

## Chapter 4 Criteria Pollutants

### Summary Statistics from Tables in this Chapter

Source		
Table 4.1	Transportation's share of U.S. emissions, 1999	
	<i>CO</i>	78.6%
	<i>NO<sub>x</sub></i>	53.4%
	<i>VOC</i>	43.5%
	<i>PM-10</i>	2.1%
	<i>PM-2.5</i>	7.6%
	<i>SO<sub>2</sub></i>	6.9%
	<i>NH<sub>3</sub></i>	5.4%
Table 4.10	Transportation's share of lead emissions	
	<i>1970</i>	82.3%
	<i>1999</i>	12.8%

*Transportation accounts for the majority of carbon monoxide and nitrogen oxide emissions. Highway vehicles are responsible for the largest share of transportation emissions.*

**Table 4.1**  
**Total National Emissions of the Criteria Air Pollutants by Sector, 1999**  
 (millions of short tons/percentage)

Sector	CO	NO <sub>x</sub>	VOC	PM-10	PM-2.5	SO <sub>2</sub>	NH <sub>3</sub>
<b>Highway vehicles</b>	<b>49.99</b>	<b>8.59</b>	<b>5.30</b>	<b>0.30</b>	<b>0.23</b>	<b>0.36</b>	<b>0.26</b>
	55.9%	35.1%	29.6%	0.8%	2.7%	1.9%	5.2%
<b>Aircraft</b>	<b>1.00</b>	<b>0.16</b>	<b>0.18</b>	<b>0.04</b>	<b>0.03</b>	<b>0.01</b>	<b>0.00</b>
	1.1%	0.7%	1.0%	0.1%	0.3%	0.1%	0.1%
<b>Railroads</b>	<b>0.12</b>	<b>0.95</b>	<b>0.05</b>	<b>0.03</b>	<b>0.03</b>	<b>0.11</b>	<b>0.00</b>
	0.1%	3.9%	0.3%	0.1%	0.4%	0.6%	0.0%
<b>Vessels</b>	<b>0.14</b>	<b>1.00</b>	<b>0.04</b>	<b>0.04</b>	<b>0.04</b>	<b>0.27</b>	<b>0.00</b>
	0.2%	4.1%	0.2%	0.1%	0.5%	1.4%	0.0%
<b>Other off-highway</b>	<b>18.71</b>	<b>3.17</b>	<b>2.19</b>	<b>0.35</b>	<b>0.31</b>	<b>0.54</b>	<b>0.00</b>
	20.9%	13.0%	12.2%	1.0%	3.7%	2.9%	0.1%
<b>Transportation total</b>	<b>70.30</b>	<b>13.05</b>	<b>7.79</b>	<b>0.72</b>	<b>0.64</b>	<b>1.30</b>	<b>0.27</b>
	78.6%	53.4%	43.5%	2.1%	7.6%	6.9%	5.4%
<b>Stationary source fuel combustion</b>	<b>5.37</b>	<b>10.19</b>	<b>0.89</b>	<b>1.09</b>	<b>0.78</b>	<b>16.09</b>	<b>0.05</b>
	6.0%	41.7%	5.0%	3.1%	9.3%	85.3%	1.0%
<b>Industrial processes</b>	<b>3.71</b>	<b>0.80</b>	<b>8.02</b>	<b>0.71</b>	<b>0.38</b>	<b>1.43</b>	<b>0.20</b>
	4.1%	3.3%	44.8%	2.0%	4.6%	7.6%	4.0%
<b>Waste disposal and recycling total</b>	<b>1.15</b>	<b>0.10</b>	<b>0.43</b>	<b>0.31</b>	<b>0.24</b>	<b>0.04</b>	<b>0.09</b>
	1.3%	0.4%	2.4%	0.9%	2.8%	0.2%	1.8%
<b>Miscellaneous</b>	<b>8.92</b>	<b>0.33</b>	<b>0.79</b>	<b>31.92</b>	<b>6.35</b>	<b>0.01</b>	<b>4.36</b>
	10.0%	1.3%	4.4%	91.9%	75.8%	0.1%	87.8%
<b>Total of all sources</b>	<b>89.45</b>	<b>24.45</b>	<b>17.92</b>	<b>34.74</b>	<b>8.38</b>	<b>18.87</b>	<b>4.96</b>
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website [www.epa.gov/ttn/chieftrends](http://www.epa.gov/ttn/chieftrends) (Additional resources: [www.epa.gov/oar/oaqps](http://www.epa.gov/oar/oaqps))

**Note:**

CO = Carbon monoxide. NO<sub>x</sub> = Nitrogen oxides. PM-10 = Particulate matter less than 10 microns.

PM-2.5 = Particulate matter less than 2.5 microns. SO<sub>2</sub> = Sulfur dioxide. VOC = Volatile organic compounds.

NH<sub>3</sub> = Ammonia.

The transportation sector accounted for more than three-fourths of the nation's carbon monoxide (CO) emissions in 1999. 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, 1970–99<sup>a</sup>**  
**(million short tons)**

Source category	1970	1980	1990	1995	1998	1999	Percent of total, 1999
Highway vehicles	88.03	78.05	58.44	54.81	52.36	49.99	51.3%
Aircraft	0.51	0.74	0.90	0.94	1.00	1.00	1.0%
Railroads	0.07	0.10	0.12	0.11	0.12	0.12	0.1%
Vessels <sup>b</sup>	0.02	0.06	0.13	0.13	0.14	0.14	0.1%
Other off-highway	11.38	13.59	17.04	19.04	23.87	23.90	24.5%
Transportation total	100.00	92.54	76.64	75.04	77.48	75.15	77.1%
Stationary fuel combustion total	4.63	7.30	5.51	5.93	5.08	5.32	5.5%
Industrial processes total	9.84	6.95	4.77	4.61	3.81	3.80	3.9%
Waste disposal and recycling total	7.06	2.30	1.08	1.19	1.14	3.79	3.9%
Miscellaneous total	7.91	8.34	11.12	7.30	9.36	9.38	9.6%
<b>Total of all sources</b>	<b>129.44</b>	<b>117.43</b>	99.12	94.06	96.87	97.44	100.0%

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website  
*www.epa.gov/ttn/chieftrends* (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.

<sup>a</sup>The sums of subcategories may not equal total due to rounding.

<sup>b</sup>Recreational marine vessels.

*Though gasoline-powered light vehicles continue to be responsible for the majority of carbon monoxide emissions from highway vehicles, the total pollution from light vehicles in 1999 is less than half what it was in 1970. This is despite the fact that there were many more light vehicles on the road in 1999.*

**Table 4.3**  
**Emissions of Carbon Monoxide from Highway Vehicles, 1970–99<sup>a</sup>**  
**(million short tons)**

Source category	1970	1975	1980	1985	1990	1995	1999	Percent of total, 1999
<b>Gasoline powered</b>								
Light vehicles & motorcycles	64.03	59.28	53.56	49.45	35.00	29.79	27.38	54.8%
Light trucks <sup>b</sup>	16.57	15.77	16.14	18.96	17.12	19.43	16.12	32.2%
Heavy vehicles	6.71	7.14	7.19	7.72	5.03	4.10	4.26	8.5%
<b>Total</b>	<b>87.31</b>	<b>82.19</b>	<b>76.89</b>	<b>76.13</b>	<b>57.14</b>	<b>53.32</b>	<b>47.76</b>	<b>95.5%</b>
<b>Diesel powered</b>								
Light vehicles	<sup>c</sup>	0.03	0.02	0.02	0.02	0.03	0.01	0.0%
Light trucks <sup>b</sup>	<sup>c</sup>	<sup>c</sup>	0.00	0.00	0.05	0.01	0.01	0.0%
Heavy vehicles	0.72	0.92	1.14	1.24	1.22	1.45	2.22	4.4%
<b>Total</b>	<b>0.72</b>	<b>0.95</b>	<b>1.16</b>	<b>1.26</b>	<b>1.30</b>	<b>1.49</b>	<b>2.23</b>	<b>4.5%</b>
<b>Total</b>								
<b>Highway vehicle total</b>	<b>88.03</b>	<b>83.13</b>	<b>78.05</b>	<b>77.39</b>	<b>58.44</b>	<b>54.81</b>	<b>49.99</b>	<b>100.0%</b>
Percent diesel	0.8%	1.1%	1.5%	1.6%	2.2%	2.7%	4.5%	

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website [www.epa.gov/ttn/chief/trends](http://www.epa.gov/ttn/chief/trends)  
(Additional resources: [www.epa.gov/oar/oaqps](http://www.epa.gov/oar/oaqps))

<sup>a</sup>The sums of subcategories may not equal total due to rounding.

<sup>b</sup>Less than 8,500 pounds.

<sup>c</sup>Data are not available.

*The transportation sector accounted for over half of the nation's nitrogen oxide (NO<sub>x</sub>) emissions in 1999, with the majority coming from highway vehicles. For details on the highway emissions of NO<sub>x</sub>, see Table 4.5.*

**Table 4.4**  
**Total National Emissions of Nitrogen Oxides, 1970–99<sup>a</sup>**  
**(million short tons)**

Source category	1970	1980	1990	1995	1998	1999	Percent of total, 1999
Highway vehicles	7.39	8.62	7.21	7.96	8.82	8.59	33.8%
Railroads	0.50	0.73	0.93	0.99	1.22	1.20	4.7%
Other off-highway	1.44	2.80	3.88	4.14	4.32	4.31	17.0%
Transportation total	9.32	12.15	12.01	13.08	14.36	14.11	55.5%
Stationary fuel combustion total	10.06	11.32	10.89	10.83	10.40	10.03	39.5%
Industrial processes total	0.78	0.56	0.80	0.77	0.85	0.85	3.4%
Waste disposal and recycling total	0.44	0.11	0.09	0.10	0.10	0.09	0.4%
Miscellaneous total	0.33	0.25	0.37	0.27	0.32	0.32	1.3%
<b>Total of all sources</b>	<b>20.93</b>	<b>24.38</b>	<b>24.17</b>	<b>25.05</b>	<b>26.02</b>	<b>25.39</b>	<b>100.0%</b>

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website [www.epa.gov/ttn/chieftrends](http://www.epa.gov/ttn/chieftrends) (Additional resources: [www.epa.gov/oar/oaqps](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.

<sup>a</sup>The sums of subcategories may not equal total due to rounding.

*Heavy diesel-powered vehicles were responsible for one-third of highway vehicle nitrogen oxide emissions in 1999, while light gasoline vehicles were responsible for nearly two-thirds.*

**Table 4.5**  
**Emissions of Nitrogen Oxides from Highway Vehicles, 1970–99<sup>a</sup>**  
**(million short tons)**

Source category	1970	1975	1980	1985	1990	1995	1999	Percent of total, 1999
<b>Gasoline powered</b>								
Light vehicles & motorcycles	4.16	4.73	4.42	3.81	3.01	3.04	2.86	33.3%
Light trucks <sup>b</sup>	1.28	1.46	1.41	1.53	1.55	1.99	1.64	19.1%
Heavy vehicles	0.28	0.32	0.30	0.33	0.31	0.33	0.46	5.3%
<b>Total</b>	<b>5.71</b>	<b>6.51</b>	<b>6.13</b>	<b>5.67</b>	<b>4.87</b>	<b>5.36</b>	<b>4.96</b>	<b>57.7%</b>
<b>Diesel powered</b>								
Light vehicles	<sup>c</sup>	0.02	0.03	0.03	0.03	0.03	0.01	0.1%
Light trucks <sup>b</sup>	<sup>c</sup>	<sup>c</sup>	0.01	0.01	0.06	0.01	0.01	0.1%
Heavy vehicles	1.68	2.12	2.46	2.39	2.25	2.54	3.62	42.1%
<b>Total</b>	<b>1.68</b>	<b>2.14</b>	<b>2.49</b>	<b>2.42</b>	<b>2.34</b>	<b>2.59</b>	<b>3.63</b>	<b>42.3%</b>
<b>Total</b>								
<b>Highway vehicle total</b>	<b>7.39</b>	<b>8.65</b>	<b>8.62</b>	<b>8.09</b>	<b>7.21</b>	<b>7.96</b>	<b>8.59</b>	<b>100.0%</b>
Percent diesel	22.7%	24.8%	28.9%	30.0%	32.4%	32.6%	42.3%	

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website [www.epa.gov/ttn/chieftrends](http://www.epa.gov/ttn/chieftrends) (Additional resources: [www.epa.gov/oar/oaqps](http://www.epa.gov/oar/oaqps))

<sup>a</sup>The sums of subcategories may not equal total due to rounding.

<sup>b</sup>Less than 8,500 pounds.

<sup>c</sup>Data are not available.

*The transportation sector accounted for over 45% of the nation's volatile organic compound (VOC) emissions in 1999, 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, 1970–99<sup>a</sup>**  
**(million short tons)**

Source category	1970	1980	1990	1995	1998	1999	Percent of total, 1999
Highway vehicles	12.97	8.98	6.44	5.82	5.44	5.30	29.2%
Off-highway	1.88	2.31	2.55	2.70	3.30	3.23	17.8%
Transportation total	14.85	11.29	8.99	8.52	8.74	8.53	47.0%
Stationary fuel combustion total	0.72	1.05	1.01	1.07	0.86	0.90	5.0%
Industrial processes total	12.33	12.10	9.01	9.71	7.88	7.41	40.8%
Waste disposal and recycling total	1.98	0.76	0.99	1.07	0.43	0.59	3.2%
Miscellaneous total	1.10	1.13	1.06	0.55	0.71	0.72	3.9%
<b>Total of all sources</b>	<b>30.98</b>	<b>26.34</b>	<b>21.05</b>	<b>20.92</b>	<b>18.61</b>	<b>18.15</b>	<b>100.0%</b>

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website [www.epa.gov/ttn/chief/trends](http://www.epa.gov/ttn/chief/trends) (Additional resources: [www.epa.gov/oar/oaqps](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.

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<sup>a</sup>The 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.

*Gasoline-powered vehicles are responsible for 95% of highway vehicle emissions of volatile organic compounds. VOC emissions from highway vehicles in 1999 were less than half the 1970 level.*

**Table 4.7**  
**Emissions of Volatile Organic Compounds from Highway Vehicles, 1970–99<sup>a</sup>**  
**(thousand short tons)**

Source category	1970	1975	1980	1985	1990	1995	1999	Percent of total, 1999
<b>Gasoline powered</b>								
Light vehicles & motorcycles	9,193	7,248	5,907	5,864	3,692	3,029	2,911	55.0%
Light trucks <sup>b</sup>	2,770	2,289	2,059	2,425	2,016	2,135	1,722	32.5%
Heavy vehicles	743	657	611	716	405	325	375	7.1%
<b>Total</b>	<b>12,706</b>	<b>10,194</b>	<b>8,577</b>	<b>9,005</b>	<b>6,113</b>	<b>5,489</b>	<b>5,008</b>	<b>94.5%</b>
<b>Diesel powered</b>								
Light vehicles	<sup>c</sup>	15	8	8	9	12	3	0.1%
Light trucks <sup>b</sup>	<sup>c</sup>	<sup>c</sup>	2	2	24	5	2	0.0%
Heavy vehicles	266	335	392	360	298	309	284	5.4%
<b>Total</b>	<b>266</b>	<b>350</b>	<b>402</b>	<b>370</b>	<b>331</b>	<b>326</b>	<b>289</b>	<b>5.5%</b>
<b>Total</b>								
<b>Highway vehicle total</b>	<b>12,972</b>	<b>10,545</b>	<b>8,979</b>	<b>9,376</b>	<b>6,443</b>	<b>5,816</b>	<b>5,297</b>	<b>100.0%</b>
Percent diesel	2.1%	3.3%	4.5%	3.9%	5.1%	5.6%	5.5%	

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website  
[www.epa.gov/ttn/chieftrends](http://www.epa.gov/ttn/chieftrends) (Additional resources: [www.epa.gov/oar/oaqps](http://www.epa.gov/oar/oaqps))

<sup>a</sup>The sums of subcategories may not equal total due to rounding.

<sup>b</sup>Less than 8,500 pounds.

<sup>c</sup>Data are not available.

*The transportation sector accounted for only 3% of the nation's particulate matter (PM-10) emissions in 1999. For details on the highway emissions of PM-10, see Table 4.9.*

**Table 4.8**  
**Total National Emissions of Particulate Matter (PM-10), 1970–99<sup>a</sup>**  
**(million short tons)**

Source category	1970	1980	1990	1995	1998	1999	Percent of total, 1999
Highway vehicles	0.44	0.40	0.35	0.30	0.31	0.30	1.2%
Off-highway	0.22	0.40	0.49	0.46	0.47	0.46	1.9%
Transportation total	0.66	0.80	0.84	0.76	0.78	0.75	3.2%
Stationary fuel combustion total	2.87	2.45	1.20	1.18	1.00	1.03	4.3%
Industrial processes total	7.67	2.75	1.04	0.95	0.67	0.68	2.9%
Waste disposal and recycling total	1.00	0.27	0.27	0.29	0.31	0.59	2.5%
Miscellaneous total	0.84	0.85	24.54	22.77	23.28	20.63	87.1%
<b>Total of all sources</b>	<b>13.04</b>	<b>7.12</b>	<b>27.88</b>	<b>25.93</b>	<b>26.04</b>	<b>23.68</b>	<b>100.0%</b>

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website [www.epa.gov/ttn/chief/trends](http://www.epa.gov/ttn/chief/trends) (Additional resources: [www.epa.gov/oar/oaqps](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.

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<sup>a</sup>Fine particle matter less than 10 microns. The sums of subcategories may not equal total due to rounding.

*Since 1980 diesel-powered vehicles have been responsible for more than half of highway vehicle emissions of particulate matter (PM-10). Heavy vehicles are clearly the cause.*

**Table 4.9**  
**Emissions of Particulate Matter (PM-10) from Highway Vehicles, 1970–99<sup>a</sup>**  
**(thousand short tons)**

Source category	1970	1975	1980	1985	1990	1995	1999	Percent of total, 1999
<b>Gasoline powered</b>								
Light vehicles & motorcycles	225	207	120	77	57	55	59	20.0%
Light trucks <sup>b</sup>	70	72	55	43	37	41	36	12.2%
Heavy vehicles	13	15	15	14	10	9	12	4.1%
<b>Total</b>	<b>308</b>	<b>294</b>	<b>190</b>	<b>134</b>	<b>104</b>	<b>105</b>	<b>107</b>	<b>36.3%</b>
<b>Diesel powered</b>								
Light vehicles	<sup>c</sup>	10	12	8	7	7	1	0.3%
Light trucks <sup>b</sup>	<sup>c</sup>	<sup>c</sup>	2	1	13	2	1	0.3%
Heavy vehicles	136	166	194	219	225	185	186	63.1%
<b>Total</b>	<b>136</b>	<b>176</b>	<b>208</b>	<b>228</b>	<b>245</b>	<b>194</b>	<b>188</b>	<b>63.7%</b>
<b>Total</b>								
<b>Highway vehicle total</b>	<b>443</b>	<b>471</b>	<b>397</b>	<b>363</b>	<b>349</b>	<b>300</b>	<b>295</b>	<b>100.0%</b>
Percent diesel	30.7%	37.4%	52.4%	62.8%	70.2%	64.7%	63.7%	

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website [www.epa.gov/ttn/chieftrends](http://www.epa.gov/ttn/chieftrends) (Additional resources: [www.epa.gov/oar/oaqps](http://www.epa.gov/oar/oaqps))

<sup>a</sup>The sums of subcategories may not equal total due to rounding.

<sup>b</sup>Less than 8,500 pounds.

<sup>c</sup>Data are not available.

*The transportation sector accounted for only 9% 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), 1990–99**  
**(million short tons)**

Source category	1990	1995	1997	1998	1999	Percent of total, 1999
Highway vehicles	0.29	0.24	0.26	0.25	0.23	3.4%
Off-highway	0.43	0.40	0.42	0.42	0.41	6.1%
Transportation total	0.72	0.64	0.69	0.67	0.64	9.4%
Stationary fuel combustion total	0.91	0.90	0.78	0.74	0.77	11.3%
Industrial processes total	0.56	0.50	0.38	0.39	0.39	5.7%
Waste disposal and recycling total	0.23	0.25	0.24	0.24	0.53	7.8%
Miscellaneous total	5.23	4.73	5.19	5.04	4.45	65.8%
<b>Total of all sources</b>	<b>7.66</b>	<b>7.01</b>	<b>7.27</b>	<b>7.07</b>	<b>6.77</b>	<b>100.0%</b>

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website [www.epa.gov/ttn/chief/trends](http://www.epa.gov/ttn/chief/trends) (Additional resources: [www.epa.gov/oar/oaqps](http://www.epa.gov/oar/oaqps))

*Diesel vehicles are responsible for the majority of highway vehicle PM-2.5 emissions. More than 70% of the PM-2.5 emissions are from heavy diesel trucks.*

**Table 4.11**  
**Emissions of Particulate Matter (PM-2.5) from Highway Vehicles, 1990–99<sup>a</sup>**  
**(thousand short tons)**

Source category	1990	1995	1997	1998	1999	Percent of total, 1999
<b>Gasoline powered</b>						
Light vehicles & motorcycles	34	32	33	34	34	14.8%
Light trucks <sup>b</sup>	24	26	22	22	22	9.6%
Heavy vehicles	6	6	9	8	8	3.5%
<b>Total</b>	<b>64</b>	<b>64</b>	<b>64</b>	<b>64</b>	<b>64</b>	<b>27.9%</b>
<b>Diesel powered</b>						
Light vehicles	6	6	2	1	1	0.4%
Light trucks <sup>b</sup>	12	2	1	1	1	0.4%
Heavy vehicles	204	165	196	179	164	71.6%
<b>Total</b>	<b>222</b>	<b>173</b>	<b>199</b>	<b>181</b>	<b>166</b>	<b>72.5%</b>
<b>Total</b>						
<b>Highway vehicle total</b>	<b>286</b>	<b>237</b>	<b>263</b>	<b>246</b>	<b>229</b>	<b>100.0%</b>
Percent diesel	77.6%	73.0%	75.7%	73.6%	72.5%	

**Source:**

U. S. Environmental Protection Agency, National Emission Inventory Air Pollutant Emission Trends website [www.epa.gov/ttn/chief/trends](http://www.epa.gov/ttn/chief/trends) (Additional resources: [www.epa.gov/oar/oaqps](http://www.epa.gov/oar/oaqps))

<sup>a</sup> The sums of subcategories may not equal total due to rounding.

<sup>b</sup> 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 1999, mainly due to off-highway fuel use.*

**Table 4.12**  
**National Lead Emission Estimates, 1970–99<sup>a</sup>**  
**(thousand short tons per year)**

Source category	1970	1975	1980	1985	1990	1995	1999	Percent of total, 1999
Highway vehicles	171.96	130.21	60.50	18.05	0.42	0.02	0.02	0.5%
Off-highway	9.74	6.13	4.21	0.92	0.78	0.54	0.52	12.3%
Transportation total	181.70	136.34	64.71	18.97	1.20	0.56	0.54	12.8%
Stationary source fuel combustion	10.62	10.35	4.30	0.52	0.50	0.49	0.50	11.9%
Industrial processes	26.36	11.38	3.94	2.53	2.48	2.27	2.35	55.9%
Waste disposal and recycling total	2.20	1.60	1.21	0.87	0.80	0.60	0.81	19.4%
<b>Total of all sources</b>	<b>220.87</b>	<b>159.66</b>	<b>74.15</b>	<b>22.89</b>	<b>4.98</b>	<b>3.93</b>	<b>4.20</b>	<b>100.0%</b>

**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](http://www.epa.gov/oar/oaqps))

<sup>a</sup>The sums of subcategories may not equal due to rounding.

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

The energy and criteria pollutant estimates of the most recent version (Beta of Version 1.6) of the GREET model are displayed in the next table. 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;

1. natural gas to compressed natural gas, liquefied natural gas, liquefied petroleum gas, methanol, Fischer-Tropsch diesel, dimethyl ether, hydrogen, and electricity;
2. coal to electricity;
3. uranium to electricity;
4. renewable energy (hydropower, solar energy, and wind) to electricity;
5. corn, woody biomass, and herbaceous biomass to ethanol;
6. soybeans to biodiesel; and
7. landfill gases to methanol.

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 and Terms Used on Table 4.13

BD20	mixture of 20% biodiesel and 80% conventional diesel (by volume)
CA	California
CH <sub>4</sub>	methane
CIDI	compression ignition, direct injection
CIDIV	compression ignition, direct injection vehicle
CNG	compressed natural gas
CNGV	compressed natural gas vehicle
CO <sub>2</sub>	carbon dioxide
DME	dimethyl ether
E90	mixture of 90% ethanol and 10% gasoline (by volume)
EtOH	ethanol
EtOHV	ethanol vehicle
EV	electric vehicle
FCV	fuel-cell vehicle
FRFG	Federal reformulated gasoline
FT	Fischer-Tropsch
FTD	Fischer-Tropsch diesel
G.H <sub>2</sub>	gaseous hydrogen
GC	grid-connected (charge depleting)
GGE	gasoline gallon equivalent
GHGs	greenhouse gases
GI	grid-independent (charge sustaining)
GV	gasoline vehicle
HEV	hybrid electric vehicle
L.H <sub>2</sub>	liquid hydrogen
LS	low-sulfur
M90	mixture of 90% methanol and 10% gasoline by volume
MeOH	methanol
MeOHV	methanol vehicle
N <sub>2</sub> O	nitrous oxide
NA	North American
NE	northeast
NG	natural gas
NNA	non-North American
SI	spark ignition
urban	Emissions occurring within air quality control regions in the U.S. These regions have emission controls in place in order to meet or maintain air quality standards.
US	United States

**Table 4. 13**  
**Fuel-Cycle Energy and Criteria Pollutant Emission Changes**  
**of Alternative and Advanced Vehicle/Fuel Systems**  
**(percentage relative to internal combustion engine vehicles**  
 **fueled with reformulated gasoline)**

	GV: FRFG (btu/mile or grams/mile)	CNGV: NA NG	CNGV: NNA NG	Propane vehicle	M90 MeOHV: NA NG	M90 MeOHV: NNA NG	E90 EtOHV: corn	E90 EtOHV: cellulosic biomass	GI SI HEV: FRFG	GC SI HEV: FRFG
MPG - GGE	24.1	24.1	24.1	25.3	25.3	25.3	25.3	25.3	33.8	54.1
Total energy	5,891	-9.5%	1.2%	-16.2%	14.6%	16.3%	10.4%	53.8%	-28.6%	-40.7%
Fossil fuels	5,872	-9.7%	1.0%	-16.0%	14.9%	16.6%	-45.3%	-79.5%	-28.6%	-43.1%
Petroleum	4,665	-99.5%	-99.5%	-59.1%	-79.1%	-79.9%	-75.0%	-74.9%	-28.6%	-57.7%
VOC: total	0.202	-68.8%	-66.1%	-55.6%	-14.7%	-15.2%	83.9%	1.4%	-20.3%	-45.7%
CO: total	2.838	-40.4%	-32.5%	-40.2%	0.3%	1.2%	5.7%	21.1%	-0.8%	-33.2%
NOx: total	0.256	-41.7%	98.6%	-37.7%	-12.6%	34.2%	151.2%	389.0%	-24.4%	-18.1%
PM10: total	0.047	190.8%	275.5%	-39.3%	-21.5%	-18.8%	574.3%	198.0%	-5.4%	2.1%
SOx: total	0.138	-80.7%	-76.4%	-69.1%	-57.7%	-50.7%	194.0%	-73.6%	-28.6%	94.5%
VOC: urban	0.150	-57.9%	-59.8%	-53.1%	-10.0%	-13.6%	-15.2%	-15.2%	-17.4%	-45.6%
CO: urban	2.775	-38.5%	-37.6%	-40.2%	-0.3%	-0.5%	-0.3%	-0.4%	-0.2%	-33.1%
NOx: urban	0.070	104.5%	111.4%	-33.9%	-30.2%	-40.5%	-25.8%	-33.4%	-13.2%	-36.8%
PM10: urban	0.037	-35.3%	-40.2%	-35.1%	-23.6%	-28.6%	-12.8%	-13.1%	0.5%	-13.5%
SOx: urban	0.073	-92.5%	-91.3%	-83.6%	-81.0%	-80.4%	-82.0%	-83.3%	-28.6%	-44.0%

	CIDIV: LS diesel	CIDIV: FTD, NA NG	CIDIV: FTD, NNA NG	CIDIV: BD20	GI CIDI HEV: LS diesel	GC CIDI HEV: LS diesel	EV: U.S. mix	EV: NE U.S. mix	EV: CA mix
MPG - GGE	29.6	29.6	29.6	29.6	41.0	57.7	84.4	84.4	84.4
Total energy	-21.7%	8.7%	10.4%	-19.0%	-43.6%	-47.2%	-45.1%	-46.2%	-50.6%
Fossil fuels	-21.7%	9.0%	10.8%	-19.1%	-43.6%	-49.6%	-52.5%	-55.6%	-61.9%
Petroleum	-10.4%	-99.0%	-98.5%	-25.5%	-35.4%	-59.7%	-98.4%	-97.5%	-99.7%
VOC: total	-59.9%	-65.3%	-50.9%	-34.6%	-64.4%	-73.4%	-89.7%	-91.4%	-93.5%
CO: total	-0.9%	2.0%	100.1%	0.2%	-1.4%	-33.5%	-98.4%	-97.4%	-97.7%
NOx: total	-15.7%	-22.6%	33.8%	4.9%	-32.0%	-19.9%	11.6%	3.7%	-20.7%
PM10: total	-8.9%	-34.3%	-22.1%	-9.6%	-15.8%	-3.6%	24.0%	4.7%	-9.8%
SOx: total	-27.9%	-83.8%	-78.0%	-43.8%	-48.0%	86.8%	369.2%	233.7%	146.2%
VOC: urban	-61.2%	-65.2%	-47.6%	-61.5%	-62.9%	-75.3%	-99.6%	-99.1%	-99.3%
CO: urban	-0.1%	-0.2%	98.8%	-0.2%	-0.3%	-33.3%	-99.8%	-99.5%	-99.5%
NOx: urban	30.4%	7.6%	62.2%	29.5%	20.3%	-28.1%	-75.5%	-65.5%	-75.1%
PM10: urban	-3.5%	-22.2%	-10.1%	-7.2%	-7.3%	-24.0%	-38.5%	-41.1%	-42.8%
SOx: urban	-26.3%	-99.2%	-98.9%	-57.5%	-46.9%	-78.0%	-44.6%	-53.7%	-71.1%

(Table continued on next page)

**Note:**

See page preceding Table 4.13 for acronym definitions.

**Table 4. 13 (Continued)**  
**Fuel-Cycle Energy and Criteria Pollutant Emission Changes**  
**of Alternative and Advanced Vehicle/Fuel Systems**  
**(percentage relative to internal combustion engine vehicles**  
**fueled with reformulated gasoline)**

	FCV: G.H2, central plant, NA NG	FCV: G.H2, central plant, NNA NG	FCV: G.H2, refueling station, NA NG	FCV: G.H2, refueling station, NNA NG	FCV: G.H2, central electrolysis, renewables	FCV: G.H2, station electrolysis, U.S. generation mix
MPG - GGE	50.7	50.7	50.7	50.7	50.7	50.7
Total energy	-35.6%	-30.0%	-32.9%	-28.4%	-37.6%	40.5%
Fossil fuels	-36.6%	-31.0%	-33.2%	-28.6%	-91.9%	22.4%
Petroleum	-99.2%	-99.3%	-99.7%	-99.6%	-99.5%	-96.3%
VOC: total	-97.1%	-93.6%	-94.7%	-91.9%	-97.9%	-68.6%
CO: total	-98.4%	-94.0%	-95.0%	-91.3%	-99.5%	-94.5%
NOx: total	-54.4%	21.6%	-21.5%	42.4%	-58.8%	285.4%
PM10: total	-36.7%	-33.9%	-44.7%	-40.9%	-44.8%	191.2%
SOx: total	-22.4%	5.8%	-58.0%	-55.0%	-5.3%	1390.5%
VOC: urban	-99.6%	-99.5%	-95.3%	-95.5%	-99.9%	-98.6%
CO: urban	-99.7%	-99.6%	-95.9%	-95.9%	-99.9%	-99.3%
NOx: urban	-81.1%	-76.2%	87.6%	86.6%	-83.5%	-22.1%
PM10: urban	-41.5%	-46.1%	-38.3%	-38.4%	-47.9%	-31.4%
SOx: urban	-89.4%	-86.4%	-95.3%	-95.0%	-87.3%	81.8%

	FCV: L.H2, central plant, NA NG	FCV: L.H2, central plant, NNA NG	FCV: L.H2, refueling station, NA NG	FCV: L.H2, refueling station , NNA NG	FCV: L.H2, central electrolysis, renewables	FCV: L.H2, station electrolysis, U.S. generation mix
MPG - GGE	50.7	50.7	50.7	50.7	50.7	50.7
Total energy	-11.6%	-8.5%	12.4%	19.5%	-44.0%	105.3%
Fossil fuels	-11.4%	-8.4%	6.0%	12.9%	-98.7%	61.7%
Petroleum	-99.3%	-99.0%	-98.4%	-98.4%	-99.4%	-95.2%
VOC: total	-96.3%	-95.3%	-86.5%	-83.7%	-98.7%	-76.0%
CO: total	-96.9%	-96.6%	-96.0%	-92.2%	-99.7%	-85.8%
NOx: total	-55.8%	-7.9%	57.3%	121.8%	-46.4%	409.0%
PM10: total	-36.8%	-33.6%	36.1%	39.9%	-57.5%	272.0%
SOx: total	-85.1%	-80.8%	434.0%	437.0%	-94.8%	1868.2%
VOC: urban	-99.5%	-99.5%	-98.3%	-98.5%	-99.9%	-98.2%
CO: urban	-99.7%	-99.7%	-98.8%	-98.8%	-100.0%	-99.1%
NOx: urban	-91.4%	-91.0%	-76.1%	-77.2%	-96.4%	2.8%
PM10: urban	-47.2%	-47.1%	-41.9%	-41.9%	-48.9%	-25.7%
SOx: urban	-99.1%	-99.0%	-99.4%	-99.1%	-99.6%	140.1%

(Table continued on next page)

**Note:**

See page preceding Table 4.13 for acronym definitions.

**Table 4. 13 (Continued)**  
**Fuel-Cycle Energy and Criteria Pollutant Emission Changes**  
**of Alternative and Advanced Vehicle/Fuel Systems**  
**(percentage relative to internal combustion engine vehicles**  
**fueled with reformulated gasoline)**

	FCV: MeOH, NA NG	FCV: MeOH, NNA NG	FCV: gasoline	FCV: cellulosic EtOH	FCV: CNG, NA NG	FCV: CNG, NNA NG	FCV: FT naphtha, NNA NG	FCV: crude naphtha
MPG - GGE	42.2	42.2	37.4	39.3	37.4	37.4	37.4	37.4
Total energy	-28.7%	-27.4%	-35.5%	19.9%	-41.6%	-34.7%	-10.3%	-38.6%
Fossil fuels	-28.5%	-27.2%	-35.5%	-96.9%	-41.7%	-34.8%	-10.0%	-38.6%
Petroleum	-98.5%	-98.1%	-35.5%	-94.4%	-99.7%	-99.7%	-98.7%	-36.4%
VOC: total	-69.0%	-67.1%	-45.9%	-49.6%	-91.0%	-87.9%	-81.8%	-78.9%
CO: total	-78.7%	-77.7%	-78.5%	-60.1%	-79.8%	-74.5%	-75.0%	-78.8%
NOx: total	-54.6%	-19.0%	-40.7%	305.7%	-69.0%	22.9%	-25.6%	-48.2%
PM10: total	-44.1%	-43.6%	-33.6%	142.9%	100.8%	153.8%	-53.7%	-42.4%
SOx: total	-81.6%	-76.6%	-36.1%	-91.7%	-88.5%	-85.6%	-82.3%	-57.3%
VOC: urban	-72.1%	-73.0%	-50.4%	-72.4%	-87.8%	-88.1%	-88.1%	-84.8%
CO: urban	-80.0%	-80.0%	-79.6%	-80.0%	-78.9%	-78.3%	-80.1%	-80.1%
NOx: urban	-83.4%	-85.2%	-53.1%	-84.4%	8.0%	15.7%	-89.0%	-88.3%
PM10: urban	-42.9%	-47.9%	-33.1%	-42.7%	-41.8%	-46.6%	-48.9%	-48.8%
SOx: urban	-98.7%	-98.5%	-37.0%	-100.2%	-97.5%	-96.8%	-99.1%	-98.5%

**Source:**

Wang, Michael, Q., model results of Beta Version of GREET 1.6, Argonne National Laboratory, Argonne, IL, August, 2001.

**Note:**

See page preceding Table 4.13 for acronym definitions.

*The average light truck pollutes 40% 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 will be changing due to the new Tier 2 standards.*

**Table 4.14**  
**Pollution from a Typical New Car and Light Truck, 2001 Model Year**  
**(pounds of pollutant per 15,000 miles of travel)**

	Car	Light truck
Carbon dioxide	21,900	30,000
Carbon monoxide	195	218
Nitrogen oxide	34	48
Hydrocarbons	29	39
Particulate matter	3.4	4.4

**Source:**

DeCicco, John and James Kliesch, *Green Guide to Cars and Trucks: Model Year 2001*, American Council for an Energy-Efficient Economy, Washington, DC, 2001, p. 111. (Additional resources: [www.aceee.org](http://www.aceee.org))

**Note:**

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

**Table 4.15**  
**Tier 2 Emission Standards for Cars and Light Trucks**  
**Effective for 2004–2009 Model Years<sup>a</sup>**  
**(grams/mile)**

Bin	NMOG	CO	NOx	PM	HCHO
50,000 miles					
10 <sup>b</sup>	0.125	3.4	0.4	c	0.015
9 <sup>b</sup>	0.075	3.4	0.2	a	0.015
8	0.100	3.4	0.14	a	0.015
7	0.075	3.4	0.11	a	0.015
6	0.075	3.4	0.08	a	0.015
5	0.075	3.4	0.05	a	0.015
120,000 miles					
MDPV <sup>b</sup>	0.280	7.3	0.9	0.12	0.032
10 <sup>b</sup>	0.156	4.2	0.6	0.08	0.018
9 <sup>b</sup>	0.090	4.2	0.3	0.06	0.018
8	0.125	4.2	0.2	0.02	0.018
7	0.090	4.2	0.15	0.02	0.018
6	0.090	4.2	0.10	0.01	0.018
5	0.090	4.2	0.07	0.01	0.018
4	0.070	2.1	0.04	0.01	0.011
3	0.055	2.1	0.03	0.01	0.011
2	0.010	2.1	0.02	0.01	0.004
1	0.000	0.0	0.00	0.00	0.000

**Source:**

*Federal Register*, Vol. 65, No. 28, Thursday, February 10, 2000, pp. 6822–6870.

**Acronyms Used on Tables 4.15 and 4.16**

CO	Carbon monoxide
GVW	Gross vehicle weight
HC	Hydrocarbons
HCHO	Formaldehyde
LDT	Light-duty truck
LEV	Low-emission vehicle
LVW	Loaded vehicle weight
MDPV	Medium-duty passenger vehicle
NMOG	Non-methane organic gases
NOx	Nitrogen oxides
PC	Passenger car
PM	Particulate matter
SULEV	Super-ultra-low-emission vehicle
ULEV	Ultra-low-emission vehicle
ZEV	Zero-emission vehicle

<sup>a</sup>Some temporary standards are not shown.

<sup>b</sup>Bin expires after 2008.

<sup>c</sup>No standard.

**Table 4.16**  
**Light Vehicle Exhaust Emission Standards in Effect in 2009**  
**When U.S. Tier 2 Standards are Final**  
**(grams/mile)**

Vehicle fuels: Gasoline AND diesel unless noted otherwise

Vehicle size: Up to 8,500 lbs GVW unless noted otherwise

Useful life:	Bins, category, size	50,000 miles						120,000 miles				
		NMOG	CO	NOx	PM	HCHO	HC+NOx	NMOG	CO	NOx	PM	HCHO
<b>Government:</b>												
U.S.	Bins											
	8	0.100	3.4	0.14	–	0.015	–	0.125	4.2	0.20	0.02	0.018
	7	0.075	3.4	0.11	–	0.015	–	0.090	4.2	0.15	0.02	0.018
	6	0.075	3.4	0.08	–	0.015	–	0.090	4.2	0.10	0.01	0.018
	5	0.075	3.4	0.05	–	0.015	–	0.090	4.2	0.07	0.01	0.018
	4	–	–	–	–	–	–	0.070	2.1	0.04	0.01	0.011
	3	–	–	–	–	–	–	0.055	2.1	0.03	0.01	0.011
	2	–	–	–	–	–	–	0.010	2.1	0.02	0.01	0.004
	1	–	–	–	–	–	–	0.000	0.0	0.00	0.00	0.000
	Average <sup>a</sup>	–	–	–	–	–	–	–	–	0.07	–	–
California	Category											
				(Diesel only)						(Diesel only)		
	LEV <sup>b</sup>	0.075	3.4	0.05	–	0.015	–	0.090	4.2	0.07	0.01	0.018
	ULEV	0.04	1.7	0.05	–	0.08	–	0.055	2.1	0.07	0.01	0.011
	SULEV	–	–	–	–	–	–	0.010	1.0	0.02	0.01	0.004
	ZEV <sup>c</sup>	0.00	0.0	0.00	–	0.00	–	0.000	0.0	0.00	0.00	0.000
	Avg. for all PCs + LDTs 0-3750 lbs LVW	0.038	–	–	–	–	–	–	–	–	–	–
	Avg. for LDTs 3751 lbs LVW - 8500 lbs GVW	0.047	–	–	–	–	–	–	–	–	–	–

**Source:**

U.S.: *Federal Register*, Vol. 65, No. 28, Thursday, February 10, 2000, pp. 6822–6870.

California *Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles*, as of December 1, 1999 (adopted August 5, 1999), incorporated by reference in section 1961(d), title 13, CCR.

**Note:**

See acronym list on previous page.

<sup>a</sup> Includes medium-duty passenger vehicles which are also required to meet bin standards.

<sup>b</sup> A LEV Option 1 with higher NOx levels also exists for up to 4% of LDTs above 3,750 lbs.

<sup>c</sup> Only apply to PCs and LDTs 0-3750 lbs LVW.

**Table 4.17**  
**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 <i>b</i>
<b>Gasoline</b>												
Hydrocarbons (total)	11	<i>c</i>	2.2	3.4		1.5		0.41				0.41 ( <i>e</i> )
Non-methane hydrocarbons	<i>d</i>	<i>e</i>										0.25 (0.31)
Carbon monoxide	80	<i>c</i>	23	39		15		7.0	3.4			3.4 (4.2)
Cold-temp. Carbon monoxide <sup>f</sup>	<i>d</i>	<i>e</i>										10 ( <i>e</i> )
Nitrogen oxides	4	<i>e</i>			3.0	3.1	2.0		1.0			0.4 (0.6)
Particulates	<i>d</i>	<i>e</i>										0.08 (0.10)
<b>Diesel</b>												
Hydrocarbons (total)	11	<i>e</i>				1.5		0.41				0.41 ( <i>e</i> )
Non-methane hydrocarbons	<i>d</i>	<i>e</i>										0.25 (0.31)
Carbon monoxide	80	<i>e</i>				15		7.0	3.4			3.4 (4.2)
Nitrogen oxides	4	<i>e</i>				3.1	2.0		1.0			1.0 (1.25)
Particulates	<i>d</i>	<i>e</i>								0.60	0.20	0.08 (0.10)
<b>Test Procedure</b>		7-mode		CVS-72		CVS-75						
<b>Useful Life (intermediate)<sup>b</sup></b>		<i>e</i>										5 yrs/50,000 mi
<b>(full)</b>												10 yrs/100,000 mi

**Source:**

40 CFR 86.085-2; 40 CFR 86.090-2; 40 CFR 86.090-8; 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.

<sup>a</sup>The 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.

<sup>b</sup>All 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.

<sup>c</sup>In 1968-69, exhaust emission standards were issued in parts per million (ppm) rather than grams per mile and are, therefore, incompatible with this table.

<sup>d</sup>No estimate available.

<sup>e</sup>No standard set.

<sup>f</sup>The 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 4.18**  
**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	1968-69	1970-71	1972	1973-74	1975	1976-78	1979-81	1982-83	1984	1985-86	1987	1988-93	1994	1995-2004		
<b>Gasoline</b>																	
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>												0.25 (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	4	<i>f</i>			3.0	3.1		2.3					1.2	0.4 (0.6)			
Particulates	<i>e</i>	<i>f</i>													0.08 (0.10)		
<b>Diesel</b>																	
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)		
<b>LDT1 Weight Criteria <i>h</i></b>		GVWR up through 6,000 lbs					GVWR up through 8,500 lbs					GVWR up through 6,000 lbs; LVW up through 3,750 lbs					
<b>Test Procedure <i>b</i></b>		7-mode		CVS-72		CVS-75											
<b>Useful Life (intermediate) <i>c</i></b>		<i>f</i>													5 yrs/50,000 mi		
<b>(full)</b>		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 86.090-9; 40 CFR 86.091-9; 40 CFR 86.094-9; 40 CFR 86.096-2; 40 CFR 86.096-9; 40 CFR 86.099-9; 40 CFR 86.000-9; 40 CFR 86.001-9; 40 CFR 86.004-9. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication.

<sup>a</sup>Light 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.

<sup>b</sup>The 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.

<sup>c</sup>Emission 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.

<sup>d</sup>In 1968-69, exhaust emission standards were issued in parts per million (ppm) rather than grams per mile and are, therefore, incompatible with this table.

<sup>e</sup>No estimate available.

<sup>f</sup>No standard set.

<sup>g</sup>The 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.

<sup>h</sup>Gross 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 4.19**  
**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		
<b>Gasoline</b>																		
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>f</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)		
<b>Diesel</b>																		
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)		
<b>LDT2 Weight Criteria <i>h</i></b>		GVWR up through 6,000 lbs					GVWR up through 8,500 lbs					GVWR up through 5,000 lbs and LVW over 3,750 lbs						
<b>Test Procedure <i>b</i></b>		7-mode		CVS-72	CVS-75													
<b>Useful Life (intermediate) <i>c</i></b>		<i>f</i>														5 yrs/50,000 mi		
<b>(full)</b>		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 86.090-9; 40 CFR 86.091-9; 40 CFR 86.094-9; 40 CFR 86.096-2; 40 CFR 86.096-9; 40 CFR 86.099-9; 40 CFR 86.000-9; 40 CFR 86.001-9; 40 CFR 86.004-9. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999.

<sup>a</sup>Light 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.

<sup>b</sup>The 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.

<sup>c</sup>Emission 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.

<sup>d</sup>In 1968-69, exhaust emission standards were issued in parts per million (ppm) rather than grams per mile and are, therefore, incompatible with this table.

<sup>e</sup>No estimate available.

<sup>f</sup>No standard set.

<sup>g</sup>The 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.

<sup>h</sup>Gross 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 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
<b>Gasoline</b>																
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>f</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)
<b>Diesel</b>																
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		(0.98)
Particulates	<i>e</i>	<i>f</i>							0.60		0.50		0.45		0.13	(0.10)
<b>LDT3 Weight Criteria</b>			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													
<b>Test Procedure <i>b</i></b>		7-mode		CVS-72		CVS-75										
<b>Useful Life (intermediate) <i>c</i></b>		<i>f</i>														5 yrs/50,000 mi
<b>(full)</b>		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 86.090-9; 40 CFR 86.091-9; 40 CFR 86.094-9; 40 CFR 86.096-2; 40 CFR 86.096-9; 40 CFR 86.099-9; 40 CFR 86.000-9; 40 CFR 86.001-9; 40 CFR 86.004-9. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999.

<sup>a</sup>Light 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.

<sup>b</sup>The 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.

<sup>c</sup>Emission 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.

<sup>d</sup>In 1968-69, exhaust emission standards were issued in parts per million (ppm) rather than grams per mile and are, therefore, incompatible with this table.

<sup>e</sup>No estimate available.

<sup>f</sup>No standard set.

<sup>g</sup>The 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.

<sup>h</sup>Gross 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 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
<b>Gasoline</b>																
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>														0.39 (0.56)
Carbon monoxide	80	<i>d</i>	23	39		20		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>	<i>f</i>														<i>f</i> (0.12)
<b>Diesel</b>																
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)
<b>LDT4 Weight Criteria <i>h</i></b>		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				
<b>Test Procedure <i>b</i></b>		7-mode		CVS-72		CVS-75										
<b>Useful Life (intermediate) <i>c</i></b>		<i>f</i>														5 yrs/50,000 mi
<b>(full)</b>		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 86.090-9; 40 CFR 86.091-9; 40 CFR 86.094-9; 40 CFR 86.096-2; 40 CFR 86.096-9; 40 CFR 86.099-9; 40 CFR 86.000-9; 40 CFR 86.001-9; 40 CFR 86.004-9. Lisa Snapp, Office of Air and Radiation, Environmental Protection Agency, Personal communication, April 1999.

<sup>a</sup>Light 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.

<sup>b</sup>The 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.

<sup>c</sup>Emission 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<sub>x</sub> 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.

<sup>d</sup>In 1968-69, exhaust emission standards were issued in parts per million (ppm) rather than grams per mile and are, therefore, incompatible with this table.

<sup>e</sup>No estimate available.

<sup>f</sup>No standard set.

<sup>g</sup>The 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.

<sup>h</sup>Gross 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 4.22**  
**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+
<b>Gasoline</b>												
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>			10.6				6.0	5.0		4.0	
Carbon Monoxide (CO)	<i>b</i>	40	25	37.1		14.4						
<b>Diesel</b>												
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
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) <i>d</i>	40/20/ <i>a</i>	20/15/50										
<b>Weight Criteria for Light Heavy Trucks <i>e</i></b>	GVWR over 6,000 lbs			GVWR over 8,500 lbs			GVWR 8,501 through 14,000 lbs					
<b>Test Procedure (gasoline) <i>f</i></b>	9-mode steady-state					MVMA transient						
<b>(diesel) <i>f</i></b>	13-mode steady-state			EPA transient								
<b>Useful Life (gasoline) <i>g</i></b>	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 86.090-11; 40 CFR 86.091-10; 40 CFR 86.091-11; 40 CFR 86.093-11; 40 CFR 86.094-11; 40 CFR 86.096-2; 40 CFR 86.096-10; 40 CFR 86.096-11; 40 CFR 86.098-10; 40 CFR 86.098-11; 40 CFR 86.099-10; 40 CFR 86.099-11; 40 CFR 86.004-11; 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.

<sup>a</sup>No standard set

<sup>b</sup>Although 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.

<sup>c</sup>Vehicles 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.

<sup>d</sup>Smoke opacity is expressed in percentage for acceleration, lugging, and peak modes (acceleration/lugging/peak). Lugging is when a vehicle is carrying a load.

<sup>e</sup>Gross vehicle weight rating (GVWR) is the maximum design loaded weight.

<sup>f</sup>Several 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.

<sup>g</sup>Emissions standards apply to the useful life of the vehicle. Useful life was 5 years/50,000 miles through 1983, and 8 years/110,000 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/110,000 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 4.23**  
**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+
<b>Gasoline</b>												
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								
<b>Diesel</b>												
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	25	15.5								
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										
<b>Weight Criteria for Heavy Heavy Trucks <i>e</i></b>	GVWR over 6,000 lbs		GVWR over 8,500 lbs			GVWR over 14,000 lbs						
<b>Test Procedure (gasoline) <i>f</i></b>	13-mode steady-state				MVMA							
<b>(diesel) <i>f</i></b>	13-mode steady-state			EPA transient								
<b>Useful Life (gasoline) <i>g</i></b>	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 86.090-11; 40 CFR 86.091-10; 40 CFR 86.091-11; 40 CFR 86.093-11; 40 CFR 86.094-11; 40 CFR 86.096-2; 40 CFR 86.096-10; 40 CFR 86.096-11; 40 CFR 86.098-10; 40 CFR 86.098-11; 40 CFR 86.099-10; 40 CFR 86.099-11; 40 CFR 86.004-11; 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.

<sup>a</sup>No standard set.

<sup>b</sup>Although 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.

<sup>c</sup>Vehicles 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.

<sup>d</sup>Smoke opacity is expressed in percentage for acceleration, lugging, and peak modes (acceleration/lugging/peak). Lugging is when a vehicle is carrying a load.

<sup>e</sup>Gross vehicle weight rating (GVWR) is the maximum design loaded weight.

<sup>f</sup>Several 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.

<sup>g</sup>Emissions standards apply to the useful life of the vehicle. Useful life was 5 years/50,000 miles through 1983, and 8 years/110,000 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/110,000 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**  
**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 <sup>a</sup>	NMHC <sup>b</sup>	NMOG <sup>c</sup>	CO	NO <sub>x</sub>	PM	HCHO	THC <sup>a</sup>	NMHC <sup>b</sup>	NMOG <sup>c</sup>	CO	NO <sub>x</sub>	PM	HCHO
Passenger car	Tier 0	–	0.39	–	7.0	0.4	0.08 <sup>d</sup>	0.015 <sup>e</sup>	–	–	–	–	–	–	–
	Tier 1	–	0.25	–	3.4	0.4	0.08 <sup>d</sup>	0.015 <sup>e</sup>	–	0.31	–	4.2	0.6	–	–
	TLEV	–	–	0.125	3.4	0.4	–	0.015	–	–	0.156	4.2	0.6	0.08 <sup>d</sup>	0.018
	LEV	–	–	0.075	3.4	0.2	–	0.015	–	–	0.090	4.2	0.3	0.08 <sup>d</sup>	0.018
	ULEV	–	–	0.040	1.7	0.2	–	0.008	–	–	0.055	2.1	0.3	0.04 <sup>d</sup>	0.011
	ZEV	0.0	0.00	0.000	0.0	0.0	0.00	0.000	0.000	0.00	0.00	0.000	0.0	0.0	0.00
LDT1	Tier 0	–	0.39	–	9.0	0.4	0.08 <sup>d</sup>	0.015 <sup>e</sup>	–	–	–	–	–	–	–
	Tier 1	–	0.25	–	3.4	0.4	0.08 <sup>d</sup>	0.015 <sup>e</sup>	–	0.31	–	4.2	0.6	–	–
	TLEV	–	–	0.125	3.4	0.4	–	0.015	–	–	0.156	4.2	0.6	0.08 <sup>d</sup>	0.018
	LEV	–	–	0.075	3.4	0.2	–	0.015	–	–	0.090	4.2	0.3	0.08 <sup>d</sup>	0.018
	ULEV	–	–	0.040	1.7	0.2	–	0.008	–	–	0.055	2.1	0.3	0.04 <sup>d</sup>	0.011
	ZEV	0.0	0.00	0.000	0.0	0.0	0.00	0.000	0.000	0.00	0.00	0.000	0.0	0.0	0.00
LDT2	Tier 0	–	0.50	–	9.0	1.0	0.08 <sup>d</sup>	0.018 <sup>e</sup>	–	–	–	–	–	–	–
	Tier 1	–	0.32	–	4.4	0.7	0.08 <sup>d</sup>	0.018 <sup>e</sup>	–	0.40	–	5.5	0.97	–	–
	TLEV	–	–	0.160	4.4	0.7	–	0.018	–	–	0.200	5.5	0.9	0.10 <sup>d</sup>	0.023
	LEV	–	–	0.100	4.4	0.4	–	0.018	–	–	0.130	5.5	0.5	0.10 <sup>d</sup>	0.023
	ULEV	–	–	0.050	2.2	0.4	–	0.009	–	–	0.070	2.8	0.5	0.05 <sup>d</sup>	0.013

**Source:**

U.S. Environmental Protection Agency, Office of Transportation and Air Quality, EPA 420-B-00-001. (Additional resources: [www.epa.gov/otag](http://www.epa.gov/otag))

**Note:**

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

<sup>a</sup> THCE for methanol vehicles. Does not apply to CNG vehicles.

<sup>b</sup> THCE for Tier 0 methanol vehicles. NMHCE for other alcohol vehicles.

<sup>c</sup> NMHC for diesel-fueled vehicles.

<sup>d</sup> Diesel-fueled vehicles only.

<sup>e</sup> 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 Tier 1 standards for all new vehicles sold in California. Currently, there is a wide array of TLEVs and LEVs, and a few ULEVs, SULEVs 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 4.25**  
**California Vehicle Emission Reduction for**  
**Passenger Cars and Light Trucks**

	Emission reduction from Tier 1 California standards <sup>a</sup>		
	HC	CO	NO <sub>x</sub>
Transitional Low-Emission Vehicle (TLEV)	50%	=	=
Low-Emission Vehicle (LEV)	70%	=	50%
Ultra-Low-Emission Vehicle (ULEV)	85%	50%	50%
Super-Ultra-Low-Emission Vehicle (SULEV)	96%	70%	95%
Zero-Emission Vehicles (ZEV)	100%	100%	100%

**Source:**

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

**Note:**

= indicates equivalent emissions to vehicles meeting the Tier 1 California standard.

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<sup>a</sup>See Table 4.24.