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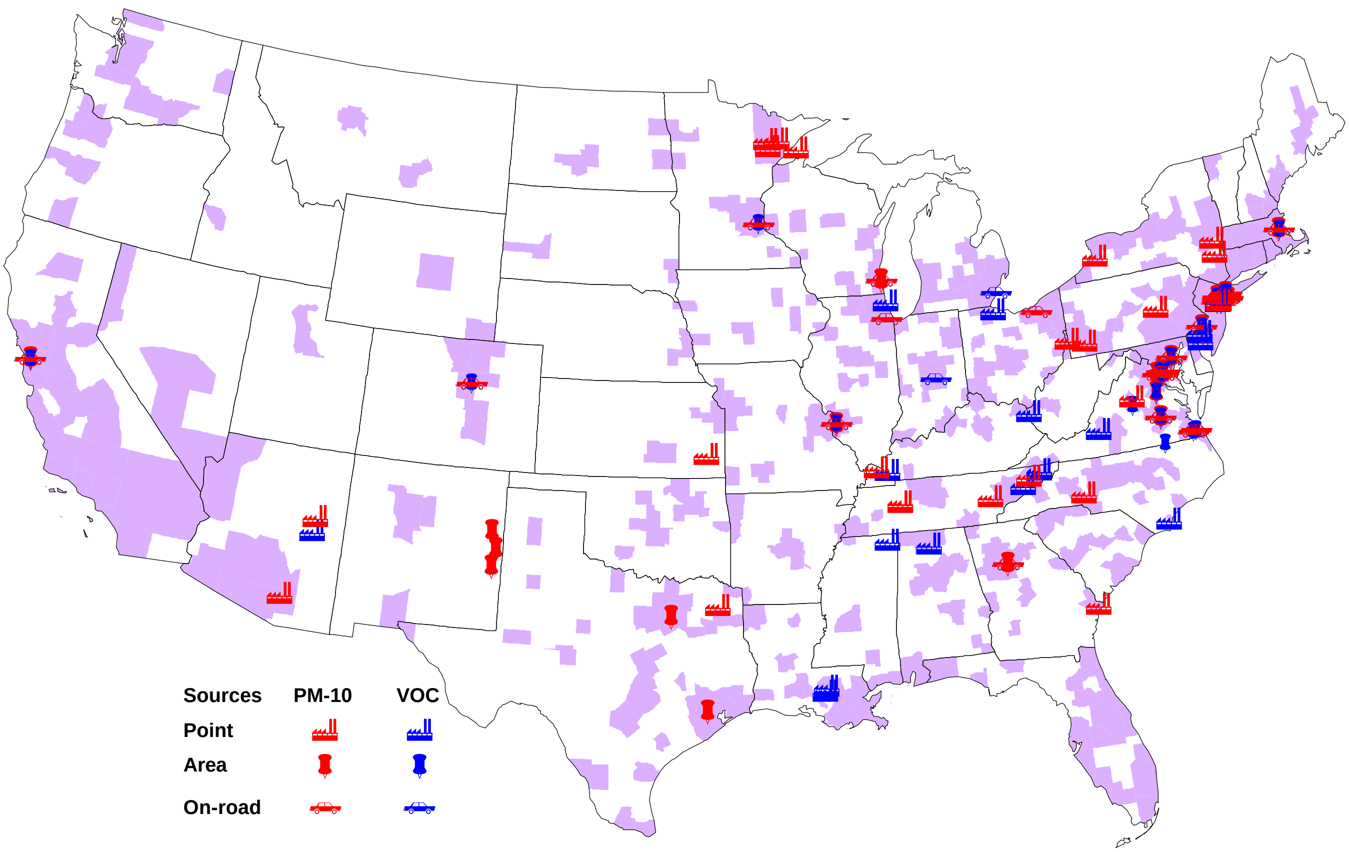
Air

NATIONAL AIR POLLUTANT EMISSION TRENDS, PROCEDURES DOCUMENT, 1900-1996



Top 25 Emitting Point, Area, and On-road Sources of PM-10 and VOC Emissions in 1996 by MSAs

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Figures

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/FS	AIRS Facility Subsystem
ARD	Acid Rain Division
ASTM	American Society for Testing and Materials
BEA	U.S. Department of Commerce, Bureau of Economic Analysis
BLS	U.S. Bureau of Labor Statistics
CAAA	Clean Air Act Amendments of 1990
CEM	continuous emissions monitor(ing)
CNOI	Census number of inhabitants
CO	carbon monoxide
CTG	Control Techniques Guidelines
CTIC	Conservation Information Technology Center
DOE	U.S. Department of Energy
DOT	Department of Transportation
DVMT	daily vehicle miles traveled
EIA	U.S. DOE, Energy Information Administration
EFIG	EPA, OAQPS, Emission Factors and Inventory Group
EG	earnings growth
EPA	U.S. Environmental Protection Agency
ERCAM/VOC	Emission Reductions and Cost Analysis Model for VOC
ESD	EPA, OAQPS, Emission Standards Division
ETS/CEM	Emissions Tracking System/Continuous Emissions Monitoring
FAA	Federal Aviation Adminstration
FCC	fluid catalytic cracking unit
FGD	flue gas desulfurization
FHWA	U.S. Federal Highway Adminstration
FID	Flame Ionization Detector
FREDS	Flexible Regional Emissions Data System
FTP	Federal Test Procedure
GCVTC	Grand Canyon Visibility Transport Commission
GT	gas turbines
HC	hydrocarbon
HCPREP	FREDS Hydrocarbon Preprocessor
HDV	heavy duty vehicle
hp	horsepower
HPMS	Highway Performance Monitoring System
IC	internal combustion (engine)
I/M	inspection and maintenance

ACRONYMS AND ABBREVIATIONS (continued)

LDT	light duty truck
LDV	light duty vehicle
LTO	landing and takeoff
MACT	maximum available control technology
MRI	Midwest Research Institute
MW	megawatts
NAA	nonattainment area
NADB	National Allowance Data Base
NAPAP	National Acid Precipitation Assessment Program
NEDS	National Emission Data System
NESHAP	National Emission Standards for Hazardous Air Pollutants
NET	National Emissions Trends (inventory)
NH_3	ammonia
NO_x	oxides of nitrogen
NPI	National Particulates Inventory
NSPS	New Source Performance Standards
OAQPS	EPA, Office of Air Quality Standards and Planning
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
PM	particulate matter
PM-2.5	particulate matter less than 2.5 microns in diameter
PM-10	particulate matter less than 10 microns in diameter
ppm	parts per million
QA	quality assurance
QC	quality control
RACT	Reasonably Available Control Technology
RCRA	Resource Conservation and Recovery Act
ROM	Regional Oxidant Model
RVP	Reid vapor pressure
SCC	source classification code
SEDS	State Energy Data System
SIC	Standard Industrial Classification (code)
SIP	State Implementation Plan
SO_2	sulfur dioxide
SO_4	sulfates
SUPROXA	Super Regional Oxidant A
TOG	total organics
tpy	tons per year
TSDF	hazardous waste treatment, storage, and disposal facility
TSP	total suspended particulate matter

ACRONYMS AND ABBREVIATIONS (continued)

USDA	U.S. Department of Agriculture
USFS	USDA Forest Service
VMT	vehicle miles traveled
VOC	volatile organic compound(s)

SECTION 1.0
INTRODUCTION

The Emission Factors and Inventory Group (EFIG) of the U.S. Environmental Protection Agency (EPA) is responsible for compiling and maintaining national emission data for the criteria pollutants. To that end, EFIG produces estimates of the annual national air pollutant emissions for six major pollutants: carbon monoxide (CO), nitrogen oxides (NO_x), lead (Pb), particulate matter less than 10 microns (PM-10), sulfur dioxide (SO_2), and volatile organic compounds (VOC). In addition, total particulate matter (TSP) has been estimated in the past. For the years 1990-1996, particulate matter less than 2.5 microns (PM-2.5) and ammonia (NH_3) have also been estimated. These estimates are published annually in two EPA reports and are entitled for 1997, "National Air Pollutant Emission Trends, 1900-1996,"[1] and "National Air Quality and Emission Trends Report, 1996."[2] Collectively, these are known as the *Trends* Reports.

The 1997 *Trends* Procedures Document is an accompanying document designed to describe the methodology and procedures used to create the emission estimates presented in the 1997 *Trends* Reports. The emission estimating methodologies fall into five major categories: 1900-1939 Methodology, 1940-1984 Methodology, 1985-1989 Methodology, 1990-1996 Methodology, and 1997-2010 Methodology. The methodology used to make specific estimates depends on the pollutant and the time period. Table 1-1 presents a detailed characterization of the emission estimates created using each of these five methodologies and the section of this report that describes the methodology.

In general, the SO_2, NO_x, and VOC emissions for the time period before 1940 were using the 1900-1939 methodology. The emissions of no other pollutants were estimated for these years.

The 1940-1984 methodology was originally developed specifically to make the emission estimates for all years and pollutants presented in the *Trends* Reports. For the 1997 *Trends* report, this methodology was generally used to estimate the emissions for the years from 1940 to 1984. In addition to SO_2, NO_x, and VOC emissions, the emissions of CO, Pb, PM-10, and TSP are estimated by this methodology.

The emissions for the years from 1985 to 1989 were estimated by the methodology underlying a new emission inventory, the Interim Inventory.[3] This methodology was applied to the emission estimates for all pollutants, except Pb and TSP. The emissions of these pollutants are estimated using the 1940-1984 methodology. (TSP estimates were last developed for the 1992 emissions. Currently there is no plan to estimate TSP emissions in the future since the current National Air Quality Standards for particulate matter are for the size 10 microns or less.)

The emissions for the year 1990 are based on State-submitted data. The 1991-1996 emissions for non-utility point and area sources are based on economic growth [Bureau of Economic Analysis (BEA) or State Energy Data System (SEDS)] data and the Clean Air Act Amendments of 1990 (CAAA) controls. The remaining sources were estimated using modifications/updates to the Interim Inventory Methodology.

For each methodology, the procedures used to estimate the emissions are described by the source category divisions most appropriate for that methodology. For a given source category, the estimating procedure is described for all pollutants collectively, unless differences exist in the methods used for different pollutants. In this case, the methods used for each pollutant are described separately. Because of the unique nature of the methodology used to estimate the lead emissions, this methodology is described in section 5. This allows each section of the manual to be used independently.

Section 6 presents the methodology used to develop the emission projections for the years 1999, 2000, 2002, 2005, 2007, 2008, and 2010.

Emission estimates presented in the 1997 *Trends* Reports are categorized using the Tier structure. Emissions derived by the 1900-1939 methodology are presented by the Tier I categories. All other emissions appear by the Tier III categories. Because the methodologies are not necessarily described by these Tier categories, a description of the correspondence between the source categories used to describe the estimating methodology and the Tier structure is included in each section of this document.

This document is best used as a reference for those personnel who already have some familiarity with the trends report production process or for a technical person inquiring about the origins of the estimates. Some details of procedures are vaguely or inadequately defined, since getting such details down on paper and keeping the document current, is a real challenge. A new person who takes over responsibility for this work will in general need help from an experienced person.

In the past, the emission estimates presented in the *Trends* reports would change from one year to the next based on the development of new information, data, or methodologies used to estimate the emissions. These changes were applied not only to the most recent year, but to all or some of the preceding years. As of 1997, no such changes are planned to be made to the emissions for the years prior to 1985. Therefore, the methodologies and reference presented in this document for the determination of the emission for these years will not change. Updates may be made, however, to the emissions for the years 1985 to the current year of the report. Any changes in the data or methodologies used to estimate the emissions for this time period will be documented in yearly addenda to this procedures document.

1.1 REFERENCES

1. *National Air Pollutant Emission Trends, 1900-1996*. EPA-454/R-97-011. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1997.

2. *National Air Quality Emissions Trends Report, 1996*. U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1997.

3. *Regional Interim Emission Inventories (1987-1991), Volume I: Development Methodologies*. EPA-454/R-93-021a. Source Receptor Analysis Branch, U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1993.

Table 1-1. Estimating Methods Used in the 1997 *Trends* Report

Tier Category	Time Period	Pollutant(s)	Methodology	Section
Fuel Combustion - Electric Utilities Fuel Combustion - Industrial Fuel Combustion - Other Chemical & Allied Product Mfg. Metals Processing Petroleum & Related Industries Other Industrial Processes Solvent Utilization Storage & Transport Waste Disposal & Recycling Natural Sources Miscellaneous	1900-1969, excluding 1940, 1950, and 1960	VOC, SO_2, and NO_x	1900-1939 Methodology	2
	1940, 1950, and 1960 and 1970 through 1984	VOC, SO_2, NO_x, CO, and PM-10	1940-1984 Methodology	3
		Pb	Lead Methodology	5
	1985 through 1989 and 1990 through 1996	VOC, SO_2, NO_x, CO, and PM-10	1985-1989 Methodology	4
		VOC, SO_2, NO_x, CO, PM-10, PM-2.5, and NH_3	1990-1996 Methodology	4
		Pb	Lead Methodology	5
	1999, 2000, 2002, 2005, 2007, 2008, 2010	VOC, SO_2, NO_x, CO, and PM-10	Projection Methodology	6
On-road Vehicles Non-road Sources	1900-1939	VOC, SO_2, NO_x	1900-1939 Methodology	2
	1940 through 1969	VOC, SO_2, NO_x, CO, and PM-10	1940-1984 Methodology	3
		Pb	Lead Methodology	5
	1970 through 1993	VOC, SO_2, NO_x, CO, and PM-10	1985-1993 Methodology	4
		PM-2.5 and NH_3	1990-1996 Methodology	4
		Pb	Lead Methodology	5
	1999, 2000, 2002, 2005, 2007, 2008, 2010	VOC, SO_2, NO_x, CO, and PM-10	Projection Methodology	6

NOTE(S): SO_2, VOC, and NO_x estimated 1900-1996.
CO, PM-10 estimated 1940-1996.
Lead estimated 1970-1996.
PM-10 fugitive Dust estimated 1985-1996.
PM-2.5 and NH_3 estimated 1990-1996.

SECTION 2.0
1900 - 1939 METHODOLOGY

The SO_2, NO_x, and VOC emission estimates presented in the 1997 *Trends* report for the years 1900 through 1969, with the exception of the years 1940, 1950, and 1960,[1] were taken from two reports on historic emissions. The first contained SO_2 and NO_x emissions for the years between 1900 and 1980.[1] The VOC emissions for the years between 1900 and 1985 were contained in the second.[2] A summary of the methodologies used to estimate these emissions is presented in this document. This summary includes the basic assumptions, categorization, and calculations used to estimate these emissions. The two reports[1,2] provide a more detailed discussion of the methodologies used to estimate these emissions.

2.1 DESCRIPTION OF EMISSION ESTIMATION METHODOLOGIES FOR SO_2 AND NO_x

A methodology for estimating historic SO_2 and NO_x emissions was developed prior to the 1940 - 1984 methodology and served as the predecessor to that methodology. These historic emissions were prepared for the years 1900 to 1980. Of these historic estimates, the 1997 *Trends* report presented the emissions for the years 1900 through 1969, except for the years 1940, 1950, and 1960.[a] The general methodologies for producing these emissions are described in this document along with specific information concerning the emissions for the years from 1900 through 1970.

The emissions were categorized based on the sources of the emissions. Each source category included specific processes which generate emissions such as the combustion of coal by railroad locomotives. The general methodology for estimating emissions was based on two factors: (1) the activity indicator which represents the activity of each process (e.g. the quantity of coal consumed by railroad locomotives) and (2) the emission factor which represents the quantity of emissions produced by the process per unit of process activity (e.g. the pounds of SO_2 produced for every ton of coal burned by a locomotive). Table 2-1 lists the source categories, along with the activity indicators and a description of the processes included in each category.

2.1.1 State-Level Estimates

The state-level SO_2 and NO_x emissions were produced for every fifth year beginning in 1900 and ending in 1970. The methodologies used to estimate the state-level emissions fall into three general groups. These groups are: (1) emissions from the combustion of fuels for heat and power, except by on-road vehicles, (2) emissions from the combustion of fuel for transportation by on-road vehicles, and (3) emissions from material processing, manufacturing, miscellaneous combustion, and miscellaneous burning. The three general methodologies used to estimate the emissions are described individually in the following sections.

[1] The emissions for the years 1940, 1950, and 1960 were estimated using the 1940-1984 methodology. This methodology is described in section 3.0 of this document.

2.1.2 Emissions from Fuel Combustion, Excluding On-road Vehicles

The source categories representing emissions produced by burning a fuel to generate heat or power are: electric utilities, industrial boilers, commercial and residential fuel uses, all uses of anthracite coal (as a fuel), all uses of wood (as a fuel), railroads, vessels, and non-road diesel engines. The emissions from each source category were further categorized by the fuel type (e.g., emissions from railroad were estimated for each of the two fuels burned by locomotives: coal and oil). The emissions from each source category and fuel type were determined using three pieces of information: (1) a fuel use indicator, (2) a fuel sulfur content (necessary to estimate SO_2 emissions only), and (3) an emission factor expressing the amount of SO_2 or NO_x produced by a given amount of fuel burned.

The primary fuel use indicator used was the state-level fuel consumption for a specific source and fuel type. If such data were unavailable, then a state-level fuel use indicator such as fuel demand, distribution, sales, or deliveries was used. Prior to 1940, state-level data were often unavailable; in these cases, a national fuel use indicator was used, if available. The national indicator was apportioned to the states using the same state/national ratios established for the earliest year having available state-level data. There were combinations of fuel types and source categories for which no fuel use indicators were available over specific time periods. For those cases listed in Table 2-2, emission estimates at the state level were not estimated.

The emission factor provided the ratio between the quantity of fuel consumed and the uncontrolled amount of SO_2 or NO_x emitted. The emission factors used to estimate the historic emissions were derived from those contained in AP-42, up to and including Supplement 14.[3] Emission factors representing a given source category, fuel type, and pollutant were weighted averages of the AP-42 emission factors representing specific processes. The weighting factors were the quantities of the specific fuel type consumed by each of the processes. These national emission factors were applied to all state-level fuel use data for all years.

In order to estimate SO_2 emissions, the sulfur content of the fuel burned was required. In 1970, the sulfur content was based on reports from individual plants. State average sulfur content was used for coal in 1965 and for other fuels in 1955. For the 1955 estimates, sulfur contents for coal were estimated for each state based on coal quality, quantity, and distribution. The emissions for all years prior to 1955 were estimated using the 1955 sulfur content data for all fuels.

The state-level emissions for SO_2 and NO_x were calculated for every fifth year between 1900 and 1970 using the general equations given below. Equations 2.1-1 and 2.1-2 were used for all fuel combustion sources.

$$SO_2\ emissions_{i,j,k} = FC_{i,j,k} \times (EF_{j,SO_2} \times S_{i,j,k}) \qquad \text{(Eq. 2.1-1)}$$

$$NO_X\ emissions_{i,j,k} = FC_{i,j,k} \times EF_{j,NO_x} \qquad \text{(Eq. 2.1-2)}$$

where: FC = fuel consumption; i = year
EF = emission factor; j = source category /fuel type
S = sulfur content; k = state

2.1.3 Emissions from Fuel Combustion by On-road Vehicles

Emissions produced by on-road vehicles were divided into two subcategories: emissions from gasoline-powered vehicles and emissions from diesel-powered vehicles. Emissions were made estimated based on three pieces of information: gasoline or diesel fuel consumption, fuel efficiency (for gasoline only), and emission factor. In 1970, vehicle miles traveled (VMT) data became available and was used in place of the state-level fuel consumption and fuel efficiency. The fuel efficiency factor was needed to correlate the amount of gasoline consumed to the average number of miles traveled. A national average miles per gallon was estimated for every fifth year between 1965 and 1935. A constant fuel efficiency was used for all years prior to 1935.

The emission factors for estimating controlled emissions from gasoline-powered vehicles were expressed in terms of the amount of SO_2 or NO_x emitted for every mile traveled. State-specific emission factors were obtained from the MOBILE2 emission factor model[4] for the years 1950 though 1970. The factors calculated for 1950 were used for all preceding years. The factors for NO_x emissions were derived to represent two distinct road types: urban and rural.

The emission factors for estimating controlled emissions from diesel-powered vehicles were expressed in term of the amount of SO_2 and NO_x emitted for every gallon of diesel fuel consumed. Unlike the emission factors for gasoline-powered vehicles, those used for diesel-powered vehicles were national and not year-specific. No fuel efficiency was required to estimate the emissions from this vehicle type.

The SO_2 and NO_x emission estimates from on-road vehicles for the years prior to 1970 were produced using Equation 2.1-3. Equation 2.1-4 was used to produce the emission estimates for 1970.

$$\text{\textit{On-road Vehicle Emissions}}_{i,\,j,\,k} = (FC_{i,\,k} \times FE_i) \times EF_{i,\,j,\,k} \qquad \text{(Eq. 2.1-3)}$$

$$\text{\textit{On-road Vehicle Emissions}}_{1970,\,j,\,k} = VMT_{1970,\,j,\,k} \times EF_{1970,\,j,\,k} \qquad \text{(Eq. 2.1-4)}$$

where:
FC = fuel consumption
FE = fuel efficiency (gasoline-powered vehicles only)
EF = emission factor
i = year
j = SO_2 or NO_x
k = state
VMT = vehicle miles traveled (1970 estimates only)

2.1.4 Emissions from Material Processing, Manufacturing, Miscellaneous Combustion, and Miscellaneous Burning

The source categories producing emissions as the result of material processing, manufacturing, miscellaneous combustion, and miscellaneous burning were: coke plants (combustion stacks), smelters, cement plants, wildfires, miscellaneous industrial processes, and miscellaneous other processes. With the exception of the two miscellaneous categories, the emissions were generally estimated from an activity indicator and an emission factor. The activity indicator specified the industrial output of the process or, in the case of the wildfire category, the area burned. The emission factors were derived from AP-42.[3] The general equation used to calculate the emissions for both pollutants is shown in Equation 2.1-5

$$E_{i,\,j,\,k,\,l} = A_{i,\,j,\,k,\,l} \times EF_{i,\,j,\,k,\,l} \qquad \text{(Eq. 2.1-5)}$$

where:	E	=	emission estimate	i	=	year
	A	=	activity indicator	j	=	SO_2 or NO_x
	EF	=	emission factor	k	=	state
				l	=	source category

Because of the diverse nature of this group, specific details of the methodologies used to calculate the emissions will be discussed for each category individually.

2.1.4.1 Coke Plants

The methodology used to estimate the uncontrolled emissions produced from the combustion stacks of coke plants was similar that used for coal combustion. In place of the amount of coal burned, these estimates were based on the amount of coal charged into the coke ovens. The SO_2 and NO_x emissions were estimated using Equations 2.1-1 and 2.1-2, respectively, with the emission factors, the state-level coal sulfur contents, and the state-level quantities of coal charged. This methodology accounts for only about 67 percent of the total SO_2 emitted by coke plants. The remaining 33 percent of the emissions were passed to the coke oven gas and were emitted latter in the steel manufacturing process and were categorized with miscellaneous industrial processes.

2.1.4.2 Smelters

The primary smelters category consisted of copper, lead, and zinc smelters. The copper smelters predominantly emitted SO_2 and only small amounts of NO_x, while the lead and zinc smelters emitted only SO_2. The methodology used to estimate the emissions from smelters varied according to the availability of pertinent data.

For the years between 1950 and 1970, the emissions from copper smelters from all but the major producing states were estimated using the state-level amounts of copper ore concentrate produced and a national emission factor. Emissions from the major copper smelter states were obtained from a visibility study.[5] After 1960, SO_2 emissions from lead and zinc smelters were based on information obtained from a study of individual smelters.[6]

For copper smelters before 1955 and for lead and zinc smelters before 1965, a different methodology was employed. The state-level quantity of ore smelted was estimated using the amount of recoverable metal produced by the mines in a given state. It was assumed that any ore mined in a given state was smelted in the same state. If the given state was known to have no smelters, then it was assumed that the ore was smelted in the nearest state having a smelter. A national SO_2 emission factor was used to convert the quantity of recoverable metal to the uncontrolled quantity of SO_2 produced. A national NO_x emission factor was used to calculate the NO_x produced by the copper smelters.

The controlled SO_2 emissions were determined by subtracting the amount of SO_2 recovered during the production of sulfuric acid. Because only national by-product sulfuric acid production data was available, it was assumed that the amount of SO_2 recovered for each state was proportional to the smelter output for that state.

2.1.4.3 Cement Plants

SO_2 and NO_x emissions from cement plants were produced by both the minerals processed in the kiln and the combustion of fuels to heat the kiln. The industrial activity indicator used to estimates the emissions was the total annual production of portland cement by state. State-level SO_2 emission factors were the sum of the emission factors for the mineral sources, the combustion of coal, and the combustion of oil. The NO_x emission factors were average national factors. The emission factors calculated for 1955 were used to determine the emission estimates for all preceding years.

2.1.4.4 Wildfires

Wildfire emissions were defined as emissions from the combustion of vegetation in any uncontrolled fire. The activity indicator for this category was the total area burned annually in each state. This information was available for most states by 1925 and for all states by 1940. Prior to 1925, the acreage burned was assumed to be equal to the acreage burned in 1925. State-level emission factors reflected variations in vegetation (e.g. woodlands as compared to grasslands).

2.1.4.5 Miscellaneous Industrial Processes

A list of the industrial processes included in this category is given in Table 2-3. The SO_2 and NO_x emissions for this source category were determined by backcasting 1980 state-level emissions obtained from the National Emission Data System (NEDS)[7] using national growth factors. The yearly national growth factors for the years after 1940 were defined as the ratio between the national emissions for the specific year and the 1980 national emissions. Growth factors for the earlier years were based on national population. Equation 2.1-6 was used to estimate the emissions for this category.

$$SE_i = SE_{1980} \times \frac{NE_i}{NE_{1980}} \qquad \text{(Eq. 2.1-6)}$$

where:
SE = SO_2 or NO_x state emission estimate
NE = SO_2 or NO_x national emission estimate
i = year

2.1.4.6 Miscellaneous Other Processes

Table 2-3 contains a list of the processes included in this category. The methodology used to estimate the emissions for this category is similar to that used above for the industrial processes. For this category, national emissions were available from the 1980 NEDS[7] and the emissions were apportioned to the states based on 1980 population data. State-level growth factors for a given year were applied to the 1980 state-level emissions to backcast the emissions for that given year. The growth factors for each state were calculated as the ratio between the estimated state population for that year and the 1980 state population. Equation 2.1-7 was used to calculate the SO_2 and NO_x emissions for this source category.

$$SE_i = SE_{1980} \times \frac{S_i}{S_{1980}} \qquad \text{(Eq. 2.1-7)}$$

where: SE = SO_2 or NO_x state emissions
S = state population
i = year

State population data for every tenth year was obtained from population census data. For the intervening years, the state populations were estimated using Equation 2.1-8.

$$S_{i+j} = (S_{i+10} - S_i) \frac{N_{i+j} - N_i}{N_{i+10} - N_i} + S_i \qquad \text{(Eq. 2.1-8)}$$

where: S = state population
N = national population
i = census year (1900, 1910, …, 1970)
j = integer 5 representing every fifth year

2.1.5 Yearly State-Level Emissions

The SO_2 and NO_x emissions were calculated every fifth year from 1900 to 1970 as described in the preceding section. For the source categories representing emissions produced by the combustion of fuels, the emissions for each intervening year were estimated by equating the changes in national fuel consumption to the changes in the state-level emissions. Consumption data for the following fuels were used: bituminous coal, anthracite coal, distillate and residual oils (combined), natural gas, wood, and gasoline and diesel fuel (combined). The interpolated state-level emissions for each pollutant were calculated using Equation 2.1-9.

$$SE_{i+j+1} = (SE_{i+5} - SE_{i+j}) \times \frac{NF_{i+j+1} - NF_{i+j}}{NF_{i+5} - NF_{i+j}} + SE_{i+j} \qquad \text{(Eq. 2.1-9)}$$

where: SE = SO_2 or NO_x state emissions by source category and fuel type
NF = national fuel consumption data corresponding to source category and fuel type
i = study year (i.e., 1900, 1905, …, 1970)
j = integer representing the intervening year (0, 1, 2, or 3)

For the following fuel types and years, the national fuel consumption changed radically and, therefore, was not used to estimate the yearly emissions: bituminous coal for the years 1912 and 1913 and natural gas for the years 1931, 1932, and 1933. In these cases, the yearly SO_2 and NO_x emissions were determined by a linear interpolation according to Equation 2.1-10.

$$SE_{i+j} = SE_i + ((SE_{i+5} - SE_i) \times j/5) \qquad \text{(Eq. 2.1-10)}$$

where: SE = SO_2 or NO_x state emissions by source category
i = study year (i.e., 1900, 1905, …, 1970)
j = integer representing the intervening year (1, 2, 3, or 4)

For the source categories in which the emissions were not based on fuel consumption (i.e., smelters, cement plants, wildfire, miscellaneous industrial processes, and miscellaneous other sources), the yearly emissions were also calculated by a linear interpolation as given in Equation 2.1-10.

2.1.6 Allocation of Emission Estimates to Tier I Categories

The emission estimates for the years 1900 through 1969 (excluding 1940, 1950, and 1960) were presented graphically in the 1997 *Trends* report by Tier I categories. These categories were not the same as those used in the original calculation of the emissions as described in the preceding sections. A correspondence was developed between the original historic emission categories and the Tier I categories.

The historic emissions were summed into five general categories as shown in Table 2-4. These categories were then mapped to the Tier I categories as shown in Table 2-5. There was a one-to-one correspondence between the major historic categories and the Tier I categories for three Tier I categories: (1) Fuel Combustion - Electric Utilities, (2) Fuel Combustion - Other, and (3) On-road Vehicles. The historic emissions were assumed to be zero for two Tier I categories: (1) Solvent Utilization and (2) Storage and Transport.

The emissions from the other two historic categories were allocated to the corresponding Tier I categories based on the distribution of emissions for a specific base year. The Industrial historic category was correlated to five Tier I categories: Fuel Combustion - Industrial (02), Chemical and Allied Products Manufacturing (04), Metals Processing (05), Petroleum and Related Industries (06), and Other Industrial Processes (07). To distribute the emissions from the Industrial historic category to a specific Tier I category, a ratio between the base year emissions for the specific Tier I category and the sum of the base year emissions for all five of the Tier I categories correlated to the Industrial historic category was used. The same procedure was used to distribute the emissions from the Other historic category which correlates to three Tier I categories: Waste Disposal and Recycling (10), Non-road Sources (12), and Miscellaneous (14). The base year was 1940, 1950, or 1960, depending on the year for which the emissions were being distributed. The emissions for these base years were developed using the 1940-1984 methodology (see section 3.0) and were distributed to the Tier I categories. The method for distributing emissions to Tier I categories is summarized in Equation 2.1-11.

$$E_{Tier1,\ i} \;=\; E_{Historic,\ i} \times \left[\frac{E_{Tier1}}{\sum (E_{Tier1\ categories\ corresponding\ to\ Historic\ category})} \right]_B \qquad \text{(Eq. 2.1-11)}$$

where: E = SO_2 or NO_x emissions
i = historic emissions year (1900, 1905, …, 1935, 1945, 1955, 1965)
B = base year: 1940 (for historic years 1900 to 1935 and 1945)
1950 (for historic year 1955)
1960 (for historic year 1965)
Historic = Industrial historic category or Other historic category
Tier I = categories 02, 04, 05, 06, or 07 or categories 10, 12, or 14
Tier I categories corresponding to Historic category
= 02 + 04 + 05 + 06 + 07 (for Industrial historic category)
10 + 12 + 14 (for Other historic category)

For the intervening years, the distribution of the emissions to the Tier I categories was made from the historic emission estimates totaled over all categories. The average percentage distribution of the total emissions to a specific Tier I category was calculated for every 6-year period (e.g., 1900 to 1905, 1925 to 1930). The percentage distribution was applied to each intervening year within the 6-year period. Equation 2.1-12 illustrates this method.

$$E_{Tier1,\ i+j} \;=\; E_{Total,\ i+j} \times \left[\frac{E_{Tier1,\ i} + E_{Tier1,\ i+5}}{E_{Total,\ i} + E_{Total,\ i+5}} \right] \qquad \text{(Eq. 2.1-12)}$$

where: E = SO_2 or NO_x emissions
i = every fifth year between 1900 and 1965
j = integer representing the intervening year (1, 2, 3, or 4)
Tier I = Tier I category
Total = totaled over all historic categories

2.2 DESCRIPTION OF EMISSION ESTIMATION METHODOLOGY FOR VOC

The basic methodology for estimating the VOC emissions was a top-down method using national activity indicators and national emission factors. This was substantially different from the methodology used to produce the SO_2 and NO_x emission estimates where more detailed state-level data was used wherever possible. The VOC emissions were divided into five broad source categories, each of which is subdivided into more refined subcategories. These categories and corresponding subcategories are presented in Table 2-6. For these emission estimates, the term national referred to the contiguous United States.

2.2.1 National VOC Emission Estimates (every 5 years between 1900 and 1970)

National emissions for the years 1940, 1950, 1960, 1965 and 1970 were obtained directly from the 1985 *Trends* report.[8] These data, along with that for 1975, 1980, and 1985, were used to estimates the emissions for every fifth year between 1900 and 1935 and the years 1945 and 1955. The methodology described below pertains to these years.

The two data values required to estimate the national annual VOC emissions for each source subcategory were: (1) national annual activity indicators and (2) national annual emission factors. The national activity indicators for each source subcategory for the years 1955, 1945 and every fifth year between 1900 and 1935 were obtained from a variety of sources. In cases where the activity indicators contained data from Alaska, Hawaii, or the U.S. territories, the activity indicators for areas outside the contiguous United States were subtracted from the total activity indicators. This resulted in the national (i.e., contiguous United States) activity indicator.

The development of the national annual emission factors required two steps: (1) back-calculation of the emission factors for the years 1940, 1950, and every fifth year between 1960 and 1985 and (2) extrapolation of these national emission factors to the years under study. In order to back-calculate emission factors, activity indicators and emissions were required. National emissions were obtained for the years 1940, 1950, and every fifth year between 1960 and 1985 from the 1985 *Trends* report.[8] These emissions were disaggregated into the source subcategories given in Table 2-6. The *Trends* report was also the source of the national activity indicators for all subcategories for the same years. For each year and source subcategory, a national emission factor was calculated using Equation 2.2-1.

$$NEF_{i,j} = \frac{NE_{i,j}}{NA_{i,j}} \qquad \text{(Eq. 2.2-1)}$$

where: NEF = national emission factor, i = year
NE = national emissions, j = source subcategory
NA = national activity indicator

For some source subcategories, these national emission factors were unchanged over time. In those cases, the constant emission factor was used in calculating the emissions for all years. For source categories where the national emission factors changed between the years 1940 through 1985, the emission factors for the years before 1940 and for the years 1945 and 1955 were extrapolated from the back-calculated data.

The national VOC emissions for the years 1945 and 1955, and for every fifth year between 1900 and 1935, were calculated for each subcategory using Equation 2.2-2.

$$NE_{i,j} = NEF_{i,j} \times NA_{i,j} \qquad \text{(Eq. 2.2-2)}$$

where: NEF = national emission factor; i = year
NE = national emission estimate; j = source subcategory
NA = national activity indicator

2.2.2 Yearly National Emissions

The national emissions for every fifth year between 1900 and 1970 were used to interpolate the national emissions for the intervening years. The activity indicators used to the interpolate the emissions for each subcategory or group of subcategories are presented in Table 2-6. The national activity data for each year were obtained from the report of historic SO_2 and NO_x emissions.[1] The national emissions for each of the intervening years were calculated by equating the yearly change in the national activity indicators to the yearly change in the national emissions. The national emissions were calculated according to Equation 2.2-3 when using fuel consumption indicators. For source categories where population was used as the activity indicators, the yearly emissions were calculated using a linear interpolation as shown in Equation 2.2-4.

$$NE_{i+j} = (NE_{i+5} - NE_{i+j-1}) \times \frac{NA_{i+j} - NA_{i+j-1}}{NA_{i+5} - NA_{i+j-1}} + NE_{i+j-1} \qquad \text{(Eq. 2.2-3)}$$

$$NE_{i+j} = NE_i + (NE_{i+5} - NE_i) \times j/5 \qquad \text{(Eq. 2.2-4)}$$

where: NE = national emissions by source subcategory
NA = national activity by source category
i = study year (1900, 1905,...,1970)
j = integer representing intervening years (1, 2, 3, or 4)

2.2.3 Changes in Emissions

The emission factors for the source category External Fuel Combustion, subcategory Wood have been changed since the time the original report[2] was published. This adjustment of the erroneously high emission factors was based on more current information. The updated emission factors for the years 1900 through 1970 are presented in Table 2-7. No changes were made to the activity indicators for this subcategory. The emissions presented in the 1993 through the 1997 *Trends* reports for the years 1900 through 1969, excluding 1940, 1950, and 1960, were based on recalculated emissions for this subcategory using the adjusted emission factors. Therefore the values published in the original report differ from those presented in the most recent *Trends* reports.

2.2.4 Allocation of Emission Estimates to Tier I Categories

The emissions for the years 1900 through 1969 (excluding 1940, 1950, and 1960) were presented graphically in the 1997 *Trends* report by Tier I categories. These categories were not the same as those used in the original calculation of the emissions as described in the preceding sections. A correspondence was developed between the original historic emission categories and the Tier I categories.

The historic emissions determined by source subcategories were summed to the five major source categories described previously in Table 2-6. These categories were then mapped to the Tier I categories as shown in Table 2-8. There was only one major historic source category (Solid Waste) which corresponds directly to a Tier I category (Waste Disposal and Recycling). For all other Tier I categories, the distribution of the historic major source categories to the Tier I categories was accomplished by the same method described in section 2.1.6 for the SO_2 and NO_x emissions and summarized in Equations 2.1-11 and 2.1-12.

2.3 REFERENCES

1. *Historic Emission 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.

2. *Historic Emission 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.

3. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.

4. *Mobile Source Emission Factors*. EPA-400/9-78-005 (NITS PB295672/A17). U.S. Environmental Protection Agency, Washington, DC. March 1978.

5. M. Marians, J. Trijonis. *Empirical Studies of the Relationship Between Emissions and Visibility in the Southeast*. EPA-405/5-79-009 (NITS PB80-156136/A06). U.S. Environmental Protection Agency, Research Triangle Park, NC. 1979.

6. *Background Information for New Source Performance Standards: Primary Copper, Zinc and Lead Smelters, Volume 1: Proposed Standards*. EPA-450/2-74-002a (NITS PB237832). U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1974.

7. *National Emissions Report, National Emissions Data System (NEDS)*. EPA-450/4-83-022 (NITS PB84-121375/MF). U.S. Environmental Protection Agency, Research Triangle Park, NC. 1984.

8. *National Air Pollutant Emission Estimates, 1940-1985*. EPA-450/4-86-018. U.S. Environmental Protection Agency, Research Triangle Park, NC. January 1987.

Table 2-1. Historic NO_x and SO_2 Emission Source Categories, Fuel Types, and Descriptions*

Source Category	Activity Indicator Consumption or Production	Description
Electric Utilities	Bituminous Coal, Residual and Distillate Oil, Natural Gas, and Wood (after 1945)	Power plants using coal, oil or gas to provide electricity for public consumption
Industrial Boilers	Bituminous Coal, Residual and Distillate Oil, Natural Gas and Wood (after 1945)	Manufacturing and mining facilities using fuel for heat, power and chemical feedstocks, and natural gas lease and plant operations
Commercial/Residential	Bituminous Coal, Residual and Distillate Oil, Natural Gas, and Wood (after 1945)	Nonmanufacturing enterprises using fuel for heat or power and agricultural, forestry, and fisheries facilities using natural gas. Private dwellings using fuel for heating, cooking, and other household uses
Anthracite Coal - all uses	Anthracite Coal	All facilities using anthracite coal as a fuel
Wood - all uses (1900 through 1945)	Wood	All facilities using wood as a fuel
Pipelines	Natural Gas	Internal combustion engines and turbines used to compress gas
On-road Vehicles	Gasoline and Diesel fuel	Automobiles, trucks, buses, and motorcycles using gasoline or diesel fuel for transportation
Railroads	Bituminous Coal and Distillate Oil	Trains, operated railroad equipment and other related operations
Coke Plants	Bituminous Coal	Furnace and merchant plants which produce coke
Smelters	Ore	Primary copper, lead, and zinc smelting facilities
Vessels	Residual and Distillate Oil	Commercial and private boats, including ocean going vessels
Non-road Diesel Engines	Diesel Fuel	engines used in construction, logging, and road building
Cement Plants	Portland Cement	Portland cement manufacturing plants
Wildfire	Area	Projected and unprotected forest land burned
Miscellaneous	Other	Industrial processes not included about and other miscellaneous anthropogenic sources

* Taken from Reference 1, Table 1 and Table 2.

Table 2-2. Historic NO_x and SO_2 Emission Source Categories Not Estimated*

Source Categories	Range of Years
All Fuel Oil Burning	1900 to 1920
Natural Gas-fired Electric Utilities	1900 to 1915
Natural Gas-fired Industrial and Commercial/Residential Uses	1900 to 1920
Pipelines	1900 to 1945

* Taken from Reference 1, page 31.

Table 2-3. Processes Included in the Miscellaneous Source Category*

Miscellaneous Subcategory	Processes	Subprocesses
Industrial Processes	Pulp and paper	
	Petroleum Refineries	
	Iron and Steel Manufacture	
	Primary Aluminum	
	Secondary Lead	
	Glass Manufacture	
	Chemical Manufacture	sulfuric acid carbon black petrochemicals ammonia nitric acid TNT
Other Sources	Aircraft	
	Vessels	gasoline-powered coal-powered
	Miscellaneous off-highway gasoline-powered vehicles	
	Fuel combustion	LPG coke-oven gas bagasse
	Solid Waste Disposal	
	Agricultural Burning	
	Coal Refuse Burning	
	Prescribed Burning	

* Taken from Reference 1, Tables 10 and 11, page 31.

Table 2-4. Major Source Categories for SO_2 and NO_x Historic Emissions

Major Source Categories	Source Categories (used in determination of emission estimates)
Electric Utilities	Electric Utilities: bituminous coal, residual oil, distillate oil, natural gas, and wood (after 1945)
Industrial	Industrial boilers: bituminous coal, residual oil, distillate oil, natural gas, and wood (after 1945) Pipelines Coke Plants Cement Plants
Commercial/Residential	Commercial/Residential: bituminous coal, residual oil, distillate oil, natural gas, and wood (after 1945)
On-road Vehicles	On-road Vehicles: gasoline and diesel
Other	Anthracite coal (all uses) Wood (all uses from 1900 to 1940) Railroads Smelters Vessels Wildfires Non-road diesel Miscellaneous

Table 2-5. Correlation between Tier I Categories and Historic Major Source Categories for SO_2 and NO_x Emission Estimates

Tier I Categories		
Code	Name	Historic Major Source Categories
01	Fuel Combustion - Electric Utilities	Electric Utilities
02	Fuel Combustion - Industrial	Industrial
03	Fuel Combustion - Other	Commercial/Residential
04	Chemical and Allied Product Manufacturing	Industrial
05	Metals Processing	Industrial
06	Petroleum and Related Industries	Industrial
07	Other Industrial Processes	Industrial
08	Solvent Utilization	assumed zero
09	Storage and Transport	assumed zero
10	Waste disposal and Recycling	Other
11	On-road Vehicles	On-road Vehicles
12	Non-road Engines and Vehicles	Other
13	Miscellaneous	Other

Table 2-6. Source Categories and Activity Indicators for Historic VOC Emission Estimates*

Source Category	Estimates for Every Fifth Year from 1900 to 1970		Estimates for Intervening Years	
	Source Subcategory	**Activity Indicators**	**Source Subcategories**	**Activity Indicators**
TRANSPORTATION				
	On-road Vehicles	On-road Vehicle Gasoline plus Diesel Consumption	On-road Vehicles	Gasoline and Diesel Consumption
	Aircraft	Population	All Other Subcategories	Population
	Railroads			
	oil-fired	Railroad Oil Consumption		
	coal-fired	Railroad Oil Consumption		
	Vessels			
	oil-fired	Vessel Oil Consumption		
	coal-fired	Vessel Coal Consumption		
	Other Non-road Source Use	Non-road Fuel Use		
EXTERNAL FUEL COMBUSTION				
	Anthracite Coal	Anthracite Consumption	Anthracite Coal	Anthracite Consumption
	Bituminous Coal	Bituminous Consumption	Bituminous Coal	Bituminous Consumption
	Residual Oil	Residual Oil Consumption	Residual and Distillate Oil	Fuel Oil Consumption
	Distillate Oil	Distillate Oil Consumption		
	Natural Gas	Natural Gas Consumption	Natural Gas	Natural Gas Consumption
	Wood	Wood Consumption	Wood	Wood Consumption
	Coke and Other Fuels	Coke Production	Coke and Other Fuels	Population
INDUSTRIAL PROCESSES				
	Petrochemical Manufacture	Population	Petrochemical Manufacture	Population
	Petroleum Marketing		Petroleum Marketing	Gasoline and Diesel Consumption
	gasoline	On-road Vehicle Gasoline Consumption		
	other	Diesel plus Distillate Oil Consumption		

Table 2-6 (continued)

Source Category	Estimates for Every Fifth Year from 1900 to 1970		Estimates for Intervening Years	
	Source Subcategory	**Activity Indicators**	**Source Subcategories**	**Activity Indicators**
INDUSTRIAL PROCESSES (continued)				
	Surface Coating Operations	Population and Cement Production	Surface Coating Operations	Population
	Petroleum Refinery Process Operations	Crude Oil Run	All Other Subcategories	Crude Oil Consumption
	Petroleum Production			
	crude oil	Crude Oil Run		
	natural gas liquids	Crude Oil Run		
	Miscellaneous Industrial Processes	Population		
	Carbon Black Mfg.	VMT		
SOLID WASTE DISPOSAL				
	Incineration	Population	All Subcategories	Population
	Open Burning	Population		
MISCELLANEOUS OTHER SOURCES				
	Wildfire	Area Burned	All Subcategories	Population
	Prescribed Fires	State Land Area minus Wildfire Area		
	Other Burning	State Land Area minus Wildfire Area		
	Other Solvent Evaporation	Population		

* Taken from Reference 2, Tables 1 and 2, pages 5 and 9, respectively.

