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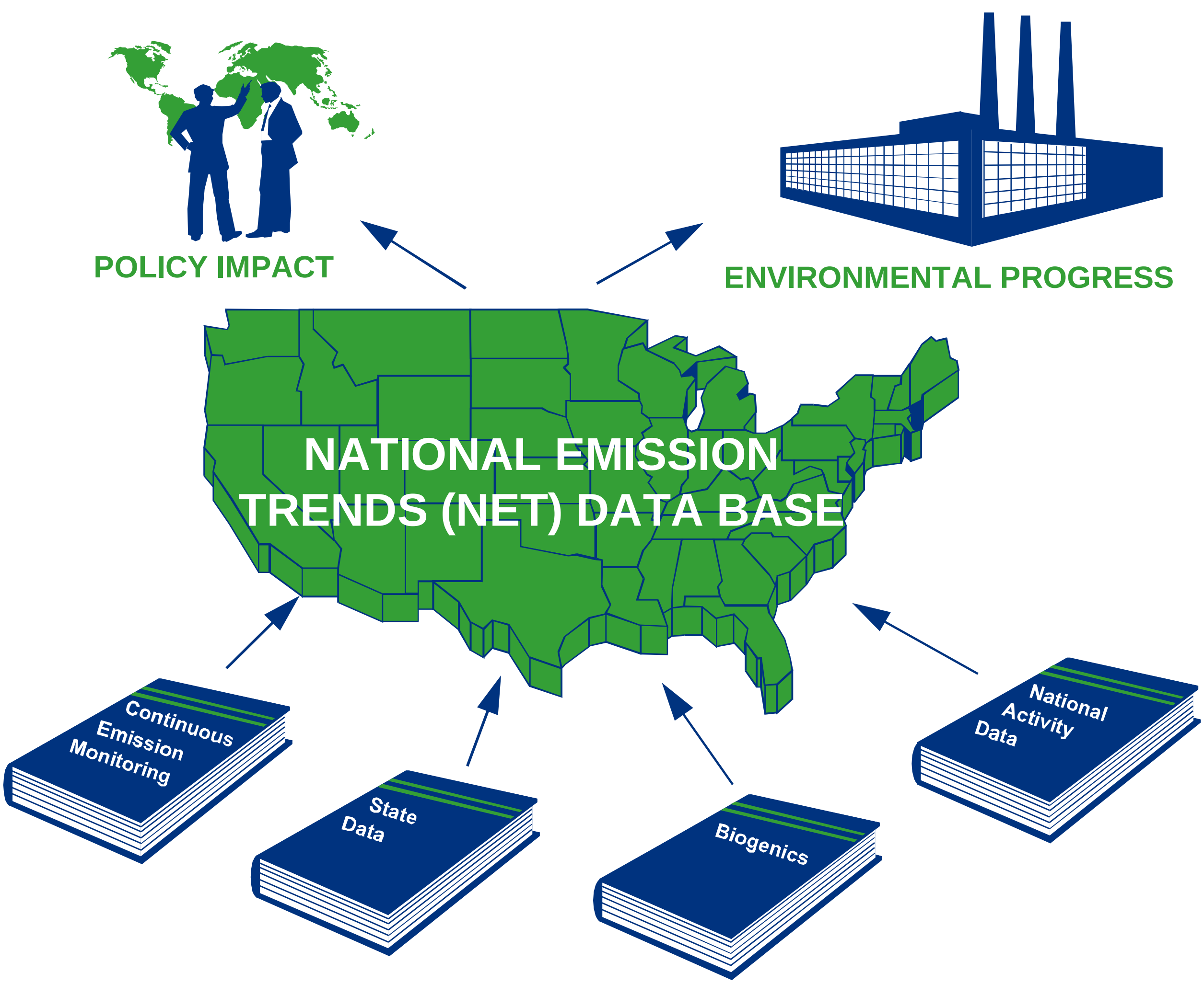
Air

NATIONAL AIR POLLUTANT EMISSION TRENDS, 1900-1996



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Foreword

This document presents the most recent estimates of national emissions of the criteria air pollutants. The emissions of each pollutant are estimated for many different source categories, which collectively account for all anthropogenic emissions. The report presents the total emissions from all 50 States and from each EPA region in the country. These estimates are updated annually.

This report tracks changes in national emissions since passage of the Clean Air Act Amendments of 1990. The emission trends are the net effect of many factors, including changes in the nation's economy and in industrial activity, technology, consumption of fuels, traffic, and other activities that cause air pollution. The trends also reflect changes in emissions as a result of air pollution regulations and emission controls. These reports will serve as a measure of our nation's progress in reducing air pollution emissions as a result of mandatory and voluntary controls and of continuous changes in national activity.

In addition to the extensive coverage of criteria air pollutant emissions from anthropogenic sources in the United States, this year’s report continues to provide limited coverage of State-derived biogenic, greenhouse gas, and air toxic emissions, and emissions for Canada and Europe. Preliminary estimates are presented for the years 1990 through 1996. Final estimates (including refinements to the data used to estimate emissions) will be presented in future reports.

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Acronyms and Abbreviations

AADT	annual average daily traffic
AAMA	American Automotive Manufacturer’s Association
AAR	Association of American Railroads
ACT	Alternative Control Technology
ADTV	average daily traffic volume
AIRS	Aerometric Information Retrieval System
AIRS/AMS	AIRS Area and Mobile Source Subsystem
AIRS/AFS	AIRS Facility Subsystem
ARD	Acid Rain Division
ASTM	American Society for Testing and Materials
BEA	U.S. Department of Commerce, Bureau of Economic Analysis
BEIS2	Biogenic Emission Inventory System version 2
BER	basic emissions rate
BLS	U.S. Bureau of Labor Statistics
Btu	British thermal unit
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CARB	California Air Resources Board
CEM	continuous emission monitor(ing)
CFCs	chloroflurocarbons
CH_4	methane
CHIEF	Clearinghouse for Inventories and Emission Factors
CNOI	Census number of inhabitants
CO	carbon monoxide
CO_2	carbon dioxide
CORINAIR	Coordination of Environmental Air
CTG	Control Techniques Guidelines
CTIC	Conservation Technology Information Center
DOE	Department of Energy
DOI	Department of Interior
DOT	Department of Transportation
DR	deterioration rate
DRI	Desert Research Institute
DVMT	daily vehicle miles traveled
EC	elemental carbon
ECOS	Environmental Council of States
EEA	European Environment Agency
EFIG	EPA, OAQPS, Emission Factors and Inventory Group
EG	earnings growth
E-GAS	Economic Growth Analysis System
EIA	U.S. DOE, Energy Information Administration

EPA	U.S. Environmental Protection Agency
ERCAM	Emission Reductions and Cost Analysis Model
ES	Executive Summary
ESD	EPA, OAQPS, Emission Standards Division
ETC/AEM	European Topic Center on Air Emissions
ETS/CEM	Emissions Tracking System/Continuous Emissions Monitoring
EU	European Union
FAA	Federal Aviation Adminstration
FCC	fluid catalytic cracking unit
FCCC	Framework Convention on Climate Change
FGD	flue gas desulfurization
FHWA	U.S. Federal Highway Adminstration
FID	Flame Ionization Detector
FIPS	Federal Information Processing Standards
FR	Federal Register
FREDS	Flexible Regional Emissions Data System
ftp	file transfer protocol
FTP	Federal Test Procedure
GACT	generally achievable control technology
GCVTC	Grand Canyon Visibility Transport Commission
GDP	gross domestic product
gpg	grams per gallon
gpm	grams per mile
GSP	gross State product
GT	gas turbines
GWP	global warming potential
HAPs	hazardous air pollutants
HC	hydrocarbon
HCFC	hydrochloroflurocarbon
HCPREP	FREDS Hydrocarbon Preprocessor
HDDT	heavy-duty diesel truck
HDDV	heavy-duty diesel vehicle
HDGT	heavy-duty gasoline truck
HDGV	heavy-duty gasoline vehicle
HDT	heavy-duty-truck
HDV	heavy-duty vehicle
HEW	Health, Education, and Welfare
HFCs	hydroflurocarbons
hp	horsepower
HPMS	Highway Performance Monitoring System
I/M	inspection and maintenance
IC	internal combustion (engine)
ID	identification (code)
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPCC	Intergovernmental Panel on Climate Change
LADCO	Lake Michigan Air Directors Consortium
lb	pound
LDDT	light-duty diesel truck
LDDV	light-duty diesel vehicle

LDGT	light-duty gasoline truck
LDGV	light-duty gasoline vehicle
LDT	light-duty truck
LDV	light-duty vehicle
LTO	landing and takeoff
MACT	maximum available control technology
MC	motorcycle
MMBtu	million British thermal units
MMTCE	million metric tons carbon-equivalent
MRI	Midwest Research Institute
MSA	metropolitan statistical area
MW	megawatts
N_2O	nitrous oxide
NAA	nonattainment area
NAAQS	National Ambient Air Quality Standard
NADB	National Allowance Data Base
NAPAP	National Acid Precipitation Assessment Program
NEC	not elsewhere classified
NEDS	National Emission Data System
NESCAUM	Northeast States for Coordinated Air Use Management
NESHAP	National Emission Standards for Hazardous Air Pollutants
NET	National Emissions Trends (inventory)
NH_3	ammonia
NLEV	national low emission vehicle
NMVOC	nonmethane volatile organic compounds
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NPI	National Particulates Inventory
NRC	National Reference Centers
NSPS	New Source Performance Standards
NTI	National Toxics Inventory
O_3	ozone
OAQPS	EPA, Office of Air Quality Planning and Standards
OC	organic carbon
OECD	Organization for Economic Cooperation and Development
OMS	EPA, Office of Mobile Sources
OSD	ozone season daily
OTAG	Ozone Transport Assessment Group
OTR	ozone transport region
Pb	lead
PCE	personal consumption expenditures
PFCs	perfluorinated carbons
PM	particulate matter
PM-10	particulate matter less than 10 microns in diameter
PM-2.5	particulate matter less than 2.5 microns in diameter
ppm	parts per million
psi	pounds per square inch
QA	quality assurance

QC	quality control
RACT	Reasonably Available Control Technology
RCRA	Resource Conservation and Recovery Act
RIA	Regulatory Impact Analysis
ROM	Regional Oxidant Model
RVP	Reid vapor pressure
SCC	source classification code
SEDS	State Energy Data System
SF_6	sulfur hexafluoride
SIC	Standard Industrial Classification (code)
SIP	State Implementation Plan
SO_2	sulfur dioxide
SO_4	sulfates
SUPROXA	Super Regional Oxidant A
TOG	total organics
TP	total particulates
tpy	tons per year
TRENDS	The Representative Emissions National Data System
TRI	Toxic Release Inventory
TSDF	hazardous waste treatment, storage, and disposal facility
TSP	total suspended particulate matter
TTN	Technology Transfer Network
UAM	Urban Airshed Model
U.S.	United States
USDA	U.S. Department of Agriculture
USFS	USDA Forest Service
VMT	vehicle miles traveled
VOC	volatile organic compound(s)
ZML	zero mile level

Acknowledgement

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Executive Summary

This report presents the United States (U.S.) Environmental Protection Agency's (EPA) latest estimates of national emissions for criteria air pollutants: carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOC), sulfur dioxide (SO_2), particulate matter less than 10 microns in aerodynamic diameter (PM-10), and lead (Pb). Estimates are presented for the years 1900 to 1996. Estimates for three criteria pollutants, NO_x, VOC, and SO_2 have been extrapolated back to 1900. Criteria pollutants are those for which ambient air standards have been set, based on established criteria for risk to human health and/or environmental degradation.

Data on emissions of hazardous air pollutants (HAPs), or air toxics, greenhouse gases (carbon dioxide [CO_2], methane [CH_4], nitrous oxide [N_2O], hydrofluorocarbons [HFCs], perfluorinated carbons [PFCs], and sulfur hexafluoride [SF_6]), and biogenic sources are also included in this report for the United States. Data for Canada and Europe for 1994 are presented for the criteria air pollutants.

Figures ES-1 and ES-2 present the long-term trends in the criteria air pollutant emissions from 1900 through 1996. Most of the criteria air pollutant emission levels peaked around 1970. PM-10 emissions peaked earlier (around 1950) due to smoke and particulates being the first pollutants to be regulated. Between 1970 and 1996 emissions for all criteria pollutants except NO_x declined, even though vehicle miles traveled (VMT) and gross domestic product (GDP) increased. These air pollution decreases are attributable to the Clean Air Act (CAA) regulations beginning in 1970 and continuing into the 1990s. (Changes in the business cycle and improved manufacturing practices have also played a role.)

Note: Methodologies to estimate pre-1990 and 1990 to the present emissions differ. Differences in methodologies for allocating emissions among source categories could result in significant changes in the emissions, particularly at the more detailed source category level. CAUTION SHOULD BE EXERCISED WHEN COMPARING TRENDS FOR TOTALS OF PRE-1990 AND 1990 TO THE PRESENT YEAR VALUES. Refer to section 6.6.

ES.1 CURRENT EMISSIONS

Tables ES-1 and ES-2 present the most current emission estimates for the criteria and other air pollutants in the United States. United States criteria pollutant emissions decreased for CO, NO_x, VOC, and Pb and increased for SO_2 and PM-10 from the previous year. The reduction in CO and VOC emissions is a result of a decrease in mobile source emissions from 1995 as a result of the use of new fuels (reformulated gasoline, oxygenated fuels, and fuels with lower Reid vapor pressures [RVP]). Particulate fugitive dust emissions from construction sources, paved roads, and tilling of agricultural crops increased due to the increases in construction, VMT, and number of acres of land tilled. The most recent available Canadian and European data for 1994 are summarized in table ES-3.

A summary description of the methods used for estimating CO, NO_x, VOC, SO_2, PM-10, and Pb can be found in chapter 6 of this report, while detailed methodology descriptions can be found in the National Air Pollutant Emission Trends Procedures Document.[1]

ES.2 EMISSION TRENDS

The level and composition of economic activity in the nation, demographic influences, meteorological conditions, and regulatory efforts to control emissions affect the trends in criteria air pollutant emissions. The emissions resulting from these economic, demographic, and regulatory influences are presented in figures ES-1 and ES-2, and table ES-4. The changes in emissions are presented in table ES-5 for several time periods. Up until the 1950s, the greatest influence on emissions were economic and demographic. Emissions grew as the economy and population increased; emissions declined in periods of economic recession. Dramatic declines in emissions in the 1930s were due to the Great Depression. More recent recession in the mid/late-1970s (largely a result from disruptions in the world oil markets) and early 1990s also led to decreases in emissions.

Emissions also increase as a result of a shift in the demand for various products. For example, the tremendous increase in demand for refined petroleum products, especially motor gasoline after World War II, increased emissions associated with petroleum refining and on-road vehicles. Increased economic production as a result of World War II raised emissions to levels higher than those of the pre-Depression Era. The declines in the 1940s through 1970s in residential wood combustion resulted from the abundant supply, low relative prices, and convenience of fossil fuel-generated electricity.

In the 1950s the States issued air pollution statutes generally targeted toward smoke and particulate emissions.

It was not until passage of the CAA as amended in 1970 (Congress passed the original CAA in 1963) that major strides were made in reducing air pollution. The 1970 Amendments created the EPA and charged it with three major tasks: 1) set National Ambient Air Quality Standards (NAAQS); 2) develop motor vehicle emission standards; and 3) set New Source Performance Standards (NSPS). As a result of these standards, CO, VOC, SO_2, and Pb emissions were reduced in the mid-1970s.

The Clean Air Act Amendments of 1990 (CAAA) are only beginning to affect emission levels. For some source categories (such as non-road engines), standards are scheduled to begin in 1996, but significant emission reductions are not expected until after the year 2000.

Some emission sources such as wildfires and fugitive dust have been influenced more by meteorological conditions than economic forces. Controls to reduce fugitive dust emissions resulting from the CAAA are beginning to take effect, but are only applied in the particulate matter (PM) nonattainment areas (NAAs). The amount of land burned in wildfires varies greatly from year-to-year. Overall emission reductions from wildfires are a result of the U.S. Department of Agriculture's (USDA) Forest Service support of state efforts in fire prevention and early control. For example, in the year 1910, 5,201 fires burned approximately 5 million acres of land, whereas in the year 1990, 11,950 fires burned only one-third of a million acres of land.

More details on the effects of economic, demographic, and regulatory forces on emission levels are presented in chapter 3.

ES.3 REFERENCES

1. *National Air Pollutant Emission Trends Procedures Document*, *1900-1996*, Draft, Prepared for the Emissions Factors and Inventory Group, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, by E.H. Pechan & Associates, Inc. under EPA Contract No. 68-D3-0035, WA No. III-102, Durham, NC. September 1997.
2. *Historic Emissions of Sulfur and Nitrogen Oxides in the United States from 1900 to 1980*, EPA-600/7-85-009a and b. U.S. Environmental Protection Agency, Cincinnati, OH. April 1985.
3. *Historic Emissions of Volatile Organic Compounds in the United States from 1900 to 1985*, EPA-600/7-88-008a. U.S. Environmental Protection Agency, Cincinnati, OH. May 1988.

Table ES-1. 1995 and 1996 National Annual Emission Estimates for Criteria Air Pollutants
(million short tons)

	Emissions	
Pollutant	**1995**	**1996**
Anthropogenic Emissions		
Carbon Monoxide	89.72	88.82
Lead (thousand short tons)	3.94	3.87
Nitrogen Oxides	23.94	23.39
Particulate Matter (PM-10)	26.89	31.30
Fugitive dust	22.82	27.23
Non-fugitive dust	4.07	4.07
Sulfur Dioxide	18.55	19.11
Volatile Organic Compounds	20.59	19.09
Biogenic Emissions		
Volatile Organic Compounds	32.74	29.25
Nitric Oxide	1.59	1.55

(Emissions of Hazardous Air Pollutants in 1990 were 4.40 million short tons.)

Table ES-2. 1994 Annual Criteria Air Pollutant Emission Estimates for Canada and Europe
(million short tons)

Pollutant	Canada	Europe
Carbon Monoxide	11.02	51.82
Nitrogen Oxides	2.20	14.33
Total Particulate Matter	69.29	NA
Sulfur Dioxide	2.94	13.48
Volatile Organic Compounds	2.98	14.60

Table ES-3. Summary of National Emissions
(thousand short tons, 1.1 million short tons equals 1 million metric tons)

Year	Carbon Monoxide	Nitrogen Oxides	Volatile Organic Compounds	Sulfur Dioxide	Particulate Matter (PM-10) w/o fugitive dust	Fugitive Dust (PM-10)[a]	Lead (short tons)
1900[b]	NA[c]	2,611	8,503	9,988	NA	NA	NA
1905[b]	NA	3,314	8,850	13,959	NA	NA	NA
1910[b]	NA	4,102	9,117	17,275	NA	NA	NA
1915[b]	NA	4,672	9,769	20,290	NA	NA	NA
1920[b]	NA	5,159	10,004	21,144	NA	NA	NA
1925[b]	NA	7,302	14,257	23,264	NA	NA	NA
1930[b]	NA	8,018	19,451	21,106	NA	NA	NA
1935[b]	NA	6,639	17,208	16,978	NA	NA	NA
1940	93,615	7,374	17,161	19,954	15,956	NA	NA
1945[d]	98,112	9,332	18,140	26,373	16,545	NA	NA
1950	102,609	10,093	20,936	22,384	17,133	NA	NA
1955[d]	106,177	11,667	23,249	21,453	16,346	NA	NA
1960	109,745	14,140	24,459	22,245	15,558	NA	NA
1965[d]	118,912	17,424	30,247	26,380	14,198	NA	NA
1970[e]	128,761	21,639	30,817	31,161	13,190	NA	220,869
1975	115,968	23,151	25,895	28,011	7,803	NA	159,659
1980	116,702	24,875	26,167	25,905	7,287	NA	74,153
1985[f]	115,644	23,488	24,227	23,230	4,695	40,889	22,890
1986	110,437	23,329	23,480	22,544	4,553	46,582	14,763
1987	108,879	22,806	23,193	22,308	4,492	38,041	7,681
1988	117,169	24,526	24,167	22,767	5,424	55,851	7,053
1989	104,447	24,057	22,383	22,907	4,590	48,650	5,468
1990[g]	96,535	23,792	20,985	23,136	4,639	25,308	4,975
1991[g]	98,461	23,772	21,100	22,496	4,299	25,258	4,168
1992[g]	95,123	24,137	20,695	22,240	4,198	25,308	3,808
1993[g]	95,291	24,482	20,895	21,879	4,086	23,937	3,911
1994[g]	99,677	24,892	21,546	21,262	4,353	26,572	4,043
1995[g]	89,721	23,935	20,586	18,552	4,068	22,820	3,943
1996[g]	88,822	23,393	19,086	19,113	4,068	27,233	3,869

Note(s):
- [a] Fugitive dust emissions not estimated prior to 1985. They include miscellaneous-agriculture & forestry, miscellaneous-fugitive dust, and natural sources-wind erosion.
- [b] National Acid Precipitation Assessment Program (NAPAP) historical emissions[2, 3]
- [c] NA denotes not available.
- [d] Combination of revised transportation values and NAPAP historical emissions.
- [e] There is a change in methodology for determining on-road vehicle and non-road sources emissions (see chapter 6).
- [f] Effective as of 1985, there is a change in methodology in all sources except on-road vehicles and non-road sources and all pollutants except lead.
- [g] 1990 through 1996 estimates are preliminary. The emissions can be converted to metric tons by multiplying the values by 0.9072.

Table ES-4. Percentage Change in National Emissions
(negative percent change indicates a decrease in emissions)

Year	Carbon Monoxide	Nitrogen Oxides	Volatile Organic Compounds	Sulfur Dioxide	Particulate Matter (PM-10)[a]	Fugitive Dust[b]	Lead
1900 to 1996	NA[c]	796	124	91	NA	NA	NA
1940 to 1996	-5	217	11	-4	-75	NA	NA
1970 to 1996	-31	8	-38	-39	-69	NA	-98
1987 to 1996[d]	-18	3	-18	-14	-9	NA	-50
1990 to 1996	-8	-2	-9	-17	-12	8	-22
1995 to 1996	-1	-2	-7	3	0	19	-2

Note(s): [a] PM-10 emissions excluding fugitive dust sources.
[b] Fugitive dust includes miscellaneous-agriculture & forestry, miscellaneous-fugitive dust, and natural sources-wind erosion.
[c] NA denotes not available. 1990 to 1996 estimates are preliminary.
[d] There are significant changes in fugitive dust emission methodology between the years 1989 and 1990.

Figure ES-1. Trends in National Emissions, NITROGEN OXIDES, VOLATILE ORGANIC COMPOUNDS, SULFUR DIOXIDE (1900 TO 1996), and PARTICULATE MATTER (PM-10 [non-fugitive dust sources] 1940 to 1996)

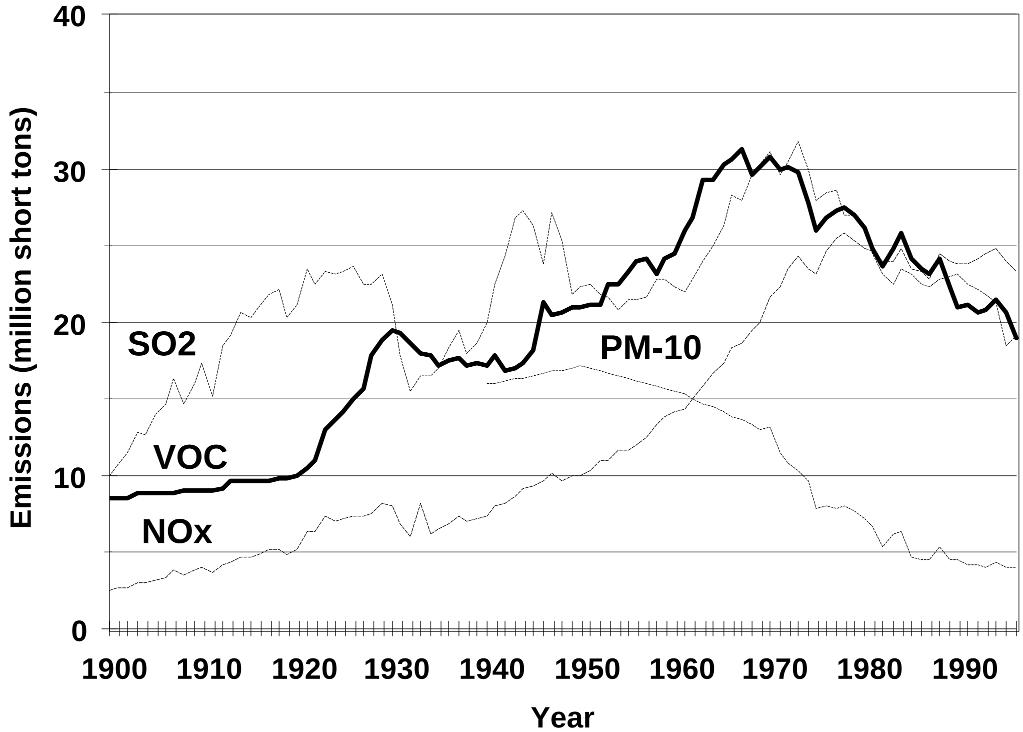
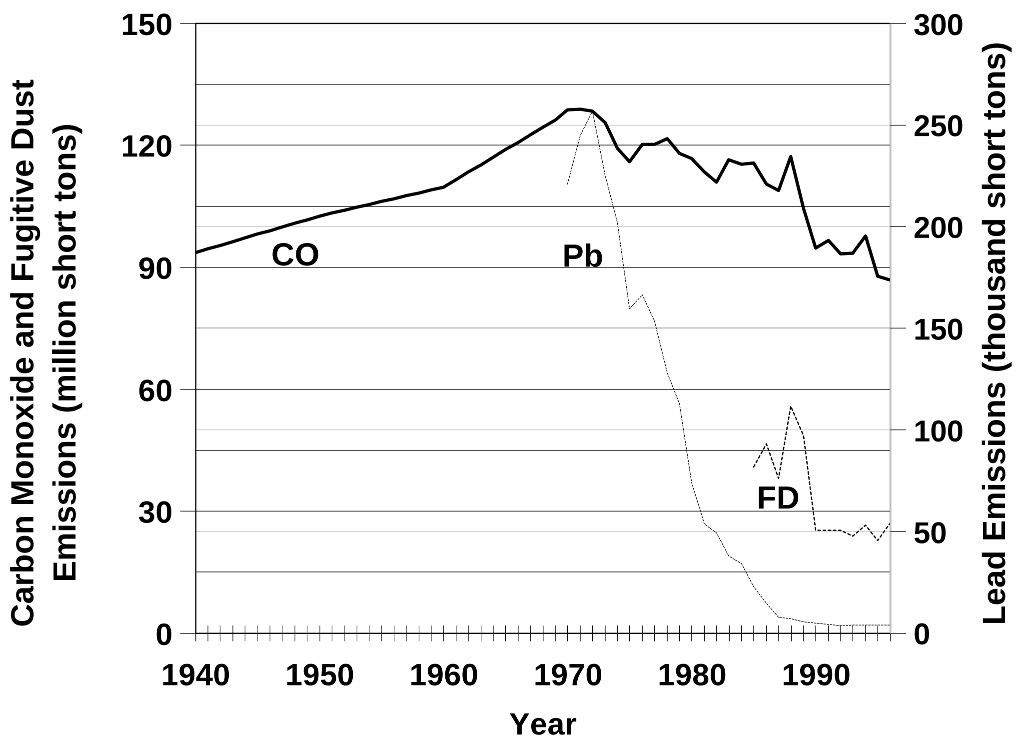


Figure ES-2. Trends in National Emissions, CARBON MONOXIDE (1940 to 1996), FUGITIVE DUST (FD [1985 to 1996]), and LEAD (1970 TO 1996)



Chapter 1.0 Introduction

This report presents the United States (U.S.) Environmental Protection Agency's (EPA) latest estimates of national emissions for criteria air pollutants: carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs [excludes certain nonreactive organic compounds]), sulfur dioxide (SO_2), particulate matter less than 10 microns (PM-10), and lead (Pb). The Clean Air Act (CAA) requires that the EPA Administrator publish a list of pollutants that have adverse effects on public health or welfare, and which are emitted from numerous and diverse stationary or mobile sources. For each pollutant, a "criteria" document must be compiled and published by the Administrator. The criteria documents are scientific compendia of the studies documenting adverse effects of specific pollutants at various concentrations in the ambient air. For each pollutant, National Ambient Air Quality Standards (NAAQS) are set at levels that, based on the criteria, protect the public health and the public welfare from any known or anticipated adverse effects. Regulated pollutants are therefore referred to as "criteria pollutants." Some of the health effects are described in section 1.1.

Graphs of national emission estimates, beginning in 1900 for NO_x, VOC, and SO_2, aggregated by major source category, are presented in chapter 3. More detail is provided for these pollutants, plus CO and PM-10 beginning with 1940. Additional detail is included for the current year. This report also contains information on the improved methodology for estimating emissions from 1985 to the present. Revised international emissions from Europe and Canada, air toxic emissions, greenhouse gas emissions, and biogenic emissions are also presented.

1.1 HEALTH AND ENVIRONMENTAL EFFECTS

Carbon monoxide enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Healthy individuals also are affected but only at higher levels. Exposure to elevated CO levels is associated with impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks.[1]

Nitrogen dioxide (NO_2) can irritate the lungs and lower resistance to respiratory infection (such as influenza). Nitrogen oxides are an important precursor both to ozone (O_3) and to acidic deposition and may affect both terrestrial and aquatic ecosystems. Atmospheric deposition of nitrogen (nitrate, NO_x, other compounds derived from NO_x) leads to excess nutrient enrichment problems ("eutrophication") in the Chesapeake Bay and several other nationally important estuaries along the East and Gulf Coasts.[2] Eutrophication can produce multiple adverse effects on water quality and the aquatic environment, including increased nuisance and toxic algal blooms, excessive phytoplankton growth, low or no dissolved oxygen in bottom waters, and reduced sunlight causing losses in submerged aquatic vegetation critical for healthy estuarine ecosystems. Nitrogen oxides are a precursor to the formation of nitrate particulate matter (PM) in the atmosphere; this effect is most important in western areas.[3] Nitrogen dioxide and airborne nitrate also contribute to pollutant haze, which impairs visibility and can reduce residential property values and revenues from tourism.

Volatile organic compounds are a principal component in the chemical and physical atmospheric reactions that form O_3 and other photochemical oxidants. The reactivity of O_3 causes health problems because it damages biological tissues and cells. Ozone is also responsible each year for agricultural crop yield loss in the United States of several billion dollars and causes noticeable foliar damage in many crops and species of trees. Forest and ecosystem studies indicate that damage is resulting from current ambient O_3 levels as well as excess nutrient enrichment and, in certain high-elevation areas, acidification.[3]

Sulfur dioxide is a precursor to the formation of sulfate PM, including acid and nonacid aerosols, in the atmosphere. Sulfate aerosols make up the largest single component of fine particulate matter in most locations in the eastern United States.[4] The major health effects of concern associated with exposures to high concentrations of SO_2, sulfate aerosols, and PM, include effects on breathing, respiratory illness and symptoms, alterations in the lung's defenses, aggravation of existing respiratory and cardiovascular disease, and mortality. Children and the elderly may also be sensitive. Also, SO_2 can produce foliar damage on trees and agricultural crops.

Together NO_x and SO_2 are the major precursors to acidic deposition (acid rain), which is associated with a number of environmental and human health effects. These effects include acidification of lakes and streams, impacts on forest soils, accelerated corrosion of buildings and monuments, and visibility impairment as well as respiratory effects on humans associated with fine sulfate and nitrate particles.

Based on studies of human populations exposed to ambient particle pollution (sometimes in the presence of SO_2), and laboratory studies of animals and humans, the major effects of concern for human health include effects on breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to lung tissue, carcinogenesis, and premature mortality. Particulate matter causes damage to materials and soiling; it is a major cause of substantial visibility impairment in many parts of the United States.[4]

Fine particles (less than 2.5 micrometers) are of health concern because they easily reach the deepest recesses of the lungs. Batteries of scientific studies have linked fine particles (alone or in combination with other air pollutants), with a series of significant health problems, including:

- Premature death
- Respiratory related hospital admissions and emergency room visits
- Aggravated asthma
- Acute respiratory symptoms, including aggravated coughing and difficult or painful breathing
- Chronic bronchitis
- Decreased lung function that can be experienced as shortness of breath
- Work and school absences[5]

Exposure to Pb can occur through multiple pathways, including inhalation of air, diet and ingestion of Pb in food, water, soil, or dust. Lead accumulates in the body in blood, bone, and soft tissue. Because it is not readily excreted, Pb also affects the kidneys, liver, nervous system, and blood-forming organs. Excessive exposure to Pb may cause neurological impairments such as seizures, mental retardation and/or behavioral disorders. Even at low doses, Pb exposure is associated with changes in fundamental enzymatic, energy transfer and homeostatic mechanisms in the body. Fetuses, infants, and children are especially susceptible to low doses of Pb, often suffering central nervous system damage. Recent studies have also shown that Pb may be a factor in high blood pressure and subsequent heart disease in middle-aged caucasian males.[6]

1.2 REPORT ENHANCEMENTS

Since 1973, EPA has prepared estimates of annual national emissions in order to assess historic trends in criteria pollutant emissions. While these estimates were prepared using consistent methodologies and were useful for evaluating emission changes from year to year, they did not provide an absolute indication of emissions for any given year. Beginning with the 1993 Emission Trends Report (containing data through 1992), EPA established a goal of preparing emission trends that would also incorporate the best available annual estimates of emissions.[a]

The EPA's Emission Factors and Inventory Group (EFIG) has developed procedures and criteria for replacing *Trends* emissions data with O_3 State Implementation Plan (SIP) submitted data. This report contains the resulting 1990 Base Year Inventory that consists of State data where available from the Ozone Transport Assessment Group (OTAG), the Grand Canyon Visibility Transport Commission (GCVTC), the Aerometric Information Retrieval System/Facility Subsystem (AIRS/AFS), and EPA-generated data for all other areas.

The EFIG is also developing a data management and reporting system of emissions data. When the system is complete, the EFIG will be able to extract the most current State inventories of emissions and supplement the gaps with EPA-generated attainment area emission inventories. The EFIG has already made several changes to the *Trends* methodology to make the transition smoother.

In this report, there are four distinct time periods: 1900 to 1939, 1940 to 1984, 1985 to 1989, and 1990 forward. Since the accuracy and availability of historical data is limited, revisions to estimates prior to 1984 are not generally made (with some exceptions, discussed in chapter 6). However, numerous changes in current year totals have been incorporated into the reported estimates using State data.

> *Please note that methodologies within a given time period (especially more recent periods) will also vary, as more accurate data are included in the* ***Trends*** *data base.*

Although there are many changes to the *Trends* methodology, some aspects have remained constant. For example, the 1900 through 1939 NO_x, VOC, and SO_2 estimates are extracted from the National Acid Precipitation Assessment Program (NAPAP) historical emissions report.[7,8] In addition, Pb estimates (1970 to present), and all CO, NO_x, VOC, SO_2, and PM-10 estimates from 1940 to 1984 reported in *Trends* are based upon the previous national "top-down" methodology. Continuous emission monitoring (CEM) data reported by electric utilities to the Acid Rain Program's Emission Tracking System (ETS) were used, whenever available and complete, for NO_x, SO_2, and heat input values for the years 1994 and 1995. (These data apply to steam generated fossil-fuel units with nameplate capacity of at least 25 megawatts [MW].) This is some of the most accurate data collected by EPA because it represents actual monitored, instead of estimated, emissions.[5] The 1996 ETS/CEM data were not available in time to incorporate into the *Trends* emissions data base. Below is a summary of the changes made this past year in support of achieving EPA's goal of preparing the best available annual estimates of emissions. As has been stated in the past several Emission Trends Reports, EPA planned to incorporate as much State derived data as possible. This report reflects the use of State data. The efforts included incorporating data from OTAG, GCVTC, and AIRS/AFS.

When data were not available or were deemed inappropriate for use in presenting emission Trends, EPA relied on nationally derived estimates. These changes are described in chapter 6 of this report and detailed in the National Air Pollutant Emission Trends, Procedures Document, 1900-1996.[9] In general the 1990 base year inventory was updated with State data and then projected based on Bureau of Economic Analysis (BEA) earnings data or State Energy Data System (SEDS) fuel consumption estimates. Reductions resulting from the Clean Air Act Amendments of 1990 (CAAA) were also applied to the 1995 and 1996 estimates. Throughout the report indications have been made when the changes in emissions are due mainly to methodological changes.

1.3 REPORT STRUCTURE

Changes instituted in the format of the October 1995[10] report, intended to make the report more comprehensible and informative, are maintained for this report. The executive summary presents a brief overview of each chapter of the report. In the introduction, chapter 1, the reader is informed of changes to the report, the health effects of criteria air pollutants, and the structure of the report. A detailed account of the current year emissions by pollutant, source category, State, nonattainment area (NAA), county, and season and by a listing of top-emitting facilities is given in chapter 2. National trends in emissions from 1900 (where available) to the current year and demographic, economic, and regulatory influences on emission trends are discussed in chapter 3. State emissions are presented in chapter 4. (State-level data for the nation are listed in chapter 2, table 2-3.) The total emission projections for the nation from 1999 to 2010 are reported in chapter 5. An explanation of the methodologies used to estimate criteria air pollutant emissions is found in chapter 6. Biogenic NO_x and VOC emissions are presented in chapter 7. Emissions from sources, noncriteria pollutants, or countries not traditionally part of the *Trends* report are displayed in chapters 8, 9, and 10. These emissions were developed by the EPA and other governmental agencies. In each of the chapters, numeric superscripts represent references and alphabetic superscripts represent endnotes.

As in last year's report, all emissions reported in tables and figures in the body of the report are in multiples of thousand short tons, except Pb.[b] The pollutants are presented in the order of CO, NO_x, VOC, SO_2, PM-10, and Pb throughout this report. Emissions were developed at the county and Source Classification Code (SCC) level for the years 1985 to 1996 for most source categories. These emissions were then summed to the national Tier level. There are four levels in the tier categorization. The first and second level, respectively referred to as Tier I and Tier II, are the same for each of the six criteria pollutants. The third level, Tier III, is unique for each of the six pollutants. The fourth level, Tier IV, is the SCC level. The match-up between SCC and all three tier levels is located on EPA's Office of Air Quality Planning and Standards' (OAQPS) Technology Transfer Network (TTN), Clearinghouse for Inventories and Emission Factors (CHIEF) electronic bulletin board. Table 1-1 lists the Tier I and Tier II categories used in chapters 1 through 6 to present the criteria air pollutant emission estimates. Tables and figures appear at the end of each chapter in the order in which they are discussed within the chapter. Appendix A contains tables listing emissions for each of the criteria pollutants by Tier III source categories. If emissions are reported as zero, the emissions are less than 0.5 thousand tons (or 0.5 tons for Pb). "NA" indicates that the apportionment of the historic emissions to these subcategories is not possible. If a tier category does not appear, then emissions are not currently estimated for that category (either EPA estimates the emissions as zero or does not currently estimate the emissions due to time or resource limitations).

Throughout this report, emission estimates of PM-10 are presented by source category as total from all sources, fugitive dust sources, and nonfugitive dust sources. Fugitive dust sources are included in the following tier categories.

Tier I	Tier I Name	Tier II	Tier II Name
13	Natural Sources	02	Geogenic (wind erosion)
14	Miscellaneous	01	Agriculture and Forestry (agricultural crops or tilling and feedlots)
		07	Fugitive Dust (paved and unpaved roads; unpaved airstrips; construction; mining and quarrying; wind erosion - industrial; point source - haul roads)

Emissions of NO_x are expressed as weight-equivalent NO_2. Thus, the actual tons of NO emitted have been inflated to report them as if they were NO_2. The molecular weight of NO_x should therefore be assumed to be that of NO_2 when using numbers in this report.[c]

The VOC emissions are reported as the actual weight of a multitude of different compounds. The relative amounts of the individual compounds emitted will determine the average molecular weight of a given source category's emissions. Therefore, no equivalent molecular weight standard exists for VOC. The VOC emissions referred to in this report exclude those organic compounds which are considered negligibly photochemically reactive, in accordance with the EPA definition of VOC at 40CFR51.100. Thus, methane, ethane, and certain other organic compounds are not included in the VOC totals.

1.4 REFERENCES

1. *Air Quality Criteria for Carbon Monoxide*. EPA/600/8-90/045F (NTIS PB93-167492). Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1991.
2. *Air Quality Criteria for Oxides of Nitrogen*. EPA/600/8-91/049aF-cF.3v. Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1993.
3. *Air Quality Criteria for Ozone and Other Photochemical Oxidants*, Volume I of III. EPA/600/8-93/004aF. Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. July 1996.
4. *Air Quality Criteria for Particulate Matter and Sulfur Oxides*. EPA/600/8-82/029aF-cF.3v (NTIS PB84-156777). Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1991.
5. *Health and Environmental Effects of Particulate Matter*, Fact Sheet. Office of Air and Radiation, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. July 17, 1997.
6. *Air Quality Criteria for Lead*. EPA/600/8-83/028aF-dF.4v (NTIS PB87-142378). Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1991.
7. *Historic Emissions of Sulfur and Nitrogen Oxides in the United States from 1900 to 1980*. EPA-600/7-85-009a and b. U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1985.
8. *Historic Emissions of Volatile Organic Compounds in the United States from 1900 to 1985*. EPA-600/7-88-008a. U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1988.
9. *National Air Pollutant Emission Trends Procedures Document, 1900-1996*, Draft, Prepared for the Emissions Factors and Inventory Group, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, by E.H. Pechan & Associates, Inc. under EPA Contract No. 68-D3-0035, WA No. III-102, Durham, NC. September 1997.
10. *National Air Pollutant Emissions Trends, 1900-1994*. EPA-454/R-95-011. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1995.

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[a] The great majority of all emission data necessarily are estimates. Exhaustive, on-site quantification, source by source, is a practical, and an economic, impossibility.

[b] Lead emissions are measured in short tons. Short tons can be converted to metric tons by dividing the emissions by a factor of 1.1023.

[c] The term nitrogen oxides (NO_x) encompasses emissions of both nitrogen dioxide (NO_2) and nitric oxide (NO).

Table 1-1. Major Source Categories

TIER I CODE*	TIER I NAME	TIER II CODE	TIER II NAME
01	***FUEL COMBUSTION-ELECTRIC UTILITIES***		
		01	Coal
		02	Oil
		03	Gas
		04	Other External Combustion
		05	Internal Combustion
02	***FUEL COMBUSTION-INDUSTRIAL***		
		01	Coal
		02	Oil
		03	Gas
		04	Other External Combustion
		05	Internal Combustion
03	***FUEL COMBUSTION-OTHER***		
		01	Commercial / Institutional Coal
		02	Commercial / Institutional Oil
		03	Commercial / Institutional Gas
		04	Misc. Fuel Combustion (except residential)
		05	Residential Wood
		06	Residential Other
04	***CHEMICAL & ALLIED PRODUCT MFG.***		
		01	Organic Chemical Mfg.
		02	Inorganic Chemical Mfg.
		03	Polymer & Resin Mfg.
		04	Agricultural Chemical Mfg.
		05	Paint, Varnish, Lacquer, Enamel Mfg.
		06	Pharmaceutical Mfg.
		07	Other Chemical Mfg.
05	***METALS PROCESSING***		
		01	Nonferrous
		02	Ferrous
		03	Metals Processing (not elsewhere classified [NEC])
06	***PETROLEUM & RELATED INDUSTRIES***		
		01	Oil & Gas Production
		02	Petroleum Refineries & Related Industries
		03	Asphalt Manufacturing
07	***OTHER INDUSTRIAL PROCESSES***		
		01	Agriculture, Food, & Kindred Products
		02	Textiles, Leather, & Apparel Products
		03	Wood, Pulp & Paper, & Publishing Products
		04	Rubber & Miscellaneous Plastic Products
		05	Mineral Products
		06	Machinery Products
		07	Electronic Equipment
		08	Transportation Equipment
		09	Construction
		10	Miscellaneous Industrial Processes
08	***SOLVENT UTILIZATION***		
		01	Degreasing
		02	Graphic Arts
		03	Dry Cleaning
		04	Surface Coating
		05	Other Industrial
		06	Nonindustrial
		07	Solvent Utilization (NEC)
09	***STORAGE & TRANSPORT***		
		01	Bulk Terminals & Plants
		02	Petroleum & Petroleum Product Storage
		03	Petroleum & Petroleum Product Transport
		04	Service Stations: Stage I
		05	Service Stations: Stage II
		06	Service Stations: Breathing & Emptying
		07	Organic Chemical Storage
		08	Organic Chemical Transport
		09	Inorganic Chemical Storage
		10	Inorganic Chemical Transport
		11	Bulk Materials Storage
		12	Bulk Materials Transport
10	***WASTE DISPOSAL & RECYCLING***		
		01	Incineration
		02	Open Burning
		03	Publicly Owned Treatment Works
		04	Industrial Waste Water
		05	Treatment Storage and Disposal Facility
		06	Landfills
		07	Other
11	***ON-ROAD VEHICLES***		
		01	Light-Duty Gasoline Vehicles & Motorcycles
		02	Light-Duty Gasoline Trucks
		03	Heavy-Duty Gasoline Vehicles
		04	Diesels
12	***NON-ROAD ENGINES AND VESSELS***		
		01	Non-road Gasoline Engines
		02	Non-road Diesel Engines
		03	Aircraft
		04	Marine Vessels
		05	Railroads
13	***NATURAL SOURCES***		
		01	Biogenic
		02	Geogenic (wind erosion)
		03	Miscellaneous (lightning/freshwater/saltwater)
14	***MISCELLANEOUS***		
		01	Agriculture & Forestry
		02	Other Combustion (wildfires)
		03	Catastrophic / Accidental Releases
		04	Repair Shops
		05	Health Services
		06	Cooling Towers
		07	Fugitive Dust

Note(s): * Code numbers are presented for The Representative Emissions National Data System (TRENDS) user.
The Source Classification Code (SCC) definitions and assignment to Tier category are available on the Technology Transfer Network's (919-541-5742) Emission Inventories/Emission Factors Information (CHIEF) Technical Information Area, or on the Internet (www.epa.gov/ttn/chief).

Chapter 2.0 1996 Emissions

This section describes the emission estimates for 1996. Comparisons are made between the previous and current year's emissions. The conclusions reached in this section are subject to change since the 1996 emission estimates are preliminary. Between 1995 and 1996 emissions decreased for CO, NO_x, VOC, and Pb but increased for SO_2 and PM-10 as shown in table 2-1. An increase in SO_2 emissions from point sources resulted primarily from increased emissions from coal-fired electric utilities. Residential consumption of wood also slightly decreased in 1996.

The decrease in CO, NO_x, VOC, and PM-10 on-road emissions is a result of reductions due to fleet turnover (Tier I standards being phased in), required reformulated gasoline, oxygenated fuels, and fuels with lower Reid vapor pressures (RVPs) overcoming the higher vehicle miles traveled (VMT). The increase in SO_2 on-road emissions from 1994 resulted from increased VMT. The 1996 emissions from non-road sources decreased slightly for NO_x, decreased for SO_2, were steady for VOC and Pb, and increased for CO and PM-10 as a result of varying consumption levels of fuels by non-road engines (gasoline and diesel) and vehicles (airplanes, locomotives, and marine).

The miscellaneous emissions increased slightly from the 1995 emissions. This is due to the increased activity of managed burning. (Wildfire emissions were not estimated for 1996 because data were not available in time to incorporate into the report. The reported estimate for 1996 is the same as that for 1995. This value was not projected since wildfire severity [i.e., how many and how intense] is due in part to meteorological conditions such as: temperatures, humidity, thunderstorms, and relative amount of rain and can not be predicted.)

2.1 EMISSIONS FOR 1996 BY POLLUTANT

The 1996 emissions of all criteria pollutants except Pb were calculated using one of five major methodologies depending on the source category. These estimates were generated using a similar manner as in the previous report but are based on a revised base year, 1990 State-generated inventory. The exceptions are detailed in chapter 6. The methodology differs for on-road vehicles, non-road engines, electric utilities, fugitive dust, and the "all other sources" categories. Estimation methods are similar to the methodologies used to produce the 1995 emissions presented in this report. Some modifications to the 1995 methodology were made in cases where information could not be obtained to generate the 1996 estimates. Other changes in methodology were required in order to make the best estimate with available data. These emissions are preliminary and will be modified in the next *Trends* report.

2.1.1 Carbon Monoxide Emissions

Figure 2-1 presents a pie chart of the 1996 CO emissions by source category. As the figure shows, on-road vehicles are the major contributors to CO emissions. In 1996, they represented 60 percent of the total CO emissions. Of the total on-road vehicle emissions, 65 percent is from cars. The second major contributor to CO emissions is non-road engines and vehicles, which constitute approximately 19 percent of total CO emissions. These emissions result primarily from the gasoline consumption by lawn and garden, industrial, and recreational marine engines. Three Tier I source categories (solvent utilization, storage and transport, and electric utility fuel combustion) constitute less than 0.5 percent of the total and are combined with petroleum and related industries, industrial fuel combustion, other industrial processes, waste disposal and recycling, and chemical and allied product manufacturing in the "all other" grouping.

Table 2-2 presents the point and area split of the Tier I source categories. Area source emissions, including transportation sources, make up 93 percent of total CO emissions in 1996.

2.1.2 Nitrogen Oxide Emissions

Figure 2-2 presents a pie chart of the 1996 NO_x emissions by source category. As shown, on-road vehicles represent 30 percent of the total 1996 NO_x emissions. Emissions from electric utilities represent 28 percent of the total emissions. Eighty-nine percent of the emissions estimated for electric utilities are attributed to coal combustion, of which 69 percent are emissions from bituminous coal combustion. As with CO emissions, light-duty gasoline vehicles (LDGVs) are a major contributor (47 percent) to 1996 on-road vehicle NO_x emissions. Four Tier I source categories (solvent utilization, storage and transport, waste disposal and recycling, and metals processing) constitute less than 1 percent of the total and are combined with chemical and allied product manufacturing, other industrial processes, miscellaneous, and petroleum and related industries in the "all other" grouping.

Table 2-2 presents the point and area split of the Tier I source categories. Area source emissions, including transportation sources, make up 60 percent of total NO_x emissions in 1996.

2.1.3 Volatile Organic Compound Emissions

Figure 2-3 presents a pie chart of the 1996 VOC emissions by source category. As shown, solvent utilization contributed 33 percent and on-road vehicles contributed 29 percent to the total 1996 VOC emissions. Light-duty gasoline vehicles produced 60 percent of the on-road vehicle 1996 VOC emissions. Surface coating represents 46 percent of the solvent utilization emissions. There are 26 subcategories of surface coating as presented in appendix A, table A-3. Two Tier I source categories (electric utility fuel combustion and metals processing) constituted less than 1 percent of the total emissions and are combined with chemical and allied product manufacturing, petroleum and related industries, miscellaneous, other industrial processes, and fuel combustion (industrial, other) in the "all other" grouping. The "all other" grouping contributed 15 percent to the total VOC estimate in 1996.

Table 2-2 presents the point and area split of the Tier I source categories. Area source emissions, including transportation sources, make up 87 percent of total VOC emissions in 1996.

2.1.4 Sulfur Dioxide Emissions

Figure 2-4 presents a pie chart of the 1996 SO_2 emissions by source category. As shown, electric utilities are the major contributor to SO_2 emissions. In 1996 they represented 67 percent of the total SO_2 emissions. The second largest contributor is industrial fuel combustion, which produced 17 percent of the 1996 SO_2 emissions. Coal combustion produces 95 percent of the electric utility emissions. Bituminous coal combustion accounts for 74 percent of the electric utility coal combustion emissions. Five Tier I source categories (solvent utilization, storage and transport, waste disposal and recycling, on-road sources, and miscellaneous) constitute 2 percent of the total and are combined with non-road sources, petroleum and related industries, and other industrial processes in the "all other" grouping.

Table 2-2 presents the point and area split of the Tier I source categories. Point source emissions make up 87 percent of total SO_2 emissions in 1996.

2.1.5 Particulate Matter (PM-10) Emissions

Figure 2-5 presents a pie chart of 1996 PM-10 emissions by source category, excluding fugitive dust sources. Figure 2-6 presents the fugitive dust sources. Fugitive dust sources constitute 89 percent of the 1996 total PM-10 emissions. Unpaved roads (38 percent of fugitive dust PM-10 emissions) are the greatest contributor to 1996 PM-10 fugitive dust emissions. The remaining four top categories are agricultural crops (17 percent), construction (14 percent), paved roads (9 percent), and natural sources-wind erosion (20 percent).

Table 2-2 presents the point and area split of the Tier I source categories. Area source emissions, including transportation sources, make up 95 percent of total PM-10 emissions in 1996.

2.1.6 Lead Emissions

Metal processing, the major contributor of Pb emissions in 1996, represents 52 percent of the total emissions (see figure 2-7). Nonferrous metal processing represents 64 percent of the 1996 metals processing Pb emissions. Primary and secondary Pb products are responsible for 52 and 38 percent, respectively, of the nonferrous metals processing Pb emissions in 1996. Based on the emissions reported in the draft Locating and Estimating Lead document,[1] the on-road vehicle emissions were over estimated in last year's report. EPA investigated the inconsistency and made revisions in this report. On-road emissions, which used to be the major contributor to Pb emissions in the 1970's and 1980's, now only contributes 0.5 percent of the total Pb estimate. Of the 14 Tier I source categories, the following 5 are not estimated for Pb, since they are thought to be negligible: solvent utilization, storage and transport, petroleum and related industries, natural sources, and miscellaneous. The remaining nine categories are presented in a pie chart in figure 2-7. The "all other" grouping includes chemical and allied product manufacturing, other industrial processes, and fuel combustion (electric utility and industrial).

2.2 SPATIAL EMISSIONS

The 1996 criteria pollutant emissions were estimated for all pollutants except Pb at the county level and summed to the State level. Table 2-3 presents the State-level emissions and rankings for the pollutants CO, NO_x, VOC, SO_2, and PM-10.

2.2.1 State Level

Table 2-3 presents the total emissions and ranking per pollutant for each State in alphabetical order. The estimates for Alaska and Hawaii include only on-road vehicle, point source, residential wood combustion, and wildfire emissions. PM-10 estimates listed in table 2-3 also include some fugitive dust estimates for Alaska and Hawaii. (A base year inventory similar to NAPAP was not available for these States.)

2.2.2 County Level

For all criteria pollutants except Pb, the emissions are derived at the county level. The exceptions, explained in detail in chapter 6, are fugitive dust sources and wildfires. Figures 2-8 to 2-12 presents the total 1996 emissions per square mile for each county. As figure 2-8 shows, the eastern third and west coast emit more CO than the western two-thirds of the continental United States. In contrast, figures 2-9 to 2-11 illustrate that the eastern half and the west coast emit more NO_x, VOC, and SO_2 than the western half of the continental United States. The emissions of PM-10 are dominated by the fugitive dust emissions that are predominant in the rural and agricultural areas.

2.3 LARGEST POINT SOURCES

The National Air Pollutant Emission Trends database (NET) has been going through substantial changes over the last few years. For the base year 1996 inventory (representing emissions for calendar year 1996), point source data were taken from several sources: the Aerometric Information Retrieval System (AIRS), the pre-1996 NET, Grand Canyon Visiblity Transport Commission (GCVTC), and the Ozone Transport Assessment Group (OTAG).

If no data were found for a source expected to emit PM and SO_2, PM or SO_2 emissions were estimated based on a ratio of PM/NO_x or SO_2/NO_x emissions. (An explanation of this approach can be found in the Procedures Document, page 4-49, at www.epa.gov/ttn/chief/ei_data.html). For each pollutant, a top 50 list was then compiled based on the 1996 NET inventory, and the list was added to the December 1997 Trends Report.

A few states and private firms have contacted us about erroneous data in the top 50 lists. Because of errors identified and because of emissions data that have been recently updated by some state agencies, we are replacing the top 50 lists with data directly from the AIRSWeb. The new tables can be found in Tables 2-5 through 2-10.

The point source inventory for calendar years 1996 and 1997 will again be revisited during fiscal year 1999. Due to resource constraints, we are unable to alter the actual database files in the NET until fiscal year 1999. We appreciate the patience of the inventory community as we work on compiling the most accurate state-supplied emission inventory possible.

2.4 REFERENCES

1. Eastern Research Group, Locating and Estimating Air Emissions from Sources of Lead and Lead Compounds, Draft Report, EPA Contract No. 68-D2-0160, Work Assignment No. 74. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. July 1996.

Table 2-1. 1995 and 1996 National Emissions by Pollutant by Principal Source Categories

(thousand short tons, except lead, short tons)

CARBON MONOXIDE Source Category	Emissions 1995	Emissions 1996	Percent Change
On-Road	54,106	52,944	-2
LDGV&MC	33,701	33,144	-2
LDGT	14,829	14,746	-1
HDGV	4,123	3,601	-13
Diesels	1,453	1,453	0
Miscellaneous	7,050	7,099	1
Wildfires	1,469	1,469	0
All other	5,581	5,630	1
Non-Road	16,841	17,002	1
Gasoline engines	13,806	13,937	1
Diesel engines	1,897	1,922	1
Planes, trains, and boats	1,138	1,143	0
Fuel combustion other	4,506	4,513	0
residential wood	3,999	3,993	0
All other	506	520	3
Metals	2,380	2,378	0
All Other	4,838	4,886	1
Total	**89,721**	**88,822**	**-1**

NITROGEN OXIDES Source Category	Emissions 1995	Emissions 1996	Percent Change
On-Road	7,323	7,171	-2
Gasoline	5,295	5,238	-1
Diesels	2,028	1,933	-5
Non-Road	4,675	4,610	-1
Gasoline engines	206	207	0
Diesel engines	3,087	3,088	0
Planes, trains, and boats	1,382	1,315	-5
Utilities	6,384	6,034	-5
Coal	5,579	5,517	-1
Oil	96	96	0
Gas	562	269	-52
All other	148	151	2
Industrial Combustion	3,144	3,170	1
Coal	597	599	0
Oil	247	246	0
Gas	1,324	1,336	1
All other	976	989	1
All Other	2,409	2,408	0
Total	**23,935**	**23,393**	**-2**

VOLATILE ORGANIC CMPDS Source Category	Emissions 1995	Emissions 1996	Percent Change
On-road	5,701	5,502	-3
LDGV&MC	3,426	3,323	-3
LDGT	1,629	1,582	-3
HDGV	327	286	-13
Diesels	319	312	-2
Non-Road	2,433	2,426	0
Gasoline engines	1,692	1,685	0
Diesel engines	466	467	0
Planes, trains, and boats	275	274	0
Solvents	6,183	6,273	1
Degreasing	789	661	-16
Graphic Arts	339	389	15
Dry Cleaning	230	190	-17
Surface Coating	2,681	2,881	7
All Other	2,144	2,152	0
Waste Disposal	1,067	433	-59
TSDF	628	45	-93
All Other	5,202	4,452	-14
Total	**20,586**	**19,086**	**-7**

SULFUR DIOXIDE Source Category	Emissions 1995	Emissions 1996	Percent Change
Utilities	12,080	12,604	4
Coal	11,603	12,114	4
Oil	413	412	0
Gas	9	21	133
All other	55	57	4
Industrial Combustion	3,357	3,399	1
Coal	1,728	1,762	2
Oil	912	918	1
Gas	548	548	0
All other	170	170	0
All Other	3,115	3,110	0
Total	**18,552**	**19,113**	**3**

PM-10 Source Category	Emissions 1995	Emissions 1996	Percent Change
Fuel combustion other (includes residential wood)	610	598	-2
On-Road	293	274	-6
Non-Road	585	591	1
Geogenic	1,146	5,316	364
Miscellaneous	22,454	22,702	1
Agricultural Crops*	4,661	4,708	1
Paved Road*	2,409	2,417	0
Unpaved Road*	10,362	10,303	-1
Construction*	3,654	3,950	8
Remaining Fugitive Dust	588	539	-8
Wildfires	145	145	0
All other	635	640	1
All Other	1,800	1,820	0
Total	**26,888**	**31,301**	**16**

LEAD Source Category	Emissions 1995	Emissions 1996	Percent Change
Metals	2,067	2,000	-3
primary lead production	674	636	-6
secondary lead production	432	400	-7
gray iron production	366	339	-7
All other	595	625	5
Fuel combustion other	414	414	0
Chemical and Allied Products	144	117	-19
lead oxide and pigments	144	117	-19
On-road	19	19	0
Non-road	545	545	0
non-road gasoline	0	0	0
aircraft	545	545	0
All Other	754	774	3
Total	**3,943**	**3,869**	**-2**

Note(s): A negative value indicates a reduction in emissions from 1995 levels.

Table 2-2. 1996 National Point and Area Emissions by Source Category and Pollutant
(thousand short tons)

	CO			NOx			VOC			SO2			PM-10		
Source Category	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**
Fuel Comb-Electric Utility	375	2	377	6,028	6	6,034	45	0	45	12,604	0	12,604	282	0	282
Fuel Comb-Industrial	879	193	1,072	2,261	910	3,170	191	17	208	2,181	1,218	3,399	268	38	306
Fuel Comb-Other	193	4,319	4,513	168	1,121	1,289	12	810	822	205	578	782	18	580	598
Chemical & Allied Product Mfg	1,223	0	1,223	159	0	159	343	93	436	287	0	287	67	0	67
Metals Processing	2,378	0	2,378	98	0	98	70	0	70	530	0	530	211	0	211
Petroleum & Related Industries	344	3	348	93	17	110	229	288	517	367	1	368	38	1	40
Other Industrial Processes	634	1	635	401	3	403	374	65	439	407	2	409	467	43	510
Solvent Utilization	6	0	6	3	0	3	881	5,392	6,273	1	0	1	6	0	6
Storage & Transport	25	0	25	6	0	6	286	1,027	1,312	2	0	2	109	0	109
Waste Disposal & Recycling	40	1,163	1,203	42	58	100	31	403	433	25	23	48	14	276	290
On-Road Vehicles	0	52,944	52,944	0	7,171	7,171	0	5,502	5,502	0	307	307	0	274	274
Non-road Engines and Vehicles	0	17,002	17,002	0	4,610	4,610	0	2,426	2,426	0	368	368	0	591	591
Natural Sources	0	0	0	0	0	0	0	14	14	0	0	0	0	5,316	5,316
Miscellaneous	0	7,098	7,099	1	238	239	3	584	587	0	9	9	27	22,675	22,702
TOTAL	**6,097**	**82,726**	**88,822**	**9,259**	**14,134**	**23,393**	**2,465**	**16,621**	**19,086**	**16,608**	**2,504**	**19,113**	**1,507**	**29,794**	**31,301**

Emissions (percent)

	CO			NOx			VOC			SO2			PM-10		
Source Category	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**
Fuel Comb-Electric Utility	6.15	0.00	0.42	65.10	0.04	25.79	1.83	0.00	0.24	75.89	0.00	65.94	18.71	0.00	0.90
Fuel Comb-Industrial	14.42	0.23	1.21	24.42	6.44	13.55	7.75	0.10	1.09	13.13	48.64	17.78	17.78	0.12	0.98
Fuel Comb-Other	3.17	5.22	5.08	1.81	7.93	5.51	0.49	4.87	4.31	1.23	23.08	4.09	1.19	1.93	1.91
Chemical & Allied Product Mfg	20.06	0.00	1.38	1.72	0.00	0.68	13.91	0.56	2.28	1.73	0.00	1.50	4.45	0.00	0.21
Metals Processing	39.00	0.00	2.68	1.06	0.00	0.42	2.84	0.00	0.37	3.19	0.00	2.77	14.00	0.00	0.67
Petroleum & Related Industries	5.64	0.00	0.39	1.00	0.12	0.47	9.29	1.73	2.71	2.21	0.04	1.93	2.52	0.00	0.13
Other Industrial Processes	10.40	0.00	0.71	4.33	0.02	1.72	15.17	0.39	2.30	2.45	0.08	2.14	30.99	0.14	1.63
Solvent Utilization	0.10	0.00	0.01	0.03	0.00	0.01	35.74	32.44	32.87	0.01	0.00	0.01	0.40	0.00	0.02
Storage & Transport	0.41	0.00	0.03	0.06	0.00	0.03	11.60	6.18	6.87	0.01	0.00	0.01	7.23	0.00	0.35
Waste Disposal & Recycling	0.66	1.41	1.35	0.45	0.41	0.43	1.26	2.42	2.27	0.15	0.92	0.25	0.93	0.93	0.93
On-Road Vehicles	0.00	64.00	59.61	0.00	50.74	30.65	0.00	33.10	28.83	0.00	12.26	1.61	0.00	0.92	0.88
Non-road Engines and Vehicles	0.00	20.55	19.14	0.00	32.62	19.71	0.00	14.60	12.71	0.00	14.70	1.93	0.00	1.98	1.89
Natural Sources	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.07	0.00	0.00	0.00	0.00	17.84	16.98
Miscellaneous	0.00	8.58	7.99	0.01	1.68	1.02	0.12	3.51	3.08	0.00	0.36	0.05	1.79	76.11	72.53
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 2-3. 1996 State-level Emissions and Rank for CO, NO_x, VOC, SO_2, and Particulate Matter (PM-10)
(thousand short tons)

	Carbon Monoxide		Nitrogen Oxides		Volatile Organic Compounds		Sulfur Dioxide		Particulate Matter (PM-10)	
State	**Rank**	**Emissions**	**Rank**	**Emissions**	**Rank**	**Emissions**	**Rank**	**Emissions**	**Rank**	**Emissions**
Alabama	13	2,405	15	628	18	426	8	788	18	587
Alaska	50	172	49	33	51	21	51	4	43	131
Arizona	22	1,603	23	436	28	286	25	227	36	291
Arkansas	30	1,202	34	261	31	247	34	137	21	519
California	1	7,112	2	1,322	1	1,605	35	129	6	1,049
Colorado	27	1,259	25	402	26	288	36	118	24	470
Connecticut	37	775	40	147	34	166	41	68	44	95
Delaware	48	218	46	68	46	54	37	96	48	41
District of Columbia	51	117	51	20	50	22	50	10	51	4
Florida	3	4,663	6	911	3	851	6	804	19	574
Georgia	5	3,981	12	674	11	598	13	576	9	1,007
Hawaii	47	221	47	50	49	32	46	34	49	34
Idaho	38	764	43	109	38	114	47	34	16	617
Illinois	8	3,092	4	1,106	4	840	4	1,058	7	1,034
Indiana	12	2,432	7	888	12	561	2	1,305	15	642
Iowa	32	1,080	29	339	29	261	24	248	17	597
Kansas	28	1,233	17	511	27	288	30	168	3	1,564
Kentucky	24	1,506	11	690	20	411	9	763	34	327
Louisiana	14	2,315	10	747	16	430	17	410	27	461
Maine	40	557	44	94	39	112	39	90	41	151
Maryland	31	1,200	30	334	32	244	18	397	40	198
Massachusetts	29	1,215	33	264	25	292	27	204	39	224
Michigan	9	2,860	8	789	7	686	12	596	22	518
Minnesota	21	1,604	22	459	21	407	33	141	10	944
Mississippi	23	1,557	27	352	23	332	22	259	25	469
Missouri	17	2,014	18	510	15	439	15	532	4	1,292
Montana	39	597	39	159	40	104	43	55	5	1,076
Nebraska	33	947	35	255	33	221	38	91	14	647
Nevada	41	483	41	146	42	93	42	62	45	78
New Hampshire	43	360	45	74	44	76	32	146	47	51
New Jersey	26	1,391	24	421	19	418	23	248	37	278
New Mexico	34	920	31	291	37	152	28	191	1	4,984
New York	7	3,141	13	658	5	760	11	624	11	812
North Carolina	10	2,792	14	634	8	681	14	549	26	464
North Dakota	45	348	36	252	41	100	20	290	31	391
Ohio	4	4,227	3	1,214	6	747	1	1,959	13	651
Oklahoma	25	1,410	21	461	24	303	26	221	8	1,013
Oregon	19	1,662	38	205	30	258	44	40	23	504
Pennsylvania	6	3,373	5	957	9	670	3	1,272	20	563
Rhode Island	49	202	50	31	47	49	49	12	50	22
South Carolina	20	1,633	26	368	22	339	21	288	33	382
South Dakota	42	433	42	118	43	91	45	36	35	316
Tennessee	11	2,462	9	775	10	607	7	797	30	392
Texas	2	6,770	1	1,828	2	1,597	5	1,053	2	2,444
Utah	36	905	37	223	36	160	40	73	38	237
Vermont	46	237	48	43	48	48	48	17	46	73
Virginia	16	2,164	16	553	13	496	16	459	28	427
Washington	15	2,274	28	342	14	445	31	148	29	417
West Virginia	35	906	19	490	35	163	10	748	42	136
Wisconsin	18	1,670	20	471	17	427	19	363	32	385
Wyoming	44	358	32	278	45	67	29	173	12	714
National		**88,822**		**23,393**		**19,086**		**19,113**		**31,301**

Note(s): The sums of States may not equal National due to rounding.

Table 2-4. Predominant Industries Listed Among the Top 50 Plants

Pollutant	Industry	SIC	Number of Plants	% Emissions
CO	Carbon black	2895	13	33
	Steel mills	3312	12	32
	Paper Mills	26x1	7	6
	Petroleum refining	2911	5	7
	Primary aluminum	3334	4	6
	Other	various	9	16
NO_x	Electric utility	4911	50	100
VOC	Petroleum refining	2911	14	28
	Chemical & allied products	28xx	9	19
	Organic chemicals	2869	7	10
	Cellulose	282x	5	9
	Steel mills	3312	4	8
	Other	various	11	26
SO_2	Electric utility	4911	50	100
Industrial SO_2	Petroleum refining	29xx	15	22
	Copper smelters	333x	11	16
	Steel mills	3312	7	14
	Chemical & allied products	28xx	6	7
	Paper mills	2621	4	7
	Other	various	7	35
PM-10	Electric utility	49x1	25	56
	Steel mills	3312	7	14
	Metal mining	10x1	5	9
	Stone, clay, glass, concrete	32xx	3	6
	Other	various	10	16

Note(s): x represents any digit 0 through 9
% emissions is the percentage of the plants emissions compared to the total emissions of the 50 plants.
This information is based on data downloaded from AIRSWeb: http://www.epa.gov/airsweb/srcrank.htm on 7/14/98.
This table represents the top 50 plants where the year indicated was 1990 through 1996.

Table 2-5. Top 50 Plants Emitting Carbon Monoxide

Rank	Plant Name	State	County Code	County	Plant ID	SIC	Emissions (tons/year)
1	Wheeling Pittsburgh Steel Steubenville S	OH	081	Jefferson Co	390815006	3312	185,571
2	U S Steel Co Gary Works Part 2	IN	089	Lake Co	180899999	3312	175,432
3	Columbian Chemicals Co.	WV	051	Marshall Co	540510019	2895	142,575
4	Cabot Corp Canl Plt	LA	101	St. Mary Par	221010004	2895	141,755
5	Bethlehem Steel Corp.	IN	127	Porter Co	181270001	3312	115,245
6	Columbian Chem	LA	101	St. Mary Par	221010005	2895	106,692
7	U S Steel Co Gary Works	IN	089	Lake Co	180890121	3312	83,268
8	Degussa Corp	LA	101	St. Mary Par	221010018	2895	72,053
9	Cabot Corporation	TX	179	Gray Co	481790001	2895	63,232
10	Engineered Carbons Incorporated	TX	201	Harris Co	482010021	2895	60,679
11	Marathon Ashland Petroleum - St Paul Pk	MN	163	Washington Co	271630003	2911	58,553
12	Phillips 66 Company	TX	233	Hutchinson Co	482330015	2911	54,916
13	Ormet Corporation	OH	111	Monroe Co	391115001	3334	52,947
14	Noranda Aluminum Inc	MO	143	New Madrid Co	291430008	3334	52,677
15	Degussa Corporation	OH	167	Washington Co	391675015	2895	48,745
16	E. I. Du Pont De Nemours And Company	TN	085	Humphreys Co	470850007	2816	46,928
17	Weirton Steel Corp.	WV	029	Hancock Co	540290001	3312	46,153
18	Inland Steel Company	IN	089	Lake Co	180890316	3312	43,833
19	Columbian Chemicals Company	KS	067	Grant Co	200670007	2895	43,347
20	Ak Steel Corporation	OH	017	Butler Co	390175002	3312	40,636
21	Entech Inc	AK	020	Anchorage Borough	020200110	4953	38,500
22	Cabot Corp./	LA	039	Evangeline Par	220390001	2895	37,328
23	Bethlehem Steel Corp/Bethlehem Steel Plt	PA	095	Northampton Co	420950048	3312	36,954
24	Chrysler Corporation Foundry	IN	097	Marion Co	180970012	3321	32,273
25	Scm Chemicals, Inc-Ashtabula Plant 2	OH	007	Ashtabula Co	390075007	2816	31,147
26	Great Southern Paper Woodlands Oper	GA	099	Early Co	130990001	2631	30,584
27	Continental Carbon Co., Inc.	TX	341	Moore Co	483410003	2895	30,023
28	Union Camp Corp	GA	051	Chatham Co	130510007	2621	29,295
29	Inland-Rome Inc	GA	115	Floyd Co	131150021	2631	28,758
30	Zinc Corp Amer/Monaca Smelter	PA	007	Beaver Co	420070032	3339	26,817
31	Alcan Ingot & Recycling	KY	101	Henderson Co	211010029	3334	25,448
32	Columbian Chemicals	AR	139	Union Co	051390014	2895	25,304
33	Gm Powertrain Div.	OH	039	Defiance Co	390395008	3321	24,296
34	Alcoa (Aluminum Co. Of America)	IN	173	Warrick Co	181730007	3334	22,272
35	Itt Rayonier Inc	GA	305	Wayne Co	133050001	2611	22,071
36	Mousa Inc	LA	087	St. Bernard Par	220870001	2911	21,422
37	Oci (Rhone-Poulenc) Wyoming	WY	037	Sweetwater Co	560370001	1474	20,450
38	Ltv Steel Company	IN	089	Lake Co	180890318	3312	20,173
39	Exxon Rfry	LA	033	East Baton Rouge Par	220330015	2911	17,145
40	Continental Carbon Company	OK	071	Kay Co	400710703	2895	16,602
41	Tenneco Packaging Inc.	WI	069	Lincoln Co	550690080	2631	16,173
42	Engineered Carbons, Inc	TX	233	Hutchinson Co	482330001	2895	16,117
43	Drummond Company, Inc.	AL	073	Jefferson Co	010730001	3312	15,786
44	Countrymark Cooperative, Inc	IN	129	Posey Co	181290003	2911	14,940
45	Wheeling Pitts Stl Steubenville North	OH	081	Jefferson Co	390815008	3312	14,800
46	Brunswick Pulp & Paper Co	GA	127	Glynn Co	131270003	2611	14,798
47	Wheeling-Pitt (Follansbee)	WV	009	Brooke Co	540090002	3312	14,228
48	Carbon Graphite Group Niagara	NY	063	Niagara Co	360630337	3624	14,108
49	Sloss Industries Corp.-Mineral Wool Plan	AL	073	Jefferson Co	010730350	3296	13,368
50	International Paper Company	AR	069	Jefferson Co	050690016	2621	12,933

Note(s): The values presented in the “County Code” column are Federal Information Processing Standards (FIPS) codes.
This information was downloaded from AIRSWeb: http://www.epa.gov/airsweb/srcrank.htm on 7/14/98.
This table represents the top 50 plants where the year indicated was 1990 through 1996.

Table 2-6. Top 50 Utility Plants Emitting Nitrogen Oxides

Rank	Plant Name	State	County Code	County	Plant ID	SIC	Emissions (tons/year)
1	Tva	KY	177	Muhlenberg Co	211770006	4911	112,800
2	Tva Cumberland Steam Plant	TN	161	Stewart Co	471610011	4911	106,928
3	Associated Electric Coop	MO	143	New Madrid Co	291430004	4911	94,716
4	General James M. Gavin Plant	OH	053	Gallia Co	390535002	4911	86,748
5	James M Stuart Elec Generating Station	OH	001	Adams Co	390015001	4911	76,905
6	Ga Power Co Bowen Stm Elec Gen Sta	GA	015	Bartow Co	130150011	4911	63,131
7	Indiana-Kentucky Electric Corporation	IN	077	Jefferson Co	180770001	4911	63,077
8	Appalachian Power - John E Amos Plant	WV	079	Putnam Co	540790006	4911	58,051
9	Cp&L Roxboro Units 1 2 3 4	NC	145	Person Co	371450029	4911	57,711
10	Kyger Creek Station Ohio Valley Elec Cor	OH	053	Gallia Co	390535001	4911	57,462
11	Teco	FL	057	Hillsborough Co	120570039	4911	57,100
12	Ohio Edison Company W H Sammis Plant	OH	081	Jefferson Co	390815010	4911	54,153
13	Entergy Mississippi. Inc.-Baxter Wilson	MS	149	Warren Co	281490027	4911	49,412
14	Gpu Gen Corp/Homer City Power Plt	PA	063	Indiana Co	420630003	4911	46,319
15	Duke Power Co - Belews Creek Steam Statn	NC	169	Stokes Co	371690004	4911	46,280
16	Mount Storm Power Plant	WV	023	Grant Co	540230003	4911	45,834
17	Muskingum River Plant	OH	167	Washington Co	391675001	4911	45,409
18	Tampa Electric Company	FL	057	Hillsborough Co	120570040	4911	44,675
19	Ga Power Co Branch Stm Elec Gen Sta	GA	237	Putnam Co	132370008	4911	43,258
20	Florida Power Corporation	FL	017	Citrus Co	120170004	4911	41,385
21	Psi Energy - Gibson	IN	051	Gibson Co	180510013	4911	40,240
22	Arizona Public Serv/4 Corners	NM	045	San Juan Co	350450002	4911	37,917
23	Ga Power Co Wansley Stm Elec Gen Sta	GA	149	Heard Co	131490001	4911	36,925
24	Monongahela Power Co-Harrison	WV	033	Harrison Co	540330015	4911	35,132
25	Tva-Environmental Affairs	KY	145	McCracken Co	211450006	4911	34,693
26	Kansas City Power & Light Co.	KS	107	Linn Co	201070005	4911	34,471
27	Pse & G Co. (Hudson Generating)	NJ	017	Hudson Co	340170021	4911	34,136
28	American Electric Power	IN	029	Dearborn Co	180290002	4911	33,697
29	Allen Fossil Plant-T.V.A.	TN	157	Shelby Co	471570528	4911	33,512
30	Salt River Project- Navajo Station	AZ	005	Coconino Co	040050423	4911	32,771
31	Duke Power Marshall Plt	NC	035	Catawba Co	370350073	4911	32,759
32	Entergy Mississippi Inc	MS	151	Washington Co	281510048	4911	31,567
33	Kpl Gas Service (Jec)	KS	149	Pottawatomie Co	201490001	4911	31,376
34	Appalachian Power Co.-Philip Sporn Plant	WV	053	Mason Co	540530001	4911	30,758
35	Pa P & L Co/Montour Ses	PA	093	Montour Co	420930003	4911	29,513
36	Ohio Power - Kammer Plant	WV	051	Marshall Co	540510006	4911	29,227
37	Tva Kingston Steam Plant Kingston	TN	145	Roane Co	471450013	4911	28,208
38	Houston Industries Incorporated	TX	157	Fort Bend Co	481570005	4911	28,098
39	American Electric Power	IN	147	Spencer Co	181470020	4911	27,189
40	Nipsco - Bailly	IN	127	Porter Co	181270002	4911	26,652
41	Kentucky Utilities Co	KY	041	Carroll Co	210410010	4911	26,312
42	Sigeco-Warrick Pwr Plant-Alcoa Generatng	IN	173	Warrick Co	181730002	4911	26,270
43	Columbus Southern Power-Conesville	OH	031	Coshocton Co	390315001	4911	26,132
44	West Penn Power/Hatfield	PA	059	Greene Co	420590006	4911	25,837
45	Gpu Gen Corp/Conemaugh Power Plt	PA	063	Indiana Co	420630001	4911	25,635
46	Southern California Edison	NV	003	Clark Co	320030001	4911	25,578
47	Nsp - Allen S King	MN	163	Washington Co	271630005	4911	24,461
48	Nsp - Sherburne Cnty	MN	141	Sherburne Co	271410004	4911	23,847
49	Pa Power Co/Bruce Mansfield Plt	PA	007	Beaver Co	420070005	4911	23,773
50	Cei - Eastlake	OH	085	Lake Co	390855012	4911	23,566

Note(s): The values presented in the “County Code” column are Federal Information Processing Standards (FIPS) codes.
This information was downloaded from AIRSWeb: http://www.epa.gov/airsweb/srcrank.htm on 7/14/98.
This table represents the top 50 plants where the year indicated was 1990 through 1996.

Table 2-7. Top 50 Plants Emitting Volatile Organic Compounds

Rank	Plant Name	State	County Code	County	Plant ID	SIC	Emissions (tons/year)
1	Tenn Eastman Co	TN	163	Sullivan Co	471631007	2819	17,824
2	Chemi-Trol Chemical Co	OH	143	Sandusky Co	391435017	3443	17,190
3	Bp Oil Company	OH	095	Lucas Co	390955046	2911	15,337
4	Allied Extruders Inc	NY	081	Queens Co	36081X2JH	3079	14,325
5	Bp Chemicals Inc.	OH	003	Allen Co	390035006	2819	12,583
6	Fantastic Dry Cleaners	PR	021	Bayamon Co	720210174	5087	12,154
7	Lenzing Fibers Corporation	TN	063	Hamblen Co	470630197	2823	11,850
8	Entech Inc	AK	020	Anchorage Borough	020200110	4953	11,550
9	Mobil Oil Corporation	TX	245	Jefferson Co	482450018	2911	11,540
10	Clark Refining & Marketing, Inc.	TX	245	Jefferson Co	482450004	2911	11,170
11	Trw Trans Elec Div Union Sp	NY	011	Cayuga Co	360110010	3679	10,200
12	Exxon Company Usa	TX	201	Harris Co	482010027	2911	9,255
13	Ak Steel Corporation	OH	017	Butler Co	390175002	3312	9,006
14	Acme Steel Company-Chicago Coke Plant	IL	031	Cook Co	170311302	3312	8,386
15	Air Products And Chemicals Inc	NJ	015	Gloucester Co	340150001	2819	7,849
16	Shell Oil Company	TX	201	Harris Co	482010039	2911	7,823
17	Wheeling-Pitt (Follansbee)	WV	009	Brooke Co	540090002	3312	7,821
18	Lyondell-Citgo Refining Company Ltd.	TX	201	Harris Co	482010040	2911	7,666
19	Impression Coatings	OH	091	Logan Co	390915008	3079	7,486
20	Tenn Eastman Co	TN	163	Sullivan Co	471631004	2824	6,978
21	Basf Corporation	TX	039	Brazoria Co	480390017	2869	6,975
22	Texas Eastman Div., Eastman Chem Co.	TX	203	Harrison Co	482030019	2869	6,956
23	Dual Lite Mfg	PR	103	Naguabo Co	721030018	5051	6,930
24	Olay Company	PR	035	Cayey Co	720350009	2834	6,501
25	Amoco Oil Company	TX	167	Galveston Co	481670001	2911	6,389
26	Citgo Corp	LA	019	Calcasieu Par	220190016	2911	6,241
27	Phillips Petroleum Company	TX	039	Brazoria Co	480390010	2911	6,175
28	Columbian Chem	LA	101	St. Mary Par	221010005	2895	6,012
29	Continental Carbon Company	OK	071	Kay Co	400710703	2895	5,968
30	Wynnewood Refining Co/Tank Farm	OK	049	Garvin Co	400490507	2911	5,842
31	Huntsman Corporation	TX	245	Jefferson Co	482450006	2813	5,802
32	Weirton Steel Corp.	WV	029	Hancock Co	540290001	3312	5,624
33	Air Products & Chemicals	KY	157	Marshall Co	211570009	2821	5,517
34	Kodak Park Div	NY	055	Monroe Co	360550258	3861	5,396
35	Union Carbide Corporation	TX	057	Calhoun Co	480570003	2869	5,314
36	Gatx Terminals Corporation	TX	201	Harris Co	482010092	4226	5,157
37	Fina Oil And Chemical Company	TX	227	Howard Co	482270001	2911	5,152
38	Stone Container Corporation	AZ	017	Navajo Co	040170424	2621	5,101
39	Union Carbide Corporation	TX	167	Galveston Co	481670009	2869	4,949
40	Exxon Rfry	LA	033	East Baton Rouge Par	220330015	2911	4,949
41	Lion Oil Company	AR	139	Union Co	051390016	2911	4,740
42	Phillips 66 Company	TX	233	Hutchinson Co	482330015	2911	4,724
43	Dupont De Nemours, E.I., & Co., Inc.	NJ	033	Salem Co	340330072	2869	4,698
44	E.I. Du Pont De Nemours & Company	TX	245	Jefferson Co	482450003	2869	4,690
45	Warren Petroleum Company, Lp	TX	071	Chambers Co	480710037	5171	4,641
46	Amerchol Corporation	NJ	023	Middlesex Co	340230343	2843	4,587
47	Amoco Chemical	SC	015	Berkeley Co	450150029	2869	4,541
48	Firestone Synthetic Rubber & Latex	TX	361	Orange Co	483610004	2822	4,498
49	Colorite Polymers (Fmly Occidental Corp)	NJ	005	Burlington Co	340050005	2821	4,358
50	Cabot Corp Canl Plt	LA	101	St. Mary Par	221010004	2895	4,328

Note(s): The values presented in the “County Code” column are Federal Information Processing Standards (FIPS) codes.
This information was downloaded from AIRSWeb: http://www.epa.gov/airsweb/srcrank.htm on 7/14/98.
This table represents the top 50 plants where the year indicated was 1990 through 1996.

Table 2-8. Top 50 Utility Plants Emitting Sulfur Dioxide

Rank	Plant Name	State	County Code	County	Plant ID	SIC	Emissions (tons/year)
1	General James M. Gavin Plant	OH	053	Gallia Co	390535002	4911	373,413
2	Tva Cumberland Steam Plant	TN	161	Stewart Co	471610011	4911	346,171
3	Ga Power Co Bowen Stm Elec Gen Sta	GA	015	Bartow Co	130150011	4911	305,302
4	Kyger Creek Station Ohio Valley Elec Cor	OH	053	Gallia Co	390535001	4911	249,143
5	Ga Power Co Wansley Stm Elec Gen Sta	GA	149	Heard Co	131490001	4911	248,651
6	Muskingum River Plant	OH	167	Washington Co	391675001	4911	245,099
7	Hoosier Energy Rural Elec Merom Station	IN	153	Sullivan Co	181530005	4911	224,252
8	Associated Electric Coop	MO	143	New Madrid Co	291430004	4911	222,084
9	James M Stuart Elec Generating Station	OH	001	Adams Co	390015001	4911	173,828
10	Entergy Mississippi. Inc.-Baxter Wilson	MS	149	Warren Co	281490027	4911	170,753
11	Ohio Edison Company W H Sammis Plant	OH	081	Jefferson Co	390815010	4911	169,131
12	West Penn Power/Hatfield	PA	059	Greene Co	420590006	4911	164,841
13	Tva	KY	177	Muhlenberg Co	211770006	4911	164,808
14	Cardinal Operating Company	OH	081	Jefferson Co	390815002	4911	148,751
15	Entergy Mississippi Inc	MS	151	Washington Co	281510048	4911	145,966
16	Penelec/Keystone Power Plt	PA	005	Armstrong Co	420050012	4911	145,165
17	Psi Energy - Gibson	IN	051	Gibson Co	180510013	4911	138,461
18	Ga Power Co Yates Stm Elec Gen Sta	GA	077	Coweta Co	130770001	4911	129,844
19	Sigeco-Warrick Pwr Plant-Alcoa Generatng	IN	173	Warrick Co	181730002	4911	129,315
20	Ameren U.E.	MO	071	Franklin Co	290710003	4911	128,805
21	Cei - Eastlake	OH	085	Lake Co	390855012	4911	128,547
22	Columbus Southern Power-Conesville	OH	031	Coshocton Co	390315001	4911	128,227
23	Gpu Gen Corp/Homer City Power Plt	PA	063	Indiana Co	420630003	4911	127,439
24	Ohio Power - Kammer Plant	WV	051	Marshall Co	540510006	4911	119,009
25	Tva Kingston Steam Plant Kingston	TN	145	Roane Co	471450013	4911	117,387
26	Pa P & L Co/Montour Ses	PA	093	Montour Co	420930003	4911	112,233
27	Mount Storm Power Plant	WV	023	Grant Co	540230003	4911	110,087
28	Tva Johnsonville Steam Plant	TN	085	Humphreys Co	470850011	4911	108,643
29	Prepa-Aguirre_Power Station	PR	123	Salinas Co	721230011	4911	103,192
30	Indiana-Kentucky Electric Corporation	IN	077	Jefferson Co	180770001	4911	103,187
31	Ga Power Co Branch Stm Elec Gen Sta	GA	237	Putnam Co	132370008	4911	101,222
32	Appalachian Power - John E Amos Plant	WV	079	Putnam Co	540790006	4911	92,714
33	Pa P & L Co/Brunner Island Steam Electri	PA	133	York Co	421330020	4911	92,457
34	Teco	FL	057	Hillsborough Co	120570039	4911	87,372
35	Duke Power Marshall Plt	NC	035	Catawba Co	370350073	4911	85,572
36	Cp&L Roxboro Units 1 2 3 4	NC	145	Person Co	371450029	4911	82,515
37	Cleveland Elec Illum Co Avon Lake Plant	OH	093	Lorain Co	390935001	4911	80,825
38	Alabama Power Company (Miller Power Plan	AL	073	Jefferson Co	010730011	4911	79,456
39	Gpu Gen Corp/Conemaugh Power Plt	PA	063	Indiana Co	420630001	4911	78,111
40	Salt River Project- Navajo Station	AZ	005	Coconino Co	040050423	4911	76,218
41	Florida Power Corporation	FL	017	Citrus Co	120170004	4911	75,824
42	Texas Utilities Generating Company	TX	161	Freestone Co	481610002	4911	75,271
43	Ohio Edison Company R E Burger Plant	OH	013	Belmont Co	390135002	4911	74,470
44	Monongahela Power Co.- Fort Martin Power	WV	061	Monongalia Co	540610001	4911	71,191
45	Ipalco-Petersburg	IN	125	Pike Co	181250002	4911	67,112
46	Ga Power Co Mcdonough	GA	067	Cobb Co	130670003	4911	66,487
47	Duke Power Co - Belews Creek Steam Statn	NC	169	Stokes Co	371690004	4911	64,476
48	Ga Power Co Hammond Stm Elec Gen Sta	GA	115	Floyd Co	131150003	4911	64,434
49	American Electric Power	IN	029	Dearborn Co	180290002	4911	64,006
50	Appalachian Power Co.-Philip Sporn Plant	WV	053	Mason Co	540530001	4911	60,978

Note(s): The values presented in the "County Code" column are Federal Information Processing Standards (FIPS) codes.
This information was downloaded from AIRSWeb: http://www.epa.gov/airsweb/srcrank.htm on 7/14/98.
This table represents the top 50 plants where the year indicated was 1990 through 1996.

Table 2-9. Top 50 Plants Emitting Sulfur Dioxide from Industrial Sources

Rank	Plant Name	State	County Code	County	Plant ID	SIC	Emissions (tons/year)
1	Cinergy - Beckjord Station	OH	025	Clermont Co	390255001	4931	104,643
2	Cincinnati Gas & Electric Co., Miami For	OH	061	Hamilton Co	390615052	4931	103,015
3	Aluminum Company Of America	TX	331	Milam Co	483310001	3334	67,364
4	Asarco	MO	093	Iron Co	290930008	3332	47,709
5	Phillips P R Core	PR	057	Guayama Co	720570003	2911	44,059
6	Uss/Kobe Steel Co. - Lorain Works	OH	093	Lorain Co	390935004	3312	34,467
7	The Doe Run Company - Smelting Division	MO	099	Jefferson Co	290990003	3339	34,254
8	Mead Corporation	OH	141	Ross Co	391415001	2621	33,921
9	Ak Steel Corporation	OH	017	Butler Co	390175002	3312	29,132
10	Mobil Joliet Refining Corp	IL	197	Will Co	171970089	2911	24,837
11	Wheeling Pittsburgh Steel Steubenville S	OH	081	Jefferson Co	390815006	3312	22,714
12	Eastman Chemical Company / Main Facility	TN	163	Sullivan Co	471630003	4961	19,236
13	Horizow Hotels Corp	PR	031	Carolina Co	720310207	7011	18,177
14	Fort Howard Corporation	WI	009	Brown Co	550090328	2621	16,555
15	Inland Steel Company	IN	089	Lake Co	180890316	3312	16,542
16	Pekin Energy Company	IL	179	Tazewell Co	171790044	2869	15,361
17	Reynolds Metals	LA	033	East Baton Rouge Par	220330021	2999	14,600
18	Phillips 66 Company	TX	233	Hutchinson Co	482330015	2911	14,063
19	Clark Refining & Marketing, Inc.	TX	245	Jefferson Co	482450004	2911	13,778
20	Conoco, Inc./Ponca City Refinery	OK	071	Kay Co	400710202	2911	13,631
21	Wis Pwr & Light-Rock River Gen Station	WI	105	Rock Co	551050037	4931	13,374
22	Ppg Industries, Inc.	WV	051	Marshall Co	540510002	2812	13,167
23	U S Steel Co Gary Works	IN	089	Lake Co	180890121	3312	13,118
24	Us Doe Y-12 Plant	TN	001	Anderson Co	470011020	3499	12,800
25	Mobil Oil Corporation	TX	245	Jefferson Co	482450018	2911	11,980
26	Wheeling Pitts Stl Steubenville North	OH	081	Jefferson Co	390815008	3312	11,815
27	Fina Oil And Chemical Company	TX	227	Howard Co	482270001	2911	11,531
28	A.E. Staley Man. Co. South Plant	IN	157	Tippecanoe Co	181570033	2046	11,368
29	Valero Refining Company - Texas	TX	201	Harris Co	482010065	2911	10,936
30	E. I. Du Pont De Nemours And Company	TN	085	Humphreys Co	470850007	2816	10,674
31	Western Gas Resources, Inc.	TX	467	Van Zandt Co	484670001	1321	10,484
32	Tennaco Packaging	OH	169	Wayne Co	391695008	2631	10,125
33	U S Steel Co Gary Works Part 2	IN	089	Lake Co	180899999	3312	10,115
34	International Paper Company-Androscoggin	ME	007	Franklin Co	230070021	2611	9,940
35	Citgo Corp	LA	019	Calcasieu Par	220190016	2911	9,896
36	Amoco Oil Company, Whiting Refinery	IN	089	Lake Co	180890003	2911	9,760
37	Puerto Rico Sun Oil-Sunoco Caribbean, In	PR	151	Yabucoa Co	721510018	2911	9,681
38	Entech Inc	AK	020	Anchorage Borough	020200110	4953	9,625
39	Zinc Corp Amer/Monaca Smelter	PA	007	Beaver Co	420070032	3339	9,556
40	Great Northern Paper Inc (West)	ME	019	Penobscot Co	230190056	2611	9,473
41	Lke Chas Calc.Plant	LA	019	Calcasieu Par	220190069	2999	9,351
42	Agrico-Uncle Sam Plnt	LA	093	St. James Par	220930004	2874	9,192
43	Great Lakes Carbon Corporation	TX	245	Jefferson Co	482450023	2999	9,173
44	Bp Oil Company - Alliance Refinery	LA	075	Plaquemines Par	220750015	2911	9,073
45	Rhone-Poulenc, Inc.	TX	201	Harris Co	482010037	2819	8,976
46	Georgia-Pacific Corp. Pulp/Paper Mill	FL	107	Putnam Co	121070005	2621	8,946
47	Inland-Rome Inc	GA	115	Floyd Co	131150021	2631	8,877
48	Ph Glatfelter Co/Spring Grove	PA	133	York Co	421330016	2621	8,803
49	Rhone-Poulenc	LA	033	East Baton Rouge Par	220330033	2819	8,648
50	Venco Moundsville Calcining Plant	WV	051	Marshall Co	540510011	2999	8,307

Note(s): The values presented in the "County Code" column are Federal Information Processing Standards (FIPS) codes.
This information was downloaded from AIRSWeb: http://www.epa.gov/airsweb/srcrank.htm on 7/14/98.
This table represents the top 50 plants where the year indicated was 1990 through 1996.
Industrial sources are defined as non-utility sources (i.e., no SIC codes equal to 4911).

Table 2-10. Top 50 Plants Emitting Particulate Matter (PM-10)

Rank	Plant Name	State	County Code	County	Plant ID	SIC	Emissions (tons/year)
1	Entergy Mississippi. Inc.-Baxter Wilson	MS	149	Warren Co	281490027	4911	8,580
2	Prepa-Aguirre Power Station	PR	123	Salinas Co	721230011	4911	5,764
3	Entergy Mississippi Inc	MS	151	Washington Co	281510048	4911	4,851
4	Kpl Gas Service (Jec)	KS	149	Pottawatomie Co	201490001	4911	3,463
5	Bethlehem Steel Corp/Bethlehem Steel Plt	PA	095	Northampton Co	420950048	3312	3,068
6	Teco	FL	057	Hillsborough Co	120570039	4911	3,048
7	U S Steel Co Gary Works	IN	089	Lake Co	180890121	3312	2,940
8	Pa P & L Co/Montour Ses	PA	093	Montour Co	420930003	4911	2,918
9	Prepa-South Coast	PR	059	Guayanilla Co	720590010	4911	2,873
10	Cal Portland Cement Co.	CA	029	Kern Co	060290009	3241	2,826
11	Ltv Steel Mining - Hoyt Lakes Taconite	MN	137	St. Louis Co	271370009	1011	2,791
12	Bethlehem Steel Corp.	IN	127	Porter Co	181270001	3312	2,717
13	Minntac Mine & Plant	MN	137	St. Louis Co	271370005	1011	2,575
14	A E Staley Manufacturing Co	IL	115	Macon Co	171150018	2046	2,567
15	Peco Energy Co/Eddystone	PA	045	Delaware Co	420450014	4911	2,398
16	International Paper - Riegelwood	NC	047	Columbus Co	370470036	2621	2,370
17	Florida Power & Light	FL	081	Manatee Co	120810010	4911	2,333
18	Nsp - Sherburne Cnty	MN	141	Sherburne Co	271410004	4911	2,328
19	Cumberland Municipal Utility	WI	005	Barron Co	550050586	4931	2,307
20	Pa P & L Co/Brunner Island Steam Electri	PA	133	York Co	421330020	4911	2,226
21	Ag Processing Inc	MO	021	Buchanan Co	290210060	2075	2,042
22	Duke Power Marshall Plt	NC	035	Catawba Co	370350073	4911	2,026
23	Indiana-Kentucky Electric Corporation	IN	077	Jefferson Co	180770001	4911	1,936
24	Cp&L Roxboro Units 1 2 3 4	NC	145	Person Co	371450029	4911	1,919
25	Isp Minerals Inc.	WI	075	Marinette Co	550750435	3295	1,888
26	Evtac Mining - Plant	MN	137	St. Louis Co	271370113	1011	1,875
27	U S Steel Co Gary Works Part 2	IN	089	Lake Co	180899999	3312	1,826
28	Tampa Electric Company	FL	057	Hillsborough Co	120570040	4911	1,821
29	Lehigh Portland Cement Co	IA	033	Cerro Gordo Co	190330035	3241	1,761
30	Ltv Steel Company	IN	089	Lake Co	180890318	3312	1,744
31	American Smelting And Refining Company	AZ	007	Gila Co	040070615	3331	1,741
32	Garnett Wood Products	MO	091	Howell Co	290910010	2421	1,703
33	Ltv Steel Company, Inc. (Republic)	IL	031	Cook Co	170311221	3312	1,653
34	Asarco- Ray Mine	AZ	021	Pinal Co	040210012	1021	1,620
35	Natl Southwire Aluminum	KY	091	Hancock Co	210910004	3334	1,603
36	International Paper Company-Androscoggin	ME	007	Franklin Co	230070021	2611	1,592
37	Arizona Public Serv/4 Corners	NM	045	San Juan Co	350450002	4911	1,549
38	Florida Coast Paper Company, L.L.C.	FL	045	Gulf Co	120450005	2621	1,490
39	Florida Power & Light	FL	099	Palm Beach Co	120990042	4911	1,464
40	Inland Steel Company	IN	089	Lake Co	180890316	3312	1,459
41	Gpu Gen Corp/Homer City Power Plt	PA	063	Indiana Co	420630003	4911	1,450
42	Jefferson Smurfit Corporation (US)	FL	089	Nassau Co	120890003	2631	1,438
43	Houston Industries Incorporated	TX	157	Fort Bend Co	481570005	4911	1,412
44	Prepa-Jobos	PR	057	Guayama Co	720570012	4911	1,378
45	Nsp - Riverside	MN	053	Hennepin Co	270530015	4911	1,374
46	Phelps Dodge Corporation	AZ	011	Greenlee Co	040110734	1021	1,346
47	Lower Colorado River Authority	TX	149	Fayette Co	481490005	4911	1,336
48	Ameren U.E.	MO	071	Franklin Co	290710003	4911	1,334
49	Duke Power Co - Belews Creek Steam Statn	NC	169	Stokes Co	371690004	4911	1,333
50	Amoco Oil Company	TX	167	Galveston Co	481670001	2911	1,325

Note(s): The values presented in the "County Code" column are Federal Information Processing Standards (FIPS) codes.
This information was downloaded from AIRSWeb: http://www.epa.gov/airsweb/srcrank.htm on 7/14/98.
This table represents the top 50 plants where the year indicated was 1990 through 1996.

Table 2-11. Ozone Season Daily Emissions for CO, NO_x, and VOC by State and Major Source Category

(tons per day)

	CO			NO_x				VOC			
State	**Area**	**Point**	**Total**	**Area**	**Point**	**Biogenic**	**Total**	**Area**	**Point**	**Biogenic**	**Total**
Alabama	4,599	696	5,295	869	1,026	56	1,951	974	235	10,169	11,379
Alaska	471	21	492	43	48		91	60	4		64
Arizona	4,254	84	4,338	888	486	248	1,622	839	68	3,644	4,551
Arkansas	2,564	286	2,849	571	242	78	891	664	46	9,904	10,614
California	15,982	195	16,177	3,116	263	188	3,566	4,112	240	15,093	19,445
Colorado	3,206	82	3,288	809	381	182	1,373	793	181		974
Connecticut	1,883	86	1,969	359	236	4	598	493	62	459	1,014
Delaware	500	42	542	110	90	7	208	136	26	135	297
District of Columbia	288	1	288	50	4	0	54	65	1	3	69
Florida	11,240	180	11,420	1,569	1,205	78	2,852	2,382	84	6,558	9,023
Georgia	7,750	466	8,216	1,172	761	79	2,012	1,563	135	9,175	10,873
Hawaii	624	26	650	63	88		151	77	17		94
Idaho	1,175	12	1,187	289	12	120	421	302	1	6,721	7,024
Illinois	7,020	1,396	8,416	1,589	1,646	377	3,612	2,014	772	1,425	4,211
Indiana	5,139	1,109	6,248	1,160	1,402	206	2,769	1,468	290	1,204	2,963
Iowa	2,627	36	2,662	768	276	405	1,450	788	39	712	1,539
Kansas	3,465	201	3,666	963	584	394	1,941	829	117	895	1,842
Kentucky	3,443	290	3,732	887	1,215	78	2,181	837	341	3,337	4,515
Louisiana	4,547	1,925	6,471	1,262	1,060	73	2,396	975	311	6,483	7,769
Maine	848	93	941	162	65	12	238	215	46	3,483	3,743
Maryland	2,744	411	3,155	515	447	25	986	651	57	859	1,568
Massachusetts	3,104	58	3,163	628	202	5	834	878	72	806	1,756
Michigan	6,155	291	6,446	1,107	949	107	2,163	1,767	270	2,765	4,802
Minnesota	3,585	229	3,814	844	470	259	1,574	1,122	121	3,935	5,178
Mississippi	3,205	293	3,497	740	396	76	1,212	781	172	8,764	9,718
Missouri	4,898	301	5,198	889	684	182	1,755	1,114	177	7,855	9,146
Montana	961	127	1,088	357	112	272	741	262	22	6,426	6,710
Nebraska	3,192	55	3,247	610	209	392	1,211	688	102	575	1,365
Nevada	1,520	46	1,566	241	193	228	662	311	9	1,408	1,728
New Hampshire	666	164	830	142	68	4	214	194	37	946	1,177
New Jersey	3,408	124	3,532	686	381	9	1,076	991	284	688	1,962
New Mexico	2,379	79	2,457	422	452	272	1,147	416	36	3,472	3,924
New York	7,450	115	7,566	1,305	361	76	1,742	2,100	184	2,007	4,291
North Carolina	6,442	225	6,667	938	1,141	86	2,165	1,687	323	5,935	7,945
North Dakota	850	37	887	452	341	226	1,019	320	5	363	687
Ohio	8,341	2,075	10,416	1,488	2,105	151	3,745	2,020	300	1,454	3,775
Oklahoma	3,583	106	3,689	861	404	154	1,420	792	66	5,898	6,755
Oregon	2,088	214	2,302	443	74	110	627	569	48	8,653	9,270
Pennsylvania	6,087	1,893	7,980	1,185	1,341	81	2,607	1,649	339	3,328	5,316
Rhode Island	505	6	510	80	3	0	83	140	19	136	295
South Carolina	3,541	146	3,687	565	537	43	1,145	842	146	3,975	4,963
South Dakota	1,296	3	1,299	322	65	265	653	304	5	806	1,116
Tennessee	5,961	302	6,263	1,140	1,110	70	2,321	1,419	369	5,648	7,436
Texas	17,576	1,376	18,953	3,120	2,400	851	6,371	4,354	709	15,335	20,398
Utah	2,127	339	2,466	369	320	143	833	440	65	3,488	3,994
Vermont	454	4	458	82	3	7	92	121	6	597	724
Virginia	5,055	132	5,187	992	613	40	1,645	1,191	278	4,786	6,255
Washington	4,128	704	4,832	799	181	73	1,053	1,013	225	5,488	6,726
West Virginia	1,608	821	2,429	316	1,347	15	1,678	360	139	2,619	3,118
Wisconsin	3,708	186	3,894	784	507	156	1,447	1,084	229	3,138	4,451
Wyoming	619	210	829	399	420	177	996	131	66	3,402	3,598
Total	**198,858**	**18,297**	**217,155**	**39,523**	**28,925**	**7,142**	**75,590**	**49,297**	**7,898**	**194,956**	**252,151**

Figure 2-1. 1996 National CARBON MONOXIDE Emissions by Principal Source Category

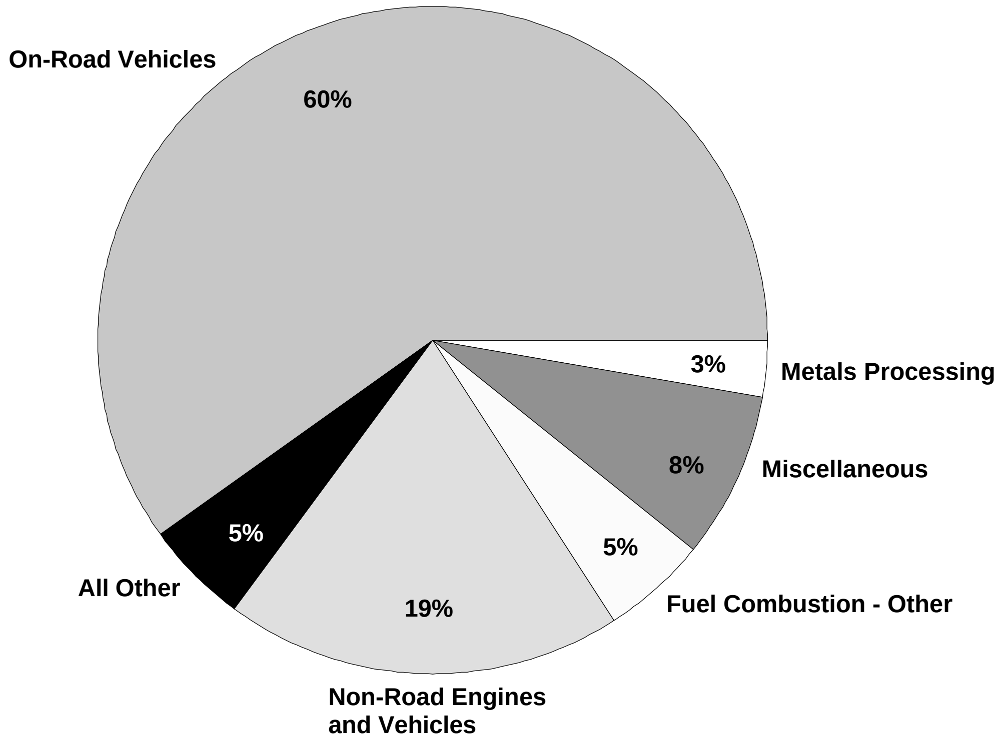


Figure 2-2. 1996 National NITROGEN OXIDE Emissions by Principal Source Category

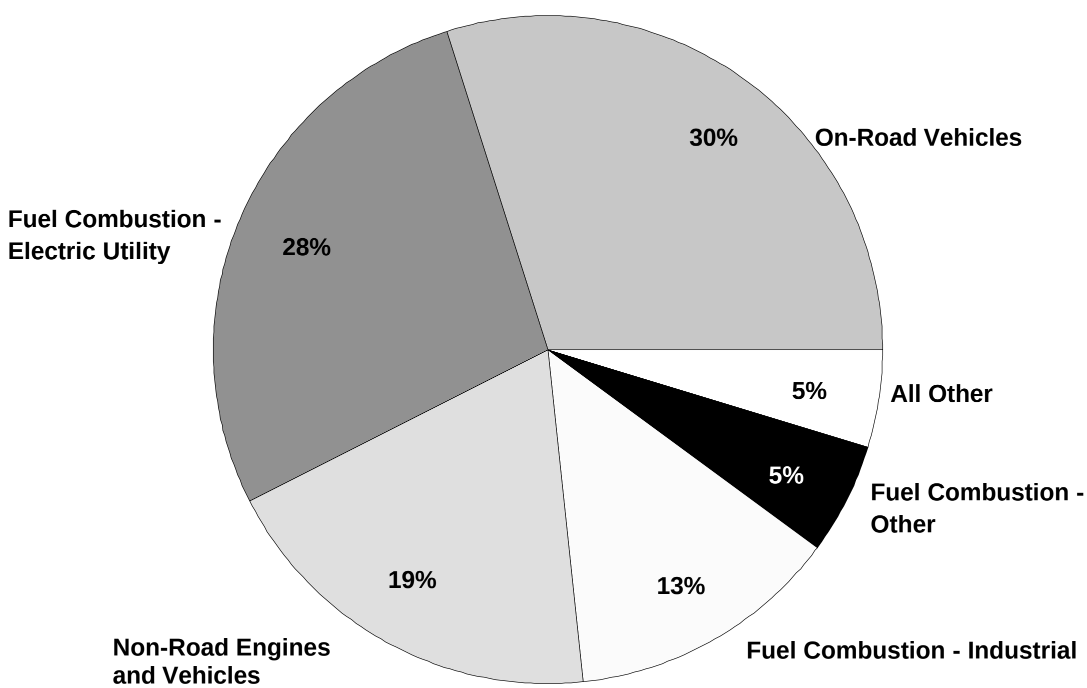


Figure 2-3. 1996 National VOLATILE ORGANIC COMPOUND Emissions by Principal Source Category

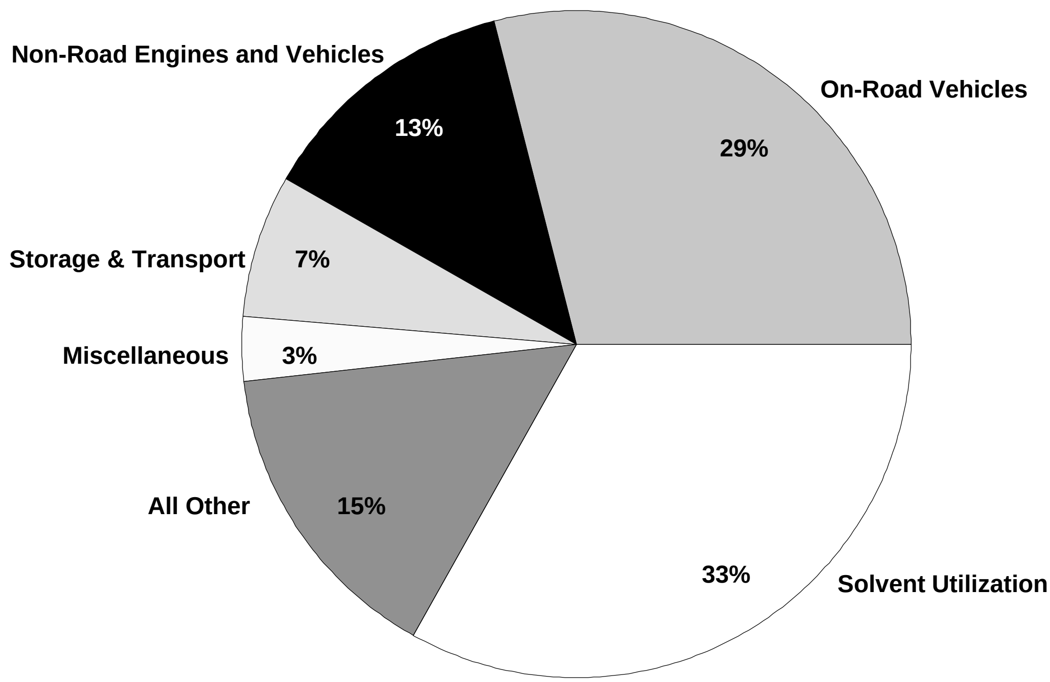


Figure 2-4. 1996 National SULFUR DIOXIDE Emissions by Principal Source Category

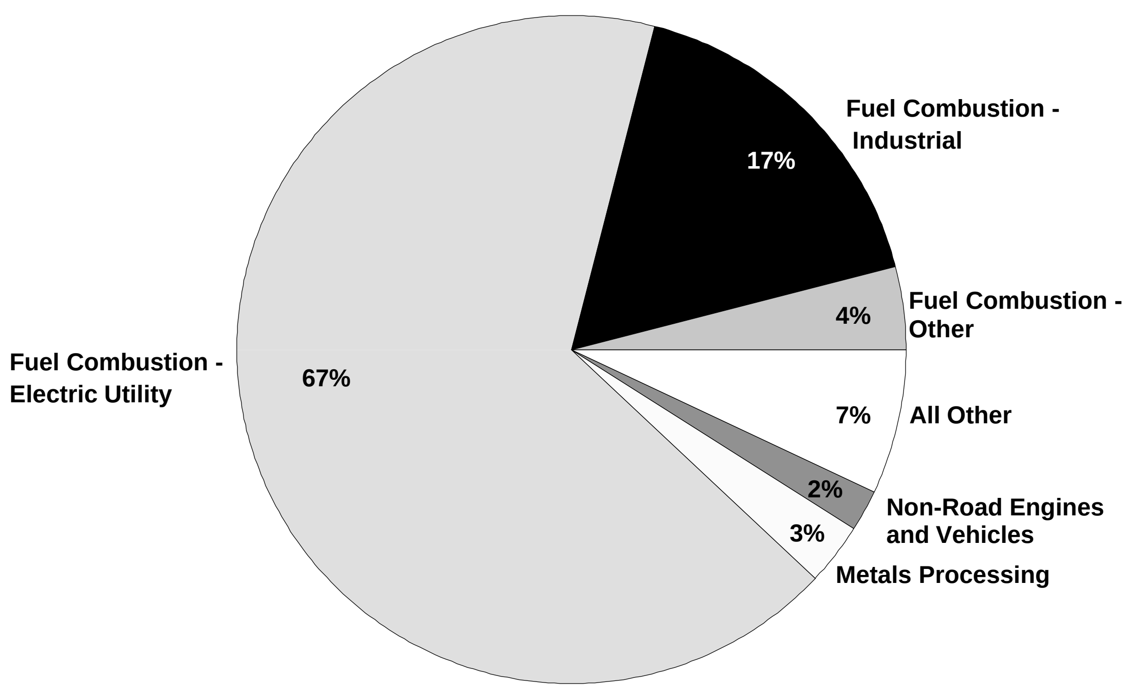


Figure 2-5. 1996 National PARTICULATE MATTER (PM-10) Emissions by Principal Source Category for Non-Fugitive Dust Sources

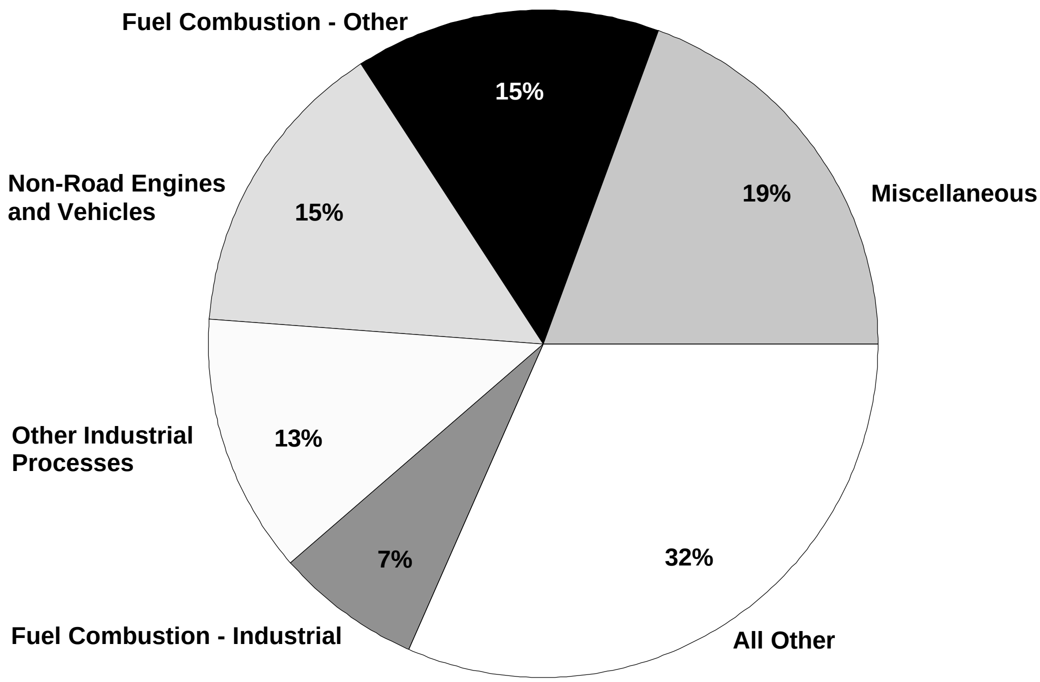


Figure 2-6. 1996 National PARTICULATE MATTER (PM-10) Emissions by Fugitive Dust Category

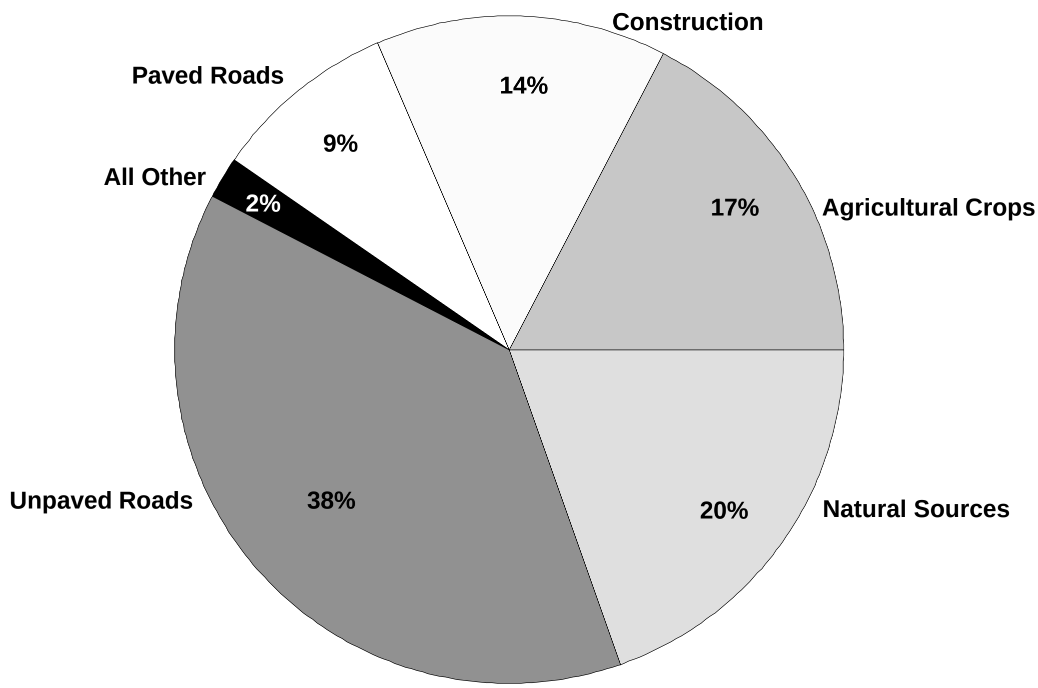


Figure 2-7. 1996 National LEAD Emissions by Principal Source Category

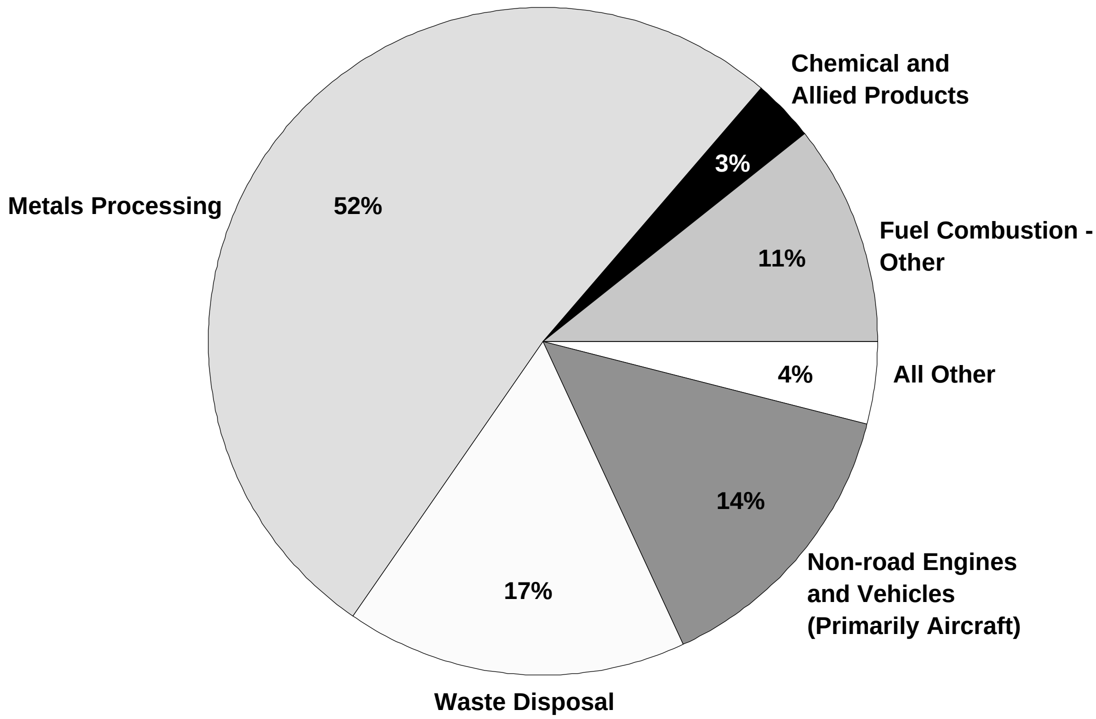


Figure 2-8. Density Map of 1996 CARBON MONOXIDE Emissions by County

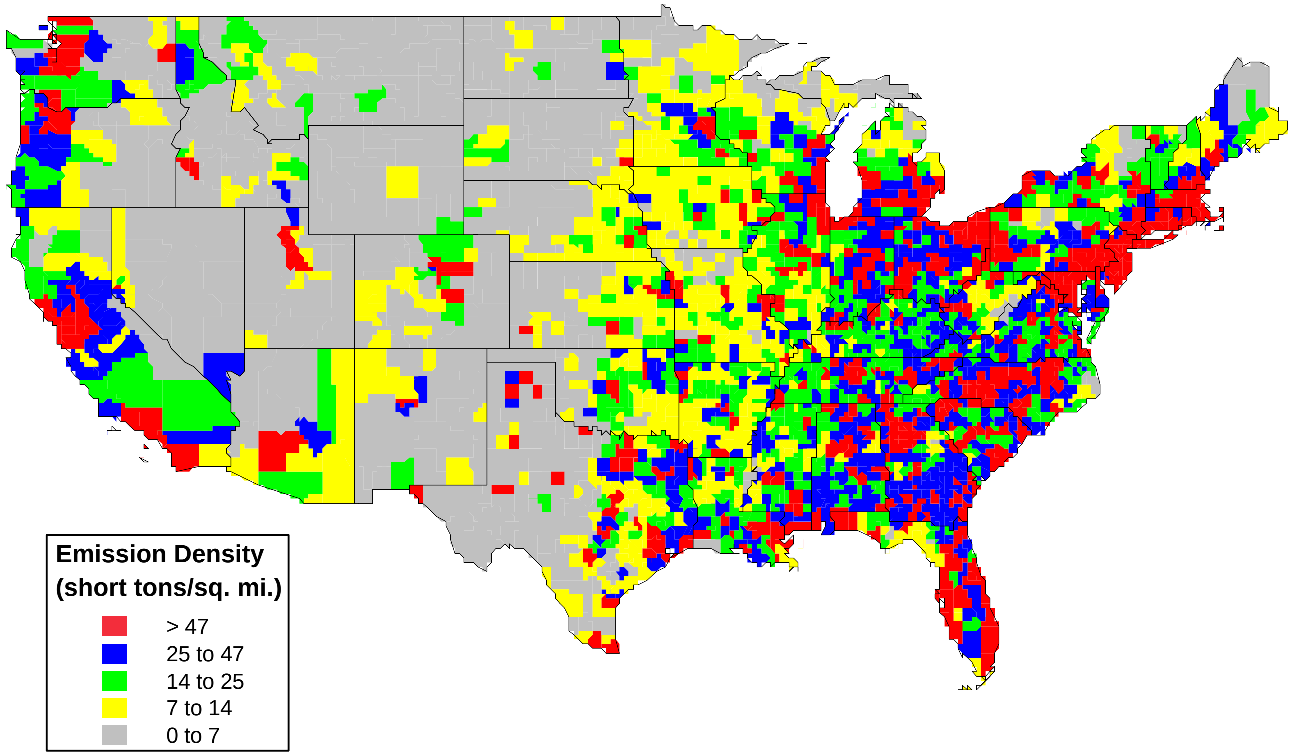


Figure 2-9. Density Map of 1996 NITROGEN OXIDE Emissions by County

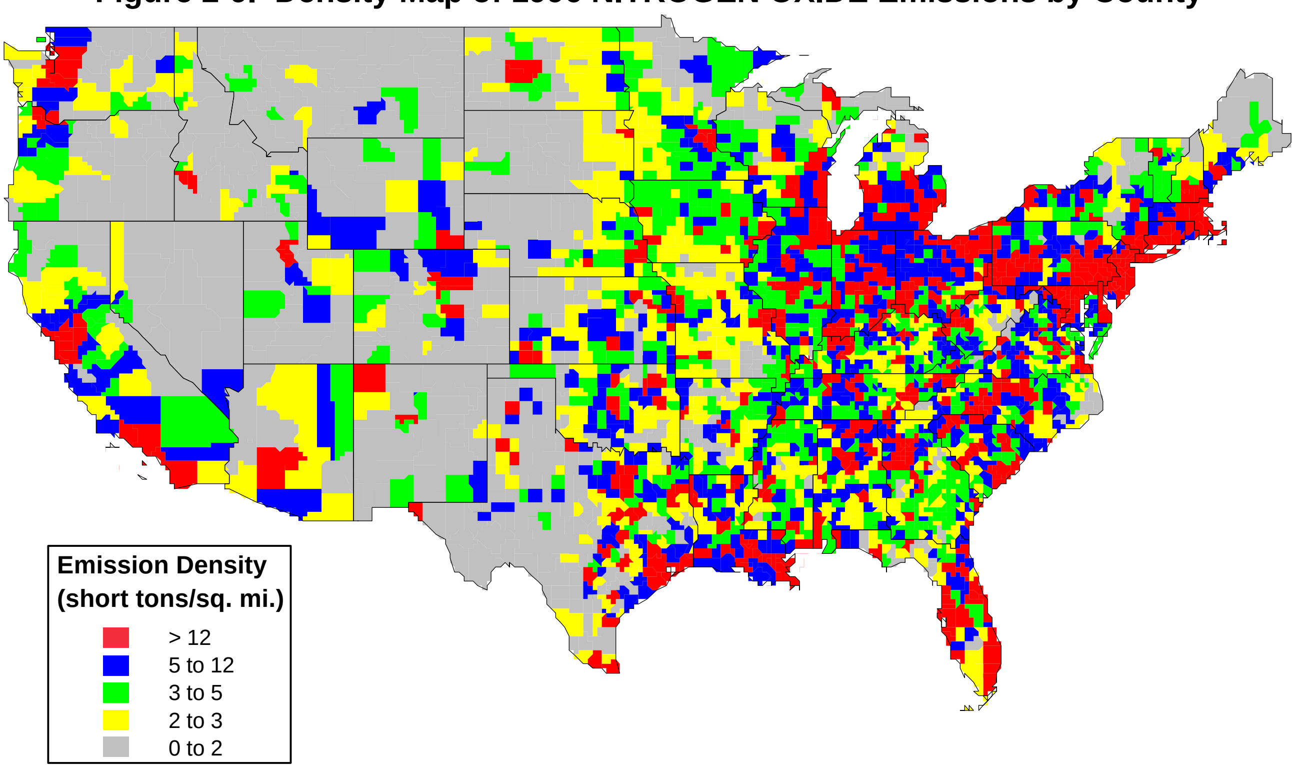


Figure 2-10. Density Map of 1996 VOLATILE ORGANIC COMPOUND Emissions by County

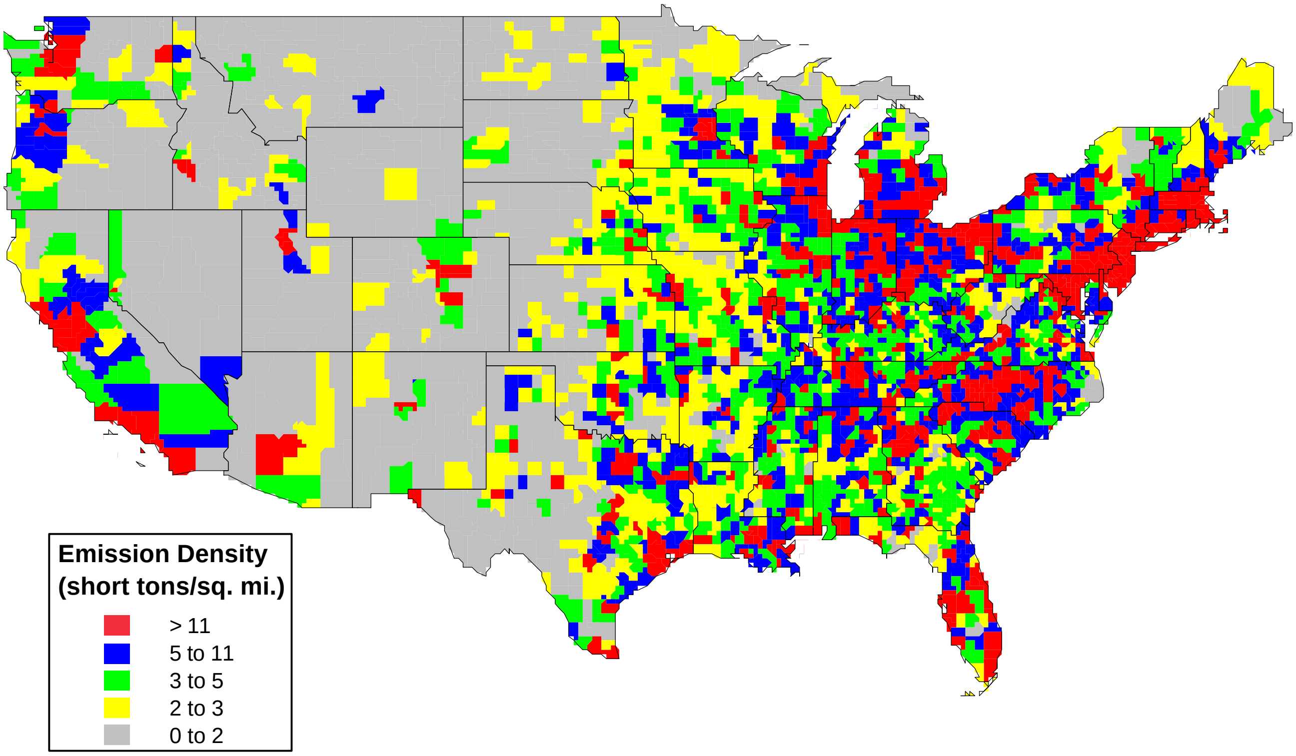


Figure 2-11. Density Map of 1996 SULFUR DIOXIDE Emissions by County

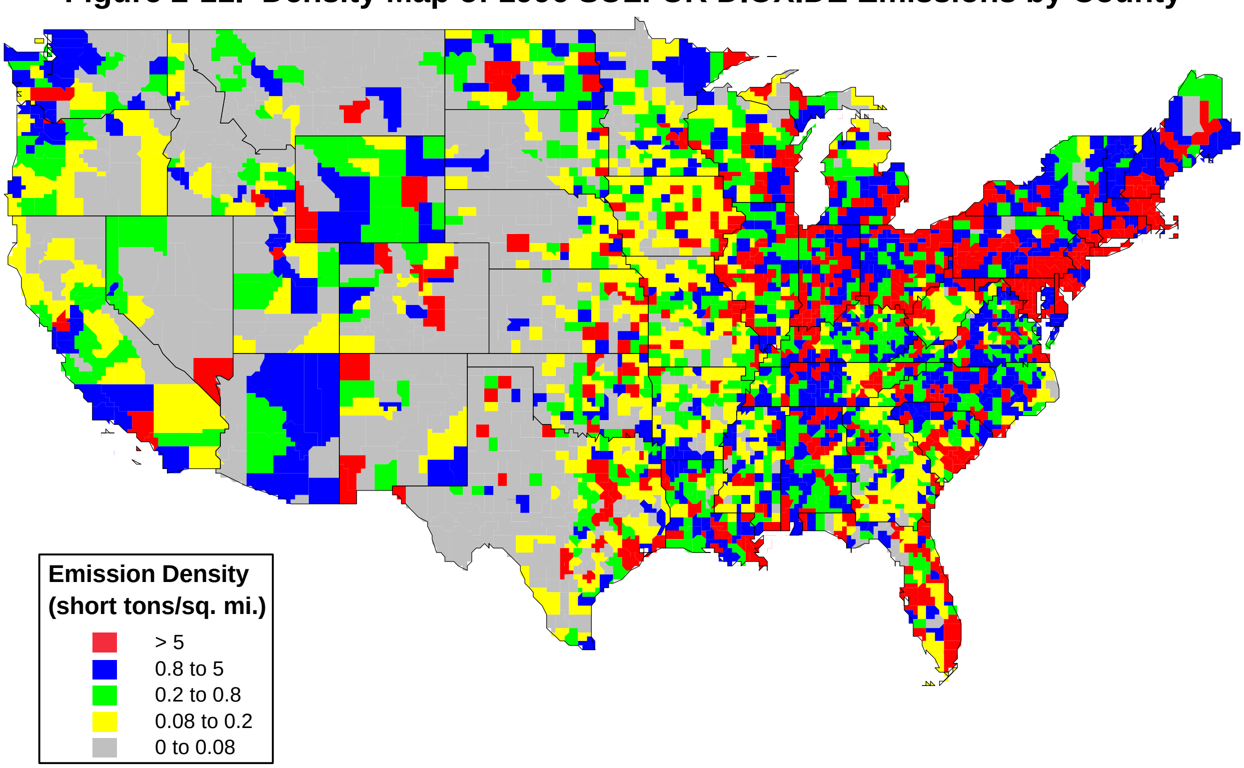


Figure 2-12. Density Map of 1996 PARTICULATE MATTER (PM-10) Emissions by County

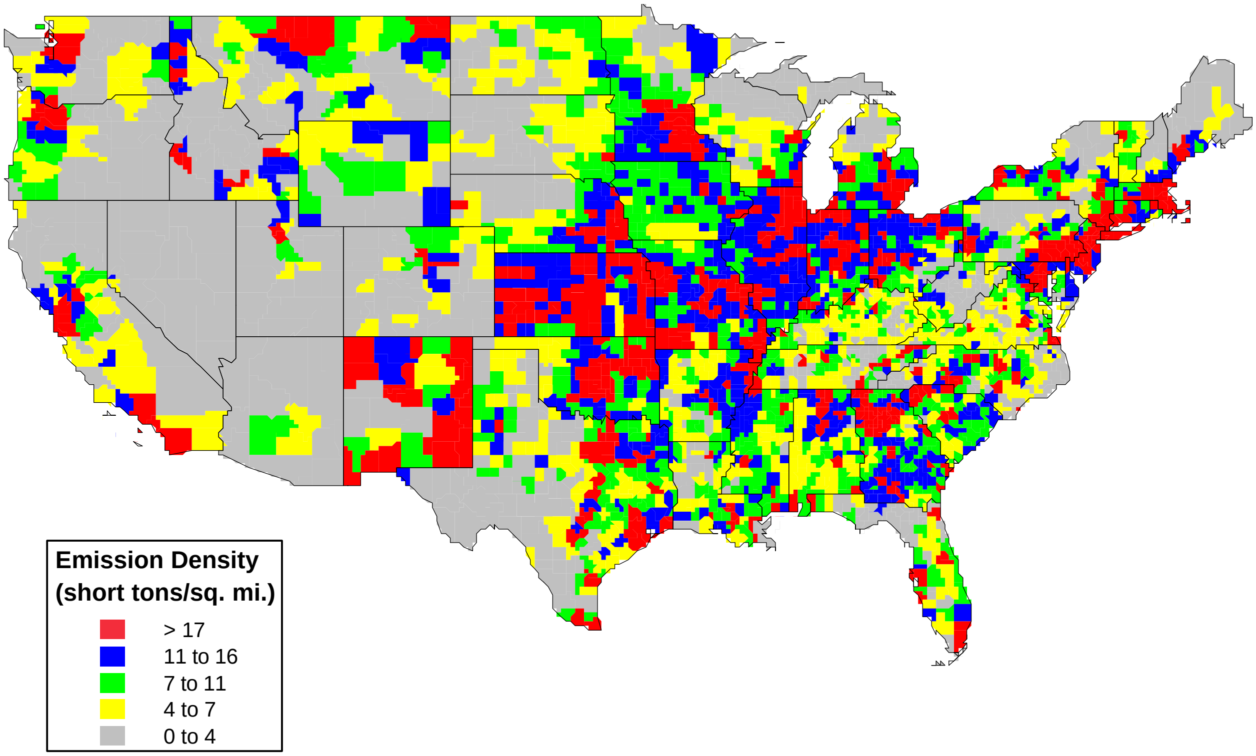
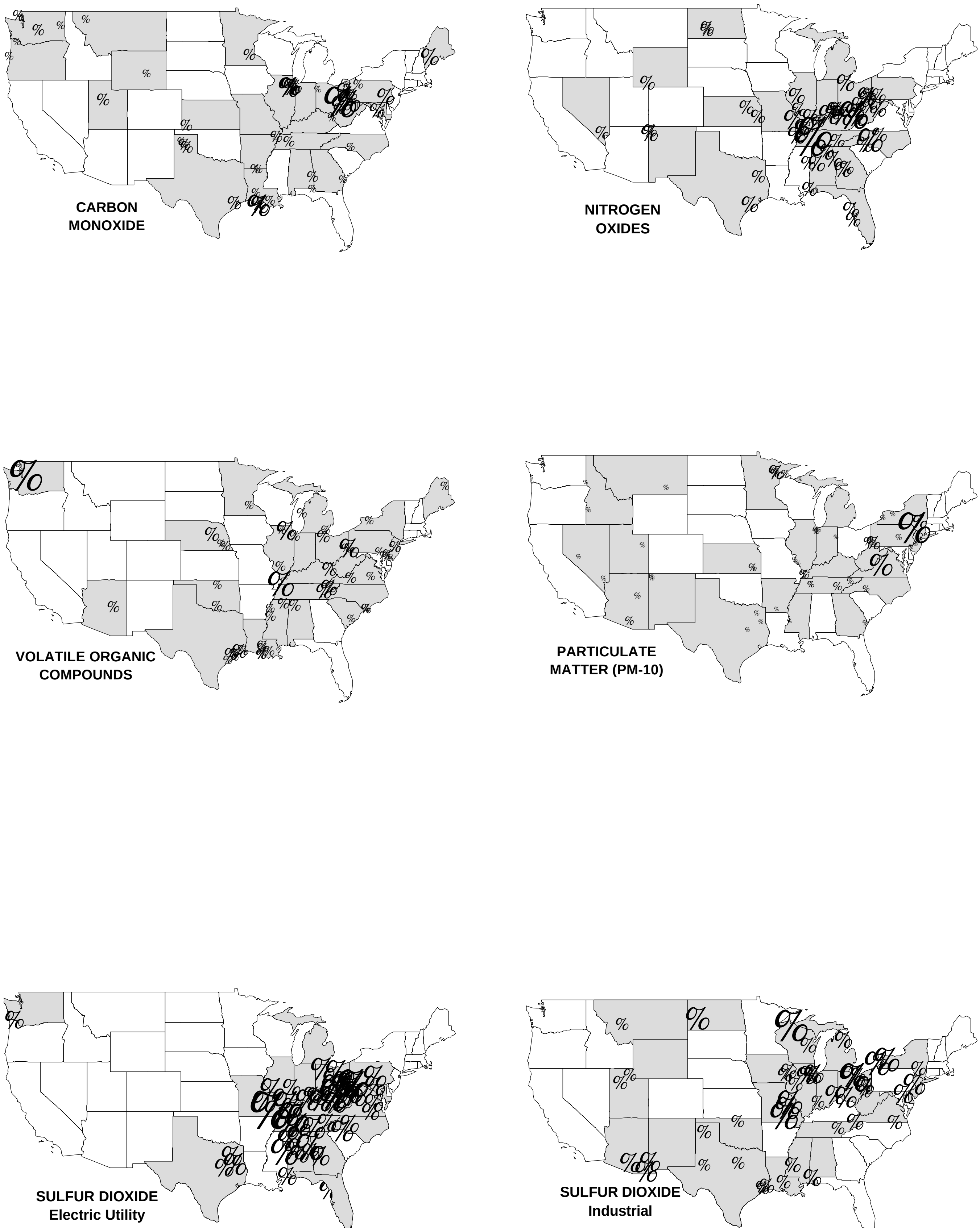


Figure 2-13. Top 50 Plants by Location and Pollutant



Chapter 3.0 National Emissions Trends, 1900 to 1996

Historical trends in criteria air pollutant emissions (CO, NO_x, VOC, SO_2, PM-10, and Pb) are presented in this chapter for the period 1900 through 1996 (where available). The effects on trends in air pollutant emissions from the level and composition of economic activity in the nation, demographic influences, and the impact of regulatory efforts to control emissions are also presented in this chapter.

3.1 OVERVIEW OF AIR POLLUTION CONTROL HISTORY

The very first air pollution statutes in the United States were passed by the cities of Chicago and Cincinnati in 1881 to control smoke and soot from furnaces and locomotives. County governments began to pass their own pollution control laws in the early 1900's. The first State to legislatively control air pollution was Oregon in 1952. Other States followed, with air pollution statutes generally targeted toward smoke and particulates. Figure 3-1 presents the number of jurisdictions with air pollution control legislation during the 100-year period starting in 1880.[1]

The Federal Government's involvement in air pollution control began in 1955 with the passage of the Air Pollution Control Act. This law limited the extent of Federal involvement to funding assistance for the States' air pollution research and training efforts. The shift toward greater involvement of the Federal Government in air pollution control began in the mid-1960s. In 1963 Congress passed the original CAA, which provided for permanent Federal support for air pollution research, continued and increased Federal assistance to the States for the development of their air pollution control agencies, and introduced a mechanism through which the Federal Government could assist the States with cross-boundary air pollution problems. In 1965, Congress amended the CAA for the first time, directing the Secretary of Health, Education, and Welfare (HEW) to set the first Federal emissions standards for motor vehicles.

In 1967 Congress passed the Air Quality Act, which required that States establish air quality control regions and that HEW publish information about the adverse health effects associated with several common air pollutants. This information was to be used by the States in setting air quality standards. In addition, HEW was to identify viable pollution control technologies for States to use to attain the air quality standards that each was to have established.

There were several perceived problems with this early period of air pollution control. The HEW had been slow in issuing guidance documents detailing the adverse health effects associated with common air pollutants; where these had been prepared, States had either failed to set air quality standards or were slow in developing implementation plans. The initial exhaust emission standards set by HEW in 1968 resulted in relatively small reductions in automobile pollutants.

With the CAA as amended in 1970, a major change took place in air pollution policy. First, a new Federal Government agency, EPA, was charged with the responsibility of setting the NAAQS. In 1971, the EPA promulgated primary and secondary NAAQS for photochemical oxidants, SO_2, suspended PM, CO, and hydrocarbons (HCs). Second, EPA was given authority to develop national emissions standards for cars, trucks, and buses. Finally, Congress gave the EPA power to set emissions standards for all new sources of the common air pollutants (NSPS). Under the CAA, the major responsibility left to the States was how to control existing sources. States were charged with the task of complying by 1975 with each of the NAAQS by developing and implementing State implementation plans (SIPs) that would demonstrate how existing sources would be controlled. Additional modifications were made to the Act in 1977, with the most significant changes occurring with passage of the CAAA.

Trends in each of the criteria air pollutants by principal source categories and the impact of economic, demographic, and regulatory influences on these emission trends are discussed in the following sections. As a point of reference, Figure 3-2 presents the trend in GDP, population, VMT, and fuel consumption (i.e., total consumed by industrial, residential, commercial, and transportation sectors) from 1970 to 1996. Because the emissions reduction impact of the CAAA mandates is only beginning to take effect, the discussion highlights pre-1990 regulatory activities that targeted specific criteria air pollutant emission reductions. It is important to note that the regulatory discussion is not comprehensive. Instead, these sections emphasize the regulatory efforts that have targeted the major source categories for each air pollutant. In addition, the lack of detail available for all of the data precludes the possibility of analyzing some of the stationary source control measures (e.g., State-specific regulations such as Reasonably Available Control Technology [RACT] provisions).

3.2 HISTORICAL EMISSION TRENDS

Emission trends are presented for the period 1940 through 1996 (where available) for CO, NO_x, VOC, SO_2, PM-10 and Pb in tables 3-1 through 3-6. Figures 3-3 and 3-4 represent long-term trends in the criteria air pollutant emissions from 1900 to 1996. Figures 3-5 through 3-11 depict emission estimates for each criteria air pollutant for 1900 to 1996 (where available). With the exception of and NO_x and PM-10, all of the criteria pollutant emissions peaked in or around 1970, and there has been a general downward trend during the 1970 through 1996 time frame. For PM-10, peak emission levels occurred around 1950; PM-10 levels steadily declined until the mid-1980s and have remained relatively stable since then. Nitrogen oxides emissions steadily increased up through the mid-1970s and levels have been fairly steady since their 1978 peak.

3.2.1 Carbon Monoxide Emission Trends, 1940 through 1996

Table 3-1 and figure 3-5 reflect historical trends in CO emissions by principal source categories. Total CO emissions increased to peak levels around 1970 and have decreased thereafter. A significant decrease in CO emissions occurred between 1973 and 1975 as a result of disruptions in world oil markets and a subsequent recession in the United States. This short-term decrease in emissions is exhibited in NO_x and VOC emission trends during the 1973 to 1975 period also for similar reasons. On-road vehicle emissions, the major source of CO emissions followed a similar trend of increasing significantly (192 percent) through 1970 and decreasing (over 40 percent) subsequently. In contrast, non-road engine and vehicle emissions have increased 90 percent during the period. Emissions from other source categories have declined over the period with the exception of fuel combustion - electric utility and industrial and other industrial processes. Carbon monoxide emissions for 1996 have decreased somewhat from the 1995 levels due primarily to decreased emissions from on-road vehicles. The “all other” grouping shown in figure 3-5 refers to the following Tier I categories: fuel combustion - electric utility; fuel combustion - industrial; petroleum and related industries; other industrial processes; solvent utilization; and storage and transport. The miscellaneous category relates primarily to wildfires and managed burning.

3.2.1.1 Fuel Combustion CO Emissions: Electric Utility, Industrial, and Other

This source category which includes fuel combustion - electric utility, fuel combustion - industrial, and fuel combustion - other, residential wood combustion is the most significant source, accounting for 16 percent of total CO national emissions in 1940, but declining to 7 percent in 1996. During the period 1940 to 1970, the residential consumption of wood declined steadily as a result of the abundant supply, low relative prices, and convenience of fossil fuels relative to wood for home heating, cooking, and heating water. The 1970 to 1980 period exhibited a resurgence in the use of wood for home heating and a corresponding increase in emissions from residential wood combustion. The increase in the use of wood for home heating during this period occurred as the result of disruptions in crude oil deliveries and related product markets that resulted in increases in the price for fossil fuel products. Since 1980, prices of fossil fuel products have declined and a reduction in the use of wood for home heating has occurred. Carbon monoxide emissions from residential wood combustion have decreased by 33 percent since 1980.

Carbon monoxide emissions from residential fuel combustion using fuels other than wood have also undergone substantial changes since 1940. An 82 percent reduction in emissions during the 1940 to 1970 period occurred as a result of the steady decline in the use of anthracite and bituminous coal for home heating. Emissions from residential combustion of fuels other than wood are currently less than 1 percent of total national CO emissions.

3.2.1.2 Industrial Process CO Emissions

Industrial processes accounted for 8 percent of total CO national emissions in 1940, but decreased to 5 percent of total emissions by 1996. Emissions from chemical and allied product manufacturing declined during the period. Metals processing emissions increased through 1970, but have declined since. Emissions from the petroleum refining industry increased by a factor of 10 through 1970 as a result of an increase in refinery throughput and an increase in demand for refined petroleum products. Emissions from the petroleum refining industry have decreased 86 percent since 1970 due to the retirement of obsolete high polluting processes such as the manufacture of carbon black by channel process and the installation of emission control devices such as fluid catalytic cracking units. Petroleum refining accounted for less than 1 percent of total CO emissions in 1996.

3.2.1.3 Transportation CO Emissions: On-Road Vehicles and Non-Road Engines and Vehicles

On-road vehicles have been the predominant source of CO emissions in the United States since World War II, contributing 68 percent to total national emissions in 1970 and 61 percent in 1996. As part of the effort to reduce CO emissions, emission standards have been developed for on-road vehicles. Table 3-7 provides a list of standards for light-duty vehicle (LDV) and light-duty truck (LDT) CO emissions, expressed in grams per mile (gpm). In addition to these standards, the CAAA require cars to meet a standard of 10 gpm at 20 degrees Fahrenheit (°F), starting with the 1996 model year to ensure that emission control devices work efficiently at low temperatures. The Federal standards through 1975 applied only to gasoline-powered LDTs. Federal standards for 1976 and later applied to both gasoline and diesel-powered LDTs. In addition, a CO standard of 0.50 percent at idle was established for 1984 and later model years; effective at high altitudes starting with the 1988 model year. Other CO standards apply to LDTs more than 6,000 lbs, heavy-duty engines and vehicles, and non-road engines and vehicles.

It is reasonable to assume that a decline in gasoline price is associated with an increase in the quantity of gasoline demanded, VMT, and CO emissions (i.e., a decrease in the price of gasoline will result in greater VMT, fuel use, and CO emissions), all other factors remaining unchanged. On-road vehicle CO emissions have declined approximately 32 percent between 1970 and 1993, although fuel use increased approximately 50 percent, VMT increased over 100 percent, and real gasoline prices decreased 17 percent in this same period.[2] This decrease in CO emissions can be attributed to the impact of regulatory measures previously noted.

Non-road CO emissions represented 9 percent of the national total in 1940, with emissions from railroad locomotives accounting for approximately 51 percent of this amount. CO emissions from non-road engines and vehicles have increased by 90 percent since 1940 and accounted for 18 percent of the national total in 1996. While emissions from locomotives have declined 97 percent during the analysis period (through technology shifts rather than emission controls), emissions from aircraft and non-road gasoline equipment have increased substantially during the period.

3.2.1.4 Remaining Sources

Carbon monoxide emissions from other sources decreased from 1940 to 1996. In 1940, the emissions from waste disposal and recycling, and miscellaneous other combustion - wildfires accounted for 4 and 31 percent, respectively of total CO emissions. Emissions from wildfires are relatively erratic from year to year due the uncontrolled nature of wildfires, but declined from 1940 levels to 2 percent of total CO emissions in 1996. In contrast, CO emissions from waste disposal and recycling increased by 94 percent between 1940 and 1970. Since 1970, CO emissions from waste disposal and recycling have declined 85 percent and accounted for 1 percent of total CO emissions in 1996.

3.2.2 Nitrogen Oxides and Volatile Organic Compound Emission Trends, 1900 through 1996

Nitrogen oxides and VOCs are grouped together here because they comprise the principal emitted primary pollutants that are acted upon by sunlight to produce the secondary pollutant, tropospheric O_3. While there is currently no ambient air quality standard for VOCs, from the standpoint of modeling O_3 formation the category of VOC emissions is as important as the so-called criteria pollutants for which there are ambient air quality standards.

The trend in NO_x emissions is presented in table 3-2 and figure 3-6. The NO_x "all other" grouping includes the following Tier I categories: petroleum and related industries; solvent utilization; metal processing; waste disposal and recycling; miscellaneous; and storage and transport. The trend in VOC emissions is presented in table 3-3 and figure 3-7. The VOC "all other" grouping includes the following Tier I categories: fuel combustion - electric utility; fuel combustion - industrial; fuel combustion - other; petroleum and related industries; and other industrial process. The VOC emissions for the miscellaneous category are primarily from wildfires.

3.2.2.1 Regulatory History for NO_x and VOC Emissions

The 1971 photochemical oxidants standard was based on an hourly average level that was not to be exceeded more than once per year; the HC standard was also first promulgated in 1971. In 1979, the photochemical oxidants standard was revised and restated as O_3, and the HC standard was reviewed and withdrawn in 1983. The O_3 standard was revised to 0.12 parts per million (ppm [from 0.08 ppm]) of O_3 measured over a 1-hour period, not to be exceeded more than three times in a 3-year period. In July 1997, EPA revised the O_3 standard back to 0.08 ppm but measured over an 8-hour period, with the average fourth highest concentration over a 3-year period. Ozone is formed through a photochemical process in the presence of VOCs and NO_x.

On-road vehicles have been one of the top contributors to each of these pollutants (e.g., in 1970, on-road vehicles accounted for 42 percent of total VOC and 34 percent of total NO_x emissions). Table 3-8 presents the VOC and NO_x emission limits that have been set over the last two decades for light-duty vehicles. The VOC and NO_x emission standards for LDTs are presented in table 3-9. In addition to these standards, LDTs over 6,000 pounds and heavy-duty trucks (HDTs) also have NO_x standards.

3.2.2.2 Nitrogen Oxide Emissions Trends

As indicated in table 3-2 and figure 3-6, NO_x emissions have increased over 220 percent between 1940 and 1996, with a 9 percent increase over the 1970 and 1996 period. All Tier I principal source categories show increases for this period with the exception of petroleum and related industries, waste disposal and recycling, and miscellaneous sources.

3.2.2.2.1 Fuel Combustion NO_x Emissions: Electric Utility, Industrial, and Other — In 1900, electric utilities accounted for 4 percent of the total national NO_x emissions. By 1930, electric utility NO_x emissions increased by a factor of 6. Emissions from this source have continued to increase to 7 million short tons in 1996, accounting for 28 percent of total NO_x emissions in that year. NO_x is emitted when fossil fuels are used to generate electricity; however, emissions using coal as an energy source represented 89 percent of fuel combustion - electric utility NO_x emissions in 1996. Figure 3-12 presents the NO_x emissions along with heat input for the years 1985 through 1996. Note that NO_x emissions from electric utilities for the years 1985 to 1994 are lower in this year's report as compared to reports from previous years. In initially estimating NO_x emissions from 1985 to 1994, EPA used AP-42 emissions factors, which are estimated NO_x emission rates based on fuel type, boiler type, and NO_x control type, to determine the emissions for all boilers for all years. This year however, in the calculation of NO_x emissions for 1985-1994, EPA has minimized its use of emission factors for coal-fired steam utility boilers (the largest stationary source NO_x emitters) and instead relied almost exclusively on boiler-specific, short-term, uncontrolled and controlled emission rates, which were obtained from CEMs during their annual certification testing (i.e., CREV data), or from submissions of CEM, EPA reference method, or other test data by utilities, and were not generally available until the Spring of 1996. As a result of using more accurate, boiler-specific NO_x emissions data, EPA's estimates of electric utility NO_x emissions are now more accurate and are lower than previous reports indicated. Thus, EPA now believes that the dramatic decrease in NO_x emissions from utility boilers from 1994 to 1995 in last year's report was more an artifact of going from primarily emissions factors (in 1994) to primarily CEM data (in 1995). As seen in this year's report, when that difference is minimized, the emissions from both those years, as well as previous years, are very similar.

3.2.2.2.2 Transportation NO_x Emissions: On-Road Vehicles and Non-Road Engines and Vehicles — In 1900, on-road vehicles made an insignificant contribution to total national NO_x emissions. By 1920, emissions from on-road sources had increased to 5 percent of total NO_x emissions and continued to increase by a factor of 3 from 1920 to 1940. Emissions from on-road vehicles peaked in 1978 and have declined since then. Currently, on-road vehicle emissions constitute approximately 30 percent of total NO_x emissions.

One would anticipate that NO_x emissions from on-road vehicles will increase as VMT and fuel use increase and as gas prices decline (all other factors remaining unchanged). This pattern does exist from the period 1940 through 1978; however, NO_x emissions begin to decline after 1978 while VMT and fuel use continue rising and gasoline prices decline in real terms.

The effects of previously noted regulations account for the declines in NO_x emissions occurring after 1978. Although VMT has more than doubled since 1970, NO_x emissions from on-road vehicles are nearly equal to their 1970 levels.

In contrast to the on-road vehicle NO_x emission trends, emissions from non-road engines and vehicles increased over the entire period of 1940 to 1996. Emission control measures (Tier I standards) for new non-road diesel engines in certain horsepower categories began in 1996 with full phase-in for all horsepower categories scheduled for 2000. Figure 3-13 presents a summary of the emission methodology changes in non-road estimates.

3.2.2.2.3 Remaining Sources — The NO_x emissions for the years 1900 through 1939 were generated by five source categories (electric utility, industrial, commercial-residential, on-road vehicle, and other), making comparisons prior to 1940 on a source category basis difficult. In general, however, the emissions for the remaining sources of industrial processes, waste disposal, and miscellaneous sources increased from 1900 to 1920 and continued to increase from 1920 to 1940, but at a slower rate. Emissions from these sources accounted for 18 percent of the total 1940 NO_x emissions. The emissions for the waste disposal and recycling category steadily increased by a factor of 4 from 1940 to 1970, but have decreased 79 percent since 1970. Emissions from industrial processes steadily increased by a factor of 3 from 1940 to 1970. The emissions then decreased by 28 percent from 1970 to 1980. The increase from 1980 to 1996 of 40 percent was due in part to a change in the methodology used to estimate emissions between 1984 and 1985. In 1996, the total emissions for the remaining sources were 4 percent of national NO_x emissions.

3.2.2.3 Volatile Organic Compound Emission Trends

Volatile organic compounds are a principal component in the chemical and physical atmospheric reactions that form O_3 and other photochemical oxidants. The emissions of VOC species that primarily contribute to the formation of O_3 are included in total VOC emissions, while emissions of methane (CH_4), a nonreactive compound, are not included. No adjustments are made to include chlorofluorocarbons or to exclude ethane and other VOCs with negligible photochemical reactivity. On-road vehicle emissions were estimated as nonmethane HCs.[a] Emissions of organic compounds from biogenic sources such as trees and other vegetation, are presented in chapter 7. Volatile organic compound emissions from natural sources were almost equal to the emissions from anthropogenic sources, according to recent research, but the extent to which biogenic emissions contribute to oxidant formation has not been clearly established.

3.2.2.3.1 Fuel Combustion VOC Emissions: Electric Utility, Industrial, and Other — In 1900, emissions from all fuel combustion sources represented 68 percent of the total national VOC emissions. Wood combustion accounted for 90 percent of the emissions from these sources. By 1940, emissions from fuel combustion sources had decreased to 12 percent of total emissions and these emissions account for less than 3 percent of total emissions currently. The decline in residential wood combustion was discussed previously in section 3.2.1.1.

3.2.2.3.2 Industrial Process VOC Emissions — The emissions from industrial processes (i.e., chemical & allied products, petroleum & related industries, other industrial processes, solvent utilization, and storage & transport) accounted for 17 percent of the total national VOC emissions in 1900. By 1940, the emissions from industrial processes had risen to 26 percent of the total. The VOC emissions from these sources increased to 12 million short tons accounting for 40 percent of VOC emissions in 1970. Since 1970, emissions from these sources have decreased 30 percent, to approximately 47 percent of total national VOC emissions. Emission control devices and process changes have helped limit the growth in these emissions since 1970. Emissions from petroleum and related industries and petroleum product storage and marketing operations increased during the mid-1970s as a result of increased demand for petroleum products, especially motor gasoline. After 1978, the emissions from these sources decreased as the result of product reformulation and other control measures. For example, VOC emissions from solvent utilization sources decreased due to the substitution of water-based emulsified asphalt for asphalt liquefied with petroleum distillates. Chemical and allied products and other industrial process categories reflect increases in emissions during the reporting period.

3.2.2.3.3 Transportation VOC Emissions: On-Road Vehicles and Non-Road Engines and Vehicles — In 1900, transportation sources accounted for 4 percent of the total national VOC emissions; railroad emissions were 99 percent of these emissions. Railroad VOC emissions peaked in 1920 when these emissions were 20 percent of the national total and have decreased since then to less than 1 percent currently. The total VOC emissions from the transportation sector increased 162 percent during the 1940 to 1970 period.

Volatile organic compound emissions from on-road vehicles peaked in 1970 at 13 million short tons, or 42 percent of the national VOC emission total. It is reasonable to assume that, absent regulation, VOC emissions will increase as VMT and fuel usage increase and as gasoline prices decrease.[2] This trend was present for the period prior to 1970. Since 1970, however, VOC emissions from on-road vehicles have declined 58 percent while VMT and fuel usage increased. Gasoline prices decreased in real terms after 1980. These trends indicate the influence of regulation in reducing national VOC emissions from on-road vehicles.

In contrast, emissions from non-road engines and vehicles continued an increasing trend through the entire reporting period. Non-road VOC emissions have increased over 33 percent since 1970.

3.2.2.3.4 Remaining Sources — In 1900, emissions from the solid waste disposal and miscellaneous sources categories represented 10 percent and 24 percent of total VOC emissions. Although wildfires are somewhat erratic from year to year, fire prevention programs have been successful at decreasing wildfire emissions to 1 percent of the national total VOC emissions in 1996. In 1996, solid waste disposal emissions accounted for 2 percent of the national VOC emissions.

3.2.3 Sulfur Dioxide Emission Trends, 1900 through 1996

The trend in SO_2 emissions between 1940 and 1996 is presented in table 3-4, and between 1900 and 1996 in figure 3-8. The "all other" grouping includes the following Tier I categories: petroleum and related industries, other industrial processes, solvent utilization, waste disposal and recycling, chemical and allied product manufacturing, and storage and transport.

3.2.3.1 Fuel Combustion SO_2 Emissions: Electric Utility, Industrial, and Other

In 1900, electric utilities accounted for 4 percent of total national SO_2 emissions. Emissions from electric utilities steadily increased over the period 1900 to 1925 by a factor of 5. The SO_2 emissions from utilities decreased during the early portion of the 1930 decade due to the Great Depression. The 1940 emissions levels approximated those existing prior to the Depression. From 1940 to 1970, SO_2 emissions from electric utilities doubled every decade as a result of increased coal consumption. In 1970, emissions from coal combustion accounted for 62 percent of total SO_2 emissions from all fuel combustion sources. From 1970 to 1996, SO_2 emissions from electric utilities using all types of energy sources decreased approximately 26 percent. Sulfur dioxide emissions from fuel combustion - electric utilities account for 67 percent of the total national SO_2 emissions in 1996.

The SO_2 NAAQS was promulgated in 1971. Also in that year, the EPA developed a NSPS requiring that all new coal-fired power plants emit no more than 1.2 pounds of SO_2 per each million British thermal units (Btus) of electricity produced. Most new plants chose to meet this NSPS by shifting to lower-sulfur coals. An amendment to the CAA in 1977 effectively required any new coal-fired power plant not only to meet the original NSPS, but also to use some form of scrubbing equipment, even when using low-sulfur coal.

Between 1970 and 1993, SO_2 emissions declined 8 percent from coal-fired electric power facilities; this contrasts with a 150 percent increase in coal consumed to produce electricity.[3] In contrast, the average price per kilowatt hour of electricity increased in real terms between 1970 and 1982 and decreased thereafter.

Emissions from fuel combustion - industrial and other sources increased through the 1940 to 1970 period. Since 1970 SO_2 emissions have declined by 26 percent and 48 percent for fuel combustion - industrial and other sources, respectively. The decreases in SO_2 emissions from these sources reflect decreases in coal burning by industrial, commercial, and residential consumers.

Title IV (Acid Deposition Control) of the CAAA specifies that SO_2 emissions will be reduced by 10 million tons and NO_x emissions by 2 million tons from 1980 emissions levels. For electric utility units, the SO_2 reductions were to occur in two stages: Phase I, which affects 263 mostly coal-fired units and began in 1995; and Phase II, which affects the rest of the affected units and begins in the year 2000. Utilities were able to choose from among a variety of possibilities to achieve SO_2 emissions reductions in a cost effective manner, including participating in a market-based allowance trading system.[4]

Many utilities switched to low sulfur coal and some installed flue gas desulfurization equipment (scrubbers) for their Phase I units, achieving greater reductions in SO_2 emissions than were required under the Acid Rain Program. The Phase I units reduced their SO_2 emissions by 40 percent in 1 year, from 7.4 million tons in 1994 to 4.5 million tons in 1995, the first year of compliance.

Because actual, rather than estimated data have become available, recent Trends fossil fuel steam utility data methodology has improved. Rather than always using DOE Form EIA-767 as the basis for estimations, for specified years, NO_x, SO_2, and heat input have been obtained from more accurate sources. For 1985-1994, NO_x rates for most coal units were obtained and the emissions tonnage was calculated more accurately and replaced the data estimated from DOE Form EIA-767 data. For 1994-1996, the NO_x, SO_2, and heat input data were obtained from EPA/ARD's ETS/CEM data,[4] when possible. For 1994, the only available ETS/CEM data were for the SO_2 Phase I designated units; for 1995 and 1996, in accordance with the CAAA, all Phase I and Phase II affected operating utility units reported to ETS. The annual ETS/CEM data were provided by ARD and were disaggregated to the boiler-SCC level by EFIG. Figure 3-12 presents the SO_2 emissions along with heat input for the years 1985 through 1996.

3.2.3.2 Industrial Process SO_2 Emissions

The SO_2 emissions for metals processing increased by 44 percent over the period 1940 to 1970 and accounted for 15 percent of the total national emissions in 1970. During the period 1970 through 1996, emissions declined from this source by 89 percent due to the increased use of emission control devices for the industry. Metals processing accounted for 3 percent of total national SO_2 emissions in 1996. In particular, SO_2 emissions were greatly reduced at nonferrous smelters. By-product recovery of sulfuric acid at these smelters has increased since 1970, resulting in the recovered sulfuric acid not being emitted as SO_2.

Processing copper is one major type of metal processing that contributes to SO_2 emissions. A NSPS was issued by the EPA to regulate SO_2 emissions from copper smelters that are new, modified, or reconstructed after October 16, 1974. A 15 percent reduction in copper production took place between 1970 and 1993, while SO_2 emissions from copper production facilities declined 91 percent.[5]

Emissions from other industrial processes, chemical and allied manufacturing, and petroleum and related industries accounted for 4 percent of total SO_2 emissions in 1940 and 7 percent in 1970. Since 1970, emissions from these sources have declined by 54 percent. One factor contributing to the decline in SO_2 emissions from these sources is the NSPS for sulfuric acid manufacturing plants built, modified, or reconstructed after 1972.

3.2.3.3 Remaining Sources

In 1940, the emissions from the remaining sources of waste disposal and recycling, on-road vehicles, non-road engines and vehicles, and miscellaneous sources were 19 percent of total national SO_2 emissions. Emissions from railroads accounted for approximately 80 percent of the remaining source emissions in 1940. From 1940 to 1970, railroad emissions decreased 99 percent as a result of the obsolescence of coal-fired locomotives. Over the same period, emissions from the waste disposal and recycling and on-road vehicle categories increased by factors of 3 and 136, respectively. Between 1970 and 1996, the emissions for: waste disposal and recycling increased by a factor of 5 while on-road vehicle emissions decreased by 25 percent. The remaining source SO_2 emissions constituted 4 percent of the national total in 1996.

On August 21, 1990, EPA published regulations (54 FR 35276) that govern desulfurization of diesel motor fuel. Beginning October 1, 1993 all diesel fuel that contains a concentration of sulfur in excess of 0.05 percent by weight or which fails to meet a minimum cetane index of 40 cannot be used in motor vehicles. Reductions in SO_2 emissions from diesel motor vehicles of approximately 75 percent are expected to result from the desulfurization regulations.[6]

3.2.4 PM-10 Emission Trends, 1940 through 1996

The 1940 to 1996 trend in PM-10 emissions is presented in table 3-5 and figures 3-9 and 3-10. The emission trends for PM-10 sources are discussed separately for the non-fugitive dust and fugitive dust sources. The PM-10 fugitive dust sources are categorized as natural sources (geogenic - wind erosion) and some miscellaneous sources. Within the miscellaneous category are agriculture and forestry (agricultural crops and livestock) and fugitive dust [construction, mining and quarrying, point and area source paved roads and unpaved roads (unpaved airstrips)]. The PM-10 non-fugitive dust sources include all other PM-10 sources. Figure 3-13 presents a summary of the emission methodology changes in non-road estimates.

3.2.4.1 Non-Fugitive Dust Sources of PM-10 Emissions

The PM-10 non-fugitive dust sources include all PM-10 sources except the fugitive dust sources listed in section 3.2.4. The totals for both categories are presented in table 3-5 for the period 1940 through 1996. The "all other" grouping includes the following Tier I categories: fuel combustion - industrial; fuel combustion - other; petroleum and related industries; other industrial processes; chemical and allied product manufacturing; and waste disposal and recycling. The miscellaneous category consists primarily of wildfires and managed burning.

3.2.4.1.1 Fuel Combustion PM-10 Emissions: Electric Utility, Industrial, and Other — In 1940, emissions from fuel combustion represented 25 percent of non-fugitive dust PM-10 emissions. Electric utility PM-10 emissions result primarily from the combustion of coal. Emissions from this source increased by approximately 85 percent between 1940 and 1970. The increase in emissions during the 1940 to 1970 period corresponds with an increase in electric production using coal as an energy source. A NAAQS for total suspended particulate (TSP) was first promulgated in 1971. In 1987, the TSP standard was reviewed and revised to include only PM with an aerodynamic diameter less than or equal to 10 microns (referred to as PM-10). Beginning in December 1976, a NSPS for new, modified, or reconstructed fossil-fuel-fired steam generators became effective.

Between 1970 and 1993, PM-10 emissions declined 85 percent from coal-fired electric power facilities while coal consumption to produce electricity increased approximately 150 percent.[3]

In 1940, fuel combustion from the residential sector was the primary source of PM-10 fuel combustion - other emissions. Since 1940, PM-10 emissions from residential fuel combustion have declined by 76 percent due to a decrease in the use of coal and wood as an energy source in the residential sector.

3.2.4.1.2 Transportation PM-10 Emissions: On-Road Vehicles and Non-Road Engines and Vehicles — In 1940, emissions from transportation sources accounted for 17 percent of non-fugitive dust PM-10 emissions. Railroads and light-duty gasoline vehicles (LDGVs) contributed significantly to total 1940 emissions. From 1940 to 1970, railroad emissions decreased by 99 percent. Over the same period, LDGV emissions decreased by 49 percent. Although the 1996 emissions from transportation sources represent 21 percent of the total national PM-10 emissions from non-fugitive dust sources, PM-10 emissions from on-road vehicles and non-road engines and vehicles have declined approximately 68 percent during the 1940 to 1996 period.

3.2.4.1.3 Remaining Sources — PM-10 emissions from industrial processes increased from 1940 to 1950, primarily as a result of increases in industrial production. From 1950 to 1970, industrial output continued to grow, but emissions from industrial processes were reduced due to the installation of pollution control equipment mandated by State and local air pollution control programs. The reduction of emissions by these control devices was more than offset by the increase in emissions due to production increases. In 1970, industrial processes contributed 58 percent to the total national PM-10 from non-fugitive dust source emissions, while in 1996, these emissions had decreased to 23 percent, reflecting significant progress achieved in reducing emissions from this source category.

Another source of PM emissions is wildfires. Annual emissions from wildfires are quite variable depending upon the incidence of wildfires and on weather conditions in forested areas. However, due to the success of fire prevention programs, wildfire emissions have declined to 4 percent of total non-fugitive dust PM-10 emissions in 1996.

3.2.4.2 Fugitive Dust Sources

Fugitive dust source emission estimates were first presented in the 1991 *Trends* report. At that time, the emission estimates for fugitive dust sources were based on old emission factors and were developed based on limited data. The methods used to produce those estimates relied on State-level default data for most source categories. Emissions from fugitive dust sources are presented in table 3-5 and figure 3-10 for the period 1985 through 1996. As shown in figure 3-10, the methods used to produce post-1989 estimates for these sources have been revised to reflect improved emission factors, improved activity data, or both. (Chapter 6 details these revisions.)

For several source categories, the methodology for estimating fugitive dust emissions utilizes meteorological data such as the number of days with greater than 0.01 inches of precipitation and average monthly wind speed. These data can vary significantly from year-to-year, resulting in highly variable emissions.

The PM-10 emissions from fugitive dust sources decreased by 33 percent from 1985 to 1996 due primarily to changes in emission methodologies for several of the fugitive dust soruces. During this time period, the emissions ranged from 56 to 23 million short tons in 1988 and 1995, respectively.

For 1996, total national fugitive dust PM-10 emissions were estimated to be about about 7 times greater than the total emissions from non-fugitive dust sources.

3.2.5 Lead Emission Trends, 1970 through 1996

The trend in Pb emissions is presented in table 3-6 and figure 3-11 for the period 1970 through 1996. The “all other” grouping includes the following Tier I categories: fuel combustion - electric utility; fuel combustion - industrial; other industrial processes; and chemical and allied product manufacturing.

3.2.5.1 Fuel Combustion Lead Emissions: Electric Utility, Industrial, and Other

Fuel combustion emissions in 1970 accounted for 5 percent of total Pb emissions. While emissions from these sources have decreased 95 percent during the 1970 to 1996 period, these sources contributed 13 percent to the total national Pb emissions in 1996.

3.2.5.2 Industrial Process Lead Emissions

Industrial process emissions contributed 12 percent to total national Pb emissions in 1970. Since that time these emissions have decreased 92 percent, but accounted for 56 percent of total Pb emissions in 1996.

3.2.5.3 Transportation Lead Emissions: On-Road Vehicles and Non-Road Engines and Vehicles

The overwhelming majority of Pb emissions has historically been attributable to one major source — on-road vehicles. Lead emissions from on-road vehicles accounted for 78 percent of total emissions in 1970. Total national Pb emissions decreased sharply from 1970 to 1996 as the result of regulatory actions. The Pb NAAQS was promulgated in October 1978. The Pb phase-down program has required the gradual reduction of the Pb content of all gasoline over a period of many years. The Pb content of leaded gasoline was reduced dramatically from an average of 1.0 gram per gallon (gpg) to 0.5 gpg on July 1, 1985, and still further to 0.1 gpg on January 1, 1986. In addition, as part of EPA's overall automotive emission control program, unleaded gasoline was introduced in 1975 for use in automobiles equipped with catalytic control devices. These devices reduce CO, VOC, and NO_x emissions. In 1975, unleaded gasoline’s share of the total gasoline market was 13 percent. In 1982, the unleaded share of the total gasoline market was approximately 50 percent. By 1996, unleaded gasoline sales accounted for 100 percent of the gasoline market. In 1996, on-road vehicles contributed 0.5 percent of annual Pb emissions, down substantially from 81 percent in 1983. The CAAA mandates that leaded gasoline be prohibited for use in highway vehicles after December 31, 1995. Table A-6 (see appendix A) indicates that Pb emissions decrease dramatically between 1990 and 1991. This decrease is the result of large changes in the values for Pb in gasoline. However, since the prohibition on Pb in gasoline did not officially begin until January 1, 1996, the reductions calculated for 1991 and later are primarily the result of limited data on trace Pb levels in gasoline for these years. Thus the full reduction that begins in 1991 may, in reality, occur several years beyond that. Figure 3-13 presents a summary of the emission methodology changes in non-road estimates.

Absent regulation, one would predict that Pb emissions from vehicles would increase as VMT and fuel use increase and as gasoline prices decline. Between 1970 and 1993, fuel consumption and VMT increased approximately 50 percent and 100 percent,[2] respectively, while on-road Pb emissions declined by 99 percent. Gasoline prices have declined since 1980 in real terms.[b] The downward trend in Pb emissions is the direct result of regulatory actions reducing the Pb content of gasoline.

3.3 REFERENCES

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3. U.S. Department of Energy, Energy Information Administration, *Electric Power Monthly*, Washington, DC, various editions.
4. *1995 Compliance Results*, Acid Rain Program, EPA-430/R-96-012. Office of Air and Radiation, U.S. Environmental Protection Agency, Washington, DC. July 1996.
5. U.S. Department of Interior, Bureau of Mines, "Cement," *Minerals Yearbook*, Washington, DC, various years.
6. *Development of an Industrial SO_2 Emissions Inventory Baseline and 1995 Report to Congress*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1994.

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[a] As an aside the non-road diesel VOC excludes CH_4 but includes aldehydes.

[b] Gasoline prices have been adjusted to consider the change in prices occurring on average for all goods and services in the economy. A decline in gasoline prices in real terms means that gasoline prices have declined, on average, relative to all other goods in the economy during the 1970 to 1993 period.

Table 3-1. Total National Emissions of Carbon Monoxide, 1940 through 1996
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1995	1996
FUEL COMB. ELEC. UTIL.	***4***	***110***	***110***	***237***	***322***	***363***	***372***	***377***
FUEL COMB. INDUSTRIAL	***435***	***549***	***661***	***770***	***750***	***879***	***1,056***	***1,072***
FUEL COMB. OTHER	***14,890***	***10,656***	***6,250***	***3,625***	***6,230***	***4,269***	***4,506***	***4,513***
Residential Wood	11,279	7,716	4,743	2,932	5,992	3,781	3,999	3,993
CHEMICAL & ALLIED PRODUCT MFG	***4,190***	***5,844***	***3,982***	***3,397***	***2,151***	***1,183***	***1,223***	***1,223***
Other Chemical Mfg	4,139	5,760	3,775	2,866	1,417	854	939	939
carbon black mfg	*4,139*	*5,760*	*3,775*	*2,866*	1,417	*798*	*845*	*845*
METALS PROCESSING	***2,750***	***2,910***	***2,866***	***3,644***	***2,246***	***2,640***	***2,380***	***2,378***
Nonferrous Metals Processing	36	118	326	652	842	436	424	424
Ferrous Metals Processing	2,714	2,792	2,540	2,991	1,404	2,163	1,930	1,929
basic oxygen furnace	*NA*	*NA*	*23*	*440*	*80*	*594*	*561*	*561*
PETROLEUM & RELATED INDUSTRIES	***221***	***2,651***	***3,086***	***2,179***	***1,723***	***333***	***348***	***348***
Oil & Gas Production	NA	NA	NA	NA	NA	38	34	34
Petroleum Refineries & Related Industries	221	2,651	3,086	2,168	1,723	291	309	308
fluid catalytic cracking units	*210*	*2,528*	*2,810*	*1,820*	*1,680*	*284*	*299*	*299*
OTHER INDUSTRIAL PROCESSES	***114***	***231***	***342***	***620***	***830***	***537***	***624***	***635***
Wood, Pulp & Paper, & Publishing Products	110	220	331	610	798	473	484	494
sulfate pulping: rec. furnace/evaporator	*NA*	*NA*	*NA*	*NA*	*NA*	*370*	*370*	*377*
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***NA***	***NA***	***5***	***6***	***6***
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***NA***	***NA***	***76***	***25***	***25***
WASTE DISPOSAL & RECYCLING	***3,630***	***4,717***	***5,597***	***7,059***	**2,300**	***1,079***	***1,185***	***1,203***
Incineration	2,202	2,711	2,703	2,979	1,246	372	432	443
residential	*716*	*824*	*972*	*1,107*	*945*	*294*	*351*	*360*
Open Burning	1,428	2,006	2,894	4,080	*1,054*	706	750	757
residential	*NA*	*NA*	*NA*	*NA*	NA	*509*	*536*	*539*
ON-ROAD VEHICLES	***30,121***	***45,196***	***64,266***	***88,034***	***78,049***	***57,848***	***54,106***	***52,944***
Light-Duty Gas Vehicles & Motorcycles	22,237	31,493	47,679	64,031	*53,561*	37,407	33,701	33,144
light-duty gas vehicles	*22,232*	*31,472*	*47,655*	*63,846*	53,342	*37,198*	*33,500*	*32,940*
Light-Duty Gas Trucks	3,752	6,110	7,791	16,570	16,137	13,816	14,829	14,746
light-duty gas trucks 1	*2,694*	*4,396*	*5,591*	*10,102*	10,395	*8,415*	*8,415*	*8,377*
light-duty gas trucks 2	*1,058*	*1,714*	*2,200*	*6,468*	5,742	*5,402*	*6,414*	*6,368*
Heavy-Duty Gas Vehicles	4,132	7,537	8,557	6,712	7,189	5,360	4,123	3,601
Diesels	NA	54	239	721	1,161	1,265	1,453	1,453
heavy-duty diesel vehicles	*NA*	*54*	*239*	*721*	*1,139*	*1,229*	*1,412*	*1,411*
NON-ROAD ENGINES AND VEHICLES	***8,051***	***11,610***	***11,575***	***11,287***	***13,758***	***16,117***	***16,841***	***17,002***
Non-Road Gasoline	3,777	7,331	8,753	9,478	*11,004*	13,090	13,806	13,937
industrial	*780*	*1,558*	*1,379*	*732*	*970*	*1,373*	*1,436*	*1,446*
lawn & garden	*NA*	*NA*	*NA*	*4,679*	*5,366*	*6,438*	*6,895*	*6,949*
light commercial	*NA*	*NA*	*NA*	*2,437*	*2,680*	*2,404*	*2,621*	*2,658*
recreational marine vessels	*60*	*120*	*518*	*976*	*1,102*	*1,681*	*1,763*	*1,775*
Non-Road Diesel	32	53	65	1,225	1,879	1,827	1,897	1,922
construction	*20*	*43*	*40*	*478*	*682*	*752*	*768*	*775*
farm	*12*	*10*	*17*	*577*	*972*	*797*	*830*	*843*
Aircraft	4	934	1,764	506	*743*	858	890	896
Railroads	4,083	3,076	332	65	*96*	110	104	103
MISCELLANEOUS	***29,210***	***18,135***	***11,010***	***7,909***	***8,344***	***11,208***	***7,050***	***7,099***
Other Combustion	29,210	18,135	11,010	7,909	*8,344*	11,207	7,049	7,098
agricultural fires	*1,653*	*2,672*	*2,200*	*873*	*501*	*415*	*465*	*475*
slash/prescribed burning	*1,476*	*2,940*	*2,940*	*1,146*	*2,226*	*4,668*	*4,916*	*4,955*
forest wildfires	*25,130*	*11,159*	*4,487*	*5,620*	*5,396*	*5,928*	*1,469*	*1,469*
TOTAL ALL SOURCES	**93,616**	**102,609**	**109,745**	**128,761**	**116,702**	**96,535**	**89,721**	**88,822**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate. Zero values represent less than 500 short tons/year.
Categories displayed below Tier I do not sum to Tier I totals because they are intended to show major contributors. 1996 emissions are preliminary.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-2. Total National Emissions of Nitrogen Oxides, 1940 through 1996
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1995	1996
FUEL COMB. ELEC. UTIL.	***660***	***1,316***	***2,536***	***4,900***	***7,024***	***6,663***	***6,384***	***6,034***
Coal	467	1,118	2,038	3,888	6,123	5,642	5,579	5,517
bituminous	*255*	*584*	*1,154*	*2,112*	*3,439*	*4,532*	*3,830*	*3,813*
Oil	193	198	498	1,012	901	221	96	96
residual	*6*	*23*	*8*	*40*	*39*	*207*	*94*	*94*
distillate	*187*	*175*	*490*	*972*	*862*	*14*	*2*	*2*
Gas	NA	NA	NA	NA	NA	565	562	269
natural	*NA*	*NA*	*NA*	*NA*	*NA*	*565*	*562*	*269*
FUEL COMB. INDUSTRIAL	***2,543***	***3,192***	***4,075***	***4,325***	***3,555***	***3,035***	***3,144***	***3,170***
Coal	2,012	1,076	782	771	444	585	597	599
Oil	122	237	239	332	286	265	247	246
Gas	365	1,756	2,954	3,060	2,619	1,182	1,324	1,336
natural	*337*	*1,692*	*2,846*	*3,053*	*2,469*	*967*	*1,102*	*1,114*
Internal Combustion	NA	NA	NA	NA	NA	874	854	864
FUEL COMB. OTHER	***529***	***647***	***760***	***836***	***741***	***1,196***	***1,298***	***1,289***
Commercial/Institutional Gas	7	18	55	120	131	200	231	234
Residential Other	177	227	362	439	356	780	847	838
natural gas	*20*	*50*	*148*	*242*	*238*	*449*	*519*	*523*
CHEMICAL & ALLIED PRODUCT MFG	***6***	***63***	***110***	***271***	***216***	***168***	***158***	***159***
METALS PROCESSING	***4***	***110***	***110***	***77***	***65***	***97***	***98***	***98***
PETROLEUM & RELATED INDUSTRIES	***105***	***110***	***220***	***240***	***72***	***153***	***110***	***110***
OTHER INDUSTRIAL PROCESSES	***107***	***93***	***131***	***187***	***205***	***378***	***399***	***403***
Mineral Products	105	89	123	169	181	270	287	290
cement mfg	*32*	*55*	*78*	*97*	*98*	*151*	*153*	*155*
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***NA***	***NA***	***1***	***3***	***3***
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***NA***	***NA***	***3***	***6***	***6***
WASTE DISPOSAL & RECYCLING	***110***	***215***	***331***	***440***	***111***	***91***	***99***	***100***
ON-ROAD VEHICLES	***1,330***	***2,143***	***3,982***	***7,390***	***8,621***	***7,040***	***7,323***	***7,171***
Light-Duty Gas Vehicles & Motorcycles	970	1,415	2,607	4,158	4,421	3,220	3,444	3,403
light-duty gas vehicles	*970*	*1,415*	*2,606*	*4,156*	*4,416*	*3,208*	*3,431*	*3,389*
Light-Duty Gas Trucks	204	339	525	1,278	1,408	1,256	1,520	1,510
light-duty gas trucks 1	*132*	*219*	*339*	*725*	*864*	*784*	*902*	*891*
light-duty gas trucks 2	*73*	*120*	*186*	*553*	*544*	*472*	*617*	*619*
Heavy-Duty Gas Vehicles	155	296	363	278	300	326	332	326
Diesels	NA	93	487	1,676	2,493	2,238	2,028	1,933
heavy-duty diesel vehicles	*NA*	*93*	*487*	*1,676*	*2,463*	*2,192*	*1,979*	*1,884*
NON-ROAD ENGINES AND VEHICLES	***991***	***1,538***	***1,443***	***2,642***	***4,017***	***4,593***	***4,675***	***4,610***
Non-Road Gasoline	122	249	312	81	102	199	206	207
Non-Road Diesel	103	187	247	1,954	2,969	3,079	3,087	3,089
construction	*70*	*158*	*157*	*864*	*1,232*	*1,394*	*1,390*	*1,386*
farm	*33*	*29*	*50*	*766*	*1,295*	*1,128*	*1,106*	*1,112*
Aircraft	NA	2	4	72	106	158	165	167
Marine Vessels	109	108	108	40	110	229	227	227
Railroads	657	992	772	495	731	929	990	922
MISCELLANEOUS	***990***	***665***	***441***	***330***	***248***	***371***	***237***	***239***
TOTAL ALL SOURCES	**7,374**	**10,093**	**14,140**	**21,639**	**24,875**	**23,792**	**23,935**	**23,393**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate. Zero values represent less than 500 short tons/year.
Categories displayed below Tier I do not sum to Tier I totals because they are intended to show major contributors. 1996 emissions are preliminary.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-3. Total National Emissions of Volatile Organic Compounds, 1940 through 1996 (thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1995	1996
FUEL COMB. ELEC. UTIL.	***2***	***9***	***9***	***30***	***45***	***47***	***44***	***45***
FUEL COMB. INDUSTRIAL	***108***	***98***	***106***	***150***	***157***	***182***	***206***	***208***
FUEL COMB. OTHER	***1,867***	***1,336***	***768***	***541***	***848***	***776***	***823***	***822***
Residential Wood	1,410	970	563	460	809	718	759	758
CHEMICAL & ALLIED PRODUCT MFG	***884***	***1,324***	***991***	***1,341***	***1,595***	***634***	***660***	***436***
METALS PROCESSING	***325***	***442***	***342***	***394***	***273***	***122***	***125***	***70***
PETROLEUM & RELATED INDUSTRIES	***571***	***548***	***1,034***	***1,194***	***1,440***	***612***	***642***	***517***
OTHER INDUSTRIAL PROCESSES	***130***	***184***	***202***	***270***	***237***	***401***	***450***	***439***
SOLVENT UTILIZATION	***1,971***	***3,679***	***4,403***	***7,174***	***6,584***	***5,750***	***6,183***	***6,273***
Degreasing	168	592	438	707	513	744	789	661
Graphic Arts	114	310	199	319	373	274	339	389
Dry Cleaning	42	153	126	263	320	215	230	190
petroleum solvent	*NA*	*NA*	*NA*	*NA*	*NA*	*104*	*112*	*119*
Surface Coating	1,058	2,187	2,128	3,570	3,685	2,523	2,681	2,881
industrial adhesives	*14*	*41*	*29*	*52*	*55*	*390*	*410*	*454*
architectural	*284*	*NA*	*412*	*442*	*477*	*495*	*522*	*554*
Nonindustrial	490	NA	1,189	1,674	1,002	1,900	2,048	2,100
cutback asphalt	*328*	*NA*	*789*	*1,045*	*323*	*199*	*227*	*128*
pesticide application	*73*	*NA*	*193*	*241*	*241*	*258*	*299*	*360*
adhesives	*NA*	*NA*	*NA*	*NA*	*NA*	*361*	*380*	*403*
consumer solvents	*NA*	*NA*	*NA*	*NA*	*NA*	*1,083*	*1,142*	*1,210*
STORAGE & TRANSPORT	***639***	***1,218***	***1,762***	***1,954***	***1,975***	***1,495***	***1,652***	***1,312***
Bulk Terminals & Plants	185	361	528	599	517	359	406	243
area source: gasoline	*158*	*307*	*449*	*509*	*440*	*282*	*322*	*162*
Petroleum & Petroleum Product Storage	148	218	304	300	306	157	191	133
Petroleum & Petroleum Product Transport	57	100	115	92	61	151	134	131
Service Stations: Stage I	117	251	365	416	461	300	334	341
Service Stations: Stage II	130	283	437	521	583	403	484	406
WASTE DISPOSAL & RECYCLING	***990***	***1,104***	***1,546***	***1,984***	***758***	***986***	***1,067***	***433***
ON-ROAD VEHICLES	***4,817***	***7,251***	***10,506***	***12,972***	***8,979***	***6,313***	***5,701***	***5,502***
Light-Duty Gas Vehicles & Motorcycles	3,647	5,220	8,058	9,193	5,907	3,947	3,426	3,323
light-duty gas vehicles	*3,646*	*5,214*	*8,050*	*9,133*	*5,843*	*3,885*	*3,385*	*3,284*
Light-Duty Gas Trucks	672	1,101	1,433	2,770	2,059	1,622	1,629	1,582
Heavy-Duty Gas Vehicles	498	908	926	743	611	432	327	286
Diesels	NA	22	89	266	402	312	319	312
NON-ROAD ENGINES AND VEHICLES	***778***	***1,213***	***1,215***	***1,713***	***2,142***	***2,502***	***2,433***	***2,426***
Non-Road Gasoline	208	423	526	1,284	1,474	1,756	1,692	1,685
lawn & garden	*NA*	*NA*	*NA*	*574*	*655*	*720*	*823*	*799*
recreational marine vessels	*16*	*32*	*124*	*350*	*395*	*562*	*432*	*459*
Non-Road Diesel	12	20	23	300	464	465	466	467
construction	*6*	*15*	*13*	*104*	*148*	*167*	*166*	*167*
farm	*6*	*5*	*8*	*152*	*257*	*224*	*219*	*220*
Aircraft	3	110	220	97	146	180	178	177
NATURAL SOURCES	***NA***	***NA***	***NA***	***NA***	***NA***	***14***	***14***	***14***
MISCELLANEOUS	***4,079***	***2,530***	***1,573***	***1,101***	***1,134***	***1,150***	***586***	***587***
Other Combustion	4,079	2,530	1,573	1,101	1,134	1,060	508	513
TOTAL ALL SOURCES	**17,161**	**20,936**	**24,459**	**30,817**	**26,167**	**20,985**	**20,586**	**19,086**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate. Zero values represent less than 500 short tons/year.
Categories displayed below Tier I do not sum to Tier I totals because they are intended to show major contributors. 1996 emissions are preliminary.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-4. Total National Emissions of Sulfur Dioxide, 1940 through 1996
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1995	1996
FUEL COMB. ELEC. UTIL.	***2,427***	***4,515***	***9,263***	***17,398***	***17,469***	***15,909***	***12,080***	***12,604***
Coal	2,276	4,056	8,883	15,799	16,073	15,220	11,603	12,114
bituminous	*1,359*	*2,427*	*5,367*	*9,574*	*NA*	*13,371*	*8,609*	*9,123*
subbituminous	*668*	*1,196*	*2,642*	*4,716*	*NA*	*1,415*	*2,345*	*2,366*
anthracite & lignite	*249*	*433*	*873*	*1,509*	*NA*	*434*	*649*	*625*
Oil	151	459	380	1,598	1,395	639	413	412
residual	*146*	*453*	*375*	*1,578*	*NA*	*629*	*408*	*408*
FUEL COMB. INDUSTRIAL	***6,060***	***5,725***	***3,864***	***4,568***	***2,951***	***3,550***	***3,357***	***3,399***
Coal	5,188	4,423	2,703	3,129	1,527	1,914	1,728	1,762
bituminous	*3,473*	*2,945*	*1,858*	*2,171*	*1,058*	*1,050*	*1,003*	*1,005*
Oil	554	972	922	1,229	1,065	927	911	918
residual	*397*	*721*	*663*	*956*	*851*	*686*	*700*	*708*
distillate	*9*	*49*	*42*	*98*	*85*	*198*	*191*	*191*
Gas	145	180	189	140	299	543	547	548
FUEL COMB. OTHER	***3,642***	***3,964***	***2,319***	***1,490***	***971***	***831***	***793***	***782***
Commercial/Institutional Coal	695	1,212	154	109	110	212	199	200
Commercial/Institutional Oil	407	658	905	883	637	425	397	389
Residential Other	2,517	2,079	1,250	492	211	175	176	173
bituminous/subbituminous coal	*2,267*	*1,758*	*868*	*260*	*43*	*30*	*24*	*21*
CHEMICAL & ALLIED PRODUCT MFG	***215***	***427***	***447***	***591***	***280***	***297***	***286***	***287***
Inorganic Chemical Mfg	215	427	447	591	271	214	199	199
sulfur compounds	*215*	*427*	*447*	*591*	*271*	*211*	*195*	*195*
METALS PROCESSING	***3,309***	***3,747***	***3,986***	***4,775***	***1,842***	***726***	***530***	***530***
Nonferrous Metals Processing	2,760	3,092	3,322	4,060	1,279	517	361	362
copper	*2,292*	*2,369*	*2,772*	*3,507*	*1,080*	*323*	*177*	*177*
lead	*80*	*95*	*57*	*77*	*34*	*129*	*126*	*126*
Ferrous Metals Processing	550	655	664	715	562	186	151	151
PETROLEUM & RELATED INDUSTRIES	***224***	***340***	***676***	***881***	***734***	***430***	***369***	***368***
Oil & Gas Production	NA	14	114	111	157	122	89	89
natural gas	*NA*	*14*	*114*	*111*	*157*	*120*	*88*	*88*
Petroleum Refineries & Related Industries	224	326	562	770	577	304	271	271
fluid catalytic cracking units	*220*	*242*	*383*	*480*	*330*	*183*	*188*	*188*
OTHER INDUSTRIAL PROCESSES	***334***	***596***	***671***	***846***	***918***	***399***	***403***	***409***
Wood, Pulp & Paper, & Publishing Products	NA	43	114	169	223	116	114	117
Mineral Products	334	553	557	677	694	275	282	285
cement mfg	*318*	*522*	*524*	*618*	*630*	181	171	172
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***NA***	***NA***	***0***	***1***	***1***
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***NA***	***NA***	***7***	***2***	***2***
WASTE DISPOSAL & RECYCLING	***3***	***3***	***10***	***8***	***33***	***42***	***47***	***48***
ON-ROAD VEHICLES	***3***	***103***	***114***	***411***	***521***	***542***	***304***	***307***
Light-Duty Gas Vehicles & Motorcycles	NA	NA	NA	132	159	138	143	144
Diesels	NA	NA	NA	231	303	337	80	80
NON-ROAD ENGINES AND VEHICLES[1]	***3,190***	***2,392***	***321***	***83***	***175***	***392***	***372***	***368***
Marine Vessels	215	215	105	43	117	251	239	237
Railroads	2,975	2,174	215	36	53	122	113	111
MISCELLANEOUS	***545***	***545***	***554***	***110***	***11***	***12***	***9***	***9***
Other Combustion	545	545	554	110	11	12	9	9
Fugitive Dust				NA	NA	0	0	0
TOTAL ALL SOURCES	**19,952**	**22,357**	**22,227**	**31,161**	**25,905**	**23,136**	**18,552**	**19,113**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate. Zero values represent less than 500 short tons/year.
Categories displayed below Tier I do not sum to Tier I totals because they are intended to show major contributors. 1996 emissions are preliminary.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.
[1] Non-road diesel emissions are not available.

Table 3-5. Total National Emissions of Particulate Matter (PM-10), 1940 through 1996
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1995	1996
FUEL COMB. ELEC. UTIL.	***962***	***1,467***	***2,117***	***1,775***	***879***	***295***	***268***	***282***
Coal	954	1,439	2,092	1,680	796	265	244	257
bituminous	*573*	*865*	*1,288*	*1,041*	*483*	*188*	*174*	*185*
FUEL COMB. INDUSTRIAL	***708***	***604***	***331***	***641***	***679***	***270***	***302***	***306***
Coal	549	365	146	83	18	84	70	71
Other	120	160	103	441	571	87	73	75
FUEL COMB. OTHER	***2,338***	***1,674***	***1,113***	***455***	***887***	***631***	***610***	***598***
Residential Wood	1,716	1,128	850	384	818	501	484	472
CHEMICAL & ALLIED PRODUCT MFG	***330***	***455***	***309***	***235***	***148***	***77***	***67***	***67***
METALS PROCESSING	***1,208***	***1,027***	***1,026***	***1,316***	***622***	***214***	***212***	***211***
Nonferrous Metals Processing	588	346	375	593	130	50	41	40
copper	*217*	*105*	*122*	*343*	*32*	*14*	*12*	*11*
Ferrous Metals Processing	246	427	214	198	322	155	149	149
primary	*86*	*98*	*51*	*31*	*271*	*128*	*123*	*123*
PETROLEUM & RELATED INDUSTRIES	***366***	***412***	***689***	***286***	***138***	***55***	***40***	***40***
OTHER INDUSTRIAL PROCESSES	***3,996***	***6,954***	***7,211***	***5,832***	***1,846***	***583***	***511***	***510***
Agriculture, Food, & Kindred Products	784	696	691	485	402	73	80	80
country elevators	*299*	*307*	*343*	*257*	*258*	*9*	*9*	*9*
terminal elevators	*351*	*258*	*224*	*147*	*86*	*6*	*7*	*7*
Wood, Pulp & Paper, & Publishing Products	511	798	958	727	183	105	81	82
sulfate (kraft) pulping	*470*	*729*	*886*	*668*	*142*	*73*	*53*	*54*
Mineral Products	2,701	5,460	5,563	4,620	1,261	367	317	314
cement mfg	*1,363*	*1,998*	*2,014*	*1,731*	*417*	*190*	*140*	*137*
stone quarrying/processing	*482*	*663*	*1,039*	*957*	*421*	*54*	*58*	*58*
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***NA***	***NA***	***4***	***6***	***6***
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***NA***	***NA***	***102***	***109***	***109***
Bulk Materials Storage	NA	NA	NA	NA	NA	100	107	107
WASTE DISPOSAL & RECYCLING	***392***	***505***	***764***	***999***	***273***	***271***	***287***	***290***
Open Burning	220	333	544	770	198	206	217	218
residential	*220*	*333*	*544*	*770*	*198*	*195*	*204*	*205*
ON-ROAD VEHICLES	***210***	***314***	***554***	***443***	***397***	***336***	***293***	***274***
Diesels	NA	9	15	136	208	235	190	172
heavy-duty diesel vehicles	*NA*	*9*	*15*	*136*	*194*	*224*	*181*	*162*
NON-ROAD ENGINES AND VEHICLES	***2,480***	***1,788***	***201***	***369***	***566***	***598***	***585***	***591***
Non-Road Diesel	1	16	22	281	439	420	438	444
construction	*0*	*12*	*12*	*102*	*148*	*160*	*164*	*166*
farm	*0*	*4*	*7*	*140*	*239*	*196*	*204*	*208*
Railroads	2,464	1,742	110	25	37	53	27	27
NATURAL SOURCES	***NA***	***NA***	***NA***	***NA***	***NA***	***2,092***	***1,146***	***5,316***
wind erosion	*NA*	*NA*	*NA*	*NA*	*NA*	2,092	1,146	5,316
MISCELLANEOUS	***2,968***	***1,934***	***1,244***	***839***	***852***	***24,419***	***22,454***	***22,702***
Agriculture & Forestry	NA	NA	NA	NA	NA	5,146	4,661	4,708
agricultural crops	*NA*	*NA*	*NA*	*NA*	*NA*	4,745	4,334	4,395
agricultural livestock	*NA*	*NA*	*NA*	*NA*	*NA*	402	328	313
Other Combustion	2,968	1,934	1,244	839	852	1,203	778	783
wildfires	*2,179*	*1,063*	*428*	*385*	*514*	*601*	*145*	*145*
managed burning	*591*	*662*	*606*	*390*	*315*	*558*	*586*	*591*
Fugitive Dust	NA	NA	NA	NA	NA	18,069	17,013	17,209
unpaved roads	*NA*	*NA*	*NA*	*NA*	*NA*	*11,234*	*10,362*	*10,303*
paved roads	*NA*	*NA*	*NA*	*NA*	*NA*	*2,248*	*2,409*	*2,417*
construction				*NA*	*NA*	*4,249*	*3,654*	*3,950*
TOTAL ALL SOURCES	**15,957**	**17,133**	**15,558**	**13,190**	**7,287**	**29,947**	**26,888**	**31,301**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate. Zero values represent less than 500 short tons/year.
Categories displayed below Tier I do not sum to Tier I totals because they are intended to show major contributors. 1996 emissions are preliminary.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-6. Total National Emissions of Lead, 1970 through 1996
(short tons)

Source Category	1970	1975	1980	1985	1990	1995	1996
FUEL COMB. ELEC. UTIL.	***327***	***230***	***129***	***64***	***64***	***57***	***62***
Coal	300	189	95	51	46	50	50
bituminous	*181*	*114*	*57*	*31*	*28*	*30*	*31*
Oil	28	41	34	13	18	7	12
FUEL COMB. INDUSTRIAL	***237***	***75***	***60***	***30***	***18***	***16***	***17***
Coal	218	60	45	22	14	14	14
bituminous	*146*	*40*	*31*	*15*	*10*	*9*	*9*
Oil	19	16	14	8	3	3	3
FUEL COMB. OTHER	***10,052***	***10,042***	***4,111***	***421***	***418***	***414***	***414***
Misc. Fuel Comb. (Except Residential)	10,000	10,000	4,080	400	400	400	400
CHEMICAL & ALLIED PRODUCT MFG	***103***	***120***	***104***	***118***	***136***	***144***	***117***
Inorganic Chemical Mfg	103	120	104	118	136	144	117
lead oxide and pigments	*103*	*120*	*104*	*118*	*136*	*144*	*117*
METALS PROCESSING	***24,224***	***9,923***	***3,026***	***2,097***	***2,169***	***2,067***	***2,000***
Nonferrous Metals Processing	15,869	7,192	1,826	1,376	1,409	1,339	1,282
primary lead production	*12,134*	*5,640*	*1,075*	*874*	*728*	*674*	*636*
primary copper production	*242*	*171*	*20*	*19*	*19*	*21*	*22*
primary zinc production	*1,019*	*224*	*24*	*16*	*9*	*12*	*13*
secondary lead production	*1,894*	*821*	*481*	*288*	*449*	*432*	*400*
secondary copper production	*374*	*200*	*116*	*70*	*75*	*79*	*85*
lead battery manufacture	*41*	*49*	*50*	*65*	*78*	*105*	*105*
lead cable coating	*127*	*55*	*37*	*43*	*50*	*16*	*21*
Ferrous Metals Processing	7,395	2,196	911	577	576	545	524
coke manufacturing	*11*	*8*	*6*	*3*	*4*	*0*	*0*
ferroalloy production	*219*	*104*	*13*	*7*	*18*	*8*	*7*
iron production	*266*	*93*	*38*	*21*	*18*	*19*	*18*
steel production	*3,125*	*1,082*	*481*	*209*	*138*	*152*	*160*
gray iron production	*3,773*	*910*	*373*	*336*	*397*	*366*	*339*
Metals Processing NEC	960	535	289	144	184	183	194
metal mining	*353*	*268*	*207*	*141*	*184*	*183*	*193*
OTHER INDUSTRIAL PROCESSES	***2,028***	***1,337***	***808***	***316***	***169***	***59***	***57***
Mineral Products	540	217	93	43	26	29	30
cement manufacturing	*540*	*217*	*93*	*43*	*26*	*29*	*30*
Miscellaneous Industrial Processes	1,488	1,120	715	273	143	30	28
WASTE DISPOSAL & RECYCLING	***2,200***	***1,595***	***1,210***	***871***	***804***	***622***	***638***
Incineration	2,200	1,595	1,210	871	804	622	638
municipal waste	*581*	*396*	*161*	*79*	*67*	*70*	*74*
other	*1,619*	*1,199*	*1,049*	*792*	*738*	*552*	*564*
ON-ROAD VEHICLES	***171,961***	***130,206***	***60,501***	***18,052***	***421***	***19***	***19***
Light-Duty Gas Vehicles & Motorcycles	142,918	106,868	47,184	13,637	314	14	14
Light-Duty Gas Trucks	22,683	19,440	11,671	4,061	100	5	5
Heavy-Duty Gas Vehicles	6,361	3,898	1,646	354	7	0	0
NON-ROAD ENGINES AND VEHICLES	***9,737***	***6,130***	***4,205***	***921***	***776***	***545***	***545***
Non-Road Gasoline	8,340	5,012	3,320	229	158	0	0
Aircraft	1,397	1,118	885	692	619	545	545
TOTAL ALL SOURCES	**220,869**	**159,659**	**74,153**	**22,890**	**4,975**	**3,943**	**3,869**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate. Zero values represent less than 500 short tons/year.
Categories displayed below Tier I do not sum to Tier I totals because they are intended to show major contributors. 1996 emissions are preliminary.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-7. Carbon Monoxide Emission Standards, 1970 to Present

	Emission Limit (grams of CO per mile)	
Model year	**Light-duty Vehicles**	**Light-duty Trucks (0 to 6,000 lbs.)**
1970-1971	23	
1972-1974	39	39
1975-1979	15	20[1]
1980-1993	3.4[2]	18[3],10[4]
1994+	3.4[5]	4.4[5]
1994+	4.2[6]	5.5[6]

Note(s):
1 Standard applies for 1975-1978 model years.
2 Certain vehicles were subject to a less stringent requirement of 7.0 grams per mile from model years 1980-1984.
3 Standard applies for 1979-1983 model years.
4 Standard applies for 1984-1993 model years.
5 Standards applicable to vehicles that have a useful life (for certification purposes) of 5 years or 50,000 miles, whichever comes first.
6 Standards applicable to vehicles that have a useful life (for certification purposes) of 10 years or 100,000 miles, whichever comes first.

Table 3-8. Nitrogen Oxide and Volatile Organic Compound Emission Limits for Light-Duty Vehicles

	Emission Limit (grams per mile)	
Model Year	**NO_x**	**VOC[1]**
1972-1974	3.0[2]	3.4
1975-1979	3.1[3], 2.0[4]	1.5
1980-1993	1.0[5]	0.41
[6]1994+	0.4	0.25
[7]1994+	0.6	0.31

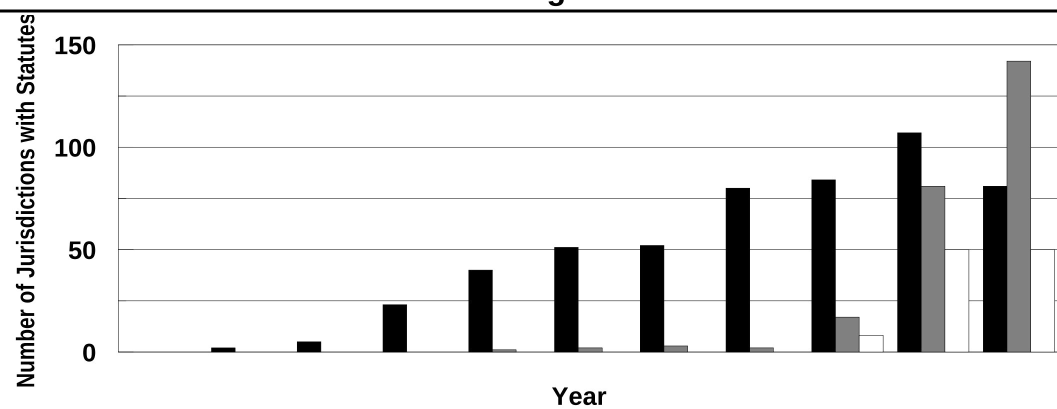
Note(s):
1 These are exhaust emission standards for VOC.
2 Standard applies for 1973-1974 model years.
3 Standard applies for 1975-1976 model years.
4 Standard applies for 1977-1980 model years.
5 Standard applies for 1981-1993 model years.
6 Standard applicable to vehicles that have a useful life (for certification purposes) of 5 years or 50,000 miles, whichever comes first.
7 Standard applicable to vehicles that have a useful life (for certification purposes) of 10 years or 100,000 miles, whichever comes first.

Table 3-9. Nitrogen Oxide and Volatile Organic Compound Emission Limits for Light-Duty Trucks

Model Year	Emission Limit (grams per mile) NO_x	VOC[1]
1972-1974	3.0[2]	3.4
1975-1978	3.1[3]	2.0
1979-1984	2.3[4]	1.7
1985-1993	1.2[5,6]	0.8
[7]1994+	0.7	0.32
[8]1994+	0.97	0.4

Note(s):
1 These are exhaust emission standards for VOC.
2 Standard applies for 1973-1974 model years.
3 Standard applies for 1975-1978 model years.
4 Standard applies for 1979-1987 model years.
5 Standard applies for 1988-1993 model years.
6 Light-duty trucks with a loaded-vehicle weight more than 3,750 pounds are subject to a 1.7 grams per mile standard for these model years.
7 Standard applicable to vehicles that have a useful life (for certification purposes) of 5 years or 50,000 miles, whichever comes first.
8 Standard applicable to vehicles that have a useful life (for certification purposes) of 10 years or 100,000 miles, whichever comes first.

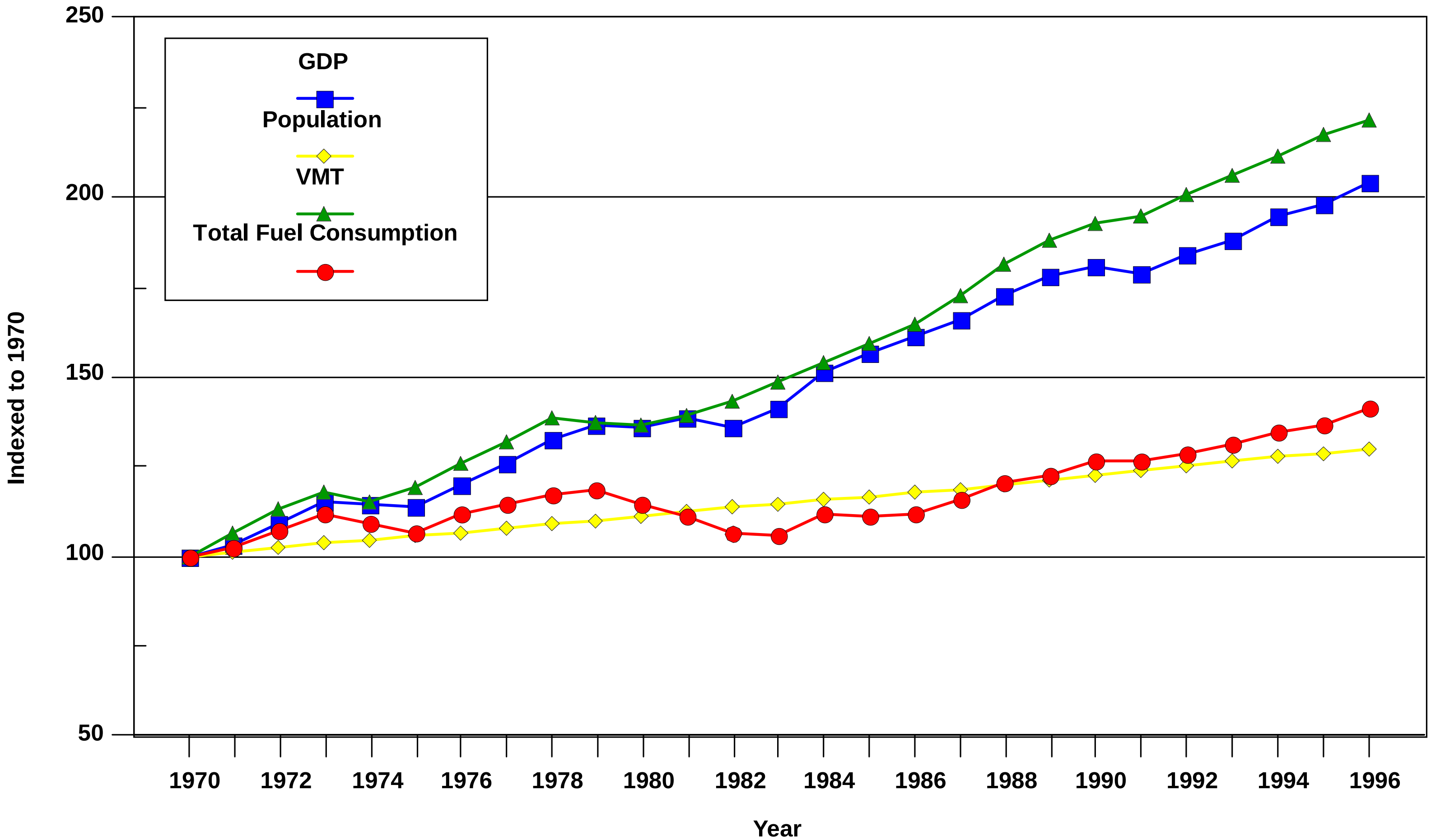
Figure 3-1. History of U.S. Municipal, County, and State Air Pollution Control Legislation



	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980
■ Municipal		2	5	23	40	51	52	80	84	107	81
■ County					1	2	3	2	17	81	142
□ State									8	50	50

Source: *Public Policies for Environmental Protection.*

Figure 3-2. Trend in Gross Domestic Product, Population, Vehicle Miles Traveled, and Total Fuel Consumption, 1970 to 1996



Note(s): All variables are expressed as a percentage of each variable's 1970 value

Figure 3-3. Trend in National Emissions, NITROGEN OXIDES, VOLATILE ORGANIC COMPOUNDS, SULFUR DIOXIDE (1900 to 1996), and PARTICULATE MATTER (PM-10 [non-fugitive dust sources] 1940 to 1996)

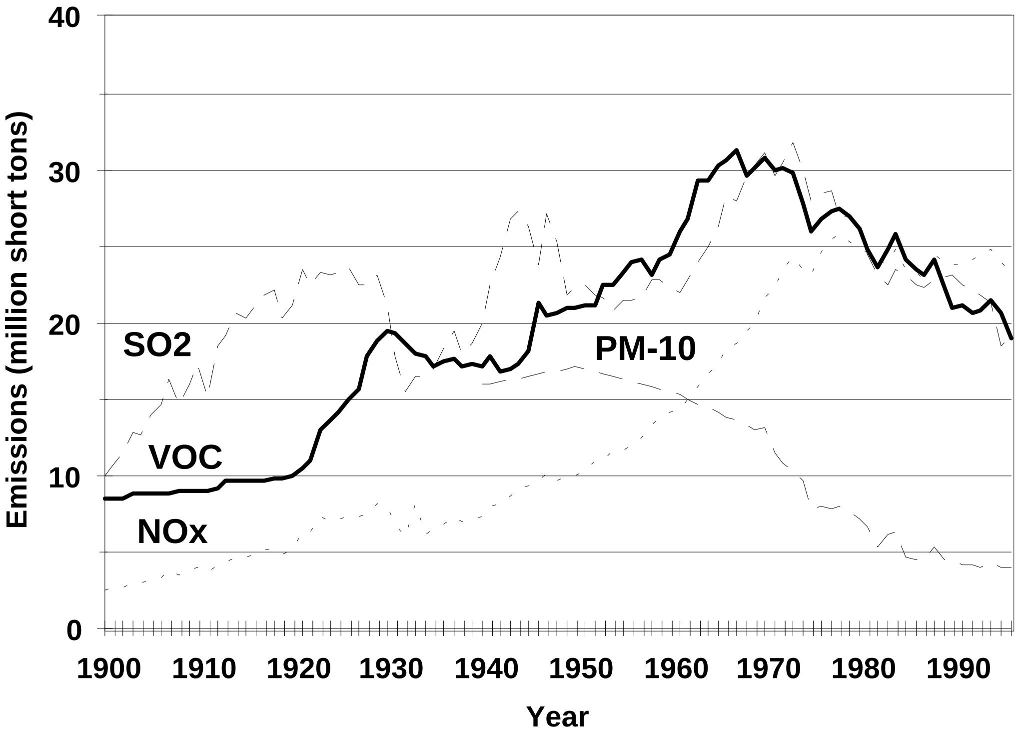


Figure 3-4. Trends in National Emissions, CARBON MONOXIDE (1940 to 1996), FUGITIVE DUST (FD [1985 to 1996]), and LEAD (1970 TO 1996)

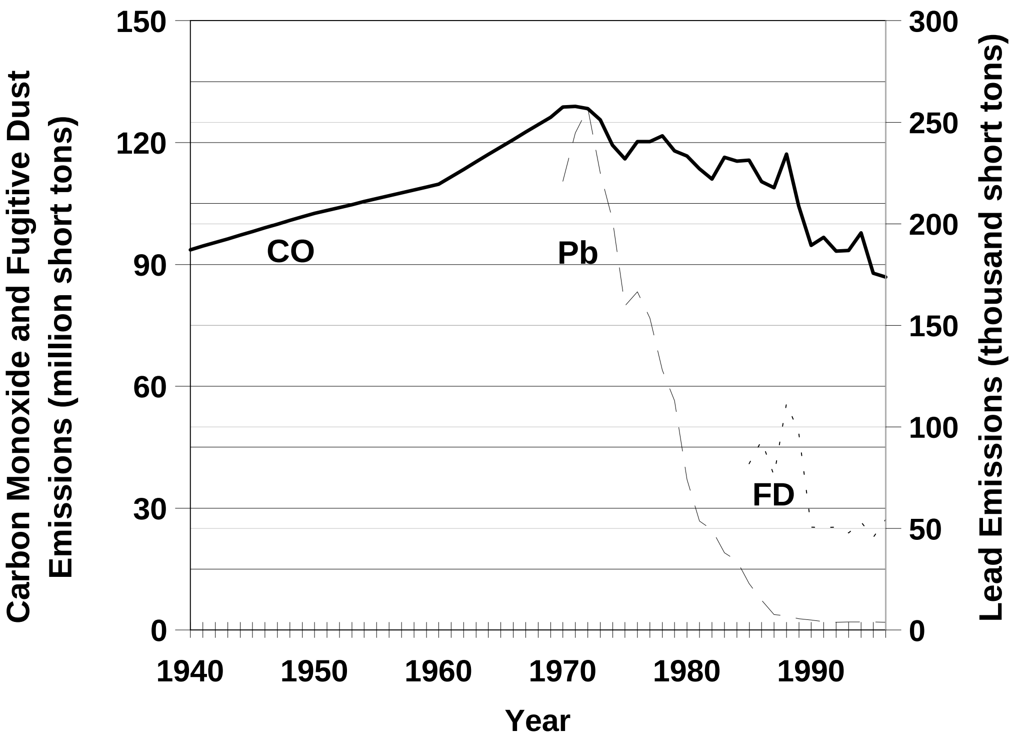


Figure 3-5. Trend in CARBON MONOXIDE Emissions by 7 Principal Source Categories, 1940 to 1996
(reading legend left to right corresponds to plotted series from top to bottom)

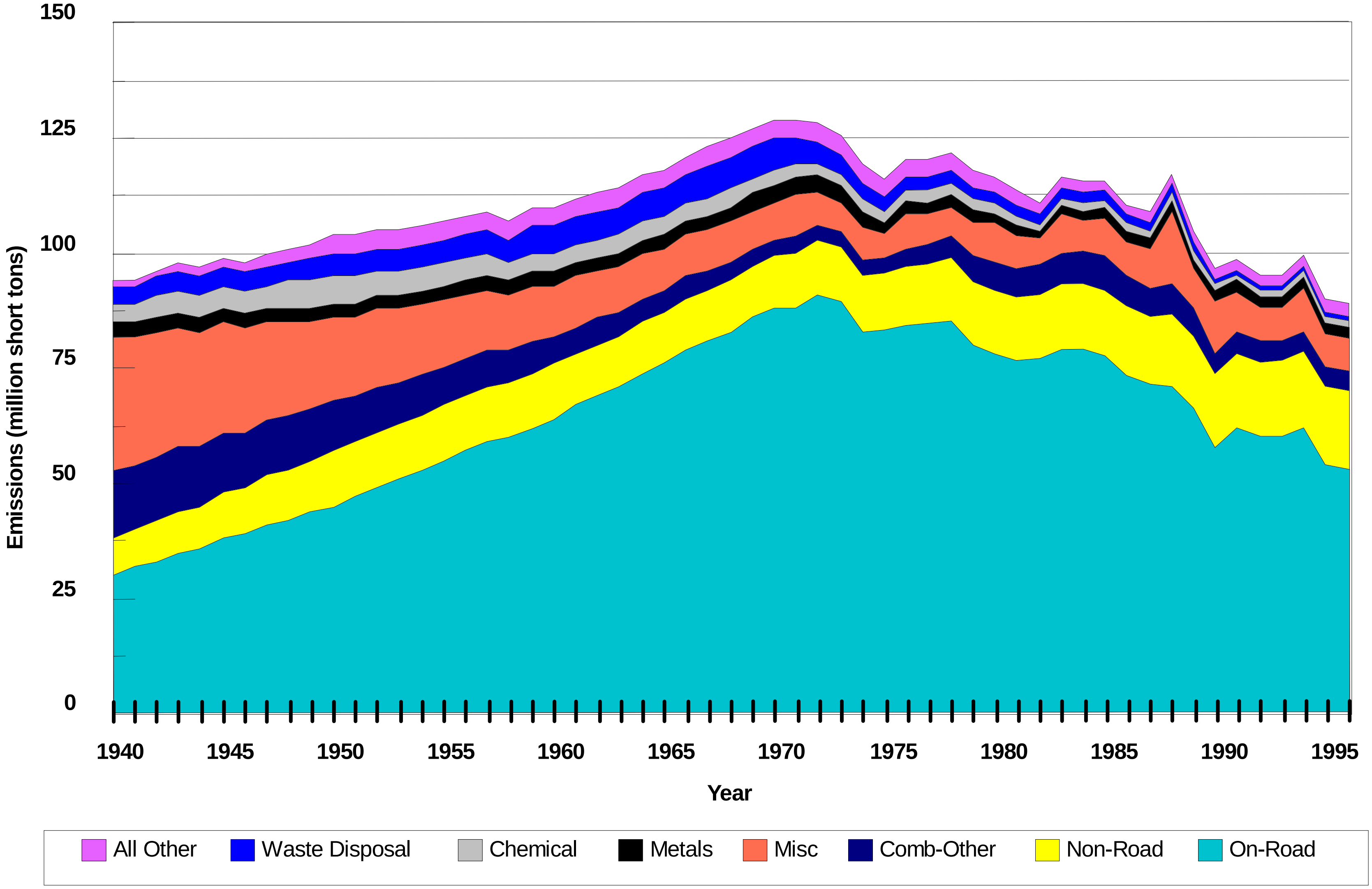


Figure 3-6. Trend in NITROGEN OXIDE Emissions by 7 Principal Source Categories, 1940 to 1996

(reading legend left to right corresponds to plotted series from top to bottom)

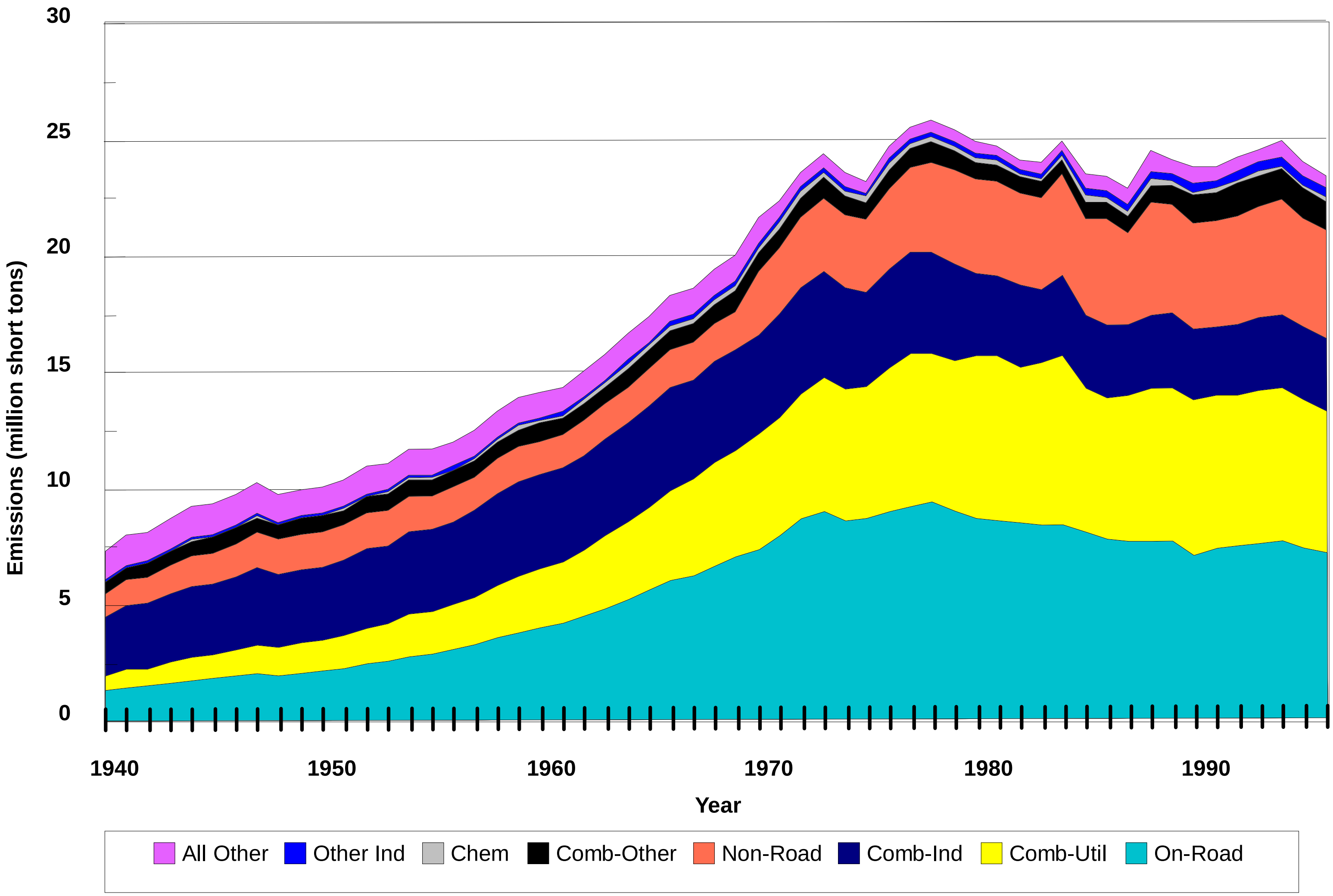


Figure 3-7. Trend in VOLATILE ORGANIC COMPOUND Emissions by 7 Principal Categories, 1940 to 1996

(reading legend left to right corresponds to plotted series from top to bottom)

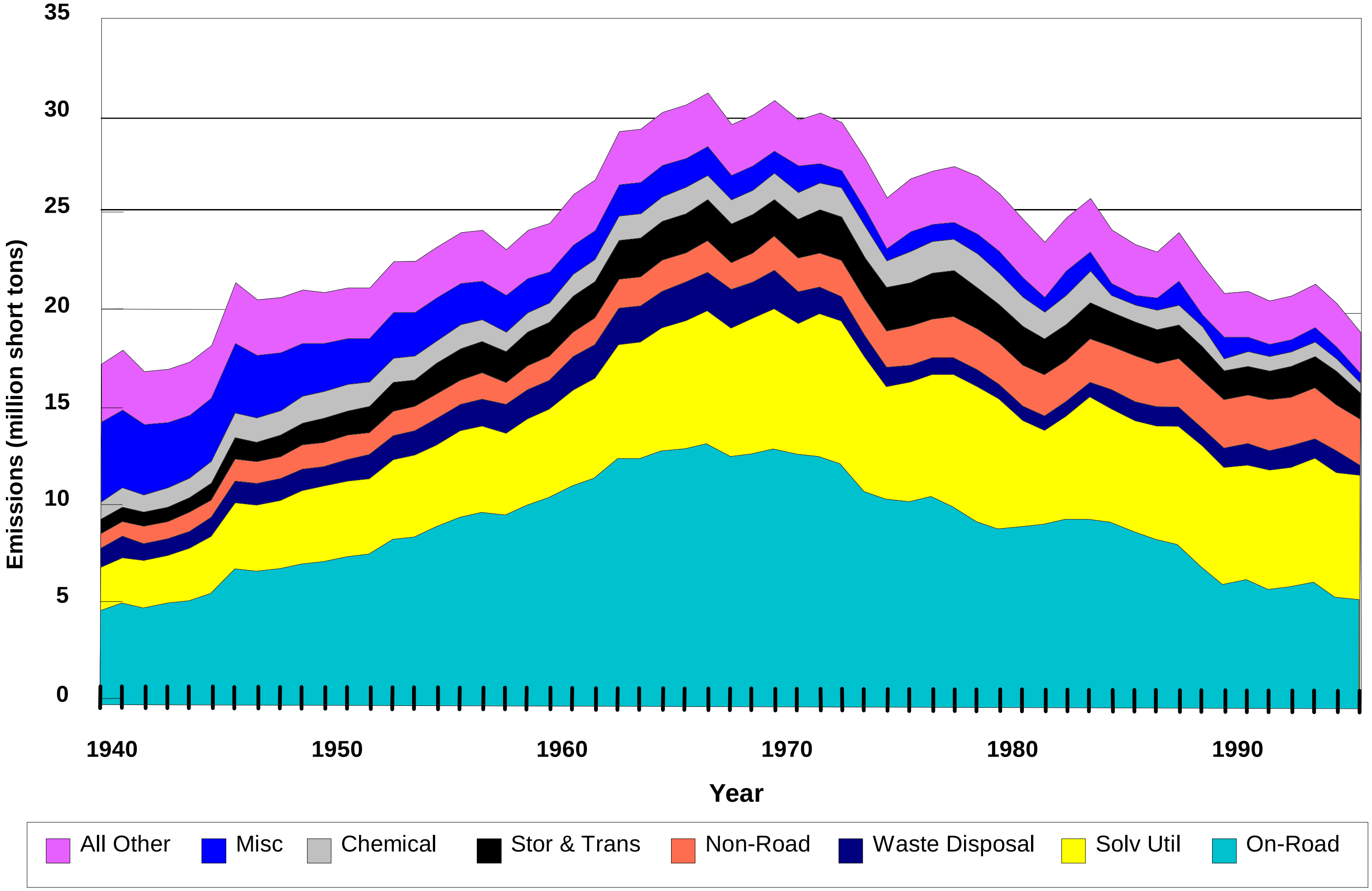


Figure 3-8. Trend in SULFUR DIOXIDE Emissions by 6 Principal Source Categories, 1940 to 1996

(reading legend left to right corresponds to plotted series from top to bottom)

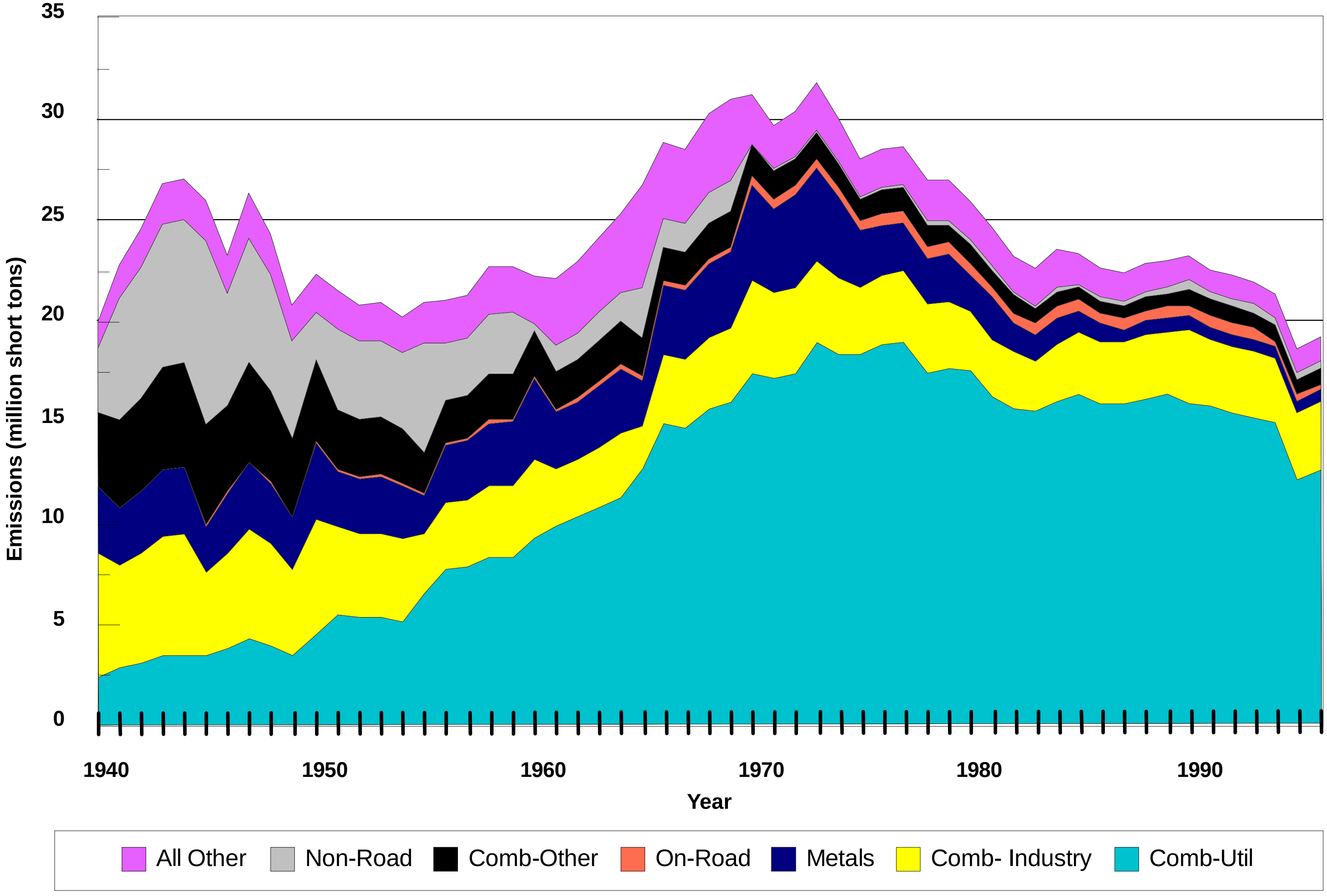


Figure 3-9. Trend in PARTICULATE MATTER (PM-10) Emissions BY 7 Principal Source Categories Excluding Fugitive Dust Sources, 1940-1996

(reading legend left to right corresponds to plotted series from top to bottom)

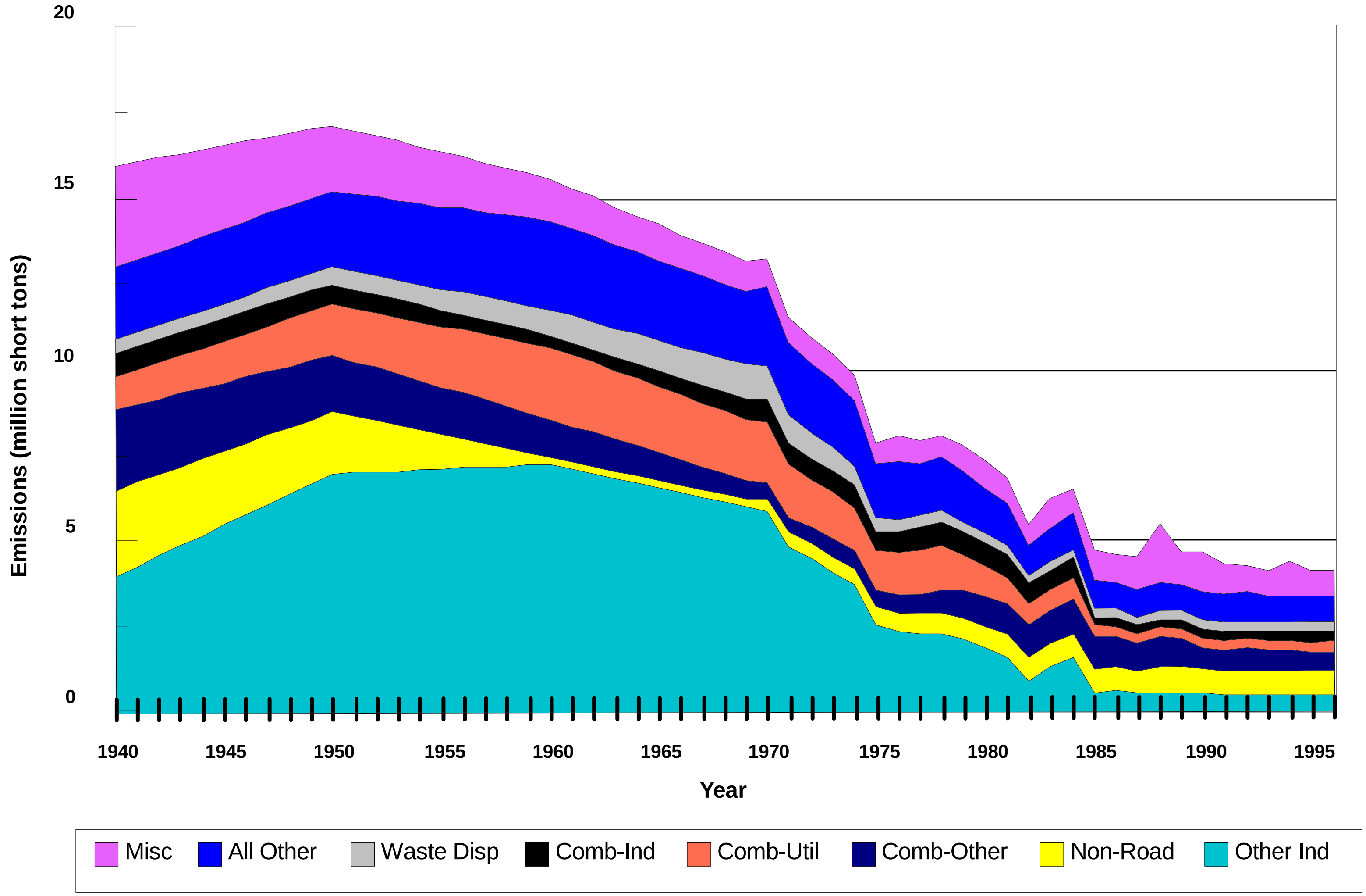
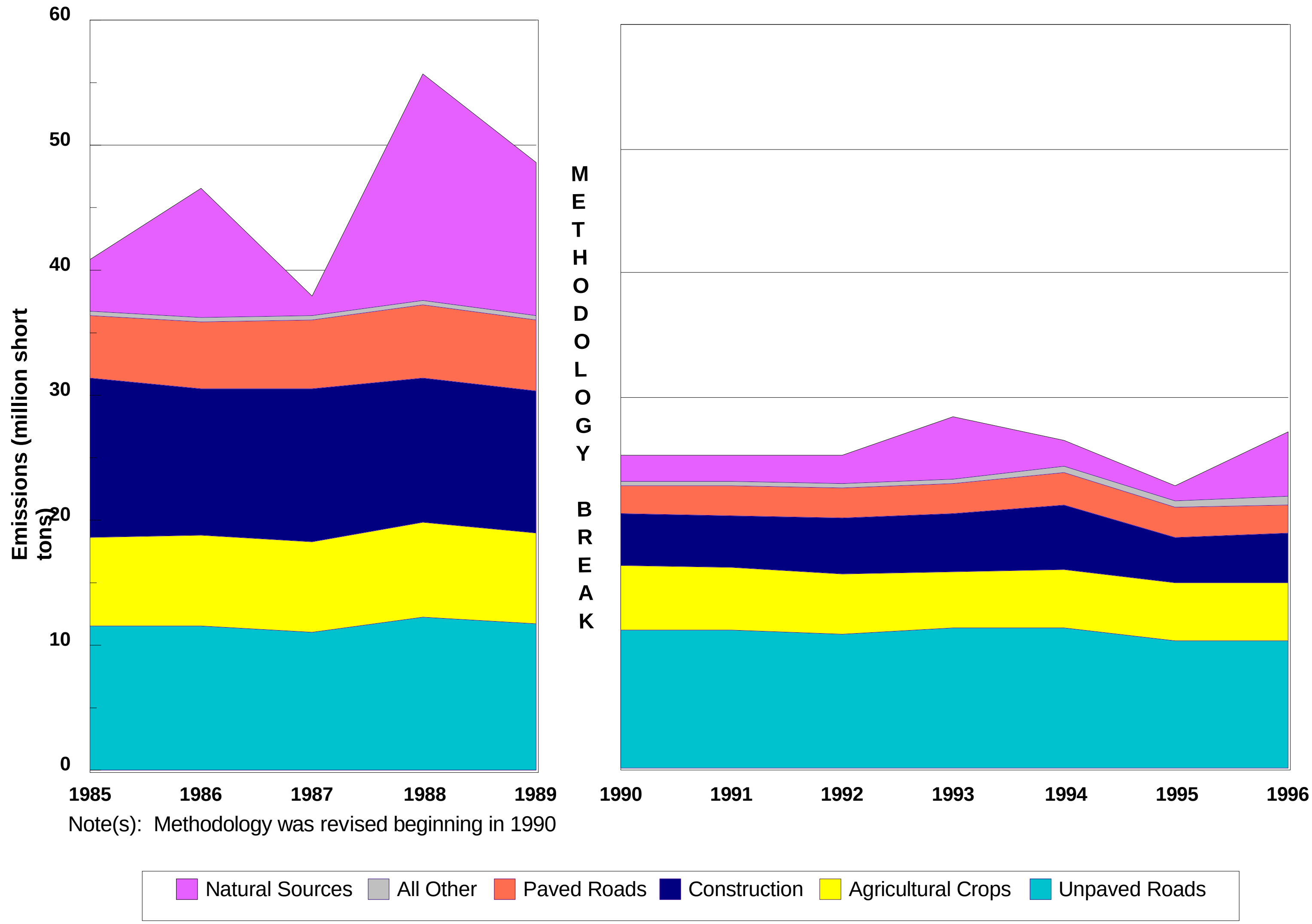


Table 3-10. Trend in PARTICULATE MATTER (PM-10) Emissions by Fugitive Dust Source Category, 1985-1996

(reading legend left to right corresponds to plotted series from top to bottom)



Note(s): Methodology was revised beginning in 1990

Figure 3-11. Trend in LEAD Emissions by 5 Principal Source Categories, 1970-1996

(reading legend left to right corresponds to plotted series from top to bottom)

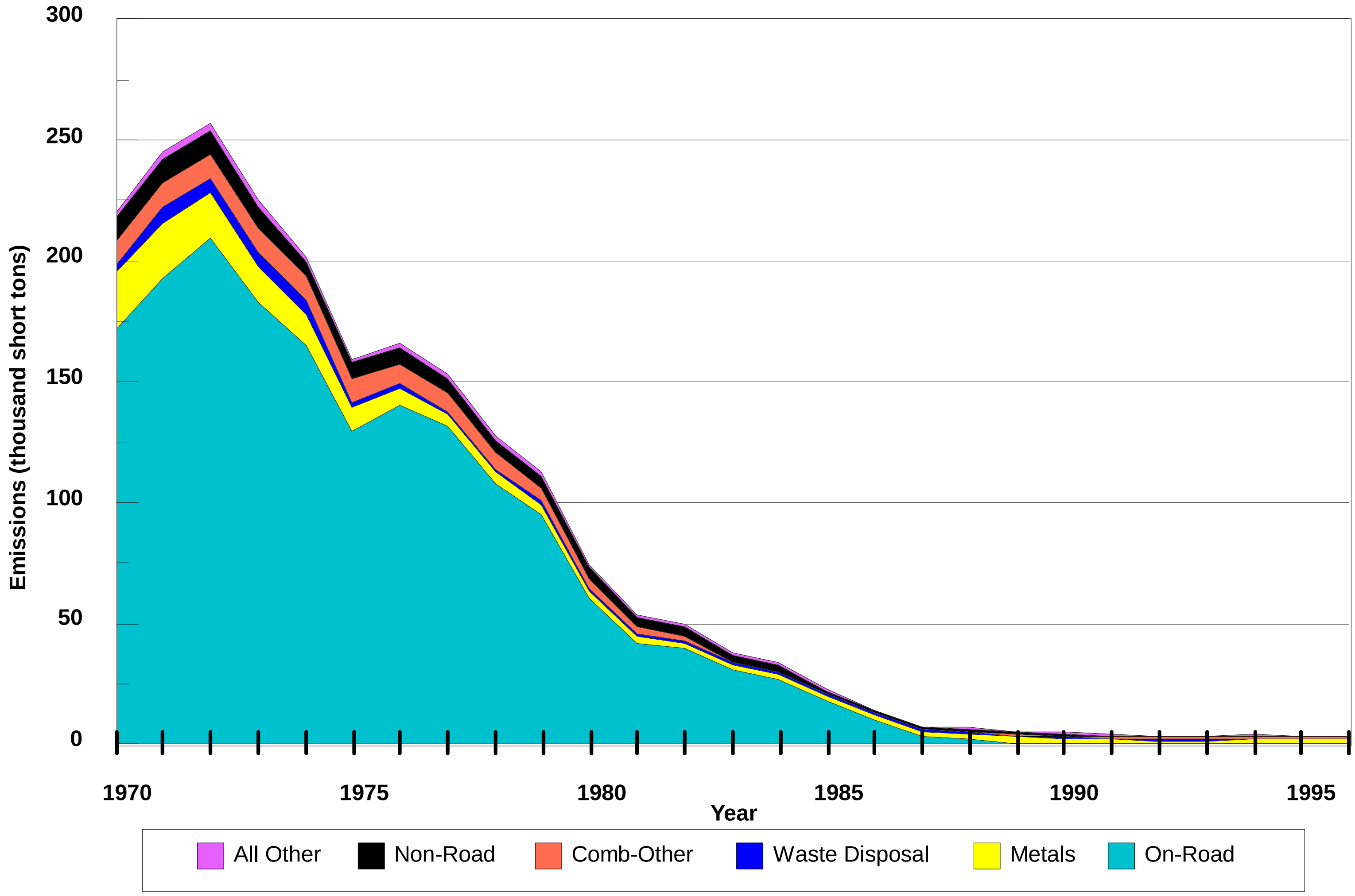
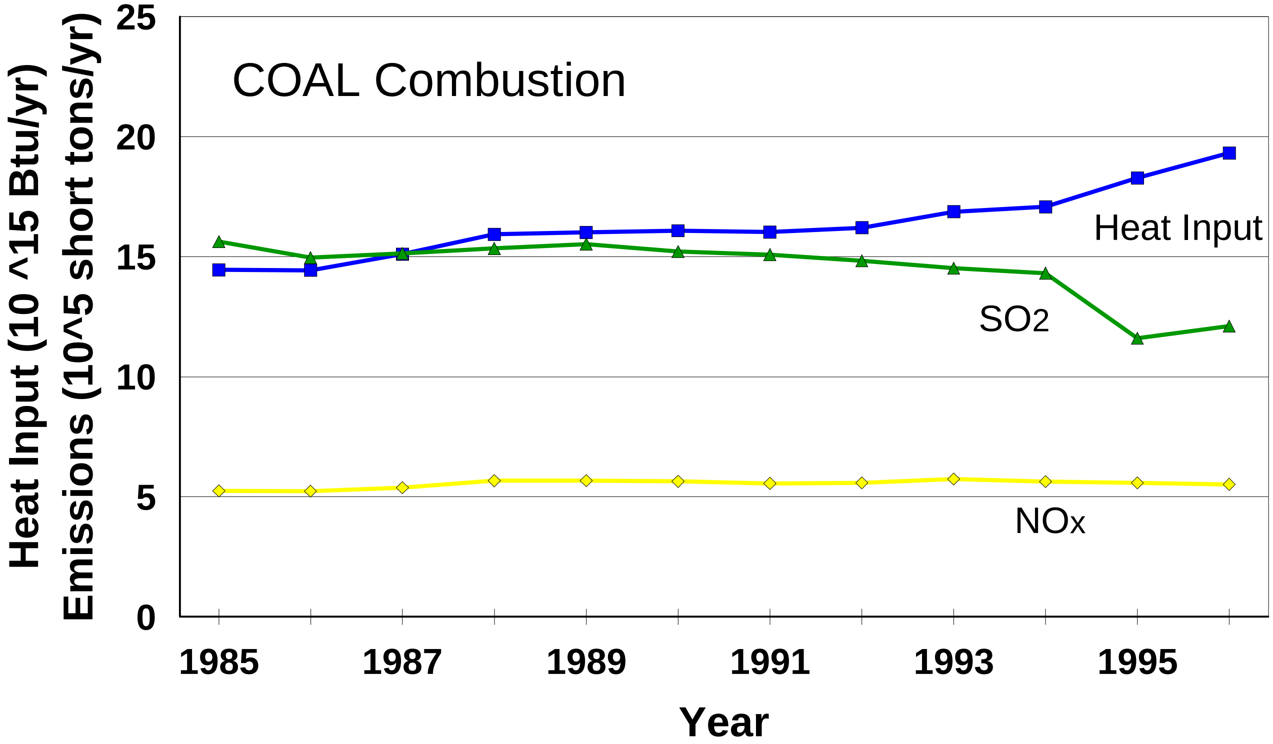


Figure 3-12. Electric Utility NO_x and SO_2 Emissions and Heat Inputs, 1985 to 1996



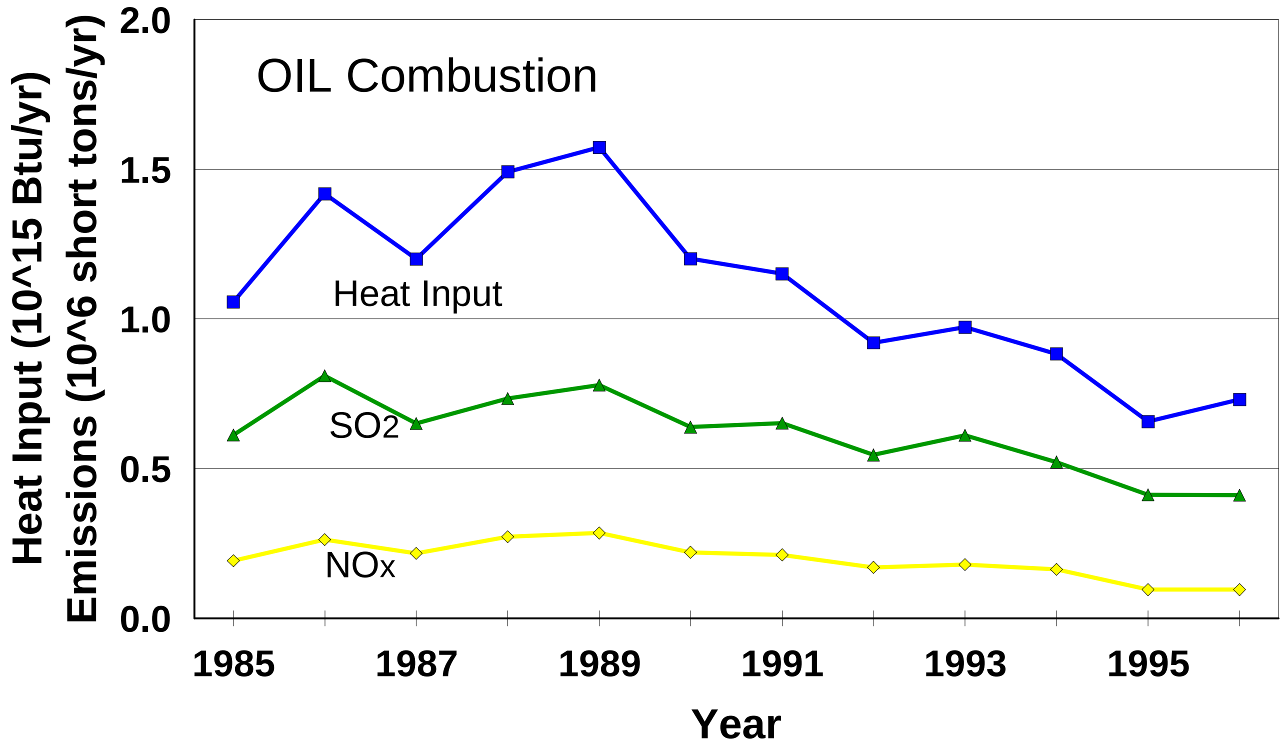
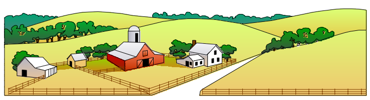


Figure 3-13. Additional Information on On-road and Non-road Sources

Non-road Engines NO_x and PM Emissions

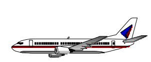
The emission estimates for NO_x and PM from non-road diesel engines increased significantly from the previous year's report. The emission estimates presented in last year's report were based on the "Non-road Engine and Vehicle Emissions Study-Report" issued by EPA in November 1991 and a later report ("Methodology to Calculate Non-road Emission Inventories at the County and Sub-County Level," July 1992). These reports give detailed inventories for each county in 33 nonattainment areas. A national non-road inventory was then calculated as the sum of the non-road emission estimates extrapolated to every county in the nation.



Since then, new information from Powers Systems Research was used as input to develop a new non-road model ("Nonroad Emission Inventory Methodology," draft report, 1997) to better predict non-road emissions. This model includes more engines (such as light commercial equipment like generator sets over 50 horsepower) which are not included in earlier inventories. The model is able to predict emissions only on a national level. Predicting emissions at the national level with the new model results in much larger farm/agricultural equipment emissions. This model accounts for the benefits of the Tier I non-road standards which reduces NO_x to 6.9 grams per brake horsepower-hour starting for certain horsepower engines in 1996 and applied to other horsepower categories through the year 2000.

On-road and Non-road Lead

The emission estimates of lead from on-road vehicles and non-road engines and vehicles reported in last year's report were too high. Adjustments based on the actual lead content of leaded and unleaded gasoline for the years 1989 through 1996 were made to the estimates. At the same time EPA decided to include a missing category, aircraft, to the list of source categories inventoried. These changes have sparked a lot of interest in reviewing other possible missing source categories such as racing cars and the use of lead additives in gasoline for farm equipment; these may be inventoried in upcoming reports.



Source(s): U.S. Environmental Protection Agency, Office of Mobile Sources, Ann Arbor, MI.

Chapter 4.0 Recent Emission Inventory Developments

4.1 RECENT INVENTORY EFFORTS

In 1994, an emission inventory[1] was developed for the GCVTC to support visibility modeling and emission management evaluation activities required under the CAAA. The inventory was developed for the 11 western States (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming). The base year for the inventory is 1990. The inventory includes county-level annual emission estimates of NO_x, VOC, SO_2, ammonia (NH_3), PM-2.5, TSP, and elemental and organic carbon particulate (EC/OC) for stationary (point and area), mobile (on-road and non-road), and biogenic sources. Development of the inventory required merging several data sets. The following data sets were used in descending order of priority: State-derived data directly available from each State; 1990 NET inventory to fill geographical data gaps in inventories provided by the States; and the 1985 NAPAP inventory to fill pollutant gaps (i.e., TSP and NH_3). EPA has incorporated nonutility point source estimates into the NET inventory. Table 4-1 summarizes the emissions from nonutility point sources in the GCVTC.

The OTAG is a regional body, chartered by the Environmental Council of States (ECOS), for the purpose of evaluating O_3 transport and recommending strategies for mitigating interstate pollution. The OTAG was a consultative process among 37 eastern States and the District of Columbia which included examination of the extent NO_x emissions from hundreds of kilometers away are contributing to smog problems in downwind cities in the eastern half of the country, such as Atlanta, Boston, and Chicago.[2] The EPA worked with OTAG over a 2-year period. To successfully perform photochemical modeling of O_3 formation, transport, and accumulation required developing high quality base and future year emission inventory inputs.[3] The base year inventory represented average summer day emissions in 1990 for CO, NO_x, and VOC for all stationary point and area sources throughout the OTAG region. Mobile emission estimates were not developed, but MOBILE emission factor inputs and VMT were collected from the States, EPA, and the Lake Michigan Air Directors Consortium (LADCO). This inventory represented the integration of all emissions data supplied by the States with EPA's NET inventory. Table 4-2 presents OTAG's 1990 average summer day emissions by State and point and area source categories. Table 4-3 presents these emissions for the OTAG region by Tier II point and area source categories. "Average summer day emissions" were defined as average daily emissions for the months of June, July, and August. The O_3 season was defined in OTAG's analyses as May 1 through September 30. The OTAG area has an eastern boundary of the Atlantic Ocean and a western border running from north to south through North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. In total, the OTAG inventory completely covers 37 States and the District of Columbia. Estimates for Mississippi and Iowa are the same as those in the NET inventory because these states did not submit data to OTAG. EPA has incorporated these estimates into the NET inventory as outlined in chapter 6. Please note on-road vehicle emissions are not presented in either table 4-2 or table 4-3 and the emission estimates developed by OTAG for electric utilities (contained in these tables) were not incorporated into the NET inventory.

4.2 COMPOSITION OF PM-2.5 IN THE AMBIENT AIR

EPA recently implemented revisions to the PM NAAQS. The new standard specifies requirements for PM-2.5. In the future, EPA will complete development of a PM-2.5 emission inventory. In the meantime, a general assessment of the emission sources contributing to PM-2.5 can be obtained by evaluating PM-2.5 monitoring data. The paragraphs below provide a broad overview of the main types of sources contributing to ambient PM-2.5 concentrations.

PM-2.5 is composed of a mixture of particles directly emitted into the air and particles formed in the air from the chemical transformation of gaseous pollutants (secondary particles). The principal types of secondary particles are ammonium sulfate and ammonium nitrate formed in the air from gaseous emissions of SO_2 and NO_x, reacting with NH_3. The main source of SO_2 is combustion of fossil fuels in boilers and the main sources of NO_x are combustion of fossil fuel in boilers and mobile sources.

The principal types of directly emitted particles are soil related particles and inorganic and EC/OC particles from the combustion of fossil fuels and biomass materials. The main sources of soil-related particles are roads, construction and agriculture. The main sources of combustion-related particles are mobile sources such as diesels, managed burning, open burning, residential wood combustion, utility and commercial boilers.

Figures 4-1 and 4-2 summarize information from actual measurements of ambient PM-2.5. They show how PM-2.5 composition varies in both the Eastern and Western United States. The ambient samples were chemically analyzed to determine the amount of ammonium sulfate and nitrate, soil and carbonaceous material present. The figures are based on at least 1 year of data from each monitoring location. The data were collected using a variety of non-Federal reference methods and should not be used to determine compliance with the PM-2.5 NAAQS.

4.2.1 PM-2.5 in the Eastern United States

Figure 4-1 shows the composition of PM-2.5 in the Eastern United States. The composition information represents a range of urban and nonurban locations. It shows relatively consistent composition of PM-2.5 across much of the East. The available information consistently shows that PM-2.5 in the East is dominated by ammonium sulfate on a regional scale and also by carbonaceous particles emitted directly by combustion processes. Regional concentrations of PM-2.5 are generally higher throughout much of the East, due to the regional influence of ammonium sulfate caused by higher SO_2 emissions throughout much of the East and the ubiquitous nature of combustion processes.

4.2.2 PM-2.5 in the Western United States

Figure 4-2 shows the composition of PM-2.5 in the Western United States. The composition represents both urban and nonurban locations and is more variable in the West than in the East. Soil is a relatively small constituent of PM-2.5 in both the West and East, even in arid and agricultural areas such as Phoenix (Arizona) and the San Joaquin Valley of California. However, the West differs from the East in two important ways. First, nonurban PM-2.5 concentrations are much lower in the West than in the East. This is because the East is blanketed regionally by relatively higher concentrations of ammonium sulfate; in contrast, regional sulfate concentrations in the West are much lower. Second, several western areas, notably the San Joaquin Valley and the Rubidoux area of the South Coast basin have higher ammonium nitrate concentrations. Nitrate concentrations are also higher in nonurban areas of Southern California inland from the South Coast basin.[4] Such pockets of higher nitrate concentrations have not been reported in the East.

4.2.3 Data Sources

Composition and concentration data for all nonurban locations were obtained from the Interagency Monitoring of Protected Visual Environments (IMPROVE) except for the New England location which is based on combined nonurban data from IMPROVE and the Northeast States for Coordinated Air Use Management (NESCAUM).[4,5] The Washington, DC data were also obtained from IMPROVE and the Boston and Rochester data are based on NESCAUM.[4,5] Note that the NESCAUM data is still subject to minor revision. The South Coast information is adapted from Christoforou.[6] The Phoenix information is based on EPA's Particulate Matter (PM) Research Monitoring Network[7] with the exception of the nitrate estimates which were adapted from Desert Research Institute (DRI).[8,9] The San Joaquin data are from DRI.[8] Spokane's composition and concentration data was obtained from Norris.[10] The published composition data for the East are somewhat limited, but preliminary information from several unpublished urban studies is consistent with figure 4-1.[11,12]

Nonurban data are based on averages of several monitoring locations in the region. Urban data are based on only one location in each area and may not represent the entire area. The exceptions to this are the South Coast and San Joaquin Valley areas of California where multiple locations are averaged together. In the South Coast basin, Rubidoux recorded the highest average PM-2.5 and nitrate concentrations. Additional information on the composition of PM-2.5 within these areas of California are discussed further in references 6 and 8.

4.3 REFERENCES

1. An Emissions Inventory for Assessing Regional Haze on the Colorado Plateau, Grand Canyon Visibility Transport Commission, Denver, CO. January 1995.
2. *Nitrogen Oxides: Impacts on Public Health and the Environment*. EPA-452/R-97-002. Office of Air and Radiation, U.S. Environmental Protection Agency, Washington, DC. August 1997.
3. Solomon, D.A., R.A. Wayland, and M. Janssen. Development of Base and Future Year Emission Inputs for OTAG Modeling, presented at the Air & Waste Management Association Specialty Conference, New Orleans, LA. September 4-6, 1996.
4. IMPROVE, Cooperative Center for Research in the Atmosphere, Colorado State University, Ft. Collins, CO, July 1996.

5. Salmon, Lynn and Glen R. Cass, October, 1997, Progress Report to NESCAUM: Determination of Fine Particle Contraction and Chemical Composition in the Northeastern United States, 1995, California Institute of Technology, Pasadena, CA 91125. Draft.
6. Christoforou, C.S., Lynn G. Salmon, Michael P. Hannigan, Paul A. Soloman and Glen R. Cass, Trends in Fine Particle Concentration and Chemical Composition. Accepted for publication in Journal of Air and Waste Management Association, Pittsburgh, PA.
7. The National Environmental Research Laboratory/Research Triangle Park PM Research Monitoring Network, US EPA, Research Triangle Park, NC 27711, 1997.
8. PM-10 and PM-2.5 Variations in Time and Space, Desert Research Institute, Reno, NV, October 1995.
9. Watson, John G. and Tom Moore, personal communications with T.G. Pace, December 1997.
10. Norris, Gary and Jane Koenig, Preliminary Analysis of PM and Daily Emergency Room Visits for Asthma in Spokane, Washington, USA, Presented at International Symposium on Health Effects of PM, Prague, Czech Republic, April 1997.
11. Preliminary PM-2.5 data summaries for Knoxville and Chattanooga, TN. Personal communication from Dr. Roger Tanner (Tennessee Valley Authority) to T.G. Pace (U.S. Environmental Protection Agency), December 1997.
12. PM-2.5 data summaries for Philadelphia, PA, Washington, DC, and Nashville, TN. Personal communication from T. Bahadori, H. Suh, and P. Koutrakis (Harvard School of Public Health) to T.G. Pace (U.S. Environmental Protection Agency), January 1998.

Table 4-1. Grand Canyon Visibility Transport Commission (GCVTC) Emissions by State from Nonutility Point Sources, 1990 (thousand short tons)

State	Carbon Monoxide	Nitrogen Oxides	Volatile Organic Compounds	Sulfur Dioxide	Particulate Matter (PM-10)
Arizona	11	40	12	60	10
California	150	192	218	54	49
Colorado	22	42	24	14	36
Idaho	5	8	1	25	17
Montana	44	16	9	48	23
Nevada	11	5	4	2	11
New Mexico	20	70	11	101	9
Oregon	106	27	19	21	29
Utah	44	17	6	52	8
Washington	236	33	24	47	13
Wyoming	15	40	20	40	4
GCVTC Region	**664**	**489**	**348**	**465**	**210**

NOTE: The sums of States may not equal GCVTC Region due to rounding.

Table 4-2. Ozone Transport Assessment Group Point and Area (Excluding On-road Vehicles) Source Emissions by State, 1990 (short tons per day)

	Volatile Organic Compounds			Nitrogen Oxides			Carbon Monoxide		
State	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**
Alabama	191	616	808	901	313	1,214	529	1,263	1,792
Arkansas	**44**	**424**	**468**	**178**	**209**	**387**	**252**	**716**	**968**
Connecticut	42	372	414	115	128	244	35	835	870
Delaware	**36**	**89**	**125**	**148**	**42**	**190**	**43**	**185**	**228**
District of Columbia	1	31	32	8	18	27	1	148	149
Florida	**97**	**1,455**	**1,552**	**1,438**	**415**	**1,853**	**188**	**3,475**	**3,663**
Georgia	142	780	921	904	307	1,211	466	1,994	2,460
Illinois	**700**	**1,392**	**2,091**	**1,806**	**553**	**2,359**	**1,457**	**2,914**	**4,371**
Indiana	347	872	1,219	1,752	388	2,140	1,066	1,148	2,214
Iowa	**39**	**493**	**532**	**423**	**169**	**592**	**34**	**745**	**778**
Kansas	138	648	786	530	400	930	195	2,038	2,232
Kentucky	**342**	**536**	**878**	**1,105**	**403**	**1,508**	**282**	**856**	**1,138**
Louisiana	317	689	1,006	1,132	722	1,854	1,593	1,727	3,320
Maine	**57**	**148**	**204**	**102**	**34**	**136**	**88**	**187**	**275**
Maryland	66	446	511	569	202	771	428	1,238	1,665
Massachusetts	**82**	**614**	**696**	**369**	**233**	**602**	**59**	**1,462**	**1,521**
Michigan	426	960	1,386	1,459	393	1,852	439	1,972	2,412
Minnesota	**168**	**806**	**974**	**400**	**202**	**602**	**221**	**1,892**	**2,114**
Mississippi	169	571	741	347	315	662	254	1,292	1,545
Missouri	**179**	**773**	**953**	**722**	**232**	**954**	**283**	**2,162**	**2,445**
Nebraska	39	366	405	278	170	449	19	1,024	1,042
New Hampshire	**28**	**92**	**120**	**115**	**27**	**142**	**64**	**154**	**218**
New Jersey	342	611	953	834	264	1,097	132	1,434	1,566
New York	**481**	**1,240**	**1,721**	**794**	**454**	**1,248**	**140**	**2,813**	**2,953**
North Carolina	352	865	1,217	847	234	1,081	236	2,552	2,788
North Dakota	**14**	**208**	**222**	**357**	**98**	**455**	**29**	**394**	**424**
Ohio	470	1,085	1,555	2,352	476	2,828	2,074	2,009	4,083
Oklahoma	**66**	**527**	**593**	**310**	**410**	**720**	**100**	**826**	**926**
Pennsylvania	426	855	1,282	2,097	402	2,499	3,015	1,745	4,759
Rhode Island	**23**	**95**	**117**	**12**	**28**	**40**	**6**	**208**	**214**
South Carolina	159	598	758	433	160	592	136	982	1,118
South Dakota	**2**	**176**	**178**	**55**	**38**	**93**	**0**	**462**	**462**
Tennessee	411	976	1,387	1,200	465	1,665	298	2,323	2,620
Texas	**811**	**2,239**	**3,050**	**2,810**	**836**	**3,645**	**1,128**	**7,278**	**8,406**
Vermont	4	45	48	1	12	13	1	79	80
Virginia	**300**	**770**	**1,070**	**328**	**387**	**715**	**114**	**1,587**	**1,701**
West Virginia	236	262	498	1,620	128	1,748	827	486	1,313
Wisconsin	**138**	**622**	**760**	**536**	**216**	**752**	**281**	**1,262**	**1,542**
TOTAL, OTAG	**7,885**	**24,346**	**32,232**	**29,387**	**10,483**	**39,870**	**16,511**	**55,867**	**72,379**

Note(s): The sums may not equal the total due to rounding.
Source: Data files downloaded from /ftp.epa.gov/

Table 4-3. Ozone Transport Assessment Group Point and Area (Excluding On-road Vehicles) Source Emissions by Tier II Source Category, 1990

(short tons per day)

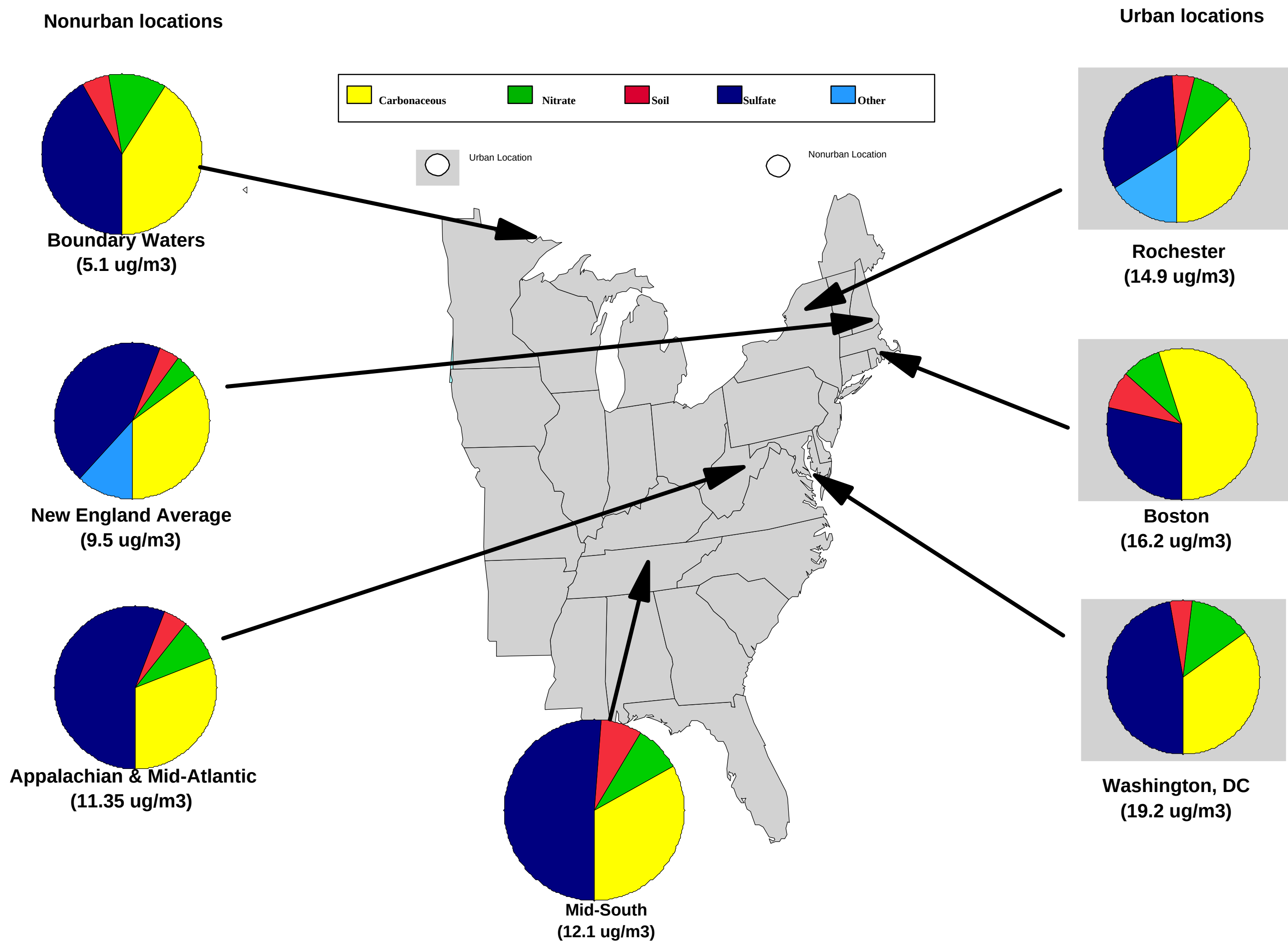
	VOC			NO_x			CO		
Source Category	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**	**Point**	**Area**	**Total**
FUEL COMB. ELEC. UTIL.	**183**	**6**	**189**	**21,682**	**18**	**21,701**	**1,181**	**4**	**1,185**
Coal	111	5	117	18,444	5	18,449	720	0	721
Oil	14	0	14	1,061	0	1,061	98	0	98
Gas	8	0	8	1,267	0	1,267	138	0	138
Other	10		10	55		55	41		41
Internal Combustion	39	1	40	857	12	869	183	3	186
FUEL COMB. INDUSTRIAL	**356**	**38**	**393**	**5,331**	**2,286**	**7,617**	**1,433**	**532**	**1,964**
Coal	16	6	23	1,098	458	1,556	164	122	285
Oil	24	7	31	400	304	705	138	54	192
Gas	112	19	131	1,707	1,505	3,212	379	242	621
Other	97	5	102	253	17	270	429	113	542
Internal Combustion	107	0	107	1,872	1	1,874	323	0	323
FUEL COMB. OTHER	**17**	**108**	**125**	**329**	**574**	**903**	**195**	**712**	**907**
Commercial/Institutional Coal	1	0	1	61	20	80	20	7	27
Commercial/Institutional Oil	1	4	5	47	128	176	7	25	32
Commercial/Institutional Gas	5	8	13	181	204	384	28	40	69
Misc. Fuel Comb. (Except Residential)	9	7	17	40	19	59	140	23	163
Residential Wood		78	78		7	7		556	556
Residential Other		11	11		197	197		61	61
CHEMICAL & ALLIED PRODUCT MFG	**1,395**	**474**	**1,869**	**454**	**0**	**455**	**3,657**		**3,657**
Organic Chemicals	432	128	560	54	0	54	480		480
Inorganic Chemicals	5	0	5	34		34	372		372
Polymers & Resins	373	324	696	19		19	8		8
Agricultural Chemicals	16		16	205		205	515		515
Paints, Varnishes, Lacquers, Enamels	54		54	0		0	0		0
Pharmaceuticals	40	23	63	0		0	0		0
Other Chemicals	474		474	142		142	2,282		2,282
METALS PROCESSING	**371**	**0**	**372**	**277**	**0**	**278**	**7,428**	**1**	**7,429**
Non-Ferrous Metals Processing	48	0	48	23	0	24	495		495
Ferrous Metals Processing	306	0	306	245	0	245	6,872	0	6,872
Metals Processing NEC	18	0	18	9	0	9	61	1	62
PETROLEUM & RELATED INDUSTRIES	**565**	**628**	**1,193**	**290**	**3**	**293**	**976**	**1**	**977**
Oil & Gas Production	131	381	512	163	2	165	85	0	86
Petroleum Refineries & Related Industries	423	247	669	112		112	879		879
Asphalt Manufacturing	11	0	12	15	1	15	12	1	13
OTHER INDUSTRIAL PROCESSES	**1,012**	**121**	**1,134**	**895**	**6**	**901**	**1,308**	**2**	**1,309**
Agriculture, Food, & Kindred Products	276	105	381	10	0	10	1	0	1
Textiles, Leather, & Apparel Products	63		63	0		0	0		0
Wood, Pulp & Paper, & Publishing Products	251		251	212		212	1,168		1,168
Rubber & Miscellaneous Plastic Products	167	2	169	0		0	0		0
Mineral Products	54	0	54	644	2	646	125	0	125
Machinery Products	37	0	37	11	0	12	2		2
Electronic Equipment	7		7	0		0	4		4
Transportation Equipment	9		9	1		1	0		0
Construction	0		0						
Miscellaneous Industrial Processes	150	14	164	17	3	20	6	2	8

Table 4-3 (continued)

Source Category	VOC Point	VOC Area	VOC Total	NO_x Point	NO_x Area	NO_x Total	CO Point	CO Area	CO Total
SOLVENT UTILIZATION	**2,965**	**11,304**	**14,269**	**5**	**0**	**6**	**12**	**0**	**12**
Degreasing	179	1,409	1,588	0		0	0		0
Graphic Arts	513	322	835	2		2	0		0
Dry Cleaning	8	458	466	0		0	0		0
Surface Coating	2,063	4,752	6,815	3	0	4	2	0	2
Other Industrial	202	44	245	0		0	10		10
Nonindustrial		4,319	4,319		0	0		0	0
Solvent Utilization NEC	0	1	1						
STORAGE & TRANSPORT	**914**	**2,716**	**3,630**	**3**	**1**	**3**	**207**		**207**
Bulk Terminals & Plants	178	671	849	0		0	0		0
Petroleum & Petroleum Product Storage	328	84	412	0	1	1	0		0
Petroleum & Petroleum Product Transport	274	104	378	0		0	0		0
Service Stations: Stage I	3	767	770						
Service Stations: Stage II	4	970	974						
Service Stations: Breathing & Emptying		113	113						
Organic Chemical Storage	92	7	99	1		1	206		206
Organic Chemical Transport	30		30	0		0	0		0
Inorganic Chemical Storage	1		1	1		1	0		0
Inorganic Chemical Transport									
Bulk Materials Storage	4		4	0		0	1		1
Bulk Materials Transport									
WASTE DISPOSAL & RECYCLING	**106**	**1,333**	**1,439**	**121**	**139**	**260**	**115**	**2,590**	**2,706**
Incineration	26	102	128	119	37	156	113	845	958
Open Burning	1	480	481	1	102	102	1	1,745	1,746
POTW	29	89	119	0		0			
Industrial Waste Water	15	26	41	0		0	0		0
TSDF	9	452	461		0	0		0	0
Landfills	25	124	148	0	0	0	1	0	1
Other	2	59	61	1		1	0		0
ON-ROAD VEHICLES (not included)									
NON-ROAD ENGINES AND VEHICLES		**6,531**	**6,531**		**7,253**	**7,253**		**44,662**	**44,662**
Non-Road Gasoline		5,344	5,344		433	433		39,651	39,651
Non-Road Diesel		615	615		4,315	4,315		2,848	2,848
Aircraft		326	326		311	311		1,687	1,687
Marine Vessels		125	125		489	489		203	203
Railroads		121	121		1,704	1,704		274	274
NATURAL SOURCES (not included)									
MISCELLANEOUS	**2**	**1,086**	**1,088**	**0**	**203**	**203**	**0**	**7,364**	**7,364**
Agriculture & Forestry		11	11						
Other Combustion	0	1,064	1,064	0	203	203	0	7,364	7,364
Catastrophic/Accidental Releases		10	10						
Health Services	1	0	1				0		0
Cooling Towers	0		0						
Fugitive Dust									
TOTAL	**7,885**	**24,346**	**32,232**	**29,387**	**10,483**	**39,870**	**16,511**	**55,867**	**72,379**

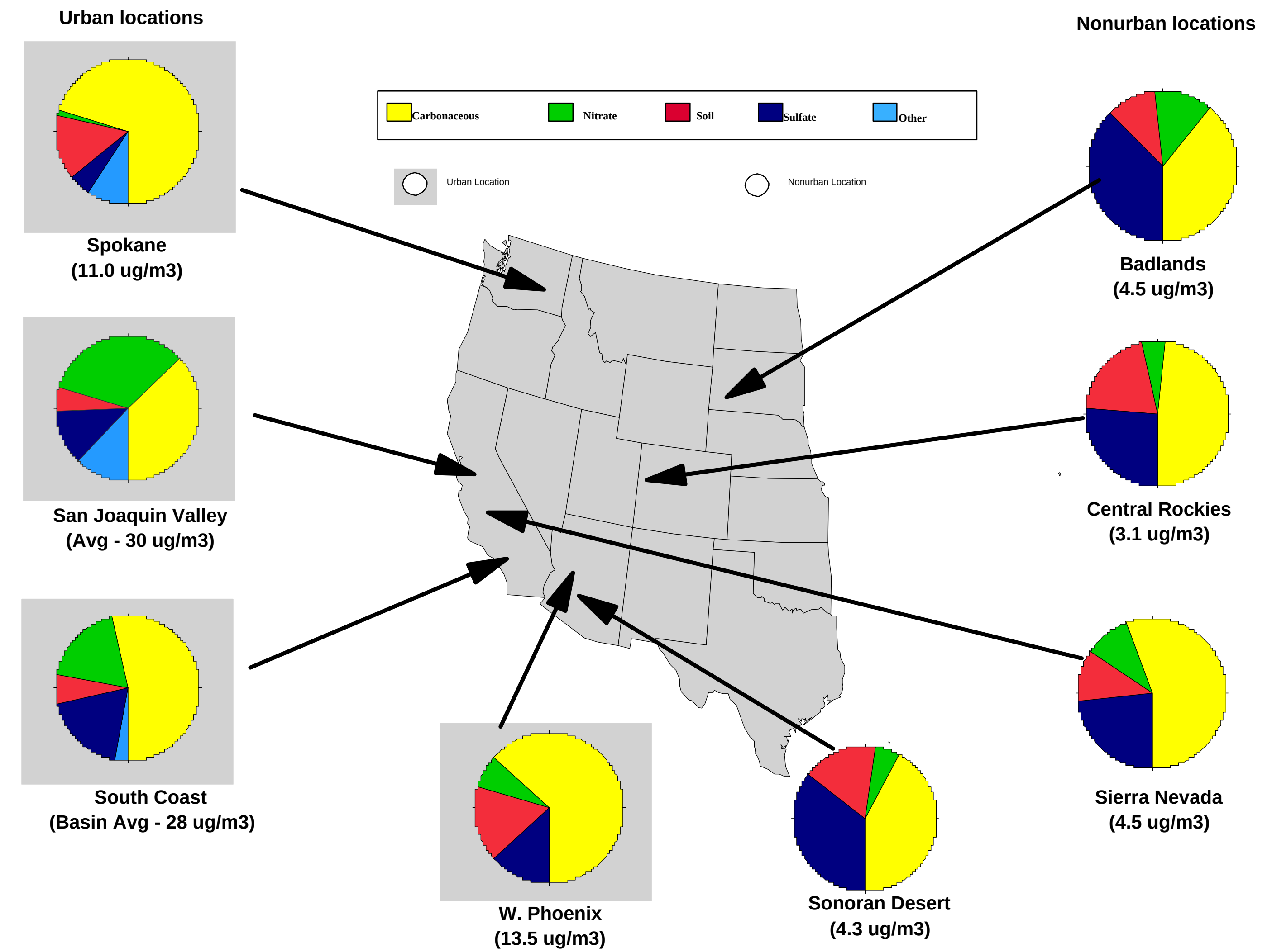
Note(s): The sums may not equal the total due to rounding. Blanks represent zero emissions.
Source: Data files downloaded from /ftp.epa.gov/

Figure 4-1. PM-2.5 Composition in the Eastern United States



Note: PM-2.5 mass concentrations are determined on at least 1 year of monitoring at each location using a variety of non-Federal reference methods. They should not be used to determine compliance with the PM-2.5 NAAQS.

Figure 4-2. PM-2.5 Composition in the Western United States



Note: PM-2.5 mass concentrations are determined on at least 1 year of monitoring at each location using a variety of non-Federal reference methods. They should not be used to determine compliance with the PM-2.5 NAAQS.

Chapter 5.0 National Emission Projections, 1996 to 2010

Emission projections by pollutant through the year 2010 are shown in tables 5-1 through 5-5 and figures 5-1 through 5-5 for CO, NO_x, VOC, SO_2, and PM-10, respectively. For most source categories, emission projections are based on projected changes in BEA earnings and SEDS fuel consumption and population.[1,2] (Department of Energy electricity generation projections[3] are used for utilities and MOBILE Fuel Consumption Model[4] VMT projections are used for motor vehicles.) Non-road projections for future years are made using the new EPA non-road model which generally incorporates BEA growth projections. Changes in emission controls are modeled to project the effects of the CAAA on future emission levels. The growth factors project growth in activity only and do not include changes that might result from new technology (i.e., improved efficiency). Additional factors were utilized in the industrial, commercial/institutional, and residential fuel combustion sectors to account for improvements in efficiency. For those sectors, ratios of fuel consumption to constant dollars (industrial sector) or fuel consumption per square foot (commercial/institutional and residential) were developed relative to the base year and were applied to the emissions projected using growth factors.[5] The control factors will capture changes in control technology mandated by the CAAA but may not capture new technologies and increased efficiency of process which are not mandated by the CAAA.

Emission projections are a function of growth factors and future control level estimates, both of which have associated uncertainties. Growth factors, in general, are more uncertain the further into the future the growth is projected. In any given projection year, unexpected upturns or downturns in the economy may occur which are unaccounted for in projections of trends in activity. While the control factors applied may account for control initiatives resulting from CAAA requirements, increased production efficiency and technological changes (which may be a result of initiatives to decrease production costs) may not be taken into account.

National projections are shown in the following tables for each pollutant. These projections can be used to show which pollutants are expected to increase or decline, and to show which sectors have the greatest impact on total emissions and future emission levels. While the future levels may give an indication of whether air quality can be expected to improve, it should be noted that air quality indicators (e.g., ambient concentrations) vary significantly by area and that these national projections may not adequately indicate the emission changes expected in individual areas currently in nonattainment for CO, SO_2, PM-10, and O_3. Caveats associated with the controls modeled for each pollutant are discussed below.

5.1 DIFFERENCES BETWEEN PROJECTIONS, 1996 AND 1997 REPORTS

As in past *Trends* reports, changes will be made to the emission estimate projections as improved information and resources become available. Anticipated beneficial effects from such widely publicized developments as the recently announced fuel cells and hybrid propulsion systems for automobiles, expected to reduce vehicle emissions, cannot realistically be quantified at this early stage.

5.2 FUTURE EXPECTED TRENDS IN CARBON MONOXIDE EMISSIONS

Trends in CO emissions through 2010 are shown in table 5-1 and illustrated in figure 5-1. Total emissions are expected to show a continued decline through 2005 with emissions showing a slight increase in 2007 continuing into the future. Emissions in 2010 likely will remain below 1990 levels. The decline through 2005 is due entirely to expected decreases in on-road vehicle emissions as a result of more stringent tailpipe standards, enhanced inspection and maintenance (I/M) in some O_3 and CO NAAs, and oxygenated fuels. These decreases in on-road vehicle emissions outweigh small increases in emissions from other source categories. As <u>VMT increases begin to dominate any further decreases in on-road vehicle emission factors, total emissions begin to increase</u>.

5.3 FUTURE EXPECTED TRENDS IN NITROGEN OXIDE EMISSIONS

Projected levels of NO_x emissions through 2010 are shown in table 5-2 and figure 5-2. Total emissions show a slight increase from 1990 to 1993 followed by a decrease in 1996 as stationary source NO_x RACT is implemented and enhanced I/M programs begin in some O_3 NAAs. Electric utility emissions show an expected decline in 1996 with RACT requirements and an additional decline between 1999 and 2000 as phase II Title IV standards become effective. While RACT control requirements for industrial fuel combustion emitters result in emission declines for this category, trends are dominated by decreases in predicted activity for coal and oil sectors. On-road vehicle emissions will likely continue to decline through 2010 as emission factor decreases due to tailpipe standards, phase II reformulated gasoline, and I/M requirements outweigh increases in VMT.

5.3.1 Utility Projections

Utility emissions growth for this Trends report was estimated using the Emission Reduction and Cost Analysis Model for NO_x (ERCAM-NO_x), and the 1995 NET Inventory as the base for the projections (refer to section 6.8.1). These projections are considered DRAFT. EPA has recently been using another forecasting model, Integrated Planning Model (IPM), to develop utility emission projections for economic analyses supporting the final Acid Rain Phase II NO_x Emission Reduction Rule[6] and the proposed Regional Ozone Transport Reduction Rule.[7] EPA used a 1994 inventory prepared by the Acid Rain Division (ARD) as the base for the IPM projections used in these rulemakings (refer to section 6.2.1). The assumptions made by ERCAM-NO_x and IPM are largely consistent with each other, but with differences occurring in the consideration of electric power deregulation, future fossil fuel estimates, and baseline and projection unit level data. EPA is evaluating whether IPM model estimates can be incorporated in future Trends reports.

Below is a table which shows the differences in projected utility NO_x emissions made by Trends (draft) and IPM model forecasts.

Predicted Annual NO_x Emissions (Tons/Year) - Electric Utility

	2000	2005	2010
Trends (draft)	5,222	5,459	5,728
IPM Forecast	4,953	5,271	5,319

5.4 FUTURE EXPECTED TRENDS IN VOLATILE ORGANIC COMPOUND EMISSIONS

Trends in VOC emissions through 2010 are shown in table 5-3 and figure 5-3. Emission levels in 2010 are expected to remain lower than 1990 although total emissions show an upturn between 2005 and 2007. Emission projections for VOC include only the mandatory provisions of the CAAA including RACT, new Control Techniques Guidelines (CTGs), Federal measures for consumer solvents, Title I and II mobile source measures, and Title III Maximum Achievable Control Technology (MACT) standards. Provisions which are not accounted for and which may result in further emission declines (in O_3 NAAs) include new source offsets, progress requirements, and attainment and maintenance provisions. The largest expected decrease in emissions occurs between 1993 and 1996, as the majority of O_3 NAA mandatory measures are implemented. Solvent utilization emissions show a continued decline through 1999 as more stringent control requirements become effective for consumer solvents. On-road vehicle emissions show a continued decline through 2010; VMT increases then begin to dominate any additional reductions due to emission factor decreases.

5.5 FUTURE EXPECTED TRENDS IN SULFUR DIOXIDE EMISSIONS

Future year expected emission trends through 2010 for SO_2 are shown in table 5-4 and figure 5-4. Total emissions are predicted to continue to decline through 2010. Sulfur dioxide emissions are dominated by electric utility and industrial fuel combustion. Electric utility fuel combustion emissions show an expected continued decline through 2010, with slight increases in the years 2002 through 2005, due to the lower emission cap in 2010. These projections assume that utilities bank a certain portion of their phase I allowances and use these banked allowances from 2000 to 2010.

Future year expected emission trends from industrial sources can be discerned from table 5-4 by combining the emissions from fuel combustion-industrial, chemical and allied products manufacturing, metals processing, petroleum and related industries, other industrial processes, solvent utilization, storage and transport, and waste disposal and recycling. When future emissions from these sources are examined, they show a slight expected decrease from 1990 to 1993, remain essentially flat through 1999, and then show an increasing trend (except for 2008) through 2010. The decrease in 2008 is predominantly due to increases in fuel efficiency in the industrial fuel combustion category. The emissions projections show that total national industrial SO_2 emissions remain below the 5.60 million short ton per year cap established by section 406 of the CAAA for all projection years evaluated.

5.6 FUTURE EXPECTED TRENDS IN PARTICULATE MATTER (PM-10) EMISSIONS

Projections of future levels of PM-10 emissions are shown in table 5-5 and figure 5-5. Clean Air Act Amendment controls reduce PM-10 emissions in NAAs; however, because this is such a small subset of total national emissions, overall levels show an increase in emissions. The lower expected increase between 1990 and 1996 is generally due to the NAA controls. Changes in emissions after 1996 are due solely to activity level changes with the exception of on-road vehicles. On-road vehicle emission factors decrease due to diesel fuel standards and increased penetration of cleaner vehicles with fleet turnover. The further decrease between 2005 and 2008 is due to the CAAA standards for heavy-duty diesel vehicles (HDDVs).

5.7 REFERENCES

1. *Table SA-5—Total Personal Income by Major Sources, 1969-1995,* Data files. Bureau of Economic Analysis, U.S. Department of Commerce, Washington. DC. 1997.
2. *State Energy Data Report—Consumption Estimates 1960-1995*, DOE/EIA-0214(89), U.S. Department of Energy, Energy Information Administration, Washington, DC. May 1997.
3. *Recommendations to NAPAP Regarding SO_2 Emission Projections.* Report to the National Acid Precipitation Assessment Program (NAPAP). Prepared by Resources for the Future. Washington, DC. June 15, 1994.
4. *MOBILE4.1 Fuel Consumption Model.* Computer reports from EPA, Office of Mobile Sources, Ann Arbor, MI. August 1991.
5. Annual Energy Outlook 1997 with Projections to 2015, DOE/EIA-0383(97), U.S. Department of Energy, Energy Information Administration, Washington, DC. December 1996.
6. *Analyzing Electric Power Generation Under the CAAA.* Office of Air and Radiation, U.S. Environmental Protection Agency, Washington, DC. July 1996.
7. *Regulatory Impact Analysis of NO_x Regulations.* Prepared by ICF Incorporated for Acid Rain Division, Office of Atmospheric Programs, U.S. Environmental Protection Agency, Washington, DC. October 1996.
8. *Proposed Ozone Transport Rulemaking Regulatory Analysis.* Office of Air and Radiation, U.S. Environmental Protection Agency, Washington, DC. September 1997.

Figure 5-1. Trend in CARBON MONOXIDE Emissions by 7 Principal Source Categories, 1990 to 2010
(reading legend left to right corresponds to plotted series from top to bottom)

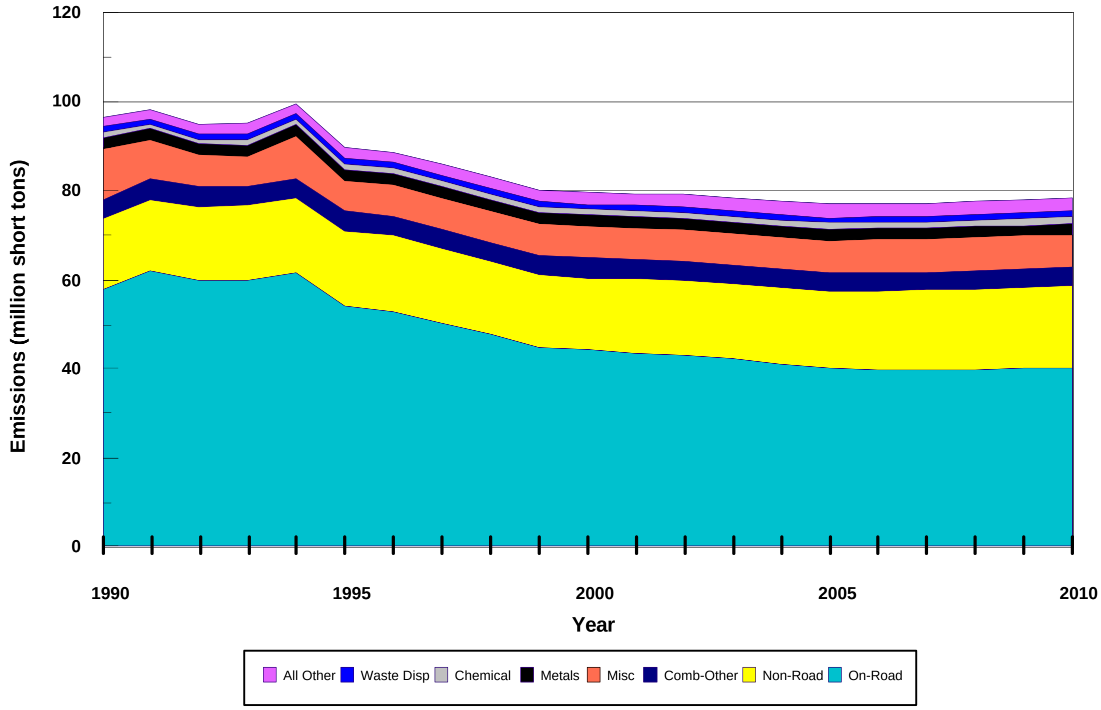


Table 5-1. National Carbon Monoxide Emissions by Source Category, 1990 to 2010

Source Category	1990	1993	1996	1999	2000	2002	2005	2007	2008	2010
FUEL COMB. ELEC. UTIL.	363	363	377	569	592	635	715	745	766	815
FUEL COMB. INDUSTRIAL	879	1,043	1,072	1,045	1,067	1,073	1,091	1,095	1,096	1,104
FUEL COMB. OTHER	4,269	4,181	4,513	4,392	4,377	4,275	4,219	4,125	4,112	4,093
CHEMICAL & ALLIED PRODUCT MFG	1,183	1,093	1,223	1,276	1,289	1,325	1,379	1,415	1,433	1,469
METALS PROCESSING	2,640	2,536	2,378	2,479	2,465	2,463	2,460	2,464	2,467	2,470
PETROLEUM & RELATED INDUSTRIES	333	371	348	365	369	379	394	403	408	418
OTHER INDUSTRIAL PROCESSES	537	594	635	683	695	720	758	783	796	822
SOLVENT UTILIZATION	5	5	6	6	6	7	7	7	7	7
STORAGE & TRANSPORT	76	51	25	26	26	27	28	28	29	29
WASTE DISPOSAL & RECYCLING	1,079	1,248	1,203	1,128	1,140	1,165	1,201	1,225	1,237	1,262
ON-ROAD VEHICLES	57,848	60,202	52,944	44,966	44,244	43,156	40,061	39,870	39,979	40,201
NON-ROAD ENGINES AND VEHICLES	16,117	16,592	17,002	16,140	16,362	16,789	17,433	17,860	18,073	18,495
MISCELLANEOUS	11,208	7,013	7,099	7,142	7,172	7,232	7,323	7,380	7,409	7,466
TOTAL	**96,535**	**95,291**	**88,822**	**80,216**	**79,805**	**79,246**	**77,068**	**77,401**	**77,811**	**78,651**

Figure 5-2. Trend in NITROGEN OXIDE Emissions by 7 Principal Source Categories, 1990 to 2010
(reading legend left to right corresponds to plotted series from top to bottom)

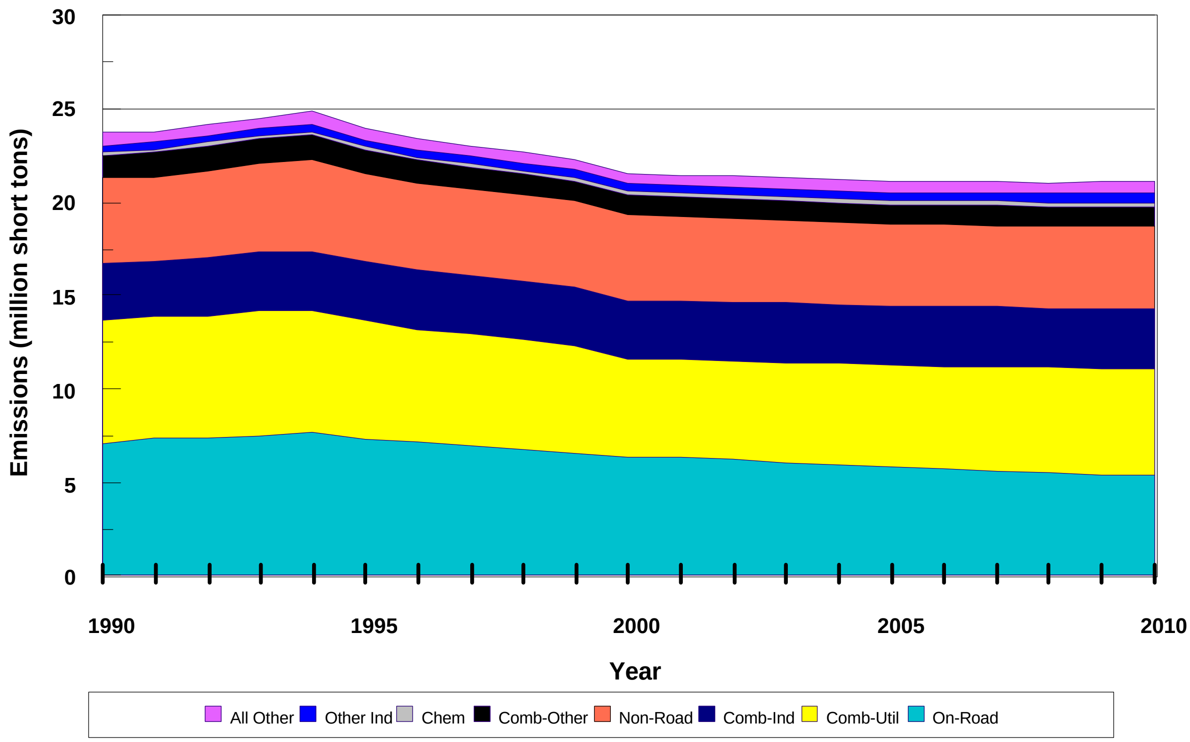


Table 5-2. National Nitrogen Oxide Emissions by Source Category, 1990 to 2010

Source Category	1990	1993	1996	1999	2000	2002	2005	2007	2008	2010
FUEL COMB. ELEC. UTIL.	6,663	6,651	6,034	5,851	5,222	5,273	5,459	5,607	5,639	5,728
FUEL COMB. INDUSTRIAL	3,035	3,151	3,170	3,086	3,160	3,159	3,184	3,199	3,193	3,195
FUEL COMB. OTHER	1,196	1,308	1,289	1,106	1,109	1,104	1,102	1,107	1,111	1,115
CHEMICAL & ALLIED PRODUCT MFG	168	155	159	166	167	172	179	183	186	190
METALS PROCESSING	97	83	98	105	105	106	108	110	110	112
PETROLEUM & RELATED INDUSTRIES	153	123	110	118	120	123	127	130	132	134
OTHER INDUSTRIAL PROCESSES	378	370	403	420	423	433	447	457	462	473
SOLVENT UTILIZATION	1	3	3	3	3	3	3	3	4	4
STORAGE & TRANSPORT	3	5	6	6	6	7	7	7	7	7
WASTE DISPOSAL & RECYCLING	91	123	100	99	100	103	107	110	111	114
ON-ROAD VEHICLES	7,040	7,510	7,171	6,504	6,397	6,227	5,796	5,571	5,491	5,354
NON-ROAD ENGINES AND VEHICLES	4,593	4,776	4,610	4,596	4,542	4,452	4,382	4,380	4,388	4,424
MISCELLANEOUS	371	225	239	240	241	242	244	246	246	248
TOTAL	**23,792**	**24,482**	**23,393**	**22,299**	**21,596**	**21,404**	**21,146**	**21,109**	**21,081**	**21,099**

Figure 5-3. Trend in VOLATILE ORGANIC COMPOUND Emissions by 7 Principal Categories, 1990 to 2010
(reading legend left to right corresponds to plotted series from top to bottom)

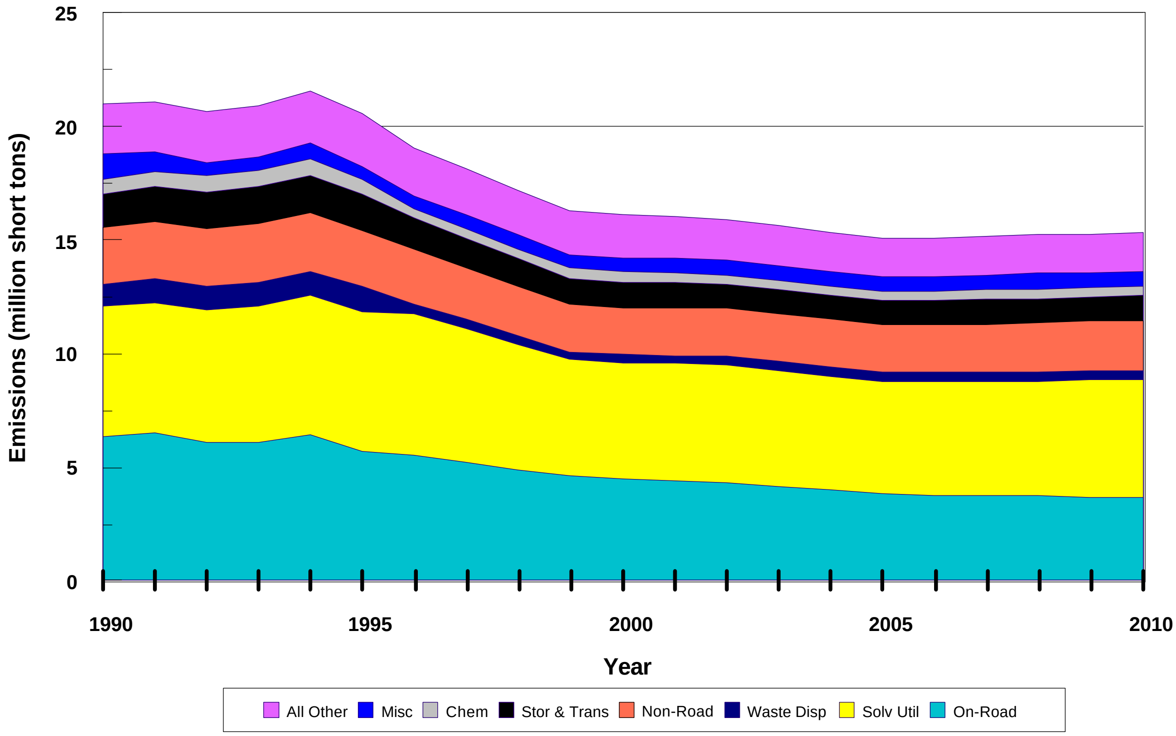


Table 5-3. National Volatile Organic Compound Emissions by Source Category, 1990 to 2010

Source Category	1990	1993	1996	1999	2000	2002	2005	2007	2008	2010
FUEL COMB. ELEC. UTIL.	47	45	45	64	67	71	80	84	86	92
FUEL COMB. INDUSTRIAL	182	186	208	205	208	207	210	210	211	212
FUEL COMB. OTHER	776	762	822	737	718	668	612	567	550	517
CHEMICAL & ALLIED PRODUCT MFG	634	701	436	463	466	421	400	411	416	427
METALS PROCESSING	122	124	70	104	104	105	107	108	108	109
PETROLEUM & RELATED INDUSTRIES	612	649	517	396	399	335	338	341	342	345
OTHER INDUSTRIAL PROCESSES	401	442	439	402	407	394	374	384	389	399
SOLVENT UTILIZATION	5,750	6,016	6,273	5,093	5,101	5,233	4,921	5,035	5,092	5,207
STORAGE & TRANSPORT	1,495	1,600	1,312	1,110	1,100	1,089	1,067	1,068	1,070	1,078
WASTE DISPOSAL & RECYCLING	986	1,046	433	369	374	378	383	392	397	406
ON-ROAD VEHICLES	6,313	6,103	5,502	4,619	4,482	4,312	3,853	3,750	3,722	3,683
NON-ROAD ENGINES AND VEHICLES	2,502	2,581	2,426	2,106	2,090	2,067	2,098	2,138	2,158	2,186
NATURAL SOURCES	14	14	14	14	14	14	14	14	14	14
MISCELLANEOUS	1,150	627	587	604	611	622	640	651	657	668
TOTAL	**20,985**	**20,895**	**19,086**	**16,286**	**16,139**	**15,916**	**15,097**	**15,152**	**15,212**	**15,342**

Figure 5-4. Trend in SULFUR DIOXIDE Emissions by 6 Principal Source Categories, 1990 to 2010
(reading legend left to right corresponds to plotted series from top to bottom)

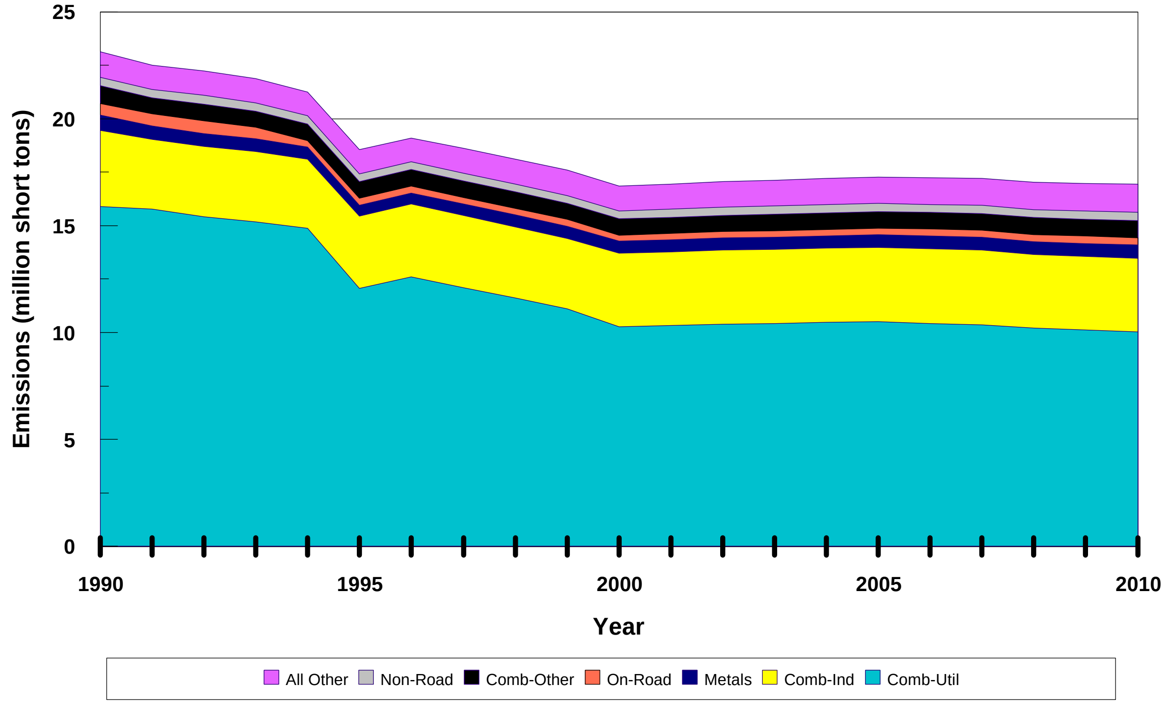


Table 5-4. National Sulfur Dioxide Emissions by Source Category, 1990 to 2010

Source Category	1990	1993	1996	1999	2000	2002	2005	2007	2008	2010
FUEL COMB. ELEC. UTIL.	15,909	15,189	12,604	11,117	10,274	10,390	10,510	10,366	10,212	10,029
FUEL COMB. INDUSTRIAL	3,550	3,284	3,399	3,295	3,428	3,459	3,479	3,498	3,437	3,457
FUEL COMB. OTHER	831	772	782	745	761	762	775	789	795	802
CHEMICAL & ALLIED PRODUCT MFG	297	269	287	300	303	311	322	330	334	342
METALS PROCESSING	726	603	530	565	568	576	588	597	601	610
PETROLEUM & RELATED INDUSTRIES	430	383	368	376	379	385	395	401	405	411
OTHER INDUSTRIAL PROCESSES	399	392	409	427	431	442	458	469	474	485
SOLVENT UTILIZATION	0	1	1	1	1	1	1	1	1	1
STORAGE & TRANSPORT	7	5	2	2	2	2	2	2	2	2
WASTE DISPOSAL & RECYCLING	42	71	48	50	51	52	55	56	57	58
ON-ROAD VEHICLES	542	517	307	327	284	295	314	327	333	347
NON-ROAD ENGINES AND VEHICLES	392	385	368	371	370	371	372	374	374	376
MISCELLANEOUS	12	9	9	9	9	9	9	9	9	9
TOTAL	**23,136**	**21,879**	**19,113**	**17,585**	**16,860**	**17,054**	**17,279**	**17,219**	**17,034**	**16,929**

Figure 5-5. PARTICULATE MATTER (PM-10) Emissions By 8 Principal Source Categories, 1990 to 2010
(reading legend left to right corresponds to plotted series from top to bottom)

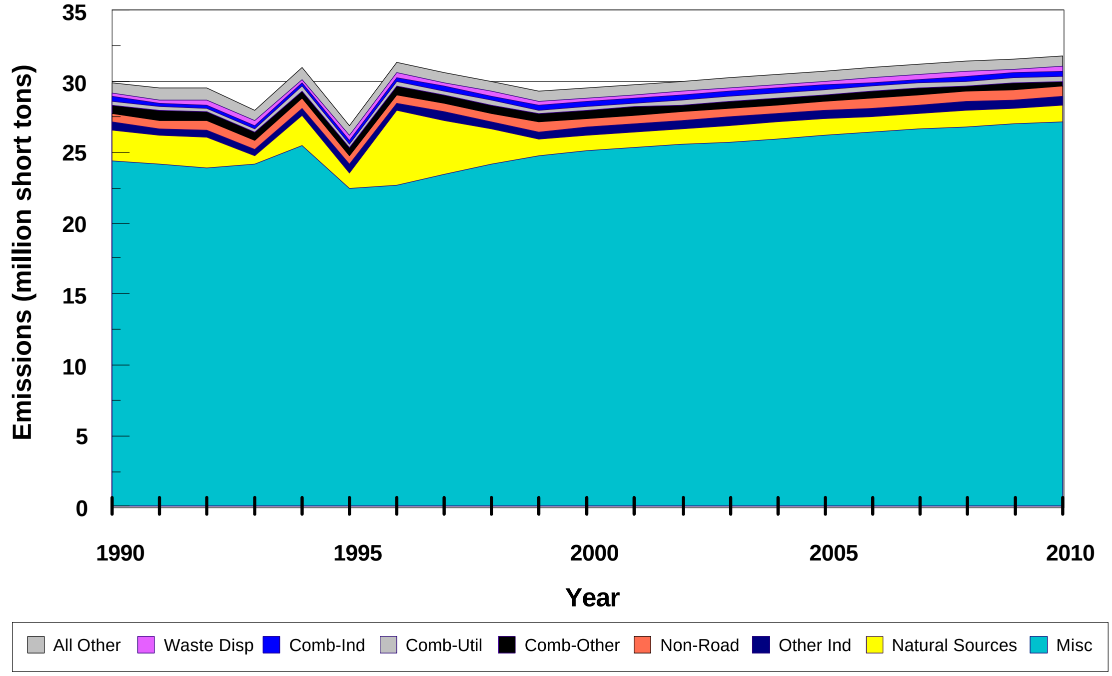


Table 5-5. National Particulate Matter (PM-10) Emissions by Source Category, 1990 to 2010

Source Category	1990	1993	1996	1999	2000	2002	2005	2007	2008	2010
FUEL COMB. ELEC. UTIL.	295	279	282	322	324	332	347	356	360	369
FUEL COMB. INDUSTRIAL	270	257	306	300	309	313	318	320	317	320
FUEL COMB. OTHER	631	588	598	605	553	526	496	472	463	446
CHEMICAL & ALLIED PRODUCT MFG	77	66	67	71	72	75	79	81	82	85
METALS PROCESSING	214	181	211	227	228	232	237	240	242	246
PETROLEUM & RELATED INDUSTRIES	55	38	40	41	42	43	45	46	46	47
OTHER INDUSTRIAL PROCESSES	583	501	510	539	545	558	578	592	598	612
SOLVENT UTILIZATION	4	6	6	7	7	7	8	8	8	8
STORAGE & TRANSPORT	102	114	109	119	121	126	133	137	139	143
WASTE DISPOSAL & RECYCLING	271	334	290	291	294	299	308	313	316	322
ON-ROAD VEHICLES	336	321	274	247	238	220	204	199	198	200
NON-ROAD ENGINES AND VEHICLES	598	633	591	613	620	635	658	675	683	700
NATURAL SOURCES	2,092	509	5,316	1,146	1,146	1,146	1,146	1,146	1,146	1,146
MISCELLANEOUS	24,419	24,196	22,702	24,802	25,074	25,534	26,205	26,614	26,821	27,165
TOTAL	**29,947**	**28,023**	**31,301**	**29,329**	**29,574**	**30,045**	**30,760**	**31,200**	**31,421**	**31,809**

Chapter 6.0 National Criteria Pollutant Estimation Methodologies

Each year, the EPA compiles emission estimates used in assessing trends in the amounts of criteria pollutants discharged into the air. Prior to 1993, the published trends primarily were intended to portray relative progress in the control of air pollutant emissions on the broad national scale. Those estimates were based on standardized emission inventory procedures using aggregate national economic and demographic data. As interest in, and the need for emission figures for individual States and metropolitan areas increased, it was obvious those techniques lacked the precision needed to provide the detailed data, representative of diverse economic and geographic areas, that could realistically assess emission reduction efforts at these smaller scales.

In recent years, the preparation and presentation of national emission estimates has evolved toward meeting the need for more detailed and more accurate inventories. To achieve this goal, a revised methodology has been developed that supports the incorporation of detailed SIP inventories and/or other regional inventories where available (e.g., OTAG and GCVTC). In addition to presenting national progress in reducing air emissions, local trends in emissions will be presented when possible.

*Because of these changes in methodologies, <u>comparison of values with previous **Trends** reports is not a valid exercise</u>. The reader should use caution when comparing estimates for the years 1985 to 1996 from this report with values in any report previously published. See section 6.6 for specific modifications.*

6.1 INTRODUCTION

This chapter presents a general description of the methodologies used to estimate emissions for 1900 through 1996 presented in this report. It does not present enough details to recreate the emissions. These details are presented in the *Trends* Procedures Document.[1] The *Trends* Procedures Document will be available via the EFIG homepage (http://www.epa.gov/oar/oaqps/efig/) during the winter of 1998.

Four major methods are used to estimate the emissions for successive intervals from 1900 through 1996. The emissions presented for the years 1900 through 1939 are taken from two reports on historic emissions.[2,3] The emissions presented for these years in the *Trends* report are unchanged from the emissions presented in past *Trends* reports. The emissions presented for the years 1940 through 1984 are based on the methodology used to estimate the emissions for these years found in all *Trends* reports prior to 1993, with several exceptions and modifications to the emissions previously presented.

For the years 1985 to 1989, the emissions are based mainly on emission inventories known as the Interim Inventories.[4] These inventories were created for the years 1987 through 1991 for use as inputs into the Regional Oxidant Model (ROM) and the Urban Airshed Model (UAM); the use of this methodology has been expanded in this report to emissions for the years 1985 and 1986.

The fourth method covers the years 1990 through 1996. This method is based on revising the 1990 Interim Inventory by replacing all the nonutility point source as well as nonmobile area source emissions with State provided data where available. When describing the inventory, it should be noted that there are two 1990 base year inventories; 1990 Interim Inventory and 1990 NET Inventory. Throughout this report the 1990 emissions presented are the 1990 NET emissions. The 1990 Interim Inventory emissions were used as the basis for the 1985 through 1989 emissions but are never presented in this report. Since there are two base year inventories, one used pre-1990 and one post-1989, the trend line presented for the time period 1985 through 1996 has apparent discontinuities between the year 1989 and 1990. EPA plans to resolve these apparent discontinuities in future reports.

The 1996 emissions are presented in this report at the State, nonattainment, and ozone season daily (OSD) level for various tier-level categories. Brief descriptions of the methodologies used to create these spatial and temporal emissions are also presented in this chapter.

In addition to presenting emissions for the current year and prior years, the *Trends* report presents national emission projections for the years 1999, 2000, 2002, 2005, 2008, and 2010. The emission values presented in the graphics for the intervening years were determined using linear interpolation and were not calculated. These emission estimates are based on current understanding of what the economic and regulatory environment will be like in the future. Since EPA cannot predict the future, these emissions will be revised in subsequent reports and the results should be used only as a general indicator of future emission trends. The methodologies used to produce these projected emissions are discussed briefly in this chapter according to the following source categories: electric utilities; nonutility point sources, area sources, on-road vehicles, and non-road mobile.

Before presenting the four major methods for estimating 1990 to 1996 emissions, a discussion of the State data used in the development of the 1990 base year NET Inventory is provided. The 1990 NET Inventory is based primarily on State data, with the 1990 Interim Inventory data filling in the gaps. The data base houses U.S. annual and average summer day emission estimates for the 50 States and the District of Columbia. Five pollutants (CO, NO_x, VOC, SO_2, and PM-10) were estimated in 1990. The State data were extracted from three sources including the OTAG[5] emission inventory, the GCVTC[6] emission inventory, and AIRS/AFS.[7] Since EPA did not receive documentation on how these inventories were developed, the following sections only describe the effort to collect the data. Additional data modifications are also discussed, as well as steps taken to fill temporal, spatial, or pollutant data gaps.

6.1.1 Ozone Transport Assessment Group

The OTAG inventory for 1990 was completed in December 1996. The data base houses emission estimates for those States in the Super Regional Oxidant A (SUPROXA) domain. The estimates were developed to represent average summer day emissions for the O_3 pollutants (CO, NO_x, and VOC). This section gives a background on the OTAG emission inventory and the data collection process.

The current SUPROXA domain is defined by the following coordinates:

North:	47.00 N	East:	67.00 W
South:	26.00 N	West:	99.00 W

Its eastern boundary is the Atlantic Ocean and its western border runs from north to south through North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. In total, the OTAG Inventory completely covers 37 States and the District of Columbia.

The OTAG inventory is primarily an O_3 precursor inventory. It includes emission estimates of CO, NO_x, and VOC for all applicable source categories throughout the domain. It also includes a small amount of SO_2 and PM-10 emission data that was sent by States along with their O_3 precursor data. Work was also performed for EFIG to convert all average summer day emission estimates in the OTAG inventory to annual emission estimates.

6.1.1.1 State Data Incorporation Procedures/Guidelines

The general procedure for incorporating State data into the OTAG Inventory was to take the data "as is" from the State submissions. There were two main exceptions to this policy. First, any inventory data for years other than 1990 was backcast to 1990 using BEA Industrial Earnings data by State and 2-digit Standard Industrial Classification (SIC) code.[8] This conversion was required for five States that submitted point source data for the years 1992 through 1994. All other data submitted were for 1990.

Second, any emission inventory data that included annual emission estimates but not average summer day values were temporally allocated to produce average summer day values. This temporal allocation was performed for point and area data supplied by several States. For point sources, the operating schedule data, if supplied, were used to temporally allocate annual emissions to average summer weekday. If operating schedule data were not supplied for the point source, annual emissions were temporally allocated to an average summer weekday using EPA's default Temporal Allocation file.[9] This computer file contains default seasonal and daily temporal profiles by SCC. There were a small number of SCCs that were not in the Temporal Allocation file. For these SCCs, average summer weekday emissions were assumed to be the same as those for an average day during the year.

6.1.1.2 Point

For stationary point sources, 36 of the 38 States in the OTAG domain supplied emission estimates covering the entire State. Data from the Interim Inventory were used for the two States (Iowa and Mississippi) that did not supply data. Most States supplied 1990 point source data, although some States supplied data for later years because the later year data reflected significant improvements over their 1990 data. Inventory data for years other than 1990 were backcast to 1990 using BEA historical estimates of industrial earnings at the 2-digit SIC level. Table 6-1 provides a brief description of the point source data supplied by each State.

6.1.1.3 Area

For area sources, 17 of the 38 States in the OTAG domain supplied emission estimates covering the entire State, and an additional 9 States supplied emission estimates covering part of their State (partial coverage was mostly in O_3 nonattainment areas [NAAs]). Interim Inventory data were the sole data source for 12 States. Where the area source data supplied included annual emission estimates, the default temporal factors were used to develop average summer daily emission estimates. Table 6-2 provides a brief description of the area source data supplied by each State.

6.1.1.4 Rule Effectiveness

For the OTAG inventory, States were asked to submit their best estimate of 1990 emissions. There was no requirement that State-submitted point source data include rule effectiveness for plants with controls in place in that year. States were instructed to use their judgment about whether to include rule effectiveness in the emission estimates. As a result, some States submitted estimates that were calculated using rule effectiveness, while other States submitted estimates that were calculated without using rule effectiveness.

6.1.2 Grand Canyon Visibility Transport Commission Inventory

The GCVTC inventory includes detailed emissions data for 11 States: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. This inventory was developed by compiling and merging existing inventory data bases. The primary data sources used were State inventories for California and Oregon, AIRS/AFS for NO_x, VOC, and SO_2 point source data for the other nine States, and the 1990 Interim Inventory for area source data for the other nine States. In addition to these existing data, the GCVTC inventory includes newly developed emission estimates for forest wildfires and prescribed burning, which had been previously incorporated into the NET Inventory.

After a detailed analysis of the GCVTC inventory, it was determined that the following portions of the GCVTC inventory would be incorporated into the NET Inventory:

- Complete nonutility point and nonmobile area source data for California
- Complete nonutility point and nonmobile area source data for Oregon
- Complete nonutility point data for the remaining States
- Forest wildfire data for the entire 11-State region
- Prescribed burning data for the entire 11-State region

State data from California and Oregon were incorporated because they are complete inventories developed by the States and are presumably based on more recent, detailed and accurate data than the Interim Inventory (some of which is still based on the 1985 NAPAP[10] inventory). The wildfire data in the GCVTC inventory represent a detailed survey of forest fires in the study area and are clearly more accurate than the wildfire data in the Interim Inventory. The prescribed burning data in the GCVTC inventory are the same as the data in the Interim Inventory at the State level, but contain more detailed county-level data.

Nonutility point source emission estimates in the GCVTC inventory from States other than California and Oregon came from AIRS/AFS. Corrections were made to the VOC and particulate matter (PM) emissions in this inventory. The organic emissions reported in GCVTC inventory for California are total organic gases (TOG). These emissions were converted to VOC using the profiles from EPA's SPECIATE data base.[11] Since the PM emissions in the GCVTC were reported as both TSP and PM-2.5, EPA estimated PM-10 from the TSP.

6.1.3 AIRS/AFS

SO_2 and PM-10 (or PM-10 estimated from TSP) sources of greater than 250 tons per year as reported to AIRS/AFS that were not included in either the OTAG or GCVTC inventories were appended to the NET Inventory. The data were extracted in late November 1996. It is important to note that estimated emissions were extracted.

6.1.4 Data Gaps

As stated above, the starting point for the 1990 NET Inventory is the OTAG, GCVTC, AIRS, and 1990 Interim inventories. Data added to these inventories include estimates of SO_2 and PM-10, as well as annual or OSD (depending on the inventory) emission estimates for all pollutants. This section describes the steps taken to fill in the gaps from the other inventories.

For SO_2 and PM-10, State data from OTAG were used where possible. (The GCVTC inventory contained SO_2 and PM annual emissions.) In most cases, there were no OTAG data for these pollutants. For point sources, data for SO_2 and PM-10 were added from AIRS/AFS. The AIRS/AFS data were matched to the OTAG plants and the emissions were attached to existing plants from the OTAG data where a match was found. Where no match was found to the plants in the OTAG data, new plants were added from AFS to the inventory.

For OTAG plants where there were no matching data in AIRS/AFS, and for all area sources of SO_2 and PM-10, emissions were calculated based on the emission estimates for other pollutants. The approach to developing SO_2 and PM-10 emissions from these point and area sources involved using uncontrolled emission factor ratios to calculate uncontrolled emissions. This method used SO_2 or PM-10 emission factor ratios to NO_x. NO_x was the pollutant utilized to calculate the ratio because: (1) the types of sources likely to be important SO_2 and PM-10 emitters are likely to be similar to important NO_x sources; and (2) the generally high quality of the NO_x emissions data. Ratios of SO_2/NO_x and PM-10/NO_x based on uncontrolled emission factors were developed. These ratios were multiplied by uncontrolled NO_x emissions to determine either uncontrolled SO_2 or PM-10 emissions. Once the uncontrolled emissions were calculated, information on CO, NO_x, and VOC control devices was used to determine if they also controlled SO_2 and/or PM-10. If this review determined that the control devices listed did not control SO_2 and/or PM-10, plant matches between the OTAG and Interim inventories were performed to ascertain the SO_2 and PM-10 controls applicable for those sources. The plant matching component of this work involved only simple matching based on information related to the State and county Federal Information Processing Standards (FIPS) code, along with the plant and point identification (ID) codes.

There was one exception to the procedures used to develop the PM-10 point source estimates. For South Carolina, PM-10 emission estimates came from the Interim Inventory. This was because South Carolina had no PM data in AIRS/AFS for 1990, and using the emission factor ratios resulted in unrealistically high PM-10 emissions.

6.1.5 Other Modifications

Additional data were also used to fill data gaps for residential wood combustion and prescribed burning. Although these categories were in the OTAG inventory, the data from OTAG were not usable since the average summer day emissions were often very small or zero. Therefore, annual and average summer day emission estimates for these two sources were taken from the NET.

Additional quality assurance (QA)/quality control (QC) of the inventory resulted in the following changes:

- Emissions with SCCs of fewer than eight digits or starting with a digit greater than the number "6" were deleted because they are invalid codes.
- Area source PM-10 utility emissions were deleted.
- A correction was made to a point (State 13/county 313/plant 0084) where the OSD value had been revised but not the annual value.
- Tier assignments were made for all SCCs.

6.2 NATIONAL EMISSIONS, 1990 THROUGH 1996

The 1990 NET emissions were revised to incorporate as much State-supplied data as possible. As described in the previous section, sources of State data include the OTAG inventory, the GCVTC inventory, and AIRS/AFS. For most nonutility point and nonmobile sources, these emissions were projected from the revised 1990 NET emission inventory to the years 1991 through 1996 using BEA[8] and SEDS[9] data. States were surveyed to determine whether EPA should project their 1990 nonutility point source emissions or extract them from AIRS/AFS. For all States that selected AIRS/AFS option, the emissions in the NET Inventory reflect their AIRS/AFS data for the years 1991 through 1995. Additional controls were added to the projected (or grown) emissions for the years 1995 and 1996.

Lead emissions for the years 1990 through 1996 have been estimated using the methodologies described in section 6.4 of this report. These methodologies were applied to estimate Pb emissions for all applicable source categories. The weighted emission factors and control efficiencies were assumed to be constant from 1990 to 1996. Using historic activity data, the 1996 preliminary estimates were made by one of two methods. The first of these two methods used a quadratic regression with weighted 20-year category-specific activity data. The second method used a linear regression with weighted 7-year activity data, and was applied to source categories where the trend in activity data has changed significantly over the past 10 years. This report also presents aviation gasoline emissions for the first time.

The following sections describe the methods used to estimate emissions for 1990 through 1996 according to major source category, which in some cases are combinations of several Tier I categories.

6.2.1 Fuel Combustion - Electric Utilities

This section describes the 1990 through 1996 emission estimates presented as "fuel combustion - electric utilities" in all the tables and graphics throughout the report. Emissions from the combustion of fuel by electric utilities have been divided into two classifications: (1) steam generated fossil-fuel units (an electric utility unit is a boiler), and (2) nonsteam generated fossil-fuel units such as gas turbines (GT) and internal combustion (IC) engines. The emission estimates for the second classification are described under section 6.2.2.

The emission estimates for the first classification for the years 1990 through 1996 are produced based on the boiler, year, and pollutant. Beginning January 1, 1994, under Title IV (Acid Deposition Control) of the CAAA, Phase I affected units were required to report heat input and SO_2 emissions; coal-fired units also had to report NO_x and CO_2 emissions. Oil-fired or gas-fired units in designated O_3 NAAs had extensions for NO_x and CO_2 reporting until July 1, 1995, whereas oil-fired or gas-fired units in other areas had extensions until January 1, 1996. Since annual NO_x, SO_2, and heat input values reported in the ETS/CEM data are generally based on continuous monitoring of hourly emission rates and flow using certified quality-assured equipment, these data are used when available for the year, rather than estimates based on emission factors and activity data.

Data sources for electric utilities include 1994 through 1996 CEM data reported to ARD's ETS by electric utilities,[13,14,15] 1990 through 1994 quality-assured boiler-specific NO_x emission rate data which ARD obtained from CEM certification test or other verifiable sources,[16] 1990 through 1995 DOE Form EIA-767[17] data, and 1996 DOE Form EIA-759[18] data. Table 6-3 outlines the different sources of data for SO_2, NO_x, and heat input.

The 1990 through 1995 estimates of CO, VOC, and PM-10 emissions are calculated for all boilers using form EIA-767[17] data and AP-42 emission factors.[19] Additionally, the methodology for estimating PM-10 emissions uses the PM-10 calculator to better establish the boiler PM-10 control efficiency.

For 1990 through 1995, the SO_2 emissions are also calculated using Form EIA-767 data and AP-42 emission factors for all boilers. However, for the years 1994 and 1995, ETS/CEM data reporting tons of SO_2 emitted per year are used whenever available since these data are among the most accurate collected by EPA.

For 1990 through 1995, NO_x emissions, too, are calculated using Form EIA-767 data and AP-42 emission factors for all boilers, but only as default values for boilers without any other available data source. The first (of two) choices of data for the years 1994 and 1995 are the ETS/CEM annual NO_x emissions data based on monitored NO_x emission rates whenever these data are available. The second source for 1990 through 1994 is the NO_x emission rates for most coal-fired boilers, referred to as "ARD NO_x emission rates." In 1996, ARD completed research on utility coal boiler-level NO_x emission rates. Most (about 90 percent) of the rates were based on relative accuracy tests performed in 1993 and 1994 as a requirement for CEM certification, while the other boiler emission rates were obtained from utility stack tests and other verifiable sources of information available to EPA.[16] These coal boiler-specific NO_x rates are considered, on the whole, to be significantly better than those calculated by using EPA's NO_x AP-42 factors, which are SCC-category averages. These rates are used in conjunction with the Form EIA-767 heat input calculations to obtain NO_x emissions in tons.

Because EIA-767 data were not available for the year 1996, the emissions are extrapolated from the 1995 boiler-level emissions based on plant-level 1996 fuel consumption. Thus, the 1996 emission and heat input estimates for all pollutants and boilers are projected (or "grown") from the 1995 values based on data derived from DOE Form EIA-759.[18] The ratio of plant fuel consumption in 1996 compared to that in 1995 as reported to Form EIA-759 is used as the inflator, unless there are ETS/CEM data (for NO_x, SO_2, and heat input) available, in which case those actual data values are used.

6.2.2 Fuel Combustion - Industrial and Other Combustion

Industrial and other combustion includes the combustion of fuels for use by industry, commercial establishments, institutions, and residences. The following subsections discuss how emissions from "fuel combustion - industrial and other combustion" were estimated for several periods within the 1990 to 1996 time frame. Except for residential wood combustion, 1990 emissions were developed according to the methods described in section 6.1.

6.2.2.1 1991-1994 Emissions

The 1991 through 1994 area source emissions were grown in a similar manner as the 1985 through 1989 estimates (see section 6.3.2), except for using a different base year inventory. The base year for the 1991 through 1994 emissions is the 1990 NET Inventory. The point source inventory was also grown for those States that did not want their AIRS/AFS data used. (The list of States are detailed in the AIRS/AFS subsection.) For those States requesting that EPA extract their data from AIRS/AFS, the years 1990 through 1995 were downloaded from the EPA IBM mainframe. The 1996 emissions were not extracted since States are not required to have the 1996 data uploaded into AIRS/AFS until July 1997.

6.2.2.1.1 *Grown Estimates* — The 1991 through 1994 point and area source emissions were grown using the 1990 NET Inventory as the basis and 1990 through 1996 BEA and SEDS data. The 1996 BEA and SEDS data were determined based on linear interpolation of the 1988 through 1995 data. Point sources were projected using the first two digits of the SIC code by State. Area source emissions were projected using either BEA or SEDS.

The 1990 through 1996 earnings data in BEA table SA-5 (or estimated from this table) are expressed in nominal dollars. In order to be used to estimate growth, these values were converted to constant dollars to remove the effects of inflation. Earnings data for each year were converted to 1992 constant dollars using the implicit price deflator for personal consumption expenditures.[20]

6.2.2.1.2 *AIRS/AFS* — Several States responded to EPA's survey and requested that their 1991 through 1995 estimates reflect their emissions as reported in AIRS/AFS. The list of these States, along with the years available in AIRS/AFS is given in table 6-4. Default estimated annual and OSD emissions (where available) were extracted from AIRS/AFS. Some changes were made to these AIRS/AFS files. For example, the default emissions for some States contain rule effectiveness and the emissions were determined to be too high by EPA. The emissions without rule effectiveness were extracted from AIRS/AFS and replaced the previously high estimates. The changes made to select State and/or plant AIRS/AFS data are listed below.

- Louisiana - All VOC source emissions were re-extracted to obtain emissions without rule effectiveness for the year 1994.

- Colorado - Mastercraft - The VOC emissions were reported as ton/year in the initial download from AIRS. The units were changed to pounds/year in AIRS.

- Wisconsin - Briggs and Stratton - The VOC emissions for two SCCs were changed from with rule effectiveness to without rule effectiveness for the years 1991, 1993, and 1994.

As noted in table 6-4, several States did not report emissions for all pollutants for all years for the 1990 to 1995 time period. To fill these data gaps, EPA applied linear interpolation or extrapolated the closest 2 years worth of emissions at the plant level. If only 1 year of emissions data was available, the emission estimates were held constant for all the years. The segment-SCC level emissions were derived using the average split for all available years. The non-emission data gaps were filled by using the most recent data available for the plant.

Some States do not provide PM-10 emissions to AIRS. These States' TSP emissions were converted to PM-10 emissions using uncontrolled particle size distributions and AP-42 derived control efficiencies. The State of South Carolina provided its own conversion factor for estimating PM-10 from TSP.[21]

For all sources that did not report OSD emissions, these emissions were estimated using the algorithm described in section 6.1.1.1.

6.2.2.2 1995 Emissions

The 1995 emission estimates were derived in a similar manner as the 1991 through 1994 emissions. The estimates were either extracted from AIRS/AFS for 1995, estimated using AIRS/AFS data for the years 1990 through 1994, or projected using the 1990 NET Inventory. The method used depended on States' responses to a survey conducted by EPA early in 1997. The following three subsections describe the projected emissions.

6.2.2.2.1 Grown Estimate — The 1995 point and area source emissions were grown using the 1990 NET Inventory as the basis and 1995 BEA or SEDS data depending on source category.

6.2.2.2.2 NO_x RACT — Major stationary source NO_x emitters in marginal and above NAAs and in Ozone Transport Regions (OTRs) are required to install RACT-level controls under the O_3 nonattainment-related provisions of Title I of the CAAA. The definition of major stationary source for NO_x differs by the severity of the O_3 problem. The application of NO_x RACT controls was only applied to grown sources.[22]

6.2.2.2.3 Rule Effectiveness — Rule effectiveness was revised in 1995 for all grown sources using the information in the 1990 data base file. If the rule effectiveness value was between 0 and 100 percent in 1990 and the control efficiency was greater than 0 percent, the uncontrolled emissions were recalculated for 1990. The 1995 emissions were calculated by multiplying the growth factor by the 1990 uncontrolled emissions and the control efficiency and a rule effectiveness of 100 percent. The adjustment for rule effectiveness was only applied to grown sources.

6.2.2.3 1996 Emissions

The 1996 emission estimates were grown using the 1995 NET Inventory as the basis. No 1996 AIRS/AFS data were available for use. The 1995 AIRS/AFS emissions and 1995 emissions grown from 1990 emissions were merged. The following three subsections describe the projected 1996 emissions.

6.2.2.3.1 Grown Estimates — The 1996 point and area source emissions were grown using the 1995 NET Inventory as the basis. Rule effectiveness was updated to 100 percent for the AIRS/AFS sources that reported rule effectiveness of less than 100 percent in 1995.

The following equation describes the calculation used to estimate the 1996 emissions:

$$CER_{1996} = UC_{1995} \times \frac{GS_{1996}}{GS_{1995}} \times \left(1 - \left(\frac{REFF}{100}\right) \times \left(\frac{CEFF}{100}\right) \times \left(\frac{RP}{100}\right)\right)$$

where:
- CER_{1996} = controlled emissions incorporating rule effectiveness
- UC_{1995} = uncontrolled emissions
- GS = growth surrogate (either BEA or SEDS data)
- REFF = rule effectiveness (percent)
- CEFF = control efficiency (percent)
- RP = rule penetration (percent)

The rule effectiveness for 1996 was always assumed to be 100 percent. The control efficiencies and rule penetrations are dependent on the type of control put in place in 1996.

6.2.2.3.2 1996 VOC Controls — 1996 emissions accounted for several VOC controls. These controls were developed to represent the measures mandated by the CAAA and in place in 1996. Title I (specifically the O_3 nonattainment provisions) affects VOC stationary sources. Title III hazardous air pollutant regulations will also affect VOC source categories. Detailed information for each category-specific control is described in the Procedures Document,[1] including regulatory authority, CAAA provisions relating to the control measure, and relevant EPA guidance. Categories with controls are listed below.

- Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDFs)
- Municipal Solid Waste Landfills
- New CTGs
- Existing CTGs
- RACT
- Vehicle Refueling Controls-Stage II Vapor Recovery
- Title III

6.2.2.3.3 NO_x Control — For all point sources that applied controls resulting from NO_x RACT requirements, the emission reductions were estimated similar to those for 1995. Further reductions were made to areas that did not put RACT controls into place until January 1996. In 1996, several plants not affected by NO_x RACT in 1995 were added.

6.2.2.4 Adjustments for a Variety of Years

Adjustments were made to the "residential - other combustion" emission estimates as a result of the QA effort. The 1990 through 1995 SO_2 and PM-10 emissions were replaced with the emission estimates reported in the 1996 report. The 1996 emissions were projected off the 1995 emissions reported in the 1996 report.

6.2.2.5 Residential Wood, 1990 through 1996

Emissions from residential wood combustion were estimated for 1990 through 1996 using annual wood consumption and an emission factor. The following general equation was used to calculate emissions:

$$E_{year} = Activity \times EF \times \left(1 - \frac{CE}{100}\right)$$

where: E_{year} = county emissions (tons)
Activity = wood consumption (cords)
EF = emission factor (tons/cord)
CE = control efficiency (percent)

Activity was based on EPA's County Wood Consumption Estimation Model.[23] This model was adjusted with heating degree day information,[24] and normalized with annual wood consumption estimates.[25] AP-42 emission factors for CO, NO_x, PM-10, SO_2 and VOC were used. A control efficiency was applied nationally to PM-10 emissions for the years 1991 through 1996.[26]

6.2.3 Chemical and Allied Products Manufacturing

The following subsections discuss how chemical and allied products emissions were estimated for several periods within the 1990 to 1996 time frame. 1990 emissions were developed according to the methods described in section 6.1.

6.2.3.1 1991-1994 Emissions

The 1991 through 1994 area source emissions were grown in a similar manner as the 1985 through 1989 estimates, except for using a different base year inventory. The base year for the 1991 through 1994 emissions is the 1990 NET Inventory. The point source inventory was also grown for those States that did not want their AIRS/AFS data used. See section 6.2.2.1 for additional information on grown estimates and AIRS/AFS estimates.

6.2.3.2 1995 Emissions

The 1995 emission estimates were derived in a similar manner as the 1991 through 1994 emissions. As described in section 6.2.2.2, the estimates were either extracted from AIRS/AFS for 1995, estimated using AIRS/AFS data for the years 1990 through 1994, or projected using the 1990 NET Inventory. The method used depended on States' responses to a survey conducted by EPA early in 1997.

6.2.3.3 1996 Emissions

The 1996 emission estimates were grown using the 1995 NET Inventory as the basis. No 1996 AIRS/AFS data were available for use. The 1995 AIRS/AFS emissions and 1995 emissions grown from 1990 emissions were merged. The projected 1996 emissions were developed as outlined in section 6.2.2.3, and accounted for the appropriate VOC and NO_x RACT controls.

6.2.4 Metals Processing, Petroleum and Related Industries, and Other Industrial Processes

The following subsections discuss how emissions for "metals processing, petroleum and related industries, and other industrial processes" were estimated for several periods within the 1990 to 1996 time frame. 1990 emissions were developed according to the methods described in section 6.1.

6.2.4.1 1991-1994 Emissions

The 1991 through 1994 area source emissions were grown in a similar manner as the 1985 through 1989 estimates, except for using a different base year inventory. The base year for the 1991 through 1994 emissions is the 1990 NET Inventory. The point source inventory was also grown for those States that did not want their AIRS/AFS data used. See section 6.2.2.1 for additional information on grown estimates and AIRS/AFS estimates.

6.2.4.2 1995 Emissions

The 1995 emission estimates were derived in a similar manner as the 1991 through 1994 emissions. As described in section 6.2.2.2, the estimates were either extracted from AIRS/AFS for 1995, estimated using AIRS/AFS data for the years 1990 through 1994, or projected using the 1990 NET Inventory. The method used depended on States' responses to a survey conducted by EPA early in 1997.

6.2.4.3 1996 Emissions

The 1996 emission estimates were grown using the 1995 NET Inventory as the basis. No 1996 AIRS/AFS data were available for use. The 1995 AIRS/AFS emissions and 1995 emissions grown from 1990 emissions were merged. The projected 1996 emissions were developed as outlined in section 6.2.2.3, and accounted for the appropriate VOC and NO_x RACT controls.

6.2.4.4 Adjustments for a Variety of Years

The following adjustments were made to the emission estimates for cotton ginning as a result of the QA effort. Cotton ginning estimates for 1995 and 1996 were calculated using the AP-42 emission factors and bales of cotton ginned. The U.S. Department of Agriculture (USDA) compiles and reports data on the amount of cotton ginned by State, district, and county for each crop year in its *Cotton Ginnings* reports.[27] (A crop year runs from September through March.). Ginning activity occurs from August/September through March, covering parts of two calendar years,[28] with the majority of ginning activity occurring between September and January. Ginning activity occurs in the 16 States where cotton is grown (i.e., Alabama, Arizona, Arkansas, California, Florida, Georgia, Louisiana, Mississippi, Missouri, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia). The majority of the ginning facilities are located in Arkansas, California, Louisiana, Mississippi, and Texas.

6.2.5 Solvent Utilization

The following subsections discuss how emissions for solvent utilization were estimated for several periods within the 1990 to 1996 time frame. 1990 emissions were developed according to the methods described in section 6.1.

6.2.5.1 1991-1994 Emissions

The 1991 through 1994 area source emissions were grown in a similar manner as the 1985 through 1989 estimates, except for using a different base year inventory. The base year for the 1991 through 1994 emissions is the 1990 NET Inventory. The point source inventory was also grown for those States that did not want their AIRS/AFS data used. See section 6.2.2.1 for additional information on grown estimates and AIRS/AFS estimates.

6.2.5.2 1995 Emissions

The 1995 emission estimates were derived in a similar manner as the 1991 through 1994 emissions. As described in section 6.2.2.2, the estimates were either extracted from AIRS/AFS for 1995, estimated using AIRS/AFS data for the years 1990 through 1994, or projected using the 1990 NET Inventory. The method used depended on States' responses to a survey conducted by EPA early in 1997.

6.2.5.3 1996 Emissions

The 1996 emission estimates were grown using the 1995 NET Inventory as the basis. No 1996 AIRS/AFS data were available for use. The 1995 AIRS/AFS emissions and 1995 emissions grown from 1990 emissions were merged. The projected 1996 emissions were developed as outlined in section 6.2.2.3, and accounted for the appropriate VOC and NO_x RACT controls.

6.2.5.4 Adjustments for a Variety of Years

Under the QA effort, an evaluation of the OTAG inventory indicated missing or incongruous data sets. As a result, the 1990 through 1995 VOC area source solvent emissions were replaced with the emission estimates reported in the 1996 report. The 1996 emissions were projected off the 1995 emissions reported in the 1996 report with the reductions described in section 6.2.2.3.2.

6.2.6 Storage and Transport, Waste Disposal and Recycling

The following subsections discuss how emissions for "storage and transport and waste disposal and recycling" were estimated for several periods within the 1990 to 1996 time frame. 1990 emissions were developed according to the methods described in section 6.1.

6.2.6.1 1991-1994 Emissions

The 1991 through 1994 area source emissions were grown in a similar manner as the 1985 through 1989 estimates, except for using a different base year inventory. The base year for the 1991 through 1994 emissions is the 1990 NET Inventory. The point source inventory was also grown for those States that did not want their AIRS/AFS data used. See section 6.2.2.1 for additional information on grown estimates and AIRS/AFS estimates.

6.2.6.2 1995 Emissions

The 1995 emission estimates were derived in a similar manner as the 1991 through 1994 emissions. As described in section 6.2.2.2, the estimates were either extracted from AIRS/AFS for 1995, estimated using AIRS/AFS data for the years 1990 through 1994, or projected using the 1990 NET Inventory. The method used depended on States' responses to a survey conducted by EPA early in 1997.

6.2.6.3 1996 Emissions

The 1996 emission estimates were grown using the 1995 NET Inventory as the basis. No 1996 AIRS/AFS data were available for use. For the nonutility point sources, the 1995 AIRS/AFS emissions and 1995 emissions grown from 1990 emissions were merged. The projected 1996 emissions were developed as outlined in section 6.2.2.3, and accounted for the appropriate VOC and NO_x RACT controls.

6.2.6.4 Adjustments for a Variety of Years

1990 VOC area source TSDF emissions reported in the 1996 report were revised to reflect some of the changes made during the OTAG effort. The emissions for 1985 through 1996 were grown using the revised 1990 base year emissions, BEA growth factors, and 1996 controls.

6.2.7 On-Road Vehicles

On-road emissions have been estimated for every year from 1990 through 1996. These annual emissions were based on county-level VMT and emission factors. Emissions were estimated for eight vehicle categories including: LDGV; LDDV; light-duty gasoline trucks-1 (LDGT-1 [trucks less than 6,000 pounds in weight]); LDGT-2 (6,000 to 8,500 pounds in weight); light-duty diesel trucks (LDDT); heavy-duty diesel trucks (HDDT); heavy-duty gasoline trucks (HDGT); and MC. The estimates were further subdivided by 12 roadway types.

6.2.7.1 VMT Data

Annual VMT data for the years 1990 through 1995 were obtained from the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS)[29] data base. The data are specified by State, vehicle type, and roadway type. Using population data from the 1990 census,[30] the data were distributed among the counties. The 1996 VMT was obtained from preliminary State-level VMT from FHWA.[31] The data for all years were then apportioned from the HPMS vehicle categories to the eight vehicle classes listed above using allocations provided by the EPA's Office of Mobile Sources (OMS).

The resulting annual county-level vehicle and roadway type specific VMT data were allocated by month. The monthly allocation was performed by using seasonal NAPAP temporal allocation factors to apportion the VMT to the four seasons. Monthly VMT data were then obtained using a ratio between the number of days in a month and the number of days in the corresponding season.

For the year 1990 EPA used county-level vehicle and road type specific VMT provided by several States mainly in the OTAG domain.

6.2.7.2 CO, NO_x, and VOC Emission Factors

County-level emission factors for CO, NO_x, and VOC for 1990 through 1994 were calculated using the MOBILE5a[32] model and for 1995 and 1996 using MOBILE5b, which is designed to estimate exhaust and evaporative emission factors for on-road vehicles. To calculate the emission factors for each year from 1990 through 1996, the models utilized information on State-level monthly maximum and minimum temperatures, nine vehicle speeds, national vehicle registration distributions, gasoline volatility given in terms of in-use RVP, and county-level I/M and oxygenated fuels programs. The Federal Test Procedure (FTP) operating mode was modeled at all speeds.

For the years 1990, 1995, and 1996 EPA used State-provided MOBILE inputs including 1990 registration distributions, I/M programs, and summer RVP data, for several States mainly in the OTAG domain. For this reason and changes in VMT, the trends in on-road emissions have apparent discontinuities from 1989 to 1990, 1990 to 1991, and 1994 to 1995. These apparent discontinuities will be resolved in future *Trends* reports.

6.2.7.3 SO_2 and PM-10 Emission Factors

County-level emission factors for SO_2 and PM-10 for 1990-1996 were calculated using the PART5[33] model which is designed to estimate particulate matter (PM) exhaust, brake wear, and reentrained road dust emissions from paved and unpaved roads (see sections 6.2.9.4.3 and 6.2.9.4.4 for road dust) and SO_2 from vehicle exhaust.

PART5 uses the same vehicle registration distributions as the MOBILE model. This registration distribution was modified by distributing the MOBILE HDDV vehicle class distribution among the five PART5 HDDV subclasses (2BHDDV [class 2B HDDV], LHDDV [light HDDV], MHDDV [medium HDDV], HHDDV [heavy HDDV], and buses). This was accomplished using HDDV subclass-specific sales, survival rates, and diesel market shares.

6.2.7.4 On-Road Lead Emissions

To estimate Pb emissions from on-road vehicles for 1990 through 1996, reported gasoline consumption was multiplied by an emission factor that accounts for the amount of Pb in leaded and unleaded gasoline. The emission factors were updated to reflect a revised Pb content (in terms of grams of Pb) for gasoline.[34]

6.2.8 Non-road Sources

The non-road category includes the estimated emissions from aircraft, commercial marine vessels, railroads, and all other non-road vehicles and equipment. The emission estimates for 1990 through 1996 were developed in a similar manner as those described in section 6.2.2. The 1990 emissions are based on State-provided emissions supplemented with 1990 Interim Inventory emissions. Emission reductions for VOC non-road spark-ignition engines <25 hp were applied in 1996. A 37 percent reduction in NO_x emissions was applied nationally to some of the new diesel compression-ignition engines for the year 1996, depending on horsepower range. A rule effectiveness of 100 percent was applied, as well as a rule penetration rate of between 0.5 and 1 percent depending on type of equipment. As an update to portions of the 1995 and 1996 NET non-road inventory, OMS agreed to provide emission estimates from their models and analyses being used for the Regulatory Impact Analysis (RIA) documents. These models and analyses generate only national totals at the SCC level. Categories for which OMS provided data are non-road diesel engines,[35,36] spark-ignition marine engines,[37,38] and locomotives. For diesel non-road engines, the pollutants covered included CO, NO_x, VOC, and PM-10. For spark-ignition marine engines, only NO_x and VOC were provided. For locomotives, only NO_x and PM-10 were provided but only PM-10 was used. These national OMS numbers were used to update the 1995 and 1996 NET emission estimates such that the sum of the county/SCC level NET estimates would equal the national/SCC level OMS estimates.

For several source categories, adjustments were made to the emission estimates as a result of the QA effort.

- Commercial aircraft emissions were recalculated using landing/takeoff operations (LTOs) instead of BEA data for the years 1991 through 1996 for all pollutants.

- Railroad NO_x emissions reverted back to emissions reported in the 1996 report for the years 1990 through 1995.

- Non-road diesel equipment emissions were adjusted for the years 1970 to 1994 to reflect the changes in the 1995 emissions. While the OMS models were only run for 1995 and 1996, ratios of the current 1995 emissions to the previous 1995 emissions were developed for each nonroad source category. These ratios were then multiplied by the emissions for these sources for 1970 through 1994 in order to be consistent with OMS's new nonroad models.

Lead emissions from non-road vehicles for 1990 through 1996 were also updated to reflect a revised Pb content (in terms of grams of Pb) for gasoline.[34] All gasoline consumed by non-road engines was assumed to be leaded.

6.2.9 Remaining Categories

"Remaining categories" include emissions for two Tier I source categories including: natural sources and miscellaneous. The CO, NO_x, VOC, SO_2, and PM-10 emissions for the years 1990 through 1996 from all source categories, except for those listed below, were produced using the methodology described in section 6.2.2.

6.2.9.1 Natural Sources, Geogenic, Wind Erosion

The PM-10 emissions for the years 1990 through 1996 from the wind erosion of agricultural lands were estimated using a modified version of the NAPAP methodology. Monthly emissions were estimated from the acres of crops planted, the number of seconds, and the dust flux. The expected dust flux was based on the probability distribution of wind energy, the mean wind speed and the coefficient of drag. This methodology is the same as that described in section 6.3.9.1 (the methodology used for the years 1985-1989) except the previous years rain data for September through December was used. A more detailed explanation on this methodology is presented in the Procedures Document.[1]

6.2.9.2 Miscellaneous, Agriculture and Forestry

PM-10 emissions from agricultural crops for the years 1990 through 1996 were estimated on a county level using the AP-42 emission factor equation for agricultural tilling. The activity data for this calculation were the acres of crops tilled in each county for each crop type and tilling method obtained for each year from the Conservation Technology Information Center (CTIC).[39] The emission factor, expressed in terms of the mass of TSP produced per acre-tilled was corrected by parameters including the silt of the surface soil, the particle size multiplier (PM-10 = 0.21), and the number of tillings per year. The silt of the surface soil was obtained by comparing the USDA[40] surface soil map with the USDA[41] county map, soil types were assigned to all counties of the continental United States. Silt percentages were determined by using a soil texture classification triangle.[42] For those counties with organic material as its soil type, EPA used the previous silt percentages presented by Cowherd.[43] These silt factors were then corrected using information from Spatial Distribution of PM-10 emissions from Agricultural Tilling in the San Joaquin Valley.[44] The number of tillings was also obtained from the CTIC.

The 1990 emissions from agricultural livestock were determined from activity data, expressed in terms of the number of heads of cattle, and a national PM-10 emission factor. The emissions for the years 1991 through 1996 were produced using the methodology described for area source emissions in section 6.2.2.

6.2.9.3 Miscellaneous, Other Combustion

The miscellaneous, other combustion category includes emissions from agricultural burning, forest fires/wildfires, prescribed/slash and managed burning, and structural fires. The emissions from agricultural burning and structural fires were developed using the methodology described in section 6.2.2.

Forest fires/wildfires emissions were generated for the years 1990 through 1995 using information on the number of forest fires, their location, and the acreage burned. These data were obtained from the Department of Interior (DOI)[45,46] and the USDA Forest Service.[47,48] The amount of biomass used to determine the quantity of vegetation burned was estimated by the EPA. Average emission factors were applied to the estimated quantities of vegetation burned.[19]

For the years 1990 through 1993, and for the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, the above emission estimates were replaced for the pollutants CO, NO_x, VOC, and PM-10 by those in the inventory produced for the GCVTC. The SO_2 emissions were estimated based on the methodology described below for determining prescribed burning estimates. The 1994 and 1995 emissions for the 11 States listed above were estimated based on the ratio of acres burned reported by the USDA and DOI for the years 1990, 1994, and 1995. Since 1996 activity data were not available in time to incorporate into this report, the 1996 emissions are the same as the 1995 emissions.

Emissions from prescribed burning were based on the 1989 USDA Forest Service[49] inventory of particulate matter from prescribed burning. The NO_x and SO_2 emissions were estimated by assuming the ratio between the CO emissions to either the NO_x or SO_2 emissions in the Forest Service inventory was equal to the corresponding ratio in the 1985 NAPAP Emission Inventory. The resulting 1989 emissions for CO, NO_x, VOC, SO_2, and PM-10 have been used for all years between 1990 and 1996.

6.2.9.4 Miscellaneous, Fugitive Dust

PM-10 fugitive dust emissions arise from construction activities, mining and quarrying, paved road resuspension, and unpaved roads. The general methodology used to estimate emissions for each of these categories required an activity indicator, an emission factor, and one or more correction factors. The activity indicator for a given category varied from year to year, as may the overall correction factor.

6.2.9.4.1 *Construction Activities* — The PM-10 emissions for the years 1990 through 1995 were calculated from an emission factor,[19] an estimate of the acres of land under construction, and the average duration of construction activity.[50] The acres of land under construction were estimated from the dollars spent on construction.[51] The PM-10 emission factor for the years 1990 through 1995 was obtained from Improvement of Specific Emission Factors.[52]

The 1996 emissions were extrapolated from the 1995 emissions using the ratio between the number of residential construction permits issued in 1996 and the number issued in 1995. A 62.5 percent reduction was applied to the PM-10 emissions for all PM NAAs for the years 1995 and 1996.[53]

6.2.9.4.2 *Mining and Quarrying* — The PM-10 emissions for the years 1990 through 1995 were the sum of the emissions from metallic ore, nonmetallic ore, and coal mining operations. These PM-10 emissions arise from the following activities: (1) overburden removal; (2) drilling and blasting; (3) loading and unloading; and (4) overburden replacement. Emissions from transfer and conveyance operations, crushing and screening operations, and storage and travel on haul roads were not included.

To calculate the emissions from metallic ore mining, the PM-10 AP-42 emission factors for copper ore processing operations were applied to the amount of metallic ores handled, obtained from the U.S. Geological Survey.[54] The PM-10 AP-42 emission factors for western surface coal mining were used to estimate the emissions from both nonmetallic ore and coal mining. Production figures for these operations were obtained from the U.S. Geological Survey[54] and the Coal Industry Annual.[55]

The 1996 PM-10 emissions were produced from a linear projection of the emissions for the years 1985 through 1995.

6.2.9.4.3 *Paved Road Resuspension* — The calculation of total State-level PM-10 emissions for the years 1990 through 1996 were based on the paved road VMT, an AP-42 base emission factor, and two correction factors: road surface silt loading[56] and the number of dry days (a dry day is defined as any day with less than 0.01 inches of precipitation).[57] The methodology used to determine these correction factors was modified from that used to calculate emissions from this source in last year's report. The methodology used to determine these correction factors in last year's report is still utilized to calculate emissions for 1985 through 1989 and is discussed in section 6.3.9.4.3.

The number of dry days term attempts to account for emission reductions resulting from the effect of precipitation. For the period 1990 through 1996, the total number of days was reduced by 50 percent. Surface silt loading values by paved road functional class and State were based on annual average traffic volumes. State-level annual average traffic volumes for each roadway functional category were utilized to calculate the average daily traffic volume (ADTV). National average measured silt loadings were then assigned to each roadway functional class based upon whether the ADTV was above or below 5000 vehicles per day. The only exception to this assignment was for local functional class roads, which were assigned a national average silt loading independent of the ADTV for local functional class roads in a State.

Total VMT data for the years 1990 through 1995 were obtained by State and roadway functional class. The total preliminary 1996 VMT data were obtained by State and two road types (urban and rural). The rural and urban VMT data were apportioned to the road functional classes using the distribution of the 1995 VMT data. The VMT from paved roads for each year was calculated by subtracting the unpaved road VMT from the total VMT for each year.

Reductions based on road-type to account for controls were applied to the PM-10 emissions for all PM NAAs for the years 1995 and 1996.

6.2.9.4.4 *Unpaved Roads* — The total PM-10 emissions for the years 1990 through 1996 were based on unpaved road VMT data, an AP-42 base TSP emission factor, and the following correction factors: particle size multiplier, silt content of road surface material,[58] mean vehicle speed, mean vehicle weight, mean number of wheels,[59,60,61] and the number of dry days.[57] Mean vehicle speeds were assigned to each unpaved road functional class. The number of dry days is defined in the same manner as for estimating the paved road emissions. The VMT data for unpaved roads were obtained for rural and urban functional classes excluding local functional class roads. Local functional class road VMT was calculated from data on the number of miles of local functional class roadways in various ADTV classes. For the years 1990 through 1996, Mississippi total unpaved road mileage for local functional class roads was redistributed to ADTV classes using distributions in neighboring States, because the reported distributions for Mississippi produced anamolous total VMT. This method is different from that used in last year's report. The methodology used in last year's report for this time period is identical to that described for 1985 through 1989 in section 6.3.9.4.4.

The 1996 PM-10 emissions were produced by multiplying the projected 1996 VMT by the AP-42 emission factor and 1996 correction factors.

Reductions based on road-type to account for controls were applied to the PM-10 emissions for all PM NAAs for the years 1995 and 1996.

6.3 NATIONAL EMISSIONS, 1985 THROUGH 1989

The CO, NO_x, SO_2, and VOC emissions presented in this report for the years 1985 through 1989 have been estimated using a methodology developed for the Interim Inventories, with some exceptions. The Interim methodology was developed to produce inventories for the years 1987 through 1991 and is presented in the *Regional Interim Emission Inventories (1987-1991).*[4] A similar methodology was developed for the preparation of a national 1990 PM-10 inventory as documented in the *Emissions Inventory for the National Particulate Matter Study*[62] and revised as documented in the draft report entitled *The National Particulates Inventory: Phase II Emission Estimates*.[63] In order to generate the necessary emissions for the *Trends* report, the Interim methodology has been expanded to generate CO, NO_x, SO_2, and VOC emissions for the years 1985 and 1986, as well as PM-10 emissions for the years 1985 through 1989.

Lead emissions for the years 1985 through 1989 have been estimated using the methodologies described in section 6.4 of this report. These methodologies were applied to estimate Pb emissions for all applicable source categories.

6.3.1 Fuel Combustion - Electric Utilities

Emissions from the combustion of fuel by electric utilities have been divided into two classifications: (1) steam generated fossil-fuel units (an electric utility unit is a boiler); and (2) nonsteam generated fossil-fuel units such as GT and IC engines.

The emissions from fossil-fuel steam electric utility units for the years 1985 through 1989 have, with one exception, been developed using the same methodology as that described under 6.2.1 for the years 1990 through 1993. The one difference is the 1985 electric utility SO_2 emissions, which are based on the National Allowance Data Base (NADB) Version 2.11, Acid Rain Division, U.S. EPA, released March 23, 1993. (Therefore, the SO_2 emissions in this report differ from the emissions included in the 1985 NET data base.) Allocations at the Tier III level for 1985 are approximations only and are based on the methodology to estimate emissions for the year 1985 for the other pollutants.

The 1990 Interim Inventory emissions for the second classification, nonsteam generated fossil-fuel units, served as the base year from which emissions for the years 1985 through 1989 were estimated. The methodology used to develop the emissions for the 1990 base year and the two methodologies used to estimate the emissions from the base year emissions are discussed in section 6.3.2.

6.3.2 Fuel Combustion - Industrial, Other Combustion

The 1990 emissions for industrial and other fuel combustion were generated from both the nonutility point source[a] and nonsolvent area source portions of the 1985 NAPAP Emissions Inventory. These 1990 emissions served as the base year from which the emissions for the years 1985 through 1989 were estimated. The emissions for the years 1985 through 1989 were estimated using historical earnings data compiled by BEA or historic estimates of fuel consumption based on the DOE's SEDS.

6.3.2.1 1990 Interim Inventory Development

The 1985 NAPAP Emission Inventory estimates for the nonutility point sources have been projected to the year 1990 based on the growth in BEA historic earnings for the appropriate State and industry, as identified by the 2-digit SIC code. State and SIC-level growth factors were calculated as the ratio of the 1990 earnings data to the 1985 earnings data.

The area source emissions from the 1985 NAPAP Emissions Inventory that fall within this category, with the exception of residential wood combustion, have been projected to the year 1990 based on BEA historic earnings data, BEA historic population data,[64] DOE SEDS data, or other growth indicators. The specific growth indicator was assigned based on the source category. The BEA earnings data were converted to 1982 dollars as described above. The 1990 SEDS data were extrapolated from data for the years 1985 through 1989. All growth factors were calculated as the ratio of the 1990 data to the 1985 data for the appropriate growth indicator.

When creating the 1990 emissions inventory, changes were made to emission factors, control efficiencies, and emissions from the 1985 inventory for both the nonutility and area sources. The PM-10 control efficiencies were obtained from revisions made to the PM-10 Calculator.[b,65] Details of these changes are presented in the *Trends* Procedures Document.[1] In addition, rule effectiveness was applied to the 1990 emissions estimated for the nonutility point sources. The CO, NO_x, and VOC point source controls were assumed to be 80 percent effective; PM-10 and SO_2 controls were assumed to be 100 percent effective.

The 1990 emissions for CO, NO_x, VOC, and SO_2 were calculated using the following steps: (1) projected 1985 controlled emissions to 1990 using the appropriate growth factors; (2) calculated the uncontrolled emissions using control efficiencies from the 1985 NAPAP Emission Inventory; and (3) calculated the final 1990 controlled emissions using revised control efficiencies and the appropriate rule effectiveness. The 1990 PM-10 emissions were calculated using the TSP emissions from the 1985 NAPAP Emission Inventory. The 1990 uncontrolled TSP emissions were estimated in the same manner as the other pollutants. From these TSP emissions, the 1990 uncontrolled PM-10 estimates were calculated by applying SCC-specific uncontrolled particle size distribution factors. The controlled PM-10 emissions were estimated in the same manner as the other pollutants. Because the majority of area sources are uncontrolled emissions, the second and third steps were not required to estimate the 1990 area source emissions.

6.3.2.2 1985 through 1989

The 1990 Interim Inventory served as the base year from which emissions for 1985 through 1989 were estimated. 1990 emissions from each point source in the 1985 NAPAP Emissions Inventory (excluding steam electric utilities) were projected to the years 1985 through 1989 based on the growth in earnings by industry (2-digit SIC code). Historical earnings data from BEA's table SA-5 were used to represent growth in earnings from 1985 through 1990.

Area source emissions were estimated using BEA historic earnings data, BEA historic population data, DOE SEDS data, or other growth indicators. All growth factors were calculated as the ratio of the earnings data for the specific year to the earnings data for 1990.

The emissions for all pollutants for a given year between 1985 and 1989 were calculated by applying the appropriate growth factors to the 1990 Interim Inventory base year emissions. The 1985 emissions estimated by this method do not equal those in the 1985 NAPAP Emissions Inventory due to the changes made when creating the 1990 emissions (e.g., the application of rule effectiveness or the application of updated emission factors).

6.3.2.3 Residential Wood, 1985 through 1989

Residential wood combustion emissions were calculated using a different methodology than the other source categories under this Tier category. Emissions for 1985 through 1989 were estimated using annual wood consumption and an emission factor. The following general equation was used to calculate emissions:

$$E_{year} = Activity \times EF \times \left(1 - \frac{CE}{100}\right)$$

where: E_{year} = county emissions (tons)
Activity = wood consumption (cords)
EF = emission factor (tons/cord)
CE = control efficiency (percent)

Activity was based on EPA's County Wood Consumption Estimation Model.[23] This model was adjusted with heating degree day information,[24] and normalized with annual wood consumption estimates.[25] AP-42 emission factors for CO, NO_x, PM-10, SO_2 and VOC were used.

6.3.3 Chemical and Allied Products Manufacturing

The CO, NO_x, VOC, SO_2, and PM-10 emissions for chemical and allied products have been estimated by the methodology described in section 6.3.2. This includes emissions based on the nonutility point source and nonsolvent area source emissions from the 1985 NAPAP Emission Inventory. In addition, the 1985 through 1989 VOC emissions from Chemical and Allied Products were revised by changing rule effectiveness from 80 percent to 100 percent for all controlled point sources.

6.3.4 Metals Processing, Petroleum and Related Industries, and Other Industrial Processes

The CO, NO_x, VOC, SO_2, and PM-10 emissions for sources under these Tier I categories have been estimated by the methodology described in section 6.3.2. This includes emissions based on the nonutility point source and nonsolvent area source emissions from the 1985 NAPAP Emission Inventory.

6.3.5 Solvent Utilization

Solvent utilization emissions are included as both point and area sources in the Emission Trends inventory. The CO, NO_x, VOC, SO_2, and PM-10 point source emissions for this Tier category, have been estimated by the methodology described in section 6.3.2.

VOC emissions from area source solvent utilization were based on a national material balance of the total point and area source solvent consumption. The national solvent emissions were calculated by subtracting the quantity of solvent transferred to waste management operations and the quantity of solvent destroyed by air pollution controls from the total national solvent consumption in 1989.[4]

The 1989 national solvent emissions were apportioned to States and counties using data from the 1988 census data base. The 1989 county-level solvent emissions were then projected to 1990 using BEA earnings data. The resulting 1990 solvent emission inventory included emissions from both area and point sources. The 1990 county-level point source solvent emissions were subtracted from the total solvent inventory to yield the 1990 area source solvent emissions. These estimates were then projected to the years 1985 through 1989 by the method described in section 6.3.2.2.

6.3.6 Storage and Transport, Waste Disposal and Recycling

The CO, NO_x, VOC, SO_2, and PM-10 emissions for these source categories have been estimated by the methodology described in section 6.3.2. This includes emissions based on the nonutility point source and nonsolvent area source emissions from the 1985 NAPAP Emission Inventory.

6.3.7 On-Road Vehicles

On-road emissions have been estimated for every year from 1970 through 1989. These annual emissions were based on county-level VMT and emission factors. Emissions were estimated for eight vehicle categories including: LDGV; LDDV; LDGT-1; LDGT-2; LDDT; HDDT; HDGT; and MC.

6.3.7.1 VMT Data

Annual VMT data for the years 1980 through 1989 were obtained from the FHWA HPMS data base. The data are specified by State, vehicle type, and roadway type. Using population data from the 1980 census,[66] the data were distributed among the counties. For the years 1970 through 1979, the State-level VMT data were obtained from FHWA's Highway Statistics[67] and apportioned to the counties based on the distribution of the 1980 county-level VMT data. The data for all years were then apportioned from the HPMS vehicle categories to the eight vehicle classes listed above using allocations provided by OMS.

The resulting annual county-level vehicle and roadway type specific VMT data were allocated by month. The monthly allocation was performed by using seasonal NAPAP temporal allocation factors to apportion the VMT to the four seasons. Monthly VMT data were then obtained using a ratio between the number of days in a month and the number of days in the corresponding season.

6.3.7.2 CO, NO_x, VOC Emission Factors

County-level emission factors for CO, NO_x, and VOC were calculated using the MOBILE5a model, which is designed to estimate exhaust and evaporative emission factors for on-road vehicles. To calculate the emission factors for each year from 1970 through 1989, the model utilized information on State-level monthly maximum and minimum temperatures, nine vehicle speeds, national vehicle registration distributions, gasoline volatility given in terms of in-use RVP, and county-level I/M and oxygenated fuels programs. The FTP operating mode was modeled at all speeds.

6.3.7.3 SO_2 and PM-10 Emission Factors

A detailed description of the methodology to estimate SO_2 and PM-10 emissions from on-road vehicles for the years 1970 through 1989 is located in chapter 11 of the *National Particulates Inventory: Phase II Emission Estimates*.[63] The EPA's on-road particulate matter emission factor model, PART5, was used to calculate highway vehicle PM-10 emission factors from vehicle exhaust, brake wear, tire wear, and reentrained road dust from paved and unpaved roads, and SO_2 vehicle exhaust emission factors.

PART5 uses the same vehicle registration distributions as the MOBILE model. This registration distribution was modified by distributing the MOBILE HDDV vehicle class distribution among the five PART5 HDDV subclasses (2BHDDV [class 2B HDDV], LHDDV [light HDDV], MHDDV [medium HDDV], HHDDV [heavy HDDV], and buses). This was accomplished using HDDV subclass-specific sales, survival rates, and diesel market shares.

6.3.8 Non-road Sources

The non-road category includes the estimated emissions from aircraft, commercial marine vessels, railroads, and all other non-road vehicles and equipment. The 1990 Interim Inventory base year emissions from aircraft, commercial marine vessels, and railroads have been estimated from the area source portion of the 1985 NAPAP Emission Inventory by the process described in section 6.3.2.2. The basis for the 1990 non-road emissions was emission inventories prepared by OMS[68] for 27 NAAs. These inventories were combined and used to create national county-level emissions. These emissions were classified by equipment and engine type in the OMS inventories and were distributed to the appropriate non-road SCCs. The OMS inventories did not contain emissions for SO_2 and, therefore, none were included for the non-road SCCs. It was assumed, based on the emissions from the 1985 NAPAP Emissions Inventory, that the SO_2 emissions for these SCCs were very small (< 92,000 short tons/year).

The non-road emissions for the years 1970 through 1989 have been based on the 1990 estimates. Historic Economic Growth Analysis System (E-GAS) growth factors[69] were obtained by Bureau of Labor Statistics (BLS) codes and matched with the non-road SCCs.

6.3.9 Remaining Categories

"Remaining categories" include emissions for two Tier I source categories including: natural sources and miscellaneous. The CO, NO_x, VOC, SO_2, and PM-10 emissions for the years 1985 through 1989 from all source categories, except for those listed below, were produced using the methodology described in section 6.3.2.

6.3.9.1 Natural Sources, Geogenic, Wind Erosion, 1985 through 1989

The PM-10 emissions for the years 1985 through 1989 from the wind erosion of agricultural lands were estimated using a modified version of the NAPAP methodology. Monthly emissions were estimated from the acres of crops planted, the number of seconds, and the dust flux. The expected dust flux was based on the probability distribution of wind energy, the mean wind speed and the coefficient of drag.

6.3.9.2 Miscellaneous, Agriculture and Forestry

PM-10 emissions from agricultural crops for the years 1985 through 1989 were estimated using the AP-42 emission factor equation for agricultural tilling. The activity data for this calculation were the acres of land planted. The emission factor, expressed in terms of the mass of TSP produced per acre-tilled was corrected by parameters including the silt of the surface soil, the particle size multiplier, and the number of tillings per year.

The 1990 Interim Inventory emissions from agricultural livestock were determined from activity data, expressed in terms of the number of heads of cattle, and a national PM-10 emission factor. The emissions for the years 1985 through 1989 were produced using the methodology described for area source emissions in section 6.3.2.2.

6.3.9.3 Miscellaneous, Other Combustion

The miscellaneous, other combustion category includes emissions from agricultural burning, forest fires/wildfires, prescribed/slash and managed burning, and structural fires. The emissions from agricultural burning and structural fires were produced using the methodology described in section 6.3.2.2.

Forest fires/wildfires emissions were generated for the years 1985 through 1989 using information on the number of forest fires, their location, and the acreage burned. These data were obtained from the DOI and the USDA Forest Service. The amount of biomass used to determine the quantity of vegetation burned was estimated by the EPA. Average emission factors were applied to the estimated quantities of vegetation burned.

For the years 1986 through 1989, and for the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, the above emission estimates were replaced for the pollutants CO, NO_x, VOC, and PM-10 by those in the inventory produced for the Grand Canyon Visibility Transport Commission. The SO_2 emissions were estimated based on the methodology described below for determining prescribed burning estimates. The 1985 emissions for the 11 States listed above were estimated based on the ratio of acres burned reported by the USDA and DOI for the years 1985 and 1990.

Emissions from prescribed burning were based on the 1989 USDA Forest Service inventory of particulate matter from prescribed burning. The NO_x and SO_2 emissions were estimated by assuming the ratio between the CO emissions to either the NO_x or SO_2 emissions in the Forest Service inventory was equal to the corresponding ratio in the 1985 NAPAP Emission Inventory. The resulting 1989 emissions for CO, NO_x, VOC, SO_2, and PM-10 have been used for all years between 1985 and 1988.

6.3.9.4 Miscellaneous, Fugitive Dust

PM-10 fugitive dust emissions arise from construction activities, mining and quarrying, paved road resuspension, and unpaved roads. The general methodology used to estimate emissions for each of these categories required an activity indicator, an emission factor, and one or more correction factors. The activity indicator for a given category varied from year to year, as may the overall correction factor.

6.3.9.4.1 Construction Activities — The PM-10 emissions for the years 1985 through 1989 were calculated from an emission factor, an estimate of the acres of land under construction, and the average duration of construction activity. The acres of land under construction were estimated from the dollars spent on construction. The PM-10 emission factor was calculated from the TSP emission factor for construction obtained from AP-42, as well as data on the PM-10/TSP ratio for various construction activities.[70]

6.3.9.4.2 Mining and Quarrying — The PM-10 emissions for the years 1985 through 1989 were the sum of the emissions from metallic ore, nonmetallic ore, and coal mining operations. These PM-10 emissions arise from the following activities: (1) overburden removal, (2) drilling and blasting, (3) loading and unloading, and (4) overburden replacement. Emissions from transfer and conveyance operations, crushing and screening operations, storage piles, and travel on haul roads were not included.

To calculate the emissions from metallic ore mining, the PM-10 emission factors for copper ore processing operations were applied to all metallic ores. The PM-10 emission factors for western surface coal mining were used to estimate the emissions from both nonmetallic ore and coal mining.

6.3.9.4.3 Paved Road Resuspension — The calculation of total PM-10 emissions for the years 1985 through 1989 were based on the paved road VMT, an AP-42 base emission factor, and two correction factors: road surface silt loading and the number of dry days. A dry day is defined as any day with less than 0.01 inches of precipitation. This term attempts to account for the effect of precipitation. Surface silt loading values by paved road functional class and State were determined using an equation that relates silt loading to ADTV.

Total VMT data for the years 1985 through 1989 were obtained by State and roadway functional class. The VMT from paved roads for each year was calculated by subtracting the unpaved road VMT from the total VMT for each year.

6.3.9.4.4 Unpaved Roads — The total PM-10 emissions for the years 1985 through 1989 were based on the unpaved roads VMT data, an AP-42 base TSP emission factor, and the following correction factors: particle size multiplier, silt content of road surface material, mean vehicle speed, mean vehicle weight, mean number of wheels, and the number of dry days. Mean vehicle speeds were assigned to each unpaved road functional class. The number of dry days is defined in the same manner as for estimating the paved road estimates. The VMT data for unpaved roads were obtained for rural and urban road functional classes excluding local types and for local road types.

6.4 NATIONAL EMISSIONS, 1940 THROUGH 1984

A top-down estimation procedure has been used to produce the criteria pollutant emission estimates for the years 1940, 1950, 1960, and 1970 through 1984, with several major exceptions. For all mobile sources, both on-road vehicles and all non-road mobile, the emissions for only the years 1940, 1190, and 1960 have been produced using this methodology.[c] The Pb emissions have been produced using the top-down approach for the years 1970 through 1994. In addition, the TSP emissions presented in appendix C have been produced by this methodology. The SO_2 emissions for copper smelters for the years 1975 to 1984 were obtained from the plants as documented by the Argonne National Laboratory. Finally, emission estimates for the years 1941 through 1949, 1951 through 1959, and 1961 through 1969 were estimated as described in section 6.5.

The emissions were estimated either for individual sources or groups of sources using three basic factors: (1) an activity indicator which represents the activity of a source producing emissions, (2) an emission factor which relates the quantity of emissions produced to the activity of the source, and (3) a control efficiency which quantifies the amount of pollutant not emitted due to the presence of control devices. Depending on the source category, the activity indicator was represented by the quantity of fuel consumed (or delivered), VMT, refuse burned, raw material processed, or some other measure of production activity. The emission factors are quantitative estimates of the average rate of emissions from many sources combined and are most valid when applied to a large number of sources.

National activity data for individual source categories were obtained from many different publications. Emission factors were generally obtained from AP-42, and from MOBILE5a. Control efficiencies were derived from several sources, depending on the year for which the emissions were being estimated. For the years 1940 through 1984, the primary source was the National Emissions Data System (NEDS) archives.

6.5 NATIONAL EMISSIONS, 1900 THROUGH 1939

The national SO_2, NO_x, and VOC emissions presented for the years 1900 through 1939 have been taken from two reports on historic emissions. In addition, these reports provided emission estimates for the years 1941 through 1949, 1951 through 1959, and 1961 through 1969.[d] The first report contains NO_x and SO_2 emissions for the years between 1900 and 1980. Volatile organic compound emissions for the years between 1900 and 1985 are contained in the second. It should be noted that emissions for the years 1940, 1950, 1960, and 1970 in the *Trends* report were estimated according to the methodology discussed in section 6.4.

Emissions of SO_2, NO_x, and VOC were estimated every 5 years from 1900 through 1970, using appropriate activity indicators and emission factors. Emissions for all intervening years between 1900 and 1970 have been extrapolated from the aforementioned emissions based on changes in the national activity for all applicable source categories.

6.6 EMISSIONS REVISIONS

The estimated emissions presented in this report have in some instances been modified from those presented in previous *Trends* reports. These modifications have come about due to the use of different methodologies to estimate the emissions, the refinement of the methodologies used for the 1996 *Trends* report, the availability of updated information used to estimate emissions, and the recategorization of some emission source categories. These modifications to the emissions are documented in this chapter.

6.6.1 Methodological Changes

The emissions presented in this report reflect several major changes in the methodologies used to estimate the emissions. These changes have been described in the preceding sections of this chapter. The changes in the methodologies from those used to estimate emissions presented in the 1996 *Trends* report are summarized below.

- Revised base year inventory to incorporate State-derived emissions primarily for nonutility point and area sources.
- 1985 -1994 fossil-fuel steam utility emissions primarily derived using ARD NO_x emission rates instead of only DOE EIA-767 data and AP-42 emission factors.
- Used MOBILE5b in 1995 and 1996 instead of MOBILE5a.
- Used pollutant-specific revisions to several non-road categories (non-road diesel, railroad, and spark ignition marine engines) as provided by OMS.
- Added Pb emission estimates from aircraft gasoline consumption.

6.6.2 Other Changes

In addition to the changes in methodology affecting most, if not all, source categories and pollutants, other changes were made to the emissions for specific pollutants, source categories, and/or individual sources. Such changes are discussed below.

- Several of the sources of activity data and correction parameters for the fugitive dust sources (agricultural crops, construction, and paved roads) were revised.
- For 1990, 1995, and 1996, used State-supplied MOBILE model inputs.
- Used 1990 State-supplied VMT.
- Modified TSDF estimates by removing emissions from counties with no TSDFs.
- Removed rule effectiveness from pre-1990 chemical and allied product emissions.
- Revised Pb content of unleaded and leaded gasoline for the on-road and non-road engine Pb emission estimates.

- For the 1995 and 1996 emission estimates, revised the rule effectiveness to 100 percent for any point that reported below 100 percent in the 1990 inventory.

- Added Alaska and Hawaii nonutility point source emissions from AIRS/AFS and area source solvent emissions from the Interim Inventory report.

6.7 TEMPORAL AND SPATIAL EMISSIONS, 1985-1996

Although the EPA has produced an annual national estimate of emission trends since 1973, this report is the first to present daily emissions (tables 4-1 and 4-2). The daily emissions were obtained primarily from the States in the OTAG domain for the O_3 pollutants (CO, NO_x, and VOC). Where State estimates were missing, EPA point source operating parameters or default seasonal/daily factors are used. Details on temporal and spatial allocations are discussed in the National Air Pollutant Emission Trends Procedures Document, 1900-1996, which is available on EFIG's Internet homepage (www.EPA.gov/oar/oaqps/efig/).

6.8 NATIONAL EMISSIONS, 1999 to 2010

Projections of future year emissions have been estimated using the following general procedure:

- Grow 1995 emissions or activity levels
- Apply future year control efficiencies or emission factors reflecting CAAA requirements

The application of the above procedure differs slightly by major emitting sector — electric utility, nonutility point, area sources, on-road vehicle, and non-road sources.

6.8.1 Electric Utilities

Utility growth was projected using the Emission Reduction and Cost Analysis Model-NO_x (ERCAM-NO_x) model, and the 1995 NET Inventory as the base for the projections.[71] In ERCAM-NO_x, changes in the capacity utilization of existing electric utility units are based on historical capacity utilization at the unit level. Additional growth is projected based on planned and projected electric utility units. Data on planned units and projected electric utility demand were obtained from DOE.[72,73] Generation projections from the existing and planned units have been subtracted from the projected generation demand at the regional and fuel type level. The remaining generation is assumed to be filled by projected units. Existing units were assumed to retire after 65 years of service, or the specified retirement age if earlier than 65 years.

Nitrogen oxides controls were applied using the ERCAM-NO_x model. This model applies Title I RACT controls and Title IV performance standards to the affected units, applying the prescribed emission limits from RACT or Title IV that are specific to the boiler type and fuel type. Planned and projected units coming on line in 1996 or later in designated O_3 NAAs and OTRs were assumed to be subject to new source review and were assumed to apply selective catalytic reduction.

In 1994, the OTR's Memorandum of Understanding (MOU) was signed by 10 Northeastern States and the District of Columbia, which required NO_x controls beyond RACT on major sources (in some States). Beginning in 1999, major sources located within the OTR's inner corridor are required to reduce NO_x emissions to either 0.20 pounds per million British thermal units (lbs/MMBtu) or achieve a 65 percent reduction from 1990 baseline levels, as specified in the Phase II round of controls. Outer region units are required to reduce emissions to either the 0.20 lbs/MMBtu or a 55 percent emission reduction under this plan. These reductions were modeled in projections of emission estimates for the years 1999 through 2010.

Sulfur dioxide projections are based on the SO_2 electric utility allowance caps of Title IV. The emission caps per year change from 1995 to 2000 to 2010. The projections presented here are based on ICF Resources, Incorporated's projections of how utilities will use these allowances.[74] Pechan developed least cost control measures at the unit/boiler level to meet target national reduction tonnage.

When fuel switching control options are applied to utility boilers in order to control SO_2 emissions, PM emissions change depending on the fuel type and quality. Percent ash content of fuel was found to directly influence the amount of PM emitted by a boiler. For this reason, ash content algorithms were established to estimate the percent ash content in fuels chosen by the SO_2 reduction model. In conjunction to reported percent ash content in the Trends baseline file, new percent ash contents were directly ratioed to calculate new PM emission levels. This was done for PM-10 emissions and for every boiler where fuel switching occurred.

No new controls were applied to CO or VOC emissions.

6.8.2 Nonutility Point Sources

Emissions were projected for the following years: 1999, 2000, 2002, 2005, 2007, 2008, and 2010. All projections were made from 1995 emissions. The BEA gross State product (GSP) projections by State and industry[75] were used as a surrogate for growth for all sources except where noted below. The BEA data projects GSP for the following years: 1998, 2000, 2005, 2010, 2015, 2025, and 2040. Data points for 1999, 2002, 2007, and 2008 were developed by assuming linear growth between the two closest surrounding years. For nonutility point sources, the growth factors were applied based on the units SIC. For area and non-road sources, growth factors were applied based on an SCC to SIC crosswalk. The following equation was used to apply growth factors to the 1995 emissions:

$$Emissions_{projection\ year} = Emissions_{95} * \frac{Earnings_{projection\ year}}{Earnings_{95}}$$

Additional factors were utilized in the industrial, commercial/institutional, and residential fuel combustion sectors to account for improvements in efficiency. For those sectors, ratios of fuel consumption to constant dollars (industrial sector) or fuel consumption per square foot (commercial/institutional and residential) were developed relative to the base year and were applied to the emissions projected using growth factors.[76] Applicable emission controls were then applied to each sector and pollutant as described below.

6.8.2.1 Carbon Monoxide Controls

Carbon monoxide NAA requirements generally focus on mobile source controls — enhanced I/M and oxygenated fuels. While there may be isolated cases of point source controls, these are not incorporated into the projections.

6.8.2.2 Nitrogen Oxides Controls

Nitrogen oxide RACT was applied to applicable sources in all moderate and above O_3 NAAs, with the exception of areas that were granted NO_x waivers. NO_x RACT controls resulted in control efficiencies ranging from 25 percent to 90 percent depending on the type of source and control modeled. Unit level NO_x RACT controls developed for OTAG modeling[77] were used where the information was available. Otherwise SCC defaults from OTAG were used.

6.8.2.3 Volatile Organic Compound Controls

The following national VOC controls were modeled on nonutility point sources:

- Marine vessel loading
- TSDFs
- Benzene NESHAP
- 2-year, 4-year, and 7/10-year Title III MACT

In addition to these national controls new CTGs, non-CTG RACT, and Group III CTG RACT controls were modeled in moderate and above O_3 NAAs, and CTG RACT was modeled in marginal and above NAAs. All VOC controls were applied at the SCC level. Information on VOC controls came from OTAG data and the Section 812 analysis.[78]

6.8.2.4 Sulfur Dioxide Controls

The CAAA does not specify any mandatory SO_2 controls for nonutility stationary point sources. Regulations applicable to SO_2 emissions from these sources are established by States for designated SO_2 nonattainment areas. Additionally, section 406 of the CAAA requires EPA to produce, and transmit to the Congress, a report every five years containing an inventory of national annual SO_2 emissions from industrial sources (as defined in Title IV of the Act), including units subject to section 405(g)(6) of the Act, as well as the likely trend in such emissions over the following 20-year period. Further, section 406(b) the CAAA states that "[w]henever the inventory required by this section indicates that sulfur dioxide emissions from industrial sources, including units subject to section 405(g)(6) of the CAA, may reasonably be expected to reach levels greater than 5.6 million tons per year, the Administrator shall take such actions under the CAA as may be appropriate to ensure that such emissions do not exceed 5.60 million tons per year. Such actions may include promulgation of new and revised standards of performance for new sources, ..., as well as promulgation of standards of performance for existing sources, ..." EPA's first report under this statutory mandate, *National Annual Industrial Sulfur Dioxide Emission Trends 1995-2015: Report to Congress*, was completed in 1995 and projected that these emissions will remain below the cap for every year through 2015. Industrial point sources of SO_2 were therefore assumed to remain at current control levels.

6.8.2.5 Particulate Matter (PM-10) Controls

Review of PM-10 SIPs indicate that control efforts are focusing primarily on area source emitters; therefore, point sources were assumed to remain at current control levels.

6.8.3 Area Sources

Area pollutant sources were projected using BEA growth factors in concert with estimates of future year control efficiencies.

6.8.3.1 Carbon Monoxide Area Controls

Carbon monoxide control efforts mandated by the CAAA focus on on-road source controls; therefore, no new area source control initiatives were modeled.

6.8.3.2 Nitrogen Oxides Area Controls

Nitrogen oxide RACT controls were modeled for area source combustion SCCs in moderate and above NAAs. Control efficiencies modeled for area source NO_x RACT were 21 percent for coal sources, 36 percent for oil sources, and 31 percent for natural gas sources. The NO_x RACT control data is consistent with its modeling in both OTAG and the Section 812 analysis.[78]

6.8.3.3 Volatile Organic Compound Area Controls

The following national VOC controls were modeled on area sources:

- Consumer solvents
- AIM coatings
- Onboard refueling vapor recovery systems
- TSDFs
- Municipal solid waste landfills
- Residential wood combustion (NSPS)
- 2-year, 4-year, and 7/10-year Title III MACT

In addition, VOC RACT controls were applied in moderate and above NAAs, except for Stage II vapor recovery controls which were applied in serious and above NAAs and the OTR. The area source VOC control data came from the Section 812 analysis.[78]

6.8.3.4 Sulfur Dioxide Area Controls

Sulfur dioxide area source emitters were projected assuming no change in current control levels.

6.8.3.5 Particulate Matter (PM-10) Area Controls

Four PM-10 area source controls were modeled:

- Residential wood combustion
- Construction fugitive dust
- Beef cattle feed lots
- Agricultural burning

The residential wood combustion was modeled nationally for all projection years. Construction fugitive dust controls were modeled in moderate and serious PM NAAs for all years. Beef cattle feed lot controls were modeled in serious PM NAAs in 2010 only. Agricultural burning controls were modeled in 11 States (Alabama, Florida, Georgia, Idaho, Kansas, Louisiana, Mississippi, North Carolina, Oregon, and Washington) in 2010 only. The area source PM-10 control data came from the Section 812 analysis.[78]

6.8.4 On-Road Vehicles

On-road emissions were projected using projected VMT and OMS's two mobile emission factor models MOBILE5b and PART5. Growth factors were first applied to 1990 VMT estimates. VMT was then allocated to the monthly level and MOBILE5b and PART5 emission factors were applied. The monthly emissions were then summed to calculate annual emissions.

The 1990 VMT estimates were projected to the future years using metropolitan statistical area (MSA) level growth factors by vehicle class. These factors were developed from national growth by vehicle class from the MOBILE4.1 Fuel Consumption Model.[79] The national growth was scaled to the MSA level based on population projections.[80] Thus, if an area shows population growth higher than the national average, VMT growth will also be higher than the national average.

The resulting annual county-level vehicle and roadway type projected VMT data were temporally allocated to months using NAPAP temporal allocation factors and the number of days in each month.

The MOBILE5b emission factor model was used to calculate all CO, NO_x, and VOC on-road emission factors for all States except California. California emission factors for these pollutants were calculated using an OMS-modified version of MOBILE5b that simulates the California fleet (CALI5). SO_2 and PM-10 emission factors were generated using PART5. As with the 1970 through 1996 on-road emission factors, the projection year emission factors were calculated at the county level.

MOBILE5b inputs were modified for the following parameters: registration distributions, RVP, temperatures, trip lengths, reformulated gasoline, oxygenated fuel, national low emission vehicle (NLEV) program, and basic emission rate (BER) corrections. For several parameters (month flag, speeds, operating mode, and altitude) the 1995 assumptions were maintained for the projection years. For alcohol fuel market shares and diesel sales shares MOBILE5b defaults were applied.

For registration distributions, any county modeled with State-supplied registration distributions in 1995 and 1996 was modeled with the same distribution in the projection years. All other counties were modeled with the MOBILE5b and PART5 registration distribution defaults.

The RVP values calculated for 1996 for all months except May through September were used in all of the projection years. For the months from May through September, the RVP values were replaced with the appropriate Phase II RVP limit, using 8.7 pounds per square inch (psi) in nine areas to account for the allowable margin of safety in meeting the RVP limits. The RVP data provided by States were not used in the projection years.

Actual temperature data cannot be used for the projection years. Also, due to the variability in temperature patterns from year to year, selecting a single historical year's data to model in the projection years would be inappropriate. Therefore, in the projection years, 30-year average temperature data are used. The average minimum and maximum daily temperature for each month and State are obtained from the Statistical Abstracts. A single site within each State is chosen to be representative of the temperature conditions within the entire State. As with the temperature data for historical years, California was modeled with two temperature regions.

Reformulated gasoline and oxygenated fuels were modeled based on a listing of areas participating in the programs provided by OMS. Guidance was also provided by OMS on the NLEV program by providing assumptions about the characteristics of the proposed NLEV program.

A correction was made to the basic emission rates for HDDVs and heavy-duty gasoline vehicles (HDGVs) as specified by OMS. This correction modifies the default MOBILE5b zero mile level (ZML [the ZML is the emission rate at the beginning of a vehicle's life]) and deterioration rate (DR [the deterioration rate reflects how quickly the emission rate of a vehicle increases with time]) for VOC for HDDVs and NO_x and VOC for HDGVs. The 2004 HDDV standards for hydrocarbons and NO_x are accounted for by modifying MOBILE5b. Use of MOBILE5b instead of MOBILE5a results in an updated corrected treatment of heavy duty emission factors. The main change is for heavy-duty diesel NO_x.

6.8.5 Non-road Engine and Vehicle Projections

Bureau of Economic Analysis earnings and population data were used as growth factors for all non-road sources except locomotives and commercial aircraft. Zero growth was assumed for all locomotive SCCs. This assumption is based on information that shows railroad use and earnings increasing, but fuel use remaining constant due to efficiency gains in locomotive design.[81] Growth factors for commercial aircraft were developed using Federal Aviation Administration (FAA) national estimates of LTOs for air carriers.[82] The FAA data includes historical LTO data through 1995, as well as estimated LTOs for 1996 and projected LTOs through the year 2008. As with the BEA data, growth factors were developed by dividing the 1995 or 1996 LTO data by the base year (1990) data.

As an update to some of the Trends non-road emission estimates, OMS agreed to provide emission estimates from their models and analyses being used for the RIA documents.[83] Categories for which OMS provided data are non-road diesel engines,[34,35] spark-ignition marine engines,[36,37] and locomotives. For each of these categories OMS provided national/SCC level emission estimates. For diesel non-road engines, the pollutants covered included CO, NO_x, VOC, and PM-10. For spark-ignition marine engines, only NO_x and VOC were provided. For locomotives, only NO_x and PM-10 were provided but only PM-10 was used.

These national OMS numbers were used to update projection year emission estimates such that the sum of the county/SCC level Trends estimates would equal the national/SCC level OMS estimates. Listed below is the procedure used to incorporate the national OMS emission estimates:

- The projection year county/SCC level emission estimates were developed from the base year emission estimates by applying the appropriate growth factors.

- The projection year county/SCC level emission estimates developed in Step 1 were aggregated to national/SCC level emission estimates. This was done at the non-road segment level (e.g., construction, agriculture, lawn and garden, etc.) rather than the specific engine level; although the OMS data were supplied at the specific engine level, a large portion of the Trends emission estimates are at the non-road segment level.

- Pollutant-specific adjustment factors for each applicable non-road segment were developed by calculating the ratio of the OMS national estimate to the Trends national estimate.

- The Trends county/SCC level estimates developed in Step 1 were then multiplied by the appropriate adjustment factor resulting in final Trends county/SCC level estimates that equal the OMS estimates when aggregated to the national level.

For non-road diesel engines and spark-ignition marine engines, adjustments were made to all pollutants for which OMS provided information (CO, NO_x, VOC, and PM-10 for non-road diesel, NO_x and VOC for non-road spark-ignition marine engines.)

6.8.5.1 Carbon Monoxide, Sulfur Dioxide, and Particulate Matter (PM-10) Non-road Controls

Carbon monoxide control efforts mandated by the CAAA focus on on-road source controls; therefore, no new non-road engine or vehicle source control initiatives were modeled. EPA also did not model any new non-road engine or vehicle source control initiatives for SO_2 or PM-10.

6.8.5.2 Nitrogen Oxides Non-road Controls

Emission reductions from Tier I of the compression-ignition standard were modeled. This national control reduces emissions from non-road diesel engines, and was accounted for in the OMS national emission totals. Therefore, the impact of this control was included in the Trends projections by the adjustment of the Trends diesel engine emissions such that the national emission total for this category equals the OMS national emission total.

6.8.5.3 Volatile Organic Compound Non-road Controls

Emission reductions resulting from Phase I of the spark-ignition standard were modeled using overall percentage reductions estimated by OMS.[84] Since Phase II of the spark-ignition standard has not been promulgated yet, only Phase I controls were modeled. This control covers the entire country and results in a decrease in VOC from gasoline engines and an increase in NO_x from gasoline engines.

VOC estimates from non-road gasoline engines were reduced by an additional 3.3 percent to account for the use of reformulated gasoline in specified areas. This 3.3 percent reduction was applied after the application of the growth factors and the spark ignition control factors.

Controls on gasoline recreational marine vessels were also modeled. This national control reduces VOC emissions, and was accounted for in the OMS national emission totals. Therefore, the impact of this control was included in the Trends projections by the adjustment of the Trends recreational marine vessels emissions such that the national emission total for this category equals the OMS national emission total.

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[a] The rule effectiveness was changed from 80 to 100 percent for a few plants as a result of comments received from State air agencies. This resulted in a reduction of NO_x and VOC emissions.

[b] Details on the PM-10 Calculator updates are available in chapter V of the National Particulates Inventory: Phase II Emission Estimates.

[c] The 1940, 1950, and 1960 on-road estimates were adjusted for this report to compensate for the methodological changes from 1960 to 1970.

[d] The trend in emissions, not the actual emissions, were extracted from references 1 and 2.

Table 6-1. Point Source Data Submitted

State	Data Source/Format	Temporal Resolution	Year of Data	Adjustments to Data
Alabama	AIRS-AFS - Ad hoc retrievals	Annual	1994	Backcast to 1990 using BEA. Average Summer Day estimated using methodology described above.
Arkansas	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using default temporal factors.
Connecticut	State - EPS Workfile	Daily	1990	None
Delaware	State - EPS Workfile	Daily	1990	None
District of Columbia	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using methodology described above.
Florida	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using methodology described above.
Georgia - Atlanta Urban Airshed (47 counties) domain	State - State format	Daily	1990	None
Georgia - Rest of State	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using default temporal factors.
Illinois	State - EPS Workfiles	Daily	1990	None
Indiana	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using methodology described above.
Kansas	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using methodology described above.
Kentucky - Jefferson County	Jefferson County - EPS Workfile	Daily	1990	None
Kentucky - Rest of State	State - EPS Workfile	Daily	1990	None
Louisiana	State - State Format	Annual	1990	Average Summer Day estimated using methodology described above.
Maine	State - EPS Workfile	Daily	1990	None
Maryland	State - EPS Workfile	Daily	1990	None
Massachusetts	State - EPS Workfile	Daily	1990	None
Michigan	State - State Format	Annual	1990	Average Summer Day estimated using methodology described above.
Minnesota	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using methodology described above.
Missouri	AIRS-AFS - Ad hoc retrievals	Annual	1993	Backcast to 1990 using BEA. Average Summer Day estimated using methodology described above.
Nebraska	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using methodology described above.
New Hampshire	State - EPS Workfile	Daily	1990	None
New Jersey	State - EPS Workfile	Daily	1990	None
New York	State - EPS Workfile	Daily	1990	None
North Carolina	State - EPS Workfiles	Daily	1990	None
North Dakota	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using methodology described above.
Ohio	State - State Format	Annual	1990	Average Summer Day estimated using methodology described above.
Oklahoma	State - State Format	Annual	1994	Backcast to 1990 using BEA. Average Summer Day estimated using methodology described above.
Pennsylvania - Allegheny County	Allegheny County - County Format	Daily	1990	None
Pennsylvania - Philadelphia County	Philadelphia County - County Format	Daily	1990	None
Pennsylvania - Rest of State	State - EPS Workfile	Daily	1990	None
Rhode Island	State - EPS Workfile	Daily	1990	None

Table 6-1 (continued)

State	Data Source/Format	Temporal Resolution	Year of Data	Adjustments to Data
South Carolina	AIRS-AFS - Ad hoc retrievals	Annual	1991	Average Summer Day estimated using default temporal factors.
South Dakota	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using methodology described above.
Tennessee	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using default temporal factors.
Texas	State - State Format	Daily	1992	Backcast to 1990 using BEA.
Vermont	State - EPS Workfile	Daily	1990	None
Virginia	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using methodology described above.
West Virginia	AIRS-AFS - Ad hoc retrievals	Annual	1990	Average Summer Day estimated using methodology described above.
Wisconsin	State - State Format	Daily	1990	None

Table 6-2. Area Source Data Submitted

State	Data Source/Format	Temporal Resolution	Geographic Coverage	Adjustments to Data
Connecticut	State - EPS Workfile	Daily	Entire State	None
Delaware	State - EPS Workfile	Daily	Entire State	None
District of Columbia	State - Hard copy	Daily	Entire State	None
Florida	AIRS-AMS - Ad hoc retrievals	Daily	Jacksonville, Miami/ Ft. Lauderdale, Tampa	Added Non-road emission estimates from Int. Inventory to Jacksonville (Duval County)
Georgia	State - State format	Daily	Atlanta Urban Airshed (47 Counties)	None
Illinois	State - State format	Daily	Entire State	None
Indiana	State - State format	Daily	Entire State	Non-road emissions submitted were county totals. Non-road emissions distributed to specific SCCs based on Int. Inventory
Kentucky	State - State Format	Daily	Kentucky Ozone Nonattainment Areas	None
Louisiana	State - State Format	Daily	Baton Rouge Nonattainment Area (20 Parishes)	None
Maine	State - EPS Workfile	Daily	Entire State	None
Maryland	State - EPS Workfile	Daily	Entire State	None
Michigan	State - State Format	Daily	49 Southern Michigan Counties	None
Missouri	AIRS-AMS- Ad hoc retrievals	Daily	St. Louis area (25 counties)	Only area source combustion data was provided. All other area source data came from Int. Inventory
New Hampshire	State - EPS Workfile	Daily	Entire State	None
New Jersey	State - EPS Workfile	Daily	Entire State	None
New York	State - EPS Workfile	Daily	Entire State	None
North Carolina	State - EPS Workfiles	Annual	Entire State	Average Summer Day estimated using default temporal factors.
Ohio	State - Hard copy	Daily	Canton, Cleveland Columbus, Dayton, Toledo, and Youngstown	Assigned SCCs and converted from kgs to tons. NO_x and CO from Int. Inventory added to Canton, Dayton, and Toledo counties.
Pennsylvania	State - EPS Workfile	Daily	Entire State	Non-road emissions submitted were county totals. Non-road emissions distributed to specific SCCs based on Int. Inventory
Rhode Island	State - EPS Workfile	Daily	Entire State	None
Tennessee	State - State format	Daily	42 Counties in Middle Tennessee	No non-road data submitted. Non-road emissions added from Int. Inventory
Texas	State - State Format	Annual	Entire State	Average Summer Day estimated using default temporal factors.
Vermont	State - EPS Workfile	Daily	Entire State	None
Virginia	State - EPS Workfile	Daily	Entire State	None
West Virginia	AIRS-AMS - Ad hoc retrievals	Daily	Charleston, Huntington/ Ashland, and Parkersburg (5 counties total)	None
Wisconsin	State - State Format	Daily	Entire State	None

Table 6-3. Boiler Emissions Data Sources for NO_x and SO_2 by Year

Year	NO_x	SO_2
1985	Overlaid ARD coal NO_x rate calculations when possible	NADBV311 data
1986	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1987	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1988	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1989	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1990	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1991	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1992	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1993	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1994	Overlaid ARD coal NO_x rate calculations when possible; overlaid ETS/CEM data when possible	Calculated from EIA-767 data
1995	Overlaid ETS/CEM data when possible	Overlaid ETS/CEM data when possible
1996	Grew from 1995 data using EIA-759 data	Grew from 1995 data using EIA-759 data

Table 6-4. Emission Estimates Available from AIRS/AFS by State, Year, and Pollutant

State	1990						1991						1992						1993						1994						1995					
	C	N	S	P	T	V	C	N	S	P	T	V	C	N	S	P	T	V	C	N	S	P	T	V	C	N	S	P	T	V	C	N	S	P	T	V
Alabama	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Alaska	✓	✓	✓		✓	✓													✓	✓	✓		✓	✓	✓	✓	✓		✓	✓						
Arizona	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
California	✓	✓	✓	✓	✓	✓													✓						✓	✓		✓	✓	✓						
Colorado	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Connecticut	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Hawaii	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Illinois	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Louisiana	✓	✓	✓		✓	✓													✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓						
Michigan	✓	✓	✓	✓	✓	✓													✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
Minnesota	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Montana	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nebraska	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
Nevada	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
New Hampshire	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
New Mexico	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
North Dakota	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Oregon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pennsylvania	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
South Carolina																			✓	✓	✓		✓	✓												
South Dakota		✓	✓	✓	✓	✓		✓	✓	✓		✓		✓	✓	✓		✓		✓	✓	✓		✓		✓	✓	✓		✓		✓	✓	✓		✓
Texas	✓	✓	✓	✓	✓	✓													✓	✓	✓	✓	✓	✓							✓	✓	✓	✓		✓
Utah	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓		✓	✓		✓	✓		✓	✓		✓
Vermont	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Virginia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Washington	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wisconsin	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
Wyoming	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes: C = CO   N = NO_2 S = SO_2 P = PM-10   T = TSP   V = VOC

Pennsylvania only includes Allegheny County (State 42, County 003); New Mexico only includes Albuquerque (State 35, County 001); Washington only includes Puget Sound (State 53, County 033, 053, or 061); Nebraska includes all except Omaha City (State 31, County 055); the CO emissions in NET were maintained for South Dakota (State 46).

Chapter 7.0 Biogenic Emissions

This report presents a preliminary estimate of biogenic VOC and nitric oxide (NO) emissions for 1988, 1990, 1991, 1995, and 1996. The methodology for computing these estimates is based on the Biogenic Emissions Inventory System — Version 2 (BEIS2).[1,2,3] The emission estimates are presented in table 7-1 for VOC and table 7-2 for NO. Except for 1990, differences in annual emission estimates are due to year-to-year variations in air temperature and cloudiness. The 1990 estimates were taken from the 1994 trends report and was based on a slightly different version of BEIS2.

Biogenic emission estimates are strongly affected by differences in climatology and land use. Tables 7-3 and 7-4 show that highest emissions occur in the summer, when temperatures are highest. Variations in biogenic emissions are influenced by fluctuations in temperature. For example an increase of 10 degrees Celsius (°C) can result in over a two-fold increase in both VOC and NO. As shown here, annual emission estimates correlate very strongly with changes in annual temperature patterns.

Figures 7-1 and 7-2 show the spatial variation in biogenic emission densities estimated for counties across the United States. While some of this variability is attributable to differences in temperature and solar radiation, much of the spatial difference can be attributed to variations in land use. Higher VOC densities in the southern United States and in Missouri are strongly linked to the large areas of high-emitting oak trees. The relatively high densities of NO in the Midwestern United States are associated with areas of fertilized crop land.

Research in the area of biogenic emissions continues to be quite active, and changes in emission estimates are to be expected in the next few years. Meanwhile, these emissions should be viewed with an uncertainty of at least a factor of two.

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Table 7-1. Biogenic Volatile Organic Compound Emissions by State (thousand short tons)

State	1988	1990	1991	1995	1996
Alabama	1,826	2,114	1,852	1,937	1,597
Arizona	535	542	517	548	591
Arkansas	1,837	1,852	1,476	1,741	1,472
California	1,815	1,778	1,711	1,794	2,125
Colorado	889	748	817	826	878
Connecticut	81	68	74	81	63
Delaware	25	19	24	26	20
District of Columbia	1	1	1	1	0
Florida	1,352	1,513	1,246	1,436	1,255
Georgia	1,666	1,958	1,609	1,721	1,454
Idaho	854	810	764	706	726
Illinois	283	227	257	244	191
Indiana	237	185	227	218	165
Iowa	141	95	103	112	89
Kansas	154	140	133	118	116
Kentucky	677	575	648	636	496
Louisiana	1,291	1,403	1,043	1,367	1,125
Maine	599	567	621	622	531
Maryland	164	132	155	169	127
Massachusetts	140	107	129	140	109
Michigan	581	422	548	533	394
Minnesota	729	519	612	636	533
Mississippi	1,662	1,801	1,450	1,642	1,402
Missouri	1,472	1,222	1,298	1,267	1,056
Montana	912	729	781	666	716
Nebraska	95	79	81	78	72
Nevada	152	140	142	135	158
New Hampshire	168	147	163	171	137
New Jersey	130	115	124	132	103
New Mexico	505	533	499	531	544
New York	350	303	328	361	280
North Carolina	1,072	1,194	1,002	1,110	908
North Dakota	69	49	51	48	46
Ohio	270	211	243	259	197
Oklahoma	1,013	1,016	864	887	836
Oregon	1,066	1,118	1,002	1,114	1,087
Pennsylvania	594	510	560	642	460
Rhode Island	24	18	21	24	18
South Carolina	738	886	652	755	626
South Dakota	142	103	113	104	102
Tennessee	1,063	1,022	1,010	997	817
Texas	2,711	2,864	2,244	2,649	2,481
Utah	407	374	353	345	410
Vermont	102	91	100	106	88
Virginia	911	886	850	917	728
Washington	685	780	650	801	735
West Virginia	510	420	473	492	383
Wisconsin	648	450	516	541	412
Wyoming	505	387	397	358	396
National	**33,852**	**33,224**	**30,536**	**32,742**	**29,254**

NOTE: The sums of States may not equal National total due to rounding.

Table 7-2. Biogenic Nitric Oxide Emissions by State (thousand short tons)

State	1988	1990	1991	1995	1996
Alabama	14	19	14	14	14
Arizona	55	51	53	55	58
Arkansas	19	21	19	19	18
California	42	40	42	42	44
Colorado	39	35	38	38	39
Connecticut	1	1	1	1	1
Delaware	2	2	2	2	2
District of Columbia	0	0	0	0	0
Florida	22	29	22	22	22
Georgia	19	29	20	20	19
Idaho	25	23	24	24	24
Illinois	90	84	90	86	81
Indiana	49	48	51	49	46
Iowa	93	82	90	87	81
Kansas	91	87	91	85	83
Kentucky	19	20	20	19	18
Louisiana	19	20	19	19	19
Maine	3	3	3	3	2
Maryland	6	6	6	6	6
Massachusetts	1	1	1	1	1
Michigan	25	25	26	25	23
Minnesota	58	52	56	54	50
Mississippi	19	22	19	19	19
Missouri	44	42	44	42	40
Montana	60	49	57	53	52
Nebraska	91	83	90	86	80
Nevada	46	38	44	44	47
New Hampshire	1	1	1	1	1
New Jersey	2	2	2	2	2
New Mexico	62	59	61	64	65
New York	17	19	18	18	17
North Carolina	21	26	22	21	20
North Dakota	51	42	48	44	43
Ohio	36	36	37	35	33
Oklahoma	35	37	35	34	34
Oregon	24	22	23	23	23
Pennsylvania	19	21	20	20	18
Rhode Island	0	0	0	0	0
South Carolina	10	16	11	11	10
South Dakota	62	53	60	56	52
Tennessee	17	18	18	17	16
Texas	199	203	199	202	206
Utah	28	25	27	28	29
Vermont	2	2	2	2	2
Virginia	10	12	10	10	9
Washington	15	15	14	15	15
West Virginia	4	4	4	4	3
Wisconsin	36	34	35	35	32
Wyoming	39	40	36	35	35
National	**1,638**	**1,596**	**1,628**	**1,591**	**1,553**

NOTE: The sums of States may not equal National total due to rounding.

Table 7-3. Biogenic Volatile Organic Compound Seasonal Allocation, 1988 to 1996 (percentages)

Year	Winter	Spring	Summer	Autumn
1988	3	18	61	18
1990	4	17	57	22
1991	3	21	62	14
1995	3	18	59	19
1996	3	19	58	20

Table 7-4. Biogenic Nitric Oxide Seasonal Allocation, 1988 to 1996 (percentages)

Year	Winter	Spring	Summer	Autumn
1988	11	23	42	24
1990	15	21	39	25
1991	12	24	40	23
1995	12	22	41	24
1996	12	23	41	24

Figure 7-1. Density Map of VOLATILE ORGANIC COMPOUND 1996 Biogenic Emissions by County

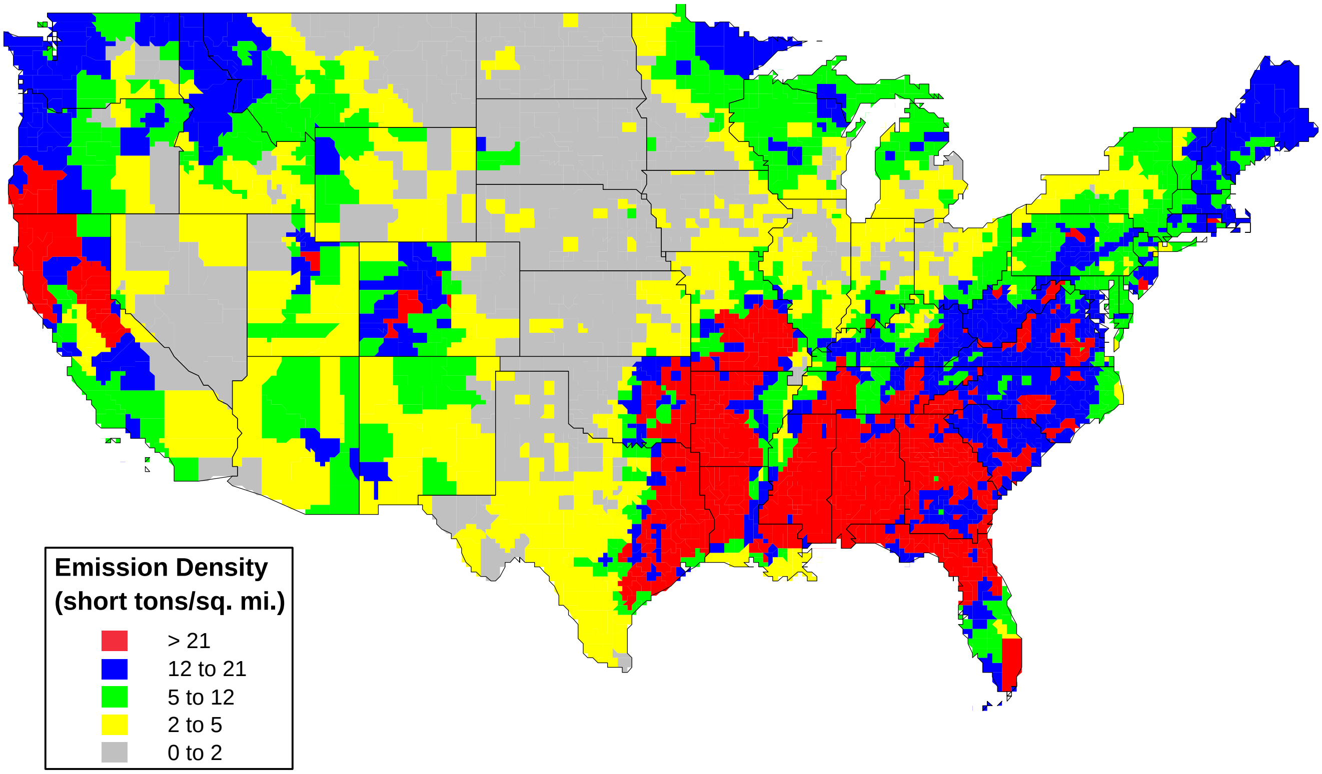
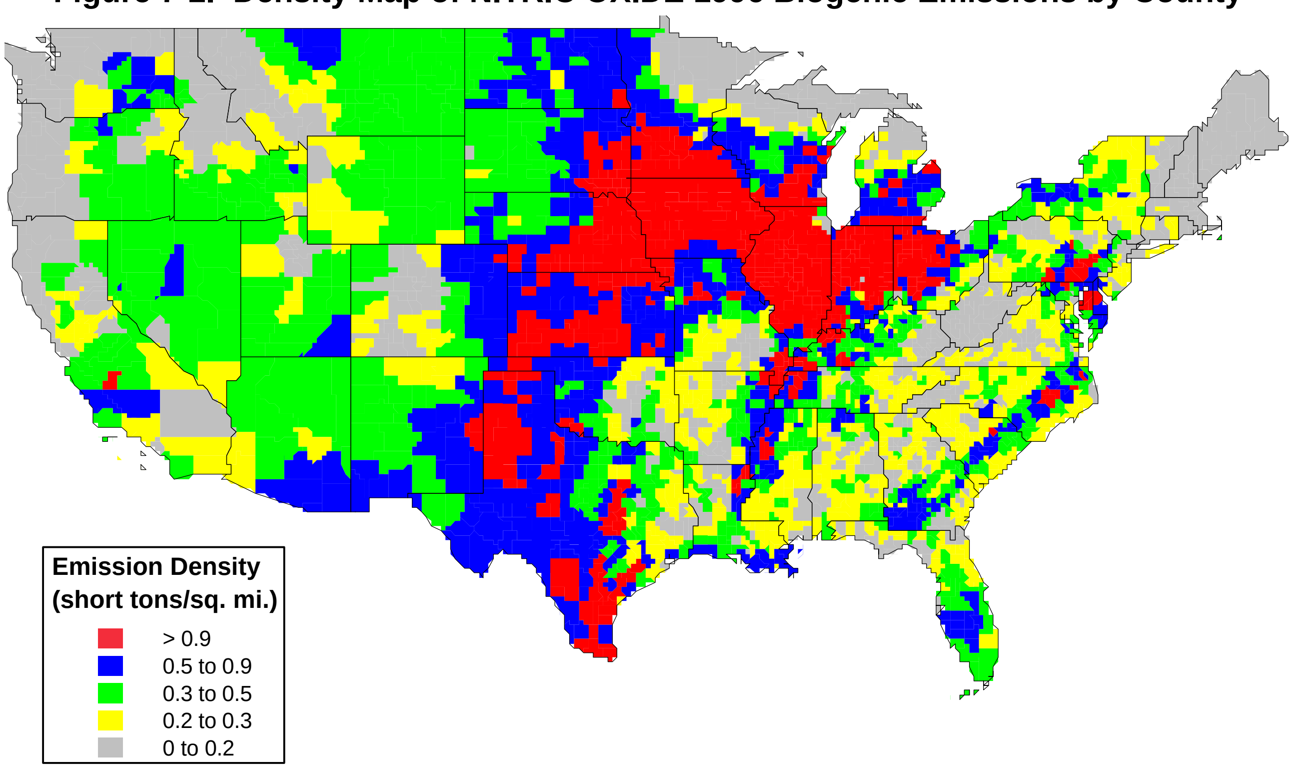


Figure 7-2. Density Map of NITRIC OXIDE 1996 Biogenic Emissions by County



Chapter 8.0 Air Toxics Emissions

8.1 BACKGROUND

Air toxics are non-criteria pollutants which have been associated with, or have the potential to cause serious health effects (e.g. cancer, reproductive disorders, developmental effects, or neurological effects) or environmental effects (e.g., similar disorders to wildlife or degradation of water or habitat quality over broad areas). Air toxics, for the purpose of the CAA, are those 188 HAPs which are listed in section 112(b) of the CAA, and for which sources are identified and regulated. The list of 188 HAPs is available from the following Internet address:

www.EPA.gov/ttn/chief/ap42etc.html.

Of the 188 HAPs listed in section 112(b), 17 are actually chemical groupings such as cadmium compounds or polycyclic organic matter. Therefore, the actual number of specific pollutants considered as HAPs is broader than 188. Of these 188 HAPs, there are approximately 3.7 million tons released into the air each year.

There is considerable uncertainty associated with the amount and quality of data available on HAPs, and as such, in evaluation of the nature and scope of the potential health effects and ecological effects caused by exposure to them (air toxics problem). For this reason, the air toxics problem is often described in qualitative rather than quantitative terms. In order to assess the air toxics problem, information must be developed concerning the potential health effects and concentrations of HAPs in the environment. To address one of the more important data limitations, the EPA's OAQPS has developed and maintains an air emissions inventory, the NTI,[1] to provide data for: trends analysis, identifying sources of HAPs for regulatory purposes; modeling of HAP concentrations; regulatory tracking of sources and emissions; and other technical and policy considerations.

8.2 THE NATIONAL TOXICS INVENTORY

The 1993 NTI is now being updated. At this time, the NTI includes emissions information for 188 HAPs from 913 point, area, and mobile source categories. Data from the Toxics Release Inventory (TRI) were used as the foundation of this inventory. However, because TRI data do not include mobile and area sources, other references needed to be considered. Data from OAQPS studies, such as the Mercury Report[2], and 112c(6) and 112(k) inventory reports, and data collected during development of MACT Standards under section 112(d), supplement the TRI data in the NTI. In addition, State and local data such as the California Air Resource Board's (CARB) Hot Spots Inventory, Houston Inventory, and the Arizona HAP Study were incorporated in the 1993 NTI. The use of non-TRI data from other sources is particularly important for providing estimates of area and mobile source contributions to total HAP emissions. It should be noted that development of the NTI is continuing and that additional information concerning emissions from sources regulated under the MACT program will be added as well as additional State and local emissions data submitted as part of Title V operating permit surveys of the CAA.

The NTI estimates of the area source (sources of HAPs emitting less than 10 ton/year of an individual HAP or 25 tons/year of aggregate emissions of HAPs each) and mobile source contributions to the national emissions of HAPs are approximately 35 and 41 percent respectively and are shown in figure 8-1. As part of the characterization of sources of HAPs nationwide, a listing of the sources emitting the largest quantity of HAPs is presented in table 8-1 for the 1993 inventory. These sources do not necessarily represent those which pose greatest risk but are an indication of the variety of sources and HAPs which are emitted from such sources in relatively high quantities. HAP emissions are not equivalent to risks posed by exposure to these compounds because some of the HAPs are more toxic than others, and actual exposures will vary by site-specific conditions. Table 8-1 shows the major contributing HAPs for each of the top 20 source categories. The 20 sources listed in table 8-1 collectively accounted for 87 percent of total emissions of the 188 HAPs for the year 1993. The first two source categories, on-road motor vehicles (a mobile source category) and consumer/commercial solvent use (an area source category) account for approximately 47 percent of the 188 HAPs emitted annually.

Figure 8-2 is presented to illustrate the geographic distribution of emissions of HAPs by mass. This figure shows total emissions of HAPs for each State and does not necessarily infer relative health risk by exposure to HAPs by State. The categorization of pollutant emissions as high, medium, and low provides a rough sense of the distribution of emissions. In addition, some States may show relatively high emissions as a result of very large emissions from a few facilities or show relatively large emissions as a result from many very small point sources.

8.3 REDUCTIONS ARE TAKING PLACE FOR AIR TOXICS

Since 1990, EPA has established standards and will continue to establish standards that reduce HAP emissions The NTI was designed specifically to give a baseline level of HAP emissions for the year 1993 and cannot currently be used to estimate emissions trends of HAPs. The EPA is updating the 1993 NTI and is currently preparing the 1996 NTI. When the 1996 NTI is compiled, emissions reductions can be more accurately documented and trends in HAP emissions can be described. In describing the HAP reductions to date, EPA must use information gathered during development of these standards.

Between the years 1990 to 1996, MACT or GACT (generally achievable control technology) standards were promulgated for 47 source categories. The CAA requires that standards be promulgated 2 and 4 years after passage of the CAA. In a report to Congress just released to comply with the requirements of section 112(s), the status of the HAP program under the CAA is described. The EPA estimates that these standards will reduce HAP emissions by approximately 980,000 tons/year when fully implemented.[3] Concurrent control of particulate matter and VOC as O_3 precursors is estimated to reduce approximately 1,810,000 tons/year that would not have occurred through other more conventional regulatory programs for these specific pollutants. A variety of programs have been put into place to reduce air toxics and include an early reductions program (6800 tons/year from 27 permit applications). The first substantive compliance date, for the MACT standards already promulgated under the CAA, has passed for about 10 source categories. In addition, under section 111(d) the municipal waste standard and the municipal waste incinerator standards have been promulgated and will reduce some air toxics.

Over the next 10 years, EPA estimates that elements of the air toxics program will reduce emissions by 1.5. million tons per year.[3] These reductions will be accomplished with the remaining MACT standards scheduled for promulgation 7 and 10 years after passage of the CAA, residual risk standards (standards which are intended to reduce unacceptable health risk after MACT has been applied to a source category), and the urban area source and 112(c)(6) programs described below.

8.4 THE URBAN AREA SOURCE PROGRAM

One of the uses of the NTI is for application to the Urban Area Source Program outlined in the CAA. As a result of this program, significant reductions of HAPs from area sources are expected in the future.

Sections 112(c)(3) and 112(k) require the EPA to identify categories and subcategories of sources of HAPs in urban areas that pose the greatest threat to human health. Specifically, the EPA must identify sources of at least 30 HAPs that present the greatest threat to urban populations ("urban HAPs") and assure that sources that account for 90 percent or more of the aggregate emissions are subject to regulation. In addition, a national strategy must be developed to reduce a cancer risk attributable to these pollutants by 75 percent. As a first step in fulfilling the requirement under section 112(c)(3) and 112(k), the EPA has compiled a draft list of pollutants which may make up the urban HAPs specified in the CAA as constituting the greatest threat to public health. Although the list has not been finalized, a list of 40 potential urban HAPs is given in table 8-2. After identification of the urban HAP is complete, the NTI can be used to identify source categories potentially subject to regulation. Using the draft list of HAPs given in table 8-2, a draft urban air toxics inventory has been developed as part of the NTI. This inventory reflects emissions for the year 1993 and not current emissions.

Figures 8-3 and 8-4 present summary data from the draft urban air emissions inventory for 40 potential urban HAPs. Mobile sources, area sources and point (major) sources account for 37, 40, and 23 percent of total emissions of the 40 potential urban HAPs. In addition, figure 8-3 shows that urban and rural emissions of the potential urban HAPs account for 67 and 33 percent of all emissions respectively.

It is important to note that emissions estimates do not necessarily reflect potential health risk from exposure to these HAPs and further analyses will be performed in conjunction with the development of the urban air toxics strategy. However, the development of the inventories for the potential urban pollutants is a critical element in the regulatory strategy to reduce emissions of HAPs from area sources in urban geographic areas. The draft report containing the potential urban HAPs and source categories is available from the following Internet address:

www.epa.gov/ttn/uatw/112k/112kfac.html

8.5 SECTION 112(c)(6)

Section 112(c)(6) of the CAA requires the EPA to identify sources of alkylated lead compounds, polycyclic organic matter, mercury, hexachlorobenzene, polychlorinated biphenyls, 2,3,7,8-tetrachlorodibenzo-p-dioxin, and 2,3,7,8-tetrachlorodibenzofuran. These identified sources will account for not less than 90 percent of the aggregate emissions of each pollutant subject to national standards. In order to meet the requirements of section 112(c)(6), the EPA compiled national inventories of sources and emissions of each of the seven HAPs. The final inventory report is available at the following Internet address: www.epa.gov/ttn/uatw/112c6fac.html.

8.6 REFERENCES

1. 1993 National Toxics Inventory, U.S. Environmental Protection Agency, Version 9702, September 1997.
2. Volume II. An Inventory of Anthropogenic Mercury Emissions in the United States. Mercury Study Report to Congress, SAB Review Draft. EPA-452/R-96-001b.
3. Second Report to Congress on the Status of the Hazardous Air Pollutant Program under the Clean Air Act, Draft. EPA-453/R-96-015. October 1997.

Table 8-1. Top 20 Sources of 1993 Toxic Emissions of Hazardous Air Pollutants (short tons)

RANK	SOURCE CATEGORY	EMISSIONS (tpy)	MAJOR HAPS BY MASS/CATEGORY
1	Mobile Sources: On- Road Vehicles	1,389,111	Acetaldehyde, Benzene, 1,3-Butadiene, Formaldehyde, Toluene, Xylenes
2	Consumer & Commercial Product Solvent Use	414,096	Methanol, Methyl chloroform, Toluene, Xylenes
3	Open Burning: Forest and Wildfires	207,663	Acetaldehyde, Acrolein, Benzene, 1,3-Butadiene, Formaldehyde, Toluene, Xylenes [a]
4	Glycol Dehydrators (Oil and Gas Production)	206,065	Benzene, Toluene, Xylenes
5	Mobile Sources: Non-Road Vehicles and Equipment	145,866	Acetaldehyde, Benzene, 1,3-Butadiene, Formaldehyde
6	Open Burning: Prescribed Burnings	134,149	Acetaldehyde, Acrolein, Benzene, Formaldehyde [a]
7	Residential Boilers: Wood/Wood Residue Combustion	98,646	Acetaldehyde, Benzene, Polycylic organic matter [b]
8	Dry Cleaning: Perchloroethylene	95,700	Perchloroethylene
9	Organic Chemical Manufacturing	91,419	Benzene, Ethylene Glycol, Hydrogen chloride, Methanol, Methyl chloride, Toluene
10	Pulp and Paper Production	88,579	Acetaldehyde, Benzene, Carbon tetrachloride, Formaldehyde, Hydrochloric acid, Methanol, Methylene chloride
11	Halogenate Solvent Cleaning (Degreasing)	61,374	Methyl chloroform, Methylene chloride, Perchloroethylene, Trichloroethylene
12	Primary Nonferrous Metals Production	37,980	Chlorine, Hydrogen chloride, Metals
13	Cellulosic Man-Made Fibers	37,605	Carbon disulfide, Hydrogen chloride
14	Petroleum Refining (All Processes)	27,115	Benzene, Hydrochloric acid, Toluene, Xylenes
15	Municipal Waste Combustion	24,777	Formaldehyde, Hydrogen chloride, Manganese, Mercury, Lead
16	Motor Vehicles (Surface Coating)	23,081	Methyl chloroform, Toluene, Xylenes
17	Gasoline Distribution State II	21,512	Benzene, Glycol ethers, Naphthalene, Toluene
18	Utility Boilers: Coal Combustion	21,404	Hydrogen fluoride, Manganese, Methylene chloride, Selenium [c]
19	Plastics Materials and Resins Manufacturing	20,830	Methanol, Methylene chloride, Styrene, Vinyl acetate
20	Flexible Polyurethane Foam Production	19,550	Methylene chloride

Note(s): [a] Polycyclic organic matter is also a constituent of emissions of this source category, although not a major contributor to emissions on a mass basis.
[b] Polycyclic organic matter is a class of hundreds of compounds of varying toxicity. Polycyclic organic matter is defined in the NTI as the sum of 16 polyaromatic hydrocarbons compounds to provide a workable definition of the more toxic compounds of the class.
[c] Mercury and hydrochloric acid are also constituents of emissions of this source category, although not major contributors to emissions on a mass basis.

Table 8-2. List of Potential 112(k) Hazardous Air Pollutants

CAS NUMBER	NAME	CAS NUMBER	NAME
79345	1,1,2,2-tetrachloroethane	140885	Ethyl acrylate
79005	1,1,2-trichloroethane	106934	Ethylene dibromide (dibromoethane)
78875	1,2-dichloropropane (propylene dichloride)	75218	Ethylene oxide
106990	1,3-butadiene	107062	Ethylene dichloride (1,2-dichloroethane)
542756	1,3 dichloropropene	50000	Formaldehyde
106467	1,4-dichlorobenzene	302012	Hydrazine
75070	Acetaldehyde		Lead compounds
107028	Acrolein		Manganese compounds
79061	Acrylamide		Mercury compounds*
107131	Acrylonitrile	74873	Methyl chloride (chloromethane)
	Arsenic compounds	75092	Methylene chloride (dichloromethane)
71432	Benzene	101688	Methylene diphenyl diisocyanate (MDI)
	Beryllium compounds		Nickel compounds
117817	Bis(2-ethylhexyl)phthalate (DEHP)		Polycyclic organic matter*
	Cadmium compounds	91225	Quinoline
56235	Carbon tetrachloride	100425	Styrene
67663	Chloroform	127184	Tetrachloroethylene (perchloroethylene)
	Chromium compounds	79016	Trichloroethylene
	Coke oven emissions	75014	Vinyl chloride
	Dioxins/furans*	75354	Vinylidene chloride

* These HAPs are also 112(c)(6)-listed HAPs. The emissions estimates for these HAPs have already been completed.

Figure 8-1. 1993 Total 188 Hazardous Air Pollutant Emissions (tpy) by Source Category

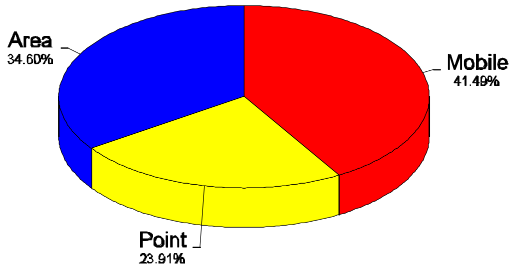


Figure 8-2. The 1993 National Toxic Inventory's 188 Hazardous Air Pollutant Emissions by State

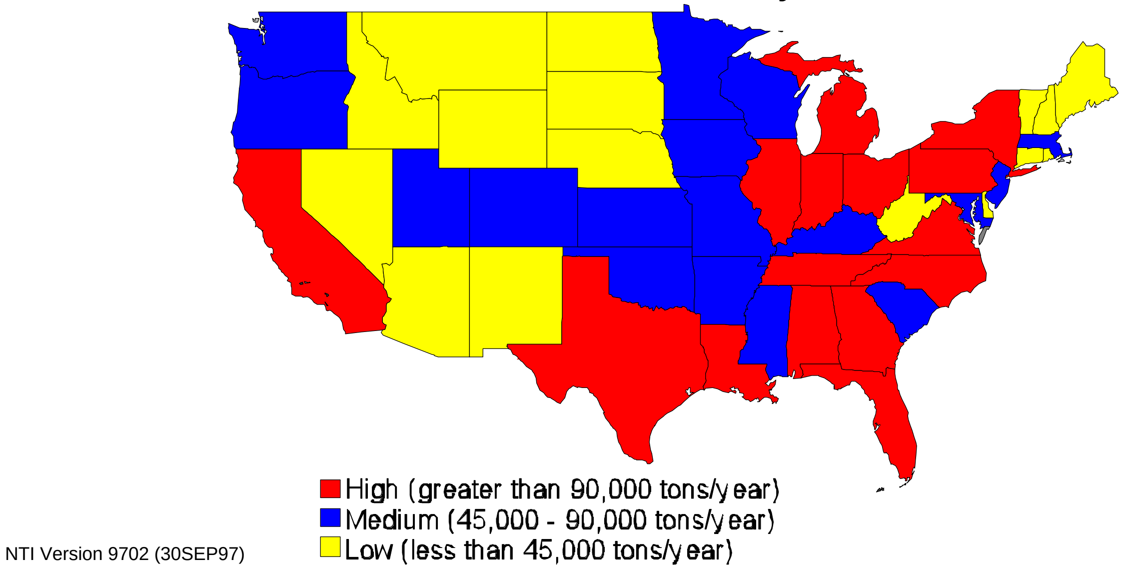


Figure 8-3. Potential 112(k) 40 Hazardous Air Pollutant Emissions (tpy) by Source Type

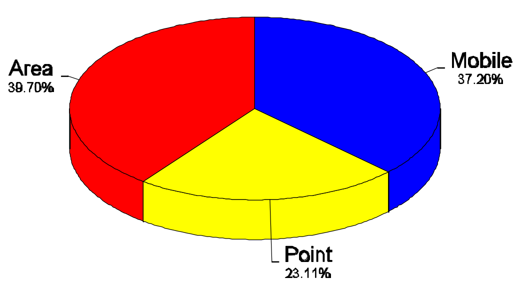
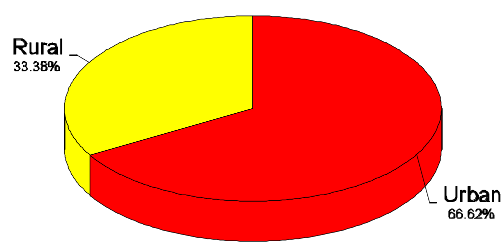


Figure 8-4. Potential 112(k) 40 Hazardous Air Pollutant Emissions (tpy) by Urban/Rural Class



Chapter 9.0 National Greenhouse Gas Emissions

Naturally occurring greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and O_3. Chlorofluorocarbons (CFCs [a family of human-made compounds]), its substitute hydrofluorocarbons (HFCs), and other compounds such as perfluorinated carbons (PFCs), are also greenhouse gases. Although CO_2, CH_4, and N_2O occur naturally in the atmosphere, their recent atmospheric build up appears to be largely the result of human activities. This growth has altered the composition of the Earth's atmosphere, and may affect future global climate.

By signing the Framework Convention on Climate Change (FCCC) at the United Nations Conference on Environment and Development in June 1992, and in October 1992, the United States became the first industrialized nation to ratify the treaty. Since the mid-1980s, the United States has actively supported international cooperation to help implement the provisions of this agreement. In particular, the United States has worked with technical experts from over 50 countries, along with the Organization for Economic Cooperation and Development (OECD), as part of the inventory program of the Intergovernmental Panel on Climate Change (IPCC). This effort has helped facilitate agreement on methods for estimating emissions of greenhouse gases, which absorb reradiated energy from the sun. This trapped energy warms the earth's surface and atmosphere, leading to what is termed the "greenhouse effect." The purpose behind this cooperative effort is twofold: (1) to provide a basis for on-going development of a comprehensive and detailed methodology for estimating sources and sinks[a] of greenhouse gases, and (2) to develop an international system of consistent national inventories of greenhouse gas emissions and sinks for all signatory countries to the FCCC.[b]

9.1 METHODOLOGY AND DATA

The U.S. greenhouse gas emissions data presented in this report are taken from an EPA report, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1995*, Final Report, July 1997.[1] Emissions of greenhouse gases for various source categories were developed using methods that are similar to those recommended by Volumes 1-3 of *IPCC Draft Guidelines for National Greenhouse Gas Inventories*.[2] The IPCC's guidelines were followed, whenever possible, to ensure that the U.S. emissions inventory is comparable to other countries' inventories submitted under the FCCC. It should be noted that the IPCC guidelines represent baseline methodologies. The methodologies are currently evolving, and efforts continue to refine the recommended procedures. For U.S. emission sources relating to energy consumption, forest sinks, and some CH_4 sources, the IPCC default methodologies were expanded, resulting in a more comprehensive estimation procedure. Details on the methods utilized to develop the U.S. emissions are available in the aforementioned July 1997, EPA report.

The current U.S. greenhouse gas emissions inventory for 1990-1995 is summarized in table 9-1. The major greenhouse gas pollutants are listed with estimates of their sources and sinks, along with net emissions. The units of the table are million metric tons carbon-equivalent (MMTCE). When emissions are reported in these units, the individual global warming potential, or GWP, of each gas is taken into account (see figure 9-1). Table 9-2 summarizes the CO_2, CH_4, N_2O emissions in units of short tons.

Since 1990, total U.S. greenhouse gas emissions have increased. From 1990 to 1995, CO_2 emissions increased an estimated 77 MMTCE, substantially more than any other greenhouse gas or category of gases. Methane, N_2O, HFCs, PFCs, and sulfur hexafluoride (SF_6) represent a much smaller portion of total emissions than CO_2. In most cases, emissions from these gases have increased slightly or remained relatively constant. The rise in HFC, PFC, and SF_6 emissions, although a small portion of the total, is significant because of their extremely high GWPs, and in the case of PFCs and SF_6, also their long atmospheric lifetimes.

The trend of emissions growth in greenhouse gases has not been steady. Emissions of greenhouse gases from anthropogenic sources in the United States dropped in 1991 from 1990 levels, then grew at an increasing rate through 1994, when the growth rate slowed. Overall, greenhouse gas emissions in the United States have increased from 1.6 to 1.7 billion metric tons, carbon-equivalent, in the period 1990 to 1995, a 6 percent increase, representing an average annual increase in emissions of just over 1 percent. This trend is largely attributable to changes in total energy consumption resulting from the economic slowdown in the United States in the early 1990s and the subsequent recovery. The U.S. energy consumption increased at an average annual rate of 2 percent over the same period—1990-1995.[3] The increase in emissions from 1993 through 1995 was also influenced by generally low energy prices which has resulted in increased demand for fossil fuels.[4]

Due largely to fossil fuel consumption, CO_2 emissions accounted for the largest share of U.S. greenhouse gas emissions—85 percent. CO_2 emissions data from the electric utility industry are submitted to EPA through continuous emission monitoring reporting under Title IV (Acid Deposition Control). Although CO_2 data were reported for Phase I affected units in 1994 and for additional units in 1995, many utilities took advantage of a reporting extension for oil-fired and gas-fired units associated with the NO_x certification deadline so the CO_2 emissions data are not complete for 1995.[6] Utility CO_2 emissions data, much of which represent monitored values, in the Acid Rain ETS will be used in future *Trends* reports. These emissions were partially offset by the sequestration that occurred on forested lands. To be consistent with the IPCC recommended guidelines, the total for 1995 excludes emissions of 22 MMTCE from bunker fuels (fuels delivered to marine vessels, including warships and fishing vessels, and aircraft, used for international transport) and includes emissions from U.S. territories.

Methane accounted for approximately 11 percent of total emissions, including contributions from landfills and agricultural activities, among others. Methane emissions have increased by slightly more than 4 percent from 1990 to 1995. The largest change in CH_4 emission estimates compared to earlier inventories is in the natural gas sector, where emissions have been adjusted upward by more than 75 percent due to improved estimation methods. These revised emissions have not changed significantly over the period 1990-1995, however. Emissions from landfills have increased over the period, due to a shift toward larger landfills, and emissions from agriculture increased due to larger animal populations and an increased use of liquid manure management systems. Coal mining emissions have declined, due to improved CH_4 recovery and lower coal production from gassy mines.

Emissions of N_2O have increased just under 10 percent since 1990, primarily for two reasons. First, emissions from fertilizer use, which account for approximately 46 percent of total U.S. N_2O emissions, increased significantly from 1993 to 1994 as farmers planted more acreage and increased fertilizer use to replace nutrients lost in the flooding of 1993. Emissions increased again in 1995 as the use of fertilizer increased. Second, emissions from other categories have also increased slightly as the U.S. economy has grown since the early 1990s.

Emissions of HFCs, PFCs, and SF_6 have begun to grow as the use of these chemicals increases to replace CFCs and other O_3-depleting compounds that are being phased out under the terms of the *Montreal Protocol* and *Clean Air Act Amendments*. One of the most significant increases since 1990 is the result of HFC-134a usage for mobile air conditioners. Emissions are also generated as byproducts from other production processes. The largest single component of HFC emissions is the emission of HFC-23 as a byproduct of the production process for another chemical, hydrochloroflurocarbon (HCFC)-22.

9.2 REFERENCES

1. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1995*. Final Report. Office of Planning and Evaluation, U.S. Environmental Protection Agency, Washington, DC. July 1997.
2. *IPCC Guidelines for National Greenhouse Gas Inventories, 3 volumes: Vol. 1, Reporting Instructions; Vol. 2, Workbook; Vol. 3, Draft Reference Manual*. Intergovernmental Panel on Climate Change, Organization for Economic Co-Operation and Development. Paris, France. 1994.
3. *Emissions of Greenhouse Gases in the United States 1995*. Energy Information Administration, U.S. Department of Energy, Washington, DC. 1996.
4. *Annual Energy Review 1995*. Energy Information Administration, U.S. Department of Energy, Washington, DC. 1996.
5. *Climate Change 1995: The Science of Climate Change*; J.T. Houghton, L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg, and K. Maskell, Eds.; Cambridge University Press. Cambridge, U.K. 1996.
6. *Nitrogen Oxides: Impacts on Public Health and the Environment*. EPA-452/R-97-002. Office of Air and Radiation, U.S. Environmental Protection Agency, Washington, DC. August 1997.

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[a] A “sink” is a mechanism that leads to the removal and/or destruction of greenhouse gases.

[b] Article 4-1 of the FCCC requires that all parties “develop, periodically update, publish, and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties.”

Table 9-1. Recent Trends in U.S. Greenhouse Gas Emissions (1990-1995)

	Emissions (MMTCE)					
Gas/Source	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Carbon Dioxide (CO_2)						
Fossil Fuel Combustion	1,336	1,320	1,340	1,370	1,391	1,403
Industrial Processes and Other	17	16	17	18	19	19
Total	1,353	1,336	1,357	1,388	1,410	1,422
Forests (sink)	(125)	(123)	(122)	(120)	(119)	(117)
Net Total	1,228	1,228	1,235	1,268	1,291	1,305
Methane (CH_4)						
Landfills	56	58	58	60	62	64
Agriculture	50	51	52	52	54	55
Coal Mining	24	23	22	20	21	20
Oil and Natural Gas Systems	33	33	34	33	33	33
Other	6	7	7	6	6	6
Total	170	172	173	176	176	177
Nitrous Oxide (N_2O)						
Agriculture	17	17	17	18	18	18
Fossil Fuel Consumption	11	11	12	12	12	12
Industrial Processes	8	8	8	8	9	9
Total	36	37	37	38	39	40
HFCs	12	12	13	14	17	21
PFCs	5	5	5	5	7	8
SF_6	7	7	8	8	8	8
U.S. EMISSIONS	**1,583**	**1,570**	**1,592**	**1,624**	**1,657**	**1,676**
NET U.S. EMISSIONS (Including Sinks)	**1,458**	**1,447**	**1,470**	**1,504**	**1,538**	**1,559**

NOTE(S): The “Totals” presented in the summary tables in this chapter may not equal the sum of the individual source categories due to rounding.

SOURCE: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1995*, Final Report. U.S. Environmental Protection Agency. July 1997.

Table 9-2. Summary Report for National Greenhouse Gas Inventories 1995 (thousand short tons)

Greenhouse Gas Source and Sink Categories	CO_2	CH_4 [a]	N_2O
Total (Net) National Emission	**5,276,390**	**34,144**	**515**
1 All Energy (Fuel Combustion + Fugitives)	**5,677,755**	**11,186**	**160**
A Fuel Combustion	5,670,921	883	160
Energy & Transformation Industries	1,996,470	15	15
Industry	1,211,558	10	19
Transport	1,761,889	311	120
Commercial/Institutional	254,906	1	1
Residential	403,283	510	4
Agriculture/Forestry	NE	NE	NE
U.S. Territories	42,816	NE	NE
Biomass Burned for Energy [b]	215,059 [b]	[b]	[b]
B Fugitive Fuel Emission	6,834	10,303	-
Oil and Natural Gas Activities	6,834	6,382	-
Coal Mining	-	3,921	-
2 Industrial Processes (Total)	**70,375**	**NE**	**116**
A Iron and Steel	NE	NE	-
B Nonferrous Metals [c]	6,874	-	
C Inorganic Chemicals (excluding solvents)	1,601	-	47
D Organic Chemicals	-	-	68
E Non-Metallic Mineral Products	68,819	NE	-
F Other Industry [d]	-	-	-
3 Solvent and Other Product Use (Total)	**-**	**-**	**-**
A Degreasing	-	-	-
B Dry Cleaning	-	-	-
C Graphic Arts	-	-	-
D Surface Coating (including paint)	-	-	-
E Other Industrial	-	-	-
F Nonindustrial	-	-	-
4 Agriculture (Total)	**-**	**10,547**	**239**
A Enteric Fermentation	-	6,715	-
B Manure Management	-	3,293	-
C Rice Cultivation	-	531	-
D Agricultural Soils	-	-	239
E Agricultural Waste Burning	-	8.2	0.1
F Savannah Burning	NO	NO	NO
5 Land Use Change and Forestry (Total)	**-428,000**	**NE**	**NE**
A Changes in Forest Stocks	NE	NE	NE
B Forest and Grassland Conversion	NE	NE	NE
C Abandonment of Managed Lands	NE	NE	NE
D Managed Forests	-428,000	NE	NE
6 Waste (Total)	**-**	**12,411**	**-**
A Landfills	-	12,236	-
B Wastewater	-	175	-
C Incineration	-	-	-
D Other	-	-	-

NOTE(S): NE = Not Estimated; NO = Not Occurring
"-" = Information not applicable
Totals may not equal sum of components due to independent rounding.
[a] Total methane emissions from energy include 35 thousand short tons from natural gas consumption which is not sector specific.
[b] CO_2 emissions estimates from biomass consumption are from commercial, industrial, residential, transportation, and electric power production applications. They are provided for information purposes only and are not included in national totals. Estimates of non-CO_2 emissions from these sources were calculated via U.S. EPA methodologies and are incorporated in sectoral estimates of stationary and mobile combustion.
[c] The nonferrous metals category consists exclusively of aluminum production. Emissions of CO_2 from aluminum production are reported in this table for informational purposes, but are not counted in the national total, because they are included under non-fuel industrial use in the Energy section.
[d] The "Other Industry" category is used to report NO_x, CO, and NMVOC emissions for industry.

SOURCE: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1995*, Final Report. U.S. Environmental Protection Agency. July 1997.

Figure 9-1. The Global Warming Potential Concept

Gases can contribute to the greenhouse effect both directly and indirectly. Direct effects occur when the gas itself is a greenhouse gas; indirect radiative forcing occurs when chemical transformations of the original gas produces a gas or gases that are greenhouse gases, or when a gas influences the atmospheric lifetimes of other gases. The concept of Global Warming Potential (GWP) has been developed to compare the ability of each greenhouse gas to trap heat in the atmosphere relative to another gas. Carbon dioxide was chosen as the reference gas to be consistent with IPCC guidelines.

Global Warming Potentials are not provided for the photochemically important gases CO, NO_x, NMVOCs, and SO_2 because there is no agreed upon method to estimate their contribution to climate change. These gases only affect radiative forcing indirectly.

All gases in this inventory are presented in units of million metric tonnes of carbon-equivalent, or MMTCE. Carbon comprises 12/44 of CO_2 by weight. In order to convert emissions reported in million metric tons of greenhouse gas *x*, to MMTCE, use the equation:

$$MMTCE = (Million\ Metric\ Tonnes\ of\ GHG\ x)(GWP\ of\ GHG\ x)(12/44)$$

The GWP of a greenhouse gas is the ratio of global warming, or radiative forcing (both direct and indirect), from one kilogram of a greenhouse gas to one kilogram of CO_2 over a period of time. While any time period can be selected, the 100-year GWPs recommended by the IPCC, and employed by the United States for policy making and reporting purposes, are used in this report.[5] The GWPs of some selected greenhouse gases are shown below.

Gas	GWP (100 Years)
Carbon Dioxide	1
Methane*	21
Nitrous Oxide	310
HFC-23	11,700
HFC-32	650
HFC-125	2,800
HFC-134a	1,300
HFC-143a	3,800
HFC-152a	140
HFC-227ea	2,900
HFC-43-10mme	1,300
CF_4	6,500
C_2F_6	9,200
C_4F_{10}	7,000
C_6F_{14}	7,400
SF_6	23,900

* The methane GWP incorporates the direct effects and indirect effects due to the production of tropospheric ozone and stratospheric water vapor. The indirect effect due to the production of CO_2 is not included.

SOURCE: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1995*, Final Report. U.S. Environmental Protection Agency. July 1997.

Chapter 10.0 International Emissions

This chapter presents the 1994 European emission estimates for the pollutants CO, NO_x, SO_2, nonmethane volatile organic compounds (NMVOCs), CH_4, CO_2, N_2O, and NH_3, and the 1994 Canadian emission estimates for the pollutants CO, NO_x, VOC, SO_2, and total particulate (TP).

10.1 EUROPEAN EMISSIONS

CORINAIR 94 (Coordination of Environmental Air) is the air emission inventory for Europe for 1994.[1] The CORINAIR project is part of the work program of the European Environment Agency (EEA). The European Topic Center on Air EMissions (ETC/AEM) is designated by the EEA to perform the CORINAIR project by assisting participating countries, in particular the National Reference Centers (NRCs), to report their national 1994 inventory as required under international obligations. Based on these reports the ETC/AEM prepares the European 1994 air emission inventory and data base.

In 1996, 20 European countries took part in the CORINAIR 94 inventory. These are the 15 European Union (EU-15) countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and United Kingdom) plus two additional members of the EEA (Norway and Iceland) as well as Croatia, Malta, and Switzerland.

Table 10-1 shows European national total emissions for 1994 for the eight pollutants included in the inventory: SO_2, NO_x, NMVOC, CH_4, CO, CO_2, N_2O and NH_3. Figures 10-1 to 10-8 show a comparison between 1990 CORINAIR emission estimates and 1994 CORINAIR emission estimates for each country and pollutant. In table 10-1 and figures 10-1 to 10- 8, emissions from nature and agricultural emissions for NMVOC and CO_2 have been emitted. The results of CORINAIR 94 provide the most detailed, complete, consistent and transparent European atmospheric emission inventory to date. Nevertheless results are estimates of actual emissions and with significant uncertainties in some cases. Furthermore some gaps and inconsistencies remain.

In comparison with CORINAIR 90, the CORINAIR 94 methodology has been further developed:

- ! To include additional source sectors and sub-sectors due to the extension of the number of pollutants.
- ! To be more consistent with international energy statistics and the IPCC guidelines for national greenhouse gas inventories.

Because of these (relatively small) differences between 1990 and 1994 emission estimates on the level of source sub-sectors, CORINAIR 94 is not fully comparable with data listed in CORINAIR 90.

Tables 10-2 to 10-11 present country-level summary data for 1994 emissions. Some countries included estimates of NMVOC and CO_2 emissions in the Nature and the Agriculture categories, some did not; therefore, a "Comparable total" line, omitting these two categories, has been included for each country.

10.2 CANADIAN EMISSIONS

The criteria air pollutant annual emissions data for Canada were provided by Environment Canada[2] for the year 1994. Emissions were provided for CO, NO_x, VOC, SO_2 and TP. Table 10-12 displays the emission estimates for Canada by major source category. Table 10-13 displays the emissions for Canada by Province.

10.3 REFERENCES

1. *CORINAIR 94 Summary Report - European Emission Inventory for Air Pollutants.* European Topic Centre on Air Emissions, European Environment Agency, Copenhagen, Denmark. April 1997.
2. Facsimile from Libby Greenwood, Pollution Data Branch, Environment Canada, Hull Quebec to Sharon Nizich, Emission Factors and Inventory Group, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. November 1997.

Table 10-1. 1994 Emission Estimates for Europe by Country and Pollutant (thousand short tons; except CO_2 [million short tons])

COUNTRY	Population (million)	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Germany	81.1	3,305	2,498	2,365	5,344	7,493	997	241	686
United Kingdom	58.2	2,972	2,631	2,591	4,242	6,578	606	110	353
France	57.7	1,117	1,854	2,544	3,132	10,585	376	217	735
Italy	57	1,584	2,378	2,468	4,554	10,170	471	144	429
Spain	39.1	2,272	1,348	1,235	2,546	5,292	272	97	380
Netherlands	15.3	161	583	417	1,188	1,000	180	50	190
Greece	10.4	613	393	399	495	1,420	97	16	491
Belgium	10.1	308	412	372	464	1,285	125	30	87
Portugal	9.9	301	274	249	279	1,317	56	42	102
Sweden	8.7	82	490	420	302	1,453	96	26	56
Austria	8	60	188	319	634	1,301	66	14	95
Denmark	5.2	174	304	170	475	789	69	13	103
Finland	5.1	122	317	195	261	483	87	18	45
Ireland	3.6	195	129	103	890	367	37	29	137
Luxembourg	0.4	14	25	19	24	160	10	1	8
EU-15	**370**	**13,280**	**13,827**	**13,866**	**24,829**	**49,695**	**3,545**	**1,048**	**3,897**
Switzerland	6.7	34	154	240	348	605	48	19	66
Norway	4.2	38	241	402	514	951	41	16	27
Malta	0.4	17	18	6	10	26	3	14	7
Iceland	0.3	9	24	8	24	28	0	1	0
Liechtenstein	0.03	NA	NA	NA	NA	NA	NA	NA	NA
Poland	38.4	NA	NA	NA	NA	NA	NA	NA	NA
Romania	23.3	NA	NA	NA	NA	NA	NA	NA	NA
Hungary	10.5	NA	NA	NA	NA	NA	NA	NA	NA
Czech Republic	10.3	NA	NA	NA	NA	NA	NA	NA	NA
Bulgaria	9	NA	NA	NA	NA	NA	NA	NA	NA
Slovakia	5.3	NA	NA	NA	NA	NA	NA	NA	NA
Croatia	4.7	98	65	80	152	514	19	16	26
Lithuania	3.8	NA	NA	NA	NA	NA	NA	NA	NA
Latvia	2.7	NA	NA	NA	NA	NA	NA	NA	NA
Slovenia	2	NA	NA	NA	NA	NA	NA	NA	NA
Estonia	1.6	NA	NA	NA	NA	NA	NA	NA	NA
Non-EU-15	**123**	**196**	**502**	**736**	**1,048**	**2,124**	**111**	**66**	**127**
Total	**493**	**13,476**	**14,329**	**14,601**	**25,878**	**51,819**	**3,656**	**1,115**	**4,024**

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: CORINAIR 94 Summary Report.[1]

Table 10-2. 1994 Emission Estimates for Austria and Belgium by Source Category and Pollutant
(thousand short tons; except CO_2 [million short tons])

Austria	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	5	7	0	0	1	10	0	0
Nonindustrial combustion plants	21	19	67	23	550	14	1	1
Combustion in manufacturing industry	13	13	1	0	7	8	0	0
Production processes	10	17	14	0	323	15	1	0
Extraction and distribution of fossil fuels / geothermal energy	1	0	6	5	0	0	0	0
Solvent and other product use	0	0	145	0	0	0	1	0
Road transport	9	106	79	4	400	16	4	4
Other mobile sources and machinery	2	17	5	0	13	2	1	0
Waste treatment and disposal	0	0	1	90	5	0	0	0
Agriculture and forestry, land use and woodstock change	0	8	139	511	2	-17	7	90
Nature	0	0	45	63	0	NA	1	1
Total	60	189	503	697	1,301	49	15	96
Comparable Total	60	188	319	634	1,301	66	14	95

Belgium	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	142	85	1	0	5	32	3	0
Nonindustrial combustion plants	44	21	11	5	131	34	4	0
Combustion in manufacturing industry	60	57	2	2	9	24	2	0
Production processes	36	5	53	2	19	8	6	3
Extraction and distribution of fossil fuels / geothermal energy	0	0	16	43	0	0	0	0
Solvent and other product use	0	0	91	0	0	0	0	0
Road transport	21	236	195	11	1,097	26	1	1
Other mobile sources and machinery	0	4	5	0	3	0	0	0
Waste treatment and disposal	4	4	0	99	21	0	0	0
Agriculture and forestry, land use and woodstock change	0	0	27	300	0	0	13	84
Nature	0	0	6	14	0	NA	1	0
Total	308	412	399	464	1,285	125	30	87
Comparable Total	308	412	372	464	1,285	125	30	87

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding. Negative emissions represent a sink for greenhouse gas.

Source: CORINAIR 94 Summary Report[1]

Table 10-3. 1994 Emission Estimates for Croatia and Denmark by Source Category and Pollutant

(thousand short tons; except CO_2 [million short tons])

Croatia	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	29	6	0	0	1	3	0	0
Nonindustrial combustion plants	11	3	7	5	124	3	0	0
Combustion in manufacturing industry	45	13	1	0	2	6	1	0
Production processes	0	1	9	1	12	2	3	2
Extraction and distribution of fossil fuels / geothermal energy	0	0	7	44	0	1	0	0
Solvent and other product use	0	0	24	0	0	0	0	0
Road transport	7	26	31	1	351	3	0	0
Other mobile sources and machinery	5	14	1	0	25	1	1	0
Waste treatment and disposal	1	0	0	32	0	0	0	0
Agriculture and forestry, land use and woodstock change	0	0	0	69	0	0	12	24
Nature	0	0	77	159	0	0	3	8
Total	98	65	157	311	514	19	19	35
Comparable Total	98	65	80	152	514	19	16	26

Denmark	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	122	113	1	1	52	39	1	0
Nonindustrial combustion plants	8	6	9	6	149	7	0	0
Combustion in manufacturing industry	25	13	1	1	5	6	0	0
Production processes	4	1	4	1	0	2	0	0
Extraction and distribution of fossil fuels / geothermal energy	0	4	8	15	40	1	0	0
Solvent and other product use	0	0	45	0	0	0	0	0
Road transport	2	97	82	2	455	10	1	1
Other mobile sources and machinery	12	70	21	1	87	4	1	0
Waste treatment and disposal	1	0	0	86	0	0	0	0
Agriculture and forestry, land use and woodstock change	0	0	13	361	0	0	10	102
Nature	0	0	0	390	0	NA	6	0
Total	174	304	183	865	789	69	19	103
Comparable Total	174	304	170	475	789	69	13	103

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: CORINAIR 94 Summary Report[1]

Table 10-4. 1994 Emission Estimates for Finland and France by Source Category and Pollutant
(thousand short tons; except CO_2 [million short tons])

Finland	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	39	60	1	2	8	28	1	0
Nonindustrial combustion plants	8	18	47	10	43	13	1	0
Combustion in manufacturing industry	45	22	1	2	45	32	1	0
Production processes	25	22	15	4	0	1	3	1
Extraction and distribution of fossil fuels / geothermal energy	0	0	11	0	0	0	0	0
Solvent and other product use	0	0	43	0	0	NA	0	0
Road transport	2	149	57	3	343	10	1	0
Other mobile sources and machinery	3	47	17	0	44	2	0	0
Waste treatment and disposal	0	0	2	134	0	1	0	0
Agriculture and forestry, land use and woodstock change	0	0	0	105	0	0	10	44
Nature	0	0	NA	NA	0	NA	NA	0
Total	122	317	195	261	483	87	18	45
Comparable Total	122	317	195	261	483	87	18	45

France	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	367	110	2	2	19	51	1	0
Nonindustrial combustion plants	123	109	241	169	2,089	97	5	0
Combustion in manufacturing industry	301	127	6	6	599	55	3	0
Production processes	97	31	110	6	687	19	107	15
Extraction and distribution of fossil fuels / geothermal energy	12	0	121	377	0	0	0	0
Solvent and other product use	0	0	673	0	0	2	2	0
Road transport	170	1,123	1,062	20	5,771	131	7	4
Other mobile sources and machinery	26	325	307	0	1,117	16	0	0
Waste treatment and disposal	21	29	23	760	257	6	3	2
Agriculture and forestry, land use and woodstock change	0	1	437	1,793	46	-36	88	714
Nature	1	2	59	105	72	0	39	0
Total	1,118	1,856	3,040	3,237	10,657	340	255	735
Comparable Total	1,117	1,854	2,544	3,132	10,585	376	217	735

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding. Negative emissions represent a sink for greenhouse gas.

Source: CORINAIR 94 Summary Report.[1]

Table 10-5. 1994 Emission Estimates for Germany and Greece by Source Category and Pollutant

(thousand short tons; except CO_2 [million short tons])

Germany	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	2,278	559	10	10	156	397	14	3
Nonindustrial combustion plants	402	154	66	67	1,297	202	5	0
Combustion in manufacturing industry	458	284	12	13	745	172	5	1
Production processes	74	25	150	9	656	28	90	9
Extraction and distribution of fossil fuels / geothermal energy	19	NA	97	1,280	14	NA	NA	NA
Solvent and other product use	NA	NA	1,202	NA	NA	NA	7	1
Road transport	56	1,153	746	39	4,358	176	21	20
Other mobile sources and machinery	18	324	82	3	266	22	NA	NA
Waste treatment and disposal	NA	NA	NA	2,094	NA	NA	4	NA
Agriculture and forestry, land use and woodstock change	NA	NA	426	1,830	NA	-33	95	651
Nature	NA	NA	NA	NA	NA	NA	NA	NA
Total	3,305	2,498	2,791	5,344	7,493	964	241	686
Comparable Total	3,305	2,498	2,365	5,344	7,493	997	241	686

Greece	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	389	85	3	1	7	51	2	0
Nonindustrial combustion plants	103	4	0	0	6	6	1	0
Combustion in manufacturing industry	63	23	2	1	6	10	1	0
Production processes	14	38	10	0	27	8	0	4
Extraction and distribution of fossil fuels / geothermal energy	0	0	16	54	0	0	0	0
Solvent and other product use	0	0	90	0	0	0	0	0
Road transport	25	142	242	4	1,079	15	0	0
Other mobile sources and machinery	21	94	26	0	121	7	3	0
Waste treatment and disposal	0	2	9	126	26	0	0	0
Agriculture and forestry, land use and woodstock change	0	6	984	308	148	0	9	486
Nature	1	1	13	37	0	NA	180	0
Total	614	394	1,396	532	1,421	97	196	491
Comparable Total	613	393	399	495	1,420	97	16	491

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding. Negative emissions represent a sink for greenhouse gas.

Source: CORINAIR 94 Summary Report.[1]

Table 10-6. 1994 Emission Estimates for Iceland and Ireland by Source Category and Pollutant
(thousand short tons; except CO_2 [million short tons])

Iceland	**SO_2**	**NO_x**	**NMVOC**	**CH_4**	**CO**	**CO_2**	**N_2O**	**NH_3**
Combustion in energy and transformation industries	0	0	0	0	0	0	0	0
Nonindustrial combustion plants	0	0	0	0	0	0	0	0
Combustion in manufacturing industry	3	1	0	0	0	0	0	0
Production processes	3	0	0	0	0	0	0	0
Extraction and distribution of fossil fuels / geothermal energy	0	0	0	0	0	0	0	0
Solvent and other product use	0	0	3	0	0	0	0	0
Road transport	0	3	3	0	21	1	0	0
Other mobile sources and machinery	3	21	2	0	6	1	0	0
Waste treatment and disposal	0	0	0	11	1	0	0	0
Agriculture and forestry, land use and woodstock change	0	0	0	13	0	0	1	0
Nature	0	0	0	0	0	NA	0	0
Total	9	24	8	24	28	2	1	0
Comparable Total	9	24	8	24	28	2	1	0

Ireland	**SO_2**	**NO_x**	**NMVOC**	**CH_4**	**CO**	**CO_2**	**N_2O**	**NH_3**
Combustion in energy and transformation industries	106	50	0	0	4	14	2	0
Nonindustrial combustion plants	35	9	6	3	66	10	1	0
Combustion in manufacturing industry	44	11	0	0	2	4	0	NA
Production processes	0	0	1	0	0	2	3	NA
Extraction and distribution of fossil fuels / geothermal energy	0	0	4	12	0	0	0	0
Solvent and other product use	0	0	24	0	0	0	0	0
Road transport	7	49	64	1	288	6	0	0
Other mobile sources and machinery	3	10	2	0	6	1	0	0
Waste treatment and disposal	0	0	0	150	1	0	0	0
Agriculture and forestry, land use and woodstock change	0	0	91	724	0	6	22	137
Nature	0	0	0	41	0	NA	0	0
Total	195	129	193	931	367	43	29	137
Comparable Total	195	129	103	890	367	37	29	137

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: CORINAIR 94 Summary Report.[1]

Table 10-7. 1994 Emission Estimates for Italy and Luxembourg by Source Category and Pollutant
(thousand short tons; except CO_2 [million short tons])

Italy	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	819	492	7	7	48	144	21	0
Nonindustrial combustion plants	79	64	26	20	318	76	8	0
Combustion in manufacturing industry	435	271	8	6	410	84	8	0
Production processes	108	12	116	11	530	31	17	26
Extraction and distribution of fossil fuels / geothermal energy	0	0	161	434	0	0	0	0
Solvent and other product use	0	0	613	0	0	0	0	0
Road transport	83	1,165	1,190	32	6,405	101	4	1
Other mobile sources and machinery	56	340	231	6	748	25	5	0
Waste treatment and disposal	4	33	116	1,946	1,683	10	1	15
Agriculture and forestry, land use and woodstock change	0	1	602	2,092	29	0	80	386
Nature	2,464	0	0	79	5	0	7	0
Total	4,048	2,378	3,070	4,634	10,175	471	152	429
Comparable Total	1,584	2,378	2,468	4,554	10,170	471	144	429

Luxembourg	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	0	0	0	0	0	1	0	0
Nonindustrial combustion plants	1	1	1	1	10	1	0	0
Combustion in manufacturing industry	12	11	0	0	84	6	0	0
Production processes	0	0	1	0	15	0	0	2
Extraction and distribution of fossil fuels / geothermal energy	0	0	2	2	0	0	0	0
Solvent and other product use	0	0	4	0	0	0	0	0
Road transport	1	11	10	0	48	1	0	0
Other mobile sources and machinery	0	1	1	0	3	0	0	0
Waste treatment and disposal	0	0	0	3	0	0	0	0
Agriculture and forestry, land use and woodstock change	0	0	1	19	0	0	1	6
Nature	0	0	1	1	0	NA	0	0
Total	14	25	22	25	160	10	1	8
Comparable Total	14	25	19	24	160	10	1	8

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: CORINAIR 94 Summary Report.[1]

Table 10-8. 1994 Emission Estimates for Malta and the Netherlands by Source Category and Pollutant
(thousand short tons; except CO_2 [million short tons])

Malta	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	13	7	0	0	0	2	0	0
Nonindustrial combustion plants	0	0	0	0	0	0	0	0
Combustion in manufacturing industry	0	0	0	0	0	0	0	0
Production processes	0	0	0	0	0	0	0	0
Extraction and distribution of fossil fuels / geothermal energy	0	0	0	0	0	0	0	0
Solvent and other product use	0	0	3	0	0	0	0	0
Road transport	0	4	3	0	23	0	0	0
Other mobile sources and machinery	3	6	0	0	2	0	0	0
Waste treatment and disposal	0	0	0	6	0	0	14	0
Agriculture and forestry, land use and woodstock change	0	0	0	4	0	0	0	7
Nature	0	0	0	0	0	0	0	0
Total	17	18	6	10	26	3	14	7
Comparable Total	17	18	6	10	26	3	14	7

Netherlands	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	47	78	1	1	9	53	1	0
Nonindustrial combustion plants	5	49	12	24	111	39	1	0
Combustion in manufacturing industry	46	66	2	4	133	42	0	0
Production processes	30	13	136	7	122	6	12	11
Extraction and distribution of fossil fuels / geothermal energy	0	1	38	207	9	0	0	0
Solvent and other product use	0	0	65	0	1	0	0	1
Road transport	14	273	151	7	568	30	7	0
Other mobile sources and machinery	15	74	8	0	29	5	1	0
Waste treatment and disposal	3	7	2	318	4	4	1	1
Agriculture and forestry, land use and woodstock change	0	22	4	620	16	11	28	178
Nature	0	11	2	124	15	0	15	0
Total	161	594	422	1,312	1,016	191	66	190
Comparable Total	161	583	417	1,188	1,001	180	51	190

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: CORINAIR 94 Summary Report.[1]

Table 10-9. 1994 Emission Estimates for Norway and Portugal by Source Category and Pollutant

(thousand short tons; except CO_2 [million short tons])

Norway	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	1	29	2	3	7	10	0	0
Nonindustrial combustion plants	2	3	12	16	176	2	1	0
Combustion in manufacturing industry	6	10	1	0	7	4	1	0
Production processes	24	9	23	1	53	7	6	0
Extraction and distribution of fossil fuels / geothermal energy	0	0	210	33	0	1	0	0
Solvent and other product use	0	0	51	0	0	0	0	0
Road transport	3	82	84	2	646	9	1	1
Other mobile sources and machinery	3	101	17	1	62	7	0	0
Waste treatment and disposal	0	6	1	351	1	1	0	0
Agriculture and forestry, land use and woodstock change	0	0	0	107	0	0	7	26
Nature	0	0	0	0	0	NA	0	0
Total	38	241	402	514	951	41	16	27
Comparable Total	38	241	402	514	951	41	16	27

Portugal	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	181	57	0	1	5	16	2	0
Nonindustrial combustion plants	6	4	12	8	131	5	0	0
Combustion in manufacturing industry	76	28	4	3	342	16	2	0
Production processes	13	5	28	2	16	5	2	6
Extraction and distribution of fossil fuels / geothermal energy	0	0	10	0	0	0	0	NA
Solvent and other product use	0	0	74	0	0	0	0	NA
Road transport	20	149	113	2	808	13	1	0
Other mobile sources and machinery	4	30	7	0	15	2	0	0
Waste treatment and disposal	0	0	0	39	0	0	0	NA
Agriculture and forestry, land use and woodstock change	0	0	4	224	0	0	34	96
Nature	0	2	438	143	0	3	19	0
Total	301	276	691	422	1,318	59	61	102
Comparable Total	301	274	249	279	1,317	56	42	102

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: CORINAIR 94 Summary Report.[1]

Table 10-10. 1994 Emission Estimates for Spain and Sweden by Source Category and Pollutant
(thousand short tons; except CO_2 [million short tons])

Spain	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	1,420	279	11	10	22	73	10	0
Nonindustrial combustion plants	84	25	63	46	955	32	3	0
Combustion in manufacturing industry	532	185	13	8	434	71	7	0
Production processes	65	11	84	4	257	17	8	11
Extraction and distribution of fossil fuels / geothermal energy	0	0	66	720	0	0	0	0
Solvent and other product use	0	0	346	0	0	0	0	0
Road transport	75	582	550	14	3,019	55	3	1
Other mobile sources and machinery	61	249	44	2	125	15	0	0
Waste treatment and disposal	35	17	56	718	347	9	1	0
Agriculture and forestry, land use and woodstock change	0	1	87	1,023	134	16	66	367
Nature	0	4,853	1	942	13	NA	118	0
Total	2,272	6,202	1,323	3,488	5,305	288	216	380
Comparable Total	2,272	1,348	1,235	2,546	5,292	272	97	380

Sweden	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	17	24	5	1	8	16	1	0
Nonindustrial combustion plants	7	10	0	0	6	9	0	0
Combustion in manufacturing industry	24	25	5	1	25	13	1	0
Production processes	16	14	37	0	5	1	3	0
Extraction and distribution of fossil fuels / geothermal energy	0	0	6	0	0	0	0	0
Solvent and other product use	0	0	167	0	0	1	0	0
Road transport	3	183	160	15	1,283	18	1	3
Other mobile sources and machinery	13	230	39	2	121	8	2	0
Waste treatment and disposal	2	3	0	44	5	31	0	0
Agriculture and forestry, land use and woodstock change	0	0	428	238	0	0	18	52
Nature	0	0	19	1,864	2	0	20	0
Total	82	490	868	2,165	1,455	96	46	56
Comparable Total	82	490	420	302	1,453	96	26	56

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: CORINAIR 94 Summary Report.[1]

Table 10-11. 1994 Emission Estimates for Switzerland and the United Kingdom by Source Category and Pollutant
(thousand short tons; except CO_2 [million short tons])

Switzerland	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	2	2	0	0	0	1	0	0
Nonindustrial combustion plants	15	15	2	4	69	18	0	0
Combustion in manufacturing industry	7	13	0	0	16	6	0	0
Production processes	4	0	15	1	12	3	0	0
Extraction and distribution of fossil fuels / geothermal energy	0	0	8	14	0	0	0	0
Solvent and other product use	0	0	130	0	0	0	0	0
Road transport	2	88	63	4	382	14	2	3
Other mobile sources and machinery	1	27	15	1	111	3	0	0
Waste treatment and disposal	3	7	5	78	13	2	0	4
Agriculture and forestry, land use and woodstock change	0	3	9	246	0	0	16	58
Nature	0	3	107	64	2	NA	5	0
Total	34	157	356	412	607	48	24	67
Comparable Total	34	154	240	348	605	48	19	66

United Kingdom	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Combustion in energy and transformation industries	2,118	646	119	13	277	218	9	0
Nonindustrial combustion plants	189	116	43	51	317	127	1	0
Combustion in manufacturing industry	414	170	11	7	58	95	1	0
Production processes	109	42	319	0	7	13	77	22
Extraction and distribution of fossil fuels / geothermal energy	2	120	365	894	52	0	NA	0
Solvent and other product use	NA	NA	730	NA	NA	NA	NA	NA
Road transport	69	1,255	839	28	4,929	122	7	NA
Other mobile sources and machinery	53	271	135	4	934	21	3	NA
Waste treatment and disposal	17	11	29	2,015	3	10	0	22
Agriculture and forestry, land use and woodstock change	0	0	44	1,230	0	1	11	309
Nature	0	0	44	0	0	0	0	0
Total	2,972	2,631	2,679	4,242	6,578	608	110	353
Comparable Total	2,972	2,631	2,591	4,242	6,578	606	110	353

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: CORINAIR 94 Summary Report.[1]

Table 10-12. 1994 Emissions for Canada by Major Source Category
(thousand short tons)

Source Category	CO	NO_x	VOC	SO_2	TP
Industrial Sources	1,463	515	938	2,109	928
Nonindustrial Fuel Combustion	774	334	266	673	321
Transportation	7,064	1,289	734	151	157
Incineration	775	61	125	8	45
Miscellaneous	944	1	914	0	67,839
Total	**11,021**	**2,199**	**2,977**	**2,941**	**69,290**

Note(s): Totals presented in this table may not equal the sum of the individual source categories due to rounding.

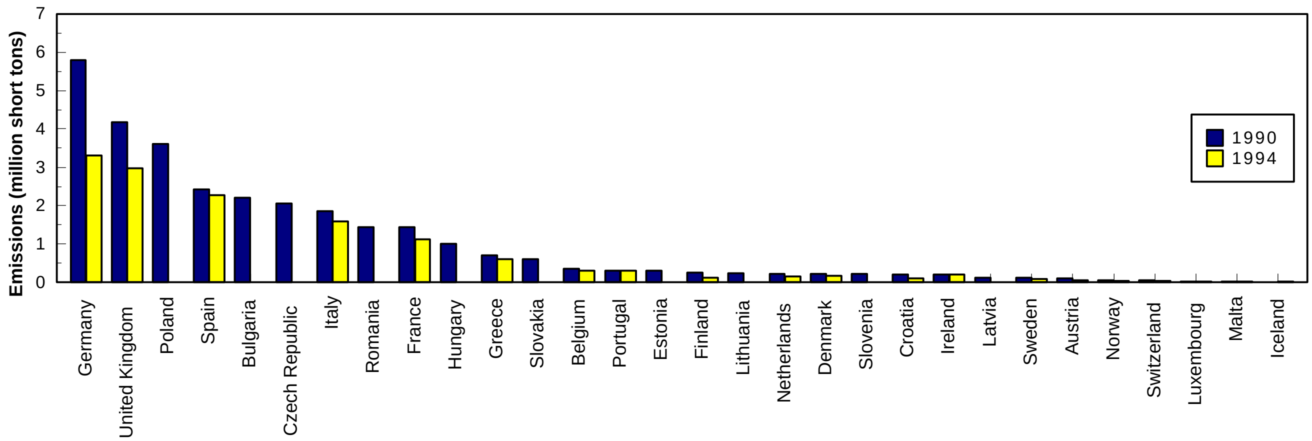
Source: Facsimile from Libby Greenwood.[2]

Table 10-13. 1994 Emissions for Canada by Province
(thousand short tons)

Source Category	CO	NOx	VOC	SO2	TP
Alberta	1,374	537	794	692	17,009
British Columbia	2,210	284	288	112	426
Manitoba	368	72	87	439	4,939
New Brunswick	245	73	41	149	1,551
Newfoundland	163	43	50	61	963
Northwest Territories	21	10	10	17	144
Nova Scotia	315	75	73	175	1,456
Ontario	3,500	598	922	696	18,860
Prince Edward Island	67	8	21	5	156
Quebec	2,098	305	426	482	11,028
Saskatchewan	644	187	264	113	12,332
Yukon	15	7	2	2	425
Total	**11,021**	**2,199**	**2,977**	**2,941**	**69,290**

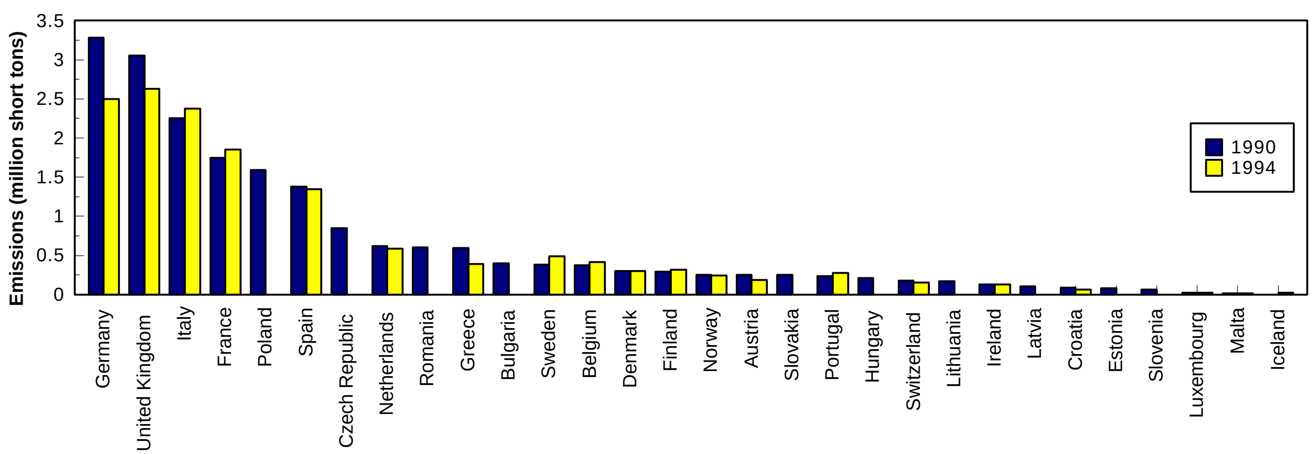
Source: Facsimile from Libby Greenwood.[2]

Figure 10-1. Comparison of European Total 1990 and 1994 Emissions by Country for Sulfur Dioxide



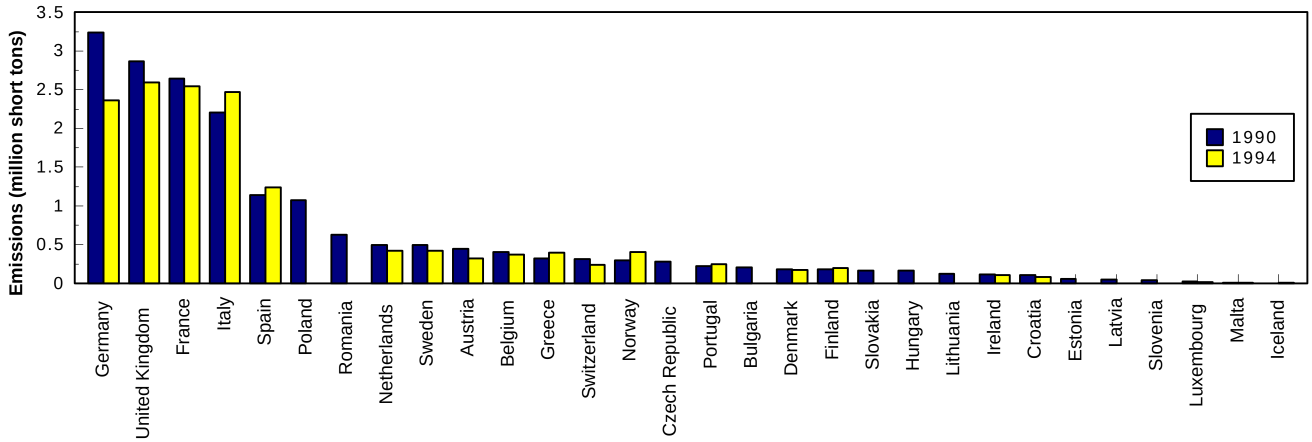
Source: CORINAIR 94 Summary Report[1]

Figure 10-2. Comparison of European Total 1990 and 1994 Emissions by Country for Nitrogen Oxides



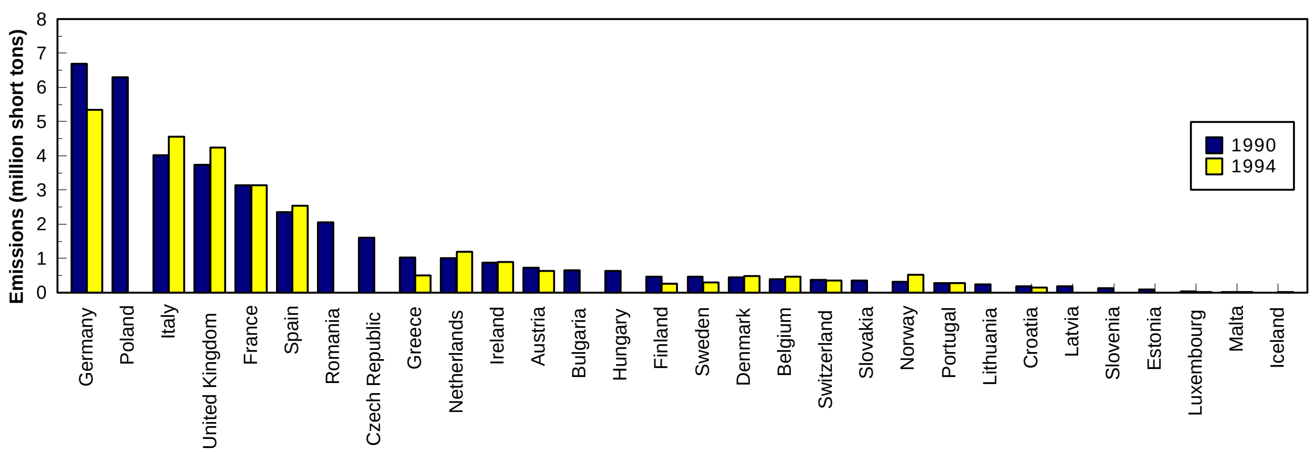
Source: CORINAIR 94 Summary Report[1]

Figure 10-3. Comparison of European Total 1990 and 1994 Emissions by Country for Nonmethane Volatile Organic Compounds



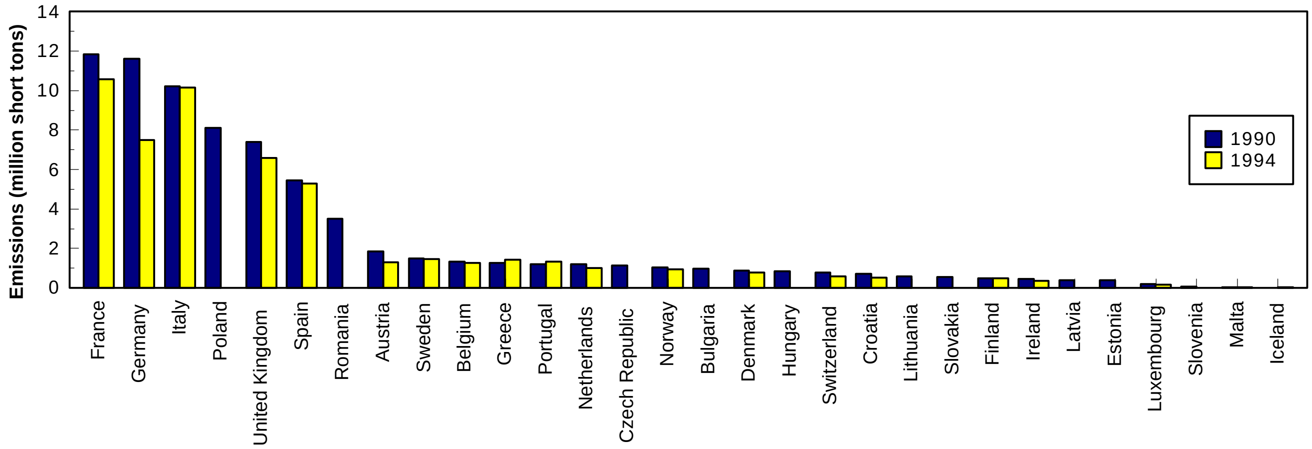
Source: CORINAIR 94 Summary Report[1]

Figure 10-4. Comparison of European Total 1990 and 1994 Emissions by Country for Methane



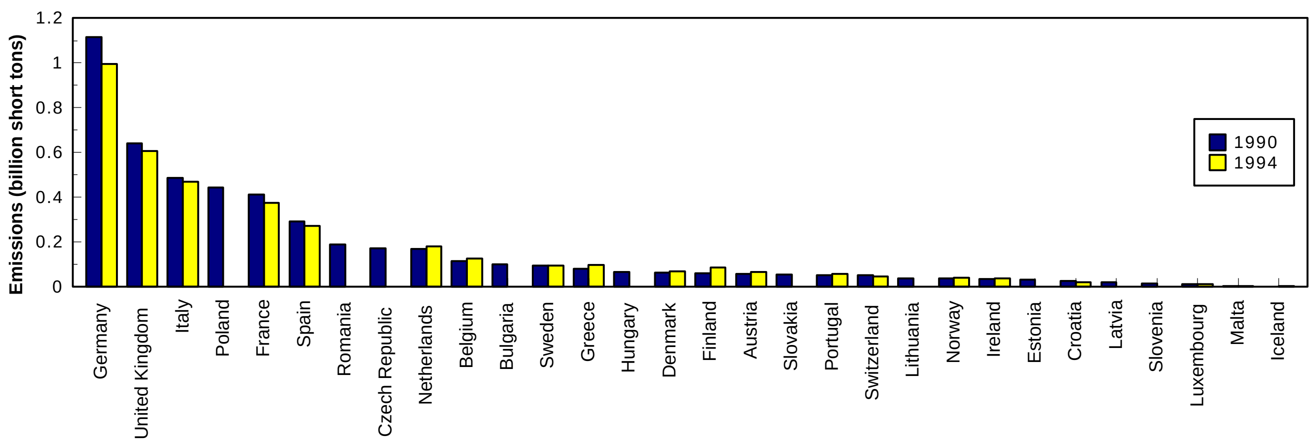
Source: CORINAIR 94 Summary Report[1]

Figure 10-5. Comparison of European Total 1990 and 1994 Emissions by Country for Carbon Monoxide



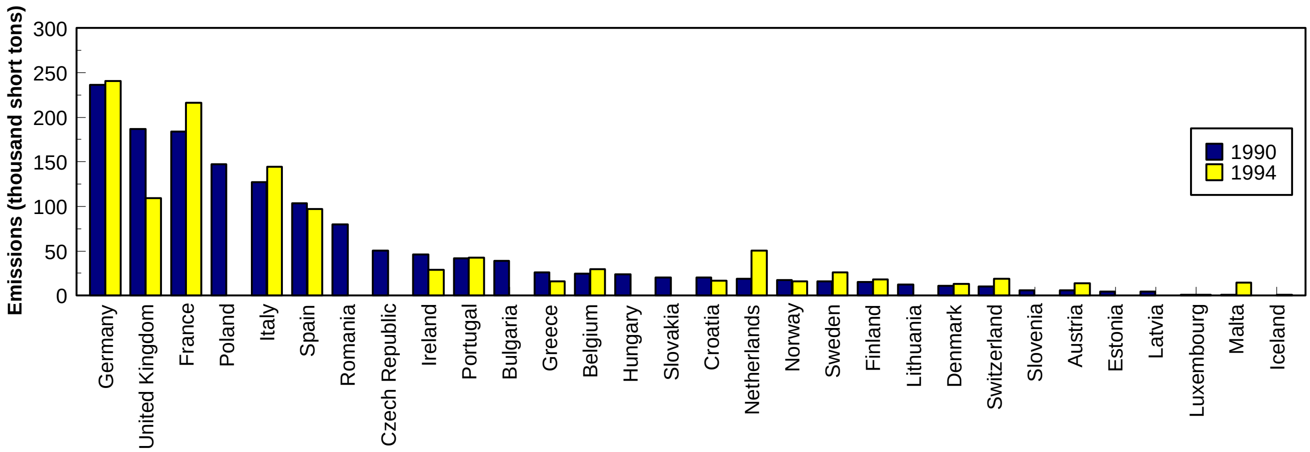
Source: CORINAIR 94 Summary Report[1]

Figure 10-6. Comparison of European Total 1990 and 1994 Emissions by Country for Carbon Dioxide



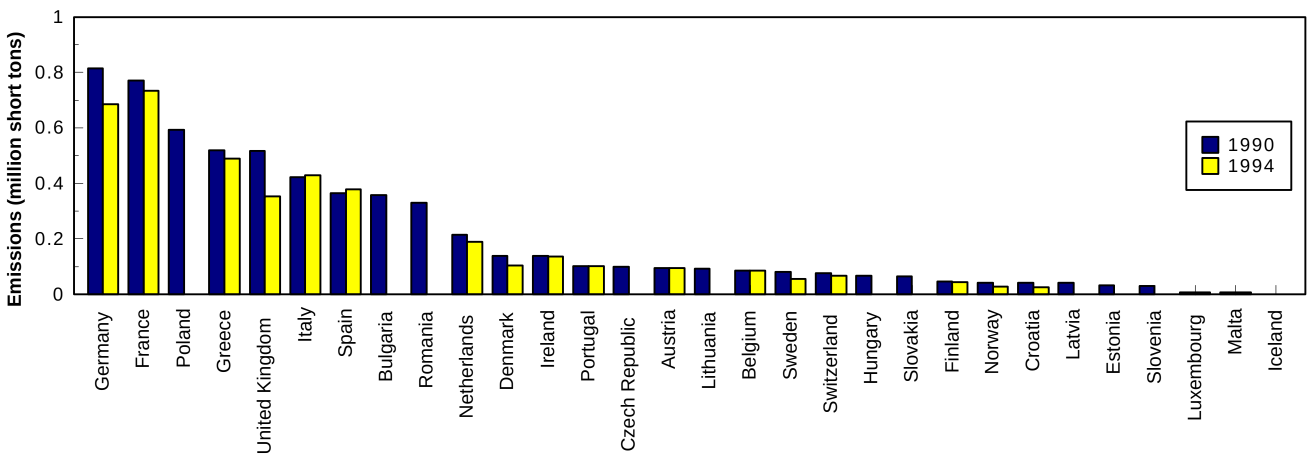
Source: CORINAIR 94 Summary Report[1]

Figure 10-7. Comparison of European Total 1990 and 1994 Emissions by Country for Nitrous Oxides



Source: CORINAIR 94 Summary Report[1]

Figure 10-8. Comparison of European Total 1990 and 1994 Emissions by Country for Ammonia



Source: CORINAIR 94 Summary Report[1]

Appendix A National Emissions (1970 to 1996) by Tier III Source Category and Pollutant

Table A-1. Carbon Monoxide Emissions (thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
FUEL COMB. ELEC. UTIL.	***237***	***276***	***322***	***295***	***296***	***307***	***320***	***327***	***363***	***349***	***350***	***363***	***370***	***372***	***377***
Coal	106	134	188	211	213	223	236	239	234	234	236	246	247	250	263
Oil	41	69	48	18	24	20	25	26	20	19	15	16	15	10	11
Gas	90	73	85	56	48	53	48	51	51	51	51	49	53	55	44
Internal Combustion	NA	NA	NA	10	11	10	11	11	57	45	47	51	55	58	59
FUEL COMB. INDUSTRIAL	***770***	***763***	***750***	***670***	***650***	***649***	***669***	***672***	***879***	***920***	***955***	***1,043***	***1,041***	***1,056***	***1,072***
Coal	100	67	58	86	87	85	87	87	105	101	102	101	100	98	99
Oil	44	49	35	47	46	46	46	46	74	60	64	66	66	71	72
Gas	462	463	418	257	242	252	265	271	226	284	300	322	337	345	348
Other	164	184	239	167	172	171	173	173	279	267	264	286	287	297	305
Internal Combustion	NA	NA	NA	113	103	96	98	96	195	208	227	268	251	245	247
FUEL COMB. OTHER	***3,625***	***3,441***	***6,230***	***7,525***	***6,607***	***6,011***	***6,390***	***6,450***	***4,269***	***4,587***	***4,849***	***4,181***	***4,108***	***4,506***	***4,513***
Commercial/Institutional Coal	12	17	13	14	14	14	15	15	14	14	15	15	15	15	15
Commercial/Institutional Oil	27	23	21	18	18	19	18	17	18	17	18	18	18	19	19
Commercial/Institutional Gas	24	25	26	42	42	43	47	49	44	44	51	53	54	54	54
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	57	60	59	55	55	149	141	141	143	147	145	163
Residential Wood	2,932	3,114	5,992	7,232	6,316	5,719	6,086	6,161	3,781	4,090	4,332	3,679	3,607	3,999	3,993
fireplaces	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
woodstoves	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Residential Other	630	262	178	162	157	157	168	153	262	281	292	274	268	273	269
CHEMICAL & ALLIED PRODUCT MFG	***3,397***	***2,204***	***2,151***	***1,845***	***1,853***	***1,798***	***1,917***	***1,925***	***1,183***	***1,127***	***1,112***	***1,093***	***1,171***	***1,223***	***1,223***
Organic Chemical Mfg	340	483	543	251	261	260	278	285	149	128	131	132	130	127	128
ethylene dichloride	*11*	*12*	*17*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
maleic anhydride	*73*	*147*	*103*	*16*	*16*	*15*	*16*	*16*	*3*	*3*	*4*	*4*	*4*	*4*	*4*
cyclohexanol	*36*	*39*	*37*	*5*	*5*	*5*	*6*	*6*	*0*	*0*	*0*	*0*	*1*	*1*	*1*
other	*220*	*286*	*386*	*230*	*240*	*240*	*256*	*264*	*146*	*125*	*127*	*128*	*125*	*123*	*123*
Inorganic Chemical Mfg	190	153	191	89	94	89	95	95	133	129	130	131	135	134	134
pigments; TiO2 chloride process: reactor	*18*	*22*	*34*	*77*	*82*	*77*	*83*	*84*	*119*	*119*	*119*	*119*	*119*	*119*	*119*
other	*172*	*131*	*157*	*12*	*12*	*11*	*12*	*12*	*14*	*11*	*12*	*13*	*16*	*15*	*15*
Polymer & Resin Mfg	NA	NA	NA	19	19	18	18	18	3	6	5	5	5	5	5
Agricultural Chemical Mfg	NA	NA	NA	16	16	16	17	17	44	19	19	18	17	17	17
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Pharmaceutical Mfg	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	2,866	1,567	1,417	1,471	1,463	1,415	1,509	1,510	854	844	827	805	885	939	939
carbon black mfg	*2,866*	*1,567*	*1,417*	*1,078*	*1,068*	*1,034*	*1,098*	*1,112*	*798*	*756*	*736*	*715*	*793*	*845*	*845*
carbon black furnace: fugitives	*NA*	*NA*	*NA*	*155*	*165*	*161*	*185*	*180*	*17*	*54*	*57*	*60*	*63*	*65*	*65*
other	*NA*	*NA*	*NA*	*238*	*231*	*219*	*226*	*219*	*39*	*35*	*34*	*30*	*30*	*29*	*29*

(continued)

Table A-1. Carbon Monoxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
METALS PROCESSING	***3,644***	***2,496***	***2,246***	***2,223***	***2,079***	***1,984***	***2,101***	***2,132***	***2,640***	***2,571***	***2,496***	***2,536***	***2,475***	***2,380***	***2,378***
Nonferrous Metals Processing	652	636	842	694	650	614	656	677	436	438	432	423	421	424	424
aluminum anode baking	*326*	*318*	*421*	*41*	*40*	*38*	*40*	*41*	*41*	*47*	*41*	*41*	*41*	*41*	*41*
prebake aluminum cell	*326*	*318*	*421*	*257*	*243*	*232*	*248*	*254*	*260*	*260*	*260*	*260*	*260*	*260*	*260*
other	*NA*	*NA*	*NA*	*396*	*367*	*344*	*368*	*382*	*135*	*131*	*131*	*122*	*120*	*123*	*123*
Ferrous Metals Processing	2,991	1,859	1,404	1,523	1,423	1,365	1,439	1,449	2,163	2,108	2,038	2,089	2,029	1,930	1,929
basic oxygen furnace	*440*	*125*	*80*	*694*	*640*	*617*	*650*	*662*	*594*	*731*	*767*	*768*	*677*	*561*	*561*
carbon steel electric arc furnace	*181*	*204*	*280*	*19*	*17*	*17*	*18*	*18*	*45*	*54*	*49*	*58*	*61*	*65*	*65*
coke oven charging	*62*	*53*	*43*	*9*	*9*	*8*	*9*	*9*	*14*	*16*	*17*	*7*	*7*	*8*	*8*
gray iron cupola	*1,203*	*649*	*340*	*302*	*294*	*281*	*288*	*280*	*124*	*118*	*114*	*121*	*128*	*120*	*118*
iron ore sinter plant windbox	*1,025*	*759*	*600*	*304*	*280*	*266*	*287*	*293*	*211*	*211*	*211*	*211*	*211*	*211*	*211*
other	*81*	*70*	*61*	*194*	*184*	*176*	*188*	*187*	*1,174*	*979*	*880*	*924*	*945*	*966*	*966*
Metals Processing NEC	NA	NA	NA	6	6	6	6	6	40	25	26	25	25	25	25
PETROLEUM & RELATED INDUSTRIES	***2,179***	***2,211***	***1,723***	***462***	***451***	***455***	***441***	***436***	***333***	***345***	***371***	***371***	***338***	***348***	***348***
Oil & Gas Production	NA	NA	NA	11	9	8	8	8	38	18	21	22	35	34	34
Petroleum Refineries & Related Industries	2,168	2,211	1,723	449	440	445	431	427	291	324	345	344	299	309	308
fcc units	*1,820*	*2,032*	*1,680*	*403*	*398*	*408*	*393*	*390*	*284*	*315*	*333*	*328*	*286*	*299*	*299*
other	*348*	*179*	*44*	*46*	*41*	*37*	*38*	*37*	*7*	*9*	*13*	*17*	*13*	*10*	*10*
Asphalt Manufacturing	11	NA	NA	2	2	2	2	2	3	4	5	5	5	5	5
OTHER INDUSTRIAL PROCESSES	***620***	***630***	***830***	***694***	***715***	***713***	***711***	***716***	***537***	***548***	***544***	***594***	***600***	***624***	***635***
Agriculture, Food, & Kindred Products	NA	NA	NA	0	0	0	0	0	3	3	3	3	2	6	7
Textiles, Leather, & Apparel Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	610	602	798	627	647	646	649	655	473	461	449	453	461	484	494
sulfate pulping: rec. furnace/evaporator	*NA*	*NA*	*NA*	*475*	*491*	*489*	*491*	*497*	*370*	*360*	*348*	*350*	*355*	*370*	*377*
sulfate (kraft) pulping: lime kiln	*610*	*602*	*798*	*140*	*145*	*144*	*145*	*146*	*87*	*81*	*75*	*78*	*76*	*82*	*84*
other	*NA*	*NA*	*NA*	*12*	*12*	*13*	*13*	*13*	*16*	*21*	*25*	*24*	*30*	*32*	*33*
Rubber & Miscellaneous Plastic Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Mineral Products	10	27	32	43	44	44	44	43	54	77	85	131	131	127	129
Machinery Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Equipment	NA	NA	NA	18	18	18	13	12	2	2	2	2	2	2	2
Transportation Equipment	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	6	5	5	5	5	5	5	6	4	4	4	4
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***2***	***2***	***2***	***2***	***2***	***5***	***5***	***5***	***5***	***5***	***6***	***6***
Degreasing	NA	NA	NA	1	1	1	1	1	0	0	0	0	0	0	0
Graphic Arts	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	1	1	1
Surface Coating	NA	NA	NA	0	0	0	1	1	0	1	1	1	1	1	1
Other Industrial	NA	NA	NA	0	0	0	0	0	4	4	4	4	4	4	4
Nonindustrial	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0

(continued)

Table A-1. Carbon Monoxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***49***	***51***	***50***	***56***	***55***	***76***	***28***	***17***	***51***	***24***	***25***	***25***
Bulk Terminals & Plants	NA	NA	NA	0	0	0	0	0	0	2	0	4	4	4	4
Petroleum & Petroleum Product Storage	NA	NA	NA	0	0	0	0	0	0	12	0	32	4	4	4
Petroleum & Petroleum Product Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Service Stations: Stage II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
Organic Chemical Storage	NA	NA	NA	42	45	44	51	49	74	13	13	13	13	13	13
Organic Chemical Transport	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Inorganic Chemical Storage	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Inorganic Chemical Transport	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	6	5	5	5	5	1	1	3	2	3	3	3
WASTE DISPOSAL & RECYCLING	***7,059***	***3,230***	***2,300***	***1,941***	***1,916***	***1,850***	***1,806***	***1,747***	***1,079***	***1,116***	***1,138***	***1,248***	***1,225***	***1,185***	***1,203***
Incineration	2,979	1,764	1,246	958	949	920	903	876	372	392	404	497	467	432	443
conical wood burner	*1,431*	*579*	*228*	*17*	*18*	*18*	*19*	*19*	*6*	*7*	*6*	*6*	*6*	*6*	*6*
municipal incinerator	*333*	*23*	*13*	*34*	*35*	*34*	*35*	*35*	*16*	*17*	*15*	*14*	*14*	*15*	*15*
industrial	*NA*	*NA*	*NA*	*9*	*9*	*9*	*10*	*9*	*9*	*10*	*10*	*87*	*48*	*10*	*10*
commmercial/institutional	*108*	*68*	*60*	*32*	*33*	*35*	*38*	*39*	*19*	*20*	*21*	*21*	*21*	*21*	*22*
residential	*1,107*	*1,094*	*945*	*865*	*852*	*822*	*800*	*773*	*294*	*312*	*324*	*340*	*347*	*351*	*360*
other	*NA*	*NA*	*NA*	*2*	*2*	*2*	*2*	*2*	*27*	*26*	*28*	*29*	*30*	*29*	*30*
Open Burning	4,080	1,466	1,054	982	966	930	903	870	706	722	731	749	755	750	757
industrial	*1,932*	*1,254*	*1,007*	*20*	*21*	*21*	*21*	*21*	*14*	*14*	*15*	*15*	*15*	*15*	*16*
commmercial/institutional	*2,148*	*212*	*47*	*4*	*4*	*4*	*4*	*5*	*46*	*48*	*50*	*52*	*54*	*52*	*53*
residential	*NA*	*NA*	*NA*	*958*	*941*	*905*	*877*	*845*	*509*	*516*	*523*	*529*	*533*	*536*	*539*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*137*	*144*	*144*	*153*	*153*	*147*	*149*
POTW	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Industrial Waste Water	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
TSDF	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Landfills	NA	NA	NA	0	0	0	0	0	1	1	2	2	2	2	2
Other	NA	NA	NA	0	0	0	0	0	0	0	0	1	1	1	1
ON-ROAD VEHICLES	***88,034***	***83,134***	***78,049***	***77,387***	***73,347***	***71,250***	***71,081***	***66,050***	***57,848***	***62,074***	***59,859***	***60,202***	***61,833***	***54,106***	***52,944***
Light-Duty Gas Vehicles & Motorcycles	64,031	59,281	53,561	49,451	46,698	45,340	45,553	42,234	37,407	40,267	39,370	39,163	37,507	33,701	33,144
light-duty gas vehicles	*63,846*	*59,061*	*53,342*	*49,273*	*46,522*	*45,161*	*45,367*	*42,047*	*37,198*	*40,089*	*39,190*	*38,973*	*37,312*	*33,500*	*32,940*
motorcycles	*185*	*220*	*219*	*178*	*175*	*179*	*186*	*187*	*209*	*177*	*180*	*190*	*195*	*200*	*204*
Light-Duty Gas Trucks	16,570	15,767	16,137	18,960	17,789	17,274	17,133	15,940	13,816	15,014	14,567	15,196	17,350	14,829	14,746
light-duty gas trucks 1	*10,102*	*9,611*	*10,395*	*11,834*	*10,795*	*10,187*	*9,890*	*9,034*	*8,415*	*8,450*	*8,161*	*8,430*	*9,534*	*8,415*	*8,377*
light-duty gas trucks 2	*6,468*	*6,156*	*5,742*	*7,126*	*6,995*	*7,087*	*7,244*	*6,906*	*5,402*	*6,565*	*6,407*	*6,766*	*7,815*	*6,414*	*6,368*
Heavy-Duty Gas Vehicles	6,712	7,140	7,189	7,716	7,601	7,347	7,072	6,506	5,360	5,459	4,569	4,476	5,525	4,123	3,601
Diesels	721	945	1,161	1,261	1,259	1,289	1,322	1,369	1,265	1,334	1,352	1,367	1,451	1,453	1,453
heavy-duty diesel vehicles	*721*	*915*	*1,139*	*1,235*	*1,232*	*1,260*	*1,290*	*1,336*	*1,229*	*1,298*	*1,315*	*1,328*	*1,411*	*1,412*	*1,411*
light-duty diesel trucks	*NA*	*NA*	*4*	*4*	*4*	*5*	*5*	*6*	*5*	*6*	*6*	*7*	*8*	*8*	*8*
light-duty diesel vehicles	*NA*	*30*	*19*	*22*	*23*	*24*	*26*	*28*	*31*	*30*	*31*	*33*	*32*	*33*	*34*

(continued)

Table A-1. Carbon Monoxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
NON-ROAD ENGINES AND VEHICLES	***11,287***	***12,321***	***13,758***	***14,626***	***15,184***	***14,959***	***15,780***	***15,781***	***16,117***	***16,040***	***16,374***	***16,592***	***16,873***	***16,841***	***17,002***
Non-Road Gasoline	9,478	10,145	11,004	11,815	12,057	12,286	12,465	12,538	13,090	13,067	13,307	13,457	13,640	13,806	13,937
recreational	*268*	*283*	*299*	*312*	*314*	*316*	*318*	*321*	*355*	*361*	*366*	*371*	*374*	*382*	*386*
construction	*250*	*274*	*368*	*421*	*416*	*402*	*401*	*398*	*351*	*326*	*331*	*345*	*378*	*393*	*400*
industrial	*732*	*803*	*970*	*1,104*	*1,137*	*1,164*	*1,207*	*1,227*	*1,373*	*1,337*	*1,360*	*1,357*	*1,389*	*1,436*	*1,446*
lawn & garden	*4,679*	*5,017*	*5,366*	*5,685*	*5,749*	*5,808*	*5,866*	*5,929*	*6,438*	*6,533*	*6,616*	*6,701*	*6,753*	*6,895*	*6,949*
farm	*46*	*60*	*77*	*84*	*85*	*47*	*92*	*63*	*211*	*168*	*197*	*207*	*173*	*145*	*150*
light commercial	*2,437*	*2,554*	*2,680*	*2,894*	*3,028*	*3,203*	*3,219*	*3,223*	*2,404*	*2,361*	*2,428*	*2,447*	*2,525*	*2,621*	*2,658*
logging	*9*	*21*	*25*	*28*	*27*	*33*	*31*	*33*	*32*	*33*	*34*	*34*	*36*	*40*	*41*
airport service	*80*	*94*	*116*	*129*	*133*	*137*	*144*	*147*	*114*	*113*	*117*	*118*	*120*	*129*	*131*
recreational marine vessels	*976*	*1,037*	*1,102*	*1,157*	*1,167*	*1,175*	*1,185*	*1,195*	*1,681*	*1,703*	*1,722*	*1,739*	*1,751*	*1,763*	*1,775*
other	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*2*	*131*	*134*	*136*	*139*	*141*	*2*	*2*
Non-Road Diesel	1,225	1,481	1,879	1,830	2,113	1,625	2,210	2,108	1,919	1,877	1,956	2,030	2,121	1,897	1,922
recreational	*2*	*3*	*3*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*5*	*5*	*5*	*5*	*5*
construction	*478*	*516*	*682*	*761*	*786*	*766*	*767*	*788*	*777*	*734*	*771*	*825*	*885*	*768*	*775*
industrial	*72*	*78*	*94*	*119*	*110*	*113*	*117*	*107*	*122*	*118*	*122*	*127*	*133*	*127*	*129*
lawn & garden	*28*	*30*	*33*	*36*	*35*	*36*	*36*	*35*	*38*	*39*	*39*	*40*	*40*	*40*	*40*
farm	*577*	*771*	*972*	*792*	*1,073*	*594*	*1,172*	*1,073*	*857*	*862*	*898*	*908*	*927*	*830*	*843*
light commercial	*41*	*43*	*45*	*54*	*51*	*54*	*54*	*49*	*56*	*55*	*57*	*59*	*61*	*59*	*60*
logging	*7*	*17*	*21*	*27*	*21*	*25*	*24*	*22*	*27*	*26*	*27*	*28*	*29*	*29*	*30*
airport service	*19*	*23*	*28*	*36*	*32*	*33*	*35*	*31*	*38*	*38*	*38*	*40*	*41*	*39*	*40*
Aircraft	506	600	743	831	858	887	931	955	904	888	901	905	915	942	949
Marine Vessels	14	17	37	44	47	50	56	59	83	87	85	81	82	82	82
coal	*2*	*2*	*4*	*5*	*5*	*6*	*6*	*7*	*4*	*4*	*4*	*4*	*5*	*4*	*4*
diesel	*12*	*14*	*32*	*39*	*41*	*44*	*48*	*52*	*46*	*47*	*45*	*43*	*44*	*44*	*44*
residual oil	*0*	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*7*	*7*	*7*	*7*	*7*	*6*	*6*
gasoline	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*24*	*27*	*27*	*25*	*25*	*26*	*26*
Railroads	65	77	96	106	109	112	118	121	121	120	125	120	114	114	112

(continued)

Table A-1. Carbon Monoxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
MISCELLANEOUS	***7,909***	***5,263***	***8,344***	***7,927***	***7,286***	***8,852***	***15,895***	***8,153***	***11,208***	***8,751***	***7,052***	***7,013***	***9,614***	***7,050***	***7,099***
Other Combustion	7,909	5,263	*8,344*	7,927	7,286	8,852	15,895	8,153	11,207	8,751	7,052	7,013	9,613	7,049	7,098
structural fires	*101*	*258*	*217*	*242*	*242*	*242*	*242*	*242*	*164*	*166*	*168*	*169*	*170*	*171*	*172*
agricultural fires	*873*	*539*	*501*	*396*	*441*	*483*	*612*	*571*	*415*	*413*	*421*	*415*	*441*	*465*	*475*
slash/prescribed burning	*1,146*	*2,268*	*2,226*	*4,332*	*4,332*	*4,332*	*4,332*	*4,332*	*4,668*	*4,713*	*4,760*	*4,810*	*4,860*	*4,916*	*4,955*
forest wildfires	*5,620*	*2,165*	*5,396*	*2,957*	*2,271*	*3,795*	*10,709*	*3,009*	*5,928*	*3,430*	*1,674*	*1,586*	*4,114*	*1,469*	*1,469*
other	*169*	*34*	*4*	*NA*	*NA*	*NA*	*NA*	*NA*	*32*	*28*	*30*	*34*	*28*	*28*	*27*
Health Services	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	0	NA	NA	NA	NA	NA	NA
Cooling Towers	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	NA	0	0	NA	0	0	0
Fugitive Dust	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	0	0	0	0	0	0	0
TOTAL ALL SOURCES	**128,761**	**115,968**	**116,702**	**115,644**	**110,437**	**108,879**	**117,169**	**104,447**	**96,535**	**98,461**	**95,123**	**95,291**	**99,677**	**89,721**	**88,822**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-2. Nitrogen Oxide Emissions
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
FUEL COMB. ELEC. UTIL.	***4,900***	***5,694***	***7,024***	***6,127***	***6,111***	***6,246***	***6,545***	***6,593***	***6,663***	***6,519***	***6,504***	***6,651***	***6,565***	***6,384***	***6,034***
Coal	3,888	4,828	6,123	5,240	5,239	5,376	5,666	5,676	5,642	5,559	5,579	5,744	5,636	5,579	5,517
bituminous	*2,112*	*2,590*	*3,439*	*4,378*	*4,387*	*4,465*	*4,542*	*4,595*	*4,532*	*4,435*	*4,456*	*4,403*	*4,207*	*3,830*	*3,813*
subbituminous	*1,041*	*1,276*	*1,694*	*668*	*635*	*702*	*867*	*837*	*857*	*874*	*868*	*1,087*	*1,167*	*1,475*	*1,447*
anthracite & lignite	*344*	*414*	*542*	*194*	*218*	*209*	*256*	*245*	*254*	*250*	*255*	*255*	*262*	*273*	*258*
other	*391*	*548*	*447*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Oil	1,012	866	901	193	263	217	273	285	221	212	170	180	163	96	96
residual	*40*	*101*	*39*	*178*	*247*	*201*	*256*	*268*	*207*	*198*	*158*	*166*	*149*	*94*	*94*
distillate	*972*	*765*	*862*	*15*	*16*	*16*	*16*	*17*	*14*	*14*	*13*	*14*	*14*	*2*	*2*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*0*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Gas	NA	NA	NA	646	559	605	557	582	565	580	579	551	591	562	269
natural	*NA*	*NA*	*NA*	*646*	*559*	*605*	*557*	*582*	*565*	*580*	*579*	*551*	*591*	*562*	*269*
Internal Combustion	NA	NA	NA	48	50	48	50	49	235	168	175	176	175	148	151
FUEL COMB. INDUSTRIAL	***4,325***	***4,007***	***3,555***	***3,209***	***3,065***	***3,063***	***3,187***	***3,209***	***3,035***	***2,979***	***3,071***	***3,151***	***3,147***	***3,144***	***3,170***
Coal	771	520	444	608	613	596	617	615	585	570	574	589	602	597	599
bituminous	*532*	*359*	*306*	*430*	*439*	*435*	*447*	*446*	*399*	*387*	*405*	*413*	*420*	*412*	*411*
subbituminous	*164*	*111*	*94*	*14*	*14*	*14*	*15*	*14*	*18*	*20*	*21*	*28*	*38*	*46*	*47*
anthracite & lignite	*75*	*51*	*44*	*33*	*31*	*27*	*29*	*30*	*26*	*26*	*26*	*26*	*27*	*26*	*26*
other	*NA*	*NA*	*NA*	*131*	*129*	*119*	*126*	*124*	*141*	*137*	*122*	*122*	*117*	*112*	*114*
Oil	332	354	286	309	300	292	296	294	265	237	244	245	241	247	246
residual	*228*	*186*	*179*	*191*	*181*	*172*	*175*	*176*	*180*	*146*	*154*	*153*	*149*	*156*	*157*
distillate	*104*	*112*	*63*	*89*	*89*	*89*	*91*	*88*	*71*	*73*	*73*	*75*	*76*	*73*	*72*
other	*NA*	*56*	*44*	*29*	*30*	*31*	*31*	*29*	*14*	*18*	*17*	*17*	*17*	*17*	*17*
Gas	3,060	2,983	2,619	1,520	1,433	1,505	1,584	1,625	1,182	1,250	1,301	1,330	1,333	1,324	1,336
natural	*3,053*	*2,837*	*2,469*	*1,282*	*1,206*	*1,285*	*1,360*	*1,405*	*967*	*1,025*	*1,068*	*1,095*	*1,103*	*1,102*	*1,114*
process	*8*	*5*	*5*	*227*	*216*	*210*	*214*	*209*	*211*	*222*	*230*	*233*	*228*	*220*	*220*
other	*NA*	*140*	*145*	*11*	*10*	*10*	*10*	*10*	*3*	*3*	*3*	*2*	*2*	*2*	*2*
Other	162	149	205	118	120	119	121	120	131	129	126	124	124	123	125
wood/bark waste	*102*	*108*	*138*	*89*	*92*	*92*	*93*	*92*	*89*	*82*	*82*	*83*	*83*	*84*	*85*
liquid waste	*NA*	*NA*	*NA*	*12*	*12*	*12*	*12*	*12*	*8*	*11*	*10*	*11*	*11*	*11*	*11*
other	*60*	*41*	*67*	*17*	*16*	*15*	*16*	*16*	*34*	*36*	*34*	*30*	*30*	*28*	*28*
Internal Combustion	NA	NA	NA	655	599	552	569	556	874	793	825	863	846	854	864
FUEL COMB. OTHER	***836***	***785***	***741***	***712***	***694***	***706***	***740***	***736***	***1,196***	***1,281***	***1,353***	***1,308***	***1,303***	***1,298***	***1,289***
Commercial/Institutional Coal	23	33	25	37	36	37	39	38	40	36	38	40	40	38	38
Commercial/Institutional Oil	210	176	155	106	110	121	117	106	97	88	93	93	95	103	102

(continued)

Table A-2. Nitrogen Oxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
FUEL COMB. OTHER (continued)															
Commercial/Institutional Gas	120	125	131	145	139	144	157	159	200	210	225	232	237	231	234
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	11	12	11	11	11	34	32	28	31	31	30	29
Residential Wood	44	39	74	88	77	69	74	75	46	50	53	45	44	49	48
Residential Other	439	412	356	326	320	323	343	347	780	865	916	867	857	847	838
distillate oil	*118*	*113*	*85*	*75*	*76*	*79*	*80*	*78*	*209*	*211*	*210*	*210*	*210*	*210*	*209*
natural gas	*242*	*246*	*238*	*248*	*241*	*241*	*259*	*267*	*449*	*469*	*489*	*513*	*516*	*519*	*523*
other	*79*	*54*	*33*	*3*	*3*	*3*	*3*	*3*	*121*	*185*	*218*	*144*	*131*	*118*	*106*
CHEMICAL & ALLIED PRODUCT MFG	***271***	***238***	***216***	***262***	***264***	***255***	***274***	***273***	***168***	***165***	***163***	***155***	***160***	***158***	***159***
Organic Chemical Mfg	70	53	54	37	38	38	42	42	18	22	22	19	20	20	20
Inorganic Chemical Mfg	201	168	159	22	19	17	18	18	12	12	10	5	6	7	7
Polymer & Resin Mfg	NA	NA	NA	22	22	22	23	23	6	6	6	5	5	4	4
Agricultural Chemical Mfg	NA	NA	NA	143	145	141	151	152	80	77	76	74	76	74	74
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Pharmaceutical Mfg	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	NA	NA	NA	38	38	37	40	39	52	48	50	51	54	54	54
METALS PROCESSING	***77***	***73***	***65***	***87***	***80***	***75***	***82***	***83***	***97***	***76***	***81***	***83***	***91***	***98***	***98***
Nonferrous Metals Processing	NA	NA	NA	16	15	14	15	15	14	15	13	12	12	12	12
Ferrous Metals Processing	77	73	65	58	53	48	53	54	78	56	62	67	75	83	83
Metals Processing NEC	NA	NA	NA	13	13	13	13	14	6	5	6	4	4	4	4
PETROLEUM & RELATED INDUSTRIES	***240***	***63***	***72***	***124***	***109***	***101***	***100***	***97***	***153***	***121***	***148***	***123***	***117***	***110***	***110***
Oil & Gas Production	NA	NA	NA	69	55	48	48	47	104	65	68	70	63	58	58
Petroleum Refineries & Related Industries	240	63	72	55	53	52	51	49	47	52	76	49	49	48	48
Asphalt Manufacturing	NA	NA	NA	1	1	1	1	1	3	4	4	5	5	5	5
OTHER INDUSTRIAL PROCESSES	***187***	***182***	***205***	***327***	***328***	***320***	***315***	***311***	***378***	***352***	***361***	***370***	***389***	***399***	***403***
Agriculture, Food, & Kindred Products	NA	NA	NA	5	5	5	5	5	3	3	3	4	3	6	6
Textiles, Leather, & Apparel Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	18	18	24	73	76	76	76	77	91	88	86	86	89	89	90
Rubber & Miscellaneous Plastic Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Mineral Products	169	164	181	239	238	230	225	220	270	249	259	267	281	287	290
cement mfg	*97*	*89*	*98*	*137*	*136*	*130*	*126*	*124*	*151*	*131*	*139*	*143*	*150*	*153*	*155*
glass mfg	*48*	*53*	*60*	*48*	*48*	*47*	*46*	*45*	*59*	*59*	*61*	*64*	*66*	*67*	*68*
other	*24*	*23*	*23*	*54*	*54*	*53*	*53*	*51*	*61*	*59*	*60*	*60*	*64*	*66*	*67*

(continued)

Table A-2. Nitrogen Oxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
OTHER INDUSTRIAL PROCESSES (continued)															
Machinery Products	NA	NA	NA	2	2	2	2	2	3	2	2	3	6	7	7
Electronic Equipment	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Transportation Equipment	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	8	8	7	7	7	10	10	10	9	9	10	10
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***2***	***3***	***3***	***3***	***3***	***1***	***2***	***3***	***3***	***3***	***3***	***3***
Degreasing	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	NA	0	0	0	0	0	0	1	1	1	1	1	1
Dry Cleaning	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Surface Coating	NA	NA	NA	2	2	2	2	2	1	2	2	2	2	2	2
Other Industrial	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Nonindustrial	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Solvent Utilization NEC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***2***	***2***	***2***	***2***	***2***	***3***	***6***	***5***	***5***	***5***	***6***	***6***
Bulk Terminals & Plants	NA	NA	NA	NA	NA	NA	NA	NA	0	1	1	1	1	1	1
Petroleum & Petroleum Product Storage	NA	NA	NA	1	1	1	1	1	2	2	0	0	0	0	0
Petroleum & Petroleum Product Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Service Stations: Stage II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
Organic Chemical Storage	NA	NA	NA	1	1	1	1	1	0	2	3	3	3	4	4
Organic Chemical Transport	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Inorganic Chemical Storage	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Inorganic Chemical Transport	NA	NA	NA	NA	NA	NA	NA	NA	1	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	0	0	0	1	1	0	0	0	0	0	1	1
WASTE DISPOSAL & RECYCLING	***440***	***159***	***111***	***87***	***87***	***85***	***85***	***84***	***91***	***95***	***96***	***123***	***114***	***99***	***100***
Incineration	110	56	37	27	29	29	31	31	49	51	51	74	65	53	54
Open Burning	330	103	74	59	58	56	54	52	42	43	43	44	44	44	45
POTW	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Industrial Waste Water	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
TSDF	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Landfills	NA	NA	NA	0	0	0	0	0	0	0	1	1	1	1	1
Other	NA	NA	NA	0	0	0	0	0	0	1	1	4	3	1	1

(continued)

Table A-2. Nitrogen Oxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
ON-ROAD VEHICLES	***7,390***	***8,645***	***8,621***	***8,089***	***7,773***	***7,651***	***7,661***	***7,682***	***7,040***	***7,373***	***7,440***	***7,510***	***7,672***	***7,323***	***7,171***
Light-Duty Gas Vehicles & Motorcycles	4,158	4,725	4,421	3,806	3,602	3,492	3,500	3,494	3,220	3,464	3,614	3,680	3,573	3,444	3,403
light-duty gas vehicles	*4,156*	*4,722*	*4,416*	*3,797*	*3,592*	*3,482*	*3,489*	*3,483*	*3,208*	*3,453*	*3,602*	*3,668*	*3,560*	*3,431*	*3,389*
motorcycles	*2*	*3*	*5*	*9*	*10*	*10*	*11*	*11*	*12*	*11*	*12*	*12*	*13*	*13*	*13*
Light-Duty Gas Trucks	1,278	1,461	1,408	1,530	1,457	1,436	1,419	1,386	1,256	1,339	1,356	1,420	1,657	1,520	1,510
light-duty gas trucks 1	*725*	*819*	*864*	*926*	*867*	*842*	*824*	*803*	*784*	*782*	*792*	*828*	*960*	*902*	*891*
light-duty gas trucks 2	*553*	*642*	*544*	*603*	*590*	*594*	*595*	*584*	*472*	*557*	*564*	*592*	*697*	*617*	*619*
Heavy-Duty Gas Vehicles	278	319	300	330	332	332	336	343	326	326	308	315	351	332	326
Diesels	1,676	2,141	2,493	2,423	2,383	2,390	2,406	2,458	2,238	2,244	2,163	2,094	2,091	2,028	1,933
heavy-duty diesel vehicles	*1,676*	*2,118*	*2,463*	*2,389*	*2,347*	*2,352*	*2,366*	*2,416*	*2,192*	*2,199*	*2,116*	*2,047*	*2,043*	*1,979*	*1,884*
light-duty diesel trucks	*NA*	*NA*	*5*	*6*	*6*	*6*	*7*	*7*	*7*	*8*	*8*	*8*	*10*	*10*	*10*
light-duty diesel vehicles	*NA*	*23*	*25*	*28*	*29*	*31*	*33*	*35*	*39*	*37*	*39*	*39*	*38*	*39*	*39*
NON-ROAD ENGINES AND VEHICLES	***2,642***	***3,141***	***4,017***	***4,150***	***4,555***	***3,947***	***4,806***	***4,693***	***4,593***	***4,518***	***4,658***	***4,776***	***4,944***	***4,675***	***4,610***
Non-Road Gasoline	81	88	102	113	116	118	122	123	199	195	197	197	199	206	207
recreational	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*6*	*6*	*6*	*6*	*6*	*6*	*6*
construction	*2*	*2*	*3*	*4*	*3*	*3*	*3*	*3*	*4*	*4*	*4*	*4*	*4*	*5*	*5*
industrial	*46*	*51*	*61*	*70*	*72*	*74*	*76*	*78*	*112*	*108*	*109*	*108*	*109*	*121*	*122*
lawn & garden	*5*	*6*	*6*	*6*	*6*	*6*	*7*	*7*	*16*	*16*	*16*	*17*	*17*	*17*	*18*
farm	*0*	*1*	*1*	*1*	*1*	*0*	*1*	*1*	*6*	*4*	*5*	*5*	*5*	*4*	*4*
light commercial	*3*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*5*	*5*	*5*	*5*	*5*	*6*	*6*
logging	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
airport service	*2*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*2*	*2*	*2*	*3*	*3*
recreational marine vessels	*16*	*17*	*18*	*19*	*19*	*19*	*19*	*19*	*30*	*30*	*31*	*31*	*31*	*42*	*42*
other	*6*	*6*	*6*	*7*	*7*	*7*	*7*	*7*	*18*	*19*	*19*	*19*	*19*	*2*	*2*
Non-Road Diesel	1,954	2,329	2,969	2,978	3,347	2,700	3,489	3,334	3,079	2,998	3,126	3,255	3,412	3,087	3,088
recreational	*5*	*5*	*6*	*7*	*7*	*7*	*7*	*7*	*11*	*11*	*11*	*11*	*11*	*8*	*8*
construction	*864*	*933*	*1,232*	*1,377*	*1,419*	*1,384*	*1,385*	*1,422*	*1,394*	*1,315*	*1,381*	*1,478*	*1,587*	*1,390*	*1,386*
industrial	*147*	*160*	*193*	*244*	*226*	*231*	*240*	*219*	*244*	*237*	*245*	*255*	*267*	*260*	*263*
lawn & garden	*45*	*48*	*52*	*58*	*56*	*57*	*58*	*56*	*61*	*61*	*62*	*63*	*64*	*63*	*64*
farm	*766*	*1,018*	*1,295*	*1,055*	*1,430*	*794*	*1,570*	*1,426*	*1,128*	*1,136*	*1,183*	*1,196*	*1,222*	*1,106*	*1,112*
light commercial	*66*	*69*	*72*	*87*	*82*	*87*	*87*	*78*	*88*	*86*	*89*	*92*	*95*	*95*	*97*
logging	*17*	*42*	*54*	*67*	*54*	*63*	*61*	*55*	*68*	*66*	*68*	*69*	*72*	*74*	*73*
airport service	*45*	*53*	*65*	*83*	*75*	*77*	*81*	*72*	*86*	*86*	*88*	*91*	*95*	*91*	*87*

(continued)

Table A-2. Nitrogen Oxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
NON-ROAD ENGINES AND VEHICLES (continued)															
Aircraft	72	85	106	119	123	128	134	138	158	155	156	156	161	165	167
Marine Vessels	40	48	110	131	140	149	165	175	229	241	233	222	225	227	227
coal	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
diesel	*34*	*41*	*93*	*110*	*118*	*125*	*138*	*147*	*147*	*152*	*146*	*139*	*141*	*144*	*143*
residual oil	*6*	*7*	*17*	*20*	*22*	*24*	*26*	*28*	*27*	*27*	*27*	*27*	*27*	*25*	*24*
gasoline	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*10*	*10*	*9*	*9*	*9*	*10*	*10*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*45*	*52*	*51*	*48*	*48*	*49*	*49*
Railroads	495	589	731	808	829	854	897	923	929	929	946	945	947	990	922
MISCELLANEOUS	***330***	***165***	***248***	***310***	***259***	***352***	***727***	***293***	***371***	***286***	***254***	***225***	***383***	***237***	***239***
Other Combustion	330	165	248	310	259	352	727	293	370	285	253	224	381	236	238
Health Services	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0
Cooling Towers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	NA	0	0	0
Fugitive Dust	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1	1	1	1	1
TOTAL ALL SOURCES	**21,639**	**23,151**	**24,875**	**23,488**	**23,329**	**22,806**	**24,526**	**24,057**	**23,792**	**23,772**	**24,137**	**24,482**	**24,892**	**23,935**	**23,393**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-3. Volatile Organic Compound Emissions (thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
FUEL COMB. ELEC. UTIL.	***30***	***40***	***45***	***33***	***34***	***35***	***37***	***38***	***47***	***44***	***44***	***45***	***45***	***44***	***45***
Coal	18	22	31	25	25	26	27	28	27	27	27	29	29	29	31
Oil	7	14	9	5	7	6	7	7	6	5	4	4	4	3	3
Gas	5	4	5	2	2	2	2	2	2	2	2	2	2	2	2
Internal Combustion	NA	NA	NA	1	1	1	1	1	12	10	10	10	10	10	10
FUEL COMB. INDUSTRIAL	***150***	***150***	***157***	***134***	***133***	***131***	***136***	***134***	***182***	***196***	***187***	***186***	***196***	***206***	***208***
Coal	4	3	3	7	7	7	7	7	7	6	7	6	8	6	6
Oil	4	5	3	17	16	16	16	16	12	11	12	12	12	12	12
Gas	77	71	62	57	57	57	61	61	58	60	52	51	63	73	73
Other	65	71	89	35	36	36	36	36	51	51	49	51	50	50	51
Internal Combustion	NA	NA	NA	18	16	15	15	15	54	68	66	66	64	65	66
FUEL COMB. OTHER	***541***	***470***	***848***	***1,403***	***1,230***	***1,117***	***1,188***	***1,200***	***776***	***835***	***884***	***762***	***748***	***823***	***822***
Commercial/Institutional Coal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Commercial/Institutional Oil	4	3	3	4	4	4	4	4	3	3	3	3	3	3	3
Commercial/Institutional Gas	6	7	7	6	6	6	6	7	8	8	10	11	11	11	11
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	4	4	4	4	4	8	8	8	9	9	8	8
Residential Wood	460	420	809	1,372	1,199	1,085	1,155	1,169	718	776	822	698	684	759	758
fireplaces	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
woodstoves	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Residential Other	70	38	28	16	16	16	17	15	38	39	40	40	40	41	41
CHEMICAL & ALLIED PRODUCT MFG	***1,341***	***1,351***	***1,595***	***881***	***916***	***923***	***982***	***980***	***634***	***710***	***715***	***701***	***691***	***660***	***436***
Organic Chemical Mfg	629	751	884	349	361	356	387	387	192	216	211	215	217	210	113
ethylene oxide mfg	*8*	*9*	*10*	*2*	*2*	*2*	*2*	*2*	*0*	*1*	*1*	*1*	*1*	*1*	*0*
phenol mfg	*NA*	*NA*	*NA*	*0*	*0*	*0*	*0*	*0*	*4*	*4*	*4*	*4*	*4*	*2*	*1*
terephthalic acid mfg	*29*	*46*	*60*	*24*	*25*	*24*	*26*	*27*	*20*	*23*	*17*	*19*	*21*	*17*	*15*
ethylene mfg	*70*	*79*	*111*	*28*	*30*	*29*	*33*	*33*	*9*	*11*	*10*	*10*	*9*	*10*	*3*
charcoal mfg	*48*	*29*	*40*	*37*	*39*	*40*	*43*	*45*	*33*	*33*	*33*	*33*	*34*	*33*	*33*
socmi reactor	*81*	*96*	*118*	*43*	*46*	*45*	*49*	*49*	*26*	*30*	*30*	*32*	*33*	*33*	*14*
socmi distillation	*NA*	*NA*	*NA*	*7*	*7*	*7*	*7*	*7*	*8*	*9*	*8*	*8*	*8*	*8*	*2*
socmi air oxidation processes	*NA*	*NA*	*NA*	*0*	*0*	*0*	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*2*	*1*
socmi fugitives	*194*	*235*	*254*	*179*	*182*	*180*	*194*	*193*	*61*	*67*	*69*	*70*	*70*	*70*	*37*
other	*199*	*257*	*291*	*27*	*28*	*28*	*31*	*30*	*29*	*38*	*37*	*36*	*35*	*34*	*8*
Inorganic Chemical Mfg	65	78	93	3	3	3	3	3	2	3	3	2	2	3	3
Polymer & Resin Mfg	271	299	384	343	361	376	392	389	242	268	283	269	257	222	135
polypropylene mfg	*0*	*0*	*1*	*12*	*12*	*12*	*13*	*13*	*2*	*2*	*2*	*2*	*2*	*2*	*1*
polyethylene mfg	*17*	*18*	*22*	*51*	*53*	*52*	*58*	*57*	*39*	*44*	*45*	*46*	*46*	*35*	*22*
polystyrene resins	*10*	*11*	*15*	*6*	*6*	*6*	*7*	*7*	*4*	*5*	*5*	*5*	*5*	*5*	*5*

(continued)

Table A-3. Volatile Organic Compound Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
CHEMICAL & ALLIED PRODUCT MFG (continued)															
Polymer & Resin Mfg (continued)															
synthetic fiber	112	149	199	217	231	247	250	250	144	161	173	157	143	142	73
styrene/butadiene rubber	77	68	70	45	47	46	50	50	15	15	16	17	18	16	16
other	55	54	77	12	12	12	14	13	37	41	42	42	43	22	18
Agricultural Chemical Mfg	NA	NA	NA	11	12	11	12	12	6	7	8	7	6	5	5
Paint, Varnish, Lacquer, Enamel Mfg	61	66	65	8	8	8	8	8	14	16	17	18	17	18	10
paint & varnish mfg	61	66	65	8	8	8	8	8	13	15	16	16	16	16	8
other	NA	NA	NA	0	0	0	0	0	1	1	1	1	1	2	1
Pharmaceutical Mfg	40	55	77	43	44	45	48	48	20	21	24	23	24	38	32
Other Chemical Mfg	275	102	92	125	127	124	132	132	158	179	169	166	168	164	138
carbon black mfg	275	102	92	26	25	24	26	26	9	17	16	16	21	24	24
printing ink mfg	NA	NA	NA	2	3	3	3	3	1	1	1	1	2	2	0
fugitives unclassified	NA	NA	NA	12	12	11	13	12	23	23	21	20	27	30	6
carbon black furnace: fugitives	NA	NA	NA	4	4	4	5	5	0	1	1	1	1	1	0
other	NA	NA	NA	81	83	81	86	87	125	136	129	127	117	107	107
METALS PROCESSING	***394***	***336***	***273***	***76***	***73***	***70***	***74***	***74***	***122***	***123***	***124***	***124***	***126***	***125***	***70***
Nonferrous Metals Processing	NA	NA	NA	18	18	18	19	19	18	19	17	18	20	21	21
Ferrous Metals Processing	394	336	273	57	54	51	54	54	98	99	100	98	97	96	42
coke oven door & topside leaks	216	187	152	12	12	11	12	12	19	22	27	27	26	26	3
coke oven by-product plants	NA	NA	NA	3	3	3	3	3	7	9	9	9	9	9	1
other	177	149	121	41	39	37	39	39	71	68	63	62	62	61	38
Metals Processing NEC	NA	NA	NA	1	1	1	1	1	7	6	8	8	8	8	8
PETROLEUM & RELATED INDUSTRIES	***1,194***	***1,342***	***1,440***	***703***	***666***	***655***	***645***	***639***	***612***	***640***	***632***	***649***	***647***	***642***	***517***
Oil & Gas Production	411	378	379	107	79	70	71	68	301	301	297	310	305	299	272
Petroleum Refineries & Related Industries	773	951	1,045	592	584	582	571	568	308	337	332	336	339	339	242
vaccuum distillation	24	31	32	15	14	14	13	13	7	7	7	7	7	6	4
cracking units	27	27	21	34	33	33	32	31	15	17	16	15	16	16	16
process unit turnarounds	NA	NA	NA	15	14	14	13	13	11	11	11	11	10	12	9
petroleum refinery fugitives	NA	NA	NA	76	71	69	66	65	99	105	103	109	109	111	111
other	721	893	992	454	452	452	447	446	177	196	195	194	198	194	103
Asphalt Manufacturing	11	13	16	3	3	3	3	3	3	3	3	3	3	4	4

(continued)

Table A-3. Volatile Organic Compound Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
OTHER INDUSTRIAL PROCESSES	***270***	***235***	***237***	***390***	***395***	***394***	***408***	***403***	***401***	***391***	***414***	***442***	***438***	***450***	***439***
Agriculture, Food, & Kindred Products	208	182	191	169	171	175	177	175	138	130	127	146	145	147	135
vegetable oil mfg	*59*	*61*	*81*	*46*	*47*	*49*	*50*	*49*	*16*	*18*	*19*	*19*	*16*	*16*	*15*
whiskey fermentation: aging	*105*	*77*	*64*	*24*	*24*	*24*	*24*	*23*	*24*	*16*	*12*	*24*	*24*	*25*	*18*
bakeries	*45*	*44*	*46*	*51*	*52*	*51*	*52*	*51*	*43*	*44*	*44*	*46*	*46*	*47*	*44*
other	*NA*	*NA*	*NA*	*49*	*50*	*51*	*52*	*52*	*55*	*52*	*51*	*58*	*58*	*60*	*58*
Textiles, Leather, & Apparel Products	NA	NA	NA	10	10	10	10	10	20	18	19	19	19	19	18
Wood, Pulp & Paper, & Publishing Products	NA	NA	NA	42	44	44	44	44	96	92	101	112	105	122	123
Rubber & Miscellaneous Plastic Products	60	51	44	41	43	43	46	46	58	59	64	62	61	60	60
rubber tire mfg	*60*	*51*	*44*	*10*	*10*	*10*	*11*	*11*	*5*	*5*	*5*	*5*	*6*	*6*	*6*
green tire spray	*NA*	*NA*	*NA*	*5*	*5*	*5*	*6*	*6*	*3*	*4*	*3*	*3*	*3*	*3*	*3*
other	*NA*	*NA*	*NA*	*26*	*28*	*28*	*29*	*29*	*50*	*50*	*55*	*53*	*52*	*51*	*51*
Mineral Products	2	2	2	15	15	15	14	14	18	17	27	28	30	31	32
Machinery Products	NA	NA	NA	4	4	4	4	4	7	8	10	8	11	11	11
Electronic Equipment	NA	NA	NA	0	0	0	0	0	2	2	3	3	3	2	2
Transportation Equipment	NA	NA	NA	1	1	1	0	0	2	2	2	3	3	2	2
Construction	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	108	108	103	112	109	59	62	62	62	62	57	57
SOLVENT UTILIZATION	***7,174***	***5,651***	***6,584***	***5,699***	***5,626***	***5,743***	***5,945***	***5,964***	***5,750***	***5,782***	***5,901***	***6,016***	***6,162***	***6,183***	***6,273***
Degreasing	707	448	513	756	634	681	754	757	744	718	737	753	775	789	661
open top	*NA*	*NA*	*NA*	*28*	*28*	*28*	*29*	*29*	*18*	*25*	*26*	*26*	*27*	*24*	*10*
conveyorized	*NA*	*NA*	*NA*	*5*	*5*	*5*	*5*	*4*	*5*	*6*	*6*	*6*	*6*	*5*	*2*
cold cleaning	*NA*	*NA*	*NA*	*31*	*33*	*31*	*34*	*35*	*30*	*23*	*24*	*24*	*22*	*23*	*9*
other	*707*	*448*	*513*	*691*	*568*	*618*	*687*	*689*	*691*	*664*	*680*	*697*	*719*	*737*	*640*
Graphic Arts	319	254	373	317	325	340	362	363	274	301	308	322	333	339	389
letterpress	*NA*	*NA*	*NA*	*2*	*2*	*2*	*2*	*2*	*4*	*8*	*8*	*8*	*8*	*8*	*8*
flexographic	*NA*	*NA*	*NA*	*18*	*19*	*19*	*20*	*20*	*20*	*24*	*26*	*26*	*25*	*24*	*23*
lithographic	*NA*	*NA*	*NA*	*4*	*4*	*4*	*4*	*4*	*14*	*17*	*18*	*21*	*22*	*20*	*20*
gravure	*NA*	*NA*	*NA*	*131*	*138*	*140*	*148*	*150*	*75*	*82*	*81*	*87*	*93*	*91*	*90*
other	*319*	*254*	*373*	*162*	*163*	*174*	*188*	*187*	*162*	*171*	*175*	*180*	*185*	*196*	*248*
Dry Cleaning	263	229	320	169	217	216	216	212	215	218	224	225	228	230	190
perchloroethylene	*NA*	*NA*	*NA*	*85*	*111*	*110*	*109*	*107*	*110*	*112*	*115*	*116*	*117*	*118*	*71*
petroleum solvent	*NA*	*NA*	*NA*	*84*	*106*	*106*	*106*	*105*	*104*	*106*	*109*	*110*	*111*	*112*	*119*
other	*263*	*229*	*320*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*

(continued)

Table A-3. Volatile Organic Compound Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
SOLVENT UTILIZATION (continued)															
Surface Coating	3,570	2,977	3,685	2,549	2,602	2,606	2,646	2,635	2,523	2,521	2,577	2,632	2,716	2,681	2,881
industrial adhesives	*52*	*41*	*55*	*381*	*353*	*353*	*366*	*375*	*390*	*374*	*386*	*400*	*419*	*410*	*454*
fabrics	*161*	*177*	*186*	*34*	*34*	*35*	*35*	*35*	*14*	*14*	*16*	*16*	*15*	*15*	*14*
paper	*652*	*548*	*626*	*106*	*109*	*110*	*114*	*114*	*75*	*64*	*61*	*59*	*59*	*52*	*53*
large appliances	*49*	*43*	*36*	*22*	*19*	*19*	*19*	*18*	*21*	*20*	*20*	*21*	*22*	*21*	*23*
magnet wire	*7*	*6*	*5*	*0*	*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
autos & light trucks	*165*	*204*	*165*	*85*	*86*	*88*	*87*	*87*	*92*	*90*	*93*	*92*	*96*	*96*	*123*
metal cans	*49*	*57*	*73*	*97*	*96*	*95*	*96*	*95*	*94*	*91*	*93*	*96*	*98*	*102*	*106*
metal coil	*18*	*19*	*21*	*50*	*50*	*49*	*50*	*50*	*45*	*49*	*47*	*49*	*48*	*47*	*49*
wood furniture	*211*	*231*	*231*	*132*	*140*	*142*	*143*	*140*	*158*	*154*	*159*	*171*	*185*	*179*	*193*
metal furniture	*35*	*42*	*52*	*41*	*44*	*44*	*44*	*44*	*48*	*47*	*49*	*52*	*56*	*53*	*58*
flatwood products	*64*	*76*	*82*	*4*	*4*	*4*	*4*	*4*	*9*	*10*	*10*	*11*	*12*	*13*	*13*
plastic parts	*17*	*18*	*25*	*11*	*11*	*11*	*11*	*11*	*27*	*22*	*23*	*22*	*22*	*18*	*18*
large ships	*21*	*20*	*20*	*15*	*16*	*15*	*16*	*15*	*15*	*14*	*15*	*15*	*15*	*13*	*12*
aircraft	*1*	*1*	*2*	*27*	*29*	*26*	*31*	*34*	*7*	*7*	*7*	*7*	*7*	*6*	*6*
misc. metal parts	*NA*	*NA*	*NA*	*14*	*14*	*14*	*14*	*14*	*59*	*87*	*90*	*92*	*93*	*92*	*92*
steel drums	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*3*	*3*	*3*	*3*	*4*	*4*	*4*
architectural	*442*	*407*	*477*	*473*	*502*	*503*	*504*	*500*	*495*	*500*	*505*	*510*	*515*	*522*	*554*
traffic markings	*NA*	*NA*	*NA*	*100*	*106*	*106*	*107*	*106*	*105*	*106*	*107*	*108*	*109*	*111*	*117*
maintenance coatings	*108*	*125*	*106*	*79*	*80*	*80*	*80*	*80*	*79*	*76*	*78*	*81*	*85*	*84*	*89*
railroad	*5*	*7*	*9*	*4*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*4*	*4*	*3*
auto refinishing	*83*	*143*	*186*	*111*	*132*	*132*	*133*	*132*	*130*	*132*	*137*	*140*	*144*	*142*	*164*
machinery	*39*	*51*	*62*	*37*	*28*	*28*	*29*	*28*	*28*	*26*	*26*	*27*	*27*	*25*	*26*
electronic & other electrical	*NA*	*NA*	*NA*	*79*	*79*	*79*	*80*	*79*	*78*	*75*	*77*	*80*	*85*	*85*	*95*
general	*79*	*61*	*52*	*146*	*147*	*148*	*158*	*154*	*121*	*127*	*129*	*133*	*140*	*138*	*138*
miscellaneous	*942*	*392*	*799*	*104*	*109*	*108*	*105*	*103*	*32*	*37*	*42*	*39*	*38*	*35*	*35*
thinning solvents	*NA*	*NA*	*NA*	*90*	*92*	*94*	*97*	*96*	*96*	*97*	*100*	*94*	*96*	*99*	*99*
other	*372*	*309*	*415*	*306*	*317*	*318*	*320*	*317*	*297*	*295*	*302*	*310*	*321*	*314*	*338*
Other Industrial	640	499	690	125	131	132	133	131	94	98	102	102	99	96	53
miscellaneous	*39*	*30*	*44*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
rubber & plastics mfg	*309*	*245*	*327*	*25*	*29*	*29*	*29*	*29*	*28*	*28*	*28*	*29*	*31*	*31*	*37*
other	*292*	*224*	*319*	*100*	*102*	*103*	*104*	*102*	*66*	*71*	*74*	*73*	*68*	*64*	*16*

(continued)

Table A-3. Volatile Organic Compound Emissions (continued) (thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
SOLVENT UTILIZATION (continued)															
Nonindustrial	1,674	1,243	1,002	1,783	1,717	1,768	1,834	1,867	1,900	1,925	1,952	1,982	2,011	2,048	2,100
cutback asphalt	*1,045*	*723*	*323*	*191*	*175*	*186*	*199*	*199*	*199*	*202*	*207*	*214*	*221*	*227*	*128*
other asphalt	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
pesticide application	*241*	*195*	*241*	*212*	*263*	*262*	*262*	*260*	*258*	*264*	*272*	*280*	*289*	*299*	*360*
adhesives	*NA*	*NA*	*NA*	*345*	*332*	*332*	*345*	*353*	*361*	*365*	*368*	*372*	*375*	*380*	*403*
consumer solvents	*NA*	*NA*	*NA*	*1,035*	*947*	*988*	*1,030*	*1,056*	*1,083*	*1,095*	*1,105*	*1,116*	*1,126*	*1,142*	*1,210*
other	*387*	*325*	*437*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Other	NA	NA	NA	NA	NA	NA	NA	NA	0	NA	NA	0	0	0	0
STORAGE & TRANSPORT	***1,954***	***2,181***	***1,975***	***1,747***	***1,673***	***1,801***	***1,842***	***1,753***	***1,495***	***1,532***	***1,583***	***1,600***	***1,629***	***1,652***	***1,312***
Bulk Terminals & Plants	599	668	517	606	620	632	652	651	359	369	384	395	403	406	243
fixed roof	*14*	*15*	*12*	*14*	*14*	*14*	*15*	*15*	*9*	*11*	*12*	*13*	*16*	*16*	*16*
floating roof	*45*	*50*	*39*	*46*	*47*	*48*	*50*	*50*	*26*	*29*	*30*	*34*	*29*	*19*	*19*
variable vapor space	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*	*2*	*1*	*1*	*1*	*0*	*0*
efr with seals	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*2*	*3*	*3*	*4*	*4*	*3*	*3*
ifr with seals	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*2*	*2*	*3*	*5*	*3*	*3*	*3*
underground tanks	*NA*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*2*	*2*	*2*	*2*	*2*	*2*
area source: gasoline	*509*	*569*	*440*	*512*	*526*	*537*	*554*	*553*	*282*	*281*	*292*	*292*	*305*	*322*	*162*
other	*30*	*33*	*26*	*32*	*32*	*32*	*33*	*33*	*36*	*40*	*42*	*44*	*43*	*41*	*38*
Petroleum & Petroleum Product Storage	300	315	306	223	217	214	215	210	157	195	204	205	194	191	133
fixed roof gasoline	*47*	*52*	*43*	*26*	*25*	*25*	*24*	*23*	*13*	*17*	*17*	*16*	*16*	*16*	*14*
fixed roof crude	*135*	*141*	*148*	*26*	*24*	*22*	*21*	*21*	*21*	*25*	*26*	*28*	*24*	*21*	*19*
floating roof gasoline	*49*	*54*	*45*	*27*	*26*	*26*	*25*	*24*	*15*	*25*	*24*	*24*	*22*	*22*	*7*
floating roof crude	*32*	*34*	*36*	*5*	*5*	*5*	*5*	*5*	*2*	*7*	*7*	*8*	*6*	*6*	*2*
efr / seal gasoline	*3*	*4*	*3*	*2*	*2*	*2*	*2*	*2*	*7*	*11*	*13*	*14*	*14*	*15*	*12*
efr / seal crude	*1*	*2*	*2*	*0*	*0*	*0*	*0*	*0*	*3*	*3*	*3*	*3*	*3*	*2*	*2*
ifr / seal gasoline	*1*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*2*
ifr / seal crude	*2*	*2*	*2*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
variable vapor space gasoline	*3*	*3*	*3*	*1*	*1*	*1*	*1*	*2*	*1*	*2*	*5*	*6*	*3*	*0*	*0*
area source: crude	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
other	*25*	*22*	*23*	*133*	*132*	*131*	*135*	*132*	*92*	*102*	*106*	*103*	*103*	*106*	*73*
Petroleum & Petroleum Product Transport	92	84	61	126	123	123	125	125	151	146	149	142	139	134	131
gasoline loading: normal / splash	*3*	*2*	*0*	*3*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*2*	*3*	*2*	*2*
gasoline loading: balanced / submerged	*20*	*13*	*2*	*21*	*20*	*21*	*21*	*22*	*15*	*17*	*15*	*13*	*11*	*10*	*8*
gasoline loading: normal / submerged	*39*	*26*	*3*	*41*	*41*	*40*	*41*	*42*	*26*	*25*	*26*	*24*	*25*	*23*	*22*
gasoline loading: clean / submerged	*2*	*1*	*0*	*2*	*2*	*2*	*2*	*2*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
marine vessel loading: gasoline & crude	*26*	*38*	*50*	*24*	*23*	*23*	*23*	*22*	*31*	*30*	*30*	*29*	*28*	*29*	*29*
other	*2*	*4*	*6*	*35*	*34*	*34*	*35*	*35*	*76*	*73*	*75*	*73*	*72*	*70*	*69*
Service Stations: Stage I	416	481	461	207	213	219	223	223	300	295	303	309	322	334	341
Service Stations: Stage II	521	602	583	485	400	511	522	441	433	430	442	449	467	484	406
Service Stations: Breathing & Emptying	NA	NA	NA	49	48	51	52	52	52	51	52	53	55	57	37
Organic Chemical Storage	26	31	46	34	35	34	37	36	30	35	38	39	39	37	16
Organic Chemical Transport	NA	NA	NA	17	17	16	16	15	10	8	8	7	7	7	5

(continued)

Table A-3. Volatile Organic Compound Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
STORAGE & TRANSPORT (continued)															
Inorganic Chemical Storage	NA	NA	NA	0	0	0	0	0	0	1	1	1	1	1	1
Inorganic Chemical Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	0	0	0	0	0	2	2	2	1	1	1	1
WASTE DISPOSAL & RECYCLING	***1,984***	***984***	***758***	***979***	***971***	***950***	***959***	***941***	***986***	***999***	***1,010***	***1,046***	***1,046***	***1,067***	***433***
Incineration	548	453	366	64	63	61	60	59	48	50	51	76	65	54	55
Open Burning	1,424	517	372	309	304	292	284	274	196	200	203	207	208	208	210
industrial	*NA*	*NA*	*NA*	*6*	*6*	*6*	*6*	*6*	*4*	*4*	*4*	*5*	*5*	*5*	*5*
commmercial/institutional	*NA*	*NA*	*NA*	*1*	*1*	*1*	*2*	*2*	*9*	*9*	*10*	*10*	*10*	*10*	*10*
residential	*NA*	*NA*	*NA*	*302*	*297*	*285*	*277*	*266*	*165*	*167*	*169*	*171*	*172*	*173*	*175*
other	*1,424*	*517*	*372*	*NA*	*NA*	*NA*	*NA*	*NA*	*19*	*20*	*20*	*21*	*21*	*20*	*20*
POTW	NA	NA	NA	10	11	11	11	11	49	47	48	50	52	51	52
Industrial Waste Water	NA	NA	NA	1	2	1	2	2	14	18	19	19	19	16	12
TSDF	NA	NA	NA	594	591	584	602	595	589	591	589	588	587	628	45
Landfills	NA	NA	NA	0	0	0	0	0	64	66	69	74	80	75	22
Other	11	14	20	0	0	0	0	0	26	28	31	33	35	36	37
ON-ROAD VEHICLES	***12,972***	***10,545***	***8,979***	***9,376***	***8,874***	***8,477***	***8,290***	***7,192***	***6,313***	***6,499***	***6,072***	***6,103***	***6,401***	***5,701***	***5,502***
Light-Duty Gas Vehicles & Motorcycles	9,193	7,248	5,907	5,864	5,537	5,281	5,189	4,462	3,947	4,069	3,832	3,812	3,748	3,426	3,323
light-duty gas vehicles	*9,133*	*7,177*	*5,843*	*5,810*	*5,483*	*5,227*	*5,136*	*4,412*	*3,885*	*4,033*	*3,799*	*3,777*	*3,711*	*3,385*	*3,284*
motorcycles	*60*	*71*	*64*	*54*	*54*	*53*	*53*	*50*	*62*	*37*	*33*	*34*	*37*	*41*	*39*
Light-Duty Gas Trucks	2,770	2,289	2,059	2,425	2,279	2,185	2,129	1,867	1,622	1,688	1,588	1,647	1,909	1,629	1,582
light-duty gas trucks 1	*1,564*	*1,251*	*1,229*	*1,437*	*1,316*	*1,227*	*1,173*	*1,018*	*960*	*906*	*849*	*875*	*1,003*	*895*	*870*
light-duty gas trucks 2	*1,206*	*1,038*	*830*	*988*	*963*	*958*	*956*	*849*	*662*	*781*	*739*	*772*	*906*	*735*	*712*
Heavy-Duty Gas Vehicles	743	657	611	716	700	662	626	517	432	423	334	326	414	327	286
Diesels	266	351	402	370	357	350	345	346	312	319	318	318	331	319	312
heavy-duty diesel vehicles	*266*	*335*	*392*	*360*	*346*	*338*	*332*	*332*	*297*	*304*	*302*	*301*	*313*	*302*	*294*
light-duty diesel trucks	*NA*	*NA*	*2*	*2*	*2*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*4*	*4*	*4*
light-duty diesel vehicles	*NA*	*15*	*8*	*8*	*9*	*9*	*10*	*11*	*13*	*12*	*13*	*13*	*13*	*14*	*14*
NON-ROAD ENGINES AND VEHICLES	***1,713***	***1,893***	***2,142***	***2,240***	***2,342***	***2,244***	***2,432***	***2,422***	***2,502***	***2,503***	***2,551***	***2,581***	***2,619***	***2,433***	***2,426***
Non-Road Gasoline	1,284	1,373	1,474	1,561	1,582	1,601	1,620	1,631	1,756	1,767	1,793	1,814	1,833	1,692	1,685
recreational	*138*	*145*	*151*	*156*	*157*	*158*	*159*	*160*	*128*	*130*	*132*	*133*	*135*	*138*	*135*
construction	*22*	*24*	*32*	*37*	*37*	*36*	*35*	*35*	*33*	*31*	*31*	*32*	*35*	*37*	*36*
industrial	*46*	*50*	*61*	*69*	*71*	*73*	*75*	*77*	*81*	*79*	*81*	*80*	*82*	*85*	*82*
lawn & garden	*574*	*614*	*655*	*691*	*699*	*706*	*713*	*720*	*766*	*777*	*787*	*797*	*803*	*823*	*799*
farm	*4*	*6*	*7*	*8*	*8*	*4*	*9*	*6*	*13*	*10*	*12*	*12*	*11*	*8*	*9*
light commercial	*142*	*151*	*158*	*171*	*178*	*188*	*189*	*190*	*138*	*136*	*140*	*141*	*145*	*152*	*148*
logging	*3*	*6*	*7*	*8*	*8*	*10*	*9*	*10*	*9*	*9*	*9*	*10*	*10*	*11*	*11*
airport service	*4*	*5*	*6*	*6*	*7*	*7*	*7*	*7*	*5*	*5*	*5*	*6*	*6*	*6*	*6*
recreational marine vessels	*350*	*372*	*395*	*413*	*416*	*419*	*422*	*425*	*562*	*569*	*576*	*581*	*585*	*432*	*459*
other	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*20*	*20*	*20*	*21*	*21*	*0*	*0*

(continued)

Table A-3. Volatile Organic Compound Emissions (continued) (thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
NON-ROAD ENGINES AND VEHICLES (continued)															
Non-Road Diesel	300	366	464	448	521	394	549	519	465	456	475	492	513	466	467
recreational	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
construction	*104*	*112*	*148*	*165*	*170*	*166*	*166*	*170*	*167*	*157*	*165*	*177*	*190*	*166*	*167*
industrial	*18*	*20*	*24*	*30*	*28*	*29*	*30*	*27*	*30*	*29*	*30*	*32*	*33*	*32*	*33*
lawn & garden	*7*	*7*	*8*	*9*	*9*	*9*	*9*	*8*	*9*	*9*	*9*	*10*	*10*	*10*	*10*
farm	*152*	*203*	*257*	*209*	*284*	*157*	*311*	*283*	*224*	*225*	*234*	*237*	*242*	*219*	*220*
light commercial	*10*	*10*	*11*	*13*	*12*	*13*	*13*	*12*	*13*	*13*	*14*	*14*	*14*	*14*	*15*
logging	*3*	*7*	*9*	*11*	*9*	*10*	*10*	*9*	*11*	*11*	*11*	*11*	*12*	*12*	*12*
airport service	*5*	*6*	*7*	*9*	*8*	*9*	*9*	*8*	*10*	*10*	*10*	*10*	*11*	*10*	*10*
Aircraft	97	116	146	165	170	176	185	190	180	177	179	176	176	178	177
Marine Vessels	9	11	25	30	32	34	38	40	49	51	50	48	49	49	48
coal	*0*	*0*	*0*	*1*	*1*	*1*	*1*	*1*	*0*	*0*	*0*	*0*	*1*	*0*	*0*
diesel	*8*	*10*	*23*	*28*	*29*	*31*	*35*	*37*	*28*	*29*	*28*	*26*	*27*	*27*	*27*
residual oil	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*3*	*4*	*4*	*4*	*4*	*4*	*3*	*3*
gasoline	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*16*	*17*	*17*	*17*	*17*	*17*	*17*
Railroads	22	27	33	37	38	39	41	42	52	52	54	52	49	49	48
NATURAL SOURCES	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***14***	***14***	***14***	***14***	***14***	***14***	***14***
Geogenic	NA	NA	NA	NA	NA	NA	NA	NA	14	14	14	14	14	14	14
MISCELLANEOUS	***1,101***	***716***	***1,134***	***566***	***547***	***655***	***1,230***	***642***	***1,150***	***831***	***565***	***627***	***784***	***586***	***587***
Agriculture & Forestry	NA	NA	NA	NA	NA	NA	NA	NA	81	69	73	86	67	67	64
Other Combustion	1,101	716	1,134	565	547	655	1,230	641	1,064	756	485	535	710	511	516
structural fires	*19*	*47*	*40*	*44*	*44*	*44*	*44*	*44*	*29*	*30*	*30*	*30*	*30*	*31*	*31*
agricultural fires	*131*	*75*	*70*	*55*	*61*	*67*	*85*	*79*	*48*	*48*	*49*	*48*	*51*	*54*	*55*
slash/prescribed burning	*147*	*290*	*285*	*182*	*182*	*182*	*182*	*182*	*234*	*236*	*239*	*241*	*246*	*252*	*256*
forest wildfires	*770*	*297*	*739*	*283*	*259*	*361*	*918*	*335*	*749*	*439*	*164*	*212*	*379*	*171*	*171*
other	*34*	*7*	*1*	*NA*	*NA*	*NA*	*NA*	*NA*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Catastrophic/Accidental Releases	NA	NA	NA	NA	NA	NA	NA	NA	4	4	4	4	4	4	4
Health Services	NA	NA	NA	0	1	0	1	1	1	0	1	1	1	1	1
Cooling Towers	NA	NA	NA	NA	NA	NA	NA	NA	0	2	2	1	2	2	2
Fugitive Dust	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	1
TOTAL ALL SOURCES	**30,817**	**25,895**	**26,167**	**24,227**	**23,480**	**23,193**	**24,167**	**22,383**	**20,985**	**21,100**	**20,695**	**20,895**	**21,546**	**20,586**	**19,086**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

No data was available after 1984 to weigh the emissions from residential wood burning devices.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-4. Sulfur Dioxide Emissions
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
FUEL COMB. ELEC. UTIL.	***17,398***	***18,268***	***17,469***	***16,273***	***15,804***	***15,819***	***16,110***	***16,340***	***15,909***	***15,784***	***15,416***	***15,189***	***14,889***	***12,080***	***12,604***
Coal	15,799	16,756	16,073	15,630	14,962	15,138	15,344	15,529	15,220	15,087	14,824	14,527	14,313	11,603	12,114
bituminous	*9,574*	*10,161*	*NA*	*14,029*	*13,450*	*13,502*	*13,548*	*13,579*	*13,371*	*13,215*	*12,914*	*12,212*	*11,841*	*8,609*	*9,123*
subbituminous	*4,716*	*5,005*	*NA*	*1,292*	*1,157*	*1,300*	*1,433*	*1,547*	*1,415*	*1,381*	*1,455*	*1,796*	*1,988*	*2,345*	*2,366*
anthracite & lignite	*1,509*	*1,590*	*NA*	*309*	*355*	*336*	*364*	*404*	*434*	*491*	*455*	*519*	*484*	*649*	*625*
Oil	1,598	1,511	1,395	612	811	651	734	779	639	652	546	612	522	413	412
residual	*1,578*	*1,462*	*NA*	*604*	*799*	*640*	*722*	*765*	*629*	*642*	*537*	*601*	*512*	*408*	*408*
distillate	*20*	*49*	*NA*	*8*	*12*	*11*	*12*	*14*	*10*	*10*	*9*	*10*	*10*	*5*	*4*
Gas	1	1	1	1	1	1	1	1	1	1	1	1	1	9	21
Internal Combustion	NA	NA	NA	30	30	29	31	30	49	45	46	49	53	55	57
FUEL COMB. INDUSTRIAL	***4,568***	***3,310***	***2,951***	***3,169***	***3,116***	***3,068***	***3,111***	***3,086***	***3,550***	***3,256***	***3,292***	***3,284***	***3,218***	***3,357***	***3,399***
Coal	3,129	1,870	1,527	1,818	1,828	1,817	1,856	1,840	1,914	1,805	1,783	1,763	1,740	1,728	1,762
bituminous	*2,171*	*1,297*	*1,058*	*1,347*	*1,375*	*1,374*	*1,395*	*1,384*	*1,050*	*949*	*1,005*	*991*	*988*	*1,003*	*1,005*
subbituminous	*669*	*399*	*326*	*28*	*29*	*29*	*29*	*29*	*50*	*53*	*60*	*67*	*77*	*81*	*83*
anthracite & lignite	*289*	*174*	*144*	*90*	*82*	*73*	*79*	*79*	*67*	*68*	*67*	*68*	*68*	*68*	*68*
other	*NA*	*NA*	*NA*	*353*	*341*	*341*	*353*	*348*	*746*	*735*	*650*	*636*	*606*	*576*	*606*
Oil	1,229	1,139	1,065	862	828	807	806	812	927	779	801	809	777	912	918
residual	*956*	*825*	*851*	*671*	*637*	*617*	*614*	*625*	*687*	*550*	*591*	*597*	*564*	*701*	*708*
distillate	*98*	*144*	*85*	*111*	*109*	*106*	*108*	*107*	*198*	*190*	*191*	*193*	*193*	*191*	*191*
other	*175*	*171*	*129*	*80*	*82*	*84*	*84*	*80*	*42*	*39*	*20*	*20*	*20*	*20*	*20*
Gas	140	263	299	397	370	356	360	346	543	516	552	555	542	548	548
Other	70	38	60	86	84	82	83	82	158	142	140	140	141	147	147
Internal Combustion	NA	NA	NA	7	6	6	6	6	9	14	16	17	19	23	23
FUEL COMB. OTHER	***1,490***	***1,082***	***971***	***579***	***611***	***662***	***660***	***624***	***831***	***755***	***784***	***772***	***780***	***793***	***782***
Commercial/Institutional Coal	109	147	110	158	161	164	172	169	212	184	190	193	192	200	200
Commercial/Institutional Oil	883	638	637	239	267	310	295	274	425	376	396	381	391	397	389
Commercial/Institutional Gas	1	1	1	2	2	2	2	2	7	7	7	8	8	8	8
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	1	1	1	1	1	6	6	6	6	6	5	5
Residential Wood	6	7	13	13	11	10	11	11	7	7	8	6	6	7	7
Residential Other	492	290	211	167	169	175	180	167	175	176	177	178	177	176	173
distillate oil	*212*	*196*	*157*	*128*	*129*	*134*	*137*	*132*	*137*	*141*	*144*	*145*	*145*	*144*	*145*
bituminous/subbituminous coal	*260*	*76*	*43*	*29*	*30*	*32*	*33*	*27*	*30*	*26*	*26*	*25*	*25*	*24*	*21*
other	*20*	*18*	*11*	*10*	*10*	*10*	*10*	*8*	*9*	*8*	*8*	*8*	*8*	*8*	*8*

(continued)

Table A-4. Sulfur Dioxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
CHEMICAL & ALLIED PRODUCT MFG	***591***	***367***	***280***	***456***	***432***	***425***	***449***	***440***	***297***	***280***	***278***	***269***	***275***	***286***	***287***
Organic Chemical Mfg	NA	NA	NA	16	16	17	19	17	10	9	9	9	8	8	8
Inorganic Chemical Mfg	591	358	271	354	329	322	341	334	214	208	203	191	194	199	199
sulfur compounds	*591*	*358*	*271*	*346*	*320*	*314*	*333*	*326*	*211*	*205*	*199*	*187*	*189*	*195*	*195*
other	*NA*	*NA*	*NA*	*8*	*8*	*8*	*8*	*8*	*2*	*3*	*4*	*4*	*4*	*4*	*4*
Polymer & Resin Mfg	NA	NA	NA	7	7	6	7	7	1	1	1	1	1	0	0
Agricultural Chemical Mfg	NA	NA	NA	4	4	4	4	4	5	4	4	4	4	5	5
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0
Pharmaceutical Mfg	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	NA	8	10	76	77	75	78	77	67	57	60	64	68	74	74
METALS PROCESSING	***4,775***	***2,849***	***1,842***	***1,042***	***888***	***648***	***707***	***695***	***726***	***612***	***615***	***603***	***562***	***530***	***530***
Nonferrous Metals Processing	4,060	2,165	1,279	853	710	479	529	513	517	435	438	431	391	361	362
copper	*3,507*	*1,946*	*1,080*	*655*	*525*	*298*	*343*	*327*	*323*	*234*	*247*	*250*	*206*	*177*	*177*
lead	*77*	*34*	*34*	*121*	*112*	*111*	*113*	*113*	*129*	*135*	*131*	*122*	*128*	*126*	*126*
aluminum	*80*	*72*	*95*	*62*	*59*	*57*	*59*	*60*	*60*	*61*	*55*	*53*	*51*	*53*	*53*
other	*396*	*113*	*71*	*14*	*13*	*13*	*14*	*13*	*4*	*5*	*5*	*6*	*6*	*6*	*6*
Ferrous Metals Processing	715	684	562	172	161	153	162	165	186	159	158	153	153	151	151
Metals Processing NEC	NA	NA	NA	18	17	15	16	17	22	18	18	19	19	18	18
PETROLEUM & RELATED INDUSTRIES	***881***	***727***	***734***	***505***	***469***	***445***	***443***	***429***	***430***	***378***	***416***	***383***	***379***	***369***	***368***
Oil & Gas Production	111	173	157	204	176	155	159	156	122	98	93	98	95	89	89
natural gas	*111*	*173*	*157*	*202*	*175*	*154*	*157*	*155*	*120*	*96*	*92*	*96*	*93*	*88*	*88*
other	*NA*	*NA*	*NA*	*2*	*1*	*1*	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*1*	*1*
Petroleum Refineries & Related Industries	770	554	577	300	291	289	283	272	304	274	315	278	276	271	271
fluid catalytic cracking units	*480*	*318*	*330*	*212*	*207*	*207*	*202*	*195*	*183*	*182*	*185*	*183*	*188*	*188*	*188*
other	*290*	*236*	*247*	*88*	*84*	*82*	*81*	*77*	*121*	*92*	*130*	*95*	*88*	*83*	*83*
Asphalt Manufacturing	NA	NA	NA	1	1	1	1	1	4	7	7	7	8	9	9
OTHER INDUSTRIAL PROCESSES	***846***	***740***	***918***	***425***	***427***	***418***	***411***	***405***	***399***	***396***	***396***	***392***	***398***	***403***	***409***
Agriculture, Food, & Kindred Products	NA	NA	NA	3	3	3	3	3	3	3	3	3	3	3	3
Textiles, Leather, & Apparel Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	169	168	223	131	135	135	135	136	116	123	119	113	109	114	117
Rubber & Miscellaneous Plastic Products	NA	NA	NA	1	1	1	1	1	0	0	0	0	0	0	0
Mineral Products	677	571	694	286	285	276	268	261	275	267	270	272	282	282	285
cement mfg	*618*	*511*	*630*	*192*	*190*	*183*	*177*	*172*	*181*	*165*	*168*	*170*	*167*	*171*	*172*
other	*59*	*60*	*64*	*95*	*95*	*93*	*91*	*89*	*94*	*102*	*102*	*102*	*114*	*111*	*112*
Machinery Products	NA	NA	NA	0	0	0	0	0	0	0	1	0	1	1	1
Electronic Equipment	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	3	3	3	3	3	5	3	3	3	3	4	4

(continued)

Table A-4. Sulfur Dioxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***1***	***1***	***1***	***1***	***1***	***0***	***0***	***1***	***1***	***1***	***1***	***1***
Degreasing	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	NA	0	0	0
Surface Coating	NA	NA	NA	1	1	1	1	1	0	0	0	0	0	0	0
Other Industrial	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***4***	***4***	***4***	***5***	***5***	***7***	***10***	***9***	***5***	***2***	***2***	***2***
Bulk Terminals & Plants	NA	NA	NA	NA	NA	NA	NA	NA	0	1	1	0	0	0	0
Petroleum & Petroleum Product Storage	NA	NA	NA	0	0	0	0	0	5	7	0	0	0	0	0
Petroleum & Petroleum Product Transport	NA	NA	NA	1	1	1	1	1	0	0	0	0	0	0	0
Service Stations: Stage II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
Organic Chemical Storage	NA	NA	NA	1	1	1	1	1	0	0	0	0	0	0	0
Organic Chemical Transport	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Inorganic Chemical Storage	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Inorganic Chemical Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	1	2	2	2	2	1	1	7	4	1	1	1
WASTE DISPOSAL & RECYCLING	***8***	***46***	***33***	***34***	***35***	***35***	***36***	***36***	***42***	***44***	***44***	***71***	***60***	***47***	***48***
Incineration	4	29	21	25	26	26	28	28	32	32	32	51	42	35	35
industrial	*NA*	*NA*	*NA*	*10*	*10*	*10*	*11*	*10*	*5*	*4*	*5*	*25*	*17*	*8*	*8*
other	*4*	*29*	*21*	*15*	*16*	*16*	*17*	*18*	*26*	*28*	*27*	*26*	*26*	*27*	*27*
Open Burning	4	17	12	9	8	8	8	8	11	11	11	11	11	11	11
industrial	*NA*	*NA*	*NA*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
other	*4*	*17*	*12*	*8*	*8*	*8*	*8*	*7*	*10*	*10*	*11*	*11*	*11*	*11*	*11*
POTW	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Industrial Waste Water	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
TSDF	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Landfills	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
industrial	*NA*	*NA*	*NA*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
other	*NA*	*NA*	*NA*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other	NA	NA	NA	0	0	0	0	0	0	1	1	8	6	0	0
ON-ROAD VEHICLES	***411***	***503***	***521***	***522***	***527***	***538***	***553***	***570***	***542***	***570***	***578***	***517***	***301***	***304***	***307***
Light-Duty Gas Vehicles & Motorcycles	132	158	159	146	143	142	144	145	138	143	146	147	141	143	144
Light-Duty Gas Trucks	40	48	50	55	55	56	58	58	57	59	59	60	70	71	71
Heavy-Duty Gas Vehicles	8	9	10	11	11	11	11	11	11	10	10	11	12	11	11
Diesels	231	288	303	311	318	328	340	356	337	358	363	299	79	80	80

(continued)

Table A-4. Sulfur Dioxide Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
NON-ROAD ENGINES AND VEHICLES	***83***	***99***	***175***	***208***	***221***	***233***	***253***	***267***	***392***	***399***	***402***	***385***	***384***	***372***	***368***
Non-Road Gasoline	NA	NA	NA	NA	NA	NA	NA	NA	8	8	8	8	8	8	8
Non-Road Diesel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aircraft	4	4	6	6	6	7	7	7	11	11	11	11	11	11	11
Marine Vessels	43	52	117	143	154	164	181	193	251	259	258	249	252	239	237
Railroads	36	43	53	59	60	62	65	67	122	120	125	117	113	113	111
MISCELLANEOUS	***110***	***20***	***11***	***11***	***9***	***13***	***27***	***11***	***12***	***11***	***10***	***9***	***15***	***9***	***9***
Other Combustion	110	20	11	11	9	13	27	11	12	11	9	8	14	9	9
Fugitive Dust	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	1	0	0	0
TOTAL ALL SOURCES	**31,161**	**28,011**	**25,905**	**23,230**	**22,544**	**22,308**	**22,767**	**22,907**	**23,136**	**22,496**	**22,240**	**21,879**	**21,262**	**18,552**	**19,113**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

The 1985 fuel combustion, electric utility category is based on the National Allowance Data Base Version 2.11, Acid Rain Division, U.S. EPA, released March 23, 1993. Allocations at the Tier 3 levels are approximations only and are based on the methodology described in section 6.0, paragraph 6.2.1.1.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-5. Particulate Matter (PM-10) Emissions
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
FUEL COMB. ELEC. UTIL.	***1,775***	***1,191***	***879***	***282***	***287***	***284***	***279***	***274***	***295***	***257***	***257***	***279***	***273***	***268***	***282***
Coal	1,680	1,091	796	270	272	271	265	259	265	232	234	253	246	244	258
bituminous	*1,041*	*661*	*483*	*217*	*216*	*212*	*190*	*193*	*188*	*169*	*167*	*185*	*181*	*174*	*185*
subbituminous	*513*	*326*	*238*	*37*	*36*	*38*	*53*	*42*	*37*	*39*	*43*	*46*	*44*	*48*	*50*
anthracite & lignite	*126*	*104*	*75*	*16*	*19*	*20*	*22*	*22*	*41*	*23*	*23*	*22*	*21*	*21*	*22*
other	*NA*	*NA*	*NA*	*0*	*0*	*0*	*0*	*0*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Oil	89	93	76	8	11	9	11	12	9	10	7	9	8	5	5
residual	*85*	*87*	*74*	*8*	*11*	*9*	*10*	*11*	*9*	*10*	*7*	*9*	*8*	*5*	*5*
distillate	*3*	*6*	*2*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Gas	7	6	7	1	1	1	1	1	1	1	0	1	1	1	1
Internal Combustion	NA	NA	NA	3	3	3	3	3	20	15	16	17	17	18	18
FUEL COMB. INDUSTRIAL	***641***	***564***	***679***	***247***	***244***	***239***	***244***	***243***	***270***	***233***	***243***	***257***	***270***	***302***	***306***
Coal	83	23	18	71	71	67	70	70	84	72	74	71	70	70	71
bituminous	*52*	*14*	*12*	*48*	*48*	*48*	*49*	*49*	*59*	*48*	*53*	*51*	*49*	*49*	*49*
subbituminous	*16*	*4*	*4*	*1*	*1*	*1*	*1*	*1*	*5*	*3*	*3*	*3*	*5*	*5*	*5*
anthracite & lignite	*15*	*4*	*2*	*7*	*6*	*6*	*6*	*6*	*2*	*1*	*1*	*1*	*1*	*1*	*1*
other	*NA*	*NA*	*NA*	*15*	*15*	*13*	*14*	*14*	*19*	*19*	*17*	*16*	*16*	*15*	*16*
Oil	89	69	67	52	49	48	48	48	52	44	45	45	44	49	50
residual	*83*	*62*	*63*	*43*	*40*	*38*	*38*	*39*	*44*	*36*	*37*	*38*	*37*	*42*	*42*
distillate	*6*	*7*	*4*	*5*	*5*	*5*	*5*	*5*	*6*	*6*	*6*	*6*	*6*	*6*	*6*
other	*0*	*0*	*0*	*4*	*4*	*4*	*4*	*4*	*2*	*2*	*1*	*1*	*1*	*1*	*1*
Gas	27	25	23	47	45	44	45	44	41	34	40	43	43	45	45
natural	*24*	*22*	*20*	*24*	*23*	*23*	*24*	*24*	*30*	*24*	*26*	*29*	*30*	*30*	*30*
process	*4*	*3*	*3*	*22*	*21*	*20*	*20*	*20*	*11*	*10*	*13*	*13*	*14*	*15*	*15*
other	*NA*	*NA*	*NA*	*1*	*1*	*1*	*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other	441	447	571	75	77	78	79	78	87	72	74	86	74	73	75
wood/bark waste	*415*	*444*	*566*	*67*	*69*	*70*	*71*	*71*	*80*	*67*	*67*	*71*	*68*	*68*	*69*
liquid waste	*NA*	*NA*	*NA*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
other	*26*	*3*	*5*	*6*	*6*	*6*	*6*	*6*	*6*	*5*	*6*	*14*	*6*	*5*	*6*
Internal Combustion	NA	NA	NA	3	3	3	3	3	6	10	11	12	38	64	65
FUEL COMB. OTHER	***455***	***492***	***887***	***1009***	***889***	***812***	***862***	***869***	***631***	***657***	***683***	***588***	***570***	***610***	***598***
Commercial/Institutional Coal	13	10	8	13	13	13	14	13	15	14	15	15	15	16	16
Commercial/Institutional Oil	52	34	30	12	14	16	15	13	13	11	12	11	12	12	12
Commercial/Institutional Gas	4	4	4	4	4	4	5	5	5	6	6	6	7	6	7
Misc. Fuel Comb. (Except Residential	NA	NA	NA	3	3	3	3	3	79	73	73	72	73	73	72

(continued)

Table A-5. Particulate Matter (PM-10) Emissions (continued) (thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
FUEL COMB. OTHER (continued)															
Residential Wood	384	407	818	959	837	758	807	817	501	535	558	464	446	484	472
fireplaces	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
woodstoves	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Residential Other	3	37	27	18	18	18	19	18	18	18	18	18	18	18	19
CHEMICAL & ALLIED PRODUCT MFG	***235***	***127***	***148***	***58***	***59***	***58***	***62***	***63***	***77***	***68***	***71***	***66***	***76***	***67***	***67***
Organic Chemical Mfg	43	21	19	19	20	20	21	22	26	28	28	28	29	29	29
Inorganic Chemical Mfg	61	31	25	7	7	7	8	8	19	4	5	5	5	5	5
Polymer & Resin Mfg	NA	NA	NA	4	4	4	5	5	5	4	5	4	4	4	4
Agricultural Chemical Mfg	46	38	61	9	9	9	9	10	11	11	11	11	10	10	10
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	NA	0	0	0	0	0	1	1	1	1	1	1	1
Pharmaceutical Mfg	NA	NA	NA	0	0	0	0	0	1	0	0	0	0	0	0
Other Chemical Mfg	86	37	42	18	18	17	18	18	14	20	20	18	27	18	18
METALS PROCESSING	***1,316***	***825***	***622***	***220***	***203***	***194***	***208***	***211***	***214***	***251***	***250***	***181***	***184***	***212***	***211***
Nonferrous Metals Processing	593	229	130	46	44	42	45	45	50	46	47	40	39	41	40
copper	*343*	*66*	*32*	*3*	*3*	*3*	*3*	*3*	*14*	*14*	*15*	*12*	*11*	*12*	*11*
lead	*53*	*31*	*18*	*4*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*2*	*2*	*3*	*3*
zinc	*20*	*11*	*3*	*3*	*2*	*2*	*3*	*3*	*6*	*6*	*6*	*1*	*2*	*2*	*2*
other	*177*	*121*	*77*	*36*	*35*	*33*	*36*	*36*	*27*	*23*	*23*	*25*	*25*	*25*	*25*
Ferrous Metals Processing	198	275	322	164	149	142	153	156	155	123	115	121	125	149	149
primary	*31*	*198*	*271*	*136*	*122*	*116*	*126*	*129*	*128*	*99*	*92*	*97*	*100*	*123*	*123*
secondary	*167*	*77*	*51*	*26*	*25*	*24*	*26*	*26*	*25*	*24*	*23*	*24*	*25*	*26*	*26*
other	*NA*	*NA*	*NA*	*2*	*2*	*2*	*2*	*2*	*2*	*0*	*0*	*0*	*0*	*0*	*0*
Metals Processing NEC	525	321	170	10	10	9	10	10	9	82	88	20	20	22	22
PETROLEUM & RELATED INDUSTRIES	***286***	***179***	***138***	***63***	***63***	***62***	***60***	***58***	***55***	***43***	***43***	***38***	***38***	***40***	***40***
Oil & Gas Production	NA	NA	NA	0	0	0	0	0	2	2	2	2	2	2	2
Petroleum Refineries & Related Indus	69	56	41	28	27	26	25	24	20	20	21	20	19	20	20
fluid catalytic cracking units	*69*	*56*	*41*	*24*	*23*	*23*	*22*	*21*	*17*	*17*	*18*	*17*	*16*	*18*	*18*
other	*NA*	*NA*	*NA*	*4*	*4*	*4*	*4*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Asphalt Manufacturing	217	123	97	35	36	35	35	34	33	21	20	17	17	18	18
OTHER INDUSTRIAL PROCESSES	***5,832***	***2,572***	***1,846***	***611***	***620***	***606***	***601***	***591***	***583***	***520***	***506***	***501***	***495***	***511***	***510***
Agriculture, Food, & Kindred Products	485	429	402	68	70	71	73	72	73	80	69	73	73	80	80
country elevators	*257*	*247*	*258*	*7*	*8*	*8*	*9*	*9*	*9*	*10*	*10*	*10*	*9*	*9*	*9*
terminal elevators	*147*	*111*	*86*	*6*	*6*	*6*	*6*	*6*	*6*	*7*	*8*	*8*	*7*	*7*	*7*
feed mills	*5*	*3*	*3*	*6*	*7*	*7*	*7*	*7*	*7*	*4*	*5*	*5*	*5*	*5*	*4*
soybean mills	*25*	*27*	*22*	*13*	*13*	*14*	*14*	*14*	*14*	*15*	*11*	*12*	*12*	*12*	*12*

(continued)

Table A-5. Particulate Matter (PM-10) Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
OTHER INDUSTRIAL PROCESSES (continued)															
Agriculture, Food, & Kindred Products (continued)															
wheat mills	5	1	1	3	4	3	4	3	3	4	4	4	4	4	4
other grain mills	9	8	6	7	7	7	8	8	8	6	5	6	6	7	7
other	38	32	26	25	26	26	26	25	25	34	26	28	30	37	37
Textiles, Leather, & Apparel Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Pr	727	274	183	101	104	106	108	106	105	81	79	78	76	81	82
sulfate (kraft) pulping	668	228	142	71	73	73	73	74	73	53	50	49	50	53	54
other	59	46	41	30	32	33	34	33	32	27	29	29	26	28	28
Rubber & Miscellaneous Plastic Produ	NA	NA	NA	3	3	3	4	4	4	4	4	3	3	3	3
Mineral Products	4,620	1,869	1,261	401	405	391	382	374	367	320	318	316	313	317	314
cement mfg	1,731	703	417	213	214	206	198	193	190	147	145	140	139	140	137
surface mining	134	111	127	20	19	16	16	15	15	14	15	17	17	17	17
stone quarrying/processing	957	508	421	52	55	55	56	54	54	59	60	60	58	58	58
other	1,798	547	296	116	117	114	113	111	108	99	98	99	100	102	102
Machinery Products	NA	NA	NA	8	8	8	9	9	9	8	9	7	7	7	7
Electronic Equipment	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	NA	NA	NA	2	2	2	2	2	2	2	2	0	0	0	0
Construction	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	28	27	24	24	23	23	25	24	22	22	23	23
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***2***	***2***	***2***	***2***	***2***	***4***	***5***	***5***	***6***	***6***	***6***	***6***
Degreasing	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating	NA	NA	NA	2	2	2	2	2	3	4	4	5	5	5	5
Other Industrial	NA	NA	NA	0	0	0	0	0	1	1	1	1	1	1	1
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***107***	***104***	***100***	***101***	***101***	***102***	***101***	***117***	***114***	***106***	***109***	***109***
Bulk Terminals & Plants	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum & Petroleum Product Stora	NA	NA	NA	0	0	0	0	0	0	1	1	1	0	0	0
Petroleum & Petroleum Product Trans	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Service Stations: Stage II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
Organic Chemical Storage	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	1
Organic Chemical Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Inorganic Chemical Storage	NA	NA	NA	0	0	0	0	0	1	1	1	1	1	1	1
Inorganic Chemical Transport	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	105	102	99	99	99	100	99	115	111	104	107	107
storage	NA	NA	NA	33	33	32	32	31	31	27	30	32	31	30	30
transfer	NA	NA	NA	72	68	66	66	67	69	71	85	79	73	76	77
combined	NA	NA	NA	1	1	1	1	1	1	0	0	0	0	0	0
other	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	NA	0	0	0
Bulk Materials Transport	NA	NA	NA	0	0	0	0	0	1	0	0	0	0	0	0

(continued)

Table A-5. Particulate Matter (PM-10) Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
WASTE DISPOSAL & RECYCLING	***999***	***371***	***273***	***278***	***274***	***265***	***259***	***251***	***271***	***276***	***278***	***334***	***313***	***287***	***290***
Incineration	229	95	75	52	52	51	51	50	65	66	65	119	96	69	71
residential	*51*	*49*	*42*	*39*	*38*	*37*	*36*	*35*	*39*	*41*	*43*	*44*	*45*	*45*	*46*
other	*178*	*46*	*32*	*13*	*14*	*14*	*15*	*15*	*26*	*25*	*23*	*74*	*52*	*25*	*25*
Open Burning	770	276	198	225	222	214	208	200	206	209	211	214	216	217	218
residential	*770*	*276*	*198*	*221*	*217*	*209*	*203*	*195*	*195*	*197*	*199*	*202*	*203*	*204*	*205*
other	*NA*	*NA*	*NA*	*4*	*4*	*4*	*5*	*5*	*11*	*12*	*12*	*13*	*13*	*13*	*13*
POTW	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Industrial Waste Water	NA	NA	NA	0	0	0	0	0	NA	0	0	0	0	0	0
TSDF	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Landfills	NA	NA	NA	0	0	0	0	0	0	0	1	1	1	0	0
Other	NA	NA	NA	0	0	0	0	0	0	0	0	0	1	1	1
ON-ROAD VEHICLES	***443***	***471***	***397***	***363***	***356***	***360***	***369***	***367***	***336***	***349***	***343***	***321***	***320***	***293***	***274***
Light-Duty Gas Vehicles & Motorcycles	225	207	120	77	69	66	66	65	61	63	64	65	62	62	63
light-duty gas vehicles	*224*	*206*	*119*	*77*	*69*	*65*	*66*	*64*	*61*	*63*	*63*	*64*	*61*	*62*	*62*
motorcycles	*1*	*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Light-Duty Gas Trucks	70	72	55	43	39	37	37	34	30	32	31	31	35	32	31
light-duty gas trucks 1	*41*	*39*	*25*	*19*	*17*	*17*	*16*	*16*	*16*	*15*	*15*	*15*	*17*	*17*	*17*
light-duty gas trucks 2	*29*	*34*	*29*	*24*	*22*	*21*	*20*	*19*	*14*	*17*	*17*	*16*	*18*	*14*	*14*
Heavy-Duty Gas Vehicles	13	15	15	14	13	12	12	11	10	10	9	10	10	9	9
Diesels	136	177	208	229	236	245	254	257	235	245	239	215	213	190	172
heavy-duty diesel vehicles	*136*	*166*	*194*	*219*	*226*	*235*	*244*	*247*	*224*	*234*	*228*	*205*	*204*	*181*	*162*
light-duty diesel trucks	*NA*	*NA*	*2*	*1*	*1*	*2*	*2*	*2*	*1*	*2*	*2*	*2*	*2*	*2*	*2*
light-duty diesel vehicles	*NA*	*10*	*12*	*8*	*8*	*8*	*9*	*9*	*9*	*9*	*9*	*8*	*8*	*8*	*8*
NON-ROAD ENGINES AND VEHICLES	***369***	***441***	***566***	***561***	***634***	***520***	***672***	***649***	***598***	***598***	***618***	***633***	***652***	***585***	***591***
Non-Road Gasoline	35	38	41	43	43	44	44	44	49	49	50	50	51	50	51
recreational	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
construction	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
industrial	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
lawn & garden	*10*	*11*	*11*	*12*	*12*	*12*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*14*
farm	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
light commercial	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
logging	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
airport service	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
other	*21*	*23*	*24*	*25*	*25*	*26*	*26*	*26*	*29*	*30*	*30*	*30*	*30*	*30*	*30*

(continued)

Table A-5. Particulate Matter (PM-10) Emissions (continued)
(thousand short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
NON-ROAD ENGINES AND VEHICLES (continued)															
Non-Road Diesel	281	341	439	420	489	371	515	488	420	420	436	457	479	438	444
recreational	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
construction	102	111	148	161	167	161	161	169	160	152	160	171	183	164	166
industrial	17	19	23	29	27	27	28	26	29	28	29	30	31	31	31
lawn & garden	6	6	7	7	7	7	7	7	7	7	8	8	8	8	8
farm	140	185	239	195	263	148	291	262	196	204	212	219	226	204	208
light commercial	8	9	9	11	10	11	11	10	11	11	11	11	12	12	12
logging	2	4	6	7	6	7	6	6	7	7	7	7	8	8	8
airport service	5	6	7	9	9	9	9	8	10	10	10	10	11	10	11
Aircraft	21	26	33	37	38	40	42	43	44	44	45	43	41	40	40
Marine Vessels	6	7	17	20	21	23	25	27	31	33	32	31	31	30	30
coal	1	1	2	2	2	3	3	3	3	3	3	3	3	3	3
diesel	4	4	10	12	13	13	15	16	18	19	19	18	18	18	18
residual oil	2	2	5	6	6	7	7	8	9	10	10	9	9	9	9
gasoline	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1	1	1	1	1
Railroads	25	30	37	41	42	43	45	47	53	53	54	52	50	27	27
NATURAL SOURCES	***NA***	***NA***	***NA***	***4,047***	***10,324***	***1,577***	***18,110***	***12,101***	***2,092***	***2,077***	***2,227***	***509***	***2,160***	***1,146***	***5,316***
Geogenic	NA	NA	NA	4,047	10,324	1,577	18,110	12,101	2,092	2,077	2,227	509	2,160	1,146	5,316
wind erosion	NA	NA	NA	4,047	10,324	1,577	18,110	12,101	2,092	2,077	2,227	509	2,160	1,146	5,316
MISCELLANEOUS	***839***	***569***	***852***	***37,736***	***37,077***	***37,453***	***39,444***	***37,461***	***24,419***	***24,122***	***23,865***	***24,196***	***25,461***	***22,454***	***22,702***
Agriculture & Forestry	NA	NA	NA	7,108	7,183	7,326	7,453	7,320	5,146	5,106	4,909	4,475	4,690	4,661	4,708
agricultural crops	NA	NA	NA	6,833	6,899	6,996	7,077	6,923	4,745	4,684	4,464	4,016	4,281	4,334	4,395
agricultural livestock	NA	NA	NA	275	285	330	376	396	402	422	446	458	409	328	313
Other Combustion	839	569	852	894	819	988	1,704	912	1,203	941	785	768	1,048	778	783
wildfires	385	206	514	308	226	389	1,086	300	601	332	171	152	424	145	145
managed burning	390	325	315	527	534	540	559	553	558	563	568	570	578	586	591
other	64	37	23	59	59	59	59	59	45	45	46	46	46	46	47
Cooling Towers	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	1	1
Fugitive Dust	NA	NA	NA	29,734	29,075	29,139	30,287	29,229	18,069	18,076	18,171	18,954	19,722	17,013	17,209
wind erosion	NA	NA	NA	0	0	0	0	0	1	1	1	1	1	1	1
unpaved roads	NA	NA	NA	11,644	11,673	11,110	12,379	11,798	11,234	11,206	10,918	11,430	11,370	10,362	10,303
paved roads	NA	NA	NA	5,080	5,262	5,530	5,900	5,769	2,248	2,399	2,423	2,462	2,538	2,409	2,417
construction	NA	NA	NA	12,670	11,825	12,121	11,662	11,269	4,249	4,092	4,460	4,651	5,245	3,654	3,950
other	NA	NA	NA	339	314	377	346	392	336	377	369	409	569	586	538
TOTAL ALL SOURCES	**13,190**	**7,803**	**7,287**	**45,584**	**51,136**	**42,533**	**61,275**	**53,240**	**29,947**	**29,557**	**29,506**	**28,023**	**30,926**	**26,888**	**31,301**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

No data was available after 1984 to weigh the emissions from residential wood burning devices.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-6. Lead Emissions
(short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
FUEL COMB. ELEC. UTIL.	***327***	***230***	***129***	***64***	***69***	***64***	***66***	***67***	***64***	***61***	***59***	***61***	***61***	***57***	***62***
Coal	300	189	95	51	50	48	46	46	46	46	47	49	49	50	50
bituminous	*181*	*114*	*57*	*31*	*30*	*29*	*28*	*28*	*28*	*28*	*28*	*30*	*30*	*30*	*31*
subbituminous	*89*	*56*	*28*	*15*	*15*	*14*	*14*	*14*	*14*	*14*	*14*	*15*	*15*	*15*	*15*
anthracite & lignite	*30*	*19*	*9*	*5*	*5*	*5*	*4*	*4*	*4*	*4*	*4*	*5*	*5*	*5*	*5*
Oil	28	41	34	13	19	16	20	21	18	15	12	12	12	7	12
residual	*27*	*40*	*34*	*13*	*19*	*16*	*20*	*21*	*18*	*15*	*12*	*12*	*12*	*7*	*12*
distillate	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
FUEL COMB. INDUSTRIAL	***237***	***75***	***60***	***30***	***25***	***22***	***19***	***18***	***18***	***18***	***18***	***19***	***18***	***16***	***17***
Coal	218	60	45	22	17	14	14	14	14	15	14	14	14	14	14
bituminous	*146*	*40*	*31*	*15*	*12*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*9*	*9*
subbituminous	*45*	*12*	*10*	*5*	*4*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
anthracite & lignite	*27*	*7*	*4*	*2*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Oil	19	16	14	8	8	8	5	4	3	3	4	5	4	3	3
residual	*17*	*14*	*14*	*7*	*7*	*7*	*5*	*3*	*3*	*2*	*3*	*4*	*4*	*2*	*3*
distillate	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*0*	*0*
FUEL COMB. OTHER	***10,052***	***10,042***	***4,111***	***421***	***422***	***425***	***426***	***420***	***418***	***416***	***414***	***415***	***415***	***414***	***414***
Commercial/Institutional Coal	1	16	12	6	6	5	5	4	4	3	4	4	3	3	3
bituminous	*1*	*6*	*6*	*4*	*4*	*3*	*3*	*3*	*3*	*2*	*2*	*2*	*2*	*2*	*2*
subbituminous	*NA*	*2*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
anthracite, lignite	*NA*	*7*	*4*	*1*	*1*	*1*	*1*	*1*	*0*	*0*	*0*	*1*	*0*	*0*	*0*
Commercial/Institutional Oil	4	11	10	4	5	5	5	4	4	4	4	3	3	3	4
residual	*3*	*10*	*9*	*3*	*4*	*4*	*4*	*3*	*3*	*3*	*3*	*3*	*3*	*2*	*3*
distillate	*NA*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
other	*1*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Misc. Fuel Comb. (Except Residential)	10,000	10,000	4,080	400	400	400	400	400	400	400	400	400	400	400	400
Residential Other	47	16	9	11	11	14	16	12	10	9	7	8	8	8	7
CHEMICAL & ALLIED PRODUCT MFG	***103***	***120***	***104***	***118***	***108***	***123***	***136***	***136***	***136***	***132***	***93***	***92***	***96***	***144***	***117***
Inorganic Chemical Mfg	103	120	104	118	108	123	136	136	136	132	93	92	96	144	117
lead oxide and pigments	*103*	*120*	*104*	*118*	*108*	*123*	*136*	*136*	*136*	*132*	*93*	*92*	*96*	*144*	*117*

(continued)

Table A-6. Lead Emissions (continued)
(short tons)

Source Category	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
METALS PROCESSING	***24,224***	***9,923***	***3,026***	***2,097***	***1,820***	***1,835***	***1,965***	***2,088***	***2,169***	***1,975***	***1,773***	***1,899***	***2,027***	***2,067***	***2,000***
Nonferrous Metals Processing	15,869	7,192	1,826	1,376	1,161	1,204	1,248	1,337	1,409	1,258	1,111	1,211	1,288	1,339	1,282
primary lead production	*12,134*	*5,640*	*1,075*	*874*	*660*	*673*	*684*	*715*	*728*	*623*	*550*	*637*	*633*	*674*	*636*
primary copper production	*242*	*171*	*20*	*19*	*16*	*16*	*17*	*19*	*19*	*19*	*20*	*21*	*22*	*21*	*22*
primary zinc production	*1,019*	*224*	*24*	*16*	*11*	*7*	*8*	*9*	*9*	*11*	*11*	*13*	*12*	*12*	*13*
secondary lead production	*1,894*	*821*	*481*	*288*	*296*	*347*	*353*	*433*	*449*	*414*	*336*	*341*	*405*	*432*	*400*
secondary copper production	*374*	*200*	*116*	*70*	*63*	*31*	*61*	*37*	*75*	*65*	*73*	*70*	*76*	*79*	*85*
lead battery manufacture	*41*	*49*	*50*	*65*	*66*	*73*	*73*	*74*	*78*	*77*	*77*	*81*	*94*	*105*	*105*
lead cable coating	*127*	*55*	*37*	*43*	*47*	*56*	*50*	*50*	*50*	*48*	*44*	*47*	*44*	*16*	*21*
other	*38*	*32*	*24*	*3*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Ferrous Metals Processing	7,395	2,196	911	577	553	499	554	582	576	517	461	495	540	545	524
coke manufacturing	*11*	*8*	*6*	*3*	*3*	*3*	*4*	*4*	*4*	*3*	*3*	*2*	*0*	*0*	*0*
ferroalloy production	*219*	*104*	*13*	*7*	*13*	*14*	*14*	*20*	*18*	*14*	*14*	*12*	*13*	*8*	*7*
iron production	*266*	*93*	*38*	*21*	*16*	*17*	*18*	*19*	*18*	*16*	*17*	*18*	*18*	*19*	*18*
steel production	*3,125*	*1,082*	*481*	*209*	*200*	*128*	*157*	*138*	*138*	*145*	*139*	*145*	*160*	*152*	*160*
gray iron production	*3,773*	*910*	*373*	*336*	*320*	*337*	*361*	*401*	*397*	*339*	*288*	*319*	*349*	*366*	*339*
Metals Processing NEC	960	535	289	144	107	132	164	169	184	199	201	193	200	183	194
metal mining	*353*	*268*	*207*	*141*	*106*	*131*	*163*	*169*	*184*	*198*	*201*	*193*	*199*	*183*	*193*
other	*606*	*268*	*82*	*3*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
OTHER INDUSTRIAL PROCESSES	***2,028***	***1,337***	***808***	***316***	***199***	***202***	***172***	***173***	***169***	***167***	***56***	***54***	***53***	***59***	***57***
Mineral Products	540	217	93	43	25	28	23	23	26	24	26	27	28	29	30
cement manufacturing	*540*	*217*	*93*	*43*	*25*	*28*	*23*	*23*	*26*	*24*	*26*	*27*	*28*	*29*	*30*
Miscellaneous Industrial Processes	1,488	1,120	715	273	174	174	149	150	143	143	30	28	26	30	28
WASTE DISPOSAL & RECYCLING	***2,200***	***1,595***	***1,210***	***871***	***844***	***844***	***817***	***765***	***804***	***807***	***812***	***824***	***829***	***622***	***638***
Incineration	2,200	1,595	1,210	871	844	844	817	765	804	807	812	824	829	622	638
municipal waste	*581*	*396*	*161*	*79*	*52*	*52*	*49*	*45*	*67*	*70*	*68*	*69*	*68*	*70*	*74*
other	*1,619*	*1,199*	*1,049*	*792*	*792*	*792*	*768*	*720*	*738*	*738*	*744*	*756*	*762*	*552*	*564*
ON-ROAD VEHICLES	***171,961***	***130,206***	***60,501***	***18,052***	***10,245***	***3,317***	***2,566***	***982***	***421***	***18***	***18***	***19***	***19***	***19***	***19***
Light-Duty Gas Vehicles & Motorcycles	142,918	106,868	47,184	13,637	7,676	2,471	1,919	733	314	13	14	14	14	14	14
Light-Duty Gas Trucks	22,683	19,440	11,671	4,061	2,400	795	605	232	100	4	4	5	5	5	5
Heavy-Duty Gas Vehicles	6,361	3,898	1,646	354	169	51	42	16	7	0	0	0	0	0	0
NON-ROAD ENGINES AND VEHICLES	***9,737***	***6,130***	***4,205***	***921***	***1,030***	***850***	***885***	***820***	***776***	***574***	***565***	***529***	***525***	***545***	***545***
Non-Road Gasoline	8,340	5,012	3,320	229	219	222	211	166	158	0	0	0	0	0	0
Aircraft	1,397	1,118	885	692	811	628	674	655	619	574	565	528	525	545	545
TOTAL ALL SOURCES	**220,869**	**159,659**	**74,153**	**22,890**	**14,763**	**7,681**	**7,053**	**5,468**	**4,975**	**4,168**	**3,808**	**3,911**	**4,043**	**3,943**	**3,869**

Note(s): NA=not available
In order to convert emissions to megagrams (metric tons), multiply the above values by 0.9072.

Appendix B National Emissions (1999 to 2010) by Tier II Source Category and Pollutant

Table B-1. Carbon Monoxide Emissions, 1999 to 2010 (thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
FUEL COMB. ELEC. UTIL.	**569**	**592**	**635**	**715**	**745**	**766**	**815**
Coal	297	298	299	302	306	306	307
Oil	13	13	14	14	13	13	13
Gas	74	75	75	76	76	76	75
Internal Combustion-new units	122	143	182	255	279	299	346
Internal Combustion-existing units	62	64	66	69	71	73	75
FUEL COMB. INDUSTRIAL	**1,045**	**1,067**	**1,073**	**1,091**	**1,095**	**1,096**	**1,104**
Coal	94	95	96	96	96	97	97
Oil	57	63	65	67	67	62	63
Gas	347	352	349	351	352	352	350
Other	293	296	304	315	316	320	327
Internal Combustion	256	260	260	262	264	265	265
FUEL COMB. OTHER	**4,392**	**4,377**	**4,275**	**4,219**	**4,125**	**4,112**	**4,093**
Commercial/Institutional Coal	12	13	13	13	14	14	14
Commercial/Institutional Oil	17	17	17	18	18	18	19
Commercial/Institutional Gas	53	54	56	58	60	61	62
Misc. Fuel Comb. (Except Residential)	149	151	156	163	168	170	175
Residential Wood	3,948	3,931	3,826	3,770	3,670	3,654	3,630
Residential Other	212	211	207	197	196	195	193
CHEMICAL & ALLIED PRODUCT MFG	**1,276**	**1,289**	**1,325**	**1,379**	**1,415**	**1,433**	**1,469**
Organic Chemicals	134	136	140	147	151	153	157
Inorganic Chemicals	140	141	145	151	155	156	160
Polymers & Resins	5	5	6	6	6	6	6
Agricultural Chemicals	18	18	18	19	20	20	21
Paints, Varnishs, Lacquers, Enamels	0	0	0	0	0	0	0
Pharmaceuticals	0	0	0	0	0	0	0
Other Chemicals	979	988	1,015	1,057	1,084	1,098	1,125
METALS PROCESSING	**2,479**	**2,465**	**2,463**	**2,460**	**2,464**	**2,467**	**2,470**
Non-Ferrous Metals Processing	450	453	457	463	468	470	475
Ferrous Metals Processing	2,001	1,984	1,978	1,967	1,966	1,966	1,964
Metals Processing NEC	27	28	29	30	30	30	31
PETROLEUM & RELATED INDUSTRIES	**365**	**369**	**379**	**394**	**403**	**408**	**418**
Oil & Gas Production	35	35	35	35	35	35	35
Petroleum Refineries & Related Industries	325	329	338	353	363	368	377
Asphalt Manufacturing	5	5	5	6	6	6	6
OTHER INDUSTRIAL PROCESSES	**683**	**695**	**720**	**758**	**783**	**796**	**822**
Agriculture, Food, & Kindred Products	7	7	7	7	8	8	8
Textiles, Leather, & Apparel Products	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	535	546	568	601	623	634	656
Rubber & Miscellaneous Plastic Products	0	0	0	0	0	0	0
Mineral Products	134	135	138	142	146	147	150
Machinery Products	0	0	0	0	0	0	0
Electronic Equipment	2	2	2	2	2	2	2
Transportation Equipment	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	4	4	4	5	5	5	5

Table B-1. Carbon Monoxide Emissions, 1999 to 2010 (continued)
(thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
SOLVENT UTILIZATION	**6**	**6**	**7**	**7**	**7**	**7**	**7**
Degreasing	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	0
Dry Cleaning	1	1	1	1	1	1	1
Surface Coating	1	1	1	1	1	1	1
Other Industrial	4	4	4	4	4	5	5
Nonindustrial	0	0	0	0	0	0	0
STORAGE & TRANSPORT	**26**	**26**	**27**	**28**	**28**	**29**	**29**
Bulk Terminals & Plants	4	4	4	4	4	4	4
Petroleum & Petroleum Product Storage	4	4	4	5	5	5	5
Petroleum & Petroleum Product Transport	0	0	0	0	0	0	0
Service Stations: Stage II	0	0	0	0	0	0	0
Organic Chemical Storage	14	14	15	15	16	16	17
Organic Chemical Transport	0	0	0	0	0	0	0
Inorganic Chemical Storage	0	0	0	0	0	0	0
Inorganic Chemical Transport	0	0	0	0	0	0	0
Bulk Materials Storage	3	3	3	3	3	3	3
WASTE DISPOSAL & RECYCLING	**1,128**	**1,140**	**1,165**	**1,201**	**1,225**	**1,237**	**1,262**
Incineration	419	424	433	446	455	459	468
Open Burning	706	714	729	752	768	775	791
POTW	0	0	0	0	0	0	0
Industrial Waste Water	0	0	0	0	0	0	0
TSDF	0	0	0	0	0	0	0
Landfills	2	2	2	2	2	2	2
Other	1	1	1	1	1	1	1
ON-ROAD VEHICLES	**44,966**	**44,244**	**43,156**	**40,061**	**39,870**	**39,979**	**40,201**
Light-Duty Gasoline Vehicles	26,987	26,467	25,596	22,984	22,442	22,305	22,149
Light-Duty Gasoline Trucks-1	8,098	8,051	8,028	7,728	7,824	7,916	8,106
Light-Duty Gasoline Trucks-2	5,465	5,449	5,517	5,490	5,695	5,832	6,071
Heavy-Duty Gasoline Trucks	2,583	2,397	2,062	1,797	1,767	1,738	1,594
Light-Duty Diesel Vehicles	11	8	5	3	1	1	0
Light-Duty Diesel Trucks	4	4	3	2	2	2	2
Heavy-Duty Diesel Vehicles	1,603	1,651	1,721	1,822	1,896	1,937	2,023
Motorcycles	213	217	224	236	243	247	255
NON-ROAD ENGINES AND VEHICLES	**16,140**	**16,362**	**16,789**	**17,433**	**17,860**	**18,073**	**18,495**
Non-Road Gasoline	12,973	13,144	13,468	13,953	14,268	14,425	14,741
Non-Road Diesel	1,998	2,022	2,071	2,150	2,205	2,234	2,294
Aircraft	989	1,017	1,071	1,150	1,205	1,233	1,279
Marine Vessels	75	76	76	76	77	77	78
Railroads	104	104	104	104	104	104	104
MISCELLANEOUS	**7,142**	**7,172**	**7,232**	**7,323**	**7,380**	**7,409**	**7,466**
Other Combustion	7,141	7,171	7,232	7,323	7,380	7,408	7,465
Cooling Towers	0	0	0	0	0	0	0
Fugitive Dust	0	0	0	1	1	1	1
TOTAL	**80,216**	**79,805**	**79,246**	**77,068**	**77,401**	**77,811**	**78,651**

Table B-2. Nitrogen Oxide Emissions, 1999 to 2010 (thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
FUEL COMB. ELEC. UTIL.	**5,851**	**5,222**	**5,273**	**5,459**	**5,607**	**5,639**	**5,728**
Coal	4,892	4,240	4,250	4,367	4,491	4,506	4,558
Oil	100	101	104	103	103	103	98
Gas	592	594	594	598	597	594	592
Internal Combustion-new units	106	122	154	211	232	248	286
Internal Combustion-existing units	161	165	171	180	186	188	194
FUEL COMB. INDUSTRIAL	**3,086**	**3,160**	**3,159**	**3,184**	**3,199**	**3,193**	**3,195**
Coal	587	598	604	603	605	615	616
Oil	187	209	215	222	225	207	212
Gas	1,308	1,332	1,325	1,338	1,346	1,348	1,345
Other	126	127	129	133	134	135	138
Internal Combustion	878	895	886	888	889	888	884
FUEL COMB. OTHER	**1,106**	**1,109**	**1,104**	**1,102**	**1,107**	**1,111**	**1,115**
Commercial/Institutional Coal	30	31	31	32	34	34	34
Commercial/Institutional Oil	90	92	93	96	98	99	100
Commercial/Institutional Gas	230	233	241	252	260	263	271
Misc. Fuel Comb. (Except Residential)	30	31	32	34	35	36	37
Residential Wood	48	48	46	46	45	44	44
Residential Other	679	674	661	642	636	636	629
CHEMICAL & ALLIED PRODUCT MFG	**166**	**167**	**172**	**179**	**183**	**186**	**190**
Organic Chemicals	21	21	22	23	23	23	24
Inorganic Chemicals	7	7	8	8	8	8	9
Polymers & Resins	4	4	4	4	4	5	5
Agricultural Chemicals	79	79	82	85	87	88	90
Paints, Varnishs, Lacquers, Enamels	0	0	0	0	0	0	0
Pharmaceuticals	0	0	0	0	0	0	0
Other Chemicals	55	55	57	59	60	61	63
METALS PROCESSING	**105**	**105**	**106**	**108**	**110**	**110**	**112**
Non-Ferrous Metals Processing	13	13	13	14	14	14	14
Ferrous Metals Processing	88	88	89	90	91	92	93
Metals Processing NEC	4	4	4	4	4	4	4
PETROLEUM & RELATED INDUSTRIES	**118**	**120**	**123**	**127**	**130**	**132**	**134**
Oil & Gas Production	64	65	67	69	70	71	73
Petroleum Refineries & Related Industries	49	49	51	53	54	55	56
Asphalt Manufacturing	5	5	5	6	6	6	6
OTHER INDUSTRIAL PROCESSES	**420**	**423**	**433**	**447**	**457**	**462**	**473**
Agriculture, Food, & Kindred Products	6	6	6	7	7	7	7
Textiles, Leather, & Apparel Products	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	97	99	103	108	112	114	117
Rubber & Miscellaneous Plastic Products	0	0	0	0	0	0	0
Mineral Products	299	300	305	313	319	322	328
Machinery Products	7	7	7	7	7	8	8
Electronic Equipment	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	10	10	10	11	11	11	11

Table B-2. Nitrogen Oxide Emissions, 1999 to 2010 (continued)
(thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
SOLVENT UTILIZATION	**3**	**3**	**3**	**3**	**3**	**4**	**4**
Degreasing	0	0	0	0	0	0	0
Graphic Arts	1	1	1	1	1	1	1
Dry Cleaning	0	0	0	0	0	0	0
Surface Coating	2	2	2	2	2	2	2
Other Industrial	0	0	0	0	0	0	0
Nonindustrial	0	0	0	0	0	0	0
Solvent Utilization NEC	0	0	0	0	0	0	0
STORAGE & TRANSPORT	**6**	**6**	**7**	**7**	**7**	**7**	**7**
Bulk Terminals & Plants	1	1	1	1	1	1	1
Petroleum & Petroleum Product Storage	0	0	0	0	0	0	0
Petroleum & Petroleum Product Transport	0	0	0	0	0	0	0
Service Stations: Stage II	0	0	0	0	0	0	0
Organic Chemical Storage	4	4	4	4	4	4	4
Organic Chemical Transport	0	0	0	0	0	0	0
Inorganic Chemical Storage	0	0	0	0	0	0	0
Inorganic Chemical Transport	0	0	0	0	0	0	0
Bulk Materials Storage	1	1	1	1	1	1	1
WASTE DISPOSAL & RECYCLING	**99**	**100**	**103**	**107**	**110**	**111**	**114**
Incineration	56	57	58	61	63	64	66
Open Burning	42	42	43	44	45	46	46
POTW	0	0	0	0	0	0	0
Industrial Waste Water	0	0	0	0	0	0	0
TSDF	0	0	0	0	0	0	0
Landfills	1	1	1	1	1	1	1
Other	1	1	1	1	1	1	1
ON-ROAD VEHICLES	**6,504**	**6,397**	**6,227**	**5,796**	**5,571**	**5,491**	**5,354**
Light-Duty Gasoline Vehicles	2,850	2,797	2,716	2,469	2,378	2,349	2,297
Light-Duty Gasoline Trucks-1	845	837	827	782	773	775	783
Light-Duty Gasoline Trucks-2	580	579	586	590	609	623	644
Heavy-Duty Gasoline Trucks	318	318	317	322	328	332	337
Light-Duty Diesel Vehicles	12	9	5	3	1	1	0
Light-Duty Diesel Trucks	5	4	3	2	2	2	2
Heavy-Duty Diesel Vehicles	1,879	1,840	1,759	1,614	1,463	1,394	1,275
Motorcycles	14	14	14	15	16	16	16
NON-ROAD ENGINES AND VEHICLES	**4,596**	**4,542**	**4,452**	**4,382**	**4,380**	**4,388**	**4,424**
Non-Road Gasoline	206	210	216	225	231	234	240
Non-Road Diesel	2,939	2,878	2,775	2,685	2,668	2,669	2,694
Aircraft	170	173	180	189	197	201	205
Marine Vessels	206	206	207	208	209	209	211
Railroads	1,075	1,075	1,075	1,075	1,075	1,075	1,075
MISCELLANEOUS	**240**	**241**	**242**	**244**	**246**	**246**	**248**
Other Combustion	238	239	240	242	244	244	246
Catastrophic/Accidental Releases	0	0	0	0	0	0	0
Health Services	0	0	0	0	0	0	0
Cooling Towers	0	0	0	0	0	0	0
Fugitive Dust	2	2	2	2	2	2	2
TOTAL	**22,299**	**21,596**	**21,404**	**21,146**	**21,109**	**21,081**	**21,099**

Table B-3. Volatile Organic Compound Emissions, 1999 to 2010 (thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
FUEL COMB. ELEC. UTIL.	**64**	**67**	**71**	**80**	**84**	**86**	**92**
Coal	33	33	34	34	35	35	35
Oil	3	3	3	3	3	3	3
Gas	4	4	4	4	4	4	4
Internal Combustion-new units	13	16	20	27	30	32	37
Internal Combustion-existing units	11	11	11	12	12	12	13
FUEL COMB. INDUSTRIAL	**205**	**208**	**207**	**210**	**210**	**211**	**212**
Coal	6	6	6	6	6	6	6
Oil	10	11	11	12	12	11	11
Gas	72	73	70	70	70	70	70
Other	50	51	52	54	55	55	57
Internal Combustion	67	69	68	68	68	68	68
FUEL COMB. OTHER	**737**	**718**	**668**	**612**	**567**	**550**	**517**
Commercial/Institutional Coal	1	1	1	1	1	1	1
Commercial/Institutional Oil	3	3	3	3	3	3	3
Commercial/Institutional Gas	11	11	11	12	12	12	12
Misc. Fuel Comb. (Except Residential)	8	9	9	9	10	10	10
Residential Wood	684	664	615	559	513	496	462
Residential Other	30	30	29	28	28	28	28
CHEMICAL & ALLIED PRODUCT MFG	**463**	**466**	**421**	**400**	**411**	**416**	**427**
Organic Chemicals	100	101	105	101	104	106	109
Inorganic Chemicals	3	3	3	3	3	3	3
Polymers & Resins	159	161	111	85	87	88	90
Agricultural Chemicals	6	6	6	5	5	5	6
Paints, Varnishs, Lacquers, Enamels	10	10	11	11	11	12	12
Pharmaceuticals	36	34	31	32	33	34	35
Other Chemicals	149	151	155	162	166	168	172
METALS PROCESSING	**104**	**104**	**105**	**107**	**108**	**108**	**109**
Non-Ferrous Metals Processing	23	23	23	23	24	24	24
Ferrous Metals Processing	73	73	73	74	74	74	75
Metals Processing NEC	9	9	9	9	10	10	10
PETROLEUM & RELATED INDUSTRIES	**396**	**399**	**335**	**338**	**341**	**342**	**345**
Oil & Gas Production	265	267	210	208	208	207	207
Petroleum Refineries & Related Industries	127	128	121	126	129	131	134
Asphalt Manufacturing	4	4	4	4	4	4	4
OTHER INDUSTRIAL PROCESSES	**402**	**407**	**394**	**374**	**384**	**389**	**399**
Agriculture, Food, & Kindred Products	135	137	140	144	147	149	152
Textiles, Leather, & Apparel Products	19	19	19	20	20	21	21
Wood, Pulp & Paper, & Publishing Products	73	74	76	58	60	61	63
Rubber & Miscellaneous Plastic Products	67	69	47	36	37	38	40
Mineral Products	33	33	34	35	35	36	36
Machinery Products	12	12	12	12	12	13	13
Electronic Equipment	2	2	2	2	2	2	2
Transportation Equipment	2	2	3	3	3	3	3
Construction	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	59	60	62	64	66	67	69

Table B-3. Volatile Organic Compound Emissions, 1999 to 2010 (continued) (thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
SOLVENT UTILIZATION	**5,093**	**5,101**	**5,233**	**4,921**	**5,035**	**5,092**	**5,207**
Degreasing	441	449	464	487	501	509	523
Graphic Arts	250	251	256	262	267	269	274
Dry Cleaning	188	190	193	146	148	150	152
Surface Coating	2,464	2,441	2,517	2,172	2,232	2,262	2,322
Other Industrial	54	55	58	62	65	66	69
Nonindustrial	1,697	1,715	1,745	1,791	1,822	1,837	1,868
Solvent Utilization NEC	0	0	0	0	0	0	0
STORAGE & TRANSPORT	**1,110**	**1,100**	**1,089**	**1,067**	**1,068**	**1,070**	**1,078**
Bulk Terminals & Plants	243	249	260	276	286	291	302
Petroleum & Petroleum Product Storage	130	132	135	141	146	148	152
Petroleum & Petroleum Product Transport	105	107	110	114	117	119	122
Service Stations: Stage I	254	258	268	284	295	301	312
Service Stations: Stage II	319	297	257	191	160	147	123
Service Stations: Breathing & Emptying	38	38	39	42	43	44	46
Organic Chemical Storage	17	17	17	16	17	17	17
Organic Chemical Transport	2	2	2	2	2	2	2
Inorganic Chemical Storage	1	1	1	1	1	1	1
Inorganic Chemical Transport	0	0	0	0	0	0	0
Bulk Materials Storage	1	1	1	1	1	1	1
WASTE DISPOSAL & RECYCLING	**369**	**374**	**378**	**383**	**392**	**397**	**406**
Incineration	51	52	53	55	56	56	57
Open Burning	193	195	199	205	209	211	215
POTW	15	15	10	11	11	11	12
Industrial Waste Water	12	12	13	13	14	14	14
TSDF	41	42	43	45	46	47	48
Landfills	22	22	23	15	16	16	16
Other	35	36	37	39	41	42	43
ON-ROAD VEHICLES	**4,619**	**4,482**	**4,312**	**3,853**	**3,750**	**3,722**	**3,683**
Light-Duty Gasoline Vehicles	2,756	2,676	2,567	2,242	2,156	2,128	2,084
Light-Duty Gasoline Trucks-1	828	810	791	729	723	724	729
Light-Duty Gasoline Trucks-2	574	565	564	545	560	570	587
Heavy-Duty Gasoline Trucks	213	198	176	155	146	140	126
Light-Duty Diesel Vehicles	4	3	2	1	0	0	0
Light-Duty Diesel Trucks	2	2	1	1	1	1	1
Heavy-Duty Diesel Vehicles	201	186	167	134	117	112	106
Motorcycles	41	42	43	45	47	48	49
NON-ROAD ENGINES AND VEHICLES	**2,106**	**2,090**	**2,067**	**2,098**	**2,138**	**2,158**	**2,186**
Non-Road Gasoline	1,366	1,346	1,314	1,329	1,355	1,367	1,380
Non-Road Diesel	470	470	473	479	485	489	499
Aircraft	180	183	189	199	207	210	215
Marine Vessels	45	45	45	45	45	46	46
Railroads	46	46	46	46	46	46	46
NATURAL SOURCES	**14**	**14**	**14**	**14**	**14**	**14**	**14**
Geogenic	14	14	14	14	14	14	14

Table B-3. Volatile Organic Compound Emissions, 1999 to 2010 (continued) (thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
MISCELLANEOUS	**604**	**611**	**622**	**640**	**651**	**657**	**668**
Agriculture & Forestry	72	74	77	81	83	84	86
Other Combustion	525	529	538	551	560	564	572
Catastrophic/Accidental Releases	4	4	4	4	5	5	5
Health Services	1	1	1	1	1	1	1
Cooling Towers	2	2	2	3	3	3	3
Fugitive Dust	1	1	1	1	1	1	1
TOTAL	**16,286**	**16,139**	**15,916**	**15,097**	**15,152**	**15,212**	**15,342**

Table B-4. Sulfur Dioxide Emissions, 1999 to 2010
(thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
FUEL COMB. ELEC. UTIL.	**11,117**	**10,274**	**10,390**	**10,510**	**10,366**	**10,212**	**10,029**
Coal	10,475	9,617	9,698	9,802	9,662	9,508	9,350
Oil	382	387	389	388	377	377	352
Gas	165	165	165	165	165	165	165
Internal Combustion-new units	33	41	72	85	90	88	86
Internal Combustion-existing units	62	63	66	70	72	73	76
FUEL COMB. INDUSTRIAL	**3,295**	**3,428**	**3,459**	**3,479**	**3,498**	**3,437**	**3,457**
Coal	1,841	1,871	1,886	1,879	1,885	1,912	1,915
Oil	726	824	850	882	899	813	835
Gas	553	557	544	535	530	527	518
Other	151	152	155	159	158	160	163
Internal Combustion	24	24	25	25	25	25	25
FUEL COMB. OTHER	**745**	**761**	**762**	**775**	**789**	**795**	**802**
Commercial/Institutional Coal	183	190	194	200	209	211	214
Commercial/Institutional Oil	374	384	389	403	411	416	424
Commercial/Institutional Gas	9	9	9	10	10	10	11
Misc. Fuel Comb. (Except Residential)	5	5	6	6	6	6	6
Residential Wood	7	7	7	7	6	6	6
Residential Other	168	165	158	150	146	145	141
CHEMICAL & ALLIED PRODUCT MFG	**300**	**303**	**311**	**322**	**330**	**334**	**342**
Organic Chemicals	9	9	10	10	10	11	11
Inorganic Chemicals	209	211	216	224	230	233	238
Polymers & Resins	0	0	0	1	1	1	1
Agricultural Chemicals	5	5	5	5	5	5	5
Paints, Varnishs, Lacquers, Enamels	0	0	0	0	0	0	0
Pharmaceuticals	0	0	0	0	0	0	0
Other Chemicals	77	77	79	82	84	85	87
METALS PROCESSING	**565**	**568**	**576**	**588**	**597**	**601**	**610**
Non-Ferrous Metals Processing	391	394	403	416	425	429	438
Ferrous Metals Processing	155	154	153	151	150	150	150
Metals Processing NEC	19	19	20	21	21	21	22
PETROLEUM & RELATED INDUSTRIES	**376**	**379**	**385**	**395**	**401**	**405**	**411**
Oil & Gas Production	90	90	89	88	88	88	87
Petroleum Refineries & Related Industries	277	279	286	296	303	306	313
Asphalt Manufacturing	9	9	10	10	11	11	11
OTHER INDUSTRIAL PROCESSES	**427**	**431**	**442**	**458**	**469**	**474**	**485**
Agriculture, Food, & Kindred Products	3	3	3	3	3	3	4
Textiles, Leather, & Apparel Products	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	126	128	133	141	146	149	154
Rubber & Miscellaneous Plastic Products	0	0	0	0	0	0	0
Mineral Products	293	295	300	308	313	316	321
Machinery Products	1	1	1	1	1	1	1
Electronic Equipment	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	4	4	5	5	5	5	5

Table B-4. Sulfur Dioxide Emissions, 1999 to 2010 (continued) (thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
SOLVENT UTILIZATION	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Degreasing	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	0
Dry Cleaning	0	0	0	0	0	0	0
Surface Coating	0	0	0	1	1	1	1
Other Industrial	0	0	0	0	0	0	0
STORAGE & TRANSPORT	**2**	**2**	**2**	**2**	**2**	**2**	**2**
Bulk Terminals & Plants	0	0	0	0	0	0	0
Petroleum & Petroleum Product Storage	0	0	0	0	1	1	1
Petroleum & Petroleum Product Transport	0	0	0	0	0	0	0
Service Stations: Stage II	0	0	0	0	0	0	0
Organic Chemical Storage	0	0	0	0	0	0	0
Organic Chemical Transport	0	0	0	0	0	0	0
Inorganic Chemical Storage	0	0	0	0	0	0	0
Inorganic Chemical Transport	0	0	0	0	0	0	0
Bulk Materials Storage	1	1	1	1	1	1	1
WASTE DISPOSAL & RECYCLING	**50**	**51**	**52**	**55**	**56**	**57**	**58**
Incineration	37	38	39	41	42	43	44
Open Burning	11	12	12	12	12	12	13
POTW	0	0	0	0	0	0	0
Industrial Waste Water	1	1	1	1	1	1	1
TSDF	0	0	0	0	0	0	0
Landfills	0	0	0	0	0	0	0
Other	1	1	1	1	1	1	1
ON-ROAD VEHICLES	**327**	**284**	**295**	**314**	**327**	**333**	**347**
Light-Duty Gasoline Vehicles	149	120	124	131	136	139	143
Light-Duty Gasoline Trucks-1	51	42	44	48	50	51	54
Light-Duty Gasoline Trucks-2	27	22	23	25	26	27	28
Heavy-Duty Gasoline Trucks	12	10	10	11	11	11	12
Light-Duty Diesel Vehicles	1	1	1	1	0	0	0
Light-Duty Diesel Trucks	0	0	0	0	0	0	0
Heavy-Duty Diesel Vehicles	87	88	92	98	102	105	109
Motorcycles	0	0	0	0	0	0	0
NON-ROAD ENGINES AND VEHICLES	**371**	**370**	**371**	**372**	**374**	**374**	**376**
Non-Road Gasoline	8	8	9	9	9	9	9
Aircraft	12	12	12	13	13	14	14
Marine Vessels	238	237	237	238	238	239	240
Railroads	113	113	113	113	113	113	113
MISCELLANEOUS	**9**	**9**	**9**	**9**	**9**	**9**	**9**
Other Combustion	9	9	9	9	9	9	9
Fugitive Dust	0	0	0	0	0	0	0
TOTAL	**17,585**	**16,860**	**17,054**	**17,279**	**17,219**	**17,034**	**16,929**

Table B-5. Particulate Matter (PM-10) Emissions, 1999 to 2010
(thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
FUEL COMB. ELEC. UTIL.	**322**	**324**	**332**	**347**	**356**	**360**	**369**
Coal	276	274	276	280	285	287	289
Oil	7	7	7	7	7	7	7
Gas	3	3	3	3	3	3	3
Internal Combustion-new units	17	19	25	35	38	40	46
Internal Combustion-existing units	20	20	21	22	23	23	24
FUEL COMB. INDUSTRIAL	**300**	**309**	**313**	**318**	**320**	**317**	**320**
Coal	73	74	74	74	74	75	75
Oil	37	43	44	46	47	42	43
Gas	45	46	45	45	45	45	45
Other	75	76	78	80	81	82	83
Internal Combustion	69	71	71	72	73	74	74
FUEL COMB. OTHER	**605**	**553**	**526**	**496**	**472**	**463**	**446**
Commercial/Institutional Coal	10	11	11	11	12	12	12
Commercial/Institutional Oil	12	12	12	13	13	13	13
Commercial/Institutional Gas	7	7	7	8	8	8	8
Misc. Fuel Comb. (Except Residential)	80	82	86	92	96	98	102
Residential Wood	477	423	392	356	327	316	295
Residential Other	18	18	17	17	17	17	16
CHEMICAL & ALLIED PRODUCT MFG	**71**	**72**	**75**	**79**	**81**	**82**	**85**
Organic Chemicals	31	31	32	33	34	35	36
Inorganic Chemicals	5	5	5	5	6	6	6
Polymers & Resins	4	4	4	4	5	5	5
Agricultural Chemicals	11	11	11	12	12	12	13
Paints, Varnishs, Lacquers, Enamels	1	1	1	1	1	1	1
Pharmaceuticals	0	0	0	0	0	0	0
Other Chemicals	20	20	21	23	23	24	25
METALS PROCESSING	**227**	**228**	**232**	**237**	**240**	**242**	**246**
Non-Ferrous Metals Processing	45	45	46	48	49	50	51
Ferrous Metals Processing	158	158	160	162	164	165	166
Metals Processing NEC	24	25	26	27	28	28	29
PETROLEUM & RELATED INDUSTRIES	**41**	**42**	**43**	**45**	**46**	**46**	**47**
Oil & Gas Production	2	2	2	2	2	2	2
Petroleum Refineries & Related Industries	21	21	22	22	23	23	24
Asphalt Manufacturing	19	19	20	20	21	21	22
OTHER INDUSTRIAL PROCESSES	**539**	**545**	**558**	**578**	**592**	**598**	**612**
Agriculture, Food, & Kindred Products	85	86	88	92	94	95	98
Textiles, Leather, & Apparel Products	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	86	88	91	95	98	99	102
Rubber & Miscellaneous Plastic Products	4	4	4	4	4	4	5
Mineral Products	331	334	340	350	357	361	368
Machinery Products	8	8	8	9	9	9	10
Electronic Equipment	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	1
Construction	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	25	25	26	28	28	29	30
SOLVENT UTILIZATION	**7**	**7**	**7**	**8**	**8**	**8**	**8**
Degreasing	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	0
Dry Cleaning	0	0	0	0	0	0	0
Surface Coating	5	5	5	6	6	6	6
Other Industrial	1	1	1	1	1	1	1

Table B-5. Particulate Matter (PM-10) Emissions, 1999 to 2010 (continued) (thousand short tons)

Source Category	1999	2000	2002	2005	2007	2008	2010
STORAGE & TRANSPORT	**119**	**121**	**126**	**133**	**137**	**139**	**143**
Bulk Terminals & Plants	0	0	0	0	0	0	0
Petroleum & Petroleum Product Storage	0	0	0	0	0	0	0
Petroleum & Petroleum Product Transport	0	0	0	0	0	0	0
Service Stations: Stage II	0	0	0	0	0	0	0
Organic Chemical Storage	1	1	1	1	1	1	1
Organic Chemical Transport	0	0	0	0	0	0	0
Inorganic Chemical Storage	1	1	1	1	1	1	1
Inorganic Chemical Transport	0	0	0	0	0	0	0
Bulk Materials Storage	117	119	124	130	134	136	140
Bulk Materials Transport	1	1	1	1	1	1	1
WASTE DISPOSAL & RECYCLING	**291**	**294**	**299**	**308**	**313**	**316**	**322**
Incineration	70	71	73	75	77	77	79
Open Burning	220	222	226	231	235	237	241
POTW	0	0	0	0	0	0	0
Industrial Waste Water	0	0	0	0	0	0	0
TSDF	0	0	0	0	0	0	0
Landfills	0	0	0	1	1	1	1
Other	1	1	1	1	1	1	1
ON-ROAD VEHICLES	**247**	**238**	**220**	**204**	**199**	**198**	**200**
Light-Duty Gasoline Vehicles	64	66	68	71	74	75	77
Light-Duty Gasoline Trucks-1	19	19	20	21	22	23	24
Light-Duty Gasoline Trucks-2	11	11	11	11	12	12	12
Heavy-Duty Gasoline Trucks	8	8	7	7	6	6	6
Light-Duty Diesel Vehicles	2	2	1	1	0	0	0
Light-Duty Diesel Trucks	1	1	0	0	0	0	0
Heavy-Duty Diesel Vehicles	141	131	111	92	84	81	79
Motorcycles	0	0	1	1	1	1	1
NON-ROAD ENGINES AND VEHICLES	**613**	**620**	**635**	**658**	**675**	**683**	**700**
Non-Road Gasoline	52	53	54	55	56	57	58
Non-Road Diesel	464	471	484	505	520	527	542
Aircraft	39	39	40	40	41	41	42
Marine Vessels	30	30	30	31	31	31	31
Railroads	27	27	27	27	27	27	27
NATURAL SOURCES	1,146	1,146	1,146	1,146	1,146	1,146	1,146
Geogenic - wind erosion	1,146	1,146	1,146	1,146	1,146	1,146	1,146
MISCELLANEOUS	**24,802**	**25,074**	**25,534**	**26,205**	**26,614**	**26,821**	**27,165**
Agriculture & Forestry	4,801	4,935	5,138	5,444	5,618	5,706	5,878
Other Combustion	771	774	778	784	787	789	727
Cooling Towers	1	2	2	2	2	2	2
Fugitive Dust - Non Road	4,540	4,589	4,697	4,858	4,965	5,018	5,125
Fugitive Dust - Paved Roads	2,613	2,672	2,790	2,973	3,097	3,160	3,288
Fugitive Dust - Unpaved Roads	12,075	12,103	12,130	12,145	12,145	12,146	12,145
TOTAL	**29,329**	**29,574**	**30,045**	**30,760**	**31,200**	**31,421**	**31,809**

Appendix C Graphical Presentation of National Emissions (1990 to 2010) by Pollutant for Several Major Source Categories

Figure C-1. Projected Total CO, NO_x, VOC, SO_2, and PM-10 Emissions (million short tons), 1990 to 2010

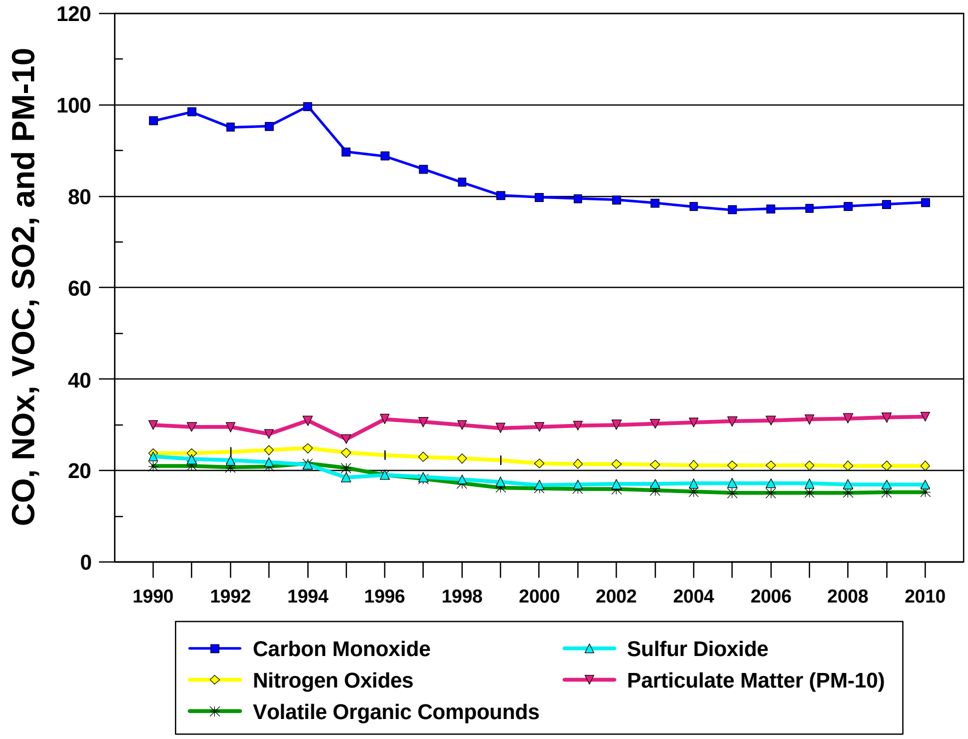


Figure C-2. Projected VMT by Vehicle Type, 1990 to 2010

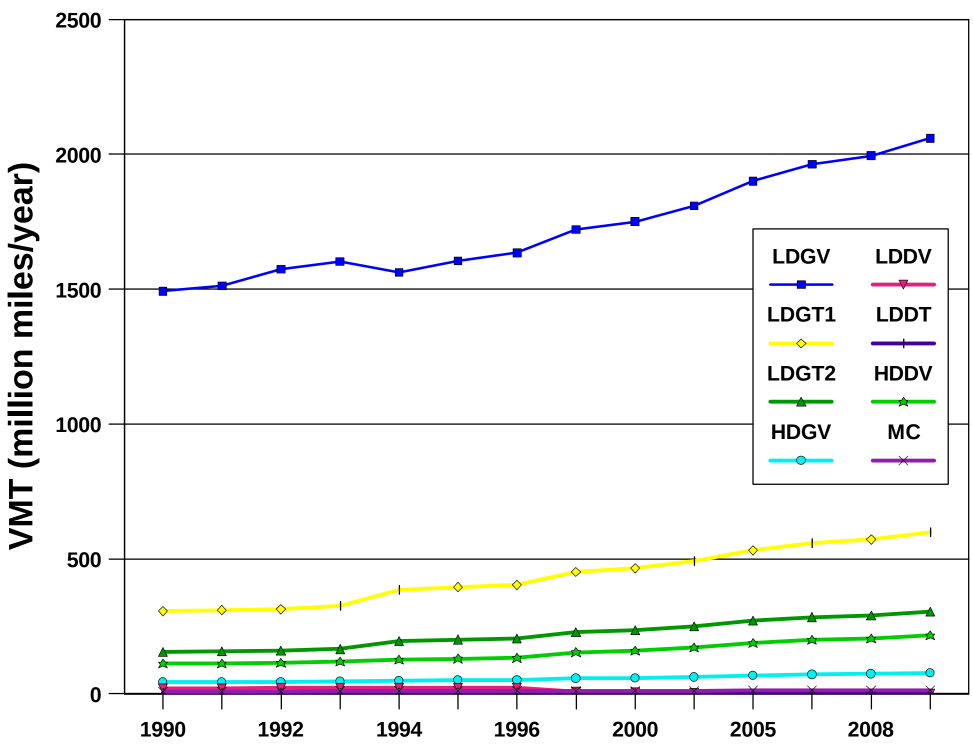


Figure C-3. Projected On-Road Vehicle CO Emissions by Vehicle Type, 1990 to 2010

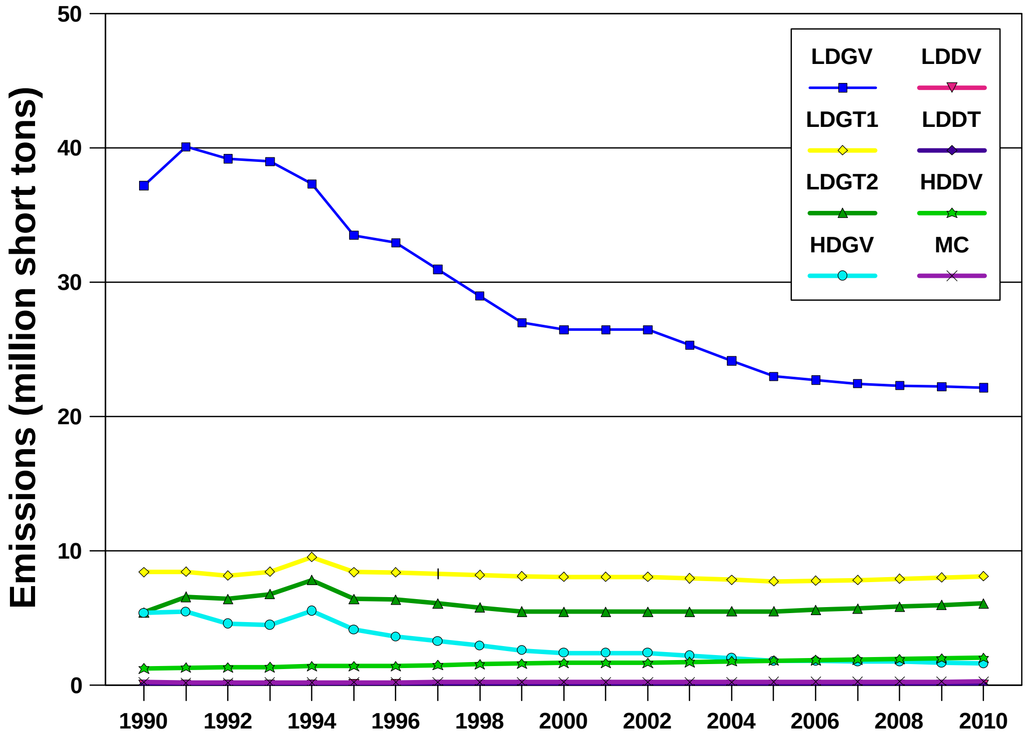


Figure C-4. Projected On-Road NO_x Emissions by Vehicle Type, 1990 to 2010

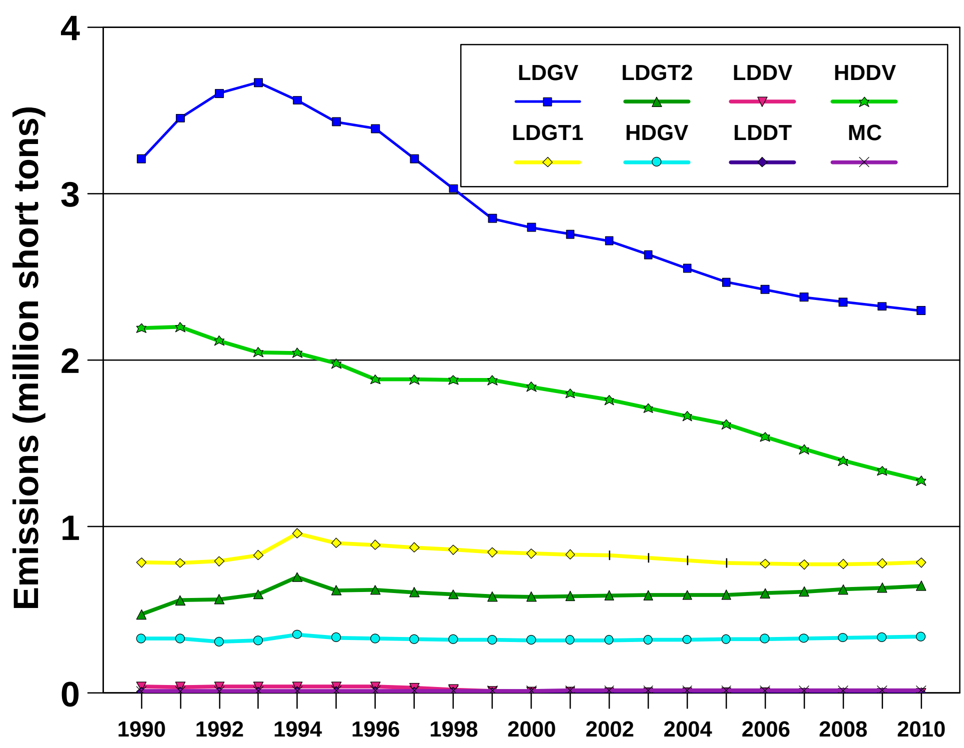


Figure C-5. Projected On-Road Vehicle VOC Emissions by Vehicle Type, 1990 to 2010

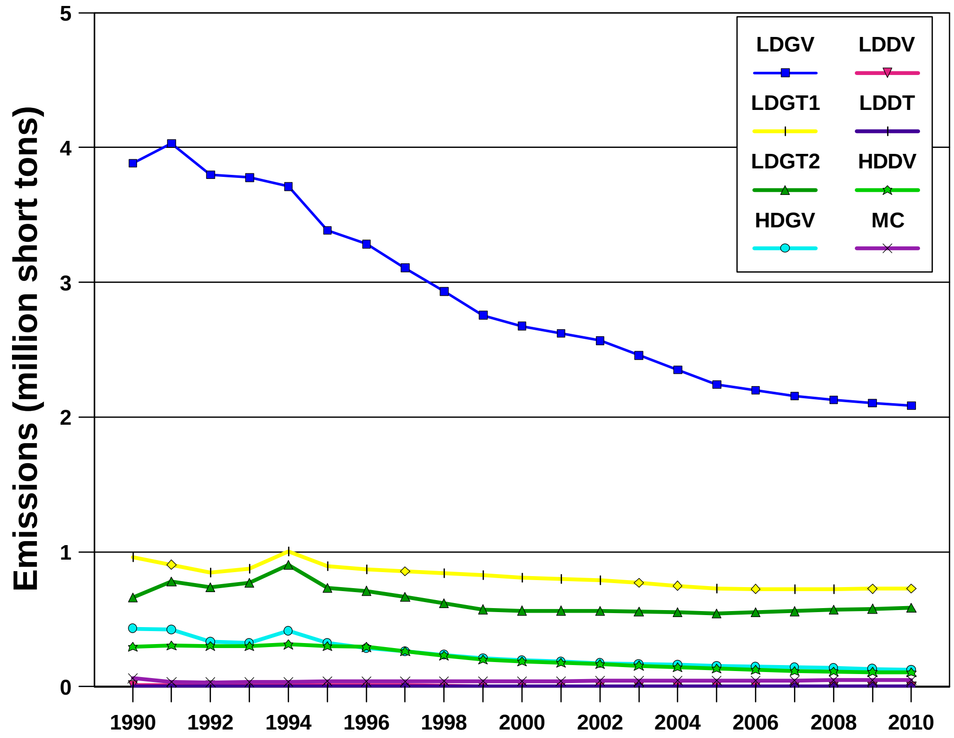


Figure C-6. Projected On-Road Vehicle SO_2 Emissions by Vehicle Type, 1990 to 2010

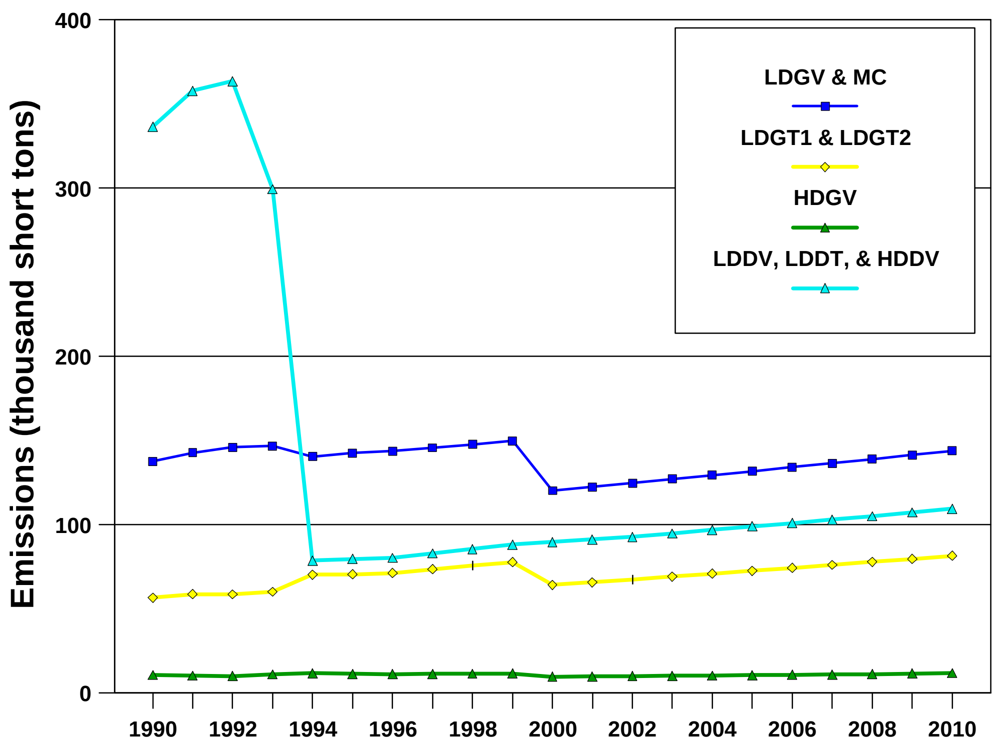


Figure C-7. Projected On-Road Vehicle PM-10 Emissions by Vehicle Type, 1990 to 2010

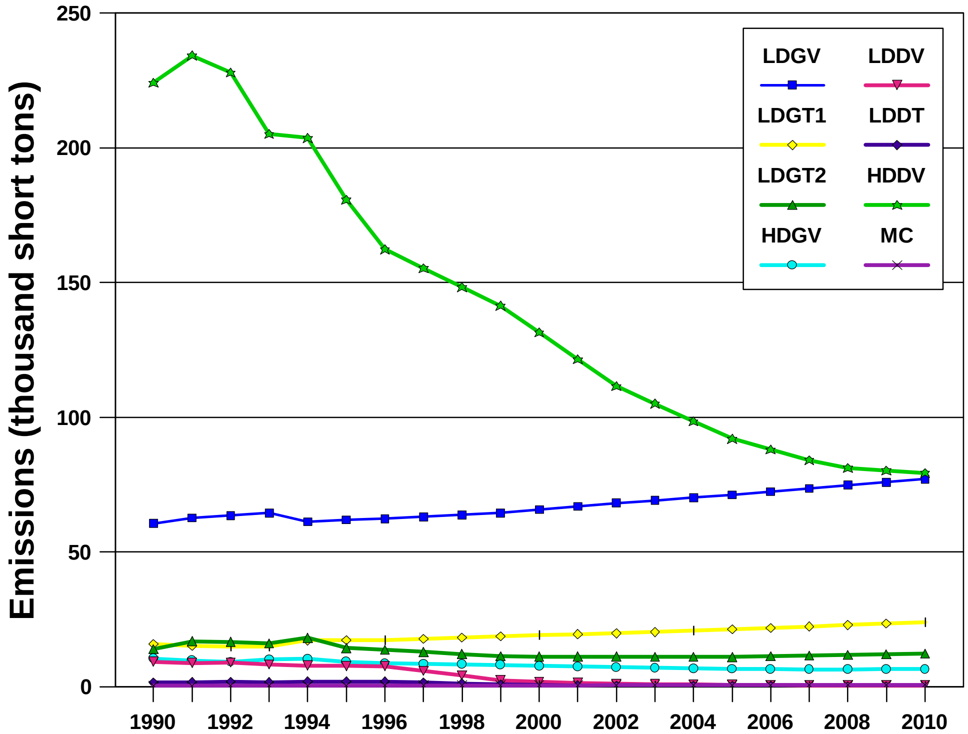


Figure C-8. Projected Non-Road Engine and Vehicle CO, NO_x, VOC, SO_2, and PM-10 Emissions (million short tons), 1990 to 2010

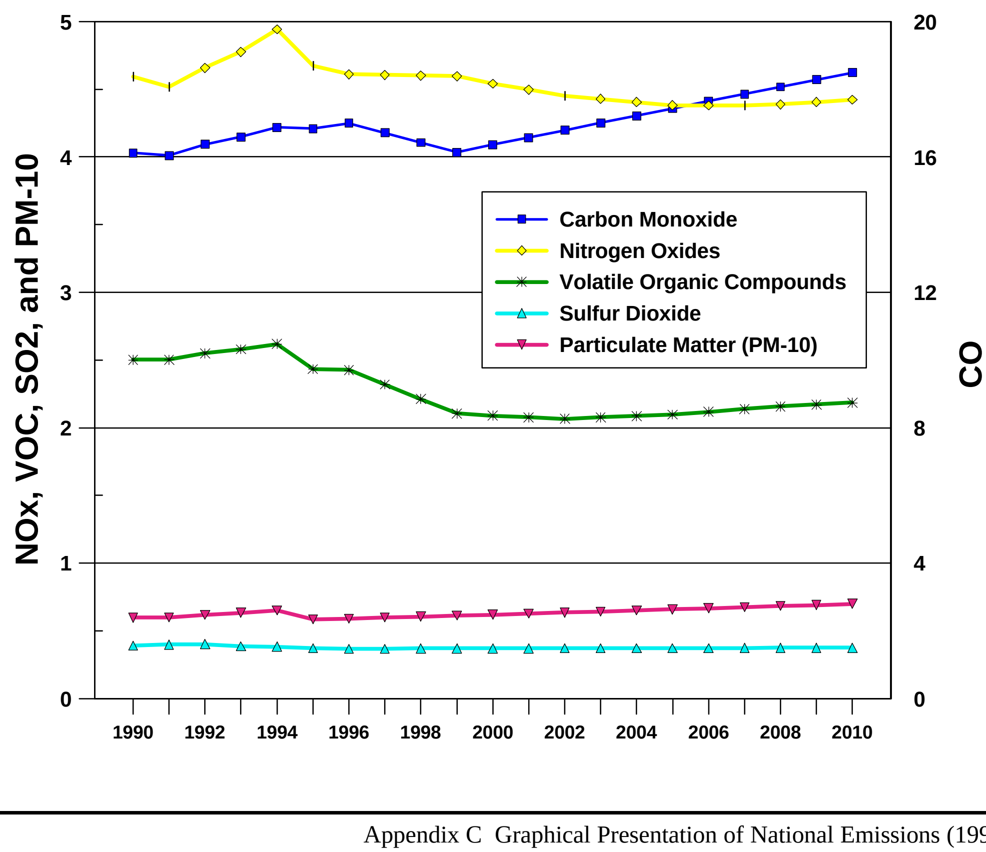
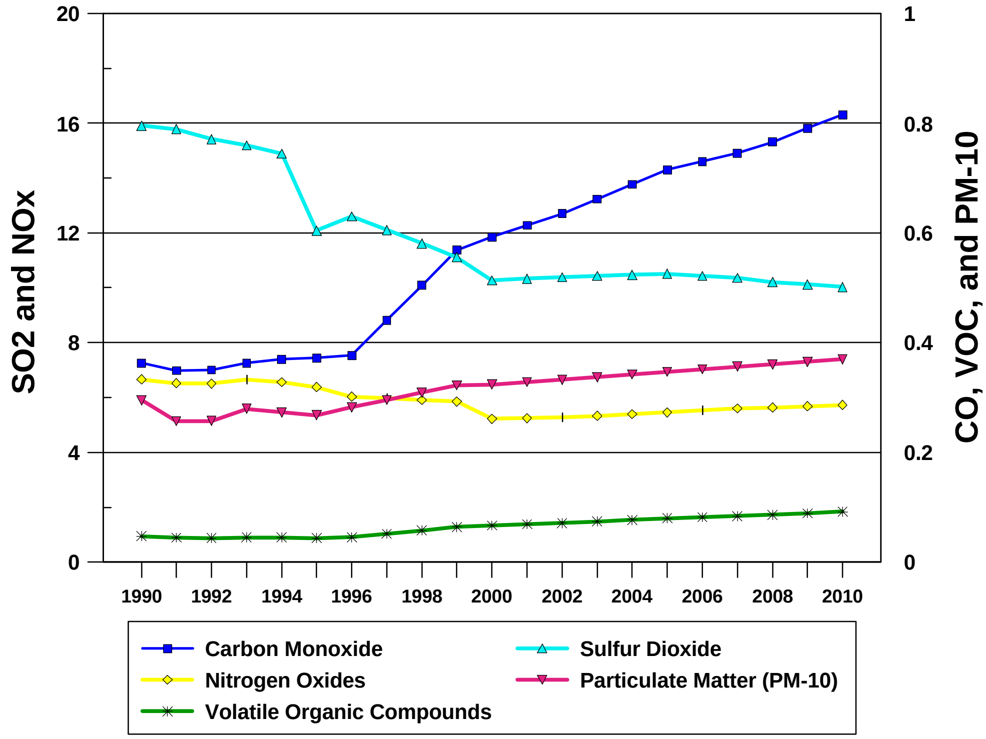


Figure C-9. Projected Electric Utility CO, NO_x, VOC, SO_2, and PM-10 Emissions (million short tons), 1990 to 2010



TECHNICAL REPORT DATA

(PLEASE READ INSTRUCTIONS ON THE REVERSE BEFORE COMPLETING)

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7. AUTHOR(S) SHARON V. NIZICH, THOMAS PIERCE AND ANNE A. POPE (U.S. EPA) AND PATTY CARLSON AND BILL BARNHARD (E. H. PECHAN & ASSOCIATES)		8. PERFORMING ORGANIZATION REPORT NO.
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16. ABSTRACT

The Emission Factor and Inventory Group (EFIG) annually produces a publication on the trends in emissions of criteria pollutants. These publications are needed by the States to evaluate emission trends in each State and to compare emission trends among the States. The latest such report, entitled **National Air Pollutant Emission Trends 1900-1995 (EPA-454-R-96-007),** was published in October 1996. Data from this report has also been used for the Biennial Assessment report, the Air Quality Trends report, the Industrial SO_2 Report to Congress, and the 1994 Report to Congress. The emission estimates developed and included in the Emission Trends data base have been utilized to support development of the National Particuiates Inventory, in support of recent evaluations of the particulate matter and ozone NAAQS, in support of the FACA process, and in support of the CAA Section 812 retrospective analysis.

The enclosed report revises the beforementioned report to include any revisions made under **Contract Number 68-D3-0035, Work Assignment Number III-102 and III-91** to the criteria air pollutants for the years 1970 through 1996.

KEY WORDS/DESCRIPTORS: CRITERIA AIR POLLUTANT, EMISSION TRENDS, GREENHOUSE GASES, BIOGENICS, AIR TOXICS, INTERNATIONAL EMISSIONS.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI FIELD/GROUP
AIR EMISSION TRENDS AIR POLLUTION AMMONIA BIOGENICS CANADA CARSON MONOXIDE NITROGEN DIOXIDE NITROGEN OXIDES OZONE PARTICULATE MATTER SULFUR DIOXIDE TOTAL SUSPENDED PARTICULATE VOLATILE ORGANIC COMPOUNDS	AIR POLLUTION CONTROL AIR POLLUTION RESEARCH AIR POLLUTION TRENDS	
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