.4%	-43.2%	-115.9%	-53.6%	-55.0%	-61.3%
Petroleum	-98.4%	-98.4%	-98.2%	-98.3%	-98.7%	-98.7%	-69.4%	-69.2%	-69.7%
VOC	-77.9%	-80.9%	-78.8%	-81.8%	-80.1%	-83.1%	-61.8%	-62.7%	-64.0%
CO	-30.4%	-32.7%	-30.4%	-32.6%	-30.7%	-32.9%	-30.3%	-30.3%	-30.6%
NOx	5.2%	-52.8%	-10.8%	-71.0%	-34.1%	-97.5%	26.8%	10.3%	-13.6%
PM10	-19.3%	-38.7%	-26.4%	-46.1%	-34.3%	-54.3%	-5.3%	-12.7%	-20.9%
SOx	51.5%	51.1%	-7.9%	-8.5%	-65.8%	-66.5%	75.4%	14.5%	-44.7%
Urban Emissions:									
VOC	-76.6%	-76.6%	-76.6%	-76.6%	-76.6%	-76.6%	-74.1%	-74.0%	-74.0%
CO	-30.2%	-30.2%	-30.1%	-30.1%	-30.1%	-30.1%	-29.8%	-29.8%	-29.8%
NOx	-2.2%	-2.2%	2.8%	2.8%	-0.9%	-0.9%	19.6%	24.6%	20.8%
PM10	-16.0%	-16.0%	-15.5%	-15.5%	-15.9%	-15.9%	-11.5%	-11.0%	-11.4%
SOx	-94.4%	-94.4%	-91.1%	-91.1%	-96.6%	-96.6%	-53.7%	-50.5%	-55.9%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)
Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	Electric Vehicle, US Mix	Electric Vehicle, NE US Mix	Electric Vehicle, CA Mix	FCV: Gaseous H ₂ , NG, Central	FCV: Gaseous H ₂ , NG, Refueling Station	FCV: Gaseous H ₂ , Solar	FCV: Liquid H ₂ , NG	FCV: Liquid H ₂ , FG	FCV: Liquid H ₂ , Solar
Total Emissions:									
Total Energy	-39.0%	-40.9%	-39.9%	-53.8%	-48.3%	-62.6%	-38.9%	-86.9%	-71.9%
Fossil fuels	-54.0%	-58.4%	-79.0%	-55.8%	-49.8%	-91.4%	-39.4%	-87.1%	-71.7%
Petroleum	-98.7%	-98.2%	-99.6%	-99.6%	-96.5%	-99.8%	-99.1%	-99.2%	-98.5%
VOC	-89.4%	-92.5%	-96.9%	-95.4%	-92.8%	-96.4%	-94.3%	-99.9%	-96.2%
CO	-97.6%	-97.4%	-98.5%	-96.9%	-95.6%	-98.8%	-96.3%	-99.8%	-99.4%
NOx	107.7%	49.7%	-34.4%	-30.8%	0.8%	-39.3%	-32.5%	-109.3%	-85.7%
PM10	18.6%	-7.0%	-35.5%	-39.7%	-37.2%	-42.0%	-37.4%	-62.8%	-49.4%
SOx	377.4%	178.8%	-14.6%	-22.6%	-33.6%	-28.4%	-87.6%	-93.1%	-98.8%
Urban Emissions:									
VOC	-99.7%	-99.5%	-99.7%	-99.7%	-94.7%	-99.4%	-99.5%	-99.5%	-99.0%
CO	-99.9%	-99.8%	-99.9%	-99.9%	-97.1%	-99.8%	-100.0%	-100.0%	-99.9%
NOx	-81.5%	-61.6%	-76.5%	-85.4%	102.7%	-72.7%	-94.5%	-94.6%	-88.2%
PM10	-32.5%	-30.6%	-32.0%	-33.7%	-26.1%	-33.4%	-33.5%	-33.5%	-32.6%
SOx	-89.3%	-78.5%	-96.7%	-98.3%	-98.0%	-98.3%	-99.4%	-99.4%	-98.7%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)
Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	FCV: MeOH, NG	FCV: MeOH, FG	FCV: RFG2, EtOH	FCV: RFD	EtOH FCVs: Corn	EtOH FCVs: WB	EtOH FCVs: HB	NG FCV: CNG	FCV: LNG, NG
Total Emissions:									
Total Energy	-45.1%	-96.4%	-50.0%	-51.4%	-37.7%	13.9%	5.5%	-51.9%	-50.5%
Fossil fuels	-44.8%	-131.4%	-50.0%	-51.3%	-77.5%	-101.0%	-95.7%	-52.4%	-50.2%
Petroleum	-98.4%	-98.4%	-50.0%	-43.7%	-96.5%	-93.9%	-95.5%	-99.7%	-98.9%
VOC	-70.7%	-74.3%	-52.8%	-85.0%	-4.0%	-47.0%	-51.1%	-88.3%	-83.4%
CO	-77.2%	-79.9%	-78.7%	-79.0%	-77.2%	-68.6%	-70.3%	-78.8%	-77.7%
NOx	-53.6%	-123.6%	-55.2%	-58.3%	50.1%	133.8%	146.7%	-36.9%	-12.4%
PM10	-46.8%	-70.2%	-41.5%	-39.3%	354.1%	63.7%	52.3%	-46.0%	-44.0%
SOx	-85.7%	-86.5%	-53.7%	-55.6%	45.9%	-146.5%	-106.6%	-65.4%	-87.9%
Urban Emissions:									
VOC	-73.5%	-73.5%	-54.1%	-90.8%	-72.0%	-72.0%	-72.0%	-87.9%	-88.5%
CO	-80.0%	-80.0%	-79.9%	-79.9%	-79.8%	-79.9%	-79.9%	-79.6%	-79.9%
NOx	-82.5%	-82.5%	-72.6%	-63.7%	-55.1%	-62.1%	-59.2%	-15.7%	-75.9%
PM10	-34.0%	-34.0%	-32.7%	-33.1%	-31.6%	-32.0%	-31.8%	-32.4%	-33.2%
SOx	-96.6%	-96.6%	-95.6%	-75.7%	-95.8%	-98.2%	-96.8%	-99.1%	-99.0%

Table continued on next page. See page preceding Table 4.14 for acronym definitions.