Table 2-7. Adjusted VOC Emission Factors for External Fuel Combustion, Wood

Year	Emission Factors (tons/1000 tons)
1900	15.28
1905	14.65
1910	14.01
1915	13.38
1920	12.74
1925	12.11
1930	11.47
1935	10.84
1940	10.21
1945	9.57
1950	8.94
1955	7.79
1960	6.65
1965	5.37
1970	4.10
1975	4.14
1980	5.24
1985	4.81
1990	5.15

Table 2-8. Correlation between Tier I Categories and Historic Major Source Categories for VOC Emission Estimates

Tier I Categories		
Code	**Name**	**Historic Major Source Categories**
01	Fuel Combustion - Electric Utilities	External Combustion
02	Fuel Combustion - Industrial	External Combustion
03	Fuel Combustion - Other	External Combustion
04	Chemical and Allied Product Manufacturing	Industrial Processes
05	Metals Processing	Industrial Processes
06	Petroleum and Related Industries	Industrial Processes
07	Other Industrial Processes	Industrial Processes
08	Solvent Utilization	Miscellaneous
09	Storage and Transport	Industrial Processes
10	Waste disposal and Recycling	Solid waste
11	On-road Vehicles	Transportation
12	Non-road Engines and Vehicles	Transportation
13	Miscellaneous	Miscellaneous

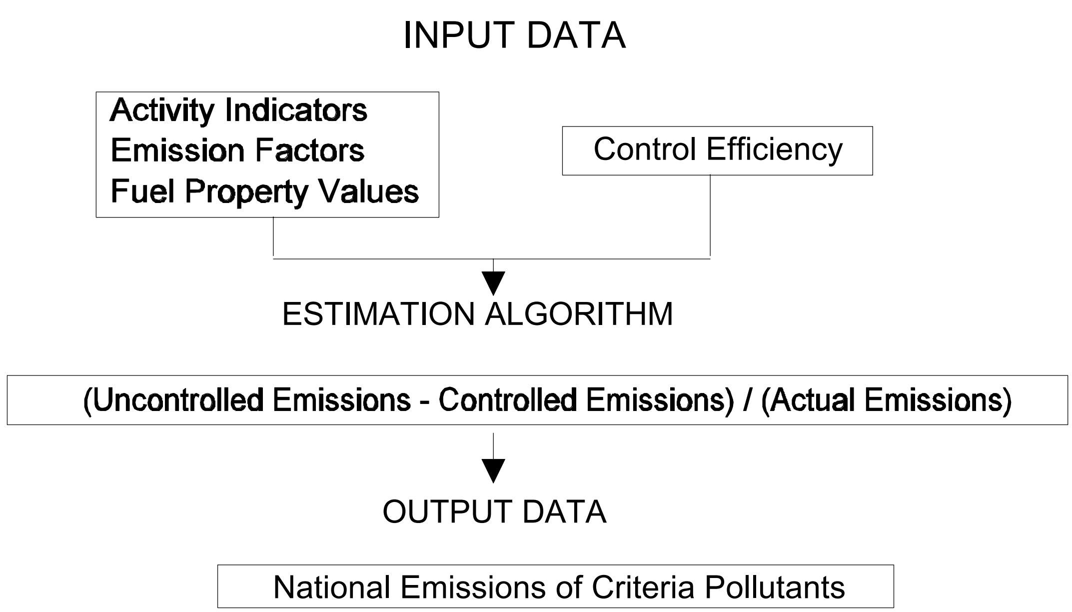
SECTION 3.0
1940 - 1984 METHODOLOGY

This methodology was used to estimate emissions for the majority of pollutants presented in the *Trends* report for the years 1940, 1950, 1960, and 1970 to 1984. For all source categories, excluding on-road vehicles and non-road engines and vehicles, this methodology was used to estimate the CO, NO_x, PM-10, SO_2, and VOC for these years. The TSP emissions for the years 1940, 1950, 1960, and 1970 to 1992 were estimated using this methodology. The lead emissions are explained in section 5.0. The emissions originating from on-road vehicles and non-road sources were estimated for the years 1940, 1950 and 1960 using this methodology. This section describes, in detail, the procedures used to estimate these emissions.

3.1 INTRODUCTION

The 1940-1984 methodology was based on a "top-down" approach where national information was used to create a national emission estimate. Emissions were estimated based on the source of the emissions and, in the case of combustion sources, the fuel type. National activity of a process producing emissions of interest was measured by the consumption of fuel, the throughput of raw materials, or some other production indicator. The emission factor was used to determine the amount of an individual pollutant emitted based on the activity of the process. In the case of PM-10, TSP, and SO_2 emissions, average fuel property values of ash and sulfur content were incorporated into the estimating procedure as part of the emission factor. The final element used to estimate emissions was the control efficiency which quantifies the amount of a pollutant not emitted due to the presence of control devices.

The overall procedure is outlined below:



The emissions were presented in the 1997 *Trends* report by Tier categories, but in the 1940-1984 methodology, the emissions were estimated by a different set of source categories. In most cases, these source categories or subcategories were regrouped into the Tier categories. For several categories or subcategories, the emissions were apportioned to more than one Tier II category. The estimation procedures are presented in this section by the Tier II categories. Correspondence between these Tier II categories and the 1940-1984 methodology source categories are presented in Table 3.1-1. This correspondence between the categories is reiterated within the description of the procedures for each Tier II category.

3.1.1 General Procedure

Since it is impossible to measure the emissions of every historic source individually, a top-down estimating procedure is used. The emissions are calculated either for individual sources or for many sources combined, using indicators of emissions. Depending on the source category, these indicators may include fuel consumption or deliveries, VMT, tons of refuse burned, or raw material processed. When indicators are used, emission factors which relate quantity of emissions to the activity indicator are also used.

Emission factors are not necessarily precise indicators of emissions. They are quantitative estimates of the average rate of emissions from many sources combined. These factors are most valid when applied to a large number of sources. If their limitations are recognized, emission factors can be extremely useful tools for estimating national emissions. The calculations of the emissions were made according to the following general equation:

$$Emissions_{i,j,k} = A_{i,j} \times EF_{i,j,k} \times [1 - CE_{i,j,k}] \quad \text{(Eq. 3.1-1)}$$

where:
A = activity
EF = emission factor
CE = control efficiency (fraction)
i = year
j = source category
k = pollutant

The SO_2 emission factor for sources where the emissions were based on fuel combustion included the sulfur content of the fuel. Emission factors for PM-10 and TSP included the ash content of the fuel for combustion sources. The VOC emission factors included a factor representing the reactive portion for a variety of source categories.

As an aid in the calculation of the emissions by the 1940-1984 Methodology, two Excel spreadsheets, collectively referred to as the *Trends* spreadsheets, were created for each year. An example is provided in Table 3.1-2. These spreadsheets were entitled TRENDSxx.XLS and MGTMPxx.XLS, where xx represents the year. The required data was entered into the TRENDSxx.XLS spreadsheet, after which the MGTMPxx.XLS spreadsheet was opened and the necessary calculations (those shown above) were made to estimate the national emissions. This procedure was designed to simplify the process of estimating emissions for a new year. By using the TRENDSxx.XLS spreadsheet from the previous year as a template, the spreadsheet for the new year was created by editing only the data requiring updating. These spreadsheets now serve as a record of the calculations used to estimate the national emissions for CO, NO_x, PM-10, SO_2, TSP, and VOC for the years 1940, 1950, 1960 and the years 1970 through 1984.

The calculations employed within the TRENDSxx.XLS spreadsheets required the use of specific units for the activity indicators and the emission factors. These required units are specified in the descriptions of the procedures for each of the Tier II categories. In general, the units for activity indicators were short tons for solids, gallons for liquids, and cubic feet for gases. Emission factors were expressed in units of metric pounds of pollutant per unit consumption or throughput. Control efficiency was expressed as a dimensionless decimal fraction. By using these units, emissions calculated within the spreadsheets are expressed in metric tons. The units of the raw data used as the basis for the activity indicator or the emission factors often required conversion to the units specified above. The following conversion factors were employed in many cases.

1 ton (metric)	=	1.1023 tons (short)
1 ton (long)	=	1.12 tons (short)
1 ton (short)	=	0.9072 tons (metric)
1 lb (metric)	=	1.1023 lb
1 bbl	=	42 gal

Emission factors were based on the most recent information available as of 1992. For many categories, this most recent emission factor was used to estimate emissions for all years. For some categories, the emission factor was the weighted average of emission factors for more specific subprocesses, equipment types, or other subcategories. Weighting factors used to calculate an average emission factor were often based on the relative activity of contributing subprocesses. In cases where the activities of the subprocesses changed from one year to the next, the emission factors also varied over time. Sulfur content or ash content of some fuels varied over time producing yearly variations in the SO_2, TSP, or PM-10 emission factors.

The PM-10 emission factors for some emission sources are not provided in the published documents referenced within this section. In these cases, the emission factors may be found in the supplemental list presented in Table 3.1-3. Therefore, the references given throughout this section are the possible sources of PM-10 emission factors, including published documents and Table 3.1-3.

Control efficiencies were calculated from information provided in the latest AIRS/AFS extraction utilizing the standard report number AFP650. This standard report contains emissions, annual throughput (when available), and number of facilities by Source Classification Codes (SCC). If a AIRS/AFS snapshot is not available for the current year, the current year's control efficiency was estimated by projecting the previous years' results. Also one should use a projection of previous years' results if the calculated control efficiency is nonsense. This could easily result if the operating rates (a confidential field in AIRS/AFS) of several SCCs are not extracted and the calculated control efficiency would be very low compare to previous year.

Calculation of the control efficiency involves three steps.

1. Calculate uncontrolled emissions for the SCC or SCCs that incorporate a source category. This is done by multiplying the operating rate by the latest emissions factor and converting to appropriate units.

2. Add all uncontrolled and then all controlled emissions separately.

3. Calculate a percentage control efficiency as follows:

$$\% \begin{matrix} Control \\ efficiency \end{matrix} = \frac{\left(\begin{matrix} Uncontrolled \\ emissions \end{matrix} - \begin{matrix} Actual \\ emissions \end{matrix}\right)}{\left(\begin{matrix} Uncontrolled \\ emissions \end{matrix}\right)} \times 100 \qquad \text{(Eq. 3.1-2)}$$

The following information used in the next two equations, can be obtained from the AFP650 Report or AP-42.

SCC	1-01-005-04	1-01-005-01
Operating rate (1000 gallons)	419,478	72,889
PM-10 Emission Factor (lbs per 1000 gallons)	5.19	1.0
PM-10 Actual Emissions (tons)	723	11
The following information was calculated.		
PM-10 Uncontrolled Emissions (tons)	1,089	36

For SCC = 1-01-005-04

$$\begin{matrix} Uncontrolled \\ emissions \end{matrix} = 419478 \left[\begin{matrix} 1000 \\ gallons \end{matrix}\right] \times 5.19 \left[\frac{lbs}{\begin{matrix} 1000 \\ gallons \end{matrix}}\right] \times \frac{1[ton]}{2000[lbs]}$$

For SCC = 1-01-005-01

$$\begin{matrix} Uncontrolled \\ emissions \end{matrix} = 72889 \left[\begin{matrix} 1000 \\ gallons \end{matrix}\right] \times 1.0 \left[\frac{lbs}{\begin{matrix} 1000 \\ gallons \end{matrix}}\right] \times \frac{1[ton]}{2000[lbs]}$$

The control efficiency for this source category was calculated as follows:

$$\% \begin{matrix} Control \\ efficiency \end{matrix} = \frac{((1089 + 36) - (723 + 11))[tons]}{(1089 + 36)[tons]} \times 100 = 35\%$$

NOTE: Since the estimates are based on input data which may be updated or revised from time to time, the estimating procedure may change. For example, the emission factors published in AP-42 may be revised. If this occurs, it is necessary to revise all previous estimates where the original emission factor was used. Similarly, fuel consumption data may change from one year to the next as the statistics produced by various trade associations and government agencies are revised. Therefore, it is necessary to revise previous annual estimates when revised data are available. During the estimation procedure, it will become known which previous estimates require updating. In addition, all information for the last calendar year may not be available. Therefore, the best available information is used with the intent to amend the estimates as necessary in the following year.

3.1.2 Organization of Procedures

The 1940-1984 Methodology used to estimate emissions is described by Tier II category. For each category the procedure is divided into four sections: (1) technical approach, (2) activity indicator, (3) emission factor, and (4) control efficiency. The procedures for obtaining the activity indicators, emission factors or control efficiencies are arranged in a variety of different ways, depending on the specific requirements of the category (e.g., by pollutant, process, or fuel type).

References are provided at the end of the description of procedures for each Tier II category. Many of these references are published annually as part of a series. In some cases, several references are provided for the same information reflecting a change or discontinuation of one source and its replacement by another. The specific source used would depend on the specific year for which information was needed. All tables and supporting data immediately follow the description of the procedures for each Tier II category.

Table 3.1-1. Correspondence Between Tier II Categories and 1940-1984 Methodology Emission Source Categories

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite	Electric Utility
			Anthracite Coal	Electric Utility
	Oil	01-02	Residual Oil	Electric Utility
			Distillate Oil	Electric Utility
	Gas	01-03	Natural Gas	Electric Utility
Fuel Combustion - Industrial	Coal	02-01	Bituminous Coal and Lignite	Industrial
			Anthracite Coal	Industrial
	Oil	02-02	Residual Oil	Industrial
			Distillate Oil	Industrial
			Industrial Processes - CO Emissions	Process Heaters (oil)
			Industrial Processes - NO_x Emissions	Petroleum Refineries (process heaters - oil)
			Industrial Processes - PM-10 Emissions	Miscellaneous Process Sources (process heaters - oil)
			Industrial Processes - SO_2 Emissions	Other Industrial Processes (petroleum refineries - process heaters (oil))
			Industrial Processes - VOC Emissions	Petroleum Refinery Process Operation (process heaters - oil)

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite	Electric Utility
			Anthracite Coal	Electric Utility
Fuel Combustion - Industrial, con't.	Gas	02-03	Natural Gas	Industrial (boilers and gas pipelines and plants)
			Miscellaneous Fuels	Industrial (coke-oven gas)
			Industrial Processes - CO Emissions	Process Heaters (gas)
			Industrial Processes - NO_x Emissions	Petroleum Refineries (process heaters - gas)
			Industrial Processes - PM-10 Emissions	Miscellaneous Process Sources (process heaters - gas)
			Industrial Processes - SO_2 Emissions	Other Industrial Processes (petroleum refineries - process heaters (gas))
			Industrial Processes - VOC Emissions	Petroleum Refinery Process Operation (process heaters - gas)
	Other	03-04	Miscellaneous Fuels	Industrial (coke, bagasse, kerosene, LPG, and wood)

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite Anthracite Coal	Electric Utility Electric Utility
Fuel Combustion - Other	Commercial and Institutional Coal	03-01	Bituminous Coal and Lignite Anthracite Coal	Commercial and Institutional Commercial and Institutional
	Commercial and Institutional Oil	03-02	Residual Oil Distillate Oil	Commercial and Institutional Commercial and Institutional
	Commercial and Institutional Gas	03-03	Natural Gas	Commercial and Institutional
	Residential Wood	03-05	Miscellaneous Fuels	Residential (wood)
	Residential Other	03-06	Bituminous Coal and Lignite Anthracite Coal Residual Oil Distillate Oil Natural Gas Miscellaneous Fuels	Residential Residential Residential Residential Residential Residential (kerosene and LPG)

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite	Electric Utility
			Anthracite Coal	Electric Utility
Chemical and Allied Product Manufacture	Organic Chemical Manufacturing	04-01	Industrial Processes - CO Emissions	Charcoal Petrochemicals
			Industrial Processes - NO_x Emissions	Petrochemicals Charcoal
			Industrial Processes - PM-10 Emissions	Chemical Industry (petrochemicals)
			Industrial Processes - VOC Emissions	Manufacture of Petrochemicals (all subcategories, excluding storage and handling and waste disposal) Miscellaneous Industrial Processes [miscellaneous chemical products (charcoal)]
	Inorganic Chemical Manufacturing	04-02	Industrial Processes - CO Emissions	Ammonia Titanium Dioxide - chloride process
			Industrial Processes - NO_x Emissions	Ammonia Nitric Acid
			Industrial Processes - PM-10 Emissions	Chemical Industry (sulfuric acid and calcium carbide)
			Industrial Processes - SO_2 Emissions	Other Industrial Processes (sulfuric acid)
			Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [miscellaneous chemical products (ammonia)]

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite Anthracite Coal	Electric Utility Electric Utility
Chemical and Allied Product Manufacture, cont.	Polymer and Resin Manufacturing	04-03	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [plastics manufacture (all subcategories, excluding fabrication) and miscellaneous chemical products (synthetic fibers and synthetic rubber)]
	Agricultural Chemical Manufacturing	04-04	Industrial Processes - PM-10 Emissions	Chemical Industry [fertilizers (ammonium nitrate, diammonium phosphate, and urea)]
	Pain, Varnish, Lacquer, and Enamel Manufacturing	04-05	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [miscellaneous chemical products (paint)]
	Pharmaceutical Manufacturing	04-06	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [miscellaneous chemical products (pharmaceuticals)]
	Other Chemical Manufacturing	04-07	Industrial Processes - CO Emissions Industrial Processes - PM-10 Emissions Industrial Processes - SO_2 Emissions Industrial Processes - VOC Emissions	Carbon Black Production (oil process, gas process, and channel process) Chemical Industry [carbon black production (oil process, gas process, and channel process), charcoal, and soap and detergent] Other Industrial Processes (carbon black) Miscellaneous Industrial Processes [miscellaneous chemical products (carbon black - oil process and gas process)]

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite	Electric Utility
			Anthracite Coal	Electric Utility
Metals Processing	Nonferrous	05-01	Industrial Processes - CO Emissions	Primary Aluminum
			Industrial Processes - PM-10 Emissions	Primary Metals Industry (aluminum, copper, zinc, and lead) Secondary Metal Industry (aluminum, copper, and lead)
			Industrial Processes - SO_2 Emissions	Nonferrous Smelters Other Industrial Processes (primary aluminum and secondary lead)
	Ferrous	05-02	Industrial Processes - CO Emissions	Iron Foundries Steel Manufacturing
			Industrial Processes - NO_x Emissions	Iron and Steel
			Industrial Processes - PM-10 Emissions	Iron and Steel Industry Primary Metals Industry (ferroalloys) Secondary Metals Industry (grey iron foundries and steel foundries)
			Industrial Processes - SO_2 Emissions	Other Industrial Processes (iron and steel)
			Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [other processes (by-product coke and sintering)]
	Not Elsewhere Classified	05-03	Industrial Processes - PM-10 Emissions	Mining Operations

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite	Electric Utility
			Anthracite Coal	Electric Utility
Petroleum and Related Industries	Oil and Gas Production	06-01	Industrial Processes - SO_2 Emissions	Other Industrial Processes [sulfur recovery plants (natural gas fields)]
			Industrial Processes - VOC Emissions	Petroleum Marketing and Production (crude oil production and natural gas liquids)
	Petroleum Refineries and Related Industries	06-02	Industrial Processes - CO Emissions	Petroleum Refineries
			Industrial Processes - NO_x Emissions	Petroleum Refineries (FCC, TCC, and flares)
			Industrial Processes - PM-10 Emissions	Miscellaneous Process Sources (petroleum refining)
			Industrial Processes - SO_2 Emissions	Other Industrial Processes [sulfur recovery plants (refineries) and petroleum refineries (FCC, TCC,and flares)]
			Industrial Processes - VOC Emissions	Petroleum Refinery Process Operation (refinery operations, compressors, blow down systems, process drains, vacuum jets, cooling towers, and miscellaneous)
	Asphalt Manufacturing	06-03	Industrial Processes - PM-10 Emissions	Mineral Products Industry (asphalt batching and asphalt roofing)
			Industrial Processes - VOC Emissions	Petroleum Refinery Process Operation (asphalt blowing)

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite	Electric Utility
			Anthracite Coal	Electric Utility
Other Industrial Processes	Agriculture, Food, and Kindred Products	07-01	Industrial Processes - PM-10 Emissions	Agricultural Industries
			Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [other processes (bakeries, fermentation, and vegetable oil)]
	Wood, Pulp and Paper, and Publishing Products	07-03	Industrial Processes - CO Emissions	Kraft Pulp and Paper
			Industrial Processes - NO_x Emissions	Kraft Pulp
			Industrial Processes - PM-10 Emissions	Miscellaneous Process Sources (pulp and paper, semi-chemical, plywood, and lumber)
			Industrial Processes - SO_2 Emissions	Other Industrial Processes (kraft pulp production and sulfite)
	Rubber and Miscellaneous Plastic Products	07-04	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [other processes (tires)]

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite Anthracite Coal	Electric Utility Electric Utility
Other Industrial Processes, con't.	Mineral Products	07-05	Industrial Processes - CO Emissions Industrial Processes - NO_x Emissions Industrial Processes - PM-10 Emissions Industrial Processes - SO_2 Emissions Industrial Processes - VOC Emissions	Asphalt Roofing Lime Cement Manufacturing Glass Manufacturing Lime Mineral Products Industry (cement manufacturing, bricks, clay sintering, concrete batching, fiber glass, glass, gypsum manufacturing, and lime manufacturing) Mining Operations (coal mining, sand and gravel, stone and rock crushing, phosphate rock, clays, and potash) Chemical Industry [fertilizers (rock pulverization)] Other Industrial Processes (cement manufacturing, glass manufacturing, and lime processing) Miscellaneous Industrial Processes [other processes (glass manufacturing)]

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite Anthracite Coal	Electric Utility Electric Utility
Solvent Utilization	Degreasing	08-01	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [other processes (degreasing)]
	Graphic Arts	08-02	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [other processes (graphic arts)]
	Dry Cleaning	08-03	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [other processes (dry cleaning)]
	Surface Coating	08-04	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [other processes (adhesives)] Surface Coating Operations Miscellaneous Organic Solvent Evaporation (architectural coating, auto refinishing, and other solvent use)
	Other Industrial	08-05	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [plastics manufacture (fabrication) and other processes (waste solvent recovery, organic solvent, and solvent extraction)]
	Nonindustrial	08-06	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [other processes (fabric scouring)] Miscellaneous Organic Solvent Evaporation (cutback asphalt paving, pesticides, and other solvent use)
Storage and Transport	Bulk Terminals and Plants	09-01	Industrial Processes - VOC Emissions	Petroleum Marketing and Production (bulk gasoline terminals and gasoline bulk plants)
	Petroleum and Petroleum Product Storage	09-02	Industrial Processes - VOC Emissions	Petroleum Marketing and Production (gasoline storage at refineries, crude oil storage, and other products)

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite Anthracite Coal	Electric Utility Electric Utility
Storage and Transport, cont.	Petroleum and Petroleum Product Transport	09-03	Industrial Processes - VOC Emissions	Petroleum Marketing and Production (refinery product loading and crude oil loading)
	Service Stations: Stage I	09-04	Industrial Processes - VOC Emissions	Petroleum Marketing and Production [gasoline service stations (loading or stage 1)]
	Service Stations: Stage II	09-05	Industrial Processes - VOC Emissions	Petroleum Marketing and Production [gasoline service stations (unloading or stage 2)]
	Organic Chemical Storage	09-07	Industrial Processes - VOC Emissions	Miscellaneous Industrial Processes [other processes (waste solvent recovery)] Manufacture of Petrochemicals (storage and handling)
Waste Disposal and Recycling	Incineration	10-01	Solid Waste Disposal	Incineration
	Open Burning	10-02	Solid Waste Disposal	Open Burning
	Other	10-07	Industrial Processes - VOC Emissions	Manufacture of Petrochemicals (waste disposal)
On-road Vehicles	(All Categories) Light-Duty Gas Vehicles and Motorcycles, Light-Duty Gas Trucks, and Heavy-Duty Gas Vehicles	11	On-road Vehicles	Gasoline (leaded and unleaded)

Table 3.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	1940-1984 Methodology Emission Source Categories	1940-1984 Methodology Emission Source Subcategories
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite Anthracite Coal	Electric Utility Electric Utility
Non-road Engines and Vehicles	Nonroad Gasoline Engines	12-01	Other Non-road Engines Vessels	Gasoline Gasoline
	Nonroad Diesel	12-02	Other Non-road Engines	Diesel
	Aircraft	12-03	Aircraft	all subcategories
	Marine Vessels	12-04	Vessels	Residual Fuel Oil Diesel Oil Coal
	Railroads	12-05	Railroads	all subcategories
Miscellaneous	Other Combustion (forest fires)	14-02	Forest fires and Prescribed Burning Other Miscellaneous Sources	all subcategories all subcategories

Table 3.1-2. Example Spreadsheet - Distillate Oil Combustion and Emission Factors for Year 19xx

Source Category	Consumption 10^6 gal	TSP Factors MLB/10^3 gal	SO_2 Factors MLB/10^3 gal	NO_x Factors MLB/10^3 gal	VOC Factors MLB/10^3 gal	CO Factors MLB/10^3 gal	Pb Factors MLB/10^6 gal	PM-10 Factors MLB/10^3 gal
Electric Utility	733.6	4.7	36.0	61.8	3.5	13.2	0.38	4.1
Industrial	3378.1	2.6	35.6	29.5	1.0	7.0	0.38	1.73
Commercial-Institutional	3555.2	1.8	39.9	18.1	0.3	4.5	0.38	0.98
Residential	6152.5	2.3	31.6	16.3	0.6	4.5	0.38	2.23
Total	13819.4							

PM-10 Control Efficiencies for Distillate Oil

Electric Utility	0.565
Industrial	0.096
Commercial-Institutional	0.123
Residential	0

Nationwide Emissions from Distillate Oil Combustion

Source Category	TSP Emissions 1000 MT	SO_2 Emissions 1000 MT	NO_x Emissions 1000 MT	VOC Emissions 1000 MT	CO Emissions 1000 MT	Pb Emissions Megagrams	PM-10 Emissions 1000 MT
Electric Utility	1.7	8.7	2.8	0.0	4.8	0.1	0.7
Industrial	4.4	60.2	49.8	1.7	11.8	0.6	2.6
Commercial-Institutional	3.2	70.9	32.2	0.5	8.0	0.7	1.5
Residential	7.1	97.3	50.1	1.8	13.8	1.2	6.9
Total	16.4	237.0	135.0	4.1	38.5	2.6	11.7

NOTES:

$$\text{gal} = \text{gallon};\ \text{MLB} = \frac{\text{lb}}{\text{ton}} * \frac{\text{ton}}{1.1023\ \text{metric ton}};\ \text{and}\ \text{MT} = \text{metric ton}$$

Table 3.1-3. Supplemental PM-10 Emission Factors

1940 - 1984 Methodology Emission Sources	TSP lb/unit	PM-10 lb/unit	PM-10 Mlb/unit	Units
External Combustion, Boilers				
Industrial				
coke, petroleum	1.5	1.2	1.09	tons burned
Residential				
Distillate oil	2.5	2.46	2.23	10^3 gallons
Kerosene	2.5	2.46	2.23	10^3 gallons
Wood				
Stoves	40.2	40.2	36.5	tons burned
Fireplaces	28.0	28.0	25.4	tons burned
Chemical Industry				
Plastics Production				
Polyethylene	1.0	0.66	.599	tons product
Primary Metals				
Copper				
Fugitives	26.5	17.5	14.42	tons of ore concentrate
Ferroalloys				
Other Ferroalloys	300.0	234.0	212.29	tons produced
Ferroalloy Handling	28.0	18.5	16.78	tons processed
Lead				
Fugitives	25.8	22.0	19.95	tons of ore concentrate
Zinc				
Fugitives	7.5	6.4	5.81	tons of ore concentrate
Mining Operations				
Copper Ore				
Crushing	8.6	3.9	3.54	tons of ore processed
Open pit overburden removal	0.0008	0.0003	0.00027	tons of ore processed
Drill/blasting	0.001	0.0008	0.00073	tons of ore processed
Loading	0.05	0.022	0.019958	tons of ore processed
Truck dumping	0.04	0.032	0.0290	tons of ore processed
Transfer/conveying	0.15	0.08	0.0726	tons of ore processed
Ore crushing	6.4	2.9	2.631	tons of ore processed
Storage	2.0	0.7	0.635	tons of ore processed
Iron Ore Mining	0.44	0.18	0.16	tons of ore processed
Lead Ore Crushing	6.0	5.1	4.63	tons of ore processed
Zinc Ore Crushing	6.0	2.3	2.09	tons of ore processed
Coal				
Surface Mining	0.5	0.2	1.81	tons of coal mined
Coal Handling	0.5	0.17	0.15	tons of coal shipped
Pneumatic Dryer	3.0	1.5	1.36	tons of coal dried
Sand and Gravel	0.1	0.029	.026	tons of product
Secondary Metals				
Aluminum				
Fugitives	3.7	3.4	3.08	tons of metal produced
Copper				
Fugitives	10.7	6.4	5.81	tons of charge
Grey Iron				
Fugitives	8.6	5.2	4.72	tons of metal charged
Steel Foundry				
Fugitives	13.0	7.8	7.08	tons of metal charged
Lead				
Fugitives	14.3	12.0	10.89	tons of metal charged

Table 3.1-3 (continued)

1940 - 1984 Methodology Emission Sources	TSP lb/unit	PM-10 lb/unit	PM-10 Mlb/unit	Units
Mineral Products				
Asphalt concrete				
Fugitives	0.3	0.15	0.14	tons of concrete produced
Brick Manufacture				
Material Handling	4.5	1.4	1.27	tons of raw material
Cement Manufacture				
Fugitives	18.0	10.4	9.44	tons of cement produced
Lime Manufacture				
Fugitives	4.7	1.75	1.59	tons of lime produced
Miscellaneous Process Sources				
Pulp and Paper				
Sulfite	14.0	12.6	11.4	ton air dry unbleached pulp
Semichemical, recovery furnace	24.0	22.3	20.2	ton air dry unbleached pulp
Wood Products				
Plywood	2.5	1.3	1.2	tons of plywood produced
Lumber	3.6	1.4	1.0	tons of lumber produced
Solid Waste Disposal				
Incinerators				
Residential Single Chamber				
w/o Primary Burner	35.0	13.0	11.8	tons of waste
w/ Primary Burner	7.0	4.7	4.3	tons of waste
Forest Fires and Prescribed Burning				
Forest Wild Fires	17.0	13.3	12.1	tons of vegetation burned
Prescribed Burning	20.0	15.6	14.2	tons of vegetation burned
Other Miscellaneous Sources				
Agricultural Burning	14.1	13.5	12.3	tons of vegetation burned
Structural Fires	16.0	6.0	5.4	tons of vegetation burned
Coal Refuse Fires	17.0	17.0	15.4	tons of vegetation burned
Non-road Vehicles				
Aircraft				
Commercial Aviation	1.0	1.0	0.9072	LTO
Air Taxi	.5	0.45	0.408	LTO
General Aviation	.2	0.18	0.163	LTO
Military	16.2	16.2	14.70	LTO
Railroads				
Diesel	25.0	25.0	22.68	10^3 Gallons
Residual	25.0	23.0	20.87	10^3 Gallons
Coal	60.0	31.0	28.12	Tons burned
Vessels				
Residual	19.3	17.8	16.15	10^3 Gallons
Diesel	24.0	24.0	21.77	10^3 Gallons
Gasoline	0.0	---		---

3.2 FUEL COMBUSTION ELECTRIC UTILITY - COAL: 01-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(01) FUEL COMBUSTION - ELECTRIC UTILITY	(01) Coal	Bituminous, Subbituminous, and Lignite Coal Anthracite Coal

3.2.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, the activity indicator for bituminous coal was expressed in million short tons and the emission factors were expressed in metric pounds/short ton. The activity indicator for anthracite coal was expressed in thousand short tons and the emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.2-1.

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.2-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

The NO_x emissions produced by the combustion of bituminous coal by electric utilities were calculated with an applied 80 percent EPA-specified rule effectiveness for post-1977 years. Equation 3.2-2 summarizes this calculation.

$$Emissions_{NO_x,\ bit.\ coal} = AI_{bit.\ coal} \times EF_{NO_x,\ bit.\ coal} \times \left[1 - \left[RE \times \frac{CE_{NO_x,\ bit.\ coal}}{100}\right]\right] \qquad \text{(Eq. 3.2-2)}$$

where: AI = activity indicator
EF = emission factor
RE = rule effectiveness of 0.80
CE = control efficiency (expressed as a percentage)

3.2.2 Activity Indicator

The activity indicator for the combustion of anthracite coal by electric utilities was the anthracite coal receipts at electric utilities obtained from Reference 1a.

The activity indicator for bituminous, subbituminous, and lignite coal combustion was calculated as the difference between the total national consumption of coal by electric utilities and the anthracite coal consumption at electric utilities as determined above. The total national consumption of coal was obtained from Reference 2 or Reference 3.

3.2.3 Emission Factor

For the combustion of anthracite coal (SCC 1-01-001-xx), the emission factors for all pollutants except PM-10 were obtained from Reference 4a. The PM-10 emission factor was obtained from Reference 5. Emission factors for PM-10 and TSP were multiplied by an ash content value of 11 percent. The SO_2 emission factor was multiplied by the national average sulfur content value obtained from Reference 1.

For the combustion of bituminous, subbituminous, and lignitecoal (SCC 1-01-002-xx), the emission factors were the weighted averages of the emission factors for different firing configurations. The CO, NO_x, TSP, and VOC emission factors for each firing configuration were obtained from References 4b and 4c. The PM-10 emissions factors were obtained from Reference 5. The CO and VOC emission factors were weighted by the 1980 quantity of bituminous coal and lignite burned by industry in each firing configuration as reported in Reference 3. For the years 1977 through 1984, the NO_x, PM-10, and TSP emission factors were weighted by the national capacity of each boiler types determined annually. Boiler capacity data was based on 1976 data obtained from Reference 6. To update the capacity data after 1976, additional capacities of all coal-fired plants that came on line during each year between 1976 and the year under study were obtained from Reference 7. All new boilers added since 1977 were assumed to be pulverized dry bottom tangentially-fired boilers and were subject to New Source Performance Standards. These weighting factors were used to determine the bituminous coal and the lignite emission factors for NO_x, PM-10, and TSP. The weighted averages of these two emission factors for each of the three pollutants were calculated using the total fuel receipts obtained from Reference 1a as weighting factors. Ash contents of 13 percent for bituminous coal and 11 percent for lignite were applied to the PM-10 and TSP emission factors.

No specific information concerning the procedures for determining the NO_x and TSP emission factors for the years prior to 1977 or the PM-10 emission factor for 1975 through 1977 is currently available. Emission factors were not used in the estimations of PM-10 emissions prior to 1975.

The uncontrolled SO_2 emission factor was the weighted average of the bituminous, subbituminous and lignite SO_2 emission factors obtained from Reference 4. Weighting factors were the quantity of fuel receipts at electric utilities for steam plants with a capacity greater than 50 MW as reported in Reference 1. Each emission factor was multiplied by the sulfur content value obtained from Reference 8. The calculation is summarized in Equation 3.2-3.

$$EF_{uncontrolled} = \frac{(Q_B \times EF_B \times S_B) + (Q_{SB} \times EF_{SB} \times S_{SB}) + (Q_L \times EF_L \times S_L)}{Q_B + Q_{SB} + Q_L} \quad \text{(Eq. 3.2-3)}$$

where:
- EF = uncontrolled emission factor
- Q = quantity of fuel receipts
- S = sulfur content value
- B = bituminous coal
- SB = subbituminous coal
- L = lignite coal

This uncontrolled emission factor was adjusted for emission controls using the control efficiency, resulting in a controlled emission factor. The procedure for determining the control efficiency is presented in the next section.

3.2.4 Control Efficiency

3.2.4.1 Anthracite Coal

The TSP control efficiency was obtained from Reference 9. When this source was unavailable, a control efficiency of 99 percent was used.

The PM-10 control efficiencies for the years 1975 through 1984 were based on the 1988 PM-10 control efficiency obtained from Reference 10. During these years, any changes in the TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were use to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate the CO, NO_x, SO_2, or VOC emissions from this source.

3.2.4.2 Bituminous, Subbituminous, and Lignite Coal

The TSP control efficiencies were derived from the uncontrolled and controlled emissions. Uncontrolled TSP emissions were calculated for all point sources with SCCs 101002xx and 101003xx by multiplying the operating rates as obtained from NEDS or AIRS (References 6 and 11) by the appropriate emission factors (see preceding section). These products were summed to obtain the total uncontrolled TSP emissions. The controlled TSP emissions for all point sources with SCCs 101002xx and 101003xx were obtained from Reference 6 or Reference 11 and summed to obtain the total controlled TSP emissions. These values were used in Equation 3.2-4 to calculate the TSP control efficiencies.

$$CE = \left[\frac{(UE - AE)}{UE}\right] \qquad \text{(Eq. 3.2-4)}$$

where: CE = control efficiency
UE = uncontrolled emissions
AE = controlled emissions

The PM-10 control efficiencies for the years 1975 through 1984 were based on the 1988 PM-10 control efficiency obtained from Reference 10. During these years, any changes in the TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate the PM-10 emissions.

No control efficiencies were applied to the activity data to estimate the CO, NO_x, or VOC emissions from bituminous, subbituminous, and lignite coal combustion.

The SO_2 control efficiency was based on plant level information on the amount of SO_2 removed by the control devices. The control efficiency was then applied to the uncontrolled emission factor to obtain the controlled SO_2 emission factor.

The following information was obtained from Reference 12: (1) plant and unit name and number, (2) percentage of SO_2 removed, and (3) commercial start-up date. The amount of SO_2 removed at each plant was calculated using this information along with the amount of coal consumed by the plant obtained from Reference 1b or Reference 13, the unit and plant capacity obtained from Reference 8, the percent sulfur content obtained from Reference 1, and the uncontrolled SO_2 emission factor for the combustion of bituminous coal at electric utilities (see preceding section). The amount of SO_2 removed at each plant was calculated according to Equation 3.2-5.

$$SO_{2,removed} = C \times \left[\frac{UC}{PC}\right] \times EF_{uncontrolled} \times RF \times SC \times OP \qquad \text{(Eq. 3.2-5)}$$

where: C = coal consumed at plant
UC = unit capacity at plant
PC = total plant capacity
EF = SO_2 emission factor
RF = fraction of SO_2 removed at plant
SC = sulfur content
OP = fraction of year plant in operation (assumed that the month after start-up date was first full month of operation)

The SO_2 removed at each unit was summed to obtain the national total SO_2 removed. The SO_2 control efficiency was calculated according to Equation 3.2-6 and was then applied to the uncontrolled emission factor to obtain the controlled emission factor.

$$CE_{SO_2} = \frac{SO_{2,\ removed}}{EF_{uncontrolled} \times AI_{Bituminous\ Coal}} \quad \text{(Eq. 3.2-6)}$$

where: CE = control efficiency
EF = emission factor
AI = activity indicator

3.2.5 References

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   (b) Appendix A

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3. *Quarterly Coal Report: January - March*. DOE/EIA-0121(xx/1Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Quarterly.

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency. Research Triangle Park, NC. September 1991.
   (a) Volume I, Table 1.2-1, Supplement B, September 1988.
   (b) Volume I, Table 1.1-1
   (c) Volume I, Table 1.7-1

5. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

6. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual

7. Energy Data System, FPC 67 form run to print boiler capacity sorted by boiler type. 1976.

8. *Inventory of Power Plants in the United States 19xx.* DOE/EIA-0095(xx). U.S. Department of Energy, Energy Information Administration. Washington, DC. Annual.

9. *Computer Retrieval, NE257 report, by Source Classification Code (SCC) from the National Emission Data System (NEDS)*. Unpublished computer report. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. February 9, 1980.

10. Barnard, William R. and Patricia M. Carlson. “PM-10 Emission Control Efficiency Calculations for Emissions Trends,” Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990..

11. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

12. Flue Gas Desulfurization Information System, FGDIS.

13. U.S. Department of Energy. Electric Generating Plant List (GURF) Report. Washington, DC.

3.3 FUEL COMBUSTION ELECTRIC UTILITY - OIL: 01-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(01) FUEL COMBUSTION - ELECTRIC UTILITY	(02) Oil	Residual Distillate

3.3.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/thousand gallons. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.3-1.

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.3-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.3.2 Activity Indicators

The activity indicators for the combustion of residual and distillate oil were the consumption of these fuel types by electric utilities. Distillate oil consumption was assumed to be equal to the "adjusted" distillate fuel oil sales to electric utilities obtained from Reference 1 or Reference 2. Residual fuel oil consumption was obtained from Reference 1 or, when this reference was unavailable, the residual oil consumption was calculated as the difference between the total oil consumption and the distillate oil consumption. The total annual oil consumption was obtained from Reference 3.

3.3.3 Emission Factors

The emission factors for residual oil were calculated from the emission factors for the following four SCCs: 1-01-004-01, 1-01004-04, 1-01-004-05, and 1-01-004-05. For each pollutant, except PM-10, these emission factors were obtained from Reference 4a. The PM-10 emission factors were obtained from Reference 5. The SO_2 emission factors for these four SCCs were each the sum of the emission factors for SO_2 and SO_3. Each SO_3 emission factor was converted to an emission factor by weight of SO_2 prior to the summing by using the ratio of the molecular weights of SO_2 and SO_3 (i.e., 64/80). The SO_2, TSP, and PM-10 emission factors for these four SCCs were multiplied by the fuel sulfur content from Reference 6.

For each pollutant, the overall emission factor for the combustion of residual oil was the arithmetic average of the emission factors for the four SCCs, with the exception for the NO_x emission factor. The NO_x emission factors for the four SCCs were weighted by the residual oil capacity of each boiler type. Any additional capacity added since 1981 was assumed to be subject to the New Source Performance Standards. An emission factor of 45 lb/thousand gallons was assumed for these boilers and was weighted by the additional capacity. The yearly boiler capacities were obtained from Reference 7.

The emission factors for the combustion of distillate oil were calculated from the emission factors for the SCCs listed in Table 3.3-1. The emission factors for all pollutants except PM-10 were obtained from References 4a, 4b, and 4c. The PM-10 emission factors were obtained from Reference 5. Weighted averages of the boiler emission factors for each pollutant, except SO_2, were calculated using the weighting factors given in Table 3.3-1. Weighted average nonboiler emission factors for each pollutant, except SO_2, were calculated in the same manner.

The SO_2 emission factors for the four SCCs were multiplied by the fuel sulfur content for #2 and #4 heating oils obtained yearly from Reference 8. The #2 heating oil sulfur content was applied to the emission factors for the SCCs 1-01-005-01 and 2-01-001-01. The #4 heating oil sulfur content was applied to the SCC 1-01-005-04. No sulfur content was applied to the emission factor for reciprocating engines. Emission factors for the two boiler SCCs were weighted according to the distribution of #2 and #4 heating oils to electric utilities as reported in Reference 6. Emission factors for the nonboiler SCCs were weighted in the same manner as described for the other pollutants.

The overall emission factors for the combustion of distillate oil were the weighted average of the boiler and nonboiler emission factors for each pollutant. Weighting factors were dependent on the year for which the emission factors were being determined. For the years 1970 through 1980, the boiler emission factors were weighted 40 percent and the nonboiler emission factors were weighted 60 percent. After 1980, weighting factors were 50 percent for both boiler and nonboiler emission factors. The weighting factors used prior to 1970 are currently unavailable.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.3.4 Control Efficiency

The PM-10 control efficiencies for the combustion of residual and distillate oil for the years 1975 through 1984 were equal to the 1988 PM-10 control efficiencies obtained from Reference 9. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, TSP, or VOC emissions from the combustion of residual and distillate oil.

3.3.5 References

1. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Petroleum Marketing Annual*. DOE/EIA-0389(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

3. *Electric Power Annual*. DOE/EIA-0348(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   (a) Volume I, Table 1.3-1
   (b) Volume I, Table 3.1-2
   (c) Volume I, Table 3.3-1

5. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

6. *Cost and Quality of Fuels for Electric Utility Plants*. DOE/EIA-0191(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

7. *Inventory of Power Plants in the United States 19xx.* DOE/EIA-0095(xx). U.S. Department of Energy, Energy Information Administration. Washington, DC. Annual.

8. *Heating Oils*. U.S. Department of Energy. Obtainable from the National Institute for Petroleum and Energy Research, ITT Research Institute, P.O. Box 2128. Bartlesville, OK. Annual.

9. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends," Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

Table 3.3-1. Emission Factor SCCs for Distillate Oil Combustion by Electric Utility

SCC	Description	Weighting Factors
1-01-005-01	Boiler - #2 oil	0.9
1-01-005-04	Boiler - #4 oil	0.1
2-01-001-01	Nonboiler - gas turbine	0.9
2-01-001-02	Nonboiler - reciprocating	0.1

3.4 FUEL COMBUSTION ELECTRIC UTILITY - GAS: 01-03

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(01) FUEL COMBUSTION - ELECTRIC UTILITY	(03) Gas	Natural Gas

3.4.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source category listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in billion cubic feet and the emission factors were expressed in metric pounds/million cubic feet. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.4-1.

$$PM\!-\!10\ \ Emissions_{year} = PM\!-\!10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.4-1)}$$

This calculation was used in place of estimating PM-10 emissions based on activity indicators, emission factors, and control efficiencies.

3.4.2 Activity Indicator

The total annual natural gas consumption obtained from Reference 1 was the activity indicator for this category.

3.4.3 Emission Factor

The emission factors for all pollutants, except NO_x, were based on the emission factors for the five boiler and nonboiler types listed by SCC in Table 3.4-1. These emission factors for all pollutants except PM-10 were obtained from Reference 2a, 2b, and 2c. The PM-10 emission factors were obtained from Reference 3. Weighted average of the boiler emission factors were calculated using weighting factors obtained from Reference 4 or Reference 5. Weighted averages of the nonboiler emission factors were calculated using the weighting factors presented in Table 3.4-1. The overall weighted emission factors were calculated by weighting the boiler emission factors 94 percent and the nonboiler emission factors 6 percent.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the source included in this Tier II category.

The NO_x emission factors were based on the emission factors for the two nonboiler types listed in Table 3.4-1 and the following three boiler types listed in Table 3.4-2. The nonboiler emission factors were obtained from Reference 2b and 2c and were weighted in the same manner as for the other pollutants. The emission factors for the three boiler types are presented in Table 3.4-2. These emission factors were weighted by the boiler capacity data which was based on 1976 data obtained from Reference 6. In order to update the capacity data to a year after 1976, the additional capacities of plants that came on line each year between 1976 and the year under study were obtained from Reference 7. The procedure for determining the boiler capacities for the years prior to 1976 is currently unavailable. All new boilers added since 1983 were assumed to be subject to New Source Performance Standards and, therefore the new boiler capacity was added to this category. The resulting boiler capacities were used as weighting factors in the calculation of average NO_x emission factors for boilers. The overall weighted emission factors were calculated in the same manner as for the other pollutants.

3.4.4 Control Efficiency

The PM-10 control efficiencies for the combustion of natural gas for the years 1975 through 1984 were equal to the 1988 PM-10 control efficiency obtained from Reference 8. For the years 1940 through 1974, no control efficiencies were used to estimate the PM-10 emissions.

No control efficiencies were applied to the activity data to estimate the CO, NO_x, SO_2, TSP, or VOC emissions from the combustion of natural gas.

3.4.5 References

1. *Natural Gas Annual*. DOE/EIA-0131(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   (a) Volume I, Table 1.4-1, Supplement A, October 1986.
   (b) Volume I, Table 3.1-2, September 1985.
   (c) Volume I, Table 3.2-1, September 1985.

3. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

4. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

5. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

6. *Inventory of Power Plants in the United States 19xx.* DOE/EIA-0095(xx). U.S. Department of Energy, Energy Information Administration. Washington, DC. Annual.

7. Energy Data System, FPC 67 form run to print boiler capacity sorted by boiler type. 1976.

8. Barnard, William R. and Patricia M. Carlson. "PM-10 emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

Table 3.4-1. Emission Factor SCCs for the Combustion of Natural Gas by Electric Utility

SCC	Description	Weighting Factors
1-01-006-01	Utility/Large Industrial Boiler	
1-01-006-02	Small Industrial Boiler	
1-01-006-04	Tangentially-Fired Boiler	
2-01-002-01	Nonboiler - gas turbine	0.9
2-01-002-02	Nonboiler - reciprocating engine	0.1

Table 3.4-2. NO_x Emission Factors by Boiler Types for the Combustion of Natural Gas by Electric Utility

Boiler Type	Emission Factor (lb/10^6 cu. ft.)
Normal	550
Tangential	275
New Source Performance Standard	200

3.5 FUEL COMBUSTION INDUSTRIAL - COAL: 02-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(02) FUEL COMBUSTION - INDUSTRIAL	(01) Coal	Anthracite Bituminous, Subbituminous, and Lignite Coal

3.5.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order the utilize these values in the *Trends* spreadsheets, the activity indicator for bituminous, subbituminous, and lignite coal was expressed in million short tons and the emission factors were expressed in metric pounds/short ton. The activity indicator for anthracite coal was expressed in thousand short tons and the emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.5-1.

$$PM-10\ \ Emissions_{year}\ =\ PM-10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.5-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.5.2 Activity Indicator

The activity indicator for the combustion of anthracite coal was the distribution of anthracite coal from Pennsylvania (i.e. District 24) obtained from Reference 1a under the category “Other Industrial”.

The activity indicator for bituminous, subbituminous, and lignite coal was based on total national coal consumption obtained from Reference 2 under the category “Other Industrial.” This value included the coal consumption from coke plants which were not appropriate for this activity indicator. Therefore, the coal consumption of cement plants and lime plants were subtracted from the total coal consumption. Coal consumption by cement plants was obtained from Reference 3. Coal consumption by lime plants was estimated by multiplying the lime production value obtained from Reference 4 by the conversion factor: 0.1 tons coal/ton lime produced.

3.5.3 Emission Factors

The emission factors for the combustion of anthracite coal were the weighted averages of the emission factors for three different firing configurations. For all pollutants except PM-10, the emission factors for each firing configuration were obtained from Reference 5a; the PM-10 emission factors were obtained from Reference 6. These emission factors were weighted by the 1980 quantity of anthracite coal burned by industry in each firing configuration as reported in Reference 7. An ash content of 11 percent was applied to selected PM-10 and TSP emission factors. The SO_2 emission factors were multiplied by a sulfur content value of 0.7 percent.

The emission factors for the combustion of bituminous, subbituminous, and lignite coal were the weighted average of the emission factors for the different firing configurations obtained from Reference 5b and 5c, respectively. These emission factors were weighted by the 1980 quantity of bituminous, subbituminous, and lignite coal burned by industry in each firing configuration as reported in Reference 7. The ash content was assumed to be 13 percent for bituminous and subbituminous coal, and 11 percent for lignite coal.

The SO_2 emission factor was multiplied by the average sulfur content for all coal shipped to industrial plants. The average sulfur content of coal was determined from the sulfur content by coal producing districts obtained for the category “Other industrial uses and retail dealers” in Reference 8a. This reference provided the sulfur content values reported in 1977 and it was assumed that these values remained constant during the years 1940 through 1984. In order to obtain the average sulfur content for a specific year, the sulfur content by district was weighted by the distribution of coal by district of origin for the category “Other Industrial” obtained from Reference 1a or Reference 9.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the source included in this Tier II category.

3.5.4 Control Efficiency

The TSP control efficiency for the combustion of anthracite coal was derived from Reference 10 or Reference 11 using Equation 3.5-2. When these values were unavailable, a control efficiency of 0.95 was used.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \quad \text{(Eq. 3.5-2)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

The TSP control efficiency for the combustion of bituminous, subbituminous, and lignite coal was calculated based on the uncontrolled and controlled emissions. In order to calculate the uncontrolled TSP emissions, the operating rates for each type of boiler using bituminous, subbituminous, and lignite coal (i.e., SCCs within the group 1-02-002-xx) were obtained from Reference 10 or Reference 11. These rates were multiplied by the corresponding emission factors obtained from Reference 5 and an ash content of 13 percent. The emissions were summed over all boiler types and converted to tons to obtain the total uncontrolled TSP emissions. The actual emissions reported in Reference 10 or Reference 11 were summed over the same boiler types to obtain the total actual TSP emissions. The TSP control efficiency was calculated from these values according to the equation given above.

The PM-10 control efficiencies for anthracite, bituminous, subbituminous, and lignite coal combustion for the years 1975 through 1984 were based on the 1988 PM-10 control efficiency obtained from Reference 12. During these years, any changes in the TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were use to estimate PM-10 emissions from the combustion of these fuels.

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, or VOC emissions from the combustion of anthracite coal and of bituminous coal and lignite.

3.5.5 References:

1. *Coal Distribution January-December 19xx*. DOE/EIA-0125(xx/4Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   (a) Table entitled, "Domestic Distribution of U.S. Coal by Origin, Destination, and Consumer: January-December 19xx".

2. *Quarterly Coal Report: January - March*. DOE/EIA-0121(xx/1Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Quarterly.

3. *Minerals Industry Surveys*, Cement. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Monthly.

4. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

5. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.

a. Volume I, Table 1.2-1, Supplement B, September 1988.
b. Volume I, Table 1.1-1
c. Volume I, Table 1.7-1

6. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

7. *Computer Retrieval, NE257 report, by Source Classification Code (SCC) from the National Emission Data System (NEDS)*. Unpublished computer report. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. February 9, 1980.

8. *Coal Production*. DOE/EIA-0118(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   (a) Table entitled, "Shipments of Bituminous Coal and Lignite by District, Consumer, Use, Average Sulfur Content - 1977."

9. *Minerals Yearbook*, Coal. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.

10. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

11. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

12. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

3.6 FUEL COMBUSTION INDUSTRIAL - OIL: 02-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(02) FUEL COMBUSTION - INDUSTRIAL	(02) Oil	Residual Distillate Process Heaters

3.6.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators for residual and distillate oil were expressed in million gallons and emission factors were expressed in metric pounds/thousand gallons. For CO, NO_x, PM-10, TSP, and SO_2 emissions, activity indicators for oil-fired process heaters were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. For VOC emissions, the activity indicator for process heaters was expressed in million barrels and the emission factors was expressed in metric pounds/thousand barrels. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.6-1.

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.6-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.6.2 Activity Indicator

The activity indicator for residual oil combustion was based on the adjusted quantity of residual oil sales for industrial and oil company use obtained from Reference 1 or 2. The total of three statistics were subtracted from this value to obtain the activity indicator. The first statistic was two-thirds of the quantity of oil consumed by cement plants reported in Reference 3 converted to gallons. The second statistic was the quantity of residual oil consumed by petroleum refineries reported in Reference 4a, converted to gallons. The third statistic was the quantity of residual oil consumed by steel mills. This value was calculated by multiplying the quantity of raw steel production obtained from Reference 5, by 0.00738 x 10^6 gal/10^3 ton steel. The conversion factor between the gallons of oil and the tons of steel was updated in 1982 based on Reference 6.

The activity indicator for distillate oil combustion was based on the adjusted quantity of distillate oil sales to industrial and oil companies obtained from Reference 1 or 2. The total of two statistics were subtracted from this value to obtain the activity indicator for distillate oil. The first statistic was one-thirds of the quantity of oil consumed by cement plants, expressed in gallons, reported in Reference 3. The second statistic was the quantity of distillate oil consumed by petroleum refineries, expressed in gallons, reported in Reference 4a.

The activity indicator for oil-fired process heaters was the total quantity of oil consumed at petroleum refineries. This value was the sum of the distillate, residual and crude oil consumptions at petroleum refineries as reported in Reference 4a.

3.6.3 Emission Factor

The emission factors for each pollutant for the combustion of residual oil (SCC 1-02-004-01) were obtained from Reference 7 under the classification industrial boilers - residual oil for all pollutants except PM-10. The PM-10 emission factors were obtained from Reference 8. The SO_2, PM-10, and TSP emission factors were multiplied by the sulfur content obtained for No. 6 fuel oil from Reference 9.

The emission factors for each pollutant for the combustion of distillate oil were the weighted average of the emission factors for two SCCs (1-02-005-01 and 1-02-005-04). These emission factors were obtained from Reference 7 for all pollutants except PM-10. The PM-10 emission factors were obtained from Reference 8. Weighting factors were obtained from Reference 10.

The SO_2 emission factors were multiplied by a weighted average sulfur content. Sulfur content values for No. 1, No. 2, and No. 4 oils were obtained from Reference 9. These values were weighted by the corresponding distribution of fuel oil sales to the industrial sector as reported in Reference 1 or 2.

For oil-fired process heaters, the emission factors for all pollutants, except PM-10, were obtained from Reference 7 under the classification for industrial boiler - residual oil. The PM-10 emission factor was obtained from Reference 8.

The TSP emission factor, as specified in Reference 7, was a function of sulfur content (10(S) + 3 lb/1,000 gal). The sulfur content was obtained for SCC 30600103 from Reference 10. The SO_2 and PM-10 emission factors were multiplied by the sulfur content. The VOC emission factor was converted to a reactive basis using the VOC species profile SDM 101004 from Reference 11.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.6.4 Control Efficiency

The PM-10 control efficiencies for all emission sources included in this Tier II category for the years 1975 through 1984 were equal to the 1988 PM-10 control efficiencies obtained from Reference 12. For the years 1940 through 1974, no control efficiencies were used to estimate the PM-10 emissions.

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, TSP, or VOC emissions from the source included in this Tier II category.

3.6.5 References

1. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

3. *Minerals Industry Surveys*, Cement. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Monthly.

4. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Fuel Consumed at Refineries by PAD District."

5. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.
   a. Table containing information on Metals and Manufacturers

6. *Census of Manufactures (Fuels and Electric Energy Consumed)*. Bureau of the Census, U.S. Department of Commerce, Washington, DC. 1982.

7. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991. Volume I, Table 1.3-1

8. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

9. *Heating Oils*. U.S. Department of Energy. Obtainable from the National Institute for Petroleum and Energy Research, ITT Research Institute, P.O. Box 2128. Bartlesville, OK. Annual.

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11. *Volatile Organic Compound (VOC) Species Data Manual*. EPA-450/4-80-015. U.S. Environmental Protection Agency, Research Triangle Park, NC. July 1980.

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3.7 FUEL COMBUSTION INDUSTRIAL - GAS: 02-03

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(02) FUEL COMBUSTION - INDUSTRIAL	(03) Gas	Natural Gas - boilers and gas pipelines and plants Coke - oven gas Process Heaters

3.7.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators for natural and coke-oven gas were expressed in billion cubic feet and emission factors were expressed in metric pounds/million cubic feet. For CO, NO_x, PM-10, TSP, and SO_2 emissions, the activity indicator for gas-fired process heaters was expressed in thousand short tons and the emission factors were expressed in metric pounds/short ton. For VOC emissions, the activity indicator for gas-fired process heaters was expressed in million barrels and the emission factor was expressed in metric pounds/thousand barrels. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.7-1.

$$PM\!-\!10\ \ Emissions_{year} \ = \ PM\!-\!10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.7-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.7.2 Activity Indicator

The activity indicator for the combustion of natural gas in industrial boilers was based on the total industrial consumption of natural gas obtained from Reference 1. From this value was subtracted the sum of the total natural gas consumption by cement plants, petroleum refineries, iron and steel industries, and glass manufacturers. Total natural gas consumption by cement plants obtained from Reference 2. Total natural gas consumption by petroleum refineries was obtained from Reference 3. The total natural gas consumption by iron and steel industries was calculated by multiplying the raw steel production obtained from Reference 4 by 4.25×10^6 cu. ft. natural gas/1000 tons steel. The conversion factor relating steel production to natural gas consumption was updated in 1982 based on data from Reference 5. Total natural gas consumption by glass manufacturers was determined from the total glass production. This total was calculated by summing the total production of flat glass from Reference 6 and the net packed weight of glass containers from Reference 7 and multiplying the resulting sum by 1.1 to account for miscellaneous glass products. The total glass production was multiplied by 10.8×10^6 cu. ft. natural gas/1000 tons glass produced to obtain the total natural gas consumption. The conversion factor relating glass production to natural gas consumption was updated in 1982 based on data from Reference 5.

The activity indicator for the combustion of natural gas by gas pipelines and plants was the total natural gas consumption for lease and plant fuel plus pipeline fuel obtained from Reference 1.

The activity indicator for coke-oven gas combustion represented the amount of coke-oven gas consumed outside of the iron and steel industry which was assumed to be 18.8 percent of the total coke-oven gas produced. The total coke-oven gas production, in cubic feet, as reported in Reference 8, was multiplied by 0.188 to obtain the activity indicator for this subcategory.

The activity indicator for gas-fired process heaters was the total of natural gas and still (process) gas consumed at petroleum refineries obtained from Reference 3.

3.7.3 Emission Factor

The emission factors for all pollutants except PM-10 for the combustion of natural gas in industrial boilers (SCC 1-02-006-02) were obtained from Reference 9a. The PM-10 emission factor was obtained from Reference 10.

The emission factors for the combustion of natural gas by gas pipeline and plants were the weighted averages of the emission factors for SCCs 2-02-002-01 and 2-02-002-02. Reference 9b was the source of the emission factors for all pollutants except PM-10; Reference 10 was the source for the PM-10 emission factors. The weighting factors were based on data from Reference 11.

The emission factors for all pollutants for the combustion of coke-oven gas were obtained from Reference 10. The SO_2 emission factor was multiplied by the constant sulfur content value of 1.605 percent.

The CO and NO_x emission factors for all types of gas-fired process heaters were obtained from Reference 9c. The PM-10 emission factor was obtained from Reference 10, the PM-10 and TSP emission factors were obtained from Reference 9a, and the VOC emission factor from Reference 9d. In each case, the emission factors were listed as the uncontrolled emission factors for small industrial boilers. The VOC emission factor was converted to a reactive basis using the VOC species profile SDM 101007 from Reference 12.

The SO_2 emission factor was the weighted average of the emission factors for natural gas obtained from Reference 9c and for refinery gas (given as 356.25 lb/10^6 cu.ft.). The weighting factors were the natural gas and refinery gas consumption obtained from Reference 3.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.7.4 Control Efficiency

The PM-10 control efficiencies for all emission sources included in this Tier II category for the years 1975 through 1984 were equal to the 1988 PM-10 control efficiencies obtained from Reference 13. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, TSP, or VOC emissions from these sources.

3.7.5 References

1. *Natural Gas Annual*. DOE/EIA-0131(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Minerals Industry Surveys*, Cement. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Monthly.

3. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

4. *Minerals Industry Surveys*, Iron Ore. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Monthly.

5. *Census of Manufactures (Fuels and Electric Energy Consumed)*. Bureau of the Census, U.S. Department of Commerce, Washington, DC. 1982.

6. *Current Industrial Reports*, Glass Containers. Bureau of the Census, U.S. Department of Commerce, Washington, DC. Annual.

7. *Current Industrial Reports*, Flat Glass. Bureau of the Census, U.S. Department of Commerce, Washington, DC. Annual.

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   (a) Volume I, Table 1.4-1
   (b) Volume I, Table 3.2-1
   (c) Volume I, Table 1.4-2
   (d) Volume I, Table 1.4-3

10. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

11. *Computer Retrieval, NE257 report, by Source Classification Code (SCC) from the National Emission Data System (NEDS)*. Unpublished computer report. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. February 9, 1980.

12. U.S. Environmental Protection Agency. Volatile Organic Compound (VOC) Species Data Manual. EPA-450/4-80-015. Research Triangle Park, NC. July 1980.

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3.8 FUEL COMBUSTION INDUSTRIAL - OTHER: 02-04

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(02) FUEL COMBUSTION - INDUSTRIAL	(04) Other External Combustion	Coke, Bagasse, Kerosene, Liquid Petroleum Gas, and Wood

3.8.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators for coke, bagasse, and wood were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. For kerosene and LPG, activity indicators were expressed in million barrels and emission factors was expressed in metric pounds/thousand barrels. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.8-1.

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.8-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.8.2 Activity Indicator

The activity indicator for the combustion of coke was the consumption of coke outside the iron and steel industry. This quantity was calculated by summing the total coke production from coal and the total petroleum coke receipts. The total quantity of petroleum coke consumed or received by power plants was obtained from Reference 1 or Reference 2.

In order to obtain the total coke produced from coal, the following data were obtained from Reference 3: (1) total breeze production at coke plants and (2) coke sales to "other industrial plants." Because it was assumed that 24 percent of the total breeze production was sold for use as boiler fuel, the total breeze production at coke plants was multiplied 0.24 to obtain the total breeze consumed as fuel. If data for foundries and other industrial plants were combined, it was assumed that 49 percent of the total was for other industrial plants. Total coke production from coal was the sum of the total breeze production used for fuel and the total coke sales to other industrial plants. Alternatively, if data from Reference 3 were not available, it was assumed that 5.75 percent of total coke production obtained from Reference 3 represented the coke consumption outside the iron and steel industry.

The activity indicator for the combustion of bagasse was the consumption of bagasse obtained from Reference 4.

The activity indicator for the combustion of kerosene was the quantity of kerosene sales. This value was obtained by summing the sales figures reported for the industrial and the all other end use categories as reported in Reference 5 or Reference 6.

The activity indicator for the combustion of liquid petroleum gas was the LPG supplied for industrial use. This quantity was derived from the 1982 consumption figures ($5,397 \times 10^6$ gal) using the ratio between the quantity of products supplied in 1982 ($1,499 \times 10^3$ bbl/day) and in the year under study. The quantity of products supplied for a given year and for 1982 was obtained from Reference 7. The Equation 3.8-2 summarizes the calculation of the LPG supplied for industrial use:

$$LPG_{Industrial,\ i} = LPG_{Industrial,\ 1982} \times \frac{Products_{Supplied,\ i}}{Products_{Supplied,\ 1982}} \qquad \text{(Eq. 3.8-2)}$$

where: i = year under study

The activity indicator for the industrial combustion of wood was based on the consumption of wood for industrial combustion obtained from Reference 8. It was assume that 15 percent of the heating value was lost to moisture on a typical basis. Therefore, the reported consumption figure was multiplied by 0.85 to obtain the activity indicator.

3.8.3 Emission Factor

The emission factors for industrial coke combustion were the weighted averages of the emission factors for petroleum coke and coal coke. These emission factors for which the references are currently unavailable are presented in Table 3.8-1. Weighting factors were the total petroleum coke receipts and the total coke produced from coal as determined for the activity indicator for the coke category. A sulfur content value of 3.25 percent was used for the petroleum coke SO_2 emission factor.

The emission factors for bagasse combustion (SCC 1-02-001-01) were obtained from Reference 9a for all pollutants except PM-10. The PM-10 emission factor was obtained from Reference 10. The TSP control efficiency was applied directly to the TSP emission factor, resulting in the controlled emission factor. The TSP control efficiency was obtained from Reference 10.

The emission factors used for kerosene combustion (SCC 1-02-005-01) were those for the combustion of distillate oil in industrial boilers obtained from Reference 9b for all pollutants except PM-10. The PM-10 emission factor was obtained from Reference 10. The SO_2 emission factors was multiplied by a sulfur content value of 0.075 percent.

The emission factors for all pollutants for LPG combustion (SCC 1-02-010-01) were obtained from Reference 9c. The PM-10 emission factor was obtained from Reference 10. The SO_2 emission factor was multiplied by a sulfur content value of 0.0013 percent.

For industrial wood combustion the emission factors were the weighted averages of the emission factors for three SCCs (1-02-009-01, 1-02-009-02, and 1-02-009-03). These emission factors were obtained from Reference 9d for all pollutants except PM-10 which was obtained from Reference 10. For the years 1975 through 1984, the weighting factors were derived from throughput data obtained from Reference 11. Prior to 1975, the procedure for determining the weighting factors is currently unavailable.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.8.4 Control Efficiency

The PM-10 control efficiencies for all emission sources included in this Tier II category for the years 1975 through 1984 were equal to the 1988 PM-10 control efficiencies obtained from Reference 12. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, TSP, or VOC emissions from the source included in this Tier II category.

3.8.5 References

1. *Cost and Quality of Fuels for Electric Utility Plants*. DOE/EIA-0191(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Electric Power Annual*. DOE/EIA-0348(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

3. *Quarterly Coal Report: January - March*. DOE/EIA-0121(xx/1Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Quarterly.

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   (a) Volume I, Table 1.8-1
   (b) Volume I, Table 1.3-1
   (c) Volume I, Table 1.5-1
   (d) Volume I, Table 1.6-1, Supplement A, October 1986

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Table 3.8-1. Emission Factors for Miscellaneous Fuels - Industrial (coke)

	Emission Factors (lb/ton)					
Coke Type	**TSP**	**SO_2**	**NO_x**	**VOC**	**CO**	**PM-10**
Petroleum Coke	1.5	38.8*	20.9	0.64	0.54	1.2
Coal Coke	4.6	30.3	14.0	0.64	0.54	3.6

* Multiply by sulfur content

3.9 FUEL COMBUSTION OTHER - COMMERCIAL/INSTITUTIONAL COAL: 03-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(03) FUEL COMBUSTION - OTHER	(01) Commercial/Institutional Coal	Anthracite Coal Bituminous, Subbituminous, and Lignite Coal

3.9.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, the activity indicator for bituminous, subbituminous, and lignite coal was expressed in million short tons and the emission factors were expressed in metric pounds/short ton. The activity indicator for anthracite coal was expressed in thousand short tons and the emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.9-1.

$$PM-10\ \ Emissions_{year} = PM-10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.9-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.9.2 Activity Indicator

The activity indicators for the combustion of these two fuels were the consumption of the specific coal type by commercial and institutional users. Determination of these activity indicators required the activity indicators for both anthracite, bituminous, subbituminous, and lignite residential coal combustion. The latter activity indicators are described both here and in section 3.13.2.

The commercial/institutional consumption of anthracite coal was obtained by subtracting residential anthracite consumption from residential and commercial/institutional anthracite consumption. Residential and commercial/institutional consumption of anthracite coal was obtained from Reference 1a for District 24 only.

$$Anthracite\ Coal_{C/I} = Anthracite\ Coal_{R\ and\ C/I} - Anthracite\ Coal_{R} \qquad \text{(Eq. 3.9-2)}$$

where: C/I = commercial/institutional consumption
R = residential consumption

Residential consumption of anthracite coal was determined by extrapolating the consumption of the previous year based on the change in the number of dwelling units in the Northeastern United States having coal as the main fuel for space heating. Data concerning the number of dwelling units was obtained from Reference 2. The calculation of the residential anthracite coal consumption is summarized in Equation 3.9-3.

$$Anthracite\ Coal_{R,\ i} = Anthracite\ Coal_{R,\ i-1} \times \frac{Dwelling\ Units_{i}}{Dwelling\ Units_{i-1}} \qquad \text{(Eq. 3.9-3)}$$

where: R = residential consumption
i = year under study

Commercial/institutional consumption of bituminous, subbituminous, and lignite coal was obtained by subtracting residential bituminous, subbituminous, and lignite consumption from residential and commercial/institutional bituminous, subbituminous, and lignite consumption. Residential and commercial/institutional consumption of bituminous coal was calculated by subtracting the residential and commercial/institutional consumption of anthracite coal from residential and commercial/institutional consumption of all types of coal. These two consumption values were obtained from Reference 1a and excluded coal from District 24 which represents anthracite coal consumption. This calculation is summarized in Equation 3.9-4.

$$Bituminous\ Coal_{C/I} = (All\ Coal_{R\ and\ C/I} - Anthracite\ Coal_{R\ and\ C/I}) - Bituminous\ Coal_{R} \qquad \text{(Eq. 3.9-4)}$$

where: C/I = commercial/institutional consumption
R = residential consumption

Residential consumption of bituminous, subbituminous, and lignite coal was determined by estimating the quantity of all coal consumed by all dwelling units using coal as the main fuel and subtracting from this value the residential consumption of anthracite coal calculated above. The quantity of all coal consumed was calculated using the number of dwelling units using coal as the main fuel for space heating obtained from Reference 2 and a factor estimating the average annual consumption of coal per dwelling unit. This calculation is summarized in Equation 3.9-5.

$$Bituminous\ Coal_R = (Dwelling\ Units \times 6.73\ tons\ burned/dwelling/year) - Anthracite\ Coal_R \quad \text{(Eq. 3.9-5)}$$

3.9.3 Emission Factors

The emission factors for anthracite coal combustion were the weighted average of the emission factors for three different firing configurations. The emission factors for each firing configuration were obtained from Reference 3a for all pollutants except PM-10. The PM-10 emission factors were obtained from Reference 4. These CO, SO_2, and VOC emission factors were weighted by the 1980 quantity of anthracite coal burned by industry in each firing configuration as reported in Reference 5. The procedure for determining the weighting factors for the NO_x, PM-10 and TSP emission factors is currently unavailable, although it is known that the same factors were applied for the years 1940 through 1984. An ash content of 11 percent was applied to selected PM-10 and TSP emission factors. The SO_2 emission factors were multiplied by a sulfur content value of 0.7 percent.

The emission factors for the combustion of bituminous, subbituminous, and lignite coal were the weighted average of the emission factors for different firing configurations. For all pollutants except PM-10, these emission factors were obtained from Reference 3b and 3c. The PM-10 emission factors were obtained from Reference 4. These emission factors were weighted by the 1980 quantity of bituminous, subbituminous, and lignite coal burned by industry in each firing configuration as reported in Reference 5. The ash content was assumed to be 13 percent for bituminous coal and 11 percent for lignite.

The SO_2 emission factor was multiplied by the average sulfur content for all coal shipped to industrial plants. The average sulfur content of coal was determined from the sulfur content by coal producing districts obtained for the category “All other uses” in Reference 6a. This reference provided the sulfur content values reported in 1977 and it was assumed that these values remained constant during the years 1940 through 1984. In order to obtain the average sulfur content for a specific year, the sulfur content by district was weighted by the distribution of coal by district of origin for the category “Residential and Commercial” obtained from Reference 1a or Reference 7.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.9.4 Control Efficiency

The TSP control efficiency for the combustion of anthracite coal was obtained from Reference 8 or Reference 9. When this value was unavailable, a control efficiency of 33 percent was used.

For bituminous, subbituminous, and lignite coal, the TSP control efficiency was calculated based on the uncontrolled and controlled emissions. In order to calculate the uncontrolled TSP emissions, the operating rates for each type of boiler using bituminous and subbituminous coal and lignite (i.e. SCCs within the group 1-02-002-xx) were obtained from Reference 8 or Reference 9. These rates were multiplied by the corresponding emission factors obtained from Reference 3a and an ash content of 13 percent. The emissions were summed over all boiler types and converted to tons to obtain the total uncontrolled TSP emissions. The actual emissions reported in Reference 8 or Reference 9 were summed over the same boiler types to obtain the total actual TSP emissions. The TSP control efficiency was calculated from these values according to Equation 3.9-6.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \qquad \text{(Eq. 3.9-6)}$$

where:
- CE = control efficiency
- UE = uncontrolled emissions
- AE = controlled emissions

The PM-10 control efficiencies for anthracite coal and bituminous, subbituminous, and lignite coal combustion for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 10. During these years, any changes in the TSP control efficiencies from the 1985 TSP control efficiency values were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were use to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, or VOC emissions from the combustion of anthracite coal and bituminous coal and lignite.

3.9.5 References

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   (a) Volume I, Table 1.2-1, Supplement B, September 1988.
   (b) Volume I, Table 1.1-2
   (c) Volume I, Table 1.7-1

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3.10 FUEL COMBUSTION OTHER - COMMERCIAL/INSTITUTIONAL OIL: 03-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(03) FUEL COMBUSTION - OTHER	(02) Commercial/Institutional Oil	Residual Distillate

3.10.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/thousand gallons. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.10-1.

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.10-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.10.2 Activity Indicator

The activity indicator for residual oil combustion was the "adjusted" total quantity of residual oil sales for commercial and military use obtained from Reference 1 or Reference 2.

The activity indicator for distillate oil combustion was the "adjusted" total quantity of distillate oil sales for commercial and military use (not including military diesel fuel) obtained from Reference 1 or Reference 2.

3.10.3 Emission Factor

The emission factors for the combustion of residual oil were the weighted average of the emission factors for the combustion of Grade 6 and Grade 5 fuel oils (SCCs 1-03-004-01 and 1-03-004-04). For all pollutants except PM-10, these emission factors were obtained from Reference 3a. The PM-10 emission factors were obtained from Reference 4. The TSP, SO_2, and PM-10 emission factors for Grade 6 fuel oil and the SO_2 emission factor for Grade 5 fuel oil were multiplied by the average sulfur content. The weighted average emission factors were determined using the relative consumption of Grade 5 and Grade 6 fuel oils obtained from Reference 5 or Reference 6.

The average sulfur content for residual oil was calculated from sulfur content values obtained from Reference 7 for No. 5 light, No. 5 heavy and No. 6 oils. The sulfur content values for the two No. 5 oils were averaged. Weighting factors for the averaged No. 5 oils and the No. 6 oil were 0.13 and 0.87, respectively. Equation 3.10-2 summarizes this calculation.

$$S_{Residual\ Oil} = \left(\left[\frac{S_{No.\ 5\ light} + S_{No.\ 5\ heavy}}{2} \right] \times 0.13 \right) + (S_{No.\ 6} \times 0.87) \qquad \text{(Eq. 3.10-2)}$$

where: S = sulfur content

The emission factors for distillate oil combustion were the weighted averages of the emission factors for the SCCs 1-03-005-01 and 1-03-005-04. The emission factors were obtained from Reference 3b for all pollutants except PM-10. The PM-10 emission factors were obtained from Reference 4. The SO_2 emission factors for both SCCs were multiplied by a weighted average sulfur content. Sulfur content values for No. 1, No. 2, and No. 4 oils were obtained from Reference 7. These values were weighted by the corresponding commercial deliveries of each oil type reported in Reference 1 or Reference 2 to obtain the weighted average sulfur content. To determine the weighted average emission factors, throughput values for the corresponding SCCs obtained from Reference 5 or Reference 6 were used as weighting factors.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.10.4 Control Efficiency

The PM-10 control efficiencies for all emission sources included in this Tier II category for the years 1975 through 1984 were equal to the 1988 PM-10 control efficiencies obtained from Reference 7. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, TSP, or VOC emissions from the source included in this Tier II category.

3.10.5 References

1. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. January issue.

2. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

3. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 1.3-1
   b. Volume I, Table 1.3-1

4. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

5. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

6. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

7. *Heating Oils*. U.S. Department of Energy. Obtainable from the National Institute for Petroleum and Energy Research, ITT Research Institute, P.O. Box 2128, Bartlesville, OK. Annual.

8. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

3.11 FUEL COMBUSTION OTHER - COMMERCIAL/INSTITUTIONAL GAS: 03-03

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(03) FUEL COMBUSTION - OTHER	(03) Commercial/Institutional Gas	Natural Gas

3.11.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the emissions from the source category listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in billion cubic feet and the emission factors were expressed in metric pounds/million cubic feet. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to the following equation:

$$PM\!-\!10\ Emissions_{year} = PM\!-\!10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.11-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.11.2 Activity Indicator

The activity indicator for natural gas combustion was the total natural gas consumption for commercial uses as reported in Reference 1.

3.11.3 Emission Factor

The emission factors for all pollutants except PM-10 for the combustion of natural gas (SCC 1-03-006-03) were obtained from Reference 2a. The PM-10 emission factor was obtained from Reference 3.

3.11.4 Control Efficiency

The PM-10 control efficiencies for the years 1975 through 1984 were equal to the 1988 PM-10 control efficiency obtained from Reference 4. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions from natural gas combustion.

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, TSP, or VOC emissions from this source.

3.11.5 References

1. *Natural Gas Annual*. DOE/EIA-0131(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
    a. Volume I, Table 1.4-1

3. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

4. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

3.12 FUEL COMBUSTION OTHER - RESIDENTIAL WOOD: 03-05

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category
(03) FUEL COMBUSTION - OTHER	(05) Residential Wood

3.12.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the emissions from the source category listed above. Emissions were estimated from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in thousand short tons and the emission factors were expressed in metric pounds/short ton.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to the following equation:

$$PM-10\ \ Emissions_{year} = PM-10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.12-1)}$$

This calculation was used in place of estimating the emissions based on activity indicators and emission factors.

3.12.2 Activity Indicator

The activity indicator for the residential combustion of wood was based on the consumption of wood for residential combustion as reported in Reference 1. It was assumed that 15 percent of the heating value is lost to moisture on a typical basis. Therefore, the reported consumption figure was multiplied by 0.85 to obtain the activity indicator. Alternatively, the procedure used to determine the emission factors for this category was used to estimate residential wood consumption as described below in section 3.12.3. The wood consumption calculated by this method was normalized to the total wood consumption reported by the Department of Energy (no reference for this value is currently available).

3.12.3 Emission Factor

The emission factors for the residential burning of wood were the weighted average of the emission factors for wood burned in wood stoves and in fireplaces. These emission factors for all pollutants except PM-10 and TSP obtained from References 2a and 2b for wood stoves and fireplaces, respectively. The PM-10 and TSP emission factors were obtained from Table 3.1-3 of this report. Weighting factors were based on the relative quantity of wood burned in wood stoves and in fireplaces. Weighting factors of 0.755 for wood stoves and 0.245 for fireplaces were used when the factors were not determined as described below.

The quantity of wood consumed in fireplaces was determined from the number of fireplaces obtained from Reference 3a and the assumption that on average one-half cord of wood is burned in each fireplace per year. The calculation, including the necessary conversion factors is shown in Equation 3.12-2.

$$Wood\ Consumption_{fireplaces} = N_{fireplaces} \times \frac{0.5\,cord}{yr} \times \frac{4\,m^3}{cord} \times \frac{0.028317\,ft^3}{m^3} \times \frac{35\,lb}{ft^3} \times \frac{1\,ton}{2{,}000\,lb} \quad \text{(Eq. 3.12-2)}$$

The quantity of wood burned in wood stoves was determined from the number of wood stoves and the stove heat input rates. The number of wood stoves being used in a given year was calculated as the number of stoves being used in the previous year, the number of new shipments of stoves, and the number of obsolete stoves as summarized in Equation 3.12-3.

$$N_{Wood\ Stoves,\ i} = N_{Wood\ Stoves,\ i-1} + N_{New\ Wood\ Stoves,\ i} - N_{New\ Wood\ Stoves,\ i-6} \quad \text{(Eq. 3.12-3)}$$

where i = year under study

The total shipments and imports of stoves was obtained from Reference 4. It was assumed that for the years 1981 through 1984, the number of shipments remained constant at the 1981 value. The number of obsolete stoves was assumed to be the number of stove shipments from the sixth previous year.

The total number of wood stoves in use was divided into two categories: primary and secondary. The number of primary stoves was extrapolated from the previous year's number based on the relative change in the number of dwelling units using wood as the primary house heating fuel obtained from Reference 3. The number of secondary stoves was calculated as the difference between the total number of wood stoves and the number of primary stoves.

The stove heat input rate for each stove type was used to calculate the total energy consumed by each stove type. The 1984 stove heat input rates for primary and secondary stoves were 112,453 x 10^6 Btu and 42.37 x 10^6 Btu, respectively. No reference is currently available for this value and it is not known at this time if year-specific heat input rates were used for the year prior to 1984. The total energy consumed by the primary and secondary wood stoves were summed and converted to the quantity of wood consumed using the factor 17.2 x 10^6 Btu/ton.

The total quantity of wood consumed by residential combustion was calculated as the sum of the quantity of wood consumed in fireplaces and in wood stoves. The relative quantities of wood consumed by fireplaces and wood stoves were calculated and used as the weighting factors for determining the emission factors for this source category.

3.12.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate the emissions from the residential combustion of wood.

3.12.5 References

1. *Estimates of U.S. Biofuels Consumption*. SR/CNEAF/91-02. Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   (a) Volume I, Table 1.10-1, Supplement D, September 1991, Supplement C, September 1990, or Supplement B, September 1988.
   (b) Volume I, Table 1.9-1, Supplement D, September 1991

3. *American Housing Survey, Current Housing Reports, Series H-150-83*. Bureau of the Census, U.S. Department of Commerce, Washington DC. Biennial.
   (a) Table 2-4, Selected Equipment and Plumbing - Occupied Units

4. *Estimates of U.S. Wood Energy Consumption from 1949 to 1981*. DOE/EIA-0341. Energy Information Administration, U.S. Department of Energy, Washington, DC. August 1982.

3.13 FUEL COMBUSTION OTHER - RESIDENTIAL OTHER: 03-06

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(03) FUEL COMBUSTION - OTHER	(06) Residential Other	Anthracite Coal
		Bituminous, Subbituminous, and Lignite Coal
		Residual Oil
		Distillate Oil
		Natural Gas
		Liquid Petroleum Gas
		Kerosene

3.13.1 Technical Approach:

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, the activity indicator for bituminous, subbituminous, and lignite coal was expressed in million short tons and the emission factors were expressed in metric pounds/short ton. The activity indicator for anthracite coal was expressed in thousand short tons and the emission factors were expressed in metric pounds/short ton. For residual and distillate oil, kerosene, and LPG, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/thousand gallons. The activity indicator for natural gas was expressed in billion cubic feet and the emission factors were expressed in metric pounds/million cubic feet. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.13-1.

$$PM\text{-}10\ Emissions_{year} = PM\text{-}10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.13-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.13.2 Activity Indicator:

The activity indicator for anthracite coal combustion was the residential consumption of anthracite coal. This value was determined by extrapolating residential consumption of anthracite coal for the previous year based on the change in the number of dwelling units in the Northeastern United States having coal as the main fuel for space heating. Data concerning the number of dwelling units was obtained from Reference 1. The calculation of the residential anthracite coal consumption is summarized in Equation 3.13-2.

$$Anthracite\ Coal_{R,\ i} = Anthracite\ Coal_{R,\ i-1} \times \frac{Dwelling\ Units_{i}}{Dwelling\ Units_{i-1}} \qquad \text{(Eq. 3.13-2)}$$

where: R = residential consumption
i = year under study

The activity indicator for bituminous, subbituminous, and lignite coal combustion was the residential consumption of bituminous, subbituminous, and lignite coal. This value was determined by estimating the quantity of all coal consumed by all dwelling units using coal as the main fuel and subtracting from this value the residential consumption of anthracite coal calculated above. The quantity of all coal consumed was calculated using the number of dwelling units using coal as the main fuel for space heating obtained from Reference 1 and a factor estimating the average annual consumption of coal per dwelling unit. This calculation is summarized in Equation 3.13-3.

$$Bituminous\,Coal_{R,i} = (Dwelling\ Units_{i} \times 6.73\ tons\ burned/dwelling/year) - Anthracite\,Coal_{R,i} \qquad \text{(Eq. 3.13-3)}$$

where: R = residential consumption
i = year under study

The activity indicator for the residential combustion of residual oil was assumed to be zero.

The activity indicator for distillate oil combustion was the sum of the “adjusted” sales (or deliveries) for residential use of distillate oil and for farm use of other distillates as reported in Reference 2 or Reference 3.

The activity indicator for natural gas combustion was the total natural gas consumption for residential use obtained from Reference 4.

The activity indicator for kerosene combustion was the quantity of kerosene sales. This value was obtained by summing sales figures reported for the residential, commercial, and farm use categories as reported in Reference 2 or Reference 3.

The activity indicator for LPG combustion was based on the 1982 total residential sales of LPG ($4,047 \times 10^6$ gal). This value was extrapolated to the year under study based on the relative change in the LPG products supplied from the year 1982 (1499×10^3 bbl/day) to the year under study. Quantities of LPG products supplied for the specific years were obtained from Reference 5. Equation 3.13-4 summarizes this calculation.

$$Residential\ Sales_{LPG,\ i} = Residential\ Sales_{LPG,\ 1982} \times \frac{Products\ Supplied_{LPG,\ i}}{Products\ Supplied_{LPG,\ 1982}} \quad \text{(Eq. 3.13-4)}$$

where: i = year under study

3.13.3 Emission Factors:

The emission factors for residential anthracite coal combustion (SCC 10300103, hand-fired units) were obtained from Reference 6a for all pollutants except PM-10. The PM-10 emission factor was obtained from Reference 7. The PM-10 and TSP factors were multiplied by an ash content of 11 percent. The SO_2 factor was multiplied by a sulfur content value of 0.7 percent.

The emission factors for all pollutants except PM-10 for the combustion of bituminous coal and lignite (SCC 10300103, hand-fired units) were obtained from Reference 6b. The PM-10 emission factor was obtained from Reference 7.

The SO_2 emission factor was multiplied by the average sulfur content for all coal used by commercial users. The average sulfur content of coal was determined from the sulfur content by coal producing districts obtained for the category "All other uses" in Reference 8a. This reference provided the sulfur content values reported in 1977 and it was assumed that these values remained constant during the years 1940 through 1984. In order to obtain the average sulfur content for a specific year, the sulfur content by district was weighted by the distribution of coal by district of origin for the category "Commercial and Residential" obtained from Reference 9a or Reference 10.

No emission factors were required for residential residual oil combustion, because the activity was assumed to be zero.

The emission factors for the combustion of distillate oil were obtained from Reference 6c under the classification residential furnaces for all pollutants except PM-10. The PM-10 emission factor was obtained from Reference 7 or Table 3.1-3 of this report. The SO_2 emission factor was multiplied by the weighted average sulfur content. Sulfur contents for No. 1 and No. 2 oils were obtained from Reference 11. Weighting factors were the corresponding quantity of sales (or deliveries) to residential users as reported in Reference 2 or Reference 3. The resulting weighted average sulfur content was applied to the SO_2 emission factor.

The emission factors for all pollutants except PM-10 for natural gas combustion (SCC 1-03-006-03) were obtained from Reference 6d. The PM-10 emission factor was obtained from Reference 7.

The emission factors for residential kerosene combustion were obtained from Reference 6c under the classification residential furnace for distillate oil for all pollutants except PM-10. The PM-10 emission factor was obtained from Reference 7 or Table 3.1-3 of this report. The SO_2 emission factor was multiplied by a sulfur content of 0.075 percent.

The emission factors for LPG combustion were obtained from Reference 6e under the classification domestic/commercial for all pollutants except PM-10. The PM-10 emission factor was obtained from Reference 7. The SO_2 emission factor was multiplied by a sulfur content of 0.0013 percent.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.13.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, TSP, and VOC emissions from the sources included in this Tier II category.

For the residential combustion of anthracite coal, bituminous coal and lignite, natural gas, and LPG, the PM-10 control efficiencies for the years 1975 through 1984 were equal to the 1988 PM-10 control efficiencies obtained from Reference 12. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions from the combustion of these fuels. For the residential combustion of residual oil, distillate oil, and kerosene, no control efficiencies were applied to the activity data to estimate PM-10 emissions.

3.13.5 References

1. *American Housing Survey, Current Housing Reports, Series H-150-83*. Bureau of the Census, U.S. Department of Commerce, Washington DC. Biennial.

2. *Petroleum Marketing Annual*. DOE/EIA-0389(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

3. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

4. *Natural Gas Annual*. DOE/EIA-0131(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

5. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

6. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   (a) Volume I, Table 1.2-1, Supplement B, September 1988.
   (b) Volume I, Table 1.1-1
   (c) Volume I, Table 1.3-1
   (d) Volume I, Table 1.4-1
   (e) Volume I, Table 1.5-1

7. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

8. *Coal Production*. DOE/EIA-0118(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   (a) Table entitled, "Shipments of bituminous coal and lignite by district, consumer, use, and average sulfur content - 1977."

9. *Coal Distribution January-December 19xx*. DOE/EIA-0125(xx/4Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   (a) Table entitled, "Domestic Distribution of U.S. Coal to the Residential and Commercial Sector by Origin."

10. *Minerals Yearbook*, Coal. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.

11. *Heating Oils*. U.S. Department of Energy. Obtainable from the National Institute for Petroleum and Energy Research, ITT Research Institute, P.O. Box 2128, Bartlesville, OK. Annual.

12. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

3.14 CHEMICAL AND ALLIED PRODUCT MANUFACTURING - ORGANIC CHEMICAL MANUFACTURING: 04-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(04) CHEMICAL AND ALLIED PRODUCT MANUFACTURING	(01) Organic Chemical Manufacturing	Petrochemicals excluding storage and handling and waste disposal Charcoal (NO_x and VOC)

3.14.1 Technical Approach

The CO, NO_x, PM-10, TSP, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.14-1.

$$PM\text{-}10\ Emissions_{year} = PM\text{-}10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.14-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.14.2 Activity Indicator

3.14.2.1 CO Emissions

The activity indicator for charcoal manufacturing was the production figure for charcoal obtained from Reference 1.

The activities indicators for petrochemical manufacturing were the production figures for each material. Production numbers for acetic acid, dimethyl terephthalate, ethylene dichloride, formaldehyde, maleic anhydride were obtained from Reference 2 or Reference 3. Total production of acrylonitrile and phthalic anhydride was obtained from Reference 2. The production level of cyclohexanone was obtained from Reference 3. The approximate production of cyclohexanol was accounted for by multiplying the cyclohexanone production level by 2. If Reference 3 was not available, the adipic acid production was obtained from Reference 2. It was assumed that the cyclohexanol/none production reported in Reference 4 for the previous year changed in direct proportion to adipic acid production.

3.14.2.2 NO_x Emissions

The activity indicator for charcoal manufacturing was the production figure for charcoal obtained from Reference 1.

The activities indicators for petrochemical manufacturing were the production figures for each material. Total production levels of acrylonitrile and adipic acid were obtained from Reference 2. In order to determine the adiponitrile production level, the total nylon production was obtained from Reference 2. It was assumed that the year-to-year change in nylon production was proportional to year-to-year change in adiponitrile production.

3.14.2.3 PM-10 and TSP Emissions

The activity indicators for petrochemical manufacturing were the production figure for each material. Production levels of phthalic anhydride, polyethylene, PVC, and polypropylene were obtained from Reference 2.

3.14.2.4 VOC Emissions

The activity indicators for petrochemical manufacturing processes, excluding the storage and handling and waste disposal, were the production figures for each material. Production numbers for the chemicals listed in Table 3.14-1 were obtained from Reference 2 or Reference 3. Activity indicators for the other products and fugitive subcategories were based on the industrial organic chemical production index obtained from Reference 2.

The activity indicator for charcoal manufacturing was the production figure for charcoal obtained from Reference 1.

3.14.3 Emission Factor

3.14.3.1 CO Emissions

The emission factor for charcoal (SCC 3-01-006-01) was obtained from Reference 5a.

The emission factors for acetic acid, acrylonitrile, cyclohexanol/none and ethylene dichloride, formaldehyde, and phthalic anhydride were obtained from Reference 6. The emission factor for dimethyl terephthalate (SCC 3-01-031-01) was obtained from Reference 5b. The emission factor for maleic anhydride (SCC 3-01-100-02) was obtained from Reference 5c.

3.14.3.2 NO_x Emissions

The emission factor for charcoal (SCC 3-01-006-01) was obtained from Reference 5a.

The emission factors for acrylonitrile and adiponitrile were obtained from Reference 7. The emission factor for the adipic acid (SCC 3-01-001-01) was obtained from Reference 5d.

3.14.3.3 PM-10 and TSP Emissions

The emission factors for phthalic anhydride were determined from the emission factors for the raw material inputs of: o-xylene or naphthalene. The emission factors for o-xylene (SCC 3-01-019-02, 3-01-019-02, and 3-01-019-04) and for naphthalene (SCC 3-01-019-05, 3-01-019-06, and 3-01-019-07) were obtained from Reference 5f for TSP and from Reference 8 for PM-10. These emission factors were weighted according to the capacity figures in Reference 9, in which a table showed the capacity of phthalic anhydride production in the United States by raw material input: o-xylene or naphthalene.

The emission factors for polyethylene were the averages of the emission factors for the SCCs 3-01-018-07 and 1-01-018-12. The TSP emission factors were obtained from Reference 7 and the PM-10 emission factors were obtained from Reference 8. Emission factors for the PVC (SCC 3-01-018-01) and polypropylene (SCC 3-01-018-02) were obtained from Reference 5e for TSP and from Reference 8 for PM-10.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.14.3.4 VOC Emissions

The emission factors for the chemical products listed in Table 3.14-1 were obtained from Reference 10, with the exception of the emission factors for acetic acid, acrylic acid and acrylonitrile which were obtained from Reference 11. Weighted average emission factors for the chemical products where more than one SCC was listed were calculated using the weighting factors given in Table 3.14-1. Where no weighting factors were given, the overall emission factor for the chemical product was the sum of the emission factors for the SCCs listed.

For the years 1940 through 1976, the VOC emission factors for other products and fugitives were obtained from Reference 12. The emission factors for the years 1982 through 1984 were obtained from Reference 6. The emission factors for the intervening years of 1977 through 1983 were derived from a linear interpolation between the values for the years 1976 and 1982.

The emission factor for charcoal (SCC 3-01-006-01) was obtained from Reference 5a.

3.14.4 Control Efficiency

3.14.4.1 CO Emissions

The control efficiency for charcoal manufacturing was derived from Reference 13 or Reference 14 using Equation 3.14-2.

$$CE = \left[\frac{(UE - AE)}{UE}\right] \qquad \text{(Eq. 3.14-2)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

No control efficiencies were applied to the activity data to estimate emissions from petrochemical production.

3.14.4.2 NO_x Emissions

No control efficiencies were applied to the activity data to estimate NO_x emissions from charcoal and petrochemical production.

3.14.4.3 PM-10 and TSP Emissions

The TSP control efficiency for PVC production was derived from Reference 13 or Reference 14 using the same equation given above for the CO control efficiency for charcoal.

The TSP control efficiency for phthalic anhydride production was assumed to have a constant value of 0.85 for the years 1979 through 1984. The procedure used to determine the control efficiencies for the years 1940, 1950, 1960, and 1970 through 1978 is currently unavailable.

No control efficiencies were applied to the activity data to estimate TSP emissions from polyethylene and polypropylene production.

The PM-10 control efficiencies for the petrochemical emission sources for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 15. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate the PM-10 emissions.

3.14.4.4 VOC Emissions

The control efficiency for charcoal manufacturing was derived from Reference 13 or Reference 14 using the same equation given above for the CO control efficiency. No control efficiencies were applied to the activity data to estimate VOC emissions from the petrochemical manufacturing sources included in this Tier II category.

3.14.5 References

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2. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

3. *Synthetic Organic Chemicals, United States Production and Sales*. USITC Publication 1745. U.S. International Trade Commission, Washington, DC. Annual.

4. *OAQPS Data File on National Emissions*. National Air Data Branch, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1984.

5. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 5.4-1
   b. Volume I, Table 5.21-1
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   d. Volume I, Table 5.1-1
   e. Volume I, Table 5.13-1
   f. Volume I, Table 5.12-1

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8. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

9. Directory of Chemical Producers

10. *VOC Emission Factors for the NAPAP Emission Inventory*. Draft Document. U.S. Environmental Protection Agency. Prepared by Radian Corporation for Air and Energy Engineering Research Laboratory. August 1986.

11. Criteria Pollutant Emission Factors for the 1985 NAPAP Emission Inventory.

12. *Organic Chemical Manufacturing, Volume 1: Program Report*. EPA-450/3-80-023. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1980.

13. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

14. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

15. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

Table 3.14-1. Chemical Products, SCCs, and Weighting Factors for VOC Emission Factors

Chemical Product	SCC	Weighting Factor
Acetic acid* - via Methanol - via Butane - via Acetaldehyde	3-01-132-01 3-01-132-05 3-01-132-10	0.43 0.28 0.29
Acrylic acid*	3-01-132-21	
Acrylonitrile*	3-01-245-05	
Adiponitrile via Butadiene	3-01-254-10	
Benzene - Reactor - Distillation Vent	3-01-258-02 3-01-258-03	
Butadiene & Butylene Fractions	3-01-153-10(20)	
1,3 Butadiene	3-01-153-10(20)	
Caprolactam	3-01-210-02 3-01-210-03 3-01-210-05 3-01-210-06 3-01-210-07 3-01-210-08 3-01-210-09 3-01-210-10	
Chlorobenzene	3-01-301-10	
Cyclohexanone	3-01-158-01	
Cumene	3-01-156-01	
Dimethyl Terephthalate	3-01-031-01	
Ethyl Benzene	3-01-169-01	
Ethylene	3-01-197-41 3-01-197-43 3-01-197-45	
Ethylene Dichloride - oxychlorination - Direct chlorination	3-01-125-01 3-01-125-02	0.996 0.004
Ethylene Glycol	3-01-251-02 3-01-251-03	
Ethylene Oxide	3-01-174-01	
Formaldehyde - Silver Catalyst - Mixed Oxide Catalyst	3-01-120-01 3-01-120-02	0.8 0.2
Linear Alkylbenzene - Olefin process - Chlorination Process	3-01-211-02 3-01-211-03 3-01-211-04 3-01-211-22 3-01-211-23 3-01-211-24 3-01-211-25	0.36 0.36 0.36 0.64 0.64 0.64 0.64

Table 3.14-1. (continued)

Chemical Product	SCC	Weighting Factor
Maleic Anhydride	3-01-100-02 3-01-100-03 3-01-100-05	
Methanol	3-01-250-02 3-01-250-03	
Methyl Methacrylate	3-01-190-02 3-01-190-03 3-01-190-04 3-01-190-10 3-01-190-11 3-01-190-12 3-01-190-13 3-01-190-14	
Nitrobenzene	3-01-195-01	
Perchloroethylene	3-01-125-20	
Phenol	3-01-202-01	
Propylene Oxide - Chlorohydrin - Isobutane - Ethylbenzene	3-01-205-** 3-01-205-** 3-01-205-**	0.53 0.33 0.14
Styrene	3-01-206-01	
Toluene Diisocyanate	3-01-181-02 3-01-181-03 3-01-181-04 3-01-181-05 3-01-181-06 3-01-181-07 3-01-181-08	
Vinyl Acetate	3-01-167-02 3-01-167-03 3-01-167-04	
Vinyl Chloride	3-01-125-40	

* The emission factors for these chemical products were obtained from Reference 10. For all other chemical products, the emission factors were obtained from Reference 9.

3.15 CHEMICAL AND ALLIED PRODUCT MANUFACTURING - INORGANIC CHEMICAL MANUFACTURING: 04-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(04) CHEMICAL AND ALLIED PRODUCT MANUFACTURING	(02) Inorganic Chemical Manufacturing	Ammonia Titanium Dioxide Nitric Acid Calcium Carbide Sulfuric Acid

3.15.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.15-1.

$$PM-10\ \ Emissions_{year} = PM-10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.15-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.15.2 Activity Indicator

3.15.2.1 CO Emissions

The activity indicator for ammonia was the total quantity of ammonia production obtained from Reference 1. The activity indicator for titanium dioxide was based on the total quantity of titanium dioxide production as reported in Reference 1. It was assumed that 73 percent of total production was by chloride process. Therefore total production was multiplied by 0.73 to calculate the total titanium dioxide produced by the chloride process. For a more accurate figure for the percentage of production by the chloride process, Reference 2 should be consulted.

3.15.2.2 NO_x Emissions

The activity indicator for ammonia was the total quantity of ammonia production obtained from Reference 1. The activity indicator for nitric acid was the total production of nitric acid obtained from Reference 1.

3.15.2.3 PM-10 and TSP Emissions

The activity indicator for calcium carbide was the total production of calcium carbide obtained from Reference 3. When data was withheld (i.e., for proprietary reasons), the previous year's data was used. The activity indicator for sulfuric acid was the total production of sulfuric acid obtained from Reference 3.

3.15.2.4 SO_2 Emissions

The activity indicator for sulfuric acid was the total production of sulfuric acid obtained from Reference 3.

3.15.2.5 VOC Emissions

The activity indicator for ammonia was the total quantity of ammonia production was obtained from Reference 1.

3.15.3 Emission Factor

3.15.3.1 CO Emissions

The emission factor for ammonia was the sum of emission factors for feedstock desulfurization (SCC 3-01-003-05), primary reformer, natural gas (SCC 3-01-003-06), and CO regenerator (SCC 3-01-003-08). These emission factors were obtained from Reference 4a. The emission factor for titanium dioxide was obtained from Reference 5 for all U.S. plants with actual CO emission source tests (SCC = 3-03-012-01).

3.15.3.2 NO_x Emissions

The emission factor for ammonia (SCC 3-01-003-06) was obtained from Reference 4a.

The emission factor for nitric acid was the weighted average of the emission factors for nitric acid production by old plants (43 lb/ton) and new plants (3 lb/ton). The weighting factors used to calculate the overall emission factor were the percentage of production from old plants and from new plants, respectively. New plant production was equal to 5 percent of the total 1970 production (380,000 tons) for each year since 1970. Old plant production was equal to the difference between total production as reported in Reference 1 and new plant production, as calculated above.

3.15.3.3 PM-10 and TSP Emissions

The PM-10 and TSP emission factors for calcium carbide were the sum of three emission factors: electric furnace (SCC 3-05-004-01), coke dryer (SCC 3-05-004-02) and furnace room vents (SCC 3-05-004-03). The TSP emission factors were obtained from Reference 4c and the PM-10 emission factors were obtained from Reference 9. The emission factors for sulfuric acid (SCC 3-01-023-01) were obtained from Reference 4b for TSP and from Reference 6 for PM-10.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.15.3.4 SO_2 Emissions

The emission factors for sulfuric acid were based on the emission factor calculated for the year previous to the year under study and the NSPS emission factor (4 lb/ton). The weighted average of these two emission factors was based on the production levels for the year under study and the previous year as presented in Equation 3.15-2.

$$EF_i = \frac{(0.95 \times EF_{i-1} \times P_{i-1}) + (0.05 \times EF_{NSPS} \times P_{i-1}) + ((P_i - P_{i-1}) \times EF_{NSPS})}{P_i} \qquad \text{(Eq. 3.15-2)}$$

where:
EF = SO_2 emission factor
i = year under study
P = total production

When the production for the year under study was less than the production for the previous year, then the last term (P_i - P_{i-1}) was set to zero. New capacity for production was only assumed for a production level above the previous record high production level.

3.15.3.5 VOC Emissions

The emission factor for ammonia was the sum of emission factors for feedstock desulfurization (SCC 3-01-003-05), primary reformer, natural gas (SCC 3-01-003-06), carbon dioxide regenerator (SCC 3-01-003-08), and condensate stripper (SCC 3-01-003-09). These emission factors were obtained from Reference 4a.

3.15.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, and VOC emissions from the source included in this Tier II category.

The TSP control efficiencies for sulfuric acid and calcium carbide production were derived from Reference 7 or Reference 8 using Equation 3.15-3.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \qquad \text{(Eq. 3.15-3)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

The PM-10 control efficiencies for sulfuric acid and calcium carbide production for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 9. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate the PM-10 emissions.

3.15.5 References

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3.16 CHEMICAL AND ALLIED PRODUCTS MANUFACTURING - POLYMER AND RESIN MANUFACTURING: 04-03

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(04) CHEMICAL AND ALLIED PRODUCT MANUFACTURING	(03) Polymer and Resin Manufacturing	Plastics Manufacturing excluding fabrication Synthetics Fibers and Rubber

3.16.1 Technical Approach

The VOC emissions included in this category were the sum of the emissions from the source categories listed above. Emissions were estimated only for VOC from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.16.2 Activity Indicator

The activity indicators for plastics manufacture were the total production levels for each material. The total production levels of high density polyethylene, low density polyethylene, polypropylene, and polyvinyl chloride were obtained from Reference 1. The production level of polystyrene was obtained from Reference 1 as the sum of production levels for the following substances: (1) styrene-acrylonitrile, (2) polystyrene, and (3) acrylonitrile-butadiene-styrene and other styrene polymers. The production level for other plastics was obtained from Reference 1 as the sum of production levels for the following substances: (1) thermosetting resins, (2) polyamides, and (3) other vinyl resins.

The activity indicator for synthetic fibers was the quantity of total man-made fiber production obtained from Reference 1. The activity indicator for the total synthetic rubber subcategory was the production of synthetic rubber obtained from Reference 1.

3.16.3 Emission Factor

The emission factors for high density polyethylene (SCC 3-01-018-07), low density polyethylene (SCC 3-01-018-12), and polystyrene (SCC 3-01-01801) were obtained from Reference 2. The emission factors for polypropylene (SCC 3-01-018-02) and polyvinyl chloride (SCC 3-01-018-01) were obtained from Reference 3a.

The emission factor for other plastics manufacturing was calculated by dividing the 1979 actual emissions for this source by the corresponding activity indicator. The calculation of the 1979 actual emissions for other plastics followed the steps described below.

1. The 1979 total actual emissions for the high density polyethylene, low density polyethylene, polypropylene and polystyrene subcategories were calculated using the corresponding 1979 activity indicators and emission factors.

2. The 1979 actual emissions of polyethylene terephthalate were added to the previous sum. Actual emissions of polyethylene terephthalate were estimated by multiplying the emission factor obtained from Reference 4 by the production level obtained from Reference 1 for 1979.

3. It was assumed that the sum calculated in step 2 represented 75 percent of the total emissions from all plastics. Therefore, the total emissions from all plastics in 1979 was calculated by dividing the total from step 2 by 0.75.

4. The 1979 actual emissions of high density polyethylene, low density polyethylene, polypropylene and polystyrene were subtracted from the total emission from all plastics calculated in step 3. The result was the total 1979 emissions from the other plastics category.

The emission factors for synthetic fibers was obtained from Reference 5. The emission factor for synthetic rubber was the weighted average of emission factors for the following compounds: polychloroprene, polyisoprene, butyl, nitrile, polybutadiene, ethylene propylene copolymers, styrene butadiene rubber, and "others." The styrene butadiene rubber emission factor was obtained from Reference 3a and all other emission factors were obtained from Reference 6. These emission factors were weighted by the relative quantity of each compound produced in 1979 as obtained from Reference 1.

3.16.4 Control Efficiency

Control efficiencies were applied to the activity data to estimate VOC emissions from high density polyethylene production processes, but the procedures for determining these control efficiencies are currently unavailable. No control efficiencies were applied to the activity data to estimate emissions from all other sources included in this Tier II category.

3.16.5 References

1. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

2. Criteria Pollutant Emission Factors for the 1985 NAPAP Emissions Inventory.

3. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
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6. *Control Techniques for VOC Emissions from Stationary Sources*. EPA-450/3-85-008. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1985.

3.17 CHEMICAL AND ALLIED PRODUCT MANUFACTURING - AGRICULTURAL CHEMICAL MANUFACTURING: 04-04

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(04) CHEMICAL AND ALLIED PRODUCT MANUFACTURING	(04) Agricultural Chemical Manufacturing	Fertilizers - ammonia nitrate, diammonium phosphate and urea

3.17.1 Technical Approach

The PM-10 and TSP emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were only estimated for particulate matter from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1992 for TSP and for the years 1975 through 1984 for PM-10. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.17-1.

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.17-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.17.2 Activity Indicator

The activity indicators for the manufacture of fertilizers were the production levels of the individual materials. Total production levels for ammonium nitrate and urea were obtained from Reference 1. Total production of diammonium phosphate was calculated as the sum of production levels of diammonium, monoammonium, and other ammonium phosphates obtained from Reference 2. Production was expressed in equivalent tons of phosphoric oxide, P_20_5 content.

3.17.3 Emission Factor

The emission factors for ammonium nitrate manufacturing were the weighted averages of the emission factors for specific processes obtained from Reference 3a for TSP and from Reference 4 for PM-10. The specific processes and SCCs included in the weighted averages along with the weighting factors are presented in Table 3.17-1. Each emission factor was multiplied by the corresponding weighting factor and the products were summed.

The emission factors for diammonium phosphate production were the sum of the emission factors for following processes: (1) dryer, cooler and (2) ammoniator - granulator. The TSP emission factors were obtained from Reference 5a; the PM-10 emission factors were obtained from Reference 4.

For urea production, the emission factors were the weighted averages of emission factors for specific processes obtained from Reference 3b for TSP and from Reference 4 for PM-10. The specific processes and SCCs included in the weighted averages along with the weighting factors are presented in Table 3.17-2. Each emission factor was multiplied by the corresponding weighting factor and the products were summed.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.17.4 Control Efficiency

The TSP control efficiency for diammonium phosphate production was derived from Reference 6 or Reference 7 using Equation 3.17-2.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \qquad \text{(Eq. 3.17-2)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

The TSP control efficiencies for ammonium nitrate and urea production were based on the controlled and uncontrolled emission factors from Reference 1. For ammonium nitrate production, this procedure for determining control efficiency was used for the years 1974 through 1984. For urea production, this procedure was used for the years 1979 through 1984. For the years prior to those stated above, the procedures for determining the TSP control efficiencies are currently unavailable.

The PM-10 control efficiencies for the production of these three fertilizers for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 8. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

3.17.5 References

1. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

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   b. Volume I, Table 6.10-1

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Table 3.17-1. Ammonium Nitrate Emission Factor SCCs and Weighting Factors

SCC	Description	Weighting Factor
3-01-027-04	Neutralizer (All Plants)	1.0
3-01-027-17(27)	Solids Evap. Concentrator (All Plants)	0.6
3-01-027-18(28)	Coating Operation	0.4
3-01-027-12	High Density Prilling (Solids Form.)	0.36
3-01-027-22	Low Density Prilling (Solids Form.)	0.18
3-01-027-07	Rotary Drum Granulators (Solids Form.)	0.04
3-01-027-08	Pan Granulators (Solids Form.)	0.01
3-01-027-14	High Density Prilling (Coolers/Dryers)	0.36
3-01-027-24	Low Density Prilling (Coolers/Dryers)	0.18
3-01-027-25	Low Density Prilling/Drying (Coolers/Dryers)	0.18
3-01-027-29	Rotary Drum Granulators (Coolers/Dryers)	0.032
3-01-027-30	Pan Granulator Coolers (Coolers/Dryers)	0.006

Table 3.17-2. Urea Emission Factor SCCs and Weighting Factors

SCC	Description	Weighting Factor
3-01-040-02	Solution Concentration	1.0
3-01-040-04	Drum Granulation	0.45
3-01-040-08	Nonfluid Bed Prilling (Agricultural Grade)	0.07
3-01-040-09	Nonfluid Bed Prilling (Feed Grade)	0.005
3-01-040-10	Fluid Bed Prilling (Agricultural Grade)	0.07
3-01-040-11	Fluid Bed Prilling (Feed Grade)	0.005
3-01-040-12	Rotary Drum Cooler	0.045
3-01-040-06	Bagging	0.045

3.18 CHEMICAL AND ALLIED PRODUCT MANUFACTURING - PAINT, VARNISH, LACQUER, AND ENAMEL MANUFACTURING: 04-05

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category
(04) CHEMICAL AND ALLIED PRODUCT MANUFACTURING	(05) Paint, Varnish, Lacquer, Enamel Manufacturing

3.18.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source category listed above. Emissions were estimated only for VOC from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in thousand short tons and the emission factor was expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.18.2 Activity Indicator

The activity indicator for paint manufacturing was the total shipments of paint and allied products obtained from Reference 1.

3.18.3 Emission Factor

The emission factor for paint manufacturing was the sum of the emission factors for general mixing/handling (SCC 3-01-014-01) and varnish manufacture, oleoresinous (SCC 3-01-015-02) obtained from Reference 2a.

3.18.4 Control Efficiency

The control efficiency for paint manufacturing was derived from Reference 3 or Reference 4 using Equation 3.18-1.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \qquad \text{(Eq. 3.18-1)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

3.18.5 References

1. *Current Industrial Reports*, Paint and Allied Products. Bureau of the Census, U.S. Department of Commerce, Washington, DC. Annual.

2. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 5.10-1

3. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

4. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

3.19 CHEMICAL AND ALLIED PRODUCT MANUFACTURING - PHARMACEUTICAL MANUFACTURING: 04-06

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category
(04) CHEMICAL AND ALLIED PRODUCT MANUFACTURING	(06) Pharmaceutical Manufacturing

3.19.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source category listed above. Emissions were estimated only for VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in thousand short tons and the emission factor was expressed in metric pounds/short ton.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.19.2 Activity Indicator

The activity indicator for pharmaceutical manufacturing was the production index for drugs and medicines obtained from Reference 1. The index was multiplied by 10 to obtain the activity indicator for pharmaceuticals.

3.19.3 Emission Factor

The emission factor for pharmaceutical manufacturing was 63.1 lb VOC/ton and comes from Reference 2.

3.19.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from the manufacture of pharmaceuticals.

3.19.5 References

1. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

2. *Control Techniques for VOC Emissions from Stationary Sources*. EPA-450/3-85-008. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1985.

3.20 CHEMICAL AND ALLIED PRODUCTS MANUFACTURING - OTHER CHEMICAL MANUFACTURING: 04-07

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(04) CHEMICAL AND ALLIED PRODUCT MANUFACTURING	(07) Other Chemical Manufacturing	Carbon Black Soap and Detergents

3.20.1 Technical Approach

The CO, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators was expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.20-1.

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.20-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.20.2 Activity Indicator

3.20.2.1 CO Emissions

The activity indicators for carbon black production by the oil and gas processes were based on the total quantity of carbon black produced as reported in Reference 1. It was assumed that 90 percent of total production was by the oil process and 10 percent of total production was by the gas process. For the years 1940 through 1973, the activity of carbon black production by the channel process was obtained from Reference 2. After 1973, production by this process was assumed to be zero.

3.20.2.2 PM-10 and TSP Emissions

The activity indicators for carbon black production by the oil and gas processes were based on the total quantity of carbon black produced obtained from Reference 1. It was assumed that 90 percent of total production was by the oil process and 10 percent of total production was by the gas process. For the years 1940 through 1973, the activity of carbon black production by the channel process was obtained from Reference 2. After 1973, production by the channel process was assumed to be zero.

The activity indicators for charcoal and soap and detergent production were based on the corresponding production figures obtained from Reference 3. Because this reference was only published every 5 years, the data from the year of publication prior to the year under study was projected to the year under study. The growth factor was based on the production index reported in Reference 1. It was calculated as the ratio between the production index for year under study and the production index for the publication year of Reference 3. The overall calculation is summarized in Equation 3.20-2.

$$Activity\ Indicator_i = Production\ figure_j \times \frac{Production\ index_i}{Production\ index_j} \qquad \text{(Eq. 3.20-2)}$$

where: i = year under study
j = year of preceding publication of Reference 2

3.20.2.3 SO_2 Emissions

The activity indicator for carbon black production was the total carbon black production obtained from Reference 1. This activity was not divided by process.

3.20.2.4 VOC Emissions

The activity indicators for carbon black production by the oil and gas processes were based on the total quantity of carbon black produced obtained from Reference 1. It was assumed that 90 percent of total production was by the oil process and 10 percent of total production was by the gas process. For the years 1940 through 1973, the activity of carbon black production by the channel process was obtained from Reference 2. After 1973, production by the channel process was assumed to be zero.

3.20.3 Emission Factor

3.20.3.1 CO Emissions

The emission factor for carbon black production by the oil process (SCC 3-01-005-04) was obtained from Reference 4a. The emission factors for carbon black production by the gas process (SCC 3-01-005-03) and the charcoal process were obtained from Reference 5.

3.20.3.2 PM-10 and TSP Emissions

The TSP emission factors for carbon black production by the oil process (SCC 3-01-005-04) was obtained from Reference 4a. The TSP emission factors for carbon black production by the gas process (SCC 3-01-005-03) and the channel process were obtained from Reference 4c. The PM-10 emission factors for the three carbon black production processes were obtained from Reference 6.

The emission factors for charcoal were derived from the emission factors for charcoal kiln (SCC 3-01-006-03) and charcoal briquetting (3-01-006-05) obtained from Reference 4b for TSP and from Reference 6 for PM-10. The overall charcoal emission factors were the sum of the kiln emission factor and a specific percentage of the briquetting emission factor. For the years 1980 through 1984, this was 90 percent. For each preceding year through the year 1950, the percentage was decreased by one. The percentage was held constant from 1940 to 1950.

The emission factors for soap and detergent production (SCC 3-01-009-01) were obtained from Reference 4c for TSP and from Reference 6 for PM-10.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.20.3.3 SO_2 Emissions

The emission factor for carbon black production was based on the emission factor for flared furnace exhaust, oil process obtained from Reference 4a and the CO control efficiency for carbon black production by the oil process. The description of this CO control efficiency is presented in the next section. The SO_2 emission factor was calculated according to Equation 3.20-3.

$$EF_{SO_2,\ carbon\ black} = (CE_{CO,\ carbon\ black} / 0.913) \times EF_{Flared\ Furnace\ Exhaust} \qquad \text{(Eq. 3.20-3)}$$

where: EF = emission factor
CE = control efficiency, expressed as a fraction

3.20.3.4 VOC Emissions

The emission factor for carbon black production by the oil process (main vent, SCC 3-01-005-04) was obtained from Reference 4a. The emission factors for carbon black production by the gas process (main vent, SCC 3-01-005-03) and the channel process were obtained from Reference 5.

3.20.4 Control Efficiency

3.20.4.1 CO Emissions

The control efficiencies for carbon black production by both the oil process and gas process were computed from actual and uncontrolled emissions reported in Reference 7 or Reference 8 using Equation 3.20-4.

$$CE = \left[\frac{(UE - AE)}{UE}\right] \qquad \text{(Eq. 3.20-4)}$$

where:
CE = control efficiency
UE = emissions before control
AE = emissions after control

No control efficiencies were applied to the activity data for carbon black production by the channel process.

3.20.4.2 PM-10 and TSP Emissions

The TSP control efficiencies for carbon black production by the oil process and gas process and for soap and detergent production were derived from Reference 7 or Reference 8 using the same equation given above for the CO control efficiencies. No control efficiencies were applied to the activity data for carbon black production by the channel process.

The TSP control efficiency for charcoal production was calculated based on the control on kilns (SCC 301-006-01) for either CO, TSP, or VOC emissions obtained from Reference 7 or Reference 8. The TSP control efficiency for this process was calculated using Equation 3.20-5.

$$CE_{charcoal} = \frac{(EF_{kiln} \times CE_{kiln}) + (EF_{Briquetting} \times 0.9 \times 0.95)}{(EF_{kiln} + EF_{Briquetting} \times 0.9)} \qquad \text{(Eq. 3.20-5)}$$

where:
CE = control efficiency
EF = emission factor

The PM-10 control efficiencies for carbon black, charcoal, and soap and detergent production for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 9. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

3.20.4.3 SO_2 Emissions

No control efficiencies were applied to the activity data to estimate SO_2 emissions from the carbon black production processes.

3.20.4.4 VOC Emissions

The VOC control efficiencies for carbon black production processes were 85 percent of the CO control efficiencies for the corresponding production process.

3.20.5 References

1. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

2. *Minerals Yearbook*, Carbon Black. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.

3. *Census of Manufactures*. Bureau of the Census, U.S. Department of Commerce, Washington, DC. Available every five years.

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 5.3-3
   b. Volume I, Table 5.4-1
   c. Volume I, Table 5.15-1

5. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.

6. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

7. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

8. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

9. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

3.21 METALS PROCESSING - NONFERROUS: 05-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(05) METALS PROCESSING	(01) Nonferrous	Primary Metals Industry (aluminum, copper, zinc, and lead) Secondary Metal Industry (aluminum, lead, and copper) Nonferrous Smelters (copper, zinc, and lead)

3.21.1 Technical Approach

The CO, PM-10, TSP, and SO_2 emissions included in this Tier category were the sum of the emissions from the source categories listed above. No estimates were made for VOC. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.21-1.

$$PM{-}10\ Emissions_{year} = PM{-}10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.21-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.21.2 Activity Indicator

3.21.2.1 CO Emissions

Primary aluminum production was obtained from Reference 1. This production level was used as the activity indicator for primary aluminum.

3.21.2.2 PM-10 and TSP Emissions

3.21.2.2.1 Primary Metals Industry - Aluminum —
The production of calcined alumina, obtained from Reference 2a, was the activity indicator for calcining of hydroxide. The primary aluminum production, obtained from Reference 1, was the activity indicator for material handling.

The Horizontal Stud Soderberg (HSS) stack was assigned an activity equivalent to 18.5 percent of the total primary aluminum production. Activity of the HSS fugitive was assumed to equal to that for HSS stack. The Vertical Stud Soderberg (VSS) stacks was assigned an activity equivalent to 10.5 percent of the total primary aluminum production. The activity of VSS fugitives was assumed to equal to that of VSS stacks.

Stack and fugitive prebake were each assigned an activity equivalent to 71 percent of the total primary aluminum production. The activity of anode baking was assumed to equal to that of prebake.

3.21.2.2.2 Primary Metals Industry - Copper —
The activity indicator for roasting was based on the primary copper smelter production from domestic and foreign ores from Reference 3a. This reference provided the units of blister copper produced. It was assumed that of the 4 tons of copper concentrate/ton of blister, only half was roasted. Therefore, units of blister copper produced multiplied by 2 resulted in the activity indicator for roasting.

The activity indicators for smelting and converting were assumed to be equivalent. The activities were calculated in the same manner as for roasting, except it was assumed that all of the blister copper produced is smelted and converted. Therefore, units of blister copper produced multiplied by 4 resulted in the activity indicators for smelting and converting.

The total new copper smelter production figure obtained from Reference 3b was used as the activity indicator for fugitives.

3.21.2.2.3 Primary Metals Industry - Zinc —
The activity indicator for roasting was assigned the total slab zinc production obtained from the Reference 4. The production figure was converted to short tons and multiplied by 2 to account for the fact that there are 2 units of concentrate/ton slab zinc.

The activity indicator for sintering was assigned the redistilled slab zinc production obtained from Reference 4a. The activity indicator for electrolytic processes was estimated by subtracting the redistilled slab zinc production from total slab zinc production. These data were obtained from Reference 4.

The activity indicator for horizontal retort process was assume to be zero. The activity indicator for vertical retort processes was assigned the same value as used for zinc sintering.

Total slab zinc production figure obtained from Reference 4 was used as the activity for fugitive processes.

3.21.2.2.4 Primary Metals Industry - Lead —
The activities for the sintering process, blast furnaces, reverberatory furnaces, and fugitive processes were set equal to the primary refined lead production from domestic and foreign ores obtained from Reference 5.

3.21.2.2.5 Secondary Metals - Aluminum —
The activity indicator for sweating was the total consumption of all scrap by “sweated pig” and “borings and turnings” was obtained from Reference 1. Total of all scrap consumed, also from Reference 1, was the activity indicator for refining.

The activity indicator for fluxing was based on the quantities of magnesium recovered from new and old aluminum-based scrap obtained from Reference 6a. The quantities of magnesium were summed and multiplied by 4.

The activity indicator for fugitive processes was the total quantity of secondary aluminum recovered obtained from Reference 1.

3.21.2.2.6 Secondary Metals - Lead —
The data used to estimate the activity for the four lead processes were obtained from Reference 5. The pot furnace activity was estimated as 90 percent of the total consumption of lead scrap by all consumers obtained from Reference 5a. The activity indicator for reverberatory furnaces was calculated by multiplying the total consumption of lead scrap by the ratio between the quantity of lead recovered as soft lead and the total lead recovered from scrap. The activity indicator for blast furnaces was calculated by multiplying the total consumption of lead scrap by the ratio between lead recovered as antimonial lead and the total lead recovered from scrap. The total quantity of secondary lead recovered in the U.S. was used as the activity indicator for fugitive processes.

3.21.2.2.7 Secondary Metals - Copper —
The data used to estimate the activity for the four copper processes were obtained from Reference 3. The activity for wire burning was calculated as one-half of the total consumption of No. 2 wire obtained from Reference 3c. The activity for brass and bronze coating was calculated by multiplying the total consumption of scrap by the ratio between the copper recovered in alloys and the total secondary copper production. The activity for smelting was calculated by multiplying the total consumption of scrap by the ratio between the copper recovered as unalloyed copper and the total secondary copper production. The total quantity of copper recovered from all scrap was assigned the activity for fugitive processes.

3.21.2.3 SO_2 Emissions

The activity indicator for copper roasting was based on the primary copper smelter production from domestic and foreign ores from Reference 3a. This reference provided the units of blister copper produced. It was assumed that of the 4 tons of copper concentrate/ton of blister, only half were roasted. Therefore, units of blister copper produced multiplied by 2 resulted in the activity indicator for copper concentrate roasting.

The activity indicators for copper smelting and converting were assumed to be equivalent. The activities were calculated in the same manner as for the roasting category, except it was assumed that all of the blister copper produced was smelted and converted. Therefore, units of blister copper produced multiplied by 4 resulted in the activity indicators for copper smelting and converting.

The activity indicator for zinc ore roasting was assigned the total slab zinc production obtained from the Reference 4. The production figure was converted to short tons and multiplied by 2 to account for the fact that there are 2 units of concentrate/ton slab zinc.

The determination for the activity indicator for lead processing required the following steps: (1) calculation of the quantity of SO_2 removed as by-product sulfuric acid by lead plants, (2) calculation of total SO_2 emissions from lead processing, and (3) calculation of lead processing activity indicator. Each of these steps are described below.

For the first step, the quantity of by-product sulfuric acid produced from lead plants was obtained from Reference 3. This value was multiplied by the ratio of the molecular weight of SO_2 to the molecular weight of sulfuric acid (64/98), in order to obtain the amount of SO_2 removed as sulfuric acid.

The second step required the actual quantity of SO_2 emitted from lead production (SCC 3-03-010-xx) obtained from Reference 7 or 8. The amount of SO_2 removed as sulfuric acid was added to the actual amount of SO_2 emitted to calculate the total amount of SO_2 emitted by lead processing.

$$Emissions_{SO_2\text{, lead proc.}} = H_2SO_{4_{SO_2,\text{lead proc.}}} + Emissions_{SO_2,\text{actual}} \qquad \text{(Eq. 3.21-2)}$$

The last step in this method calculated the production level for lead processing by using the total amount of SO_2 emitted by lead processing, converted to metric pounds, and the emission factor for lead processing. The emission factor was determined according to the description presented later in this section. Equation 3.21-3 was used to complete the calculation of the activity indicator for lead processing.

$$Production_{\text{lead proc.}} = \frac{Emission_{SO_2,\text{lead proc.}} \times 2000\,lb/ton}{540\,lb\ SO_2/tons\ \ lead\ proc.} \qquad \text{(Eq. 3.21-3)}$$

The primary aluminum production obtained from Reference 1 was the activity indicator for primary aluminum processes.

The data used to estimate the activity for the two furnace types used in secondary lead production were obtained from Reference 5. The activity indicator for reverberatory furnaces was calculated by multiplying the total consumption of lead scrap by the ratio between the quantity of lead recovered as soft lead and the total lead recovered from scrap. The activity indicator for blast furnaces was calculated by multiplying the total consumption of lead scrap by the ratio between lead recovered as antimonial lead and the total lead recovered from scrap.

3.21.3 Emission Factor

3.21.3.1 CO Emissions

The emission factor for primary aluminum was obtained from Reference 9.

3.21.3.2 PM-10 and TSP Emissions

3.21.3.2.1 Primary Metals Industry - Aluminum —
The TSP emission factors for all aluminum production processes, with the exception of material handling, were obtained from Reference 10a. The TSP emission factor for material handling was obtained from Reference 11a. The PM-10 emission factors for all aluminum production processes were obtained from Reference 12. The SCCs corresponding to each of the production processes are presented in Table 3.21-1.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.21.3.2.2 Primary Metals Industry - Copper —
The emission factors for roasting were the weighted averages of the emission factors for two process types listed in Table 3.21-2. The TSP emission factor was obtained from Reference 10b and the PM-10 emission factors were obtained from Reference 12. Weighting factors were the 1981 capacity for each process type as presented in Table 3.21-2.

The emission factors for smelting were the weighted averages of the emission factors for four process types. The emission factors were obtained from Reference 10b for TSP and from Reference 12 for PM-10. These emission factors were weighted using the 1981 capacity for each process. The SCCs and descriptions of the four processes along with the 1981 capacity data are presented in Table 3.21-3.

The emission factors for converting were obtained from Reference 10c for TSP and from Reference 12 for PM-10. The TSP emission factor for fugitive processes was obtained from Reference 13. The PM-10 emission factor for fugitive processes was obtained from Reference 12 or Table 3.1-3 of this report.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.21.3.2.3 Primary Metals Industry - Zinc —
The emission factors were obtained from Reference 10c for the following processes: roasters (SCC 3-03-030-02 for multiple hearth roaster), sintering (SCC 3-03-030-03), electrolytic (SCC 3-03-030-06), and vertical retorts (SCC 3-03-030-05). The emission factor for horizontal retorts (SCC 3-03-030-xx) was obtained from Reference 11b. The PM-10 emission factors for these processes were obtained from

Reference 12. The emission factors for fugitive processes were obtained from Reference 13 for TSP and from Reference 12 or Table 3.1-3 of this report for PM-10.

The emission factors for sintering, electrolytic, horizontal retorts, vertical retorts, and fugitive processes were multiplied by 2 to account for the fact that there were 2 units of concentrate/ton of slab zinc.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.21.3.2.4 Primary Metals Industry - Lead —

The emission factors were obtained from Reference 10d for the following processes: sintering (SCC 3-03-010-01), blast furnaces (SCC 3-03-010-02), and reverberatory furnaces, dross (SCC 3-03-010-03). The PM-10 emission factors for these processes were obtained from Reference 12. The emission factors for fugitive processes were obtained from Reference 13 for TSP and from Reference 12 or Table 3.1-3 of this report for PM-10.

The emission factors for sintering and blast furnaces were multiplied by 2 to account for the fact that there were 2 units of concentrate/ton of slab lead.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.21.3.2.5 Secondary Metal Industry - Aluminum —

The emission factors for sweating were the weighted averages of the emission factors for sweating furnaces (SCC 3-04-001-01) and scrap dryers (3-04-002-07). The TSP emission factors for these processes were obtained from Reference 10e and 10f; the PM-10 emission factors were obtained from Reference 12. The scrap dryer emission factors were used as surrogates. The sweating furnace emission factors were weighted by the consumption of sweated pig and the scrap dryer emission factors were weighted by the consumption of borings and turnings. Consumption data were obtained from Reference 1.

The emission factors for refining were the weighted averages of the emission factors for smelting furnace/crucible (SCC 3-04-001-02) and smelting furnace/reverberatory (3-04-001-03). The TSP emission factors were obtained from Reference 10e and the PM-10 emission factors from Reference 12. These emission factors were weighted based on Reference 7 or Reference 8.

The emission factors for fluxing (SCC 3-04-001-04) were obtained from Reference 10e for TSP and from Reference 12 for PM-10. The TSP emission factor for fugitive processes was obtained from Reference 13. The PM-10 emission factor for fugitive processes was obtained from Reference 12 or Table 3.1-3 of this report.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.21.3.2.6 Secondary Metal Industry - Lead —

The emission factor for pot furnaces or kettle refining (SCC 3-04-004-01), reverberatory furnaces (SCC 3-04-004-02), and blast furnaces (SCC 3-04-004-03) was obtained from Reference 11c The PM-10 emission factors for these processes were obtained from Reference 12. The fugitive processes emission factors were obtained from Reference 13. The PM-10 emission factor for fugitive processes was obtained from Reference 12 or Table 3.1-2 of this report.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.21.3.2.7 Secondary Metal Industry - Copper —

The emission factors for wiring burning were obtained from Reference 14 for TSP and from Reference 12 for PM-10.

The emission factors for brass and bronze casting were the weighted averages of the emission factors for five casting methods added to the emission factor for a sixth method, cupola (SCC 3-04-002-12). All TSP emission factors were obtained from Reference 10f. The PM-10 emission factors were obtained from Reference 12. Operating rates obtained from Reference 9 for the five casting methods were used to calculated the weighted average emission factors. The casting methods, SCCs, and weighting factors for the five casting methods are presented in Table 3.21-4. The resulting weighted average emission factors were added to the cupola emission factors to obtain the overall brass and bronze casting PM-10 and TSP emission factors.

The emission factor for smelting were the weighted sum of the emission factors for the following four smelter types: (1) cupola, scrap copper (SCC 3-04-002-10), (2) reverberatory, scrap copper (SCC 3-04-002-14), (3) electric arc, scrap copper (SCC 3-04-002-20), and electric induction, scrap copper (SCC 3-04-002-23). These emission factors were obtained from Reference 10f for TSP and from Reference 12 for PM-10. The emission factors were summed according to Equation 3.21-4.

$$EF = EF_C + (2 \times EF_{RF}) + [(EF_{EA} + EF_{EI}) / 2] \qquad \text{(Eq. 3.21-4)}$$

where:
- EF = emission factor
- C = cupola for scrap copper
- RF = reverberatory furnace for scrap copper
- EA = electric arc for scrap copper
- EI = electric induction

The TSP emission factor for fugitive processes was obtained from Reference 11d. The PM-10 emission factor was obtained from Reference 12 or Table 3.1-3 of this report.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.21.3.3 SO_2 Emissions

The emission factor for roasting was the weighted average of the emission factors for two process types. The emission factors were obtained from Reference 10b and were weighted using the 1981 capacity for each process type. The SCCs and descriptions of the two process types along with the 1981 capacity data are presented in Table 3.21-2. To account for fugitive emissions, 1 lb/ton was added to the weighted average emission factor.

The emission factor for copper smelting was the weighted average of the emission factors for six process types. Emission factors were obtained from Reference 10b and were weighted using the 1981 capacity for each process type. The SCCs and descriptions of the six process types along with the 1981 capacity data are presented in Table 3.21-5. The weighting factors were changed from the 1981 capacity data when an existing smelter ceased operations, a new smelter began operations, or an existing smelter was modified. This information was obtained from Reference 3a. To account for fugitive emissions, 4 lb/ton was added to the weighted average emission factor.

The emission factor for copper converting was the weighted average of the emission factors for six process types. The emission factors were obtained from Reference 10b, except for the noranda reactor emission factor which was assumed. The emission factors were weighted using the 1981 capacity for each process type. The SCCs and descriptions of the six process types along with the 1981 capacity data are presented in Table 3.21-6. To account for fugitive emissions, 130 lb/ton was added to the weighted average emission factor.

The emission factor for zinc roasting (SCC 3-03-030-02) was obtained from Reference 10d.

The emission factor for lead roasting was the sum of the emission factors for sintering (SCC 3-03-010-01) and blast furnace (SCC 3-03-010-02). These emission factors were obtained from Reference 10d.

The emission factor for primary aluminum was obtained from Reference 9.

The emission factors for secondary lead processing in reverberatory furnaces (SCCS-04-004-02) and blast furnaces (SCC 3-04-004-03) were obtained from Reference 10g.

3.21.4 Control Efficiency

3.21.4.1 CO Emissions

No control efficiencies were applied to the activity data to estimate emissions from primary aluminum production.

3.21.4.2 PM-10 and TSP Emissions

The TSP control efficiencies for all primary metals industry production processes and all secondary metals industry production processes, except for any fugitive processes were derived from Reference 7 or Reference 8 using Equation 3.21-5. For those processes where the emission factor was calculated as the weighted average of the emission factors of several process types, the control efficiency was calculated as the weighted average of the individual control efficiencies in the same manner.

$$CE = \left[\frac{(UE - AE)}{UE}\right] \qquad \text{(Eq. 3.21-5)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

The TSP control efficiencies for the primary metals industry fugitive processes for aluminum, copper, lead and zinc production were obtained by engineering judgment. No additional information is currently available concerning the origin of these TSP control efficiencies. The same is true for the control efficiencies for the secondary metals industry fugitive processes for aluminum, lead, and copper.

The PM-10 control efficiencies for all primary metals industry and secondary metals industry production process, excluding the fugitive processes for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 15. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency values were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate PM-10 emissions from fugitive processes for either the primary metals industry or the secondary metals industry.

3.21.4.3 SO_2 Emissions

No control efficiencies were applied to the activity data to estimate SO_2 emissions from the source included in this Tier II category.

3.21.5 References

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   (b) Table entitled, "Primary and Secondary Copper Produced by Refineries and Electrowinning plants in the U.S."

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    b. Volume I, Table 7.3-2
    c. Volume I, Table 7.7-1
    d. Volume I, Table 7.6-1
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Table 3.21-1. PM-10 Emission Factors SCCs for the Primary Metals Industry - Aluminum

SCC	Description
3-03-002-01	Calcining of Hydroxide
3-03-001-02	HSS - Stack
3-03-001-09	HSS - Fugitive
3-03-001-03	VSS - Stack
3-03-001-10	VSS - Fugitive
3-03-001-01	Prebake - Stack
3-03-001-08	Prebake - Fugitive
3-03-001-05	Anode Baking
3-03-001-04	Materials Handling

Table 3.21-2. PM-10 and SO_2 Emission Factors SCCs and Weighting Factors for the Primary Metals Industry - Copper Roaster

SCC	Description	1981 Capacity
3-03-005-02	Multiple Hearth Roaster	430
3-03-005-09	Fluidized Bed Roaster	230

Table 3.21-3. PM-10 Emission Factors SCCs and Weighting Factors for the Primary Metals Industry - Copper Smelting

SCC	Description	1981 Capacity
3-03-005-07	Reverb. Furnace w/o Roasting	636
3-03-005-31	Reverb. Furnace + Multi-Hearth Reverb.	430
3-03-005-32	Furnace + Fluid Bed Roaster	212
3-03-005-10	Electric Smelting Furnace	257

Table 3.21-4. PM-10 Emission Factors SCCs and Weighting Factors for the Secondary Metals Industry - Copper Brass and Bronze Casting

SCC	Description	Weighting Factors
3-04-002-15	Reverberatory - Brass & Bronze	36
3-04-002-17	Rotary - Brass & Bronze	300
3-04-002-19	Crucible & Pot - Brass & Bronze	21
3-04-002-21	Electric Arc - Brass & Bronze	11
3-04-002-24	Electric Induction - Brass & Bronze	20

Table 3.21-5. SO_2 Emission Factors SCCs and Weighting Factors for the Primary Metals Industry - Copper Smelting

SCC	Description	1981 Capacity
3-03-005-03	Multi-Hearth + Reverb. Furnace + Convertors	405
3-03-005-07	Reverb. Furnace + Convertors	430
3-03-005-10	Electric Furnace + Convertors	212
3-03-005-25	Fluid Bed Roaster + Reverb. Furn. + Convertors	124
3-03-005-26	Flash Furnace + Cleaning Furnace + Convertor	18
3-03-005-	Fluid Bed + Electric Arc + Convertors	115

Table 3.21-6. SO_2 Emission Factors SCCs and Weighting Factors for the Primary Metals Industry - Copper Converting

SCC	Description	Weighting Factor
3-03-005-23	Reverberatory Furnace + Convertor	405
3-03-005-24	Multi-Hearth + Reverb. + Convertor	448
3-03-005-25	Fluid Bed Roaster + Reverb. + Convertor	212
3-03-005-26	Electric Arc + Convertor	124
3-03-005-27	Flash Furn. + Cleaning Furn. + Convertor	115
3-03-005-28	Noranda Reactor + Convertor	231

3.22 METALS PROCESSING - FERROUS: 05-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(05) METALS PROCESSING	(02) Ferrous	Iron and Steel Manufacturing Primary Metals Industry - ferroalloys Secondary Metals Industry - grey iron and steel foundries

3.22.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators for all processes, except for iron and steel industry processes were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. For iron and steel industrial processes emitting PM-10 and TSP, the activity indicators were expressed in million short tons and the emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.22-1.

$$PM\text{-}10\ Emissions_{year} = PM\text{-}10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.22-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.22.2 Activity Indicator

3.22.2.1 CO Emissions

The activity indicator for cupola furnaces in iron foundries was based on the combined quantity of scrap and pig iron consumed by cupola furnaces. This value was obtained from Reference 1a under the category of iron foundries and miscellaneous users. The final activity was determined by adjusting this production value to account for the fact that the emission factor used for this subcategory was in terms of the charged quantity and not the fresh feed quantity. This adjustment required dividing the production value by 0.78 to account for recycling.

The activity indicator for by-product coke from steel manufacturing was the oven production figure, expressed in thousand short tons, from Reference 2a.

The activity indicator for steel manufacturing blast furnaces was the total pig iron production including exports obtained from Reference 2b.

The activity indicator for steel manufacturing sintering was one-third of the total production of pig iron obtained from Reference 2 or Reference 3.

The activity indicators for steel manufacturing open hearth and electric arc furnace types were based on the total scrap and pig iron consumption. Reference 1 contained the total scrap and pig iron consumed by each of three furnace types (including basic oxygen) by manufacturers of pig iron and raw steel and castings. The fraction of combined quantity of scrap and pig iron consumed by each of the three furnace types was calculated. The total raw steel production reported in Reference 2b was multiplied by the fractions for the open hearth and electric arc furnaces to obtain the raw steel production for these two furnace types.

3.22.2.2 NO_x Emissions

The activity indicator for open hearth furnaces used in iron and steel manufacturing was based on the total scrap and pig iron consumption. Reference 1 contained the total scrap and pig iron consumed by each of the three furnace types (open hearth, basic oxygen, and electric arc) by manufacturers of pig iron and raw steel and castings. The fraction of the combined quantity of scrap and pig iron consumed by each of the three furnace types was calculated. The total raw steel production reported in Reference 2b was multiplied by the open hearth fraction to obtain the raw steel production for this furnace type.

The activity indicator for roll and finish processes in iron and steel manufacturing was the total raw steel production obtained from Reference 2a.

3.22.2.3 PM-10 and TSP Emissions

3.22.2.3.1 Iron and Steel Industry —

The activity indicator for by-product coke was the oven or by-product production figure from Reference 2a. The same activity indicator was used for coal preparation and coke handling.

The activity indicator for blast furnaces was the total pig iron production obtained from Reference 2b. This value included exports.

The activity indicators for windbox, discharge, and sinter-fugitive processes were based on the total production of pig iron obtained from Reference 2 or Reference 3. The activity indicator for each process was one-third of this production value.

The activity indicators for open hearth, basic oxygen, and electric arc furnaces were based on the total scrap and pig iron consumption. Reference 1 contained the total scrap and pig iron consumed by each furnace type by manufacturers of pig iron and raw steel and castings. The fraction of the combined quantity of scrap and pig iron consumed by each furnace type was calculated. The total raw steel production reported in Reference 2b was multiplied by each fraction to obtain the raw steel production for each furnace type. These final results were used as the activity indicators for the both "stack" and "fugitive" subcategories of each furnace type.

The activity indicator for slag blast furnaces was the total quantity of iron blast furnace slag sold reported in Reference 4. The same reference was used to obtain the total quantity of steel slag sold. This value was used as the activity indicator for slag steel furnaces.

The activity indicator for scarfing was one-third of the total raw steel production obtained from Reference 2b.

The activity indicators for teeming, soaking pits, reheat furnaces, and open dust were the total raw steel production reported in Reference 2b.

The activity indicator for ore screening was the total consumption of iron ore and agglomerates obtained from Reference 3.

3.22.2.3.2 Primary Metals Industry (ferroalloys) —

The activity indicator for ferrosilicon was the net gross weight production obtained from Reference 5a. The silicon manganese activity indicator was assumed to be 42.1 percent of the net production of ferrosilicon. The activity indicator for the ferromanganese, electric furnaces was assumed to be 57.9 percent of the net production of ferrosilicon. For the ferromanganese, blast furnace, the activity indicator was assumed to be zero.

The activity indicator for silicon metal was the production value obtained from Reference 6a. The activity indicator for other ferroalloys was the sum of the gross weight production figures for chromium alloys, ferrocolumbium, ferrophosphorus and other ferroalloys as reported in Reference 5a. For ferroalloy material handling, the total gross weight production of all ferroalloys obtained from Reference 5a was used as the activity indicator.

3.22.2.3.3 Secondary Metals Industry —

The activity indicator for cupola furnaces at grey iron foundries was based on the combined quantity of scrap and pig iron consumed by cupola furnaces. This value was obtained from Reference 1a under the category of iron foundries and miscellaneous users. The final activity was determined by adjusting this production value to account for the fact that the emission factor was in terms of the charged quantity and not the fresh feed quantity. This adjustment required dividing the production value by 0.78 to account for recycling.

The activity indicator for electric induction furnaces at grey iron foundries was based on the combined quantity of iron and steel scrap and pig iron consumed in electric furnaces. This value was obtained from Reference 1a under the category of iron foundries and miscellaneous users. The final activity indicator was adjusted to account for recycling by dividing the consumption value by 0.78 to account for recycling.

The activity indicator for iron fugitive processes at grey iron foundries was the sum of the activity indicators for the cupola and electric induction furnaces.

The activity indicators for electric arc and steel-fugitive processes at steel foundries were both based on the combined quantity of iron and steel scrap and pig iron consumed. This value was obtained from Reference 1a under the category of manufacturers of steel casting. The final activity indicators used were the consumption value divided by 0.78 to account for recycling.

3.22.2.4 SO_2 Emissions

The activity indicator for coking in iron and steel manufacturing was the oven production figure obtained from Reference 2a.

The activity indicators for sintering in iron and steel manufacturing was based on the total production of pig iron obtained from Reference 2 or Reference 3.

The activity indicator for open hearth furnaces in iron and steel manufacturing was based on the total scrap and pig iron consumption. Reference 1 contained the total scrap and pig iron consumed by each furnace type (open hearth, basic oxygen, and electric arc) by manufacturers of pig iron and raw steel and castings. The fraction of the combined quantity of scrap and pig iron consumed by each of the three furnace types was calculated. Total raw steel production reported in Reference 2b was multiplied by the fraction for open hearth furnaces to obtain the raw steel production for this furnace type.

The activity indicator for roll and finish processes was the total raw steel production obtained from Reference 2b.

3.22.2.5 VOC Emissions

The activity indicator for by-product coke was the oven production figure obtained from Reference 2a. The activity indicator for sintering was based on the total production of pig iron obtained from Reference 2 or Reference 3.

3.22.3 Emission Factor

3.22.3.1 CO Emissions

The emission factor for iron foundries (SCC 3-04-003-01) was obtained from Reference 7a.

The emission factor for by-product coke from steel manufacturing was the sum of the emission factors for three separate processes: charging (SCC 3-03-003-02), pushing (SCC 3-03-003-03) and oven/door leaks (SCC 3-03-003-08). These emission factors were obtained from Reference 7b. The units of the emission factor were changed from quantity of coal charged to quantity of coke produced by using the relationship that one ton of coal charged produces 0.7 tons of coke.

The emission factors for steel manufacturing windbox sintering (SCC 3-03-008-13), basic oxygen furnaces (SCC 3-03-009-13 and 3-03-009-14), and electric arc furnaces (SCC 3-03-009-04 and 3-03-009-08) were obtained from Reference 7c.

The uncontrolled emission factor for steel manufacturing blast furnaces was obtained from Reference 8a. The control emission factor was calculated by applying the control efficiency as shown in Equation 3.22-2.

$$EF_{controlled} = EF_{uncontrolled} \times (1 - CE) \qquad \text{(Eq. 3.22-2)}$$

where: EF = emission factor
CE = control efficiency

For the years 1970 through 1984, the control efficiency for blast furnaces was assumed to the 0.999. The control efficiencies for the years 1960, 1950, and 1940 were 0.995, 0.990, and 0.975, respectively.

3.22.3.2 NO_x Emissions

3.22.3.2.1 Iron and Steel Industry —

The emission factor for open hearths was calculated by dividing the emissions by the operating rate as reported in Reference 9.

The emission factor for roll and finish was based on the emissions from the fuels used in this process divided by the process operating rate. The fuels used in this process were coke oven gas, residual oil, and natural gas. The emissions from roll and finish processes were assumed to be the difference between the total NO_x emissions from iron and steel processes and the NO_x emissions from open hearth furnaces.

The total NO_x emissions from all iron and steel processes using coke oven gas, residual oil, and natural gas were the sum of the separate emissions from the three fuels. Emissions were calculated by multiplying the quantity of fuel consumed by the fuel specific emission factor. The quantity of coke oven gas consumed by iron and steel processes was assumed to be 40 percent of the total annual coke oven gas production as reported in Reference 10. The quantity of residual oil consumed was calculated by multiplying the quantity of raw steel production obtained from Reference 2b by a factor converting tons of steel produced to the gallons of residual oil consumed (0.00738 x 10^6 gal/10^3 ton steel). The quantity of natural gas consumed was calculated in the same manner as was the quantity of residual oil consumed, except that a conversion factor of 4.25 x 10^6 cu. ft gas consumed/10^3 ton steel was used.

The NO_x emission factor for the combustion of coke oven gas was obtained from Reference 7. The emission factors for the combustion of residual oil, and natural gas were obtained from Reference 7h (industrial boilers) and 7i (small industrial boilers), respectively. Based on these emission factors and the fuel consumption data, the NO_x emissions from the combustion of coke oven gas, residual oil, and natural gas were calculated.

The sum of these emissions was the total NO_x emissions from the iron and steel processes. The quantity of emissions from the open hearth furnaces was calculated by multiplying the activity indicator by the emission factor. The origin of these data were described earlier in this section. The difference between the total NO_x emissions and the open hearth furnace emissions was assumed to be the emissions from the roll and finish process. The emission factor for this process was calculated by dividing the emissions by the total steel produced obtained from Reference 11a.

3.22.3.3 PM-10 and TSP Emissions

3.22.3.3.1 Iron and Steel Industry —

The PM-10 and TSP emission factors for by-product coke were based on the sum of the emission factors for following six SCCs: 3-03-003-02, 3-03-003-03, 3-03-003-04, 3-03-003-06, 3-03-003-08, and 3-03-003-14. The TSP emission factors for these SCCs were obtained from Reference 7b, with the exception of SCC 3-03-003-04. The emission factor for this SCC was obtained from Reference 8b. The PM-10 emission factors of the six SCCs were obtained from Reference 12. The sum of these emission factors for PM-10 and TSP were divided by 0.7 to convert the emission factors from the amount of coal charged to the amount of coke produced.

The TSP emission factor for coal preparation and coke handling was obtained from Reference 7. The PM-10 emission factor was obtained from Reference 13. The TSP emission factors for the beehive process for the years 1940 through 1975 were obtained from Reference 7. The PM-10 emission factors for this process for all years and the TSP emission factor after 1975 were assumed to be zero.

The TSP emission factors for blast furnaces were the sum of the emission factors reported in Reference 14a for the SCCs 3-03-008-01 and 3-03-008-02. The PM-10 emission factors for these two SCCs were obtained from Reference 12.

The emission factors for windbox (SCC 3-03-0080-13) and discharge (SCC 3-03-008-14) were obtained from Reference 7d for TSP and from Reference 12 for PM-10. The windbox emission factors were after coarse particle removal. The emission factors for fugitive processes (SCC 3-03-008-19) were obtained from Reference 13 for TSP and from Reference 12 for PM-10.

The TSP emission factor for the open hearth furnaces, stack subcategory (SCC 3-03-009-01) was obtained from Reference 7d. The open hearth furnace, fugitive subcategory TSP emission factor was obtained from Reference 14. The PM-10 emission factors for these sources were obtained from Reference 12.

The TSP emission factor for the basic oxygen furnaces, stack subcategory (SCC 3-03-009-13) was obtained from Reference 7d. The basic oxygen furnace, fugitive subcategory TSP emission factor was obtained from Reference 13. The PM-10 emission factors for these sources were obtained from Reference 12.

The emission factors for the electric arc furnaces, stack subcategory were based on the emission factors for carbon steel, stack (SCC 3-03-009-04) and alloy steel, stack (SCC 3-03-009-08) obtained from Reference 7d for TSP and from Reference 12 for PM-10. Weighted average PM-10 and TSP emission factors were calculated from these emission factors. Weighting factors were the relative production levels of carbon and alloy steel as reported in Reference 11a. For the electric arc furnace, fugitive subcategory, PM-10 and TSP emission factors were obtained from Reference 12 and Reference 13, respectively.

The PM-10 and TSP emission factors for slag blast furnaces and steel furnaces were obtained from Reference 12 and Reference 13, respectively.

The emission factors for scarfing (SCC 3-03-009-32) were obtained from Reference 7d for TSP and from Reference 12 for PM-10.

The PM-10 and TSP emission factors for teeming, soaking pits, reheat furnaces, open dust, and ore screening were obtained from Reference 12 and Reference 13, respectively.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.22.3.3.2 Primary Metals Industry (ferroalloys) —

The emission factors for ferrosilicon were based on the emission factors for the following three electric smelting processes: 50 percent Fe Si (SCC 3-03-006-01), 75 percent Fe Si (SCC 3-03-006-02), and 90 percent Fe Si (SCC 3-03-006-03). The TSP emission factors for these processes were obtained from Reference 7e. The PM-10 emission factors were obtained from Reference 12. Weighed averages of these PM-10 and TSP emission factors were calculated using ferrosilicon production levels obtained from Reference 6 as weighting factors.

The PM-10 and TSP emission factors for silicon manganese (SCC 3-03-006-05), ferromanganese, electric furnaces (SCC 3-03-007-01), and silicon metal (SCC 3-03-006-04) subcategories were obtained from Reference 7e and Reference 12, respectively. The activity for ferromanganese, blast furnaces was assumed to be zero and, therefore, no emission factor was necessary. The emission factors for other ferroalloys and ferroalloy material handling were obtained from Table 3.1-3 of this report. The emission factors for other ferroalloys were based on engineering judgement and those for ferroalloy material handling were based on data from Reference 15.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.22.3.3.3 Secondary Metals —

The PM-10 and TSP emission factors for cupola furnaces (SCC 3-04-003-01) and electric induction furnaces (SCC 3-04-003-03) at grey iron foundries were obtained from Reference 7f. The emission factors for fugitive processes were the sum of the emission factors for all processes reported emitting to the atmosphere in Reference 8c. It was assumed that the magnesium treatment applied to only 20 percent of the production. The PM-10 emission factor for fugitive processes was obtained from Reference 12 or Table 3.1-3 of this report.

The PM-10 and TSP emission factors for steel foundries electric arc furnaces (SCC 3-04-007-01) at steel foundries were obtained from Reference 7g. The TSP emission factor for fugitive processes was the sum of the emission factors for all processes, except for magnesium treatment, reported emitting to the atmosphere in Reference 8c. The PM-10 emission factor for fugitive processes was obtained from Reference 12 or Table 3.1-3 of this report.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.22.3.4 SO_2 Emissions

The emission factor for coking in iron and steel manufacturing was based on the emission factors for six processes. Charging (SCC 3-03-003-02) and interfering (SCC 3-03-003-06) emission factors were obtained from Reference 7b. Emission factors for pushing (SCC 3-03-003-03), quenching (SCC 3-03-003-04), oven/door leaks (SCC 3-03-003-08) and topside leaks (SCC 3-03-003-14) were obtained from Reference 12. Emission factors from all six processes were summed and the result was multiplied by 0.7 to convert the factors from the amount of coal consumed to the amount of coke produced.

The emission factor for sintering in iron and steel manufacturing was calculated by dividing the emissions by the production rate as reported in Reference 9. This same procedure was used to calculate the open hearth emission factor.

The emission factor for roll and finish in iron and steel manufacturing was based on the emissions from the fuels used in this process divided by the process operating rate. The fuels used in this process were coke oven gas and residual oil. The emissions from the roll and finish process were assumed to be the difference between the total SO_2 emissions from iron and steel processes and the SO_2 emissions from open hearth furnaces.

Total SO_2 emissions from all iron and steel processes using coke oven gas and residual oil were the sum of the separate emissions from the two fuels. The emissions were calculated by multiplying the quantity of fuel consumed by the fuel specific emission factor. The quantity of coke oven gas consumed by the iron and steel processes was assumed to be 40 percent of the total annual coke oven gas production as reported in Reference 10. The quantity of residual oil consumed was calculated by multiplying the quantity of raw steel production obtained from Reference 2b by a factor converting tons of steel produced to the gallons of residual oil consumed (0.00738×10^6 gal/10^3 ton steel).

The SO_2 emission factor for the combustion of coke oven gas was obtained from Reference 7. The emission factor for the combustion of residual oil was obtained from Reference 7i and multiplied by the sulfur content obtained yearly for No. 6 fuel oil from Reference 16. Based on these emission factors and the fuel consumption data, the SO_2 emissions from the combustion of coke oven gas and residual oil were calculated.

Summing of these emissions resulted in the total SO_2 emissions from the iron and steel processes. The quantity of emissions from the open hearth furnaces was calculated by multiplying the activity indicator by the emission factor. The origin of these data were described earlier in this section. The difference between total SO_2 emissions and open hearth furnace emissions was assumed to be the emissions from the roll and finish processes. The emission factor for this process was calculated by dividing the emissions by the quantity of raw steel produced obtained from Reference 9.

3.22.3.5 VOC Emissions

The emission factor for coking was based on the emission factors for six processes. Charging (SCC 3-03-003-02) and pushing (SCC 3-03-003-03), and oven/door leaks (SCC 3-03-003-08) emission factors were obtained from Reference 7b. Emission factors for quenching (SCC 3-03-003-04), interfering (SCC 3-03-003-06) and topside leaks (SCC 3-03-003-14) were obtained from Reference 17. The emission factors from all six processes were summed and the result was multiplied by 0.7 to convert the factors from the amount of coal consumed to the amount of coke produced.

The VOC emission factor for windbox sintering (SCC 3-03-008-13) was obtained from Reference 17.

3.22.4 Control Efficiency

The control efficiencies for several processes were derived from the actual and uncontrolled emissions reported in Reference 18 or Reference 19 using Equation 3.22-3.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \qquad \text{(Eq. 3.22-3)}$$

where: CE = control efficiency
UE = uncontrolled emissions
AE = actual emissions

3.22.4.1 CO Emissions

The control efficiency for iron foundries was derived from Reference 18 or Reference 19 using Equation 3.22-3.

The control efficiency for steel manufacturing basic oxygen furnaces was computed from Reference 18 or Reference 19 using Equation 3.22-3. For blast furnaces, the percentage control efficiency was assumed to be 99.9 percent. This was taken into account in the calculation of the CO emission factor and, therefore, no separate control efficiency was used. For all other steel manufacturing processes, no control efficiencies were applied to the activity data to estimate the CO emissions.

3.22.4.2 NO_x Emissions

No control efficiencies were applied to the activity data to estimate NO_x emissions from the iron and steel manufacturing processes included in this Tier II category.

3.22.4.3 PM-10 and TSP Emissions

3.22.4.3.1 Iron and Steel Industry —

The TSP control efficiencies for by-product coke production were derived from Reference 18 or Reference 19 using Equation 3.22-3. The control efficiencies for the beehive process for the years 1940, 1950, 1960, and 1970 through 1975 and for coal preparation/coke handling processes for the years 1976 through 1984 were based on the estimated control efficiency reported in Reference 13. These TSP control efficiencies were adjusted according to engineering judgement.

The PM-10 control efficiencies for by-product coke production for the years 1975 through 1984 were based on the 1985 PM-10 control efficiency obtained from Reference 20. During these years, any changes in the TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate the PM-10 emissions from by-product coke production. No control efficiencies were applied to the activity data to estimate PM-10 emissions from the beehive process or the coal preparation/coke handling processes.

For blast furnaces, the TSP control efficiencies for the years 1973 through 1984 were assumed to 0.996. No procedure for determining the control efficiencies for the years 1940, 1950, 1960, and 1970 through 1972 is currently available. The PM-10 control efficiencies for the years 1975 through 1984 were equal to the 1985 PM-10 control efficiency obtained from Reference 20. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions from blast furnaces.

The TSP control efficiencies for the windbox and discharge processes were derived from Reference 18 or Reference 19 using Equation 3.22-3. The control efficiencies for sinter-fugitive processes were based on the estimated control efficiency reported in Reference 13. This control efficiency was adjusted annually based on engineering judgement. The PM-10 control efficiencies for these three processes for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 20. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

The TSP control efficiencies for the stack processes of open hearth, basic oxygen, and electric arc furnaces were derived from Reference 18 or Reference 19 using Equation 3.22-3. The control efficiencies for the fugitive processes of the basic oxygen and electric arc furnaces were based on the estimated control efficiencies reported in Reference 13. The control efficiency for the fugitive processes of the basic oxygen furnace was assumed to be zero for all years.

The PM-10 control efficiencies for the stack processes of these three furnace types for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 20. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions. No control efficiencies were applied to the activity data to estimate PM-10 emissions from the fugitive processes of all three furnace types.

The TSP control efficiencies for slag blast and slag steel furnaces were based on the estimated control efficiencies reported in Reference 13. The yearly variations in these control efficiencies are assumed to be the results of adjustments made based on engineering judgement.

The PM-10 control efficiencies for slag steel furnaces for the years 1975 through 1984 were based on the 1988 PM-10 control efficiency obtained from Reference 20. During these years, any changes in the TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were use to PM-10 emissions. No control efficiencies were applied to the activity to estimate PM-10 emissions from slag blast furnaces.

The TSP control efficiencies for scarfing were derived from Reference 18 or Reference 19 using Equation 3.22-3. The PM-10 control efficiencies for the years 1975 through 1984 were based on the 1988 PM-10 control efficiency obtained from Reference 20. During these years, any changes in the TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were use to estimate PM-10 emissions for scarfing.

No control efficiencies were applied to the activity data to estimate PM-10 and TSP emissions from teeming, soaking pits, and reheat furnaces.

The TSP control efficiencies for open dust and ore screening were based on the estimated control efficiencies reported in Reference 13. The yearly variations in these control efficiencies are assumed to be the results of adjustments made based on engineering judgement. No control efficiencies were applied to the activity data to estimate PM-10 emissions from open dust and ore screening.

3.22.4.3.2 Primary Metals Industry (ferroalloys) —

The TSP control efficiencies for all production processes, except other ferroalloy production and ferroalloy material handling processes were derived from Reference 18 or Reference 19 using Equation 3.22-3. The TSP control efficiencies for ferroalloy production and ferroalloy material handling processes were based on engineering judgment.

The PM-10 control efficiencies for ferrosilicon, silicon manganese, and silicon metal production and the ferromanganese electric furnace for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 20. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate PM-10 emissions from ferromanganese blast furnace, other ferroalloy production, and ferroalloy material handling processes.

3.22.4.3.3 Secondary Metals Industry —

The TSP control efficiencies for all grey iron and steel foundry processes were derived from Reference 18 or Reference 19 using Equation 3.22-3.

The PM-10 control efficiencies for all grey iron and steel foundry processes, excluding the fugitive processes for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 20. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate PM-10 emissions from the fugitive processes of grey iron and steel foundries.

3.22.4.4 SO_2 Emissions

No control efficiencies were applied to the activity data to estimate SO_2 emissions from the iron and steel manufacturing processes included in this Tier II category.

3.22.4.5 VOC Emissions

No control efficiencies were applied to the activity data to estimate VOC emissions from the by-product coke and sintering processes included in this Tier II category.

3.22.5 References

1. *Minerals Industry Surveys*, Iron and Steel Scrap. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Monthly.
   (a) Table on consumption of iron and steel scrap and pig iron in the United States by type of furnace or other use.

2. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.
   (a) Table containing information on “Petroleum, Coal, and Products.”
   (b) Table containing information on “Metals and Manufactures.”

3. *Minerals Industry Surveys*, Iron Ores. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Monthly.

4. *Minerals Yearbook*, Slag Iron and Steel. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.

5. *Minerals Yearbook*, Ferroalloys. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.
   (a) Table entitled, “Table 2. Ferroalloys Produced and Shipped from Furnaces in the U.S.”

6. *Minerals Yearbook*, Silicon. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.
   (a) "Table 1. Production, Shipments, and Stocks of ... and Silicon Metal in the U.S. in 19xx"

7. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 7.10-3
   b. Volume I, Table 7.2-1
   c. Volume I, Table 7.5-3
   d. Volume I, Table 7.5-1
   e. Volume I, Table 7.4-3
   f. Volume I, Table 7.10-2
   g. Volume I, Table 7.13-1
   h. Volume I, Table 1.3-1
   i. Volume I, Table 1.4-1

8. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
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   b. Volume I, Table 7.2-1, Supplement 11, October 1980
   c. Volume I, Table 7.10-2, Supplement 11, October 1980

9. *Computer Retrieval, NE257 report, by Source Classification Code (SCC) from the National Emission Data System (NEDS)*. Unpublished computer report. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. February 9, 1980.

10. *Quarterly Coal Report: January - March*. DOE/EIA-0121(xx/1Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Quarterly.

11. *Minerals Yearbook*, Iron and Steel. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.
   (a) Table 1, Salient Iron and Steel Statistics.

12. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

13. Internal Memorandum from Walt Barber to David Hawkins on Final Fugitive Emission Factors derived by Joint EPA/AISI Study. U.S. Environmental Protection Agency. November 6, 1978.

14. *Compilation of Air Pollutant Emission Factors, Second Edition, Supplements 1 through 14, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC.
   a. Volume I, Part B, Table 7.5-1

15. *Summary of Particulate and Sulfur Oxide Emission Reductions Achieved National for Selected Industrial Source Categories*. EPA-340/1-76-0086. U.S. Environmental Protection Agency. Washington, DC. November 1976.

16. *Heating Oils*. U.S. Department of Energy. Obtainable from the National Institute for Petroleum and Energy Research, ITT Research Institute, P.O. Box 2128, Bartlesville, OK. Annual.

17. Criteria Pollutant Emission Factors for the 1985 NAPAP Emissions Inventory

18. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

19. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

20. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

3.23 METALS PROCESSING - NOT ELSEWHERE CLASSIFIED: 05-03

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(05) METALS PROCESSING	(03) Metals Processing not elsewhere classified (NEC)	Mining Operations (iron ore mining, taconite processing, bauxite crushing, copper ore crushing, zinc ore crushing, and lead ore crushing)

3.23.1 Technical Approach

The PM-10 and TSP emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated only for particulate matter from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1992 for TSP and for the years 1975 through 1984 for PM-10. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.23-1.

$$PM\!-\!10\ Emissions_{year} = PM\!-\!10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.23-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.23.2 Activity Indicator

The activity indicator for iron ore mining was the total quantity of crude iron ore mined obtained from Reference 1. The activity indicator for taconite processing was the quantity of pellet production (agglomerates) obtained from Reference 1a. The activity indicator for bauxite crushing was the consumption of crude and dried bauxite (domestic and foreign ores combined) reported in Reference 2. The activity indicator for copper ore crushing was the gross weight of copper ore produced on a dry weight basis obtained from Reference 3a. The activity indicator for zinc ore crushing was the gross weight of zinc ore produced on a dry weight basis reported in Reference 4a. The activity indicator for lead ore crushing was the gross weight of lead ore produced on a dry weight basis obtained from Reference 4.

3.23.3 Emission Factor

The TSP emission factors for iron ore mining were obtained from Reference 5. The TSP emission factors for taconite processing were the sum of the emission factors for nine individual processes obtained from Reference 6a. The processes and SCCs are listed in Table 3.23-1. The TSP emission factors were obtained from Reference 6b for bauxite crushing (SCC 3-03-000-01). The PM-10 emission factors for these sources were obtained from Reference 7.

The TSP emission factors for zinc ore crushing and lead ore crushing were obtained from Reference 6c. The PM-10 emission factors were obtained from Reference 7 or Table 3.1-3 of this report.

The emission factors for copper ore crushing were the sum of the emission factors for seven individual processes. These processes and the corresponding SCCs are listed in Table 3.23-2. The TSP emission factors were obtained from Reference 5 with the exception of the copper ore crushing emission factors which were obtained from Reference 6c. The PM-10 emission factors for all seven processes were obtained from Reference 7 or Table 3.1-3 of this report.

3.23.4 Control Efficiency

The TSP control efficiencies for taconite processing and bauxite crushing were derived from Reference 8 or Reference 9 using Equation 3.23-2.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \qquad \text{(Eq. 3.23-2)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

The TSP control efficiencies for copper, zinc, and lead ore crushing were based on engineering judgment. No additional basis for the yearly variations in these control efficiencies is currently available.

The PM-10 control efficiencies for taconite processing and bauxite crushing for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 10. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate PM-10 emissions from iron ore mining and copper, zinc, and lead ore crushing.

3.23.5 References

1. *Minerals Yearbook*, Iron Ore. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.
   a. Table entitled, "Usable Iron Ore Produced in the U.S. in 19xx by District, State, & Type of Product."

2. *Minerals Yearbook*, Bauxite and Alumina. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.

3. *Minerals Yearbook*, Copper. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.
   a. Table entitled, "Salient Copper Statistics."

4. *Minerals Yearbook*, Lead. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual.
   a. Table entitled, "Production of Lead and Zinc in Terms of Recoverable Metals, in U.S. in 19xx, by State."

5. *Assessment of Fugitive Particulate Emission Factors for Industrial Processes*. EPA-450/3-78-107. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1978.

6. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
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   c. Volume I, Table 7.18-1

7. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

8. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

9. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

10. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

Table 3.23-1. PM-10 and TSP Emission Factor SCCs for Taconite Processing

SCC	Description
3-03-023-01	Primary Crushing
3-03-023-02	Fines Crushing
3-03-023-04	Ore Transfer
3-03-023-07	Bentonite Storage
3-03-023-08	Bentonite Blending
3-03-023-09	Traveling Grate Feed
3-03-023-10	Traveling Grate Discharge
3-03-023-12	Indurating Furnace
3-03-023-16	Pellet Transfer

Table 3.23-2. PM-10 and TSP Emission Factor Processes for Copper Ore Crushing

Description
Open pit/overburden removal
Drill/blast
Loading
Truck dumping
Transfer/conveying
Copper Ore Crushing
Storage

3.24 PETROLEUM AND RELATED INDUSTRIES - OIL AND GAS PRODUCTION: 06-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(06) PETROLEUM AND RELATED INDUSTRIES	(01) Oil and Gas Production	Petroleum Marketing and Production - crude oil and natural gas Sulfur Recovery Plants - natural gas fields

3.24.1 Technical Approach

The SO_2 and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated only for SO_2 and VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicator for SO_2 emissions from natural gas fields was expressed in thousand short tons and the emission factor was expressed in metric pounds/short ton. For VOC emissions from crude oil production and natural gas liquids, the activity indicators were expressed in millions barrels and the emission factors were expressed in metric pounds/thousand barrels.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, 1960, and 1970 through 1984 for both pollutants.

3.24.2 Activity Indicator

The activity indicator for the SO_2 emissions from natural gas fields was the quantity of sulfur recovered by natural gas plants obtained from Reference 1. The activity indicator for VOC emissions from crude oil production was the total U.S. field production including lease condensate obtained from Reference 2a. The activity indicator for VOC emissions from natural gas liquids category was the total field production of natural gas plant liquids was obtained from Reference 2a.

3.24.3 Emission Factor

The SO_2 emission factor for natural gas fields was based on the actual emissions for the SCCs 3-01-032-01 through 3-01-032-04. These emission data were summed and divided by the sum of the corresponding operating rates. All data was obtained from Reference 3 or Reference 4.

The VOC emission factor for crude oil production was obtained from Reference 5. The VOC emission factor for natural gas liquids was obtained from Reference 5.

3.24.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate the SO_2 and VOC emissions from the sources included in this Tier II category.

3.24.5 References

1. *Minerals Industry Surveys*, Sulfur. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Monthly.

2. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   (a) Table 1

3. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

4. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

5. *Control Techniques for VOC Emissions from Stationary Sources*. EPA-450/3-85-008. U.S. Environmental Protection Agency, Research Triangle Park, NC. September, 1985.

3.25 PETROLEUM AND RELATED INDUSTRIES - PETROLEUM REFINERIES AND RELATED INDUSTRIES: 06-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(06) PETROLEUM AND RELATED INDUSTRIES	(02) Petroleum Refineries and Related Industries	FCC, TCC, and Flares Sulfur Recovery Compressors Blow Down Systems Process Drains Vacuum Jets and Cooling Towers

3.25.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators for CO, NO_x, PM-10, TSP, and SO_2 emissions were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. For VOC emissions, activity indicators were expressed in millions barrels and emission factors were expressed in metric pounds/thousand barrels. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.25-1.

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.25-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.25.2 Activity Indicator

3.25.2.1 CO Emissions

The activity indicators for Fluid Catalytic Cracking (FCC) and Thermal Catalytic Cracking (TCC) units in petroleum refineries were based on the separate FCC and TCC capacities. The TCC capacity was obtained from Reference 1 as the value reported in the "other" category for cnt cracking fresh feed charge capacity. (Sum of values for individual refineries.) The FCC capacity was not available directly, but was calculated as the difference between the total capacity and the TCC capacity. Total capacity of catalytic cracking fresh feed in bbl/stream day was obtained from Reference 1. This value was converted to bbl/calendar year by multiplying by 328.5 (365 days/year x 0.9 calendar day/stream day).

The FCC and TCC capacities were converted to throughput data using the refinery operating ratio. This ratio was obtained from Reference 2a and converted to a percentage. Capacities were multiplied by this refinery operating percentage to obtain the corresponding throughputs. The FCC and TCC throughputs were used as the activity indicators.

3.25.2.2 NO_x Emissions

The activity indicators for FCC and TCC in petroleum refineries were based on the separate FCC and TCC capacities. The TCC capacity was obtained from Reference 1 as the value reported in the "other" category for cnt cracking fresh feed charge capacity. (Sum of values for individual refineries.) The FCC capacity was not available directly, but was calculated as the difference between total capacity and TCC capacity. Total capacity of catalytic cracking fresh feed in bbl/stream day was obtained from Reference 1. This value was converted to bbl/calendar year by multiplying by 328.5 (365 days/year x 0.9 calendar day/stream day).

The FCC and TCC capacities were converted to throughput data using the refinery operating ratio. This ratio was obtained from Reference 2a and converted to a percentage. Capacities were multiplied by this refinery operating percentage to obtain the corresponding throughputs. The FCC and TCC throughputs were used as the activity indicators.

The activity indicator for flares in petroleum refineries was based on total refinery crude capacity in bbl/calendar day obtained from Reference 1. This value was multiplied by 365 to convert it to an annual value. The activity indicator was calculated by multiplying the capacity by the VOC control efficiency for blow down systems, expressed as a percentage. The derivation of this control efficiency is described in section 3.25.4.4.

3.25.2.3 PM-10 and TSP Emissions

The activity indicators for FCC and TCC in petroleum refineries were based on the separate FCC and TCC capacities. The TCC capacity was obtained from Reference 1 as the value reported in the "other" category. The FCC capacity was not available directly, but was calculated as the difference between total capacity and TCC capacity. Total capacity of catalytic cracking fresh feed in bbl/stream day was obtained from Reference 1. This value was converted to bbl/calendar year by multiplying by 328.5 (365 days/year x 0.9 calendar day/stream day).

The FCC and TCC capacities were converted to throughput data using the refinery operating ratio. This ratio was obtained from Reference 2a and converted to a percentage. Capacities were multiplied by this refinery operating percentage to obtain the corresponding throughputs. The FCC and TCC throughputs were used as the activity indicators.

3.25.2.4 SO_2 Emissions

The activity indicator for sulfur recovery plants at refineries was the quantity of sulfur recovered by petroleum refineries obtained from Reference 3.

The activity indicators for FCC and TCC in petroleum refineries were based on the separate FCC and TCC capacities. The TCC capacity was obtained from Reference 1 as the value reported in the "other" category. The FCC capacity was not available directly, but was calculated as the difference between total capacity and TCC capacity. Total capacity of catalytic cracking fresh feed in bbl/stream day was obtained from Reference 1. This value was converted to bbl/calendar year by multiplying by 328.5 (365 days/year x 0.9 calendar day/stream day).

The FCC and TCC capacities were converted to throughput data using the refinery operating ratio. This ratio was obtained from Reference 2a and converted to a percentage. Capacities were multiplied by this refinery operating percentage to obtain the corresponding throughputs. The FCC and TCC throughputs were used as the activity indicators.

The activity indicator for flares in petroleum refineries was based on the total refinery crude capacity in bbl/calendar day obtained from Reference 1. This value was multiplied by 365 to convert it to an annual value. The activity indicator was calculated by multiplying the capacity by the VOC control efficiency for blow down systems, expressed as a percentage. The derivation of this control efficiency is described in section 3.25.4.4.

3.25.2.5 VOC Emissions

The activity indicators for FCC and TCC in petroleum refineries were based on the separate FCC and TCC capacities. The TCC capacity was obtained from Reference 1 as the value reported in the "other" category. The FCC capacity was not available directly, but was calculated as the difference between total capacity and TCC capacity. Total capacity of catalytic cracking fresh feed in bbl/stream day was obtained from Reference 1. This value was converted to bbl/calendar year by multiplying by 328.5 (365 days/year x 0.9 calendar day/stream day).

The FCC and TCC capacities were converted to throughput data using the refinery operating ratio. This ratio was obtained from Reference 2a and converted to a percentage. Capacities were multiplied by this refinery operating percentage to obtain the corresponding throughputs. The FCC and TCC throughputs were used as the activity indicators.

The activity indicators for the petroleum refinery process operations of compressor, blow down systems, process drains, cooling towers, and miscellaneous processes were the total crude capacity reported in Reference 1. The capacity, expressed in bbl/calendar day, was multiplied by 365 to convert it to an annual figure. The activity indicator for vacuum jets was the total vacuum distillation capacity obtained from Reference 1. The capacity, expressed in bbl/stream day, was multiplied by the following factor to convert it to an annual value: 365 days/year x 0.95 calendar day/stream day.

3.25.3 Emission Factor

3.25.3.1 CO Emissions

The emission factors for FCC and TCC in petroleum refineries were obtained from Reference 4a for SCCs 3-06-002-01 and 3-06-003-01, respectively. In this reference, TCC was categorized as moving-bed catalytic cracking units.

3.25.3.2 NO_x Emissions

The emission factors for FCC, TCC, and flares in petroleum refineries were obtained from Reference 4a for SCCs 3-06-002-01, 3-06-003-01, and 3-06-004-01, respectively. In this reference, TCC was categorized as moving-bed catalytic cracking units and flares were categorized as blow down system with vapor recovery.

3.25.3.3 PM-10 and TSP Emissions

The TSP emission factors for FCC and TCC in petroleum refineries were obtained from Reference 4a for SCCs 3-06-002-01 and 3-06-003-01, respectively. In this reference, TCC was categorized as moving-bed catalytic cracking units. The PM-10 emission factors for these sources were obtained from Reference 5. For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from these emission sources.

3.25.3.4 SO_2 Emissions

The emission factor for sulfur recovery plants at refineries was based on SCCs 3-01-032-01 through 3-01-032-04. These emission data were summed and divided by the sum of the corresponding operating rates. All data was obtained from Reference 6 or Reference 7.

The emission factors for FCC, TCC, and flares in petroleum refineries were obtained from Reference 4a for SCCs 3-06-002-01, 3-06-003-01, and 3-06-004-01, respectively. In this reference, TCC was categorized as moving-bed catalytic cracking units and flares were categorized as blow down system with vapor recovery.

3.25.3.5 VOC Emissions

The emission factors for FCC and TCC in petroleum refineries were obtained from Reference 1. These emission factors were converted to a reactive basis using the profile SDM 306002 obtained from Reference 8.

The emission factors for the petroleum refinery process operations of blow down systems, process drains, vacuum jets, cooling towers, and miscellaneous processes were obtained from Reference 1. The emission factor for compressors was obtained from Reference 9.

The emission factors were converted to a reactive basis using profiles from Reference 8, except for the emission factor for vacuum jets for which the profile was obtained from Reference 10. Compressors, blow down systems, process drains, and cooling towers were converted to a reactive basis using the profiles SDM 202002, SDM 306009, SDM 306005, and SDM 306007, respectively, obtained from Reference 8. The emission factor for miscellaneous processes was converted using the profiles SDM 306008A, 8P, 8Y 8Z (Aug), and 8N.

3.25.4 Control Efficiency

3.25.4.1 CO Emissions

The control efficiencies for FCC and TCC in petroleum refineries were derived from the actual and uncontrolled emissions reported in Reference 6 or Reference 7 according to Equation 3.25-2.

$$CE = \left[\frac{(UE - AE)}{UE}\right] \qquad \text{(Eq. 3.25-2)}$$

where: CE = control efficiency
UE = uncontrolled emissions
AE = actual (controlled) emissions

3.25.4.2 NO_x Emissions

No control efficiencies were applied to the activity data to estimate the NO_x emissions from the petroleum refinery sources included in this Tier II category.

3.25.4.3 PM-10 and TSP Emissions

The TSP control efficiencies for FCC and TCC in petroleum refineries were derived from the actual and uncontrolled emissions reported in Reference 6 or Reference 7 according to Equation 3.25-2. The PM-10 control efficiencies for these processes for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 11. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

3.25.4.4 VOC Emissions

The control efficiencies for FCC and TCC in petroleum refineries were assumed to be 95 percent of the corresponding CO control efficiencies.

For the years 1970 through 1984, the emission factors for the petroleum refinery process operations of blow down systems, process drains, and vacuum jets were based on the controlled and uncontrolled emission factors. The controlled emission factors were estimated using weighted averages of emission factors for “old” refinery capacity (pre-1970) and “new” refinery capacity where the “old” and “new” capacities for used as weighting factors. A detailed description of the calculation procedure is presented below.

The first step in this procedure was the development of the breakdown of the refineries capacity into "old" and "new". For blow down systems and process drains, the total crude oil capacity of refineries was obtained from Reference 1 for the year under study and for the previous year. The difference between total capacity for the year under study and capacity from the previous year was assumed to be the new capacity for the year under study. If the difference was negative, the new capacity was assumed to be zero.

In order to calculate the old capacity, the NSPS capacity was calculated. This was done by adding the new capacity for the year under study to 1 percent of the total capacity from the previous year. This sum, the NSPS capacity, was subtracted from the total capacity for the year under study, resulting in the old capacity.

The same procedure was used to estimate the old and new capacities for vacuum jets. In place of the total crude oil capacity, the total vacuum distillation capacity obtained from Reference 1 was used.

For each of the three processes, two controlled emission factors were used to calculate a weighted average controlled emission factor. The average 1970 emission factor represented the emission rate of older operations and, therefore, was weighted by the old capacity. The NSPS emission factor, applicable to newer operation, was weighted by the new capacity. The 1970 and NSPS emission factors for each subcategory are presented in Table 3.25-1, along with the corresponding uncontrolled emission factors. The calculation of the weighted average controlled emission factors is summaries in Equation 3.25-3.

$$EF_{Controlled} = \frac{(Capacity_{old} \times EF_{old}) + (Capacity_{new} \times EF_{new})}{(Capacity_{old} + Capacity_{new})} \qquad \text{(Eq. 3.25-3)}$$

where: EF = emission factor

The control efficiency for each process was calculated as the percentage difference between the controlled emission factor calculated according to the methodology above and the uncontrolled emission factors presented in Table 3.25-1. This calculation is summarized in Equation 3.25-4.

$$CE = \frac{(EF_{Uncontrolled} - EF_{Controlled})}{EF_{Uncontrolled}} \qquad \text{(Eq. 3.25-4)}$$

where: CE = control efficiency
EF = emission factor

For the years 1940, 1950, and 1960, the procedure for determining the control efficiencies for blow down systems, process drains, and vacuum jets is currently unavailable.

No control efficiencies were applied to the activity data to estimate VOC emissions from compressors, cooling towers, or miscellaneous processes used in petroleum refinery process operations.

3.25.5 References

1. *Oil and Gas Journal*. Annual Refining Survey, P.O. Box 2601, Clinton, IA. Annual.

2. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC. Annual.
   (a) Table containing information on Petroleum, Coal, and Products

3. *Minerals Industry Surveys*, Sulfur. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Monthly.

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   (a) Volume I, Table 9.1-1

5. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

6. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

7. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

8. *Volatile Organic Compound (VOC) Species Data Manual*. EPA-450/4-80-015. U.S. Environmental Protection Agency, Research Triangle Park, NC. July 1980.

9. *Air Pollution Aspects of Petroleum Refining*. PHS-763. U.S. Public Health Service, Washington, DC.

10. *Control Techniques Guidelines*. EPA-450/2-77-025. U.S. Environmental Protection Agency, Washington, DC. 1977.

11. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

Table 3.25-1. Emission Factors Used in the Calculation of the Control Efficiencies for the Blow Down Systems, Process Drains, and Vacuum Jets Subcategories

Subcategories	Emission Factors ($lb/10^6$ bbl)		
	1970	NSPS	Uncontrolled
Blow down Systems	178.84	5.26	263
Process Drains	205.2	57.0	570
Vacuum Jets	108.75	0.0	145

3.26 PETROLEUM AND RELATED INDUSTRIES - ASPHALT MANUFACTURING: 06-03

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(06) PETROLEUM AND RELATED INDUSTRIES	(03) Asphalt Manufacturing	Batching - dryers and fugitives Roofing - blowing and felt saturation Blowing

3.26.1 Technical Approach

The PM-10, TSP, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated only for particulates and VOC from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators for PM-10 and TSP emissions were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. For VOC emissions, the activity indicator was expressed in millions barrels and the emission factor was expressed in metric pounds/thousand barrels. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies for VOC were used for the years 1940, 1950, 1960, and 1970 through 1984 and for TSP for the years through 1992. For PM-10, these procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.26-1.

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.26-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.26.2 Activity Indicator

The total amount of asphalt and road oil supplied, expressed in barrels, was obtained from Reference 1 and was multiplied by 2.29. This result was used as the PM-10 and TSP activity indicators for the asphalt batching operations of dryers and fugitive processes. The activity indicators for the asphalt roofing operations of blowing and felt saturation were the total domestic consumption of asphalt obtained from Reference 2.

The VOC activity indicator for asphalt blowing was the total crude capacity, expressed in barrels/day obtained from Reference 3. This daily value was multiplied by 365 to convert to an annual figure.

3.26.3 Emission Factor

The PM-10 and TSP emission factors for asphalt batching dryers were the weighted average of the emission factors for rotary dryers, conventional plant (SCC 3-05-002-01), drum dryers, and drum mix plant (SCC 3-05-002-05). The TSP emission factors were obtained from References 4a and 4b and the PM-10 emission factors were obtained from Reference 5. These emission factors were weighted by the number of records in Reference 6 or Reference 7 corresponding to the rotary and drum dryer SCCs.

The PM-10 and TSP emission factors for asphalt batching fugitive processes were obtained from Reference 5 and Reference 8, respectively.

The TSP emission factors for blowing operations for asphalt roofing were obtained from Reference 4c for saturant (SCC 3-05-001-01) and coating (SCC 3-05-001-02). The PM-10 emission factors were obtained from Reference 5. Weighted averages of these two emission factors were calculated by weighting the saturant emission factor by 95 percent and the coating emission factor by 5 percent.

The TSP emission factors for felt saturation operations in asphalt roofing were obtained from Reference 4c for dipping only (SCC 3-05-001-03) and dipping/spraying (SCC 3-05-001-04). The PM-10 emission factors were obtained from Reference 5. Weighted average of these emission factors were calculated by weighting the dipping only emission factors by two-thirds and the dipping/spraying emission factors by one-third.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

The VOC emission factor for asphalt blowing was obtained from Reference 4.

3.26.4 Control Efficiency

The TSP control efficiencies for asphalt batching dryers were the weighted average of the control efficiencies for drum and rotary dryers derived from Reference 6 or Reference 7 using Eqiatopm 3.26-2. These control efficiencies were weighted in the same manner as the drum and rotary dryer emission factors.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \quad \text{(Eq. 3.26-2)}$$

where: CE = control efficiency
UE = uncontrolled emissions
AE = controlled emissions

The 1980 TSP control efficiency for asphalt batching fugitive processes was calculated using data from Reference 3 for the SCCs 3-05-002-03 and 3-05-002-04. For subsequent years, it was assumed that the fugitive control efficiencies changed in proportion to the changes in dryer control efficiencies. No procedure for determining the control efficiencies prior to 1980 is currently available.

The TSP control efficiencies for blowing operations in asphalt roofing were the weighted averages of the control efficiencies for saturant and coating derived from Reference 6 or Reference 7 using the equation given above. These individual control efficiencies were weighted in the same manner as the saturant and coating emission factors.

The TSP control efficiencies for felt saturation operation in asphalt roofing were the weighted averages of the control efficiencies for dipping and dipping/spraying derived from Reference 6 or Reference 7 using the equation given above. These individual control efficiencies were weighted in the same manner as the dipping and dipping/spraying emission factors.

The PM-10 control efficiencies for asphalt batching dryers and for blowing and felt saturation operations for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 9. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency values were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions from asphalt roofing operations or asphalt batching fugitive processes.

No control efficiencies were applied to the activity data to estimate VOC emissions from asphalt blowing.

3.26.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Asphalt Usage United States & Canada*. The Asphalt Institute, College Park, MD. Annual.

3. *Oil and Gas Journal*. Annual Refining Survey, P.O. Box 2601, Clinton, IA. Annual.

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 8.1-1
   b. Volume I, Table 8.1-3
   c. Volume I, Table 8.2-1

5. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

6. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

7. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

8. *Assessment of Fugitive Particulate Emission Factors for Industrial Processes*. EPA-450/3-78-107. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1978.

9. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

3.27 OTHER INDUSTRIAL PROCESSES - AGRICULTURE, FOOD, AND KINDRED PRODUCTS: 07-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(07) OTHER INDUSTRIAL PROCESSES	(01) Agriculture, Food, and Kindred Products	Cotton ginning, cattle feedlots, alfalfa dehydrators, country elevators, terminal elevators, feed mills, grain milling (wheat, corn-dry, corn-wet, rice, soybeans) Bakeries, fermentation, and vegetable oil

3.27.1 Technical Approach

The PM-10, TSP, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated only for particulates and VOC from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, the activity indicators were expressed in thousand short tons and the emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies for VOC were used for the years 1940, 1950, 1960, and 1970 through 1984 and for TSP for the years through 1992. For PM-10, these procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.27-1.

$$PM{-}10\ Emissions_{year} = PM{-}10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.27-1)}$$

This calculation was used in place of estimating the emissions based on activity indicators, emission factors, and control efficiencies.

3.27.2 Activity Indicator

3.27.2.1 PM-10 and TSP Emissions

The activity indicator for cotton ginning was the number of running bales obtained from Reference 1a.

The cattle feedlot activity indicator was based on the number of cattle and calves slaughtered, expressed in thousands, reported in Reference 1b. This value was multiplied by 0.46 to determine the final activity indicator.

The activity indicator for alfalfa dehydrators was total production obtained from Reference 2.

The activity indicators for country elevators and terminal elevators were based on the total production of five major grains. Total production of sorghum was obtained from Reference 3. Total productions of wheat, corn, oats, and barley were each obtained from Reference 1b. Production figures for each grain were converted from bushels to total weight using the conversion factors listed in Table 3.27-1. The production figures for the five grains were summed and multiplied by 0.8. This grain production by weight was the activity indicator for both country elevators and terminal elevators.

The activity indicator for feed mills is the total consumption of wheat, corn, oats, barley, sorghum, and alfalfa meal. When the year under study was a census year, total consumption data (SIC 2048) was obtained from Reference 2. For a noncensus year, grain consumption by feed mills was estimated using the total grain production as determined for the country elevator subcategory. Total production was multiplied by the ratio of total grain production to total grain consumption data (SIC 2048) obtained for the previous census year.

The activity indicator for the wheat milling was the total quantity of grindings of wheat expressed in thousands of bushels reported in Reference 1a. The quantity was converted to weight using the wheat conversion factor presented in Table 3.27-1.

The activity indicator for the dry corn milling was the total production of dry corn. When the year under study was a census year, the total dry corn production was obtained from Reference 2. For noncensus years, the dry corn production was calculated by multiplying the total corn production obtained from Reference 1b for the year under study by the factor 0.021. For the years 1940 through 1973, this multiplicative factor, as well as a procedure for determining the factor, is currently unavailable.

The activity indicator for wet corn milling was determined in the same manner as dry corn milling. The only difference being the use of 0.059 as the multiplicative factor for noncensus years after 1974.

The activity indicator for rice was the total rice production. The production figure was obtained as the total shipments from mills in southern states and California or the total production reported in Reference 1b.

The activity indicator for soybeans was based on the total soybean production as obtained from Reference 3. This value was converted from bushels to weight using the conversion factor for wheat given in Table 3-27-1. It was assumed that 70 percent of the total production was domestic consumption. The final activity indicator for soybeans represented only the domestic consumption.

3.27.2.2 VOC Emissions

The activity indicator for bakeries was the production of wheat flour obtained from Reference 1b. This value, expressed in thousand sacks, was multiplied by 27.21 tons bread baked/10^6 sacks.

The activity indicator for the fermentation processes was based on the stocks of distilled spirits and production of beer reported in Reference 1b. Stocks of distilled spirits were converted to metric pounds by the factor 0.1814 metric lb/gal. Beer production figure was converted to metric pound using the factor 0.06 metric lb/bbl. The activity indicator was the sum of distilled spirits and beer production figures.

The activity indicator for vegetable oil subcategory was the refined oil production for soybean, cotton seed, corn, and coconut obtained from Reference 4.

3.27.3 Emission Factor

3.27.3.1 PM-10 and TSP Emissions

The emission factors for cotton ginning were the sum of the emission factors for the following four processes: unleading fan (3-02-004-01), seed cotton cleaning system (SCC 3-02-004-02), stick/burr machine (SCC 3-02-004-03), and miscellaneous (SCC 3-02-004-04). These emission factors were obtained from Reference 5a for TSP and from Reference 6 from PM-10.

The PM-10 and TSP emission factors for cattle feedlots (SCC 3-02-020-01) were obtained from Reference 6 and Reference 5b, respectively.

The emission factors for alfalfa dehydrator were the sum of the emission factors from three processes: primary cyclone and dryer (SCC 3-02-001-02), meal collector (SCC 3-02-001-03), and pellet cooler (SCC 3-02-001-04). The emission factors for these processes were obtained from Reference 5c for TSP and from Reference 6 for PM-10.

The emission factors for country elevators were the sum of the emission factors from six process listed in Table 3.27-2. The emission factors for terminal elevators were the sum of the emission factors from seven process listed in Table 3.27-3. The PM-10 and TSP emission factors for the elevator processes were obtained from Reference 6 and Reference 5d, respectively.

The emission factors for feed mills were the sum of the emission factors from five process listed in Table 3.27-4. The emission factors for these processes were obtained from Reference 5e for TSP and from Reference 6 for PM-10.

The PM-10 and TSP emission factors for wheat milling were based on the emission factors obtain from Reference 6 and Reference 5e, respectively, for the following three processes: receiving (SCC 3-02-007-31), precleaning/handling (SCC 3-02-007-32), and millhouse (3-02-007-34). It was assumed that a

99 percent control applied to the millhouse emission factor. The resulting controlled emission factors for the millhouse process were added to the other emission factors to obtain the final PM-10 and TSP emission factors.

The PM-10 and TSP emission factors for dry corn were the sum of the emission factors obtain from Reference 6 and Reference 5e, respectively, for the following four processes: receiving (SCC 3-02-007-41), drying (SCC 3-02-007-42), precleaning/handling (SCC 3-02-007-43), and cleaning (3-02-007-44). The emission factors for wet corn were the sum of the emission factors for the following three processes: receiving (SCC 3-02-007-51), handling (SCC 3-02-007-52), and cleaning (3-02-007-53). The PM-10 emission factors were obtained from Reference 6; the TSP emission factors were obtained from Reference 5e .

The PM-10 and TSP emission factors for rice were the sum of the emission factors obtain from Reference 6 and Reference 5e, respectively, for the following processes: receiving (SCC 3-02-007-71) and precleaning/handling (SCC 3-02-007-72).

The emission factors for soybeans were the sum of the emission factors from 10 processes listed in Table 3.27-5. The emission factors for these processes were obtained from Reference 5e for TSP and from Reference 6 for PM-10.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.27.3.2 VOC Emissions

The emission factor for bakeries was weighted average of the emission factors for sponge dough (SCC 3-02-032-01) and straight dough (SCC 3-02-032-02). These emission factors were obtained from Reference 5f. The weighting factor for sponge dough was 0.915 and for straight dough was 0.085.

The emission factor for fermentation processes was based on the assumption of complete evaporation of all volatile compounds (i.e. the emission factor was 2000 lb/ton).

The emission factor for vegetable oil was based on the 1979 emission estimates obtained from the EPA's Emission Standards and Engineering Division. The total emissions were divided by the 1977 production rate to obtain the emission factor for vegetable oil. The source of the 1977 production rate is currently unavailable.

3.27.4 Control Efficiency

3.27.4.1 PM-10 and TSP Emissions

The TSP control efficiencies for all agricultural industrial processes, excluding country and terminal elevators, were derived from Reference 7 or Reference 8 using Equation 3.27-2.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \qquad \text{(Eq. 3.27-2)}$$

where: CE = control efficiency
UE = uncontrolled emissions
AE = actual (controlled) emissions after

The TSP control efficiencies for country and terminal elevators were the weighted average of the control efficiencies for the SCCs given in Table 3.27-2 and Table 3.27-3, respectively. These individual control efficiencies were derived from Reference 7 or Reference 8 using Equation 3.27-2. The final country and terminal elevator control efficiencies were calculated using weighting factors obtained in Reference 5d.

The PM-10 control efficiencies for all agricultural industry emission sources for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 9. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

3.27.4.2 VOC Emissions

No control efficiencies were applied to the activity data to estimate VOC emissions from bakeries, fermentation processes, and vegetable oil production.

3.27.5 References

1. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.
   (a) Table containing information on "textile products."
   (b) Table containing information on "food and kindred products."

2. *Census of Manufactures*. Bureau of the Census, U.S. Department of Commerce, Washington, DC. Available every 5 years.

3. *Crop Production*. GPO 20-B-S/N001/028/80029/1. Crop Reporting Board Economic Statistics & Cooperative Service, U.S. Department of Agriculture, Washington, DC. Monthly.

4. *Current Industrial Reports*, Fats and Oil. Bureau of the Census, U.S. Department of Commerce, Washington, DC. Annual.

5. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 6.3-1
   b. Volume I, Table 6.15-1
   c. Volume I, Table 6.1-1

d. Volume I, Table 6.4-5 (column 3)
e. Volume I, Table 6.4-6
f. Volume I, Section 6.13

6. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

7. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

8. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

9. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

Table 3.27-1. Conversion of Grain Volume (in bushels) to Weight (in pounds)

Grain	lb/bu
Wheat	60
Corn	56
Oats	32
Barley	48
Sorghum	56

Table 3.27-2. PM-10 and TSP Emission Factor SCCs for Country Elevators

SCC	Description
3-02-006-03	Cleaning
3-02-006-04	Drying
3-02-006-05	Unloading (receiving)
3-02-006-06	Loading (shipping)
3-02-006-09	Removal from bins
3-02-006-10	Headhouse (legs)

Table 3.27-3. PM-10 and TSP Emission Factor SCCs for Terminal Elevators

SCC	Description
3-02-005-03	Cleaning
3-02-005-04	Drying
3-02-005-05	Unloading (receiving)
3-02-005-06	Loading (shipping)
3-02-005-09	Tripper (gallery belt)
3-02-005-10	Removal from bins
3-02-005-11	Headhouse (legs)

Table 3.27-4. PM-10 and TSP Emission Factor SCCs for Feed Mills

SCC	Description
3-02-008-02	Receiving
3-02-008-03	Shipping
3-02-008-04	Handling
3-02-008-05	Grinding
3-02-008-06	Pellet Coolers

Table 3.27-5. PM-10 and TSP Emission Factor SCCs for Soybean Milling

SCC	Description
3-02-007-81	Receiving
3-02-007-82	Handling
3-02-007-84	Drying
3-02-007-85	Cracking/Dehulling
3-02-007-86	Hull Grinding
3-02-007-87	Bean Conditioning
3-02-007-88	Flaking
3-02-007-89	Meal Dryer
3-02-007-90	Meal Cooler
3-02-007-91	Bulk Loading

3.28 OTHER INDUSTRIAL PROCESSES - WOOD, PULP AND PAPER, AND PUBLISHING PRODUCTS: 07-03

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(07) OTHER INDUSTRIAL PROCESSES	(03) Wood, Pulp and Paper, and Publishing Products	Pulp and Paper - kraft and sulfite Semi-Chemical Wood Pulp Production Plywood Lumber

3.28.1 Technical Approach

The CO, NO_x, PM-10, TSP, and SO_2 emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.28-1.

$$PM{-}10\ \ Emissions_{year} = PM{-}10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.28-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.28.2 Activity Indicator

For CO and NO_x emissions, the activity indicator for kraft pulp and paper was the production value reported for sulfate obtained from Reference 1. For SO_2 emissions, the activity indicator for kraft pulp production and sulfite was the combined production of sulfate and sulfite at kraft mills and sulfite mills obtained from Reference 1.

The PM-10 and TSP activity indicators for the two pulp and paper production processes were obtained from Reference 1. The activity indicator for kraft pulp was the production value reported for sulfate and the indicator for sulfite was the production value reported for sulfite.

The PM-10 and TSP activity indicators for the two semi-chemical processes were based on the total semi-chemical wood pulp production obtained from Reference 2. It was assumed that indicator for recovery furnaces was one-third of the total production while the indicator for fluid bed reactors was 15 percent of the total production.

The PM-10 and TSP activity indicator for plywood was the softwood plywood production obtained from Reference 3a. When this reference was not available, the total plywood production was estimated using the total plywood production from Reference 4 for the census year preceding the year under study. The combined total production values of plywood from southern pine and douglas fir were obtained from Reference 2 for the census year and the year under study. Total plywood production was projected to the year under study using Equation 3.28-2.

$$P_{plywood,i} = P_{plywood,j} \times \left[\frac{P_{(pine + fir),i}}{P_{(pine + fir),j}} \right] \qquad \text{(Eq. 3.28-2)}$$

where: i = year under study
j = census year
P = production

The PM-10 and TSP activity indicator for lumber was total lumber production obtained from Reference 5 or Reference 2.

3.28.3 Emission Factor

The CO emission factor for kraft pulp and paper processes was the sum of the emission factors for recovery furnaces (SCC 3-07-001-04) and lime kilns (SCC 3-07-001-06) obtained from Reference 6a.

The NO_x emission factor for kraft pulp processes was calculated by dividing the actual emissions by the operating rate. These values were obtained from Reference 7.

The PM-10 and TSP emission factors for the kraft process in pulp and paper production were the sum of the emissions factors for the following three processes: recovery furnaces/direct contact evaporators (SCC 3-07-001-04), smelt tanks (SCC 3-07-001-05), and lime kilns (SCC 3-07-001-06). These PM-10 and TSP emission factors were obtained from Reference 8 and Reference 9a.

The TSP emission factor for the sulfite process in pulp and paper production was obtained from Reference 10. The PM-10 emission factor was obtained from Table 3.1-3 in this report.

The TSP emission factors for the two semi-chemical processes of recovery furnaces and fluid red reactors were obtained from Reference 11. The PM-10 emission factor was obtained from Reference 8 or Table 3.1-3 of this report.

The TSP emission factor for plywood was obtained from Reference 10. The PM-10 emission factor was obtained from Table 3.1-3 of this report.

The TSP emission factor for lumber was calculated by dividing the actual emissions reported in Reference 7 by the 1977 lumber production reported in Reference 2. The PM-10 emission factor was obtained from Reference 8 or Table 3.1-3 of this report.

The SO_2 emission factor for kraft pulp production and sulfite was the weighted sum of the emission factors for kraft pulp production and for sulfite mills. The emission factor for kraft pulp production was obtained from Reference 9a. The sulfite mills emission factor was calculated from the controlled and uncontrolled sulfite mills emission factors of 20 lb/ton and 52 lb/ton, respectively. These emission factors were obtained from Reference 10. Assuming the particulate control efficiency was 0.90 for sulfite mills, the controlled emission factor was multiplied by 0.9 and the uncontrolled emission factor by 0.1. The resulting products were summed. Weighting factors for summing the emission factors for kraft pulp production and sulfite mills were the relative production levels obtained from Reference 1.

3.28.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate CO, NO_x, or SO_2 emissions from the pulp and paper sources included in this Tier II category.

The TSP control efficiencies for the pulp and paper, plywood, and lumber production processes were derived from Reference 12 or Reference 13 using Equation 3.28-3. The TSP control efficiencies for the semi-chemical processes were assumed to be equal to the control efficiencies for the kraft process in pulp and paper production.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \qquad \text{(Eq. 3.28-3)}$$

where: CE = control efficiency
UE = uncontrolled emissions
AE = actual (controlled) emissions after

The PM-10 control efficiencies for kraft processes in pulp and paper production and fluid red reactors in semi-chemical production for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 14. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

No control efficiencies were applied to the activity data to estimate PM-10 emissions from sulfite processes in pulp and paper production and recovery furnaces in semi-chemical production. For plywood and lumber production, no control efficiencies were applied in the estimation of PM-10 and TSP emissions.

3.28.5 References

1. *Current Industrial Reports*, Pulp, Paper and Board. Bureau of the Census, U.S. Department of Commerce, Washington, DC. Annual.

2. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC. Annual.

3. *Current Industrial Reports*, Softwood Plywood
   (a) Table: Production, Quantity and Value of Shipments of Softwood Plywood

4. *Census of Manufactures*. U.S. Department of Commerce, Bureau of the Census, Washington, DC. (available every 5years)

5. *Current Industrial Report*s, Lumber Production and Mill Stocks. Bureau of the Census, U.S. Department of Commerce, Washington, DC. Annual.

6. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Volume I, Table 10.1.2-1

7. *Computer Retrieval, NE257 report, by Source Classification Code (SCC) from the National Emission Data System (NEDS)*. Unpublished computer report. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. February 9, 1980.

8. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

9. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 10.1-1

10. *Compilation of Air Pollutant Emission Factors, Third Edition, and Supplements 1-14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.

11. *Particulate Pollution System Study*. U.S. Environmental Protection Agency. Prepared by Midwest Research Institute, Kansas City, MO. 1970.

12. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

13. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

14. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

3.29 OTHER INDUSTRIAL PROCESSES - RUBBER AND MISCELLANEOUS PLASTIC PRODUCTS: 07-04

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(07) OTHER INDUSTRIAL PROCESSES	(04) Rubber and Miscellaneous Plastic Products	Tires

3.29.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source category listed above. Emissions were estimated only for VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in thousand short tons and the emission factor was expressed in metric pounds/short ton.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.29.2 Activity Indicator

The activity indicator for tires was the production of pneumatic casing obtained from Reference 1a.

3.29.3 Emission Factor

The VOC emission factor for tires was the sum of the emission factors for the processes listed in Table 3.29-1 and were extracted from Reference 2. These emission factors were expressed as lbs/1,000 tires. The summed emission factor was converted to lbs/ton, assuming that 1,000 tires weigh one ton.

3.29.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from tire production.

3.29.5 References

1. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.
   (a) Table containing information on "rubber and rubber products."

2. *Control Techniques Guidelines*. EPA-450/2-77-025. U.S. Environmental Protection Agency, Washington, DC. 1977.

Table 3.29-1. VOC Emissions Factor SCCs for Tire Production

SCC	Description
3-08-001-01	Undertread & Sidewall Cementing
3-08-001-02	Bead Dipping
3-08-001-03	Bead Swabbing
3-08-001-04	Tire Building
3-08-001-05	Tread End Cementing
3-08-001-06	Green Tire Spraying
3-08-001-07	Tire Curing

3.30 OTHER INDUSTRIAL PROCESSES - MINERAL PRODUCTS: 07-05

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(07) OTHER INDUSTRIAL PROCESSES	(05) Mineral Products	Mineral Products (cement, bricks, clay, concrete, glass, gypsum, and lime) Mining Operations (coal, sand and gravel, stone and rock, phosphate rock, clay, and potash) Chemical Industry (fertilizers - rock pulverization) Asphalt Roofing

3.30.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.30-1.

$$PM{-}10\ Emissions_{year} = PM{-}10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.30-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.30.2 Activity Indicator

3.30.2.1 CO Emissions

The activity indicator for asphalt roofing was the total domestic consumption obtained from Reference 1.

The activity indicators for kiln and fugitive processes in lime production were the lime production obtained from Reference 2.

3.30.2.2 NO_x Emissions

The activity indicator for cement manufacturing was the total quantity of cement production as obtained from Reference 3.

The activity indicator for glass manufacturing was based on the sum of total production of flat glass obtained from Reference 4 and the net packed weight of glass containers obtained from Reference 5. The resulting value was multiplied by 1.10 to account for miscellaneous glass products.

The activity indicator for lime kiln and fugitive processes was the lime production obtained from Reference 2.

3.30.2.3 PM-10 and TSP Emissions

3.30.2.3.1 Mineral Products Industry —
The activity indicators for the three cement manufacturing processes were the total quantity of cement production as obtained from Reference 3.

The total brick production, expressed in millions of bricks, was obtained from Reference 6. The quantity was multiplied by 6.5 lb/brick. To this value was added the sum of the sewer pipes and fittings production value and the structural facing tile production value as reported in Reference 6a. The final result was the activity indicator for bricks.

The activity indicator for clay sintering was the quantity of common clay and shale used in lightweight aggregate production as reported Reference 7.

The activity indicator for concrete batching was based on the sum of the total shipments of portland cement to concrete product manufacturers and to ready-mix plants as reported in Reference 3a. The resulting sum was multiplied by 7.5.

The activity indicators for the furnace, forming, and curing processes of fiber glass production were the production of textile type and wool type glass fiber obtained from Reference 8.

The activity indicator for glass was based on the sum of the flat glass production value obtained from Reference 4 and the net packed weight of glass containers obtained from Reference 5. The resulting value was multiplied by 1.10 to account for miscellaneous glass products.

The activity indicator for calciners used in gypsum manufacturing was the quantity of calcined gypsum produced as reported in Reference 9. For dryers used in gypsum manufacturing , the activity indicator was one-half of the total quantity produced.

The activity indicators for kilns and fugitive processes used in lime manufacturing were the lime production figure obtained from Reference 2.

3.30.2.3.2 Mining Operations —

The activity indicator for surface coal mining was the total coal production by surface mining methods obtained from Reference 10 or from Reference 11.

For coal handling, the activity indicator was the sum of the quantity of coal cleaned and crushed and screened as reported in Reference 10. For years when these data were not reported, the value was extrapolated from latest available data based on the total coal production.

The activity indicator for coal mining thermal dryers was the quantity of coal thermally dried obtained from Reference 10. For years when these data were not available, the value was extrapolated from previous year's data, based on the change in the total coal production from Reference 10.

For coal mining, pneumatic dryers, the activity indicator was the quantity of coal processed obtained from Reference 10. For years when these data were not available, the value was extrapolated from the previous year's data based on the change in the total coal production from Reference 10.

The activity indicator for sand and gravel was the sum of the total production of sand and gravel for construction and for industrial purposes obtained from Reference 12. The total production of stone and rock crushing was obtained from Reference 13. The activity indicators for the three phosphate rock processing operations were the marketable production of phosphate rock obtained from Reference 14.

The activity indicator for clays was the total domestic clay sold or used by producers as reported in Reference 7.

The activity indicator for potash was the total potash production, expressed in potassium oxide (K_2O) equivalent, and was obtained from Reference 2.

3.30.2.3.3 Chemical Industry —

The activity indicator for rock pulverization for fertilizers was the sum of the phosphate rock sales of single superphosphate and triple superphosphate obtained from Reference 14.

3.30.2.4 SO_2 Emissions

The activity indicators for the three cement manufacturing processes were the total quantity of cement production as obtained from Reference 3.

The activity indicator for glass manufacturing was based on the sum of the flat glass production value obtained from Reference 4, and the net packed weight of glass containers obtained from Reference 5. The resulting value was multiplied by 1.10 to account for miscellaneous glass products.

The activity indicators for the lime kiln and fugitive processes were the lime production figure obtained from Reference 2.

3.30.2.5 VOC Emissions

The activity indicator for glass manufacturing was based on the sum of the flat glass production value obtained from Reference 4, and the net packed weight of glass containers obtained from Reference 5. The resulting value was multiplied by 1.10 to account for miscellaneous glass products.

3.30.3 Emission Factor

3.30.3.1 CO Emissions

The emission factor for asphalt roofing was the weighted average of the emission factors for controlled plants (2.85 lb/ton) and uncontrolled plants (0.22 lb/ton). The weighting factors were the fraction of plants with controls and the faction of plants without controls. The fraction of plants with controls was calculated by dividing the TSP control efficiency for the category asphalt roofing - blowing by 0.956. All other plants were assumed to operate without controls. The overall emission factor calculation is summarized in Equation 3.30-2.

$$EF = \left[2.85 \times \left(\frac{CE_{TSP}}{0.956}\right)\right] + \left[0.22 \times \left(1 - \frac{CE_{TSP}}{0.956}\right)\right] \qquad \text{(Eq. 3.30-2)}$$

where: CE_{TSP} = TSP control efficiency for the category asphalt roofing - blowing

The emission factor for lime manufacturing (SCC 3-05-016-04) was obtained from Reference 15a.

3.30.3.2 NO_x Emissions

The emission factor for cement manufacturing (SCC 3-05-006-06) was obtained from Reference 15b.

The emission factor for glass manufacturing was the weighted average of the emission factors for three glass types as reported in Reference 15c. A list of the glass types, SCCs and weighting factors are presented in Table 3.30-1.

The emission factor for lime was the weighted average of the emission factors for the SCCs 3-05-016-xx. These emission factors and the corresponding weighting factors were obtained from Reference 16.

3.30.3.3 PM-10 and TSP Emissions

3.30.3.3.1 Mineral Products Industry —

The PM-10 and TSP emission factors for kilns used in cement manufacturing were the weighted average of the emission factors for the dry process kilns (SCC 3-05-006-06) and the wet process kilns

(SCC 3-05-007-06). These emission factors were obtained from Reference 15b for TSP and Reference 17 for PM-10. The weighting factors were the relative capacity of the wet process and of the dry process as reported in Reference 3.

The emission factors for grinders used in cement manufacturing were the weighted average of the emission factors for the dry process clinker grinder (SCC 3-05-006-17) and the wet process clinker grinder (SCC 3-05-007-17). The PM-10 and TSP emission factors were obtained from Reference 17 and Reference 15b, respectively, and were weighted by the relative capacity of the wet process and of the dry process as reported in Reference 3.

The TSP emission factors for cement manufacturing fugitive processes were obtained from Reference 18. The PM-10 emission factor was obtained from Reference 17 or Table 3.1-3 of this report.

The PM-10 and TSP emission factors for bricks was the sum of the emission factors for materials handling and for kilns. The emission factors for material handling were obtained from Reference 18 for TSP and from Reference 17 or Table 3.1-3 of this report for PM-10. The PM-10 and TSP emission factors for kilns were the weighted average of the SCCs listed in Table 3.30-2 and were obtained from Reference 17 and Reference 15d, respectively. The weighting factors were based on References 19 or 20.

The emission factors for clay sintering were the sum of the emission factors for the five processes listed in Table 3.30-3. These represent the processing of raw clay and shale combined. The raw clay sintering and finished product processing and screening emission factors for TSP were obtained from Reference 15e. The emission factors for crushing and screening and transfer and conveying were obtained from Reference 17. The storage emission factor was assumed to be 0.3 lb/ton for TSP and zero for PM-10.

The PM-10 and TSP emission factors for concrete batching (SCC 3-05-011-01) were obtained from Reference 17 and Reference 15f, respectively. The values were converted from lb/yd^3 to lbs/ton using the factor 0.5.

The emission factors for furnaces used in fiber glass manufacturing were the weighted average of the emission factors for the furnace types listed in Table 3.30-4. The emission factors for these furnace types were obtained from Reference 15g for TSP and from Reference 17 for PM-10. The weighting factors were based on the operating rates obtained from Reference 19 or 20 for these types of furnaces.

The emission factors for fiber glass forming and curing processes were the weighted average of the emission factors for three processes. The TSP emission factor for the rotary spun wool type (SCC 3-05-012-04) was obtained from Reference 21a. The TSP emission factors for the flame attenuation wool type (SCC 3-05-012-08) and the textile type (SCC 3-05-012-014) were obtained from Reference 15g. The PM-10 emission factors for the three processes were obtained from Reference 17. The weighting factors were based on the operating rates obtained from Reference 19 or 20 for these three processes.

The emission factors for glass were based on the emission factors for three types of glass: container glass, melting furnace (SCC 3-05-014-02), flat glass, melting furnace (SCC 3-05-014-03), and pressed and blown glass, melting furnace (SCC 3-05-014-04). These emission factors were obtained from

Reference 15c for TSP and From Reference 17 for PM-10. The weighted averages of these emission factors were calculated using the following weighting factors: 0.75 for container glass, 0.15 for flat glass, and 0.1 for blown and pressed glass.

The PM-10 and TSP emission factors for gypsum manufacturing dryers (SCC 3-05-015-01) and calciners (SCC 3-05-015-11) were obtained from Reference 17 and Reference 21b, respectively. For calciners, it was assumed that all calciners were continuous kettle calciners.

The emission factors for lime manufacturing kilns were the weighted average of the emission factors for two types of kilns: vertical kilns (SCC 3-05-016-03) and rotary kilns (SCC 3-05-016-04). These PM-10 and TSP emission factors were obtained from Reference 17 and Reference 15h, respectively, and were weighted using the data from Reference 22. The PM-10 and TSP emission factors for the fugitive processes were obtained from Reference 18 or Table 3.1-3 of this report.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.30.3.3.2 Mining Operations —

The PM-10 and TSP emission factors for surface mining and coal handling were obtained from Reference 18. The emission factors for thermal dryers (SCC 3-05-010-01) were obtained from Reference 15i for TSP and from Reference 17 for PM-10. The pneumatic dryers emission factors were based on engineering judgement and are presented in Table 3.1-3 of this report.

The TSP emission factor for sand and gravel was obtained from Reference 21c. The PM-10 emission factor was obtained from Reference 17 or Table 3.1-3 of this report.

The emission factors for stone and rock crushing were the weighted averages of the emission factors for the processes listed in Table 3.30-5. The PM-10 and TSP emission factors for these processes were obtained from Reference 17 and Reference 21d, respectively, and were weighted by the number of records in Reference 19 or Reference 20, except for miscellaneous operations process (SCC 3-05-020-06). Emission factors for this process were added to the weighted average of the emission factors of the other four processes.

The emission factors for phosphate rock drying or calcining processes were the weighted average of the emission factors for drying (SCC 3-05-019-01) and calcining (SCC 3-05-019-05) processes. The PM-10 and TSP emission factors were obtained from Reference 17 and Reference 15j, respectively, and were weighted by the 1974 production of phosphate rock reported in Reference 14a. It was assumed that phosphate rock production from Florida represented the drying processes and production from the western States represented the calcining process.

The emission factors for phosphate rock grinding (SCC 3-05-019-02) and material handling (SCC 3-05-019-03) were obtained from Reference 15j for TSP and from Reference 17 for PM-10.

The emission factors for clays were the weighted averages of the emission factors for three processes: drying (SCC 3-05-008-01), grinding (SCC 3-05-008-02), and storage (SCC 3-05-008-03). The PM-10 and TSP emission factors were obtained from Reference 17 and Reference 15k, respectively.

Weighting factors were 0.7 for the drying process, 1 for the grinding process and 0.5 for the storage process.

The TSP emission factor for potash was calculated by dividing actual emissions reported in Reference 16 by total production of potash, expressed in potassium oxide (K_2O) equivalent weights, obtained from Reference 7. The PM-10 emission factor was obtained from Reference 17.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.30.3.3.3 Chemical Industry —

The PM-10 and TSP emission factors for rock pulverization (SCC 3-05-019-02) were obtained from Reference 17 and Reference 22, respectively. For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.30.3.4 SO_2 Emissions

The emission factor for cement manufacturing was based on the uncontrolled SO_2 emissions, the total cement production, and the SO_2 control efficiency for cement kilns. The uncontrolled emissions were produced by mineral sources and by the combustion of fuels used to fire the kilns. The uncontrolled emission factors for the mineral sources and the combustion of coal, residual oil, and distillate oil are presented in Table 3.30-6. The uncontrolled emissions from mineral sources were calculated using the emission factor and the total cement production obtained from Reference 3.

The uncontrolled emissions from coal combustion were calculated using the emission factor, the coal consumed by cement plants obtained from Reference 3, and the sulfur content of the coal. The sulfur content was the average sulfur content for all coal shipped to industrial plants. The average sulfur content of coal was determined from the sulfur content by coal producing districts obtained for the category “Other industrial uses and retail dealers” in Reference 10a. This reference provided the sulfur content values reported in 1977 and it was assumed that these values remained constant during the years 1940 through 1984. In order to obtain the average sulfur content for a specific year, the sulfur content by district was weighted by the distribution of coal by district or origin for the category “Other Industrial” obtained from Reference 23 or 24.

The uncontrolled emissions from residual oil were calculated using the emission factor, the residual oil consumed by cement plants, and the sulfur content of the oil. The quantity of residual oil consumed by cement plants was assumed to be two-thirds of the total oil consumed by cement plants as reported in Reference 3. The sulfur content for residual oil was for No. 6 fuel oil obtained from Reference 25.

The uncontrolled emissions from distillate oil were calculated using the emission factor, the residual oil consumed by cement plants, and the sulfur content of the oil. The quantity of distillate oil consumed by cement plants was assumed to be one-third of the total oil consumed by cement plants as reported in Reference 3. The sulfur content for distillate oil was assumed to be 0.3 percent.

The uncontrolled emission factor for cement manufacturing was determined by dividing the total uncontrolled emissions from mineral sources and fuel combustion by the total cement production obtained from Reference 3. These calculations are summarized in Equation 3.30-3:

$$EF_{SO_2,\ controlled} = \frac{E_{SO_2,\ uncontrolled}}{P_{cement}} \times (1 - CE_{SO_2,\ klins}) \qquad \text{(Eq. 3.30-3)}$$

where:
EF = emission factor
E = emissions
P = production
CE = control efficiency

The SO_2 control efficiency for kilns was interpolated from the TSP control efficiency for cement kilns. The TSP control efficiency is described in section 3.30.4.2. The interpolation of the SO_2 control efficiency from the TSP control efficiency was made using the following two reference points: TSP control efficiency of 0.99 corresponded to a SO_2 control efficiency of 0.1375 and TSP control efficiency of 0.95 corresponded to a SO_2 control efficiency of 0.12.

The SO_2 emission factor for glass manufacturing was the weighted average of the emission factor for the three types of glass: container glass, furnace (SCC 3-05-014-02), flat glass, furnace (SCCS-05-014-03), and blown glass, furnace (SCC 3-05-014-04). These emission factors were obtained from Reference 15c. The weighting factors were 0.75 for container glass, 0.15 for flat glass, and 0.1 for blown glass.

The SO_2 emission factor for lime processing was calculated by dividing the total actual SO_2 emissions by the lime production rate. These values were obtained from Reference 16.

3.30.3.5 VOC Emissions

The VOC emission factor for glass manufacturing was the weighted average of the emission factor for the three types of glass: container glass, furnace (SCC 3-05-014-02), flat glass, furnace (SCCS-05-014-03), and blown glass, furnace (SCC 3-05-014-04). These emission factors were obtained from Reference 15c. The weighting factors were 0.75 for container glass, 0.15 for flat glass, and 0.1 for blown glass.

3.30.4 Control Efficiency

3.30.4.1 CO, NO_x, SO_2, and VOC Emissions

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, or VOC emissions from the sources included in this Tier II category.

3.30.4.2 PM-10 and TSP Emissions

3.30.4.2.1 Mineral Products Industry —

The TSP control efficiencies for all Mineral Products Industry production processes, except the fugitive processes, were derived from Reference 19 or Reference 20 using Equation 3.30-4. For any process where the emission factor was the weighted average of more specific emission factors, the control efficiency was calculated in the same manner. The more specific control efficiencies were derived using Equation 3.30-4.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \quad \text{(Eq. 3.30-4)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

The TSP control efficiencies for the fugitive processes in cement manufacturing and lime manufacturing were based on engineering judgment.

The PM-10 control efficiencies for all mineral products industry production processes, except the fugitive processes, for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 26. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate the PM-10 emissions.

No control efficiencies were applied to the activity data to estimate PM-10 emissions from the fugitive processes in cement and lime manufacturing.

3.30.4.2.2 Mining Operations —

The TSP control efficiencies for all mining operations processes, except those described below, were derived from Reference 19 or Reference 20 using the equation given for the Mineral Products Industry processes. For any process where the emission factor was the weighted average of more specific emission factors, the control efficiency was calculated in the same manner. The more specific control efficiencies were derived using Equation 3.30-4.

For coal mining, pneumatic dryers, the TSP control efficiencies for the years 1980 through 1984 were obtained from Reference 22. No procedure for determining the control efficiencies for the years prior to 1980 is currently available.

The TSP control efficiency for clay production was the weighted average of the control efficiencies for the drying, grinding, and storage processes obtained from Reference 19 or Reference 20. The weighted average of these individual process control efficiencies was calculated in the same manner described for the clay emission factor. No procedure for determining the yearly variation in the control efficiencies is currently available.

The TSP control efficiency for potash production for the years 1981 through 1984 was assumed to be a constant value of 0.80. This value was based on engineering judgment. For the years prior to 1981, no control efficiency was applied to the activity data to estimate TSP emissions from potash production.

The PM-10 control efficiencies for coal mining thermal dryers, stone and rock crushing, phosphate rock production processes, clay production, and potash production for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 26. During these years, any changes in the corresponding TSP control efficiencies from the 1985 TSP control efficiency value were reflected in the PM-10 control efficiencies. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

3.30.4.2.3 Chemical Industry —

For rock pulverization, the TSP control efficiencies for the years 1974 through 1984 were obtained from Reference 22. For the years prior to 1974, no procedure to determined the TSP control efficiencies is currently available.

The PM-10 control efficiencies for rock pulverization for the years 1975 through 1984 were equal to the 1988 PM-10 control efficiency obtained from Reference 26. For the years 1940 through 1974, no control efficiencies were use to estimate PM-10 emissions.

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2. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

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Table 3.30-1. NO_x Emission Factor SCCs and Weighting Factors for Glass Manufacturing

SCC	Description	Weighting Factor
3-05-014-02	Container Glass: Melting Furnace	0.75
3-05-014-03	Flat Glass: Melting Furnace	0.15
3-05-014-04	Blown Glass: Melting Furnace	0.10

Table 3.30-2. PM-10 and TSP Emission Factor SCCs for Kilns Used in Brick Manufacturing

SCC	Description
3-05-003-11	Curing and firing - gas fired tunnel kiln
3-05-003-12	Curing and firing - oil fired tunnel kiln
3-05-003-13	Curing and firing - coal fired tunnel kiln
3-05-003-14	Gas fired periodic kiln
3-05-003-15	Oil fired periodic kiln
3-05-003-16	Coal fired periodic kiln

Table 3.30-3. PM-10 and TSP Emission Factor SCCs for Clay Sintering

SCC	Description
3-05-009-03	Raw clay sintering
3-05-009-04	Crushing and screening
3-05-009-05	Transfer and conveying
	Storage
3-05-009-08	Finished product processing & screening

Table 3.30-4. PM-10 and TSP Emission Factor SCCs for Fiber Glass Furnaces

SCC	Description
3-05-012-01	Glass Furnace Wool - Regenerative
3-05-012-02	Glass Furnace Wool - Recuperative
3-05-012-03	Glass Furnace Wool - Electric
3-05-012-07	Glass Furnace Wool - Unit Melter
3-01-012-11	Glass Furnace Textile - Regenerative
3-05-012-12	Glass Furnace Textile - Recuperative
3-05-012-13	Glass Furnace Textile - Unit Melter

Table 3.30-5. PM-10 and TSP Emission Factor SCCs for Stone and Rock Crushing

SCC	Description
3-05-020-01	Primary Crushing
3-05-020-02	Secondary Crushing
3-05-020-03	Tertiary Crushing
3-05-020-04	Recrushing/Screening
3-01-020-06	Miscellaneous Operations

Table 3.30-6. Uncontrolled SO_2 Emissions Factors for Cement Manufacturing

Fuel	Emission Factor	
Mineral Source	10.2	lb/ton cement produced
Coal	30.45	lb/ton coal consumed
Residual Oil	124.5	lb/1,000 gal residual oil consumed
Distillate Oil	112.35	lb/1,000 gal distillate oil consumed

3.31 SOLVENT UTILIZATION - DEGREASING: 08-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category
(08) SOLVENT UTILIZATION	(01) Degreasing

3.31.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source category listed above. Emissions were estimated only for VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in thousand short tons and the emission factor was expressed in metric pounds/short ton.

The procedures for determining the activity indicator and emission factor were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.31.2 Activity Indicator

The activity indicator for degreasing was the weighted sum of the total consumption of six solvents as reported in References 1, 2, and 3. These solvents are listed in Table 3.31-1, along with the corresponding weighting factors, expressed as percentages, and references for consumption information.

$$Activity = \sum_{i=1}^{n} (S_i \times U_i) \qquad \text{(Eq. 3.31-1)}$$

where: S_i = total production/sales of solvent
U_i = fraction of S_i for end use as degreasing solvent (the "weighting factor" of Table 3.31-1)

3.31.3 Emission Factor

For this category, it was assumed that all of the solvents evaporated. Therefore, the VOC emission factor for degreasing was 2,000 lb/ton.

3.31.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from degreasing.

3.31.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

3. *Synthetic Organic Chemicals, United States Production and Sales*. USITC Publication 1745. U.S. International Trade Commission, Washington, DC. Annual.

Table 3.31-1. Solvents and Weighting Factors for Degreasing

Solvent	Weighting Factor (%)	Consumption References
Special Naphtha	6.7	1
Perchloroethylene	16.3	2
Trichloroethylene	98	3
Monochlorobenzene	20	3
Cyclohexanone	1	3
Ethylene Butyl (EB) Glycol Ether	9	3

3.32 SOLVENT UTILIZATION - GRAPHIC ARTS: 08-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category
(08) SOLVENT UTILIZATION	(02) Graphic Arts

3.32.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source category listed above. Emissions were estimated only for VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in thousand short tons and the emission factor was expressed in metric pounds/short ton.

The procedures for determining the activity indicator and emission factor were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.32.2 Activity Indicator

The activity indicator for graphics arts was the weighted sum of the total consumption of four solvents, as reported in References 1, 2, and 3. These solvents are listed in Table 3.32-1, along with the corresponding weighting factors, expressed as percentages, and references for consumption information. To account for miscellaneous solvent usage, 1.8 percent of the weighted sum was added to obtain the final activity.

$$Activity = \sum_{i=1}^{n} (S_i \times U_i) \qquad \text{(Eq. 3.32-1)}$$

where: S_i = total production/sales of solvent
U_i = fraction of S_i for end use as degreasing solvent (the "weighting factor" of Table 3.32-1)

3.32.3 Emission Factor

For this category, it was assumed that all of the solvents evaporated. Therefore, the VOC emission factor for graphic arts was 2,000 lb/ton.

3.32.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from graphic arts.

3.32.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Synthetic Organic Chemicals, United States Production and Sales*. USITC Publication 1745. U.S. International Trade Commission, Washington, DC. Annual.

3. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

Table 3.32-1. Solvents and Weighting Factors for Graphic Arts

Solvent	Weighting Factor (%)	Consumption References
Special Naphtha	6.4	1
Ethyl Acetate	20.0	2
Ethyl Benzene	0.025	3
Ethylene Ethyl (EE) Glycol Ether	5.0	2

3.33 SOLVENT UTILIZATION - DRY CLEANING: 08-03

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category
(08) SOLVENT UTILIZATION	(03) Dry Cleaning

3.33.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source category listed above. Emissions were estimated only for VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in thousand short tons and the emission factor was expressed in metric pounds/short ton.

The procedures for determining the activity indicator and emission factor were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.33.2 Activity Indicator

The activity indicator for dry cleaning was the weighted sum of the total consumption of two solvents, as reported in References 1 and 2. These solvents are listed in Table 3.33-1, along with the corresponding weighting factors, expressed as percentages, and references for consumption information.

3.33.3 Emission Factor

For this category, it was assumed that all of the solvents evaporated. Therefore, the VOC emission factor for dry cleaning was 2,000 lb/ton.

3.33.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from dry cleaning.

3.33.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

Table 3.33-1. Solvents and Weighting Factors for Dry Cleaning

Solvent	Weighting Factor (%)	Consumption References
Special Naphtha	2.0	1
Perchloroethylene (93.4%)	58.9	2

3.34 SOLVENT UTILIZATION - SURFACE COATINGS: 08-04

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(08) SOLVENT UTILIZATION	(04) Surface Coatings	Architectural Coating
		Auto Refinishing
		Adhesives
		Other Solvent Use

3.34.1 Technical Approach

The VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above, except for the other solvent use subcategory. One-half of the VOC emissions for this subcategory are included in this Tier II category. Emissions were estimated only for VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.34.2 Activity Indicator

The activity indicator for adhesives was the weighted sum of the total consumption of the three following solvents: special naphtha, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK). The consumption data for special naphtha was obtained from Reference 1, MEK was obtained from Reference 2, and MIBK was obtained from Reference 3. The weighting factors for the three solvents were 1, 2.1, and 0.7, respectively. The activity indicator for this source category was the sum of the weighted consumption values.

The activity indicator for architectural coating processes was based on the quantity of paint shipped obtained from Reference 4 for the paint types listed in Table 3.34-1. The quantity of paint shipped was multiplied by the corresponding solvent content given in Table 3.34-1 for each paint type. The solvent content for the architectural coatings n. s. k. type was the weighted average of the solvent content values for the other architectural coating paint types subcategories. The weighting factors were the ratio of the quantity of paint shipped for the specific paint type divided by the total quantity of paint shipped for all of the architectural coating paint types. The activity indicator for this source category was the total amount of solvent contained in the total quantity of paint shipped for all paint types.

The activity indicator for auto refinishing was the quantity of paint shipped multiplied by a solvent content value of 11.95 lb/gal. The quantity of paint shipped was obtained from Reference 4 under the category "Automotive, other transportation and machinery refinish paints, and enamels, including primers."

The activity indicator for other solvent uses was based on the production of the solvents listed in Table 3.34-2, along with the references for these data values. The production values were converted to gallons and then to pounds using the conversion factors 43 gallons/barrel and 6.5 pounds/gallon, respectively. Each solvent production value was multiplied by the corresponding percentage consumption presented in Table 3.34-2 to obtain the solvent consumption. The values presented in Table 3.34-2 under "Solvent Consumption" were used when the referenced data was unavailable. The amount of each solvent included in this source category was the product of the solvent consumption and the corresponding percent miscellaneous solvent presented in Table 3.34-2. These products were summed and an additional 1.8 percent was added to account for miscellaneous solvents. This final result was the activity indicator for the other solvent use subcategory.

The activity indicators for the fourteen surface coating operations listed in Table 3.34-3 were based on the quantity of paint shipped obtained from Reference 4. For aircraft, railroads, and other metal products, the quantity of paint shipped was multiplied by 72.7, 27.3, and 6.5, respectively, to determine the quantity of paint included in those subcategories. The quantity of paint shipped was multiplied by the corresponding solvent content given in Table 3.34-3 for operation. The activity indicator for maintenance coatings subcategory was the sum of the activity for the interior and exterior paints as listed in Table 3.34-3.

The activity indicator for fabric coating operations was based on the textile production index obtained from Reference 1 or Reference 2. The index for 1983 and 1984 was multiplied by an adjustment factor of 3.96.

The activity indicator for plastics parts surface coating operations was based on the rubber and plastic production index obtained from Reference 1 or Reference 2. The index for 1983 and 1984 was multiplied by an adjustment factor of 0.59. For the years 1970 through 1982, the annual indicies were multiplied by an adjustment factor of 0.254. Prior to 1970, the activity was assumed to be zero for plastics parts coating surface.

The activity indicator for paper coating operations was the quantity of solvents used in the production of paper and in the production of pressure tape and labels. The amount of solvents used in the production of paper was based on the quantity of paper produced as reported in Reference 4 under the classification "paper, paperboard, film and foil finishes". This production value was multiplied by the solvent content value of 38.8 lb/gal to obtain the quantity of solvent used in the production of paper.

The quantity of solvents used in the production of pressure tape and labels was based on the consumption of the four solvents listed in Table 3.34-4. The quantity of each solvent produced was obtained from the references provided in Table 3.34-4. Each production value was multiplied by the percent consumption to determine the quantity of solvent consumed and the percent of solvent use to determine the amount of each solvent used in the production of pressure tape and labels. These values are presented in Table 3.34-4. The total quantity of solvents used was the sum of the quantities of the individual solvents.

The final activity indicator for paper coating operations was the sum of the quantity of solvent used in the production of paper and in the production of pressure tape and labels.

The activity indicator for miscellaneous surface coating processes was sum of the quantities of solvents used for the three processes listed in Table 3.34-5 and the quantity of solvent "slop". The quantities of solvents used for the three processes listed in Table 3.34-5 were calculated from the quantity of paint shipped for each process obtained from Reference 4. Each of these production values were multiplied by the corresponding percentage of solvent consumed and solvent content. The resulting solvent quantities were summed over the three processes.

To this total was added solvent "slop". This quantity was based on the difference between the following two values: (1) total quantity of specific solvents consumed by surface coating operations and (2) quantity of solvents consumed by all within the surface coating operations. The first value was based on the production level of each solvent listed in Table 3.34-6 as reported in the references indicated. Production values were converted to gallons and then to pounds using the conversion factors 43 gallons/barrel and 6.5 pounds/gallon, respectively. Each solvent production value was multiplied by the corresponding percentage consumption presented in Table 3.34-6 to obtain the solvent consumption. The values presented in Table 3.34-6 under "Solvent Consumption" were used when the referenced data was unavailable. The amount of each solvent included was the product of the solvent consumption and the corresponding percent surface coating use presented in Table 3.34-6. These products were summed and an additional 1.8 percent was added to account for miscellaneous solvents. This final result was the total quantity of solvents consumed by surface coating operations.

The second value was the sum of the quantity of solvents consumed for operations listed in Table 3.34-7. In some cases, the solvents consumed by specific processes are excluded. The solvent "slop" value was calculated by subtracting this second value from the first value, as described above.

The final activity indicator for the miscellaneous surface coating processes was the sum of the quantity of solvents consumed by the three specific processes and from solvent "slop."

3.34.3 Emission Factor

For all source categories included in this Tier II category, it was assumed that all of the solvents evaporated completely. Therefore, the VOC emission factors for all operations were 2,000 lb/ton.

Beginning in 1970, the emission factors for the following operations were scaled by annual average control efficiencies: large appliances, magnet wire, automobiles, cans, metal coils, paper, fabric, metal furniture, wood furniture, plastic parts, aircraft, machinery, other metal products, and miscellaneous processes. An adequate procedure for determining the individual control efficiencies applied to the emission factors for each opeation is currently unavailable.

3.34.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from surface coating operations included in this Tier II category.

3.34.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

3. *Synthetic Organic Chemicals, United States Production and Sales*. USITC Publication 1745. U.S. International Trade Commission, Washington, DC. Annual.

4. *Current Industrial Reports*, Paint and Allied Products. Bureau of the Census, U.S. Department of Commerce, Washington, DC. Annual.

Table 3.34-1. Determination of Activity Indicator for Architectural Coating Processes: Paint Types

Paint Type Category	Paint Type Subcategory	Solvent Content (lb/gal)
Architectural Coatings	Exterior Solvent Type	36
	Exterior Water Type	.54
	Interior Solvent Type	3.3
	Interior Water Type	.56
	Architectural lacquers	5
	Architectural coatings n.s.k.	a
Traffic marking paints		3.89
Special purpose coatings n.s.k.		5
Aerosols		5

Table 3.34-2. Determination of Activity Indicator for Miscellaneous Organic Solvent Extraction (other solvent use): Included Solvents

Compound	Solvent Production Reference	% Solvent Consumption	Solvent Consumption*	% Other Solvent Use
Special Naphthas	1	100	5461.6	5.2
n-Butanol	2	100	1269.0	0.4
Isobutanol	3	100	181.207	3.1
Butyl Acetates	3	84.2	212.4	40
Perchloroethylene	2	93.4	358.7	1
p-dichlorobenzene	3	100	90.3	90
Ethanol	2	100	549.0	35.6
Ethylene Butyl (EB) Glycol Ether	3	100	413.0	7
Diethylene Methyl (DM) Glycol Ether	3	100	46.9	30
Isopropanol	2	42	579.6	21.4
Methanol	2	95.3	7610.7	2.8
Miscellaneous**			565.9	

* Use default values used in the event that more appropriate numbers are not available.

** Compute Miscellaneous solvents consumption as 1.8 percent of the total consumption of all other solvents

Table 3.34-3. Determination of Activity Indicators for 14 Surface Coating Operations: Solvent Contents and Reference 4 Categories

Surface Coating Operation	Reference 4 Category	Solvent Content (lb/gal)
Large Appliances	Appliance, heating equipment, & air conditioner finishes	7.35
Magnet Wire	Electrical insulating coatings	8.48
Automobiles	Automobile finishes	6.95
Cans	Container and closure finishes	4.93
Metal Coils	Sheet, strip, and coil coatings, including siding	3.15
Metal Furniture	Nonwood furniture and fixture finishes, including business equipment finishes	8.61
Wood Furniture	Wood furniture, cabinet, and fixture finishes	20.78
Flat Wood Products	Wood and composition board flat stock finishes	4.50
Large ships	Marine Paints	5.65
Machinery	Machinery and equipment finishes, including road building equipment and farm	6.63
Maintenance Coatings	Industrial new construction & maintenance paints: Interior Industrial new construction & maintenance paints: Exterior	5.66 6.30
Aircraft	Other Transportation Equipment	0.5
Railroads	Other Transportation Equipment	3.83
Other Metal Products	Other Industrial Product Finishes	19.98

Table 3.34-4. Determination of Activity Indicator for Production of Pressure Tape and Labels: Solvents Used

Solvent Category	Reference	% Solvent Consumption	% Solvent Use
Special Naphthas	2	100	10.3
Butyl Acetate	4	84.2	42.3
Methyl ethyl ketone (MEK)	3	100	15.8
Methyl isobutyl ketone (MIBK)	4	100	4.2

Table 3.34-5. Determination of the Activity Indicator for Miscellaneous Surface Coating Operations: Solvent Use in Three Processes

Process by Reference 4 category	% Solvent Consumed	Solvent Content (lb/gal)
Other Industrial Product Finishes	93.5	19.98
Product Finishes for OEM (n.s.k.)	100.0	19.98
Truck, bus, and RV	100.0	6.95

Table 3.34-6. Determination of Activity Indicator for Miscellaneous Surface Coatings Operations: Solvent Consumptions for Determination of Solvent "Slop"

Compound	Solvent Production Reference	% Solvent Consumption	Solvent Consumption*	% Surface Coating Use
Special Naphthas	2	100	5461.6	48.7
Acetone	3	89	1976.7	15.4
n-Butanol	3	100	1269.0	15.3
Isobutanol	4	100	181.207	16.7
Butyl Acetates	4	84.2	212.4	60
Cyclohexanone	4	100	1043.64	3.5
Ethyl Acetate	4	70	190.5	65
Ethanol	3	100	549.0	17.1
Ethylbenzene	3	100	8987.0	0.4
Propylene Glycol	3	100	800.0	5.7
Ethylene Methyl Glycol Ether	4	100	83.493	47
Ethylene Ethyl Glycol Ether	4	100	117.8	40
Ethylene Butyl Glycol Ether	4	100	413.0	52
Diethylene Methyl Glycol Ether	4	100	46.9	70
Diethylene Ethyl Glycol Ether	4	100	38.1	50
Diethylene Butyl Glycol Ether	4	100	9037	30
Isopropanol	3	42	579.6	21.2
Methyl Ethyl Ketone (MEK)	3	100	473.0	85.4
Methyl Isobutyl Ketone (MIBK)	4	100	426.9	71.9
Miscellaneous**			565.9	

* Use default values in the event that more appropriate numbers are not available.
** Compute Miscellaneous solvents consumption as 1.8 percent of the total consumption of all other solvents.

Table 3.34-7. Determination of Activity Indicator for Miscellaneous Surface Coatings Operations: Solvent Consumptions for All Surface Coating Operations for the Determination of Solvent "Slop"

Category	Subcategory	Excluded Sources
Surface Coating Operations	Large Appliances	
	Automobiles	
	Cans	
	Metal Coils	
	Paper	Pressure Tapes & Labels
	Metal Furniture	
	Wood Furniture	
	Flat Wood Products	
	Large Ships	
	Aircraft	
	Railroads	
	Machinery	
	Other Metal Products	
	Miscellaneous Processes	Solvent "slop"
	Maintenance Coatings	
Miscellaneous Organic Solvent Extraction	Architectural Coatings	
	Auto Refinishing	

3.35 SOLVENT UTILIZATION - OTHER INDUSTRIAL: 08-05

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(08) SOLVENT UTILIZATION	(05) Other Industrial	Waste Solvent Recovery Miscellaneous Organic Solvent Use Solvent Extraction Plastics Manufacturing - fabrication

3.35.1 Technical Approach

The VOC emissions included in this Tier category were the sum of the emissions from the waste solvent recovery source category multiplied by 0.78 and the emissions from the other source categories listed above. Emissions were estimated only for VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.35.2 Activity Indicator

The activity indicator for waste solvent recovery processes was assumed to be zero.

The activity indicator for miscellaneous organic solvent uses was the weighted sum of the total consumption of eight solvents, as reported in References 1, 2, and 3. These solvents are listed in Table 3.35-1, along with the corresponding weighting factors, expressed as percentages, and references for consumption information. To account for miscellaneous solvent usage, 7.1 percent of the weighted sum was added to obtain the final activity.

The activity indicator for solvent extraction processes was the weighted sum of the total consumption of two solvents, as reported in References 1, 2, and 3. These solvents are listed in Table 3.35-2, along with the corresponding weighting factors, expressed as percentages, and references for consumption information.

The activity indicator for plastics fabrication processes was the weighted sum of the total consumption of three solvents, as reported in References 1, 2, and 3. These solvents are listed in Table 3.35-3 along with the corresponding weighting factors, expressed as percentages, and references for consumption information.

3.35.3 Emission Factor

The VOC emission factor for waste solvent recovery processes was the sum of the emission factors for the five sources presented in Table 3.35-4. These emission factors were obtained from Reference 4a.

For miscellaneous organic solvent uses, solvent extraction processes, and plastics fabrication processes it was assumed that all of the solvents evaporated completely. Therefore, the VOC emission factors for these categories were 2,000 lb/ton.

3.35.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from the source included in this Tier II category.

3.35.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

3. *Synthetic Organic Chemicals, United States Production and Sales*. USITC Publication 1745. U.S. International Trade Commission, Washington, DC. Annual.

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 4.7-1

Table 3.35-1. Determination of Activity Indicator for Miscellaneous Organic Solvent Uses: Solvents, Weighting Factors, and References

Solvent	Weighting Factor (%)	Consumption References
Special Naphtha	1	1
Acetone (89.0%)	0.5	2 or 3
O-Dichloro-benzene	25	2 or 3
Ethanol	5.8	2
Ethylbenzene	0.075	2
Ethylene Ethyl (EE) Glycol Ether	12	3
Ethylene Butyl (EB) Glycol Ether	12	3
Methanol (95.3%)	4.7	2

Table 3.35-2. Determination of Activity Indicator for Solvent Extraction Processes: Solvents, Weighting Factors, and References

Solvent	Weighting Factor (%)	Consumption References
Methyl Ethyl Ketone (MEK)	12.5	2
Methyl Isobutyl Ketone (MIBK)	8.9	3

Table 3.35-3. Determination of Activity Indicator for Plastics Fabrication Processes: Solvents, Weighting Factors, and References

Solvent	Weighting Factor (%)	Consumption References
Special Naphtha	6.5	1
Ethyl Acetate	12	3
Ethylbenzene	0.25	2

Table 3.35-4. VOC Emission Factor SCCs for Waste Solvent Recovery Processes

SCC	Description
4-90-002-01	Storage Tank Vent
4-90-002-02	Condenser Vent
4-90-002-03	Incinerator Stack
4-90-002-04	Solvent Spillage
4-90-002-05	Solvent Loading

3.36 SOLVENT UTILIZATION - NONINDUSTRIAL: 08-06

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(08) SOLVENT UTILIZATION	(06) Nonindustrial	Fabric Scouring Cutback Asphalt Paving Pesticides Other Solvent Use

3.36.1 Technical Approach

The VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above, except for the other solvent use category. One-half of the VOC emissions for this source category are included in this Tier II category. Emissions were estimated only for VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.36.2 Activity Indicator

The activity indicator for fabric scouring was the consumption of perchloroethylene, obtained from Reference 1, multiplied by 0.062.

The activity indicator for cutback asphalt paving were based on the total quantity of cutback asphalt obtained from Reference 2. For years since 1980, production figures for cutback paving asphalts reported in Reference 3 were used to update the 1980 emissions. It was assumed that the 1980 emissions were proportional to changes in cutback paving asphalt production.

The activity indicator for pesticides was the weighted sum of the total consumption of six solvents, as reported in References 4 and 5. These solvents are listed in Table 3.36-1, along with the corresponding weighting factors, expressed as percentages, and references for consumption information.

The activity indicator for other solvent uses was based on the consumption of eleven solvents, as reported in References 4 and 5. These solvents are listed in Table 3.36-2, along with the corresponding references for the consumption information. Consumption value for each solvent was converted to million pounds by using the following conversion factors: 42 gallons/barrel and 6.5 pounds/gallon. The consumption data for each solvent was multiplied by the general consumption weighting factor and by the miscellaneous solvent use weighting factor in order to obtain the consumption of each solvent included within this category. Weighted solvent consumptions were summed and an additional 1.8 percent was added to account for miscellaneous solvent use.

3.36.3 Emission Factor

For all sources included in this Tier II category, it was assumed that solvents evaporated completely. Therefore, the VOC emission factors for fabric scouring, cutback asphalt paving, pesticides, and other solvent uses.

3.36.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from the source included in this Tier II category.

3.36.5 References

1. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

2. *Energy Data Reports, Sales of Asphalt in 1980*. U.S. Department of Energy, Washington, DC. June 1981.

3. *Asphalt Usage United States & Canada*. The Asphalt Institute, College Park, MD. Annual.

4. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

5. *Synthetic Organic Chemicals, United States Production and Sales*. USITC Publication 1745. U.S. International Trade Commission, Washington, DC. Annual.

Table 3.36-1. Determination of Activity Indicator for Pesticides: Solvents, Weighting Factors, and References

Solvent	Weighting Factor (%)	Consumption References
Special Naphthas	3.3	4
Isobutanol	3.2	5
m-chlorobenzene	30.0	5
Ethyl Benzene	0.19	1
Ethylene Butyl (EB) Glycol	13.0	5
Ether	2.3	5
Methyl Isobutyl Ketone (MIBK)		

Table 3.36-2. Determination of Activity Indicator for Other Solvent Uses of Miscellaneous Organic Solvents: Solvents, Weighting Factors, and References

Solvent	General Consumption Weighting Factor (%)	Miscellaneous Consumption Weighting Factor (%)	Consumption References
Special Naphthas	100	5.2	4
n-Butanol	100	0.4	1
Isobutanol	100	3.1	5
Butyl Acetates	84.2	40.0	5
Perchloroethylene	93.4	1.0	1
p-dichlorobenzene	100	90.0	5
Ethanol	100	35.6	1
Ethylene Butyl (EB) Glycol Ether	100	7.0	5
Diethylene Methyl (DM) Glyco Ether	100	30.0	5
Isopropanol	42	21.4	1
Methanol	95.3	2.8	1

3.37 STORAGE AND TRANSPORT - BULK TERMINALS AND PLANTS: 09-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category
(09) STORAGE AND TRANSPORT	(01) Bulk Terminals and Plants

3.37.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source categories listed above. Emissions were estimated only for VOC from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million barrels and emission factors were expressed in metric pounds/thousand barrels. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.37.2 Activity Indicator

The activity indicators for bulk gasoline terminal transfer and storage were the production of finished motor gasoline obtained from Reference 1a. This quantity was reported under the heading "Disposition: Products Supplied."

The activity indicators for bulk gasoline plant transfer and storage were 30 percent of the production of finished motor gasoline obtained from Reference 1a. This quantity was reported under the heading "Disposition: Products Supplied."

3.37.3 Emission Factor

For the years 1970 through 1984, the emission factors for all source categories included in this Tier II category were based on 1980 emissions data obtained from Reference 2 and 1979 production data from Reference 1. A more detailed procedure is currently unavailable.

For the years 1960, 1950, and 1940, the emission factors for all source categories, except for transport at bulk gasoline terminals, steadily increased from the 1970 value. No procedure for determining these emission factors is currently available.

3.37.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from transfer and storage at gasoline bulk plants. For the years 1974 through 1984, control efficiencies were applied to the activity data to estimate emissions from transfer and storage at gasoline bulk terminals. No procedure for determining these control efficiencies is currently available.

3.37.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Supply and Disposition of Crude Oil and Petroleum Products."

2. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. June 12, 1980.

3.38 STORAGE AND TRANSPORT - PETROLEUM AND PETROLEUM PRODUCT STORAGE: 09-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(09) STORAGE AND TRANSPORT	(02) Petroleum and Petroleum Product Storage	Gasoline Storage at Refineries Crude Oil Storage - oil field storage and refinery storage Other Products - jet naphtha storage, jet naphtha transfer, kerosene storage, and distillate oil storage

3.38.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source categories listed above. Emissions were estimated only for VOC from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million barrels and emission factors were expressed in metric pounds/thousand barrels. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.38.2 Activity Indicator

The activity indicator for gasoline storage at refineries was the production of finished gasoline obtained from Reference 1a.

The activity indicators for crude oil field storage was the total U.S. field production including lease condensate obtained from Reference 1b.

The activity indicators for crude refinery storage was the crude oil input to refineries obtained from Reference 1c.

The activity indicators for both jet naphtha transfer and jet naphtha storage were the production of naphtha-type jet fuel obtained from Reference 1c. The activity indicators for kerosene storage was the sum of kerosene-type jet fuel and kerosene obtained from Reference 1c. The activity indicator for distillate oil storage was the quantity of distillate fuel oil obtained from Reference 1c. These quantities were reported under the heading “Disposition: Products Supplied.”

3.38.3 Emission Factor

For the years 1970 through 1984, the emission factors for crude oil storage at refineries, gasoline storage at refineries, jet naphtha storage, jet naphtha transfer, kerosene storage, and distillate oil storage were based on 1980 emissions data from Reference 2 and 1979 petroleum production data from Reference 1. A more detailed procedure is currently unavailable.

For the years 1960, 1950, and 1940, emission factors for crude oil storage at refineries and gasoline storage at refineries steadily increased from the 1970 value. The emission factors of the other sources listed above remained constant at the 1970 value. No procedure for determining these changing emission factors is currently available.

For the years 1970 through 1984, the emission factor for crude oil storage at oil fields was based on the typical losses from storage tank types. The losses were calculated using equations and typical values from Reference 3. The losses from the different tank types were weighted based on data from Reference 2. A more detailed procedure is currently unavailable. The emissions factors for the years 1960, 1950, and 1940 increased steadily over the 1970 value. No procedure for determining these emission factors is currently available.

3.38.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from the source included in this Tier II category, except for gasoline storage at refineries. For the years 1974 through 1984, control efficiencies were applied to the activity data to estimate emissions from gasoline storage at refineries. No procedure is currently available to determine these control efficiencies.

3.38.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, “Refinery Production of Petroleum Products by PAD District.”
   b. Table 1
   c. Table entitled, “Supply and Disposition of Crude Oil and Petroleum Products.”

2. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. June 12, 1980.

3. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.

3.39 STORAGE AND TRANSPORT - PETROLEUM AND PETROLEUM PRODUCT TRANSPORT: 09-03

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(09) STORAGE AND TRANSPORT	(03) Petroleum and Petroleum Product Transport	Refinery Product Loading - gasoline tank car and tanker and barge Crude Oil Loading - tank car/ truck, ship and barge, and tanker ballasting

3.39.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source categories listed above. Emissions were estimated only for VOC from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million barrels and emission factors were expressed in metric pounds/thousand barrels. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.39.2 Activity Indicator

The activity indicator for refinery product loading of tankers and barges was the total movement of finished motor gasoline between the following PAD districts: from PAD III to PAD I, from PAD II to PAD II, from PAD III to PAD V, and from PAD V to PAD III. This information was obtained from Reference 1a.

The activity indicator for refinery product loading of gasoline tank cars was assumed to be 3.35 percent of the total U.S. production of finished gasoline obtained from Reference 1b.

The activity indicator for crude oil loading of tank cars/trucks was the total receipts of domestic tank cars and domestic trucks. The activity indicator for ship and barge loading was the total receipts of domestic crude oil on tankers and barges. The activity indicator for the tanker ballasting was one-half of the total receipts of domestic crude oil on tankers and barges added to the total receipts of foreign crude oil on tankers and barges. Information required for these activity indicators was obtained from Reference 1c.

3.39.3 Emission Factor

The emission factors for all sources included in this Tier II category were based on 1980 emissions data from Reference 2 and 1979 petroleum production data from Reference 1. The emission factors were constant for all years. More detailed procedures are currently unavailable.

3.39.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from the source included in this Tier II category, except for gasoline transfer at refineries. For the years 1974 through 1984, control efficiencies were applied to activity to estimate emissions from gasoline transfer at refineries. No procedure for determining these control efficiencies is currently available.

3.39.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Movements of Crude Oil and Petroleum by Tanker and Barge Between PAD District."
   b. Table entitled, "Refinery Production of Petroleum Products by PAD District."
   c. Table entitled, "Refinery Receipts of Crude Oil by Method of Transportation."

2. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. June 12, 1980.

3.40 STORAGE AND TRANSPORT - SERVICE STATIONS: STAGE I: 09-04

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(09) STORAGE AND TRANSPORT	(04) Service Stations: Stage I	Gasoline Service Stations - loading or stage I

3.40.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source categories listed above. Emissions were estimated only for VOC from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in million barrels and the emission factor was expressed in metric pounds/thousand barrels. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.40.2 Activity Indicator

The activity indicator for gasoline service station loading or stage I was the production of finished motor gasoline obtained from Reference 1a. This quantity was reported under the heading "Disposition: Products Supplied."

3.40.3 Emission Factor

The emission factor for gasoline service station loading for the years 1970 through 1984 was based on the 1980 emission data from Reference 2 and 1979 petroleum production data from Reference 1. A more detailed procedure is currently unavailable.

For the years 1960, 1950, and 1940, the emission factors steadily increased from the 1970 value. No procedure for determining these emission factors is currently available.

3.40.4 Control Efficiency

For the years 1978 through 1984, control efficiencies were applied to the activity to estimate VOC emissions from gasoline station loading. No procedure for determining these control efficiencies is currently available.

3.40.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
    a. Table entitled, "Supply and Disposition of Crude Oil and Petroleum Products."

2. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. June 12, 1980.

3.41 STORAGE AND TRANSPORT - SERVICE STATIONS: STAGE II: 09-05

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(09) STORAGE AND TRANSPORT	(05) Service Stations: Stage II	Gasoline Service Stations - loading or stage II

3.41.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source categories listed above. Emissions were estimated only for VOC from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million barrels and emission factors were expressed in metric pounds/thousand barrels. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.41.2 Activity Indicator

The activity indicator for gasoline service station unloading or stage II was the production of finished motor gasoline obtained from Reference 1a. This quantity was reported under the heading "Disposition: Products Supplied."

3.41.3 Emission Factor

The emission factor for gasoline service station unloading was based on 1980 emissions data from Reference 2 and 1979 petroleum production data from Reference 1. This value was used for all years. More detailed procedure is currently unavailable.

3.41.4 Control Efficiency

For the years 1979 through 1984, control efficiencies were applied to the activity data to estimate VOC emissions from gasoline service station unloading. No procedure for determining these control efficiencies is currently available.

3.41.5 References

1. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
    a. Table entitled, "Supply and Disposition of Crude Oil and Petroleum Products."

2. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. June 12, 1980.

3.42 STORAGE AND TRANSPORT - ORGANIC CHEMICAL STORAGE: 09-07

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(09) STORAGE AND TRANSPORT	(07) Organic Chemical Storage	Waste Solvent Recovery Waste Disposal

3.42.1 Technical Approach

The VOC emissions included in this Tier category were the sum of the emissions from the waste solvent recovery source category multiplied by 0.22 and the emissions from the other source categories listed above. Emissions were estimated only for VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicators were expressed in thousand short tons and the emission factors were expressed in metric pounds/short tons.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.42.2 Activity Indicator

The activity indicator for waste solvent recovery was assumed to be zero.

The activity indicator for waste disposal in petrochemical manufacturing was based on the industrial organic chemical production index obtained from Reference 1.

3.42.3 Emission Factor

The VOC emission factor for waste solvent recovery was the sum of the emission factors for the five source listed in Table 3.42-1. Emission factors for these sources were obtained from Reference 2a.

The emission factor for waste disposal in petrochemical manufacturing was obtained from Reference 3.

3.42.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from the source included in this Tier II category.

3.42.5 References

1. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

2. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 4.7-1

3. *Organic Chemical Manufacturing, Volume 1: Program Report*. EPA-450/3-80-023. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1980.

Table 3.42-1. VOC Emission Factor SCCs for Waste Solvent Recovery

SCC	Description
4-90-002-01	Storage Tank Vent
4-90-002-02	Condenser Vent
4-90-002-03	Incinerator Stack
4-90-002-04	Solvent Spillage
4-90-002-04	Solvent Loading

3.43 WASTE DISPOSAL AND RECYCLING - INCINERATION: 10-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(10) WASTE DISPOSAL AND RECYCLING	(01) Incineration	Municipal Residential Commercial/Institutional Conical Woodwaste

3.43.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emission factor, and control efficiency, where applicable. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million short tons and emission factors were expressed in metric pounds/short ton. All control efficiencies were expressed as dimensionless fractions.

The procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.43-1.

$$PM{-}10\ Emissions_{year} = PM{-}10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.43-1)}$$

This calculation was used in place of estimating emissions based on activity indicators, emission factors, and control efficiencies.

3.43.2 Activity Indicator

The activity indicator for municipal incineration was the sum of the operating rates for the SCCs 5-01-001-01 and 5-01-001-02 obtained from Reference 1 or 2.

The activity indicator for residential incineration was the operating rate for residential on-site incineration obtained from Reference 3.

The activity indicator for commercial/industrial incineration was based on the sum of the operating rates provided in Reference 1 or 2 for the following SCCs: 5-02-001-01, 5-02-001-02, 5-03-001-01, and 5-03-001-02. The total operating rates for these SCCs were calculated for the year under study and for the previous year. The activity indicator for the year under study was determined by scaling the activity indicator for the previous year with the rate of the total operating rates for the year under study and the previous year. Equation 3.43-2 summarizes this calculation.

$$AI_i = AI_{i-1} \times \left(\frac{OR_i}{OR_{i-1}} \right) \qquad \text{(Eq. 3.43-2)}$$

where: i = year
AI = activity indicator
OR = total operating rates

The activity indicator for conical woodwaste incineration was the sum of the operating rates for the SCCs 5-02-001-05 and 5-03-001-05 obtained from Reference 1 or 2.

3.43.3 Emission Factor

The emission factors for all pollutants except PM-10 and VOC for municipal incineration were obtained from Reference 4a for the starved air category. The TSP emission factor represented controlled emissions and, therefore, a separate TSP control efficiency was not used for this category. The PM-10 emission factor was obtained from Reference 5. The source of the VOC emission factor for this source is currently unavailable.

The emission factors for the residential category were the weighted average of the emission factors for the two types of domestic single chamber incinerators. These emission factors were obtained from Reference 4b for all pollutants except PM-10. The PM-10 emission factors for these incinerators were obtained from Reference 5 or Table 3.1-3 of this report. The weighting factor for the incinerator without a primary burner was 0.9 and with a primary burner was 0.1.

The emission factor for the commercial/institutional category were the weighted average of the emission factors for the two combustor types: multiple chamber (SCC 5-02-001-01) and single chamber (SCC 5-02-001-02). These emission factors for all pollutants except PM-10 were obtained from Reference 4c. The PM-10 emission factors were obtained from Reference 5. The weighting factor for the multiple chamber combustor was 0.85 and for the single chamber burner was 0.15.

The emission factors for all pollutants except PM-10 for the conical woodwaste category (SCC 5-02-001-05) were obtained from Reference 4d. The PM-10 emission factor was obtained from Reference 5.

3.43.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate CO, NO_x, SO_2, TSP, or VOC emissions from solid waste disposal processes.

The PM-10 control efficiencies for incineration of municipal and commercial and industrial waste for the years 1975 through 1984 were based on the 1988 PM-10 control efficiencies obtained from Reference 6. For the years 1940 through 1974, no control efficiencies were used to estimate PM-10 emissions.

3.43.5 References

1. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

2. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

3. *Standard Computer Retrievals, NE260 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 2.1-1
   b. Volume I, Table 2.1-4
   c. Volume I, Table 2.1-3
   d. Volume I, Table 2.3-1

5. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listings for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

6. Barnard, William R. and Patricia M. Carlson. "PM-10 Emission Control Efficiency Calculations for Emissions Trends." Prepared for Arch A. MacQueen, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1990.

3.44 WASTE DISPOSAL AND RECYCLING - OPEN BURNING: 10-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(10) WASTE DISPOSAL AND RECYCLING	(02) Open Burning	Dumps On-site

3.44.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million short tons and emission factors were expressed in metric pounds/short ton.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to the following equation:

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.44-1)}$$

This calculation was used in place of estimating emissions based on activity indicators and emission factors.

3.44.2 Activity Indicator

The activity indicator for open burning dumps was the sum of the operating rates for open burning dumps (SCCs 5-01-002-01 and 5-01-002-02) obtained from Reference 1 or 2.

The activity indicator for on-site open burning was the sum of the operating rate for open burning (SCCs 5-02-002-01, 5-02-002-02, 5-03-002-01, 5-03-002-02, 5-03-002-03, and 5-03-002-04) obtained from Reference 3.

3.44.3 Emission Factor

The emission factors for all pollutants except PM-10 for both open burning sources were obtained from Reference 4a. The PM-10 emission factors were obtained from Reference 5.

3.44.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate emissions from solid waste disposal processes.

3.44.5 References

1. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

2. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

3. *Standard Computer Retrievals, NE260 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Table 2.4-1

5. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

3.45 WASTE DISPOSAL AND RECYCLING - OTHER: 10-07

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(10) WASTE DISPOSAL AND RECYCLING	(07) Other	Waste Disposal of Petrochemicals

3.45.1 Technical Approach

The VOC emissions included in this Tier category were the emissions from the source category listed above. Emissions were estimated only for VOC from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicator was expressed in thousand short tons and the emission factor was expressed in metric pounds/short tons.

The procedures for determining activity indicator and emission factor were used for the years 1940, 1950, 1960, and 1970 through 1984.

3.45.2 Activity Indicator

The activity indicators for the disposal of waste from the manufactur of petrochemicals was based on the industrial organic chemical production index obtained from Reference 1.

3.45.3 Emission Factor

The VOC emission factor for this source category was obtained from Reference 2.

3.45.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate VOC emissions from solid waste disposal processes.

3.45.5 References

1. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

2. *Organic Chemical Manufacturing, Volume 1: Program Report*. EPA-450/3-80-023. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1980.

3.46 ON-ROAD VEHICLES: 11

The emissions for all Tier II categories under this Tier I category were determined by the 1940-1984 Methodology for the following source category:

Tier I Category	Tier II Category
(11) ON-ROAD VEHICLES	(01) Light-duty Gasoline Vehicles (LDGV) and Motorcycles (MC)
	(02) Light-duty Gasoline Trucks (LDGT)
	(03) Heavy-duty Gasoline Vehicles (HDGV)
	(04) Diesels

3.46.1 Technical Approach

On-road vehicle emissions for the years 1940, 1950, and 1960 were estimated at the national level for CO, NO_x, and VOC (modeled as nonmethane organic gases (NMOG)). The emissions were based on vehicles miles traveled (VMT) and mobile emission factors. The emissions were calculated for eight vehicle types [LDGV, MC, LDGT-1, LDGT-2, HDGV, heavy-duty diesel vehicles (HDDV), light-duty diesel trucks (LDDT), and light-duty diesel vehicles (LDDV)] and three road types (limited access roads, urban roads, and rural roads). The national annual SO_2, TSP, and PM-10 emissions were calculated using total VMT and emission factors.

3.46.2 Activity Indicator

The activity indicator was national VMT data for each vehicle type and road type as shown in Tables 3.46-1, 3.46-2, and 3.46-3 for 1940, 1950, and 1960, respectively. These data were developed from VMT data from Reference 1 and redistributed by vehicle type and road type using information from References 2 and 3.

Difficulty arises in determining the VMT due to the fact that the EPA vehicle classifications do not correspond directly to the classifications reported in Highway Statistics, Reference 1. As a result, the reported VMTs will need to be reclassified.

The following procedures were performed except for those instances where the data was not available then assumptions were made. These assumptions were not documented and therefore cannot be included in this report.

Step 1.

Tables VM-1 and VM-2 from the latest version of Highway Statistics, Reference 1 were obtained.

Step 2.

The total national VMTs for each EPA vehicle classification were calculated as follows:

For LDDV: The latest issue of the Market Data Book, Reference 3 was obtained. From this document, the total number of original sales of diesel passenger cars for the latest model year were extracted. The estimate of the number of LDDV surviving by calendar year since 1968 was calculated as follows:

$$\begin{matrix} LDDV\,surviving \\ by\,model\,year \end{matrix} = \begin{bmatrix} passenger\,car\,survival \\ rate\,by\,age \end{bmatrix} \times \begin{bmatrix} LDDV\,original \\ sales\,by\,model\,year \end{bmatrix} \qquad \text{(Eq. 3.46-1)}$$

Where the passenger car survival rates were found in Reference 2.

For LDGV: The total VMT for LDDV was subtracted from the total passenger car VMT reported in VM-1 to get the total number of VMT for LDGV.

For LDGT1, LDGT2, and HDGV: The number of truck sales by weight category was obtained from Reference 2. For example, in the 1986 edition these values were in the two tables entitled "Retail Sales of New Trucks by Gross Vehicle Weight and Body Type" and "Total Retail Sales of New Trucks in the United States." The U.S. factory sales of domestic trucks was obtained from Reference 2. It was assumed that all imports are in the 0 - 6,000-lb class. Equations 3.42-2 through 3.46-6 summarizes how the sales of each truck class were calculated.

$$Sales\ LDGT1 = RS_{0\,to\,6K} + I - DFS_{0\,to\,6K} \qquad \text{(Eq. 3.46-2)}$$

$$Sales\,LDGT2 = RS_{6\,to\,10K} - VCC - M - 0.05 \times CP - DFS_{6\,to\,10K} - DT_{10\,to\,14K} \qquad \text{(Eq. 3.46-3)}$$

$$Sales\,HDGT = VCC + M + 0.05 \times CP - HDDT + RS_{>10K} \qquad \text{(Eq. 3.46-4)}$$

$$Sales\,LDDT = DFS_{0\,to\,6k} + 0.1 \times DFS_{6\,to\,10k} \qquad \text{(Eq. 3.46-5)}$$

$$Sales\,HDDT = 0.9 \times DFS_{6\,to\,10k} + DFS_{10\,to\,14k} + DFS_{14\,to\,16k} + DFS_{16\,to\,19.5k} + DFS_{19.5\,to\,26k} + DFS_{26\,to\,33k} + DFS_{733k} \quad \text{(Eq. 3.46-6)}$$

where:

where:	RS	=	retail sales of domestic trucks
	I	=	retail sales of import trucks
	DFS	=	factory sales of diesel trucks
	VCC	=	retail sales of van cutaway chassis
	M	=	retail sales of multistops
	CP	=	retail sales of conventional pickups
	HDDT	=	sales HDDT, also calculated above.

Step 3.

This next step converted the original sales of trucks into the number of trucks actually operating. For each of the past 20 years, the ratio of the total number of trucks operating to the total number of sales was calculated using the table entitled "Trucks in Operation by Model Year" from Reference 2. The number of trucks in each category operating by model year was then calculated by multiplying the ratio for the given year by the estimated retail sales for the year of interest. Equation 3.46-7 was used.

$$LDGT1 = RS_{iLDGT1} \times \frac{TT_i}{TRS_i} \quad \text{(Eq. 3.46-7)}$$

where:	LDGT1	=	number of trucks in this category
	RS_{ixxx}	=	retail sales for year i and truck type xxx
	TT_i	=	total number of trucks operating for year i from Reference 2
	TRS_i	=	total retail sales of trucks for year i.

The same procedure was repeated for each vehicle classification.

Note: The MVMA report, Reference 2, may only give operating and sales statistics for the past 16 years. Yet, this must be completed for the past 20 years. This can be done by estimating the number of trucks in operation for the i-16th through i-19th years as shown in Equation 3.46-8.

$$\begin{array}{c} Model\,yr\,i\text{-}16 \\ trucks\,in\,operation \\ in\,calendar\,year\,i \end{array} = \left[1 - \left(\begin{array}{c} Model\,yr\,i\text{-}14 \\ trucks\,in\,operation \end{array} \frac{\begin{array}{c} Model\,yr\,i\text{-}15 \\ trucks\,in\,operation \end{array}}{\begin{array}{c} Model\,yr\,i\text{-}14 \\ trucks\,in\,operation \end{array}} \right) \right] \times \begin{array}{c} Model\,yr\,i\text{-}15 \\ trucks\,in\,operation \end{array} \quad \text{(Eq. 3.46-8)}$$

Step 4.

The total number of VMT by vehicle class is calculated next. This was done by multiplying the number of trucks for each year by the corresponding VMT value. The exception to this procedure was the calculation for HDDT, in which the average of all factory sales data available in each weight class was used to weight the VMT subtotals. Equation 3.46-9 was used.

$$HDDT = \frac{VMT_{HDD-2B} \times 0.9 \times avg[DFS_{HDD-2B}] + VMT_{LHDD} \times avg[DFS_{LHDD}] + VMT_{MHDD} \times avg[DFS_{MHDD}] + VMT_{HHDD} \times avg[DFS_{HHDD}]}{0.9 \times avg[DFS_{HDD-2B}] + avg[DFS_{LHDD}] + avg[DFS_{MHDD}] + avg[DFS_{HHDD}]} \quad \text{(Eq. 3.46-9)}$$

where: VMT = vehicle miles traveled
avg (DFS) = "U.S. factory sales of diesel trucks" data available from AAMA, Reference 2, for respective weight class weighted by information on trucks in use by age, available from AAMA, Reference 2.

The totals were then sum on each vehicle type. The estimates were then normalized to the total number of VMT reported in VM-1 for all trucks and buses. This was done by multiplying each of the total VMTs for each truck category by the ratio of the total VMT reported in VM-1 to the total VMT estimated above.

Step 5.

Next the fraction of the VMT reported for "Other Urban" in Table VM-1 for 55 MPH and 19.6 MPH was calculated using Equations 3.46-10 and 3.46-11.

$$OU_{55MPH} = \frac{Other\,Freeways + Other\,Principal\,Arterial}{Other\,Urban} \quad \text{(Eq. 3.46-10)}$$

$$OU_{19.6MPH} = \frac{Minor\,Arterial + Collector + Local}{Other\,Urban} \quad \text{(Eq. 3.46-11)}$$

where: OU = Other Urban VMT obtained from Table VM-1.

All other values obtained from Table VM-2.

Step 6.

The total VMTs by vehicle type were then divided into 3 road speed categories: 55 MPH, 45 MPH, and 19.6 MPH. For each vehicle type, the VMTs were added together for all road speed categories and the fraction of total VMT represented by each speed category was computed using Equations 3.46-12 through 3.46-14.

$$Fraction_{55MPH,i} = InterstateRural_i + OtherRural_i + InterstateUrban_i + OU_{55MPH} \times OtherUrban_i \quad \text{(Eq. 3.46-12)}$$

$$Fraction_{45MPH,i} = \frac{OtherRural_i}{Total\,Rural\,and\,Urban_i} \quad \text{(Eq. 3.46-13)}$$

$$Fraction_{19.6\ MPH} = \frac{OU_{19.6\ MPH} \times Other\,Urban_i}{Total\,Rural\,and\,Urban_i} \quad \text{(Eq. 3.46-14)}$$

where: i = vehicle type (personal passenger vehicles, 2-axle 4-tire single unit trucks, combination trucks)

OU_{55MPH} = value calculated in Equation 3.46-10

$OU_{19.6MPH}$ = value calculated in Equation 3.46-11

All other values taken from Table VM-1.

The fractions computed for the VMTs for "Personal Passenger Vehicles" were used to represent the distribution of VMT for LDGV, LDDV, and MC by road speed categories. The fractions were then multiplied by the total VMT for those categories to obtain VMT for each road speed category for each vehicle class. The fraction computed for "2-axle, 4-tire single-unit trucks" was used to distribute total VMT for LDGT1, LDGT2, and LDDT. The fractions computed for "combinations" were used to distribute HDDT and HDGT. As a final QA check, the VMT for each road speed category and MOBILE5 vehicle class was summed to verify that the total VMT agreed with the total VMT in Table VM-1.

3.46.3 Emission Factors

The emission factors for CO, NO_x, and NMOG, were determined using EPA's MOBILE5 model as documented in Reference 4. This model required information on the following parameters: calendar year, vehicle speeds, temperature, vehicle operating mode, vehicle registration distribution, Reid vapor pressure (RVP), and altitude. For the years 1940, 1950, and 1960, national annual average conditions were used as inputs into MOBILE5 to determine national emission factors for each unique combination of vehicle type, vehicle speed, and altitude.

The earliest calendar year for which on-road vehicle emission factors can be estimated using MOBILE5 is 1960. Therefore, the emission factors for 1940, 1950, and 1960 were all modeled using a calendar year of evaluation of 1960. The use of 1960 as the calendar year for each of these years gives reasonable results since no emission standards were in place before 1960.

Three speeds were modeled in each of the years evaluated. A single speed was selected to represent each of three road classes — urban, rural, and limited access roads. In 1940 and 1950, the speeds modeled to correspond with each of these road classes were 19.6 mph for urban roads, 35 mph for rural roads, and 45 mph for limited access roads. In 1960, the modeled speeds were 19.6 mph for urban roads, 45 mph for rural roads, and 55 mph for limited access roads.

Two sets of temperature data were used in the modeling. For low altitude areas, the average maximum daily temperature modeled was 65°F and the average minimum daily temperature modeled was 41°F. For high altitude areas, the average maximum daily temperature modeled was 62°F and the average minimum daily temperature modeled was 38°F. These temperatures were selected to be representative of national average daily temperature conditions for low and high altitude areas.

In all of the MOBILE5 modeling, the operating mode assumptions of the Federal Test Procedure (FTP) were used. In the FTP operating mode, 20.6 percent of all VMT is accumulated in the cold start mode, 27.3 percent of all VMT is accumulated in the hot start mode, and 52.1 percent of all VMT is accumulated in the hot stabilized mode.

A national registration distribution was developed for 1970 based on the cars and trucks in operation by model year obtained from Reference 2 and on truck sales data from References 2 and 3. This registration distribution was used in determining the emission factors for the years 1940, 1950, and 1960 and is presented in Table 3.46-4.

The gasoline volatility, or Reid vapor pressure (RVP) for the years 1940, 1950, and 1960 was modeled at 10.1 pounds per square inch (psi). Separate emission factors were calculated for high and low altitude areas.

Based on these input values for each year, the MOBILE5 model produced year-specific CO, NO_x, and NMOG emission factors for each combination of vehicle type, road type, and altitude.

The emission factors for PM-10, SO_2, and TSP are presented in Table 3.46-5. The procedure for determining these emission factors is currently unavailable.

3.46.4 Calculation of Emissions

Average national emission factors for CO, NO_x, and NMOG by vehicle type and road type were calculated by weighting the high and low altitude emission factors by the proportion of the VMT estimated for each of these two altitude groups. It was estimated that 93.5 percent of national VMT was accumulated in low altitude areas and the remaining 6.5 percent of VMT was accumulated in high altitude areas. These national average emission factors by vehicle type and road type were then multiplied by the corresponding national VMT by vehicle type and road type to estimate total national annual emissions for CO, NO_x, and NMOG from on-road vehicles in 1940, 1950, and 1960.

The national annual PM-10, SO_2, and TSP emissions were calculated using the total VMT and emission factors by vehicle type as presented in Tables 3.46-1, 3.46-2, 3.46-3 and 3.46-5.

3.46.5 References

1. *Highway Statistics*. Federal Highway Administration, U.S. Department of Transportation, Washington, DC. Annual.

2. *AAMA Motor Vehicle Facts and Figures 19xx*. American Automobile Manufacturers Association of the United States, 1620 Eye Street, N.M., Suite 1000, Washington, DC. Annual.

3. *19xx Market Data Book*. Automotive News. 965 E. Jefferson Ave., Detroit, MI. Annual.

4. *User's Guide to MOBILE5 (Mobile Source Emissions Model), Chapter 2*. Draft. Office of Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, MI. December 1992.

Table 3.46-1. 1940 VMT by Road Type

	VMT (billion miles per year)			
Vehicle Type	**Limited Access Roads**	**Urban Roads**	**Rural Roads**	**Total VMT**
Gasoline				
Passenger Cars	93.4	96.6	59.1	249.1
Light duty Trucks 1	9.8	7.7	8.5	26.0
Light duty Trucks 2	2.5	1.9	2.1	6.5
Heavy duty Trucks	8.5	6.1	5.4	20.0
Motorcycles	0.2	0.1	0.1	0.4
Diesel				
Passenger Cars	0.0	0.0	0.0	0.0
Light Trucks	0.0	0.0	0.0	0.0
Heavy duty Trucks	0.0	0.0	0.0	0.0
Total	**114.4**	**112.4**	**75.2**	**302.0**

Table 3.46-2. 1950 VMT by Road Type

	VMT (billion miles per year)			
Vehicle Type	**Limited Access Roads**	**Urban Roads**	**Rural Roads**	**Total VMT**
Gasoline				
Passenger Cars	147.0	127.2	87.8	362.0
Light duty Trucks 1	17.1	11.9	14.1	43.1
Light duty Trucks 2	4.3	2.9	3.5	10.7
Heavy duty Trucks	16.8	9.5	11.6	37.9
Motorcycles	0.6	0.6	0.4	1.6
Diesel				
Passenger Cars	0.0	0.0	0.0	0.0
Light Trucks	0.0	0.0	0.0	0.0
Heavy duty Trucks	1.6	0.6	0.7	2.9
Total	**187.4**	**152.7**	**118.1**	**458.2**

Table 3.46-3. 1960 VMT by Road Type

	VMT (billion miles per year)			
Vehicle Type	**Limited Access Roads**	**Urban Roads**	**Rural Roads**	**Total VMT**
Gasoline				
Passenger Cars	256.8	184.5	144.8	586.1
Light duty Trucks 1	24.5	15.0	19.2	58.7
Light duty Trucks 2	6.1	3.8	4.7	14.6
Heavy duty Trucks	21.7	9.0	12.7	43.4
Motorcycles	1.0	0.6	0.4	2.0
Diesel				
Passenger Cars	0.0	0.0	0.0	0.0
Light Trucks	0.0	0.0	0.0	0.0
Heavy duty Trucks	7.9	2.7	2.3	12.9
Total	**318.0**	**215.6**	**184.1**	**717.7**

Table 3.46-4. National Vehicle Registration Distribution used in Determining Emission Factors for the Years 1940, 1950, and 1960

Number of Years Preceding Current Year	Vehicle Types							
	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC
-1	0.081	0.085	0.1	0.058	0.081	0.085	0.104	0.133
-2	0.111	0.119	0.122	0.077	0.111	0.119	0.132	0.145
-3	0.105	0.094	0.109	0.071	0.105	0.094	0.11	0.138
-4	0.102	0.093	0.094	0.082	0.102	0.093	0.114	0.116
-5	0.099	0.085	0.086	0.072	0.099	0.085	0.098	0.123
-6	0.096	0.078	0.072	0.073	0.096	0.078	0.085	0.114
-7	0.089	0.073	0.068	0.07	0.089	0.073	0.08	0.069
-8	0.082	0.063	0.058	0.066	0.082	0.063	0.062	0.044
-9	0.068	0.052	0.048	0.061	0.068	0.052	0.048	0.024
-10	0.05	0.04	0.037	0.053	0.05	0.04	0.033	0.009
-11	0.036	0.036	0.034	0.052	0.036	0.036	0.03	0.084
-12	0.024	0.03	0.028	0.042	0.024	0.03	0.025	0.001
-13	0.014	0.025	0.023	0.035	0.014	0.025	0.019	0
-14	0.01	0.024	0.022	0.034	0.01	0.024	0.017	0
-15	0.008	0.02	0.018	0.027	0.008	0.02	0.014	0
-16	0.006	0.02	0.019	0.029	0.006	0.02	0.01	0
-17	0.006	0.016	0.016	0.025	0.006	0.016	0.006	0
-18	0.006	0.018	0.017	0.028	0.006	0.018	0.004	0
-19	0.005	0.013	0.014	0.021	0.005	0.013	0.004	0
-20	0.001	0.003	0.003	0.004	0.001	0.003	0.001	0
-21	0.001	0.003	0.002	0.003	0.001	0.003	0.001	0
-22	0	0.002	0.002	0.003	0	0.002	0.001	0
-23	0	0.002	0.002	0.002	0	0.002	0.001	0
-24	0	0.002	0.001	0.002	0	0.002	0	0
-25	0.001	0.005	0.005	0.009	0.001	0.005	0.001	0

Table 3.46-5. PM-10, TSP, and SO_2 On-road Vehicles Emission Factors for 1940, 1950, and 1960

	PM-10 (lb/thousand VMT)			TSP (lb/thousand VMT)			SO2 (lb/thousand VMT)		
Vehicle Type	**1940**	**1950**	**1960**	**1940**	**1950**	**1960**	**1940**	**1950**	**1960**
Gasoline									
Passenger Cars	1.28	1.21	1.42	1.36	1.28	1.5	NA	NA	NA
Light duty Trucks 1	1.3	1.24	1.46	1.38	1.32	1.54	NA	NA	NA
Light duty Trucks 2	1.37	1.27	1.35	1.53	1.41	1.51	NA	NA	NA
Heavy duty Trucks	2.88	2.69	3.15	2.88	2.69	3.15	0.1	0.81	0.54
Motorcycles	0	0	0.77	0	0	0.77	NA	NA	NA
Diesel									
Passenger Cars	NA	NA	NA	NA	NA	NA	NA	NA	NA
Light Trucks	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heavy duty Trucks	NA	6.51	2.39	NA	6.51	2.30	NA	NA	NA

3.47 NON-ROAD ENGINES AND VEHICLES - NON-ROAD GASOLINE ENGINES: 12-01

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(12) NON-ROAD ENGINES AND VEHICLES	(01) Non-road Gasoline Engines	Farm Tractors Other Farm Equipment Construction Snowmobiles Small Utility Engines Heavy-duty General Utility Engines Motorcycles

3.47.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. For all pollutants except PM-10, the emissions were estimated from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/thousand gallons.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, and 1960 for CO, NO_x, SO_2, and VOC and for TSP the procedures were used for the years 1940, 1950, 1960, and 1970 through 1992.

The estimation of PM-10 emissions for the years 1940, 1950, and 1960 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.47-1.

$$PM\!-\!10\ \ Emissions_{year} \ = \ PM\!-\!10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.47-1)}$$

This calculation was used in place of estimating the emissions based on activity indicators and emission factors.

The 1975 PM-10 emissions were determined using the 1975 activity indicators as described in section 3.47.2 and the 1975 PM-10 emission factors. The PM-10 emission factors for all sources except gasoline-powered heavy duty general utility engines were determined from the corresponding TSP emission factors and the particle size distributions obtained from Reference 1a. For snowmobiles and motorcycles, the size distribution for unleaded gasoline was used. For the other gasoline-powered engines, the leaded gasoline size distribution was used. The emission factor for gasoline-powered heavy duty general utility engines was obtained for SCC 2-02-003-01 from Reference 2.

3.47.2 Activity Indicator

The activity indicator for gasoline-powered farm tractors was based on the 1973 gasoline consumption by farm tractors.[3] The 1973 consumption was adjusted to the year under study using the ratio of the quantity of gasoline consumed by all agricultural equipment in 1973 to the quantity in the year under study. These data were obtained from Reference 4a.

$$GC_{Tractor,\ i} = GC_{Tractor,\ 1973} \times \frac{GC_{Agriculture,\ i}}{GC_{Agriculture,\ 1973}} \qquad \text{(Eq. 3.47-2)}$$

where: i = year under study
GC = gasoline consumption

The activity indicator for other gasoline-powered farm equipment was based on gasoline consumption. Gasoline consumption by other farm equipment was assumed to be equivalent to 8.52 percent of the quantity of gasoline consumed by farm tractors as determined by the preceding procedure.

The activity indicator for gasoline-powered construction equipment was the total gasoline consumption by construction equipment as reported in Reference 4.

The activity indicator for gasoline-powered snowmobiles was based on the 1973 gasoline consumption by snowmobiles as reported in Reference 3. The 1973 consumption data was adjusted to the year under study using the ratio of the number of snowmobile registrations in 1973 and in the year under study as reported in Reference 5. Equation 3.47-3 summarizes this procedure.

$$GC_{Snowmobiles,\ i} = GC_{Snowmobiles,\ 1973} \times \frac{R_{Snowmobiles,\ i}}{R_{Snowmobiles,\ 1973}} \qquad \text{(Eq. 3.47-3)}$$

where: i = year under study
GC = gasoline consumption
R = registration of snowmobiles

The activity indicator for small utility gasoline engines was based on the 1980 gasoline consumption by small engines (533×10^6 gallons). The 1980 consumption data was adjusted to the year under study using the ratio of the number of single unit dwellings in 1980 and in the year under study. The number of single unit dwellings in 1980 was obtained from Reference 6. For the year under study, the number of single unit dwellings was estimated by adjusting the number of single unit dwellings in 1980 with the number of new one-family structures started each year between 1980 and the year under study. The number of new one-family structure started was obtained from Reference 7 for each year. Equation 3.47-4 summarizes this procedure.

$$GC_{Small\,Engines,\,i} = (533 \times 10^6\ gal) \times \frac{Single\ Unit\ Dwellings_i}{Single\ Unit\ Dwellings_{1980}} \qquad \text{(Eq. 3.47-4)}$$

where: i = year under study
GC = gasoline consumption

The activity indicator for heavy duty general utility gasoline engines was the total gasoline consumed by the industrial commercial category obtained from Reference 4.

The activity indicator for motorcycles was the gasoline consumption calculated from the number of motorcycles, the average annual off-highway mileage traveled, and the median estimated average miles per gallon. The motorcycle population and the off-highway mileage were obtained from Reference 8. The average miles per gallon (MPG) was assumed to be 44.0. Equation 3.47-5 summarizes this calculation.

$$GC_{Motorcycles} = Number\ of\ Motorcycles \times \frac{Off\text{-}Highway\ Mileage}{MPG} \qquad \text{(Eq. 3.47-5)}$$

The activity indicator for gasoline-powered vessels was the total quantity of gasoline consumed by the marine sector (private and commercial) from Reference 4a.

3.47.3 Emission Factor

The emission factors for gasoline-powered farm tractors and other farm equipment were obtained from Reference 1b for all pollutants except PM-10. The VOC emission factors were multiplied by the reactive VOC fraction of 0.918, based on data for profile 90-6021D from Reference 9.

The emission factors for all pollutants, except PM-10, for gasoline construction equipment were the weighted averages of the emission factors for five equipment types. These equipment types and corresponding weighting factors are listed in Table 3.47-1. Emission factors for each equipment type were obtained from Reference 1c. The VOC emission factor was multiplied by the reactive VOC fraction of 0.918. This fraction was based on data for profile 90-6021D from Reference 9.

The emission factors for snowmobiles were obtained from Reference 1d for all pollutants except PM-10. The VOC emission factors were multiplied by the reactive VOC fraction of 0.918, based on data for profile 90-6021D from Reference 9.

The emission factors for all pollutants, except PM-10, for small gasoline utility engines were the weighted averages of the emission factors for five equipment types. These equipment types and corresponding weighting factors are listed in Table 3.47-2. Emission factors for each type were obtained from Reference 1e. The VOC emission factor was multiplied by the reactive VOC fraction of 0.918, based on data for profile 90-6021D from Reference 9.

The emission factors for heavy duty general utility gasoline engines were obtained from Reference 1f for all pollutants except PM-10. The VOC emission factors were multiplied by the reactive VOC fraction of 0.918, based on data for profile 90-6021D from Reference 9.

The emission factors for all pollutants, except PM-10, for motorcycles were obtained from the MOBILE 2 (1978 version) model.[10] Specific parameters used in the model are provided in Table 3.47-3. Resulting emission factors, expressed as grams/VMT were converted to lbs/1,000 gal using the factor 20.8.

The CO, NO_x, SO_2, and VOC emission factors for gasoline-powered vessels were the weighted averages of the emission factors for inboard and outboard motors. The emission factors were obtained from Reference 1g and 1h. Two sets of weighting factors were used for each type of motor. The first weighting factors were the number of registered inboard and outboard motorboats obtained from Reference 11. The second weighting factors accounted for the greater fuel consumption per hour of operation for inboards (2.55) than for outboards (1.55). Equation 3.47-6 summarizes the calculation of the emission factors.

$$EF = \frac{[(EF_{in} \times R_{in} \times 2.55) + (EF_{out} \times R_{out} \times 1.55)]}{[(R_{in} \times 2.55) + (R_{out} \times 1.55)]} \qquad \text{(Eq. 3.47-6)}$$

where: EF = emission factor
R = number of registrations
in = inboards
out = outboards

The VOC emission factor was multiplied by the reactive VOC fraction of 0.9172. This fraction was based on data for profile 9-60-21B from Reference 9. The TSP emission factor for gasoline powered vessels was assumed to be zero.

For the years 1940, 1950, and 1960, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.47.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate emissions from nonroad gasoline vehicles and engines.

3.47.5 References

1. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume II, Table 2-20, Appendix L
   b. Volume II, Table II-6-2
   d. Volume II, Table II-8-1
   e. Volume II, Table II-5-1

f. Volume I, Table 3.3-1
g. Volume II, Table II-3.5
h. Volume II, Table II-4.1

2. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

3. *Exhaust Emissions from Uncontrolled Vehicles and Related Equipment Using Internal Combustion Engines*. U.S. Environmental Protection Agency. Prepared by Southwest Research Institute, San Antonio, TX, under Contract No. EHS-70-108. October 1973.

4. *Highway Statistics*. Federal Highway Administration, U.S. Department of Transportation, Washington, DC. Annual.
   a. Table MF-24

5. International Snowmobile Industry Association, 7535 Little River Turnpike, Suite 330, Annandale, VA 22003. Contact: Roy Muth (703) 273-9606.

6. *American Housing Survey, Current Housing Reports, Series H-150-83*. Bureau of the Census, U.S. Department of Commerce, Washington DC. Biennual.

7. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC. Annual.

8. Motorcycle Industry Council, Inc., 19xx Motorcycle Statistical Annual. Costa Mesa, CA. Annual.

9. *Volatile Organic Compound (VOC) Species Data Manual*. EPA-450/4-80-015. U.S. Environmental Protection Agency, Research Triangle Park, NC. July 1980.

10. *Mobile Source Emissions Model (MOBILE2) Version 2*. Office of Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, MI. 1978.

11. *Boating Registration Statistics*. National Marine Manufacturers Association, 401 N. Michigan Avenue, Suite 1150, Chicago, IL. Annual.

Table 3.47-1. Emission Factor Equipment Types and Weighting Factors for Gasoline Construction Equipment

Equipment Type	Weighting Factor, based on consumption in 1,000 gal/year
Wheel Tractor	94,774
Motor Grader	12,240
Wheel Loader	104,726
Roller	147,439

Table 3.47-2. Emission Factor Equipment Types and Weighting Factors for Gasoline Small Utility Gasoline Engines

Engine Type	Weighting Factor, based on percentage consumption
Wheel Tractor (2-stroke)	0.065
Motor Grader (4-stroke)	0.935

Table 3.47-3. MOBILE 2 (1978 version) Parameters for Calculation of Emission Factors for Motorcycles

Altitude	Low
Speed	19.6 MPH
Ambient Temp.	57°F
Hot Start/Cold Start Percentages	Zero
All other variables	default values

3.48 NON-ROAD ENGINES AND VEHICLES - NON-ROAD DIESEL ENGINES: 12-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category. The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(12) NON-ROAD ENGINES AND VEHICLES	(02) Non-road Diesel Engines	Farm Tractors Other Farm Equipment Heavy-duty General Utility Engines

3.48.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. For all pollutants except PM-10, the emissions were estimated from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/thousand gallons.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, and 1960 for CO, NO_x, SO_2, and VOC. For TSP, the procedures were used for the years 1940, 1950, 1960, and 1970 through 1992.

The estimation of PM-10 emissions for the years 1940, 1950, and 1960 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.48-1.

$$PM-10\ \ Emissions_{year} = PM-10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.48-1)}$$

This calculation was used in place of estimating emissions based on activity indicators and emission factors.

The 1975 PM-10 emissions were determined using the 1975 activity indicators as described in section 3.48.2 and the 1975 PM-10 emission factors. The PM-10 emission factors for all sources, except diesel-powered heavy duty general utility engines were determined from the corresponding TSP emission factor and the particle size distribution obtained from Reference 1a. The emission factor for diesel-powered heavy duty general utility engines was obtained from Reference 2 for SCC 2-02-001-02.

3.48.2 Activity Indicator

The activity indicators for diesel farm tractors and other diesel farm equipment were based on the adjusted total sales (or deliveries) of diesel fuel used on farms obtained from Reference 3a or 4a. It was assumed that 95.5 percent of this quantity was consumed by farm tractors and 4.5 percent was consumed by other farm equipment.

The activity indicator for diesel construction equipment was the adjusted total sales (or deliveries) of off-highway diesel distillate fuel oil for use in construction from Reference 3b or 4b.

The activity indicator for heavy-duty general utility diesel engines was the sum of the adjusted total sales (or deliveries) of off-highway diesel distillate fuel oil for other uses and of diesel for military uses. These data was obtained from Reference 3b or 4b.

3.48.3 Emission Factor

The emission factors for all pollutants except PM-10 for farm diesel tractors and other farm diesel equipment were obtained from Reference 1b. The VOC emission factors were multiplied by the reactive VOC fraction of 0.952, based on data for profile 90-7021 from Reference 5.

For diesel construction equipment, the emission factors for all pollutants except PM-10 were the weighted averages of the emission factors for nine equipment types. These equipment types and the corresponding weighting factors are listed in Table 3.48-1. Emission factors for each equipment type were obtained from Reference 1c. The VOC emission factor was multiplied by the reactive VOC fraction of 0.952, based on data for profile 90-7021 from Reference 5.

The emission factors for heavy duty general utility diesel engines were obtained from Reference 1d for all pollutants except PM-10. The VOC emission factors were multiplied by the reactive VOC fraction of 0.952, based on data for profile 90-7021 from Reference 5.

For the years 1940, 1950, and 1960, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.48.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate emissions from nonroad diesel vehicles and engines

3.48.5 References

1. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
    a. Volume II, Table 2-2, Appendix L,
    b. Volume II, Table II-6-2
    c. Volume II, Table II-7-1
    d. Volume II, Table 3.3-1

2. *AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants*. EPA-450/4-90-003. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. March 1990.

3. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Deliveries for Farm Use: Distillate Fuel Oil and Kerosene"
   b. Table entitled, "Deliveries for Military Use: Distillate Fuel Oil and Residual Fuel Oil; Deliveries for Off-Highway Use: Diesel"

4. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Adjusted Sales for Farm Use: Distillate Fuel Oil and Kerosene."
   b. Table entitled, "Adjusted Sales for Military Use: distillate Fuel Oil and Residual Fuel Oil; Adjusted Sales for Off-Highway Use: Diesel."

5. *Volatile Organic Compound (VOC) Species Data Manual*. EPA-450/4-80-015. U.S. Environmental Protection Agency, Research Triangle Park, NC. July 1980.

Table 3.48-1. Emission Factor Equipment Types and Weighting Factors for Diesel Construction Equipment

Equipment Type	Weighting Factor, based on consumption in 1,000 gal/year
Tracklaying Tractor	912,279
Wheel Tractor	846,035
Wheeled Dozer	47,077
Scraper	621,523
Motor Grader	164,368
Wheeled Loader	753,511
Tracklaying Loader	229,680
Off-Highway Truck	470,550
Roller	30,180

3.49 NON-ROAD ENGINES AND VEHICLES - AIRCRAFT: 12-03

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(12) NON-ROAD ENGINES AND VEHICLES	(03) Aircraft	FAA Facilities Military Facilities General Aviation

3.49.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. For all pollutants except PM-10, the emissions were estimated from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in thousand LTO cycles and emission factors were expressed in metric pounds/LTO cycle.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, and 1960 for CO, NO_x, SO_2, and VOC and for TSP the procedures were used for the years 1940, 1950, 1960, and 1970 through 1992.

The estimation of PM-10 emissions for the years 1940, 1950, and 1960 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.49-1.

$$PM-10\ \ Emissions_{year} = PM-10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.49-1)}$$

This calculation was used in place of estimating PM-10 emissions based on activity indicators and emission factors.

The 1975 PM-10 emissions were determined using the 1975 activity indicators as described in section 3.49.2 and the 1975 PM-10 emission factor obtained from Table 3.1-3 of this report.

3.49.2 Activity Indicator

The activity indicators for commercial, air taxi, general aviation, and military aircraft using Federal Aviation Administration (FAA) facilities were the landings and take-offs (LTOs). The total airport operations reported in Reference 1 for each aircraft category were divided by 2 in order to obtain the number of LTO cycles.

The activity indicator for general aviation aircraft using military facilities was assumed to be a constant 1200 LTOs.

The activity indicator for military aircraft using military facilities was based on the military LTOs at military facilities from the year preceding the year under study. Total military LTOs from the year preceding were calculated as the sum of military LTOs from military facilities and from FAA facilities. Total LTOs were projected to the year of study by using the ratio between total flying hours for active U.S. military aircraft flying in the continental United States for the year under study and for the preceding year. Total flying hours data were obtained from Reference 2. From the resulting total military LTOs for the year under study, military LTOs from FAA facilities were subtracted in order to determine military LTOs from military facilities for the year under study. The procedure for determining the miliary LTOs from FAA facilities was described previously. This overall calculation of the activity indicator is summarized in Equation 3.49-2.

$$MLTO_{MF,\ i} = \left[(MLTO_{FAA,\ i-1} + MLTO_{MF,\ i-1}) \times \left(\frac{FH_i}{FH_{i-1}} \right) \right] - MLTO_{FAA,\ i} \qquad \text{(Eq. 3.49-2)}$$

where:
MLTO = military LTO
MF = military facilities
FAA = FAA facilities
FH = total flying hours
i = year under study

The activity indicator for general aviation aircraft using other facilities was based on the assumption that civil aircraft average 250 LTO cycles per year. Total general aviation LTOs were estimated by multiplying the number of registered civil aircraft, excluding gliders, blimps, and balloons, by the average LTO cycles per year. The number of registered civil aircraft was obtained from Reference 3. From this total was subtracted the general aviation LTOs at FAA facilities and at military facilities. These values were determine using procedures described previously. This calculation is summarized in Equation 3.49-3.

$$GA_{OF} = (AC \times 250\ cycles/year) - GA_{FAA} - GA_{MF} \qquad \text{(Eq. 3.49-3)}$$

where:
GA = General Aviation LTOs
AC = Number of U.S. registered civil aircraft, excluding gliders, blimps, and balloons
OF = Other Facilities
FAA = FAA Facilities
MF = Military Facilities

3.49.3 Emission Factor

The emission factors for all pollutants except PM-10 for commercial aircraft using FAA facilities were the weighted averages of the emission factors for each commercial aircraft type. These emission factors are presented in Table 3.49-1. The weighting factors were the estimated LTO's for each aircraft type.

In order to estimate the LTO's for each aircraft type, the estimated number of LTOs by aircraft type from the year preceding the year under study were projected to the year under study. This projection was accomplished for each aircraft type using the ratio of the number of aircraft in operation in the year under study to the number in the the preceding year. These values were obtained from Reference 3. The estimated number of LTO's by aircraft type for the preceding year were obtained by using this same methodology on data from the preceding year.

The estimated LTOs by aircraft type for the year under study were normalized to the actual total number of LTO's as reported in Reference 1. These normalized LTOs for each aircraft type were the weighting factor used to calculate the weight average emission factors for commercial aircraft using FAA facilities.

The emission factors for all pollutants except PM-10 for air taxis using FAA facilities were the weighted averages of the emission factors for each air taxi aircraft type.[4] These emission factors are presented in Table 3.49-2. