

Section D

Air Pollution

Table 4-29

Federal Exhaust Emission Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Light-Duty Vehicles^{a,b} (Grams per mile)

Engine type and pollutant	Prior to control ^d	1968-1969	1970-1971	1972	1973-1974	1975-1976	1977-1979	1980	1981	1982-1986	1987-1993	Tier 1 ⁱ 1994-2003 ^b	Interim Tier 2 ⁱ 2004-2006	Tier 2 ⁱ 2007+				
Gasoline																		
HC (total)	11	g	2.2	3.4	1.5		0.41				0.41	(^h)	^h					
NMHC	e	h											0.25	(0.31)	^h			
NMOG	e	h													0.125	(0.156)	0.100	(0.125)
CO	80	g	23	39	15		7.0	3.4			3.4	(4.2)						
Cold-temp. CO ^c	e	h											10	(^h)				
NO _x	4	h			3.0	3.1	2.0	1.0				0.4	(0.6)			0.14	(0.20)	
Particulates	e	h											0.08	(0.10)	0.08	(0.08)	0.02	(0.02)
Formaldehyde	e	h													0.015	(0.018)		
Diesel																		
HC (total)	11	h			1.5		0.41				0.41	(^h)	^h					
NMHC	e	h											0.25	(0.31)	^h			
NMOG	e	h													^h	(0.156)	0.100	(0.125)
CO	80	h			15		7.0	3.4			3.4	(4.2)	^h	(4.2)	3.4	(4.2)		
NO _x	4	h			3.1	2.0	1.0				1.0	(1.25)	^h	(0.6)	0.14	(0.20)		
Particulates	e	h											0.08	(0.10)	^h	(0.10)	0.02	(0.02)
Formaldehyde	e	h													^h	(0.018)	0.015	(0.018)
Test procedure			7-mode	CVS-72	CVS-75													
Useful life (intermediate)^{b,f}												5 years/50,000 miles						
(full)			5 years/50,000 miles									10 years/100,000 miles			10 years/120,000 miles			

^a The test procedure for measuring exhaust emissions has changed several times over the course of vehicle emissions regulations. 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 procedure became the test procedure as of model year 1975. While it may appear that the total HC and CO 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 CO and composite standards for NMHC and NO_x tested under the new Supplemental Federal Test Procedure will be phased-in beginning with model year 2000; these standards are not shown in this table.

^b All emissions standards must be met for a useful life of 5 years/50,000 miles. Beginning with model year 1994, a second set of emissions 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%, respectively.

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

^d The "Prior to control" column reports emissions estimates of a typical newly manufactured car in the years before exhaust emissions certification standards were implemented.

^e No estimate available.

^f Manufacturers can opt to certify vehicles for a full useful life of 15 years/150,000 miles and have either 1) intermediate useful life standards waived or 2) receive additional NO_x credits.

^g In 1968-69, exhaust emissions standards were issued in parts per million rather than grams per mile and are, therefore, incompatible with this table.

^h No standard has been set.

ⁱ The term "tier" refers to a level of standards and is associated with specific years. Interim Tier 2 refers to an intermediate level of standards that move manufacturers toward compliance with Tier 2 standards. Interim Tier 2 and Tier 2 standards are established as "bins." Each bin is a set of standards for NO_x, CO, NMOG, formaldehyde, and particulate matter; HC and NMHC standards are dropped for Tier 2 and Interim Tier 2. Manufacturers may certify any given vehicle family to any of the bins available for that vehicle class as long as the resulting sales-weight corporate average NO_x standard is met for the full useful life of the vehicle. The Tier 2 corporate average NO_x standard is 0.07 grams/mile. Interim corporate-based average NO_x standards are based on vehicle type. The interim sales-weighted average for light-duty vehicles (LDVs) is 9.3 grams/mile. For LDVs, Tier 2 standards will be phased in at a rate of 25% in 2004, 50% in 2005, 75% in 2006, and 100% in 2007. During this period, all LDVs not meeting the Tier 2 standards must meet Interim Tier 2 standards.

SOURCES: 40 CFR 86, Subpart A (July 1, 1998). U.S. Environmental Protection Agency, Office of Air and Radiation, personal communication.

KEY: CO = carbon monoxide; HC = hydrocarbons; NMHC = nonmethane hydrocarbons; NMOG = nonmethane organic gases; NO_x = nitrogen oxides

Table 4-30a

Federal Exhaust Emission Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Light Duty Trucks (Category LDT1) ^{a,b,c} (Grams per mile)

Engine type and pollutant	Prior to control ^g	1968-1969	1970-1971	1972	1973-1974	1975	1976-1978	1979-1981	1982-1983	1984	1985-1986	1987	1988-1993	Tier 1 ^k 1994	1995-2003	Interim Tier 2 ^k 2004-2006	Tier 2 ^k 2007+		
Gasoline																			
HC (total)	11	i	2.2	3.4		2.0		1.7		0.80				j		j			
NMHC	h	j												0.25 (0.31)		j			
NMOG	h	j														0.125 (0.156)	0.100 (0.125)		
CO	80	i	23	39		20		18		10				3.4 (4.2)					
Cold-temp. CO ^d		e												10 ^l					
NO _x	4	j			3.0	3.1		2.3					1.2	0.4 (0.6)			0.14 (0.20)		
Particulates	h	j													0.08 (0.10)	0.08 (0.08)	0.02 (0.02)		
Formaldehyde	h	j														0.015 (0.018)			
Diesel																			
HC (total)	11	j					2.0	1.7		0.80				j (0.80)		j			
NMHC	h	j												0.25 (0.31)		j			
NMOG	h	j														j (0.156)	0.100 (0.125)		
CO	80	j					20	18		10				3.4 (4.2)		j (4.2)	3.4 (4.2)		
NO _x	4	j					3.1	2.3					1.2	1.0 (1.25)		j (0.6)	0.14 (0.20)		
Particulates	h	j							0.60			0.26			0.08 (0.10)	j (0.10)	0.02 (0.02)		
Formaldehyde	h	j														j (0.018)	0.015 (0.018)		
LDT1 weight criteria^e		GVWR up through 6,000 pounds					GVWR up through 8,500 pounds					GVWR up through 6,000 lbs; LVW up through 3,750 pounds							
Test procedure^b		7-mode		CVS-72			CVS-75												
Useful life (intermediate)^{c,f}		j													5 years/50,000 miles		5 years/50,000miles		
(full)		5 years/50,000 miles					11 years/120,000 miles					10 years/100,000 miles			10 years/120,000 miles				

KEY: CO=carbon monoxide; GVWR=gross vehicle weight rating; HC=hydrocarbons; LVW=loaded vehicle weight; NMHC=nonmethane hydrocarbons; NMOG= nonmethane organic gases; NO_x=nitrogen oxides

Continued next page

Table 4-30a
Cont'd

Federal Exhaust Emission Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Light Duty Trucks (Category LDT1)^{a,b,c} (Grams per mile)

^a Light-duty truck categories LDT1-LDT4 were not created until 1994. From 1968 to 1978, all trucks with a GVWR up to 6,000 pounds were classified as light-duty trucks and were required to meet the same standards. As of 1979, the maximum weight was raised to 8,500 pounds GVWR. During 1988-93, light duty trucks were divided into two subcategories that coincide with the current LDT1-LDT4 categories. The standards for LDT2, LDT3, and LDT4 are shown in tables 4-30b through 4-30d.

^b 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 procedure became the test procedure as of model year 1975. While it may appear that total HC and CO 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 CO and composite standards for NMHC and NO_x tested over the new Supplemental Federal Test Procedure will be phased-in beginning with model year 2000. These standards are not shown in this table.

^c Emissions 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, emissions standards were established for an intermediate useful life of 5 years/50,000 miles as well as a full useful life (full useful life standards are shown in parentheses). HC standards, however, were established only for full useful life. Tier 1 exhaust standards, except particulates standards, were phased-in during 1994-96 at a rate of 40%, 80%, and 100%, respectively. PM standards were phased-in at a rate of 40%, 80%, and 100% during 1995-97.

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

^e GVWR is the maximum design loaded weight. LVW is the curb weight (nominal vehicle weight) plus 300 pounds.

^f Manufacturers can opt to certify vehicles for a full useful life of 15 years/150,000 miles and either have (1) intermediate useful life standards waived or (2) receive additional NO_x credits.

^g The "Prior to controls" column reports emissions estimates of a typical newly manufactured car in the years before exhaust emissions certification standards, were implemented.

^h No estimate available.

ⁱ In 1968-69, exhaust emissions standards were issued in parts per million rather than grams per mile and are, therefore, incompatible with this table.

^j No standard has been set.

^k The term "tier" refers to a level of standards for specific years. Interim Tier 2 refers to an intermediate level of standards that move manufacturers toward compliance with Tier 2 standards. Interim Tier 2 and Tier 2 standards are established as "bins." Each bin is a set of standards for NO_x, CO, NMOG, formaldehyde, and particulates (HC and NMHC standards are dropped for Tier 2 and Interim Tier 2). Manufacturers may certify any given vehicle family to any of the bins available for that vehicle class as long as the resulting sales-weighted corporate average NO_x standard is met for the full useful life. The Tier 2 corporate average NO_x standard is 0.07 grams/mile. Interim corporate-based average NO_x standards are based on vehicle type. The interim corporate sales-weighted average for LDT1 vehicles is 0.3 grams/mile. Tier 2 standards will be phased in at a rate of 25% in 2004, 50% in 2005, 75% in 2006, and 100% in 2007. During this period, all LDT1 vehicles not meeting the Tier 2 standards must meet Interim Tier 2 standards.

SOURCES: 40 CFR 86, Subpart A (July 1, 1998). U.S. Environmental Protection Agency, Office of Air and Radiation, personal communication, April 1999, and the Federal Register, Vol. 65, No. 28, pp. 6851-6870.

Table 4-30b

Federal Exhaust Emission Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Light Duty Trucks (Category LDT2)^{a,b,c} (Grams per mile)

Engine type and pollutant	Prior to control ^g	1968-	1970-	1973-	1976-	1979-	1982-	1984	1985-	1988-	1991-	Tier 1 ^k	Interim Tier 2 ^k	Tier 2 ^k							
		1969	1971	1974	1975	1978	1981	1983	1986	1987	1990	1993			1994	1995-2003	2004-2006	2007+			
Gasoline																					
HC (total)	11	^e	2.2	3.4	2.0	1.7	0.80					j (0.80)									
NMHC	^h											j (0.40)									
NMOG	^h												0.125 (0.156)	0.100 (0.125)							
CO	80		23	39	20	18	10					4.4 (5.5)	3.4 (4.2)								
Cold-temp. CO ^d	^h											12.5 ⁽ⁱ⁾									
NO _x	4			3.0	3.1	2.3				1.7		0.7 (0.97)	0.4 (0.6)	0.14 (0.20)							
Particulates	^h												0.08 (0.10)	0.08 (0.08)							
Formaldehyde	^h													0.02 (0.02)							
													0.015 (0.018)								
Diesel																					
HC (total)	11				2.0	1.7	0.80					j (0.80)									
NMHC	^h											0.32 (0.40)									
NMOG	^h												(0.156)	0.100 (0.125)							
CO	80				20	18	10					4.4 (5.5)	(4.2)	3.4 (4.2)							
NO _x	4				3.1	2.3				1.7		j (0.97)	(0.6)	0.14 (0.20)							
Particulates	^h						0.60		0.50	0.45	0.13		0.08 (0.10)	(0.10)							
Formaldehyde	^h												(0.018)	0.015 (0.018)							
LDT2 weight criteria^o		GVWR up through 6,000 pounds			GVWR up through 8,500 pounds			GVWR up through 6,000 pounds; LVW over 3,750 pounds													
Test procedure^b		7-mode	CVS-72	CVS-75																	
Useful life (intermediate)^{e, f}							5 years/50,000 miles					5 years/50,000miles									
(full)		5 years/50,000 miles					11 years/120,000 miles					10 years/100,000 miles					10 years/120,000 miles				

KEY: CO=carbon monoxide; GVWR=gross vehicle weight rating; HC=hydrocarbons; LVW=loaded vehicle weight; NMHC=non-methane hydrocarbons; NMHC=nonmethane hydrocarbons; NMOG=nonmethane organic gases; NO_x=nitrogen oxides

Continued next page

Table 4-30b
Cont'd

Federal Exhaust Emission Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Light Duty Trucks (Category LDT2)^{a,b,c} (Grams per mile)

^a Light-duty truck categories LDT1-LDT4 were not created until 1994. From 1968 to 1978 all trucks with a GVWR up to 6,000 pounds were classified as light-duty trucks and were required to meet the same standards. As of 1979, the maximum weight was raised to 8,500 pounds GVWR. During 1988-93, light-duty trucks were divided into two subcategories that coincide with the current LDT1-LDT4 categories. The standards for LDT1, LDT3, and LDT4 are shown in tables 4-30a, 4-40c, and 4-30d.

^b 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 procedure became the test procedure as of model year 1975. While it may appear that the total HC and CO 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 CO and composite standards for NMHC and NO_x tested over the new Supplemental Federal Test Procedure will be phased-in beginning with model year 2000. These standards are not shown in this table.

^c Emissions 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, emissions standards were established for an intermediate useful life of 5 years/50,000 miles as well as a full useful life (full useful life standards are shown in parentheses). HC standards, however, were established only for full useful life. Tier 1 exhaust standards, except particulates standards, were phased-in during 1994-96 at a rate of 40%, 80%, and 100%, respectively. Particulates standards were phased-in at a rate of 40%, 80%, and 100% during 1995-97.

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

^e GVWR is the maximum design loaded weight. LVW is the curb weight (nominal vehicle weight) plus 300 pounds.

^f Manufacturers can opt to certify vehicles for a full useful life of 15 years/150,000 miles and either have (1) intermediate useful life standards waived or (2) receive additional NO_x credits.

^g The "Prior to controls" reports emissions estimates of a typical newly manufactured car in the years before exhaust emissions certification standards were implemented.

^h No estimate available.

ⁱ In 1968-69, exhaust emissions standards were issued in parts per million rather than grams per mile and are, therefore, incompatible with this table.

^j No standard has been set.

^k The term "tier" refers to a level of standards for specific years. Interim 2 refers to an intermediate level of standards that move manufacturers toward compliance with Tier 2 standards. Interim Tier 2 and Tier 2 standards are established as "bins." Each bin is a set of standards for NO_x, CO, NMOG, formaldehyde, and particulates (HC and NMHC standards are dropped for Tier 2 and Interim Tier 2). Manufacturers may certify any given vehicle family to any of the bins available for that vehicle class as long as the resulting sales-weighted corporate average NO_x standard is met for the full useful life. The Tier 2 corporate average NO_x standard is 0.07 grams/mile. Interim corporate-based average NO_x standards are based on vehicle type. The interim corporate sales-weighted average for LDT2 vehicles is 0.3 grams/mile. Tier 2 standards will be phased in at a rate of 25% in 2004, 50% in 2005, 75% in 2006, and 100% in 2007. During this period all LDT2 vehicles not meeting the Tier 2 standards must meet Interim Tier 2 standards.

SOURCES: 40 CFR 86, Subpart A (July 1, 1998). U.S. Environmental Protection Agency, Office of Air and Radiation, personal communication, April 1999, and the Federal Register, Vol. 65, No. 28, pp. 6851-6870.

Table 4-30c

Federal Exhaust Emission Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Light Duty Trucks (Category LDT3)^{a,b,c} (Grams per mile)

Engine type and pollutant	Prior to control ^g	1968-1969	1970-1971	1972	1973-1974	1975	1976-1978	1979-1981	1982-1983	1984	1985-1986	1987	1988-1989	1990	1991-1995	Tier 1 ^k 1996-2007	Interim Tier 2 ^k 2008	Tier 2 ^k 2009+	
Gasoline																			
HC (total)	11		2.2	3.4		2.0		1.7		0.80						(0.80)			
NMHC																0.32	(0.46)		
NMOG																	0.160	(0.230)	0.125 (0.156)
CO	80		23	39		20		18		10						4.4	(6.4)		3.4 4.2
Cold-temp. CO ^d																12.5	(^h)		
NO _x	4				3.0	3.1		2.3					2.3	1.7		0.7	(0.98)	0.4 (0.6)	0.14 (0.20)
Particulates																	(0.10)	0.08 (0.08)	0.02 (0.02)
Formaldehyde																		0.018 (0.027)	0.015 (0.018)
Diesel																			
HC (total)	11					2.0		1.7		0.80						(0.80)			
NMHC																0.32	(0.46)		
NMOG																		(0.230)	0.125 (0.156)
CO	80					20		18		10						4.4	(6.4)		3.4 4.2
NO _x	4					3.1		2.3					2.3	1.7		(0.98)		(0.6)	0.14 (0.20)
Particulates									0.60			0.50	0.45		0.13		(0.10)	(0.08)	0.02 (0.02)
Formaldehyde																		(0.027)	0.015 (0.018)
LDT3 weight criteria^e		GVWR up through 6,000 pounds					GVWR up through 8,500 pounds					Any ALVW		ALVW up through 5,750 pounds					
												GVWR 6,001-8,500 pounds							
Test procedure^b		7-mode	CVS-72	CVS-75															
Useful life (intermediate)^{c,f}																	5 years/50,000 miles		
(full)		5 years/50,000 miles							11 years/120,000 miles										

KEY: ALVW=adjusted loaded vehicle weight; CO = carbon monoxide; GVWR=gross vehicle weight rating; HC = hydrocarbons; NMHC=nonmethane hydrocarbon; NMOG=nonmethane organic gases; NO_x=nitrogen oxides

Continued next page

Table 4-30c
Cont'd

Federal Exhaust Emission Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Light Duty Trucks (Category LDT3)^{a,b,c} (Grams per mile)

^a Light-duty truck categories LDT1-LDT4 were not created until 1994. From 1968 to 1978 all trucks with a GVWR up to 6,000 pounds were classified as light-duty trucks and were required to meet the same standards. As of 1979, the maximum weight was raised to 8,500 pounds GVWR. During 1988-93, light-duty trucks were divided into two subcategories that coincide with the current LDT1-LDT4 categories. The standards for LDT1, LDT2, and LDT4 are given in tables 4-30a, 4-40b, and 4-30d.

^b 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 procedure became the test procedure as of model year 1975. While it may appear that the total HC and CO 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 CO and composite standards for NMHC and NO_x tested over the new Supplemental Federal Test Procedure will be phased-in beginning with model year 2002. These standards are not shown in this table.

^c Emissions 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, emissions 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 (intermediate and full useful life standards are shown in parentheses). This applied to all pollutants except HC and particulates for all LDT3 vehicles and NO_x for diesel-powered LDT3 vehicles, 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%, respectively.

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

^e GVWR is the maximum design loaded weight. ALVW is the numerical average of the GVWR and the curb weight.

^f Manufacturers can opt to certify vehicles for a full useful life of 15 years/150,000 miles and either have (1) intermediate useful life standards waived or (2) receive additional NO_x credits.

^g The "Prior to controls" column reports emissions estimates of a typical newly manufactured car in the years before exhaust emissions certification standards were implemented.

^h No estimate available.

ⁱ In 1968-69, exhaust emissions standards were issued in parts per million rather than grams per mile and are, therefore, incompatible with this table.

^j No standard has been set.

^k The term "tier" refers to a level of standards for specific years. Interim 2 refers to an intermediate level of standards that moves manufacturers toward compliance with Tier 2 standards. Interim Tier 2 and Tier 2 standards are established as "bins." Each bin is a set of standards for NO_x, CO, NMOG, formaldehyde, and particulates (HC and NMHC standards are dropped for Tier 2 and Interim Tier 2). Manufacturers may certify any given vehicle family to any of the bins available for that vehicle class as long as the resulting sales-weighted corporate average NO_x standard is met for full useful life. The Tier 2 corporate average NO_x standard is 0.07 grams/mile. Interim corporate-based average NO_x standards are based on vehicle type. The interim corporate sales-weighted average for LDT3 vehicles is 0.6 grams/mile. Tier 2 LDT3 standards will be phased in during 2008 and 2009. In 2008, 50% of LDT3 vehicles must meet Tier 2 standards; the others must meet Interim Tier 2 standards. Beginning in 2009, all LDT3 vehicles must meet Tier 2 standards.

SOURCES: 40 CFR 86, Subpart A (July 1, 1998). U.S. Environmental Protection Agency, Office of Air and Radiation, personal communication, April 1999, and the Federal Register, Vol. 65, No. 28, pp. 6851-6870.

Table 4-30d

Federal Exhaust Emission Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Light Duty Trucks (Category LDT4)^{a,b,c} (Grams per mile)

Engine type and pollutant	Prior to control ^g	1968-1969	1970-1971	1972	1973-1974	1975	1976-1978	1979-1981	1982-1983	1984	1985-1986	1987	1988-1989	1990	1991-1995	Tier 1 ^k 1996-2007	Interim Tier 2 ^k 2008	Tier 2 ^k 2009+			
Gasoline																					
HC (total)	11		2.2	3.4		2.0		1.7		0.80						(0.80)					
NMHC	^h															0.39	(0.56)				
NMOG	^h																0.160	(0.230)	0.125	(0.156)	
CO	80		23	39		20		18		10						5.0	(7.3)	4.4	(6.4)	3.4	(4.2)
Cold-temp. CO ^d	^h															12.5	^o				
NO _x	4				3.0	3.1		2.3					2.3	1.7		1.1	(1.53)	0.4	(0.6)	0.14	(0.20)
Particulates	^h																(0.12)	0.08	(0.08)	0.02	(0.02)
Formaldehyde	^h																	0.018	(0.027)	0.015	(0.018)
Diesel																					
HC (total)	11						2.0	1.7		0.80						(0.80)					
NMHC	^h															0.39	(0.56)				
NMOG	^h																(0.230)		0.125	(0.156)	
CO	80					20		18		10						5.0	(7.3)	(6.4)		3.4	(4.2)
NO _x	4						3.1	2.3					2.3	1.7		(1.53)		(0.6)		0.14	(0.20)
Particulates	^h								0.60		0.50	0.45		0.13		(0.12)		(0.08)		0.02	(0.02)
Formaldehyde	^h																	(0.027)		0.015	(0.018)
LDT4 weight criteria^e		GVWR up through 6,000 pounds					GVWR up through 8,500 pounds					Any ALVW		ALVW over 5,750 pounds							
												GVWR 6,001-8,500 pounds									
Test procedure^b		7-mode	CVS-72	CVS-75																	
Useful life (intermediate)^{c, f} (full)		5 years/50,000 miles							11 years/120,000 miles							5 years/50,000 miles					

KEY: ALVW=adjusted loaded vehicle weight; CO = carbon monoxide; GVWR=gross vehicle weight rating; HC = hydrocarbons; NMHC=nonmethane hydrocarbon; NMOG=nonmethane organic gases; NO_x=nitrogen oxides

Continued next page

Table 4-30d
Cont'd

Federal Exhaust Emission Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Light Duty Trucks (Category LDT4)^{a,b,c} (Grams per mile)

^a Light-duty truck categories LDT1-LDT4 were not created until 1994. From 1968 to 1978 all trucks with a GVWR up to 6,000 pounds were classified as light-duty trucks and were required to meet the same standards. As of 1979, the maximum weight was raised to 8,500 pounds GVWR. During 1988-93, light-duty trucks were divided into two sub categories that coincide with the current LDT1-LDT4 categories. The standards for LDT1, LDT2, and LDT3 are given in tables 4-30a, 4-40b, and 4-30c.

^b 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 procedure became the test procedure as of model year 1975. While it may appear that the total HC and CO 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 CO and composite standards for NMHC and NO_x tested over the new Supplemental Federal Test Procedure will be phased-in beginning with model year 2002. These standards are not shown in this table.

^c Emissions 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, emissions 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 (intermediate and full useful life standards are shown in parentheses). This applied to all pollutants except HC and particulates for all LDT4 vehicles and NO_x for diesel-powered LDT4 vehicles, 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%, respectively.

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

^e GVWR is the maximum design loaded weight. ALVW is the numerical average of the GVWR and the curb weight.

^f Manufacturers can opt to certify vehicles for a full useful life of 15 years/150,000 miles and either have (1) intermediate useful life standards waived or (2) receive additional NO_x credits.

^g The "Prior to controls" column reports emissions estimates of a typical newly manufactured car in the years before exhaust emissions certification standards were implemented.

^h No estimate available.

ⁱ In 1968-69, exhaust emissions standards were issued in parts per million rather than grams per mile and are, therefore, incompatible with this table.

^j No standard has been set.

^k The term "tier" refers to a level of standards for specific years. Interim 2 refers to an intermediate level of standards that moves manufacturers toward compliance with Tier 2 standards. Interim Tier 2 and Tier 2 standards are established as "bins." Each bin is a set of standards for NO_x, CO, NMOG, formaldehyde, and particulate matter (HC and non-methane HC standards are dropped for Tier 2 and interim Tier 2). Manufacturers may certify any given vehicle family to any of the bins available for that vehicle class as long as the resulting sales-weighted corporate average NO_x standard is met for full useful life. The Tier 2 corporate average NO_x standard is 0.07 grams/mile. Interim corporate-based average NO_x standards are based on vehicle type. The interim corporate sales-weighted average for LDT4 vehicles is 0.6 grams/mile. Tier 2 standards will be phased in during 2008 and 2009. In 2008, 50% of LDT4 vehicles must meet Tier 2 standards; the others must meet Interim Tier 2 standards. Beginning in 2009, all LDT4 vehicles must meet Tier 2 standards.

SOURCES: 40 CFR 86, Subpart A (July 1, 1998). US Environmental Protection Agency, Office of Air and Radiation, personal communication, April 1999, and the U.S. Federal Register, Vol. 65, No. 28, pp. 6851-6870.

Federal Exhaust Emission Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Medium-Duty Passenger Vehicles (MDPV)^{a,b}
(Grams per mile)

Table 4-31

Engine type and pollutant	2004	2008	2009+
<i>Gasoline</i>			
NMOG	0.195 (0.280)		0.125 (0.156)
CO	5.0 (7.3)		3.4 (4.2)
Cold-temp. CO ^c	12.5		
NO _x	0.6 (0.9)		0.14 (0.20)
Particulates	0.12 (0.12)		0.02 (0.02)
Formaldehyde	0.022 (0.032)		0.015 (0.018)
<i>Diesel</i>			
HC	1.3 g/bhp-hr		
NMHC + NO _x	2.4 g/bhp-hr		
NMOG		^g (0.280)	0.125 (0.156)
CO	15.5 g/bhp-hr	^g (7.3)	3.4 (4.2)
NO _x	4.0 g/bhp-hr	^g (0.9)	0.14 (0.20)
Particulates	0.10 g/bhp-hr	^g (0.12)	0.02 (0.02)
Formaldehyde		^g (0.032)	0.015 (0.018)
Smoke opacity (acceleration/lugging/peak) ^d	20/15/50		
Weight Criteria	Greater than 8,500 pounds GVWR; less than 10,000 pounds GVWR		
Test procedure-gasoline	CVS-75		
Test procedure-diesel	EPA Transient	CVS-75	
Useful life-gasoline (intermediate)^{b,e} (full)	5 years/50,000 miles		
	11 years/120,000 miles		
Useful life-diesel (intermediate)^{b,e} (full)	^g	5 years/50,000 miles	
	8 years/110,000 miles	11 years/120,000 miles	

^a The MDPV category was created for the Interim Tier 2 and Tier 2 vehicle emissions standards. This category was specifically designed to help bring passenger vehicles (such as large sport utility vehicles and passenger vans) over 8,500 pounds GVWR into the Tier 2 program. MDPVs are defined as any complete heavy-duty vehicle less than 10,000 pounds GVWR designed primarily for transportation of persons, including conversion vans (i.e., vans which are intended to be converted to vans used primarily for transporting people). This does not include vehicles that have 1) a capacity of more than 12 persons total, or 2) are designed to accommodate more than 9 persons seated rearward of the driver's seat, or 3) have a cargo box (i.e., a pickup-bed or box) of six feet or more in interior length. Prior to Tier 2 standards, these vehicles would have been regulated as light heavy-duty trucks.

^b Diesel MDPVs can continue to use light heavy-duty truck standards for new vehicle certification until 2008. Note that these standards are measured in grams per brake horsepower-hour (g/bhp-hr). Beginning in 2008, MDPVs must use the same on-chassis testing procedure as heavy light-duty trucks (categories LDT3 and LDT4) and must meet standards for MDPVs. Beginning in 2009, MDPVs must meet the same standards as light heavy-duty trucks, except MDPVs are not required to meet Supplemental Federal Test Procedure standards.

^c The cold CO emissions standard is measured at 20 °F (rather than 75 °F) and is applicable for a full useful life of 5-years/50,000-miles.

^d Smoke opacity is expressed as a percentage for acceleration, lugging, and peak operation modes. Lugging occurs when a vehicle is carrying a load.

KEY: CO = carbon monoxide; g/bhp-hr = grams per brake horsepower/hour; GVWR = gross vehicle weight rating; HC = hydrocarbons; NMHC=nonmethane hydrocarbon; NMOG = nonmethane organic gases; NO_x = nitrogen oxides

^e Manufacturers can opt to certify vehicles for a full useful life of 15 years/150,000 miles and have either 1) intermediate useful life standards waived or 2) receive additional NO_x credits.

^f The term "tier" refers to a level of standards for specific years. Interim 2 refers to an intermediate level of standards that moves manufacturers toward compliance with Tier 2 standards. Tier 2 and interim Tier 2 standards are established as "bins." Each bin is a set of standards for NO_x, CO, NMOG, formaldehyde, and particulates (HC and NMHC standards are dropped for Tier 2 and Interim Tier 2). Manufacturers may certify any given vehicle family to any of the bins available for that vehicle class as long as the resulting sales-weighted corporate average NO_x standard is met for full useful life. The Tier 2 corporate average NO_x standard is 0.07 grams/mile. Interim corporate-based average NO_x standards are based on vehicle type. The interim corporate sales-weighted average for MDPVs is 0.6 grams/mile. Tier 2 MDPV standards will be phased in during 2008 and 2009. In 2008, 50% of MDPVs must meet Tier 2 standards; the other 50% of MDPVs must meet interim Tier 2 standards. Beginning in 2009, all MDPVs must meet Tier 2 standards.

^g Diesel MDPVs are not required to meet intermediate life standards during this time period.

SOURCE: Federal Register, Vol. 65, No. 28, pp. 6698-6870.

Table 4-32a

Federal Exhaust Emissions Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Light Heavy-Duty Trucks (Grams per brake horsepower-hour)

Engine type and pollutant	1970-73	1974-78	1979-83	1984	1985-86	1987	1988-89	1990	1991-93	1994-97	1998-2003	2004+
<i>Gasoline</i>												
HC + NO _x	e	16	10	e								
HC	f	e	1.5	1.9	1.1							
NO _x	e				10.6		6.0	5.0		4.0		
CO	f	40	25	37.1	14.4							
<i>Diesel</i>												
HC + NO _x	e	16	10	e								
HC	f	e	1.5	1.3								
NO _x	e				10.7		6.0	5.0		4.0		
Nonmethane HC + NO _x	e											2.4 ^g
CO	f	40	25	15.5								
Particulates	e						0.60		0.25	0.10		
Smoke opacity (acceleration/lugging/peak) ^a	40/20 ^e		20/15/50									
Weight criteria for light heavy-duty trucks^b	GVWR over 6,000 lbs			GVWR over 8,500 lbs			GVWR 8,501 through 14,000					
Test procedure (gasoline)^c	9-mode steady-state				MVMA transient							
(diesel)^c	13-mode steady-state			EPA transient								
Useful life (gasoline)^d	5 years/50,000 miles				8 years/110,000 miles							

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

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

^c Several testing procedures have been used during the course of exhaust emissions 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 U.S. Environmental Protection Agency (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 the Motor Vehicle Manufacturers Association (MVMA) transient test procedure could be used during 1985-86, and the MVMA procedure was required thereafter.

^d 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 NO_x standards for 1998 and after is 10 years/110,000 miles. The useful life requirements for heavy-duty 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.

^e No standard set.

^f Although emissions standards for HC and CO were in effect for these years, they were not measured in grams per brake horsepower-hour and are, therefore, incompatible with this table.

^g Vehicles can meet a composite nonmethane HC and NO_x standard of 2.5, given they meet a nonmethane HC standard of no more than 0.5.

NOTE: Tables 4-31a and 4-31b are identical for diesel.

SOURCES: 40 CFR 86, Subpart A (July 1, 1998); U.S. Environmental Protection Agency, Office of Air and Radiation, personal communication, April 1999.

KEY: CO = carbon monoxide; HC = hydrocarbon; NO_x = nitrogen oxides

Table 4-32b

Federal Exhaust Emissions Certification Standards for Newly Manufactured Gasoline- and Diesel-Powered Heavy Heavy-Duty Trucks (Grams per brake horsepower-hour)

Engine type and pollutant	1970-73	1974-78	1979-83	1984	1985-86	1987	1988-89	1990	1991-93	1994-97	1998-2003	2004+	
<i>Gasoline</i>													
HC + NO _x	e	16	10	e									
HC	f	e	1.5	1.9									
NO _x	e				10.6	6.0	5.0	4.0					
CO	f	40	25	37.1									
<i>Diesel</i>													
HC + NO _x	e	16	10	e									
HC	f	e	1.5	1.3									
NO _x	e				10.7	6.0	5.0	4.0					
Nonmethane HC + NO _x	e	2.4 ^g											
CO	f	40	25	15.5									
Particulates	e						0.60	0.25	0.10				
Smoke opacity (acceleration/lugging/peak) ^a	40/20 ^e	20/15/50											
Weight criteria for heavy heavy-duty trucks ^b	GVWR over 6,000 lbs		GVWR over 8,500 lbs			GVWR over 14,000 lbs							
Test procedure (gasoline) ^c	13-mode steady-state				MVMA								
(diesel) ^c	13-mode steady-state			EPA transient									
Useful life (gasoline) ^d	5 years/50,000 miles				8 years/110,000 miles								

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

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

^c Several testing procedures have been used during the course of exhaust emissions 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 U.S. Environmental Protection Agency (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 the Motor Vehicle Manufacturers Association (MVMA) transient test procedure could be used during 1985-86, and the MVMA procedure was required thereafter.

^d 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 NO_x standards for 1998 and after is 10 years/110,000 miles. The useful life requirements for heavy-duty 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.

KEY: CO = carbon monoxide; HC = hydrocarbon; NO_x = nitrogen oxides

^e No standard set.

^f Although emissions standards for HC and CO were in effect for these years, they were not measured in grams per brake horsepower-hour and are, therefore, incompatible with this table.

^g Vehicles can meet a composite nonmethane HC and NO_x standard of 2.5, given they meet a nonmethane HC standard of no more than 0.5.

NOTES: Tables 4-31a and 4-31b are identical for diesel.

SOURCES: 40 CFR 86, Subpart A (July 1, 1998).

U.S. Environmental Protection Agency, Office of Air and Radiation, personal communication, April 1999.

Table 4-33

Federal Exhaust Emissions Standards for Newly Manufactured Motorcycles^a (g/km)^b

Pollutant	Engine displacement	Emissions prior to controls ^c	1978-79	1980-89	1990-96	1997+
<i>Gasoline-powered</i>						
HC	50-169 cc	1.0-13.8	5			
	170-749 cc		$5 + 0.0155(D-170)^d$	5.0		
	750 cc and greater		14	5.0		
CO	50 cc and greater	11.0-31.0	17	12		
<i>Methanol-powered</i>						
Total HC equivalent	50 cc and greater				5.0	
CO	50 cc and greater				12	
<i>Natural gas- and LPG-powered</i>						
HC	50 cc and greater					5.0
CO	50 cc and greater					12
Useful life	(Class I)	50-169 cc	5 years or 12,000 km (7,456 mi), whichever comes first			
	(Class II)	170-279 cc	5 years or 18,000 km (11,185 mi), whichever comes first			
	(Class III)	280 cc and greater	5 years or 30,000 km (18,641 mi), whichever comes first			

^a A motorcycle is any motor vehicle with a headlight, taillight, and stoplight, and having two or three wheels and a curb mass less than or equal to 793 kg (1,749 lb). (The limit was 680 kg, or 1,499 lb prior to the 1998 model year.) A motorcycle is excluded from the standards if it has a displacement of less than 50 cc (3.1 cubic inches) or if with a 80 kg (176 lb) driver it cannot start from a dead stop using only the engine or exceed a speed of 40 km/h (25 mph) on a level, paved surface.

^b Readers who wish to compare motorcycle regulations with passenger car and truck regulations should note that 5.0 g/km = 8.0 g/mi and 12 g/km = 19 g/mi. The formula for 1978-79 HC emissions by motorcycles 170-749 cc becomes, in g/mi., approximately $8.0 + 0.025(D-170)$.

^c Estimates of emissions rates prior to controls are ranges of emissions for all engine displacements. Not available for motorcycles powered by fuels other than gasoline.

KEY: cc = cubic centimeters; D = engine displacement; g = gram; h = hour; HC = hydrocarbon; kg = kilogram; km = kilometer; lb = pound; LPG = liquefied petroleum gas; mi = miles; mph = miles per hour

^d D = engine displacement in cubic centimeters (cc). For example, the standard for a 300 cc engine would be $5.0 + 0.0155(300-170) = 7.0$ g/km.

SOURCES: 40 CFR 86 Subpart E (July 1, 1998); U.S. Environmental Protection Agency, Office of Air and Radiation, personal communication, Apr. 4, 1998.

Table 4-34

Federal Exhaust Emissions Standards for Newly Manufactured and In-Use Aircraft Engines^{a, b}

Engine type ^c	Pollutant	Year of engine manufacture						
		1974-75	1976-77	1978-82	1983	1984-96	1997-99	2000+
Turboprop								
	Smoke							^h 187(rO) ^{-0.168}
Class T3 turbojet								
	CO (g/kN) ^d							118
	HC (g/kN) ^d					19.6		
	NO _x (g/kN) ^d						^j 40 + 2(rPR)	^k 32 + 1.6(rPR)
	Smoke			25				ⁱ 83.6(rO) ^{-0.274}
Class T8 turbojet								
	CO (g/kN) ^d							118
	HC (g/kN) ^d					19.6		
	NO _x (g/kN) ^d						^j 40 + 2(rPR)	^k 32 + 1.6(rPR)
	Smoke	^e 30						ⁱ 83.6(rO) ^{-0.274}
Turbofan and turbojet engines other than Classes T3, T8, and TSS								
	CO (g/kN) ^d							118
	HC (g/kN) ^d					19.6		
	NO _x (g/kN) ^d						^j 40 + 2(rPR)	^k 32 + 1.6(rPR)
	Smoke		^f 83.6(rO) ^{-0.274}		^g 83.6(rO) ^{-0.274}			ⁱ 83.6(rO) ^{-0.274}
TSS engines (supersonic aircraft engines)								
	HC (g/kN)							^{rPR} 140(0.92)
	Smoke							ⁱ 83.6(rO) ^{-0.274}

KEY: CO = carbon monoxide; g = gram; g/kN = grams of pollutant per kilonewtons of thrust; HC = hydrocarbon, kN = kilonewtons; kW = kilowatt; NO_x = nitrogen oxides; rO = rated output, which is the maximum power or thrust available for takeoff; rPR = rated pressure ratio

Continued next page

Table 4-34
Cont'd

Federal Exhaust Emissions Standards for Newly Manufactured and In-Use Aircraft Engines^{a, b}

^a Federal standards apply to all planes operating in the United States, regardless of where they were manufactured. This table primarily displays exhaust emissions standards for newly manufactured aircraft engines. Only two standards (smoke standards) have been set for in-use aircraft engines (see footnotes j and k). Therefore, unless otherwise noted, emissions in this table apply to new aircraft engines only.

^b HC, CO, and NO_x are measured using the International Civil Aviation Organization (ICAO) Gaseous Emissions Test Procedure. Smoke is measured using the ICAO Smoke Emission Test Procedure. There is no useful life or warranty period for purposes of compliance with emissions standards.

^c Examples of commercial aircraft that use each engine type include the following:

- Class T3 turbojet--Boeing 707-320s (Class T3 engines are currently out of production, though some are still in use).
- Class T8 turbojet--Boeing 727s and 737-200s, and McDonnell-Douglas MD-80s and DC-9s.
- Turbofans and turbojets other than T3, T8, and TSS--Boeing 747-400s, 757s, 767-200s and 777s, and McDonnell-Douglas MD-11s; Canadair Regional Jets.
- Turboprops--Used mostly in regional airliners such as ATR 72, Dornier 328, and Saab SF 340.
- TSS--British Aircraft Corp./Aerospatiale Concorde (the only supersonic aircraft currently used in commercial civil aviation).

^d rO >= 1,000 kW

^e Applies to engines with rO>26.7 kN.

^f Effective as of July 7, 1997. This standard applies only to those engines of a type or model for which the date of manufacture of the first individual production model was on or before Dec. 31, 1995 and for which the date of manufacture of the individual engine was on or before Dec. 31, 1999.

^g Effective as of July 7, 1997. This standard also applies to engines of a type or model for which the date of manufacture of the first individual production model was after Dec. 31, 1995 and for which the date of manufacture of the individual engine was on or before Dec. 31, 1999.

^h Engines with rO>=26.7 kN. Smoke number may not exceed 50.

ⁱ Engines manufactured after Feb. 1, 1974 and before 1984. This is also the in-use standard for all such aircraft engines manufactured after Feb. 1, 1974.

^j Engines with rated output rO>=129 kN. This is also the in-use standard for all such aircraft engines.

^k Engines with rO<26.7 kN. Smoke number may not exceed 50.

SOURCES: 40 CFR 87, Subparts A-D (July 1, 1998); Jane's Information Group Inc. 1992. *Jane's All the World's Aircraft, 1992-93* (Alexandria, VA).

Table 4-35 Federal Exhaust Emissions Standards for Locomotives^a (g/bhph except where noted)

Pollutant	Duty-cycle ^f	Tier 0 1973-2001 ^h	Tier 1 2002-2004	Tier 2 2005+
Total HC ^b	Line-haul	1.00	0.55	0.30
	Switch	2.10	1.20	0.60
Nonmethane HC ^c	Line-haul	1.00	0.55	0.30
	Switch	2.10	1.20	0.60
Total HC equivalent ^d	Line-haul	1.00	0.55	0.30
	Switch	2.10	1.20	0.60
CO	Line-haul	5.0	2.2	1.5
	Switch	8.0	2.5	2.4
	Line-haul (optional standard) ^g	10.0	10.0	10.0
	Switch (optional standard) ^g	12.0	12.0	12.0
NO _x	Line-haul	9.5	7.4	5.5
	Switch	14.0	11.0	8.1
Particulates	Line-haul	0.60	0.45	0.20
	Switch	0.72	0.54	0.24
	Line-haul (optional standard) ^g	0.30	0.22	0.10
	Switch (optional standard) ^g	0.36	0.27	0.12
Smoke opacity (% opacity-normalized) ^e	Steady-state	30%	25%	20%
	30-second peak	40%	40%	40%
	3-second peak	50%	50%	50%
Useful life		7.5 MWh per hp or 10 years ^{i,j}		

KEY: bhp = boiler horsepower; bhph = boiler horsepower hour;
 CO = carbon monoxide; g = gram; h = hour;
 MW = megawatt; MWh = megawatt hour;
 NO_x = nitrogen oxides; PM = particulate matter

Continued next page

Table 4-35
Cont'd

Federal Exhaust Emissions Standards for Locomotives^a (g/bhph except where noted)

- ^a Locomotive standards apply to both new and remanufactured locomotives, except as noted.
- ^b Total HC standards apply to locomotives powered by any fuel except alcohol or natural gas or fuels primarily composed of alcohol or natural gas.
- ^c Nonmethane HC standards apply to locomotives powered by natural gas or fuels that are primarily composed of natural gas.
- ^d Total HC equivalent standards apply to locomotives powered by alcohol or fuels that are primarily composed of alcohol.
- ^e Smoke opacity values are normalized to be equivalent to a 1 meter path length.
- ^f The line-haul duty-cycle is weighted toward operation in the higher power notches and is typical of line-haul applications. The switch duty-cycle is typical of switch operations, with more emphasis on idle and low power notch emissions. Locomotives generally are required to meet the standards for both duty-cycles. However, Tier 0 dedicated switch locomotives rated at 2,300 hp or less are only required to meet the switch duty-cycle standard.
- ^g Manufacturers and remanufacturers can elect to comply with the alternate CO and PM

standards. However, a manufacturer or remanufacturer using the alternate standards must meet both the CO and the PM standards. This allows locomotives to have higher CO emissions in exchange for meeting more stringent PM standards.

^h Tier 0 standards apply to all new production locomotives in the 2001 model year, as well as for any 1994 through 2001 model year freight locomotives remanufactured on or after Jan. 1, 2001. They also apply to all other 1973 through 2001 model year locomotives remanufactured on or after Jan. 1, 2002. Other phase-in options are also available for manufacturers (see 40 CFR 92 for more detail on phase-in options).

ⁱ For Tier 0 locomotives not equipped with MW/h meters, the minimum useful life is 750,000 miles or 10 years, whichever comes first.

^j This is a minimum standard. The certifying manufacturer or remanufacturer must specify a longer useful life if the locomotive or locomotive engine is designed to last longer than the applicable minimum useful life.

SOURCE: 40 CFR 92, July 1, 1998.

Table 4-36

Federal Exhaust Emissions Standards for Newly Manufactured Marine Spark-Ignition Outboard, Personal Watercraft^a, and Jet-Boat Engines^b (g/kWh)

HC + NOx (g/kWh)			Warranty period	Useful life ^e
Year	Rated power < 4.3 kW	Rated power ≥ 4.3 kW ^{c,d,e}		
1998	278.00	$(0.917 \times (151 + 557/P^{0.9})) + 2.44$	1 yr for all emissions-related components	Outboard engines: 350 hr/10 yr Personal watercraft: 350 hr/5 yr
1999	253.00	$(0.833 \times (151 + 557/P^{0.9})) + 2.89$		
2000	228.00	$(0.750 \times (151 + 557/P^{0.9})) + 3.33$		
2001	204.00	$(0.667 \times (151 + 557/P^{0.9})) + 3.78$	1 yr for all emission-related components; 3 yr/200 hr for specified major emissions control components	
2002	179.00	$(0.583 \times (151 + 557/P^{0.9})) + 4.22$		
2003	155.00	$(0.500 \times (151 + 557/P^{0.9})) + 4.67$	2 yr/200 hr for all emissions-related components; 3 yr/200 hr for specified major emissions control components	
2004	130.00	$(0.417 \times (151 + 557/P^{0.9})) + 5.11$		
2005	105.00	$(0.333 \times (151 + 557/P^{0.9})) + 5.56$		
2006+	81.00	$(0.250 \times (151 + 557/P^{0.9})) + 6.00$		

^a The standards for personal watercraft did not go into effect until 1999, although the standard went into effect for outboard engines in 1998.

^b The standards apply to marine spark-ignition outboard, personal watercraft, and jet-boat engines only. There are currently no federal standards for marine spark-ignition sterndrive/inboard engines (previously proposed standards have not been finalized). Marine compression-ignition engines under 50 hp are covered under the proposed non road compression-ignition engine standards. Federal standards are in development for marine compression-ignition engines over 50 hp.

^c P = the average power of the engine family in kilowatts (sales-weighted).

KEY: g = gram; hr = hour; HC = hydrocarbon; hp = horsepower; kW = kilowatt; kWh = kilowatt hour; NOx = nitrogen oxide; yr = year

^d As an example, the standards for an outboard engine of 125 hp (just over 93 kW) would be 149.53 g/kWh in 1998, 123.63 g/kWh in 2000, 97.74 g/kWh in 2002, 72.00 g/kWh in 2004, and 46.10 g/kWh in 2006.

^e All emissions standards must be met for the useful life of the engine.

SOURCES: 40 CFR 91 July 1, 1998 edition, pp. 242-243.

Society of Automotive Engineers, Small Craft--Marine Propulsion Engine and Systems--Power Measurements, Document J1228, November 1991.

Table 4-37

Tier 2 Federal Exhaust Emissions Standards for Newly Manufactured Commercial Marine Compression-Ignition Engines^{a b}

Engine Category ^c	Displacement (liters/cylinder)	Rated Power (kW)	Year	NOx + THC (g/kW-hr)	PM (g/kW-hr)	CO (g/kW-hr)	Useful Life ^d	Warranty Period 5
1	< 0.9	37 kW and above	2005	7.5	0.40	5.0	10 yrs or 10,000 hrs operation	5 yrs or 5,000 hrs operation
	0.9 to < 1.2		2004	7.2	0.30			
	1.2 to < 2.5		2004	7.2	0.20			
	2.5 to < 5.0		2007	7.2	0.20			
2	5.0 to < 15.0	37 kW and above	2007	7.8	0.27	5.0	10 yrs or 20,000 hrs operation	5 yrs or 10,000 hrs operation
	15.0 to < 20.0	37 kW to < 3,300 kW		8.7	0.50			
	15.0 to < 20.0	3,300 kW and above		9.8	0.50			
	20.0 to < 25.0	37 kW and above		9.8	0.50			
	25.0 to < 30.0	37 kW and above		11.0	0.50			
3	30 and above	37 kW and above	No Tier 2 emissions standards have been set for Category 3 commercial marine vessels.					

^a Tier 2 emissions standards established by Congress apply to commercial compression-ignition (diesel) engines with a power rating of at least 37 kW. Both propulsion and auxiliary engines are covered under these standards, but land-based engines used in portable auxiliary equipment are exempted. Smaller compression-ignition engines are covered under a separate rule. The U.S. Environmental Protection Agency (EPA) also intends to regulate recreational diesel engine emissions under a separate rule and is establishing provisions to allow exemptions for category 1 and 2 engines used as auxiliary engines in U.S.-flagged vessels engaged in foreign trade or overseas operations at least 75 percent of the time (i.e., operation will occur more than 320 nautical kilometers outside the United States, not including trips between U.S. ports in Alaska, Hawaii, the continental United States, or its territories).

^b MARPOL Annex VI nitrogen oxide (NO_x) standards (international standards adopted by the International Maritime Convention on the Prevention of Pollution from Ships) are referred to as Tier 1 emissions standards. These standards apply to any diesel engine over 130 kW installed on a vessel constructed on or after Jan. 1, 2000 and to any engine that undergoes major conversion after that date. MARPOL standards are currently voluntary for ships engaged in domestic travel but will be required for ships engaged in foreign trade with countries that ratify MARPOL standards. Although they have not yet been ratified by the United States, EPA encourages engine manufacturers to make compliant engines and encourages owners to purchase them. If ratified by the United States, MARPOL Annex VI NO_x standards will be retroactively effective Jan. 1, 2000.

^c Emissions standards are based on displacement/cylinder and rated power. The three standards categories are as follows:
 Category 1 (< 5 liters displacement/cylinder and rated power >=37 kW): These engines are typically used as propulsion engines on relatively small commercial vessels (fishing vessels, tugboats, crewboats, etc.). They are also used as auxiliary engines on vessels of all sizes and applications.

KEY: CO=carbon monoxide; disp=displacement; g/kW-hr=gram per kilowatt-hour; hrs=hours;kW=kilowatt; NOx=nitrogen oxides; PM=particulate matter; THC=total hydrocarbons; yrs=years

Category 2 (>= 5 liters displacement/cylinder to < 30 liters displacement/cylinder and rated power >=37 kW): The largest engines that are widely used as propulsion engines in harbor and coastal vessels in U.S. waters. These engines also provide auxiliary power on very large vessels. Many of these engines are of similar size and configuration as locomotive engines or use comparable emissions control technologies.

Category 3 (>= 30 liters displacement/cylinder and rated power = 37kW): These are very large high-power engines that are used almost exclusively for propulsion on vessels engaged in international trade.

^d Manufacturers must demonstrate that the engine or engine family will meet all standards for its useful life. Certification for useful life is accomplished by testing a sample of engines. The warranty period applies to each engine manufactured. The manufacturer of each engine must provide a warranty to the ultimate purchaser or owner (and each subsequent purchaser or owner) that the engine is designed, built, and equipped so as to conform at the time of sale with Tier 2 standards and is free from defects in materials and workmanship that would cause the engine to fail to conform to these standards for the warranty period. Furthermore, this warranty cannot be shorter than any mechanical warranty on the engine and must be at least one half of the useful life period.

SOURCE: Federal Register, Vol. 64, No. 249, Dec. 29, 1999, pp 73,299-73,373.

Table 4-38**Estimated National Average Vehicle Emissions Rates by Vehicle Type and Fuel (Grams per mile)**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000 ^E
GASOLINE (assuming zero RFG)											
Light-duty vehicles											
Exhaust and nonexhaust hydrocarbons (HC)	3.09	2.91	2.77	2.65	2.57	2.49	^R 2.42	2.36	2.29	2.23	2.16
(Exhaust HC)	(2.05)	(1.92)	(1.81)	(1.72)	(1.66)	(1.60)	(1.55)	(1.51)	(1.47)	(1.44)	(1.42)
(Nonexhaust HC)	(1.04)	(0.99)	(0.96)	(0.93)	(0.91)	(0.89)	(0.87)	(0.85)	(0.82)	(0.79)	(0.74)
Exhaust carbon monoxide (CO)	24.68	23.42	22.40	21.65	21.10	20.52	20.14	19.86	19.52	19.36	19.28
Exhaust nitrogen oxide (NO _x)	1.81	1.76	1.72	1.69	1.67	1.61	1.56	1.51	1.45	1.41	1.38
Light-duty trucks											
Exhaust and nonexhaust HC	4.68	4.34	4.01	3.77	3.57	3.38	3.24	3.14	3.01	2.93	2.85
(Exhaust HC)	(3.24)	(3.03)	(2.80)	(2.61)	(2.46)	(2.31)	(2.21)	(2.13)	(2.05)	(1.99)	(1.95)
(Nonexhaust HC)	(1.44)	(1.31)	(1.21)	(1.16)	(1.11)	(1.07)	(1.03)	(1.01)	(0.96)	(0.94)	(0.90)
Exhaust CO	36.32	34.01	31.78	30.03	28.62	27.41	26.83	26.38	25.69	25.29	24.99
Exhaust NO _x	2.36	2.25	2.16	2.10	2.04	1.97	1.95	1.92	1.87	1.84	1.80
Heavy-duty vehicles											
Exhaust and nonexhaust HC	11.89	10.90	10.06	9.24	8.49	7.89	7.30	6.70	6.11	5.70	5.32
(Exhaust HC)	(7.45)	(6.79)	(6.22)	(5.53)	(4.92)	(4.51)	(4.13)	(3.73)	(3.33)	(3.07)	(2.82)
(Nonexhaust HC)	(4.44)	(4.11)	(3.84)	(3.71)	(3.57)	(3.38)	(3.17)	(2.97)	(2.78)	(2.63)	(2.50)
Exhaust CO	131.19	120.49	111.05	101.92	93.61	85.10	76.97	69.13	61.07	54.65	48.67
Exhaust NO _x	6.49	6.28	6.05	5.85	5.69	5.48	5.36	5.25	5.05	4.89	4.72
Motorcycles											
Exhaust and nonexhaust HC	4.68	4.56	4.48	4.41	4.38	4.33	4.29	4.29	4.27	4.26	4.26
(Exhaust HC)	(2.31)	(2.19)	(2.11)	(2.05)	(2.02)	(1.96)	(1.93)	(1.92)	(1.90)	(1.89)	(1.89)
(Nonexhaust HC)	(2.37)	(2.37)	(2.37)	(2.36)	(2.36)	(2.37)	(2.36)	(2.37)	(2.37)	(2.37)	(2.37)
Exhaust CO	20.89	20.61	20.60	20.59	20.59	20.47	20.47	20.47	20.35	20.35	20.35
Exhaust NO _x	0.85	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.83	0.83	0.83

KEY: E = estimate; GVWR = gross vehicle weight rating;
R = revised; RFG = reformulated gasoline

Continued next page

Table 4-38

Cont'd

Estimated National Average Vehicle Emissions Rates by Vehicle Type and Fuel (Grams per mile)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000 ^E
DIESEL											
Light-duty vehicles											
Exhaust HC	0.73	0.74	0.75	0.75	0.76	0.77	0.76	0.74	0.71	0.67	0.63
Exhaust CO	1.68	1.71	1.72	1.73	1.74	1.74		1.71	1.67	1.62	1.57
Exhaust NO _x	1.65	1.67	1.68	1.68	1.66	1.64	1.60	1.55	1.48	1.40	1.33
Light-duty trucks											
Exhaust HC	1.08	1.14	1.15	1.14	1.13	1.11	1.09	1.05	0.98	0.91	0.84
Exhaust CO	2.03	2.10	2.09	2.07	2.04	2.02	1.99	1.95	1.88	1.80	1.73
Exhaust NO _x	1.97	2.00	1.99	1.97	1.94	1.90	1.85	1.78	1.67	1.56	1.46
Heavy-duty vehicles											
Exhaust HC	3.30	3.08	2.89	2.75	2.65	2.54	2.44	2.36	2.30	2.25	2.22
Exhaust CO	13.71	13.38	13.07	12.76	12.50	12.28	12.08	11.93	11.77	11.63	11.53
Exhaust NO _x	21.05	19.59	18.14	16.89	15.81	14.79	13.96	13.33	12.66	11.93	11.24
AVERAGE OF ALL VEHICLES, GASOLINE AND DIESEL											
Exhaust and nonexhaust HC	3.75	3.52	3.31	3.15	3.02	2.90	2.80	2.71	2.62	2.54	2.47
(Exhaust HC)	(2.56)	(2.40)	(2.25)	(2.13)	(2.03)	(1.93)	(1.86)	(1.80)	^R (1.74)	(1.70)	(1.67)
(Nonexhaust HC)	^R (1.18)	(1.12)	(1.06)	(1.02)	^R (1.00)	(0.97)	(0.94)	(0.91)	(0.88)	(0.84)	(0.80)
Exhaust CO	29.97	28.29	26.81	25.62	24.68	23.75	23.11	22.58	21.94	21.53	21.20
Exhaust NO _x	3.09	2.99	2.89	2.80	2.73	2.63	2.56	2.50	2.41	2.34	2.27

NOTES: As of July 1 of each year. Vehicles types are defined as follows: light-duty vehicles (passenger cars up to 6,000 lb GVWR); light-duty trucks (pickups and minivans up to 8,500 lb GVWR); heavy-duty vehicles (8,501 lbs or more GVWR); motorcycle (highway only). This table revises the data shown in *National Transportation Statistics 1999* because it is based on MOBILE5b, the U.S. Environmental Protection Agency's (EPA) latest highway vehicle emissions factor model. Interested readers can learn more about the Mobile5b model at the following EPA Internet site <http://www.epa.gov/otaq>. Emissions factors are national averages based on the following assumptions: ambient temperature 75 °F, daily temperature range 60-84 °F, average traffic speed 19.6 mph (representative of overall traffic in urban areas), standard operating mode (cold-start, hot-start, stabilized), vehicle-miles traveled fractions, no inspection/maintenance or antitampering programs, and gasoline volatility 9.0 per square inch RVP (Reid vapor pressure).

See Table 4-37 for emissions from vehicles operating on reformulated gasoline.

KEY: E = estimate; GVWR = gross vehicle weight rating; R = revised; RFG = reformulated gasoline

Data for nonexhaust HC is negligible for diesel light-duty vehicles, light-duty trucks, and heavy-duty vehicles.

SOURCE: U.S. Environmental Protection Agency, National Vehicle and Fuel Emissions Laboratory, unpublished data, Aug. 10, 2000.

Table 4-39 Estimated National Average Vehicle Emissions Rates by Vehicle Type Using Reformulated Gasoline (Grams per mile)

	1995	1996	1997	1998	1999	2000 ^E
Light-duty vehicles						
Exhaust HC	1.43	1.38	1.34	1.30	1.28	1.16
Nonexhaust HC	0.69	0.68	0.66	0.64	0.60	0.37
Total HC	2.12	2.06	2.00	1.94	1.88	1.53
Exhaust CO	16.46	16.14	15.90	15.62	15.48	15.41
Exhaust NO _x	1.59	1.54	1.49	1.43	1.39	1.29
Light-duty trucks						
Exhaust HC	2.11	2.02	1.93	1.84	1.78	1.63
Nonexhaust HC	0.85	0.80	0.78	0.75	0.73	0.47
Total HC	2.96	2.82	2.71	2.59	2.51	2.10
Exhaust CO	22.15	21.62	21.20	20.59	20.22	19.95
Exhaust NO _x	1.96	1.93	1.91	1.85	1.82	1.71
Heavy-duty vehicles						
Exhaust HC	4.40	4.02	3.62	3.22	2.96	2.65
Nonexhaust HC	2.53	2.38	2.24	2.10	1.99	1.30
Total HC	6.93	6.40	5.86	5.32	4.95	3.95
Exhaust CO	72.26	65.30	58.59	51.68	46.18	41.04
Exhaust NO _x	5.47	5.35	5.24	5.04	4.88	4.67
Motorcycles						
Exhaust HC	1.92	1.89	1.88	1.86	1.86	1.82
Nonexhaust HC	1.91	1.91	1.91	1.91	1.90	1.43
Total HC	3.83	3.80	3.79	3.77	3.76	3.25
Exhaust CO	17.46	17.46	17.46	17.36	17.36	17.36
Exhaust NO _x	0.84	0.84	0.84	0.83	0.83	0.83
Average of all RFG and diesel vehicles						
Exhaust HC	1.77	1.70	1.64	1.58	1.54	1.41
Nonexhaust HC	^R 0.75	0.73	0.71	^R 0.68	0.64	0.41
Total HC	2.52	2.43	2.35	2.25	2.18	1.82
Exhaust CO	19.38	18.83	18.37	17.81	17.45	17.17
Exhaust NO _x	2.61	2.54	2.48	2.39	2.32	2.19

NOTES: As of July 1 of each year. Vehicle types are defined as follows: light-duty vehicles (passenger cars up to 6,000 lb gross vehicle weight rating GVWR); light-duty trucks (pickups and minivans up to 8,500 lb GVWR); heavy-duty vehicles (8,501 lb or more GVWR); motorcycle (on-highway only). The data in this table are based on MOBILE5b, and reflect the introduction of RFG starting in 1995. Emissions factors are national averages based on the following assumptions: ambient temperature 75 °F, daily temperature range 60 - 84 °F, average traffic speed 19.6 mph (representative of overall traffic in urban areas), standard operating mode (cold-start, hot-start, stabilized), vehicle-miles traveled fractions, no inspection/maintenance or

KEY: CO = carbon monoxide; E = estimate;
HC = hydrocarbon; NO_x = nitrogen oxide;
R = revised; RFG = reformulated gasoline

antitampering programs, and gasoline volatility 9.0 per square inch RVP (Reid vapor pressure).

Emissions estimates in this table assume 100% RFG.

SOURCE: U.S. Environmental Protection Agency, National Vehicle and Fuel Emissions Laboratory, unpublished data, Aug. 10, 2000.

Table 4-40

Estimated National Emissions of Carbon Monoxide (Million short tons)

	1970	1975	1980	1985	1990	1995	1996	1997	1998
Transportation									
On-road vehicles	88.03	83.13	78.05	77.39	57.85	54.11	53.26	^R 51.67	50.39
Off-road									
Aircraft	0.51	0.60	0.74	0.83	0.90	0.94	0.95	^R 0.95	0.96
Railroads	0.07	0.08	0.10	0.11	0.12	0.11	0.11	0.12	0.12
Marine vessels ^R	0.02	0.03	0.06	0.07	0.13	0.13	0.13	0.14	0.14
Other off-road ^{a, R}	2.04	2.17	2.30	2.43	2.50	2.56	2.56	2.57	2.58
Total transportation^R	90.67	86.01	81.25	80.83	61.50	57.85	57.01	55.45	54.19
Nontransportation									
Fuel combustion	4.63	4.48	7.30	8.49	5.51	5.93	^R 6.15	^R 5.42	5.37
Industrial processes ^b	9.84	7.54	6.95	5.28	4.77	4.61	^R 3.57	^R 3.70	3.71
Waste disposal and recycling	7.06	3.23	2.30	1.94	1.08	1.19	^R 1.13	^R 1.14	1.15
Miscellaneous ^{c, R}	17.25	15.50	19.63	20.49	25.66	23.78	27.62	28.71	25.05
Total nontransportation^R	38.78	30.75	36.18	36.20	37.02	35.51	38.47	38.97	35.28
TOTAL all sources^R	129.44	116.76	117.43	117.01	98.52	93.35	95.48	94.41	89.45

^a Other off-road comprises nonroad gasoline- and diesel-powered recreational, airport service and railway maintenance vehicles, and recreational marine vessels.

^b Industrial processes comprise chemical and allied product manufacturing, metals processing, petroleum and related industries, and other industrial processes; and solvent utilization, storage, and transport.

^c Miscellaneous comprises nonroad gasoline- and diesel-powered construction, industrial, lawn and garden, farm, light-commercial, logging vehicles and other non-road sources; health services, cooling towers, fugitive dust; and other combustion sources that could not be accurately allocated to specific source categories.

NOTES: The methodologies used to estimate emissions constantly evolve and undergo major changes. These improved methods are often used to revise estimates for previous

years. Therefore, some estimates in this table may not match estimates produced in previous reports, and some trends may not be consistent across years in which major methodology changes have occurred.

Numbers may not add to totals due to rounding.

SOURCES: U.S. Environmental Protection Agency, *National Air Pollutant Emission Trends: 1900-1998* (EPA-454/R-00-002) (Research Triangle Park, NC: March 2000), table A-1; also available at Internet site www.epa.gov/ttn/chief/trends98/emtrnd.html, as of Aug. 8, 2000.

KEY: R = revised

Table 4-41 Estimated National Emissions of Nitrogen Oxides (Million short tons)

	1970	1975	1980	1985	1990	1995	1996	1997	1998
Transportation									
On-road vehicles	7.39	8.65	8.62	8.09	^R 7.09	^R 7.83	^R 7.85	^R 7.88	7.77
Off-road									
Aircraft	0.07	0.09	0.11	0.12	0.16	0.17	0.17	^R 0.17	0.17
Railroads	0.50	0.59	0.73	0.81	0.93	0.99	0.92	0.95	0.95
Marine vessels ^R	0.17	0.21	0.47	0.56	0.94	0.94	0.99	1.00	1.01
Other off-road ^{a, R}	0.04	0.04	0.04	0.06	0.08	0.08	0.09	0.09	0.09
Total transportation^R	8.17	9.58	9.97	9.64	9.20	10.01	10.02	10.09	9.99
Nontransportation									
Fuel combustion	10.06	10.49	11.32	10.05	10.89	10.83	^R 10.35	^R 10.40	10.19
Industrial processes ^b	0.78	0.54	0.56	0.80	0.80	0.77	^R 0.76	^R 0.79	0.80
Waste disposal and recycling	0.44	0.16	0.11	0.09	0.09	0.10	0.10	0.10	0.10
Miscellaneous ^c	^R 1.49	^R 1.88	^R 2.43	^R 2.62	^R 3.07	^R 3.22	^R 3.46	^R 3.46	3.40
Total nontransportation	^R12.77	^R13.07	^R14.42	^R13.56	^R14.85	^R14.92	^R14.67	^R14.75	14.49
TOTAL all sources^R	20.93	22.63	24.38	23.20	24.05	24.92	24.68	24.82	24.45

^a Other off-road comprises nonroad gasoline- and diesel-powered recreational, airport service and railway maintenance vehicles, and recreational marine vessels.

^b Industrial processes comprises chemical and allied product manufacturing, metals processing, petroleum and related industries, and other industrial processes; and solvent utilization, storage, and transport.

^c Miscellaneous comprises nonroad gasoline- and diesel-powered construction, industrial, lawn and garden, farm, light-commercial, logging vehicles, and other non-road sources; health services, cooling towers, fugitive dust; and other combustion sources that could not be accurately allocated to specific source categories.

NOTES: The methodologies used to estimate emissions constantly evolve and undergo major changes. These improved methods are often used to revise estimates for previous

years. Therefore, some estimates in this table may not match estimates produced in previous reports, and some trends may not be consistent across years in which major methodology changes have occurred.

Numbers may not add to totals due to rounding.

SOURCES: U.S. Environmental Protection Agency, *National Air Pollutant Emission Trends: 1900-1998* (EPA-454/R-00-002) (Research Triangle Park, NC: March 2000), table A-2; also available at Internet site www.epa.gov/ttn/chief/trends98/emtrnd.html, as of Aug. 8, 2000.

KEY: R = revised

Table 4-42

Estimated National Emissions of Volatile Organic Compounds (Million short tons)

	1970	1975	1980	1985	1990	1995	1996	1997	1998
Transportation									
On-Road vehicles	12.97	10.55	8.98	9.38	6.31	5.70	5.49	^R 5.33	5.33
Off-Road									
Aircraft	0.10	0.12	0.15	0.17	0.18	0.18	0.18	^R 0.18	0.18
Railroads	0.02	0.03	0.03	0.04	0.05	0.05	0.05	0.05	0.05
Marine vessels	0.01	0.01	^R 0.02	^R 0.02	^R 0.03	^R 0.03	^R 0.03	^R 0.03	0.04
Other off-road ^a	^R 0.87	^R 0.93	^R 0.98	^R 1.03	^R 0.92	^R 0.93	^R 0.92	^R 0.92	0.92
Total transportation	^R13.97	^R11.64	^R10.16	^R10.64	^R7.49	^R6.89	^R6.67	^R6.51	6.52
Nontransportation									
Fuel combustion	0.72	0.66	1.05	1.57	1.01	1.07	^R 1.04	^R 0.90	0.89
Industrial processes ^b	12.33	11.10	12.10	9.50	9.01	9.71	^R 8.17	^R 8.39	8.02
Waste disposal and recycling	1.98	0.98	0.76	0.98	0.99	1.07	^R 0.42	^R 0.43	0.43
Miscellaneous ^{c, R}	^R 1.98	^R 1.71	^R 2.22	^R 1.75	^R 2.42	^R 2.07	^R 2.43	^R 2.64	2.05
Total nontransportation	^R17.02	^R14.45	^R16.13	^R13.80	^R13.44	^R13.93	^R12.07	^R12.37	11.40
TOTAL all sources^R	^R30.98	^R26.08	^R26.34	^R24.43	20.94	^R20.82	^R18.74	^R18.88	17.92

^a Other off-road comprises nonroad gasoline- and diesel-powered recreational, airport service and railway maintenance vehicles, and recreational marine vessels.

^b Industrial processes comprises chemical and allied product manufacturing, metals processing, petroleum and related industries, and other industrial processes; and solvent utilization, storage, and transport.

^c Miscellaneous comprises nonroad gasoline- and diesel-powered construction, industrial, lawn and garden, farm, light-commercial, logging vehicles, and other non-road sources; geogenic sources, catastrophic and accidental releases, health services, cooling towers, nontransportation-related fugitive dust, agriculture and forestry, structural fires, agriculture fires, slash/prescribed burning, forest wildfires, and other combustion sources that could not be accurately allocated to specific source categories.

NOTES: The methodologies used to estimate emissions constantly evolve and undergo major changes. These improved methods are often used to revise estimates for previous years. Therefore, some estimates in this table may not match estimates produced in previous reports, and some trends may not be consistent across years in which major methodology changes have occurred.

Numbers may not add to totals due to rounding.

SOURCES: U.S. Environmental Protection Agency, *National Air Pollutant Emission Trends: 1900-1998* (EPA-454/R-00-002) (Research Triangle Park, NC: March 2000), table A-3; also available at Internet website www.epa.gov/ttn/chief/trends98/emtrnd.html, as of Aug. 8, 2000.

KEY: R = revised

Table 4-43

Estimated National Emissions of Particulate Matter (PM-10)^a (Million short tons)

	1970	1975	1980	1985	1990	1995	1996	1997	1998
Transportation									
On-road vehicles	0.44	0.47	0.40	0.36	0.34	0.29	0.28	0.27	0.26
Off-road									
Aircraft	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
Railroads	0.03	0.03	0.04	0.04	0.05	0.03	0.03	0.03	0.03
Marine vessels	0.01	0.01	0.02	^R 0.03	^R 0.04	^R 0.04	^R 0.04	^R 0.04	0.04
Other off-road ^b	^R <0.01	0.03	^R 0.03	^R 0.03	0.04	^R 0.04	^R 0.04	^R 0.04	0.04
Total transportation-fuel-related	^R0.49	0.57	0.52	0.50	0.51	0.44	0.43	0.42	0.41
Transportation-related fugitive dust									
Unpaved highways	N	N	N	11.64	11.23	10.36	12.06	^R 12.53	12.67
Paved highways	N	N	N	5.08	2.25	2.41	2.39	^R 2.54	2.62
Total transportation	^R0.49	^R0.57	^R0.52	17.22	^R13.99	13.21	14.88	^R15.49	15.70
Nontransportation									
Fuel combustion	2.87	2.25	2.45	1.54	1.20	1.18	^R 1.17	^R 1.09	1.09
Industrial processes ^c	7.67	3.70	2.75	1.06	1.04	0.95	^R 0.68	^R 0.70	0.71
Waste disposal and recycling	1.00	0.37	0.27	0.28	0.27	0.29	^R 0.30	^R 0.31	0.31
Miscellaneous ^{d,R}	1.00	0.78	1.13	25.34	13.47	11.45	16.00	16.64	16.94
Total nontransportation^R	12.54	7.10	6.60	28.22	15.98	13.87	18.15	18.74	19.05
TOTAL all sources^R	13.04	7.67	7.12	45.45	29.96	27.07	33.04	34.23	34.74

^a Fine particulate matter less than 10 microns.

^b Other off-road comprises nonroad gasoline- and diesel-powered recreational, airport service and railway maintenance vehicles, and recreational marine vessels.

^c Industrial processes comprise chemical and allied product manufacturing, metals processing, petroleum and related industries, and other industrial processes; solvent utilization; and storage and transport.

^d Miscellaneous comprises nonroad gasoline- and diesel-powered construction, industrial, lawn and garden, farm, light-commercial, logging vehicles and other non-road sources; geogenic sources; agriculture and forestry, cooling towers, nontransportation-related fugitive dust, wildfires, managed burning, and other combustion sources that could not be accurately allocated to specific source categories.

NOTES: The methodologies used to estimate emissions constantly evolve and undergo major changes. These improved methods are often used to revise estimates for previous years. Therefore, some estimates in this table may not match estimates produced in previous reports, and some trends may not be consistent across years in which major methodology changes have occurred.

Numbers may not add to totals due to rounding.

SOURCES: U.S. Environmental Protection Agency, *National Air Pollutant Emission Trends: 1900-1998* (EPA-454/R-00-002) (Research Triangle Park, NC: March 2000), table A-5; also available at Internet site www.epa.gov/ttn/chief/trends98/emtrnd.html, as of Aug. 8, 2000.

KEY: N = data do not exist; R = revised

Table 4-44

Estimated National Emissions of Particulate Matter (PM-2.5)^a (Million short tons)

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Transportation									
On-road vehicles	0.28	0.29	0.28	0.26	0.26	0.23	0.22	0.21	0.20
Aircraft	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Railroads	0.05	0.05	0.05	0.05	0.05	0.03	0.02	0.03	0.03
Marine vessels	^R 0.03	^R 0.03	^R 0.03	^R 0.03	^R 0.03	^R 0.03	^R 0.04	^R 0.04	0.04
Other off-road ^b	^R 0.03	^R 0.03	^R 0.03	0.04	0.04	0.04	0.04	0.04	0.04
Transportation-related fugitive dust									
Unpaved roads	1.69	1.68	1.64	1.72	1.71	1.56	1.82	^R 1.89	1.91
Paved roads	0.56	0.60	0.61	0.62	0.63	0.59	0.60	^R 0.64	0.66
Total transportation	2.67	2.71	2.67	^R2.75	^R2.75	^R2.51	^R2.77	^R2.88	2.91
Nontransportation									
Fuel combustion	0.91	0.89	0.93	0.85	0.84	0.90	^R 0.86	^R 0.79	0.79
Industrial processes ^c	0.56	0.57	0.58	0.50	0.50	0.50	^R 0.38	^R 0.39	0.39
Waste disposal and recycling	0.23	0.24	0.24	0.29	0.27	0.25	^R 0.23	^R 0.24	0.24
Miscellaneous ^d	3.59	3.32	^R 3.22	^R 2.95	^R 3.62	^R 3.04	^R 3.96	^R 4.21	4.06
Total nontransportation	5.29	5.02	^R4.97	^R4.59	^R5.23	^R4.69	^R5.43	^R5.63	5.49
TOTAL	7.96	7.74	^R7.65	^R7.33	^R7.98	^R7.18	^R8.19	^R8.48	8.38

KEY: R = revised

^a Particulate matter less than 2.5 microns in size.

^b Other off-road comprises nonroad gasoline- and diesel-powered recreational, airport service and railway maintenance vehicles and recreational marine vessels.

^c Industrial processes comprise chemical and allied product manufacturing, metals processing, petroleum and related industries, and other industrial processes; solvent utilization; and storage and transportation.

^d Miscellaneous comprises nonroad gasoline- and diesel-powered construction, industrial, lawn and garden, farm, light-commercial, logging vehicles and other non-road sources; geogenic sources, agriculture and forestry, cooling towers, nontransportation-related fugitive dust, wildfires, managed burning, and other fugitive dust and combustion (that could not accurately be allocated to specific source categories).

NOTES: The emissions estimates shown here are those that are directly emitted, which represent only a portion of the total PM-2.5 emissions found in the air. Secondary

formation of fine particulates resulting from emissions of nitrogen oxide, sulfur dioxide, volatile organic compounds, and other substances is also a significant source of PM-2.5.

Numbers may not add to totals due to rounding.

The methodologies used to estimate emissions constantly evolve and undergo major changes. Improved methods are often used to revise estimates for previous years. Therefore, some estimates in this table may not match estimates produced in previous reports, and some trends may not be consistent across years in which major methodology changes have occurred.

SOURCES: U.S. Environmental Protection Agency, *National Air Pollutant Emission Trends: 1900-1998* (EPA-454/R-00-002) (Research Triangle Park, NC: March 2000), table A-6; also available at Internet site www.epa.gov/ttn/chief/trends98/emtrnd.html, as of Aug. 8, 2000.

Table 4-45 Estimated National Emissions of Sulfur Dioxide (Million short tons)

	1970	1975	1980	1985	1990	1995	1996	1997	1998
Transportation									
On-road vehicles	0.41	0.50	0.52	0.52	0.54	0.30	0.32	0.32	0.33
Off-road									
Aircraft	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Railroads	0.04	0.04	0.05	0.06	0.12	0.11	0.11	0.12	0.11
Marine vessels	0.04	0.05	0.12	0.14	0.25	0.24	0.24	0.25	0.26
Total transportation	0.49	^R0.59	0.70	0.73	^R0.92	^R0.66	0.68	^R0.70	0.71
Nontransportation									
Fuel combustion	23.46	22.66	21.39	20.02	20.29	16.23	^R 16.32	^R 16.73	16.72
Industrial processes ^a	7.09	4.68	3.77	2.43	1.86	1.59	^R 1.41	^R 1.46	1.46
Waste disposal and recycling	0.01	0.05	0.03	0.03	0.04	0.05	^R 0.04	^R 0.04	0.04
Miscellaneous ^b	0.11	0.02	0.01	^R 0.44	^R 0.55	0.65	^R 0.67	^R 0.69	0.71
Total nontransportation	30.67	27.41	25.20	^R22.92	^R22.74	18.52	^R18.44	^R18.92	18.93
TOTAL all sources	31.16	28.01	25.91	^R23.66	^R23.66	^R19.18	^R19.12	^R19.62	19.65

^a Industrial processes comprise chemical and allied product manufacturing, metals processing, petroleum and related industries, and other industrial processes; solvent utilization; and storage and transport.

^b Miscellaneous comprises nontransportation-related fugitive dust, nonroad gasoline, nonroad diesel, other nonroad sources and other miscellaneous combustion that could not be accurately allocated to specific source categories.

NOTES: The methodologies used to estimate emissions constantly evolve and undergo major changes. These improved methods are often used to revise estimates for previous years. Therefore, some estimates in this table may not match estimates produced in previ-

ous reports, and some trends may not be consistent across years in which major methodology changes have occurred.

Numbers may not add to totals due to rounding.

SOURCES: U.S. Environmental Protection Agency, *National Air Pollutant Emission Trends: 1900-1998* (EPA-454/R-00-002) (Research Triangle Park, NC: March 2000), table A-4; also available at Internet site www.epa.gov/ttn/chief/trends98/emtrnd.html, as of Aug. 8, 2000.

KEY: R = revised

Table 4-46
Estimated National Emissions of Lead (Thousand short tons)

	1970	1975	1980	1985	1990	1995	1996	1997	1998
Transportation									
Highway vehicles	171.96	130.21	60.50	18.05	0.42	0.02	0.02	0.02	0.02
Aircraft	1.40	1.12	0.89	0.69	0.62	0.54	0.51	0.50	0.50
Total transportation^R	173.36	131.33	61.39	18.74	1.04	0.56	0.53	0.52	0.52
Fuel combustion	10.62	10.35	4.30	0.52	0.50	0.49	0.49	0.50	0.50
Industrial processes ^a	26.36	11.38	3.94	2.53	^R 2.48	2.27	2.27	^R 2.32	2.33
Waste disposal and recycling	2.20	1.60	1.21	0.87	0.80	0.60	^R 0.61	^R 0.62	0.62
Miscellaneous ^b	8.34	5.01	3.32	0.23	0.16	<0.01	<0.01	<0.01	<0.01
Total nontransportation	47.52	^R28.34	12.77	4.15	3.94	^R3.36	^R3.37	^R3.44	3.45
TOTAL	220.87	159.66	74.15	22.89	4.98	^R3.93	^R3.90	^R3.95	3.97

^a Industrial processes comprise chemical and allied product manufacturing, metals processing, and other industrial processes.

^b Miscellaneous comprises other nonroad gasoline, engines and vehicles that could not be accurately allocated to specific source categories.

NOTES: Total lead emissions decreased sharply from 1970 to 1995 as a result of regulatory actions. The lead content of leaded gasoline was reduced dramatically in 1985. In addition, unleaded gasoline was introduced in 1975 for use in automobiles equipped with catalytic control devices. By 1995, unleaded gasoline sales accounted for 99% of the gasoline market. The methodologies used to estimate emissions constantly evolve and under-

go major changes. Improved methods are often used to revise estimates for previous years. Therefore, some estimates in this table may not match estimates produced in previous reports, and some trends may not be consistent across years in which major methodology changes have occurred.

Numbers may not add to totals due to rounding.

SOURCES: U.S. Environmental Protection Agency, *National Air Pollutant Emission Trends Update: 1970-1997* (EPA 454/E-98-007) (Research Triangle Park, NC: December 1998), table A-7; also available at Internet website <http://www.epa.gov/ttn/chief/trends98/emtrnd.html>, as of Sep. 22, 2000.

KEY: R = revised

Table 4-47
Air Pollution Trends in Selected Metropolitan Statistical Areas^R
 (Number of days with AQI values greater than 100 at trend sites and all monitoring sites)

	All sites		Number of trend sites	Trend sites									
	Total number of sites	AQI days > 100 (1998)		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Akron, OH	6	14	5	15	9	30	8	10	8	12	11	6	14
Albany-Schenectady-Troy, NY	13	2	7	4	4	9	5	5	6	3	4	3	2
Albuquerque, NM	25	0	21	8	8	5	0	0	1	0	0	0	0
Allentown-Bethlehem-Easton, PA	9	18	9	11	10	14	3	6	10	17	6	13	18
Atlanta, GA	18	60	7	14	42	23	18	30	12	33	21	26	43
Austin-San Marcos, TX	5	6	5	4	4	3	1	2	4	12	0	0	5
Bakersfield, CA	16	78	7	113	97	109	100	97	98	104	109	55	75
Baltimore, MD	22	51	15	28	29	50	23	48	41	36	28	30	51
Baton Rouge, LA	10	21	6	12	28	11	5	5	7	15	7	8	14
Bergen-Passaic, NJ	8	0	8	12	8	11	2	3	5	11	3	5	0
Birmingham, AL	16	23	16	5	28	5	12	10	6	32	15	8	23
Boston, MA-NH	25	9	25	12	7	13	9	6	10	8	2	8	7
Buffalo-Niagara Falls, NY	21	13	21	4	8	9	3	1	4	6	3	1	13
Charleston-North Charleston, SC	9	3	9	5	1	2	0	2	2	1	3	3	3
Charlotte-Gastonia-Rock Hill, NC-SC	26	51	10	13	31	12	11	23	9	13	18	26	48
Chicago, IL	61	10	46	16	4	22	4	3	8	21	6	9	7
Cincinnati, OH-KY-IN	23	20	20	19	19	22	3	13	19	23	11	11	14
Cleveland-Lorain-Elyria, OH	40	22	24	18	10	23	11	13	23	24	17	12	20
Columbus, OH	12	23	10	7	4	17	5	7	10	15	16	8	19
Dallas, TX	11	36	8	18	24	2	11	12	15	36	12	15	18
Dayton-Springfield, OH	13	21	10	10	13	12	2	11	14	11	18	9	19
Denver, CO	29	9	20	14	9	6	8	3	1	2	0	0	5
Detroit, MI	32	17	30	18	11	28	8	5	13	14	13	12	17
El Paso, TX	22	8	17	25	19	7	10	7	11	5	7	3	5
Fort Lauderdale, FL	18	1	8	6	1	0	2	4	1	1	1	0	1

KEY: R = revised

Continued next page

Table 4-47
Cont'd

Air Pollution Trends in Selected Metropolitan Statistical Areas^R
(Number of days with AQI values greater than 100 at trend sites and all monitoring sites)

	All sites		Number of trend sites	Trend sites									
	Total number of sites	AQI days > 100 (1998)		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Fort Worth-Arlington, TX	8	17	8	17	16	20	7	9	31	28	14	14	17
Fresno, CA	15	69	11	91	62	83	69	59	55	61	70	75	67
Gary, IN	22	10	18	15	2	8	5	0	6	17	11	12	9
Grand Rapids-Muskegon-Holland, MI	10	19	8	16	10	26	6	3	12	17	7	8	13
Greensboro-Winston-Salem-High Pt, NC	16	30	7	6	12	5	2	20	7	6	6	13	25
Greenville-Spartanburg-Anderson, SC	7	29	5	3	2	3	5	9	5	8	7	10	29
Harrisburg-Lebanon-Carlisle, PA	7	22	7	10	10	21	1	15	12	13	3	9	22
Hartford, CT	15	10	15	19	13	23	15	14	18	14	5	16	10
Honolulu, HI	14	0	6	0	0	0	0	0	0	0	0	0	0
Houston, TX	26	40	26	43	54	37	32	28	45	66	28	47	38
Indianapolis, IN	37	22	29	15	9	12	7	9	22	19	13	12	19
Jacksonville, FL	15	10	15	4	3	0	2	3	2	1	1	4	10
Jersey City, NJ	7	7	7	15	15	25	9	19	12	16	5	9	7
Kansas City, MO-KS	22	15	21	4	2	11	1	4	10	22	10	18	15
Knoxville, TN	18	55	14	2	23	10	7	20	13	20	19	36	52
Las Vegas, NV-AZ	28	11	6	36	21	8	4	6	8	1	5	0	0
Little Rock-North Little Rock, AR	7	3	7	1	1	3	0	2	2	7	1	1	2
Los Angeles-Long Beach, CA	38	56	38	215	173	169	175	134	139	113	94	60	56
Louisville, KY-IN	26	29	18	15	10	15	2	20	27	21	10	13	24
Memphis, TN-AR-MS	14	27	13	8	24	9	14	15	10	21	19	17	27
Miami, FL	12	8	10	5	1	1	3	6	1	2	1	3	8
Middlesex-Somerset-Hunterdon, NJ	4	22	4	19	24	24	8	13	9	16	8	18	21
Milwaukee-Waukesha, WI	22	12	18	17	8	24	3	4	9	14	5	4	10
Minneapolis-St. Paul, MN-WI	37	1	24	8	4	2	3	0	4	7	1	0	0
Monmouth-Ocean, NJ	4	31	3	15	21	20	6	11	3	6	12	12	19

KEY: R = revised

Continued next page

Table 4-47
Cont'd

Air Pollution Trends in Selected Metropolitan Statistical Areas^R
(Number of days with AQI values greater than 100 at trend sites and all monitoring sites)

	All sites		Number of trend sites	Trend sites									
	Total number of sites	AQI days > 100 (1998)		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Nashville, TN	21	32	17	12	31	13	6	18	21	28	23	20	30
Nassau-Suffolk, NY	8	11	4	14	20	25	5	15	10	9	6	8	10
New Haven-Meriden, CT	10	10	10	11	17	29	10	17	14	14	8	19	10
New Orleans, LA	11	7	11	4	6	2	5	6	8	20	8	7	7
New York, NY	39	21	29	29	36	49	10	19	21	19	15	23	17
Newark, NJ	12	23	12	21	23	35	10	13	13	20	12	13	23
Norfolk-VA Beach-Newport News, VA-NC	12	15	12	4	8	7	8	19	6	6	4	17	15
Oakland, CA	29	12	20	6	4	4	3	4	3	12	11	0	11
Oklahoma City, OK	14	7	10	4	4	4	2	2	5	13	2	4	7
Omaha, NE-IA	12	5	9	1	1	0	0	1	1	1	1	0	5
Orange County, CA	11	6	11	56	45	35	35	25	15	9	9	3	6
Orlando, FL	13	14	9	9	4	1	4	4	3	1	1	4	11
Philadelphia, PA-NJ	44	38	36	44	39	49	24	51	26	30	22	32	37
Phoenix-Mesa, AZ	49	37	23	30	12	11	13	16	10	22	17	12	17
Pittsburgh, PA	53	39	41	21	19	21	9	13	19	25	11	20	39
Ponce, PR	1	0	1	0	0	0	0	0	0	0	0	0	0
Portland-Vancouver, OR-WA	17	3	12	2	11	8	6	0	2	2	6	0	3
Providence-Fall River-Warwick, RI-MA	13	5	11	9	13	20	5	7	7	11	4	10	4
Raleigh-Durham-Chapel Hill, NC	18	40	4	14	15	5	0	11	2	1	1	13	21
Richmond-Petersburg, VA	11	28	10	11	6	18	8	30	13	19	5	21	28
Riverside-San Bernardino, CA	51	96	35	187	158	154	174	168	149	124	119	106	94
Rochester, NY	8	4	8	5	5	16	2	0	1	6	0	6	4
Sacramento, CA	33	33	13	63	36	54	44	14	30	32	30	5	17
St. Louis, MO-IL	63	24	54	25	23	32	15	9	32	34	20	15	23
Salt Lake City-Ogden, UT	23	19	12	21	5	20	9	5	13	4	8	1	12

KEY: R = revised

Continued next page

Table 4-47
Cont'd

Air Pollution Trends in Selected Metropolitan Statistical Areas^R
(Number of days with AQI values greater than 100 at trend sites and all monitoring sites)

	All sites		Number of trend sites	Trend sites									
	Total number of sites	AQI days > 100 (1998)		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
San Antonio, TX	7	6	7	3	4	3	1	3	4	18	3	3	6
San Diego, CA	28	35	23	127	96	67	66	58	46	48	31	14	33
San Francisco, CA	11	0	9	0	0	0	0	0	0	2	0	0	0
San Jose, CA	11	8	8	18	7	11	3	4	2	10	7	0	5
San Juan-Bayamon, PR	27	1	10	0	0	0	0	0	0	0	1	2	1
Scranton-Wilkes Barre-Hazleton, PA	11	7	11	6	9	17	3	10	7	12	4	11	7
Seattle-Bellevue-Everett, WA	26	3	16	6	9	4	3	0	3	0	6	1	3
Springfield, MA	13	7	13	10	13	15	12	13	12	9	5	10	7
Syracuse, NY	8	3	6	2	1	11	2	4	0	1	0	0	2
Tacoma, WA	9	4	7	3	5	1	2	0	2	0	1	0	4
Tampa-St. Petersburg-Clearwater, FL	32	11	22	4	6	1	1	1	3	2	3	4	11
Toledo, OH	6	6	6	8	3	6	2	7	9	9	11	4	5
Tucson, AZ	25	0	20	2	1	0	1	1	1	3	0	1	0
Tulsa, OK	11	9	11	5	16	12	1	4	12	21	14	7	9
Ventura, CA	15	30	12	87	70	87	54	37	63	65	62	44	29
Washington, DC-MD-VA-WV	46	47	32	24	25	48	14	48	20	29	18	29	45
West Palm Beach-Boca Raton, FL	9	2	6	1	0	0	0	3	0	0	0	0	2
Wilmington-Newark, DE-MD	10	28	5	12	9	12	7	10	5	12	3	6	8
Youngstown-Warren, OH	15	22	9	8	3	14	5	2	0	11	5	3	15

NOTES: The Air Quality Index (AQI) integrates information on 5 major pollutants (particulate matter less than 10 microns in diameter, sulfur dioxide, carbon monoxide, ozone, and nitrogen dioxide) across an entire monitoring network into a single number that represents the worst daily air quality experienced in an urban area. An AQI greater than 100 indicates that at least 1 criteria pollutant exceeded air quality standards on a given day; therefore, air quality would be in the unhealthful range on that day. In 1997, 4,738 monitoring sites reported air quality data. Air quality monitoring sites are selected as

"trend sites" if they have complete data for at least 8 of the 10 years between 1989 and 1998.

KEY: R = revised

SOURCE: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *National Air Quality and Emissions Trends Report, 1998* (Research Triangle Park, NC: 2000), table A-15.

Table 4-48

**Areas in Nonattainment of National Ambient Air Quality Standards for Criteria Pollutants
(Condensed nonattainment area list as of July 31, 2000)**

Ref. no.	States	Consolidated nonattainment area name ^a	Number of areas in nonattainment ^c					Area population, in 1000s ⁿ						
			O ₃ ^e	CO	SO ₂	PM-10	Pb	NO ₂ ^d	O ₃ ^d	CO	SO ₂	PM-10	Pb	Total exposed
1	AK	Anchorage	•	1	•	1	•	•		222		170		222
2	AK	Fairbanks	•	1	•	•	•	•		30				30
3	AK	Juneau	•	•	•	1	•	•				12		12
4	AL	Birmingham	1	•	•	•	•	•	751					751
5	AZ	Ajo	•	•	1	1	•	•			6	6		6
6	AZ	Bullhead City	•	•	•	1	•	•				5		5
7	AZ	Douglas	•	•	1	1	•	•			13	13		13
8	AZ	Miami-Hayden	•	•	2	1	•	•			3	3		3
9	AZ	Morenci	•	•	1	•	•	•			8			8
10	AZ	Nogales	•	•	•	1	•	•				19		19
11	AZ	Paul Spur	•	•	•	1	•	•				1		1
12	AZ	Payson	•	•	•	1	•	•				8		8
13	AZ	Phoenix	1	1	•	1	•	•	2,092	2,006		2,122		2,122
14	AZ	Rillito	•	•	•	1	•	•				0		0
15	AZ	San Manuel	•	•	1	•	•	•			5			5
16	AZ	Yuma	•	•	•	1	•	•				54		54
17	CA	Imperial Valley	•	•	•	1	•	•				92		92
18	CA	Los Angeles-South Coast Air Basin	1	1	•	1	•	•	13,000	13,000		13,000		13,000
19	CA	Mono Basin (in Mono Co.)	•	•	•	1	•	•				0		0
20	CA	Owens Valley	•	•	•	1	•	•				18		18
21	CA	Sacramento Metro	1	•	•	1	•	•	1,639			1,041		1,639
22	CA	San Diego	1	•	•	•	•	•	2,498					2,498
23	CA	San Francisco-Oakland-San Jose	1	•	•	•	•	•	5,815					5,815
24	CA	San Joaquin Valley	1	•	•	1	•	•	2,742			2,742		2,742
25	CA	Santa Barbara-Santa Maria-Lompoc	1	•	•	•	•	•	370					370
26	CA	Searles Valley	•	•	•	1	•	•				30		30
27	CA	Southeast Desert Modified AQMA	1	•	•	2	•	•	384			349		384
28	CA	Ventura Co.	1	•	•	•	•	•	669					669
29	CO	Aspen	•	•	•	1	•	•				5		5
30	CO	Denver-Boulder	•	1	•	1	•	•		1,800		1,836		1,836

KEY: CO = carbon monoxide; NO₂ = nitrogen dioxide; O₃ = ozone; Pb = lead; PM-10 = particulate matter smaller than 10 microns; SO₂ = sulfur dioxide; • = all areas in attainment for a particular pollutant

Continued next page

Table 4-48
Cont'd

Areas in Nonattainment of National Ambient Air Quality Standards for Criteria Pollutants
(Condensed nonattainment area list as of July 31, 2000)

Ref. no.	States	Consolidated nonattainment area name ^a	Number of areas in nonattainment ^c					Area population, in 1000s ⁿ					Total exposed	
			O ₃ ^e	CO	SO ₂	PM-10	Pb	NO ₂ ^d	O ₃ ^d	CO	SO ₂	PM-10		Pb
31	CO	Fort Collins	•	1	•	•	•	•	106					106
32	CO	Lamar	•	•	•	1	•	•			8			8
33	CO	Pagosa Springs	•	•	•	1	•	•			1			1
34	CO	Steamboat Springs	•	•	•	1	•	•			6			6
35	CO	Telluride	•	•	•	1	•	•			1			1
36	CT	Greater Connecticut	1	•	•	1	•	•	2,470		126			2,470
37	DC-MD-VA	Washington	1	•	•	•	•	•	3,923					3,923
38	GA	Atlanta	1	•	•	•	•	•	2,653					2,653
39	GU ^b	Piti Power Plant	•	•	1	•	•	•			0			0
40	GU ^b	Tanguisson Power Plant	•	•	1	•	•	•			0			0
41	ID	Bonner Co.(Sandpoint)	•	•	•	1	•	•			26			26
42	ID	Fort Hall Indian Reservation	•	•	•	1	•	•			1			1
43	ID	Portneuf Valley	•	•	•	1	•	•			74			74
44	ID	Shoshone Co.	•	•	•	2	•	•			13			13
45	IL-IN	Chicago-Gary-Lake County	1	•	1	3	•	•	7,887		475	625		7,887
46	KY	Boyd Co. (Ashland)	•	•	⁹¹	•	•	•			51			51
47	KY-IN	Louisville	1	•	•	•	•	•	834					834
48	LA	Baton Rouge	1	•	•	•	•	•	559					559
49	MA	Springfield (W. Mass)	1	•	•	•	•	•	812					812
50	MD	Baltimore	1	•	•	•	•	•	2,348					2,348
51	MD	Kent and Queen Anne Cos.	1	•	•	•	•	•	52					52
52	MN	Minneapolis-St. Paul	•	•	•	1	•	•			272			272
53	MN	Olmsted Co. (Rochester)	•	•	1	•	•	•			71			71
54	MO	Dent	•	•	•	•	1	•					3	3
55	MO	Liberty-Arcadia	•	•	•	•	1	•					2	2
56	MO-IL	St. Louis	1	•	•	•	ⁱ 1	•	2,390				2	2,390
57	MT	Butte	•	•	•	1	•	•			33			33
58	MT	Columbia Falls	•	•	•	1	•	•			3			3
59	MT	Kalispell	•	•	•	1	•	•			12			12
60	MT	Lame Deer	•	•	•	1	•	•			1			1

KEY: CO = carbon monoxide; NO₂ = nitrogen dioxide; O₃ = ozone; Pb = lead; PM-10 = particulate matter smaller than 10 microns; SO₂ = sulfur dioxide; • = all areas in attainment for a particular pollutant

Continued next page

Table 4-48
Cont'd

Areas in Nonattainment of National Ambient Air Quality Standards for Criteria Pollutants
(Condensed nonattainment area list as of July 31, 2000)

Ref. no.	States	Consolidated nonattainment area name ^a	Number of areas in nonattainment ^c						Area population, in 1000s ⁿ					
			O ₃ ^e	CO	SO ₂	PM-10	Pb	NO ₂ ^d	O ₃ ^d	CO	SO ₂	PM-10	Pb	Total exposed
61	MT	Lewis & Clark (E. Helena)	•	•	1	•	1	•			2		2	2
62	MT	Libby	•	•	•	1	•	•				3		3
63	MT	Missoula	•	1	•	1	•	•		43		43		43
64	MT	Polson	•	•	•	1	•	•				3		3
65	MT	Ronan	•	•	•	1	•	•				2		2
66	MT	Thompson Falls	•	•	•	1	•	•				1		1
67	MT	Whitefish	•	•	•	1	•	•				3		3
68	MT	Yellowstone Co. (Laurel)	•	•	1	•	•	•			5			5
69	NE	Douglas Co. (Omaha)	•	•	•	•	1	•					1	1
70	NM	Anthony	•	•	•	1	•	•				2		2
71	NM	Grant Co.	•	•	1	•	•	•			28			28
72	NM	Sunland Park	1	•	•	•	•	•	8					8
73	NV	Central Steptoe Valley	•	•	1	•	•	•			2			2
74	NV	Las Vegas	•	1	•	1	•	•		258		741		741
75	NV	Reno	•	1	•	1	•	•		134		254		254
76	NY-NJ-CT	New York-N. New Jersey-Long Island	1	1	•	1	•	•	17,943	12,338		1,488		17,943
77	OH	Cleveland-Akron-Lorain	•	•	1	1	•	•			1,412	1,412		1,412
78	OH	Jefferson Co. (Steubenville)	•	•	•	1	•	•				4		4
79	OH	Lucas Co. (Toledo)	•	•	1	•	•	•			462			462
80	OR	Grants Pass	•	1	•	1	•	•		17		17		17
81	OR	Klamath Falls	•	1	•	1	•	•		18		18		18
82	OR	LaGrande	•	•	•	1	•	•				12		12
83	OR	Lakeview	•	•	•	1	•	•				3		3
84	OR	Medford	•	1	•	1	•	•		62		63		63
85	OR	Oakridge	•	•	•	1	•	•				3		3
86	OR	Springfield-Eugene	•	•	•	1	•	•				157		157
87	PA	Lancaster	1	•	•	•	•	•	423					423
88	PA	Pittsburgh-Beaver Valley	1	•	2	1	•	•	2,468		446	75		2,468
89	PA	Warren Co	•	•	2	•	•	•			22			22
90	PA-DE-NJ-MD	Philadelphia-Wilmington-Trenton	1	•	•	•	•	•	6,010					6,010

KEY: CO = carbon monoxide; NO₂ = nitrogen dioxide; O₃ = ozone; Pb = lead; PM-10 = particulate matter smaller than 10 microns; SO₂ = sulfur dioxide; • = all areas in attainment for a particular pollutant

Continued next page

Table 4-48
Cont'd

Areas in Nonattainment of National Ambient Air Quality Standards for Criteria Pollutants
(Condensed nonattainment area list as of July 31, 2000)

Ref. no.	States	Consolidated nonattainment area name ^a	Number of areas in nonattainment ^c					Area population, in 1000s ⁿ					Total exposed	
			O ₃ ^e	CO	SO ₂	PM-10	Pb	NO ₂ ^d	O ₃ ^d	CO	SO ₂	PM-10		Pb
91	PA-NJ	Allentown-Bethlehem		•	1						91			91
92	PR	Guaynabo Co.	•	•	•	1	•	•				85		85
93	TN	Shelby Co. (Memphis)	•	•	•	•	k1	•					826	826
94	TX	Beaumont-Port Arthur	1	•	•	•	•	•	361					361
95	TX	Dallas-Fort Worth	1	•	•	•	•	•	3,561					3,561
96	TX	El Paso	1	1	•	1	•	•	592	54		515		592
97	TX	Houston-Galveston-Brazoria	1	•	•	•	•	•	3,731					3,731
98	UT	Ogden	•	1	•	1	•	•		63		63		63
99	UT	Salt Lake City	•	•	1	1	•	•			725	725		725
100	UT	Tooele Co.	•	•	1	•	•	•			26			26
101	UT	Utah Co. (Provo)	•	1	•	1	•	•		85		263		263
102	WA	Olympia-Tumwater-Lacey	•	•	•	1	•	•				63		63
103	WA	Seattle-Tacoma	•	•	•	3	•	•				730		730
104	WA	Spokane	•	1	•	1	•	•		279		177		279
105	WA	Wallula	•	•	•	1	•	•				47		47
106	WA	Yakima	•	•	•	1	•	•				54		54
107	WI	Manitowoc Co.	1	•	•	•	•	•	80					80
108	WI	Marathon Co. (Wausau)	•	•	1	•	•	•			115			115
109	WI	Milwaukee-Racine	1	•	•	•	•	•	1,735					1,735
110	WI	Oneida Co. (Rhineland)	•	•	1	•	•	•			31			31
111	WV	Follansbee	•	•	•	1	•	•				3		3
112	WV	New Manchester Gr. (in Hancock Co)	•	•	1	•	•	•			10			10
113	WV	Wier.-Butler-Clay (in Hancock Co)	•	•	1	1	•	•			25	22		25
114	WY	Sheridan	•	•	•	1	•	•				13		13
National totals (114 areas)^c			31	17	28	76	6	0	90,800	30,515	4,664	29,792	836	100,593

KEY: CO = carbon monoxide; NO₂ = nitrogen dioxide; O₃ = ozone; Pb = lead;
PM-10 = particulate matter smaller than 10 microns; SO₂ = sulfur dioxide;
• = all areas in attainment for a particular pollutant

Continued next page

**Areas in Nonattainment of National Ambient Air Quality Standards for Criteria Pollutants
(Condensed nonattainment area list as of July 31, 2000)**

- ^a This is a simplified listing of classified nonattainment areas. Unclassified and Section 185a (transitional) nonattainment areas are not included. Names of nonattainment areas are listed alphabetically within each state. Note that several smaller nonattainment areas may be inside one larger nonattainment area. In these cases, the smaller nonattainment areas are listed on the same line as the larger one, and the number of nonattainment areas are indicated under each pollutant.
- ^b Guam (U.S. territory)
- ^c National total includes Guam (U.S. territory).
- ^d The number of nonattainment areas for each of the criteria pollutants is listed. A dot (.) indicates that all areas are in attainment for that pollutant.
Note that there are no areas in nonattainment for NO₂.
- ^e 1-hour ozone standard.
- ^f Ozone nonattainment area is a portion of Dona Ana County, New Mexico.
- ^g SO₂ nonattainment area is a portion of Boyd County, Kentucky.
- ^h Lead nonattainment area is a portion of Franklin township, Marion County, Indiana.
- ⁱ Lead nonattainment area is Herculaneum, Missouri in Jefferson County.

- ^j Lead nonattainment area is a portion of Lewis and Clark County, Montana.
- ^k Lead nonattainment area is a portion of Shelby County, Tennessee.
- ^l Lead nonattainment area is a portion of Williamson County, Tennessee.
- ^m Lead nonattainment area is Frisco, Texas, in Collin County.
- ⁿ Population figures were obtained from the 1990 census data. For nonattainment areas defined as only partial counties, population figures for just the nonattainment area were used when these were available. Otherwise, whole county population figures were used. When a larger nonattainment area encompasses a smaller one, double counting the population in the "Total exposed" column is avoided by only counting the population of the larger nonattainment area.
The "Total exposed" values represent estimated population living in areas that are in nonattainment for at least one pollutant.

NOTE: Reference numbers 1-130 do not indicate ranking.

SOURCE: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, USA Air Quality Nonattainment Areas, Internet website <http://www.epa.gov/airs/nonattn.html> as of Oct. 17, 2000.

Table 4-49

U.S. Carbon Dioxide Emissions from Energy Use by Sector, 1990-1998 (Million Metric tons of Carbon)

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Industrial	454.8	444.1	461.6	461.0	471.0	469.2	483.8	489.7	480.2	481.2
Residential	254.2	259.0	258.6	274.3	272.2	273.4	289.6	288.6	288.8	290.1
Commercial	207.7	208.0	207.8	213.6	217.1	220.6	229.2	241.5	244.5	243.5
Transportation	431.8	424.3	431.1	436.4	449.1	457.6	468.7	473.6	481.9	496.1
Motor Gasoline	260.6	259.2	263.1	268.9	273.3	279.0	284.0	286.5	292.9	299.1
Liquid Petroleum Gas	0.4	0.3	0.3	0.3	0.6	0.3	0.3	0.2	0.2	0.3
Jet Fuel	60.1	58.1	57.6	58.1	60.4	60.0	62.7	63.3	64.2	66.3
Distillate Fuel	75.7	72.6	75.3	77.3	82.5	85.1	89.7	93.5	96.4	100.1
Residual Fuel	21.9	22.0	23	19.4	19.1	19.7	18.4	15.5	15.2	17.5
Lubricants	1.8	1.6	1.6	1.6	1.7	1.7	1.6	1.7	1.8	1.8
Aviation Gas	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total Petroleum	421.2	414.6	421.6	426.4	438.2	446.5	457.4	461.5	471.5	485.8
Natural Gas	9.8	9.0	8.8	9.3	10.2	10.4	10.6	11.2	9.5	9.5
Electricity	0.7	0.7	0.7	0.7	0.9	0.8	0.8	0.8	0.9	0.8
Total CO₂ Emissions from End-Use Sector Energy Consumption	1,348.6	1,335.3	1,359.1	1,385.3	1,409.6	1,421.0	1,471.5	1,493.4	1,495.4	1,510.8
Total U.S. CO₂ Emissions	1,350.0	1,338.4	1,365.1	1,396.8	1,422.5	1,434.7	1,484.1	1,505.2	1,507.4	1,526.8

NOTES: Electric utility emissions are distributed across end-use sectors.

Numbers may not add to totals due to rounding.

Tons of carbon can be converted to tons of carbon dioxide gas by multiplying by 3.667. One ton of carbon equals 3.667 tons of carbon dioxide gas.

SOURCE: U.S. Department of Energy, Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1999*, DOE/EIA-0573(98) (Washington, DC: October 1999), available at Internet site www.eia.doe.gov/oiaf/1605/ggrpt/html, as of Nov. 7, 2000.