Table 4.15 (continued)
LONG-TERM Technology (for MY 2010 vehicles)
Fuel-Cycle Energy and Criteria Pollutant Emission Changes of Alternative Transportation Fuels and Advanced Vehicle Technologies
(percentage relative to gasoline vehicles fueled with reformulated gasoline)

	FCV: LNG, FG	FCV: LPG, NG	FCV: LPG, Crude
Total Emissions:			
Total Energy	-94.7%	-54.8%	-54.3%
Fossil fuels	-94.7%	-54.6%	-54.3%
Petroleum	-97.9%	-99.0%	-96.9%
VOC	-86.5%	-86.2%	-82.9%
CO	-79.9%	-79.4%	-79.1%
NO _x	-65.4%	-72.2%	-67.5%
PM ₁₀	-64.5%	-48.3%	-43.8%
SO _x	-88.0%	-84.5%	-71.6%
Urban Emissions:			
VOC	-88.7%	-84.8%	-86.8%
CO	-80.0%	-79.9%	-79.9%
NO _x	-77.3%	-72.9%	-72.4%
PM ₁₀	-33.3%	-32.7%	-32.7%
SO _x	-99.1%	-95.3%	-95.2%

Source:

Wang, Michael Q., GREET 1.5a Model Results, Argonne National Laboratory, Argonne, IL, April 2000.

Note: See page preceding Table 4.14 for acronym definitions.

The average light truck pollutes 40 percent more than the average car, according to the American Council for an Energy-Efficient Economy. One reason for the difference is that cars and light trucks have not been held to the same emissions standards. However, that is beginning to change.

Early in 2000, the Environmental Protection Agency issued a final rule for more stringent tailpipe emission standards for all new passenger vehicles, including sport utility vehicles (SUVs), minivans, vans, and pick-up trucks. This is the first time that SUVs and other light-duty trucks are subjected to the same national pollution standards as passenger cars.

Table 4.16
Pollution from a Typical New Car and Light Truck, 2000 Model Year
(pounds of pollutant per 15,000 miles of travel)

	Car	Light truck
Carbon dioxide	15,200	21,200
Carbon monoxide	420	547
Nitrogen oxide	50	83
Hydrocarbons	55	74
Particulate matter	2.7	3.3

Source:

DeCicco, John, and Martin Thomas, *Green Guide to Cars and Trucks: Model Year 2000*, American Council for an Energy-Efficient Economy, Washington, DC, 2000, p. 113. (Additional resources: www.aceee.org)

Note:

Includes both tailpipe and fuel-cycle emissions. Assumes 15,000 miles driven per year.

Table 4.17
Tier 2 Federal Emission Standards

Vehicle types	Standard	Time frame
Light-duty vehicles and light light-duty trucks (less than 6,000 lbs. GVW)	0.07 grams per mile NO _x	Phased in 2004–2007
Heavy light-duty trucks (6,000–8,500 lbs. GVW) and medium-duty passenger vehicles (8,500–10,000 lbs. GVW)	0.07 grams per mile NO _x	Phased in 2004–2009

Source:

U.S. Environmental Protection Agency, Office of Mobile Sources, Regulatory Announcement, “EPA’s Program for Cleaner Vehicles and Cleaner Gasoline,” EPA420-F-99-051, December 1999. (*Federal Register*, Vol. 65, No. 28, Thursday, February 10, 2000.) (Additional resources: www.epa.gov/oms/tr2home.htm)

Table 4.18
Federal Exhaust Emission Certification Standards for Gasoline- and Diesel-Powered Light Vehicles *a,b*
(grams per mile)

Engine Type & Pollutant	Prior to control	1968-69	1970-71	1972	1973-74	1975-76	1977-79	1980	1981	1982-86	1987-93	1994-2004 ^b
Gasoline												
Hydrocarbons (total)	11	^c	2.2	3.4		1.5		0.41				0.41 (e)
Non-methane hydrocarbons	^d	^e										0.25 (0.31)
Carbon monoxide	80	^c	23	39		15		7.0	3.4			3.4 (4.2)
Cold-temp. carbon monoxide ^f	^d	^e										10 (e)
Nitrogen oxides	4	^e			3.0	3.1	2.0		1.0			0.4 (0.6)
Particulates	^d	^e										0.08 (0.10)
Diesel												
Hydrocarbons (total)	11	^e					1.5	0.41				0.41 (e)
Non-methane hydrocarbons	^d	^e										0.25 (0.31)
Carbon monoxide	80	^e				15		7.0	3.4			3.4 (4.2)
Nitrogen oxides	4	^e					3.1	2.0	1.0			1.0 (1.25)
Particulates	^d	^e								0.60	0.20	0.08 (0.10)
Test Procedure		7-mode	CVS-72		CVS-75			CVS-75				
Useful Life (intermediate) ^b		^e										5 yrs/50,000 mi
(full)			5 yrs/50,000 mi									10 yrs/100,000 mi

Source:

40 CFR 86.085-2; 40 CFR 86.090-2; 40 CFR 86.090-S; 40 CFR 86.094-8; 40 CFR 86.096-2; 40 CFR 86.096-8; 40 CFR 86.098-8; 40 CFR 86.099-8; 40 CFR 86.082-2; 40 CFR 86.000-8. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999.

^aThe test procedure for measuring exhaust emissions has changed several times over the course of vehicle emissions regulation. The 7-mode procedure was used through model year 1971 and was replaced by the CVS-72 procedure beginning in model year 1972. The CVS-75 became the test procedure as of model year 1975. While it may appear that the total hydrocarbon and carbon monoxide standards were relaxed in 1972-74, these standards were actually more stringent due to the more stringent nature of the CVS-72 test procedure. Additional standards for carbon monoxide and composite standards for non-methane hydrocarbons and nitrogen oxides tested over the new Supplemental Federal Test Procedure will be phased-in during model years 2000-02; these standards are not shown in this table.

^bAll emission standards must be met for a useful life of 5 years/50,000 miles. Beginning in with model year 1994, a second set of emission standards must also be met for a full useful life of 10 years/100,000 miles (these standards are shown in parentheses). Tier 1 exhaust standards were phased-in during 1994-96 at a rate of 40, 80, and 100 percent, respectively.

^cIn 1968-69, exhaust emission standards were issued in parts per million (ppm) rather than grams per mile and are, therefore, incompatible with this table.

^dNo estimate available.

^eNo standard set.

^fThe cold CO emission standard is measured at 20 degrees F (rather than 75 degrees F) and is applicable for a 5-year/50,000-mile useful life.

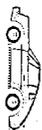




Table 4.19
Federal Exhaust Emission Certification Standards for Gasoline- and Diesel-Powered Light Trucks (Category LDT1) a,b,c
(grams per mile)

Engine Type & Pollutant	Prior to control	Year													
		1968-69	1970-71	1972	1973-74	1975	1976-78	1979-81	1982-83	1984	1985-86	1987	1988-93	1994	1995-2004
Gasoline															
Hydrocarbons (total)	11	<i>d</i>	2.2	3.4		2.0	1.7		0.80					<i>f</i> (0.80)	
Non-methane hydrocarbons	<i>e</i>													0.25 (0.31)	
Carbon monoxide	80	<i>d</i>	23	39		20	18		10					3.4 (4.2)	
Cold-temp. carbon monoxide <i>g</i>	<i>e</i>	<i>f</i>												10 (<i>f</i>)	
Nitrogen oxides <i>i d e</i>	4 <i>s</i>	<i>f</i>			3.0	3.1	2.3					1.2		0.4 (0.6)	
Particulates	<i>e</i>													0.08 (0.10)	
Diesel															
Hydrocarbons (total)	11	<i>f</i>				2.0	1.7		0.80					<i>f</i> (0.80)	
Non-methane hydrocarbons	<i>e</i>	<i>f</i>												0.25 (0.31)	
Carbon monoxide	80	<i>f</i>				20	18		10					3.4 (4.2)	
Nitrogen oxides	4	<i>f</i>				3.1	2.3					1.2		1.0 (1.25)	
Particulates	<i>e</i>	<i>f</i>						0.60			0.26			0.08 (0.10)	
LDT1 Weight Criteria <i>h</i>		GVWR up through 6,000 lbs					GVWR up through 8,500 lbs					GVWR up through 6,000 lbs; LVW up through 3,750 lbs			
Test Procedure <i>b</i>		7-mode	CVS-72	CVS-75											
Useful Life (intermediate) <i>c</i>		<i>f</i>												5 yrs/50,000 mi	
(full)		5 yrs/50,000 mi										11 yrs/120,000 mi	11 yrs/120,000 mi		

Source:

40 CFR 86.082-2; 40 CFR 86.085-2; 40 CFR 86.090-2; 40 CFR 86.090-g; 40 CFR 86.091-g; 40 CFR 86.094-g; 40 CFR 86.096-2; 40 CFR 86.096-g; 40 CFR 86.099-g; 40 CFR 86.000-g; 40 CFR 86.001-g; 40 CFR 86.004-g. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication.

^aLight truck categories LDT1-LDT4 were not actually created until 1994. From 1968 to 1978 all trucks with a Gross Vehicle Weight Rating (GVWR) up to 6,000 lbs were classified as light trucks and were required to meet the same standards. As of 1979, the maximum weight was raised to 8,500 lbs GVWR. During 1988 through 1993, light trucks were divided into two subcategories that coincide with the current LDT1 and LDT2/3/4 categories.

^bThe test procedure for measuring exhaust emissions has changed several times over the course of vehicle emissions regulation. The 7-mode procedure was used through model year 1971 and was replaced by the CVS-72 procedure beginning in model year 1972. The CVS-75 became the test procedure as of model year 1975. While it may appear that the total hydrocarbon and carbon monoxide standards were relaxed in 1972-74, these standards were actually more stringent due to the more stringent nature of the CVS-72 test procedure. Additional standards for carbon monoxide and composite standards for non-methane hydrocarbons and nitrogen oxides tested over the new Supplemental Federal Test Procedure will be phased-in during model years 2000-02; these standards are not shown in this table.

^cEmission standards had to be met for a useful life of 5 years/50,000 miles through model year 1983, and a full useful life of 11 years/120,000 miles was defined for 1985-93 (several useful life options were available for 1984). Beginning in model year 1994, emission standards were established for an intermediate useful life of 5 years/50,000 miles as well as a full useful life of 11 years/120,000 miles (these standards are shown in parentheses). Hydrocarbon standards, however, were established only for full useful life. Tier 1 exhaust standards, except PM standards, were phased-in during 1994-96 at a rate of 40, 80, and 100 percent, respectively. PM standards were phased-in at a rate of 40, 80, and 100 percent during 1995-97.

^dIn 1968-69, exhaust emission standards were issued in parts per million (ppm) rather than grams per mile and are, therefore, incompatible with this table.

^eNo estimate available.

^fNo standard set.

^gThe cold CO emission standard is measured at 20 degrees F (rather than 75 degrees F) and is applicable for a 5-year/50,000-mile useful life.

^hGross vehicle weight rating (GVWR) is the maximum design loaded weight. Loaded vehicle weight (LVW) is the curb weight (nominal vehicle weight) plus 300 lbs.

Table 4.20
Federal Exhaust Emission Certification Standards for Gasoline- and Diesel-Powered Light Trucks (Category LDT2) *a,b,c*
(grams per mile)

Engine Type & Pollutant	Prior to control															
	1968-69	1970-71	1972	1973-74	1975	1976-78	1979-81	1982-83	1984	1985-86	1987	1988-90	1991-93	1994	1995-2004	
Gasoline																
Hydrocarbons (total)	11	<i>d</i>	2.2	3.4		2.0		1.7		0.80				<i>f</i>	(0.80)	
Non-methane hydrocarbons	<i>e</i>	<i>f</i>												0.32	(0.40)	
Carbon monoxide	80	<i>d</i>	23	39		20		18		10				4.4	(5.5)	
Cold-temp. carbon monoxide <i>g</i>	<i>e</i>	<i>f</i>												12.5	(<i>ff</i>)	
Nitrogen oxides	4	<i>f</i>			3.0	3.1		2.3				1.7		0.7	(0.97)	
Particulates	<i>e</i>	<i>f</i>													0.08 (0.10)	
Diesel																
Hydrocarbons (total)	11	<i>f</i>				2.0		1.7		0.80				<i>f</i>	(0.80)	
Non-methane hydrocarbons	<i>e</i>	<i>f</i>												0.32	(0.40)	
Carbon monoxide	80	<i>f</i>				20		18		10				4.4	(5.5)	
Nitrogen oxides	4	<i>f</i>				3.1		2.3				1.7		<i>f</i>	(0.97)	
Particulates	<i>e</i>	<i>f</i>							0.60		0.50	0.45	0.13		0.08 (0.10)	
LDT2 Weight Criteria <i>h</i>		GVWR up through 6,000 lbs					GVWR up through 8,500 lbs					GVWR up through 6,000 lbs and LVW over 3,750 lbs				
Test Procedure <i>b</i>		7-mode		CVS-72		CVS-75										
Useful Life (intermediate) <i>c</i>		<i>f</i>													5 yrs/50,000 mi	
(full)		5 yrs/50,000 mi					11 yrs/120,000 mi					11 yrs/120,000 mi				

Source:
 40 CFR 86.082-2; 40 CFR 86.085-2; 40 CFR 86.090-2; 40 CFR 86.090-g; 40 CFR 86.091-g; 40 CFR 86.094-g; 40 CFR 86.096-2; 40 CFR 86.096-g; 40 CFR 86.099-g; 40 CFR 86.000-g; 40 CFR 86.001-9; 40 CFR 86.004-g. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999.

^aLight truck categories LDT1-LDT4 were not actually created until 1994. From 1968 to 1978 all trucks with a Gross Vehicle Weight Rating (GVWR) up to 6,000 lbs were classified as light trucks and were required to meet the same standards. As of 1979, the maximum weight was raised to 8,500 lbs GVWR. During 1988-93, light trucks were divided into two subcategories that coincide with the current LDT1 and LDT2/3/4 categories.

^bThe test procedure for measuring exhaust emissions has changed several times over the course of vehicle emissions regulation. The 7-mode procedure was used through model year 1971 and was replaced by the CVS-72 procedure beginning in model year 1972. The CVS-75 became the test procedure as of model year 1975. While it may appear that the total hydrocarbon and carbon monoxide standards were relaxed in 1972-74, these standards were actually more stringent due to the more stringent nature of the CVS-72 test procedure. Additional standards for carbon monoxide and composite standards for non-methane hydrocarbons and nitrogen oxides tested over the new Supplemental Federal Test Procedure will be phased-in during model years 2000-02; these standards are not shown in this table.

^cEmission standards had to be met for a useful life of 5 years/50,000 miles through model year 1983, and a full useful life of 11 years 120,000 miles was defined for 1985-93 (several useful life options were available for 1984). Beginning in model year 1994, emission standards were established for an intermediate useful life of 5 years/50,000 miles as well as a full useful life of 11 years/120,000 miles (these standards are shown in parentheses). Hydrocarbon standards, however, were established only for full useful life. Tier 1 exhaust standards, except PM standards, were phased-in during 1994-96 at a rate of 40, 80, and 100 percent, respectively. PM standards were phased-in at a rate of 40, 80, and 100 percent during 1995-97.

^dIn 1968-69, exhaust emission standards were issued in parts per million (ppm) rather than grams per mile and are, therefore, incompatible with this table.

^eNo estimate available.

^fNo standard set.

^gThe cold CO emission standard is measured at 20 degrees F (rather than 75 degrees F) and is applicable for a 5-year/50,000-mile useful life.

^hGross vehicle weight rating (GVWR) is the maximum design loaded weight. Loaded vehicle weight (LVW) is the curb weight (nominal vehicle weight) plus 300 lbs.



Table 4.21
Federal Exhaust Emission Certification Standards for Gasoline- and Diesel-Powered Light Trucks (Category LDT3) *a,b,c*
(grams per mile)

Engine Type & Pollutant	Prior to control	1968-69	1970-71	1972	1973-74	1975	1976-78	1979-81	1982-83	1984	1985-86	1987	1988-89	1990	1991-95	1996-2004
Gasoline																
Hydrocarbons (total)	11	<i>d</i>	2.2	3.4		2.0		1.7		0.80						<i>f</i> (0.80)
Non-methane hydrocarbons	<i>e</i>	<i>f</i>														0.32 (0.46)
Carbon monoxide	80	<i>d</i>	23	39		20		18		10						4.4 (6.4)
Cold-temp. carbon monoxide <i>g</i>	<i>e</i>	<i>f</i>														12.5 (<i>g</i>)
Nitrogen oxides	4	<i>f</i>			3.0	3.1		2.3					2.3	1.7		0.7 (0.98)
Particulates	<i>e</i>	<i>f</i>														<i>f</i> (0.10)
Diesel																
Hydrocarbons (total)	11	<i>f</i>					2.0	1.7		0.80						<i>f</i> (0.80)
Non-methane hydrocarbons	<i>e</i>	<i>f</i>														0.32 (0.46)
Carbon monoxide	80	<i>f</i>					20	18		10						4.4 (6.4)
Nitrogen oxides	4	<i>f</i>					3.1	2.3					2.3	1.7		<i>f</i> (0.98)
Particulates	<i>e</i>	<i>f</i>							0.60		0.50		0.45	0.13		<i>f</i> (0.10)
LDT3 Weight Criteria <i>h</i>		GVWR up through 6,000 lbs					GVWR up through 8,500 lbs					Any ALW		ALW up through 5,750 lbs		
												GVWR 6,001-8,500 lbs				
Test Procedure <i>b</i>	7-mode	CVS-72			CVS-75											
Useful Life (intermediate) <i>c</i>												5 yrs/50,000 mi				
(full)		5 yrs/50,000 mi										11 yrs/120,000 mi		11 yrs/120,000		

Source:

40 CFR 86.082-2; 40 CFR 86.085-2; 40 CFR 86.090-2; 40 CFR 86.090-g; 40 CFR 86.091-g; 40 CFR 86.094-g; 40 CFR 86.096-2; 40 CFR 86.096-g; 40 CFR 86.099-g; 40 CFR 86.000-g; 40 CFR 86.001-g; 40 CFR 86.004-g. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999.

^aLight truck categories LDT1-LDT4 were not actually created until 1994. From 1968 to 1978 all trucks with a Gross Vehicle Weight Rating (GVWR) up to 6,000 lbs were classified as light trucks and were required to meet the same standards. As of 1979, the maximum weight was raised to 8,500 lbs GVWR. During 1988-93, light trucks were divided into two subcategories that coincide with the current LDT1 and LDT2/3/4 categories.

^bThe test procedure for measuring exhaust emissions has changed several times over the course of vehicle emissions regulation. The 7-mode procedure was used through model year 1971 and was replaced by the CVS-72 procedure beginning in model year 1972. The CVS-75 became the test procedure as of model year 1975. While it may appear that the total hydrocarbon and carbon monoxide standards were relaxed in 1972-74, these standards were actually more stringent due to the more stringent nature of the CVS-72 test procedure. Additional standards for carbon monoxide and composite standards for non-methane hydrocarbons and nitrogen oxides tested over the new Supplemental Federal Test Procedure will be phased-in during model years 2002-04; these standards are not shown in this table.

^cEmission standards had to be met for a full useful life of 5 years/50,000 miles through model year 1983, and a full useful life of 11 years/120,000 miles was defined for 1985-93 (several useful life options were available for 1984). Beginning in model year 1996, emission standards were established for an intermediate useful life of 5 years/50,000 miles as well as a full useful life of 11 years/120,000 miles (these standards are shown in parentheses). This applied to all pollutants except hydrocarbons and particulates for all LDT3s and NOx for diesel-powered LDT3s, which were only required to meet full useful life standards. Tier 1 exhaust standards were phased-in during 1996-97 at a rate of 50 and 100 percent, respectively.

^dIn 1968-69, exhaust emission standards were issued in parts per million (ppm) rather than grams per mile and are, therefore, incompatible with this table.

^eNo estimate available.

^fNo standard set.

^gThe cold CO emission standard is measured at 20 degrees F (rather than 75 degrees F) and is applicable for a 5-year/50,000-mile useful life.

^hGross vehicle weight rating (GVWR) is the maximum design loaded weight. Loaded vehicle weight (LVW) is the curb weight (nominal vehicle weight) plus 300 lbs.

Table 4.22
Federal Exhaust Emission Certification Standards for Gasoline- and Diesel-Powered Light Trucks (Category LDT4) *a,b,c*
(grams per mile)

Engine Type & Pollutant	Prior to control	1968-69	1970-71	1972	1973-74	1975	1976-78	1979-81	1982-83	1984	1985-86	1987	1988-89	1990	1991-95	1996-2004
Gasoline																
Hydrocarbons (total)	11	<i>d</i>	2.2	3.4		2.0		1.7		10.80						<i>f</i> (0.80)
Non-methane hydrocarbons	<i>e</i>															0.39 (0.56)
Carbon monoxide	80	<i>d</i>	23	39		Go		18		10						5.0 (7.3)
Cold-temp. carbon monoxide <i>g</i>	<i>e</i>	<i>f</i>														12.5 (<i>f</i>)
Nitrogen oxides	4	<i>f</i>			3.0	3.1		2.3				2.3	1.7			1.1 (1.53)
Particulates	<i>e</i>															(0.12)
Diesel																
Hydrocarbons (total)	11	<i>f</i>					2.0	1.7		0.80						<i>f</i> (0.80)
Non-methane hydrocarbons	<i>e</i>	<i>f</i>														0.39 (0.56)
Carbon monoxide	80	<i>f</i>					20	18		10						5.0 (7.3)
Nitrogen oxides	4	<i>f</i>					3.1	2.3				2.3	1.7			<i>f</i> (1.53)
Particulates	<i>e</i>	<i>f</i>							0.60			0.50	0.45		0.13	<i>f</i> (0.12)
LDT4 Weight Criteria <i>h</i>		GVWR up through 6,000 lbs					GVWR up through 8,500 lbs					Any ALVW		ALVW over 5,750 lbs		
												GVWR 6,001-8,500 lbs				
Test Procedure <i>b</i>		7-mode	I	CVS-72		CVS-75										
Useful Life (intermediate) <i>c</i>												5 yrs/50,000 mi		11 yrs/120,000 mi		
(full)		5 yrs/50,000 mi					11 yrs/120,000 mi					11 yrs/120,000				

Source:

40 CFR 86.082-2; 40 CFR 86.085-2; 40 CFR 86.090-2; 40 CFR 86.090-g; 40 CFR 86.091-g; 40 CFR 86.094-g; 40 CFR 86.096-2; 40 CFR 86.096-g; 40 CFR 86.099-g; 40 CFR 86.000-g; 40 CFR 86.001-g; 40 CFR 86.004-g. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999.

^aLight truck categories LDT1-LDT4 were not actually created until 1994. From 1968 to 1978 all trucks with a Gross Vehicle Weight Rating (GVWR) up to 6,000 lbs were classified as light trucks and were required to meet the same standards. As of 1979, the maximum weight was raised to 8,500 lbs GVWR. During 1988-93, light trucks were divided into two subcategories that coincide with the current LDT1 and LDT2/3/4 categories.

^bThe test procedure for measuring exhaust emissions has changed several times over the course of vehicle emissions regulation. The 7-mode procedure was used through model year 1971 and was replaced by the CVS-72 procedure beginning in model year 1972. The CVS-75 became the test procedure as of model year 1975. While it may appear that the total hydrocarbon and carbon monoxide standards were relaxed in 1972-74, these standards were actually more stringent due to the more stringent nature of the CVS-72 test procedure. Additional standards for carbon monoxide and composite standards for non-methane hydrocarbons and nitrogen oxides tested over the new Supplemental Federal Test Procedure will be phased-in during model years 2002-04; these standards are not shown in this table.

^cEmission standards had to be met for a full useful life of 5 years/50,000 miles through model year 1983, and a full useful life of 11 years/120,000 miles was defined for 1985-93 (several useful life options were available for 1984). Beginning in model year 1996, emission standards were established for an intermediate useful life of 5 years/50,000 miles as well as a full useful life of 11 years/120,000 miles (these standards are shown in parentheses). This applied to all pollutants except hydrocarbons and particulates for all LDT3s and NO_x for diesel-powered LDT3s, which were only required to meet full useful life standards. Tier 1 exhaust standards were phased-in during 1996-97 at a rate of 50 and 100 percent, respectively.

^dIn 1968-69, exhaust emission standards were issued in parts per million (ppm) rather than grams per mile and are, therefore, incompatible with this table.

^eNo estimate available.

^fNo standard set.

^gThe cold CO emission standard is measured at 20 degrees F (rather than 75 degrees F) and is applicable for a 5-year/50,000-mile useful life.

^hGross vehicle weight rating (GVWR) is the maximum design loaded weight. Adjusted loaded vehicle weight (ALVW) is the numerical average of the GVWR and the curb weight.





**Table 4.23
Federal Exhaust Emission Certification Standards for Gasoline- and Diesel-Powered Light Heavy Trucks
(Grams per brake horsepower-hour)**

Engine Type & Pollutant	1970-73	1974-78	1979-83	1984	1985-86	1987	1988-89	1990	1991-93	1994-97	1998-2003	2004+
Gasoline												
Hydrocarbons + nitrogen oxides (HC + NOx)	<i>a</i>	16	10	<i>a</i>								
Hydrocarbons (HC)	<i>b</i>	<i>a</i>	1.5	1.9	1.1							
Nitrogen oxides (NOx)	<i>a</i>				110.6	6.0	15.0	14.0				
Carbon Monoxide (CO)	<i>b</i>	(40)	25	137.1	114.4							
Diesel												
Hydrocarbons + nitrogen oxides (HC + NOx)	<i>a</i>	16	10	<i>a</i>								
Hydrocarbons (HC)	<i>b</i>	<i>a</i>	1.5	1.3								
Nitrogen oxides (NOx)	<i>a</i>				10.7	6.0	5.0	4.0				
Non-methane hydrocarbons + nitrogen oxides	<i>a</i> 2.4 <i>c</i>											
Carbon Monoxide (CO)	<i>b</i>	40	(2 5	115.5								
Particulates	<i>a</i>						0.60	0.25	(0.10)			
Smoke Opacity (acceleration/lugging/peak) <i>d</i>	40/20/ <i>a</i>	20/15/50										
Weight Criteria for Light Heavy Trucks <i>e</i>	GVWR over 6,000 lbs			GVWR over 8,500 lbs			GVWR 8,501 through 14,000 lbs					
Test Procedure (gasoline)<i>f</i> (diesel) <i>f</i>	9-mode steady-state				MVMA transient							
	13-mode steady-state				EPA transient							
Useful Life (gasoline) <i>g</i>	5 years/50,000 miles				8 years/1 10,000 miles							

Sources:

40 CFR 86.082-2; 40 CFR 86.085-2; 40 CFR 86.088-10; 40 CFR 86.090-2; 40 CFR 86.090-10; 40 CFR 86,090-1 1; 40 CFR 86.091-10; 40 CFR 86.091-1 1; 40 CFR 86.093-1 1; 40 CFR 86.094-1 1; 40 CFR 86.096-2; 40 CFR 86.096-10; 40 CFR 86,096-1 1; 40 CFR 86.098-10; 40 CFR 86,098-1 1; 40 CFR 86.099-10; 40 CFR 86,099-1 1; 40 CFR 86,004-1 1; 40 CFR 86.004-15. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999. Rob French, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999.

^aNo standard set.

^bAlthough emission standards for hydrocarbons and carbon monoxide were in effect for these years, they were not measured in grams/brake horsepower-hour and are, therefore, incompatible with this table.

^cVehicles can meet a composite non-methane hydrocarbon and nitrogen oxide standard of 2.5, if they meet a non-methane hydrocarbon standard of no more than 0.5.

^dSmoke opacity is expressed in percentage for acceleration, lugging, and peak modes (acceleration/lugging/peak). Lugging is when a vehicle is carrying a load.

^eGross vehicle weight rating (GVWR) is the maximum design loaded weight.

^fSeveral testing procedures have been used during the course of exhaust emission control. A steady-state 9-mode test procedure (13-mode for diesel) was used for 1970-83 standards. For 1984, either the steady-state tests or the EPA transient test procedure could be used. For diesels, the EPA transient test was required from 1985 to the present. For gasoline-powered vehicles, either the EPA or MVMA (Motor Vehicle Manufacturers Association) transient test procedure could be used during 1985-86, and the MVMA procedure was required thereafter.

^gEmissions standards apply to the useful life of the vehicle. Useful life was 5 years/50,000 miles through 1983, and 8 years/1 10,000 miles for model year 1985 and after. 1984 was a transitional year in which vehicles could meet the older standard (and test procedure) or the newer one. Useful life requirement for gasoline-powered trucks meeting NOx standards for 1998 and after is 10 years/1 10,000 miles. The useful life requirements for heavy diesel truck standards are more complex and vary by vehicle weight, pollutant, test procedure, and year. Consult the U.S. Code of Federal Regulations for further information.

Table 4.24
Federal Exhaust Emission Certification Standards for Gasoline- and Diesel-Powered Heavy Heavy Trucks
(Grams per brake horsepower-hour)

Engine Type & Pollutant	1970-73	1974-78	1979-83	1984	1985-86	1987	1988-89	1990	1991-93	1994-97	1998-2003	2004+
Gasoline												
Hydrocarbons + nitrogen oxides (HC + NOx)	<i>a</i>	16	10	<i>a</i>								
Hydrocarbons (HC)	<i>b</i>	<i>a</i>	1.5	1.9								
Nitrogen oxides (NOx)	<i>a</i>			10.6			6.0	5.0	4.0			
Carbon Monoxide (CO)	<i>b</i>	40	25	37.1								
Diesel												
Hydrocarbons + nitrogen oxides (HC + NOx)	<i>a</i>	16	10	<i>a</i>								
Hydrocarbons (HC)	<i>b</i>	<i>a</i>	1.5	1.3								
Nitrogen oxides (NOx)	<i>a</i>			10.7			6.0	5.0	4.0			
Non-methane hydrocarbons + nitrogen oxides	<i>a</i>											2.4 ^c
Carbon Monoxide (CO)	<i>b</i>	40	25	15.5								
Particulates	<i>a</i>						0.60	0.25	0.10			
Smoke Opacity (acceleration/lugging/peak) ^d	40/20/ <i>a</i>	20/15/50										
Weight Criteria for Heavy Heavy Trucks ^e	GVWR over 6,000 lbs		GVWR over 8,500 lbs			GVWR over 14,000 lbs						
Test Procedure (gasoline) ^f (diesel) ^f	13-mode steady-state			MVMA								
	13-mode steady-state			EPA transient								
Useful Life (gasoline) ^g	5 years/50,000 miles			8 years/110,000 miles								

Sources:

40 CFR 86.082-2; 40 CFR 86.085-2; 40 CFR 86.088-10; 40 CFR 86.090-2; 40 CFR 86.090-10; 40 CFR 86.090-1 1; 40 CFR 86.091-10; 40 CFR 86.091-11; 40 CFR 86.093-1 1; 40 CFR 86.094-1 1; 40 CFR 86.096-2; 40 CFR 86.096-10; 40 CFR 86.096-1 1; 40 CFR 86.098-10; 40 CFR 86.098-1 1; 40 CFR 86.099-10; 40 CFR 86.099-1 1; 40 CFR 86.004-1 1; 40 CFR 86.004-15. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999. Rob French, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999.

^aNo standard set

^bAlthough emission standards for hydrocarbons and carbon monoxide were in effect for these years, they were not measured in grams/brake horsepower-hour and are, therefore, incompatible with this table.

^cVehicles can meet a composite non-methane hydrocarbons and nitrogen oxides standard of 2.5, if they meet a non-methane hydrocarbon standard of no more than 0.5.

^dSmoke opacity is expressed in percentage for acceleration, lugging, and peak modes (acceleration/lugging/peak). Lugging is when a vehicle is carrying a load.

^eGross vehicle weight rating (GVWR) is the maximum design loaded weight.

^fSeveral testing procedures have been used during the course of exhaust emission control. A steady-state 9-mode test procedure (13-mode for diesel) was used for 1970-83 standards. For 1984, either the steady-state tests or the EPA transient test procedure could be used. For diesels, the EPA transient test was required from 1985 to the present. For gasoline-powered vehicles, either either the EPA or MVMA (Motor Vehicle Manufacturers Association) transient test procedure could be used during 1985-86, and the MVMA procedure was required thereafter.

^gEmissions standards apply to the useful life of the vehicle. Useful life was 5 years/50,000 miles through 1983, and 8 years/10,000 miles for model year 1985 and after. 1984 was a transitional year in which vehicles could meet the older standard (and test procedure) or the newer one. Useful life requirement for gasoline-powered trucks meeting NOx standards for 1998 and after is 10 years/10,000 miles. The useful life requirements for heavy diesel truck standards are more complex and vary by vehicle weight, pollutant, test procedure, and year. Consult the U.S. Code of Federal Regulations for further information.



Table 4.25
California Passenger Cars and Light Trucks Emission Certification Standards
(grams/mile)

Vehicle Type	Emission Category	Vehicle Useful Life													
		5 Years / 50,000 Miles							10 Years / 100,000 Miles						
		THC ¹	NMHC ²	NMOG ³	CO	NO _x	PM	HCHO	THC ^a	NMHC ^b	NMOG ^c	CO	NO _x	PM	HCHO
Passenger car	Tier 0	–	0.39	–	7.0	0.4	0.08 ^d	0.015 ⁵							
	Tier 1	–	0.25	–	3.4	0.4	0.08 ^d	0.015 ^e	–	0.31	–	4.2	0.6	–	–
	TLEV	–	–	0.125	3.4	0.4	–	0.015	–	–	0.156	4.2	0.6	0.08 ^d	0.018
	LEV	–	–	0.075	3.4	0.2	–	0.015	–	–	0.090	4.2	0.3	0.08 ^d	0.018
	ULEV	–	–	0.040	1.7	0.2	–	0.008	–	–	0.055	2.1	0.3	0.04 ^d	0.011
	ZEV	0.0	0.00	0.000	0.0	0.0	0.00	0.000	0.00	0.00	0.000	0.0	0.0	0.00	0.000
LDT1	Tier 0	–	0.39	–	9.0	0.4	0.08 ^d	0.015 ^e							
	Tier 1	–	0.25	–	3.4	0.4	0.08 ^d	0.015 ^e	–	0.31	–	4.2	0.6	–	–
	TLEV	–	–	0.125	3.4	0.4	–	0.015	–	–	0.156	4.2	0.6	0.08 ^d	0.018
	LEV	–	–	0.075	3.4	0.2	–	0.015	–	–	0.090	4.2	0.3	0.08 ^d	0.018
	ULEV	–	–	0.040	1.7	0.2	–	0.008	–	–	0.055	2.1	0.3	0.04 ^d	0.011
	ZEV	0.0	0.00	0.000	0.0	0.0	0.00	0.000	0.00	0.00	0.000	0.0	0.0	0.00	0.000
LDT2	Tier 0	–	0.50	–	9.0	1.0	0.08 ^d	0.018 ^e							
	Tier 1	–	0.32	–	4.4	0.7	0.08 ^d	0.018 ^e	–	0.40	–	5.5	0.97	–	–
	TLEV	–	–	0.160	4.4	0.7	–	0.018	–	–	0.200	5.5	0.9	0.10 ^d	0.023
	LEV	–	–	0.100	4.4	0.4	–	0.018	–	–	0.130	5.5	0.5	0.10 ^d	0.023
	ULEV	–	–	0.050	2.2	0.4	–	0.009	–	–	0.070	2.8	0.5	0.05 ^d	0.013

Source:

U.S. Environmental Protection Agency, Office of Mobile Sources, EPA 420-B-98-001. (Additional resources: www.epa.gov/OMSWWW)

Note:

LDT1 = light truck up through 3,750 lbs. loaded vehicle weight; LDT2 = light truck greater than 3,750 lbs. loaded vehicle weight.

¹ THCE for methanol vehicles. Does not apply to CNG vehicles.

² THCE for Tier 0 methanol vehicles. NMHCE for other alcohol vehicles.

³ NMHC for diesel-fueled vehicles.

⁴ Diesel-fueled vehicles only.

⁵ Ethanol- and methanol-fueled vehicles only.

California's Low-Emission Vehicle regulations provide for reduced emission vehicles to be available to consumers. Vehicles meeting these standards have even lower emissions than the basic standards for all new vehicles sold in California. Currently, there is a wide array of TLEVs and LEVs, and a few ULEVs and ZEVs on the market. For a listing of the available low emission vehicles, see the California Air Resources Board web site referenced below.

Table 4.26
California Vehicle Emission Reduction for
Passenger Cars and Light Trucks

	Emission reduction from the basic California standards ¹		
	HC	CO	NOx
Transitional Low-Emission Vehicle (TLEV)	50%	=	=
Low-Emission Vehicle (LEV)	70%	=	50%
Ultra-Low-Emission Vehicle (ULEV)	85%	50%	50%
Zero-Emission Vehicles (ZEV)	100%	100%	100%

Source:

California Air Resources Board web site, www.arb.ca.gov/msprog/ccbg/ccbg.htm
(Additional resources: www.arb.ca.gov)

Note:

= indicates equivalent emissions to vehicles meeting the basic California standard.

¹See Table 4.23.

The California Air Resources Board adopted requirements in 1991 for fleet mixture in order to meet the emission standards. By the year 2001, it is proposed that 90% of each vehicle manufacturer's fleet be low-emission vehicles. A March 1996 amendment to the plan allows the marketplace to determine the number of zero emission vehicles from 1998 to 2002.

Table 4.27
California Air Resources Board Requirements for Meeting Emission Standards

Year	Conventional vehicles	Transitional low- emission vehicles	Low-emission vehicles	Ultra-low- emission vehicles	Zero emission vehicles
1993	100%				
1994	90%	10%			
1995	85%	15%			
1996	80%	20%			
1997	73%		25%	2%	
1998	48%		48%	2%	
1999	25%		73%	2%	
2000			90%	2%	
2001			90%	5%	
2002			85%	10%	
2003			75%	15%	10%

Source:

California Air Resources Board, Mobile Sources Division, El Monte, CA, 1996.
(Additional resources: www.arb.ca.gov)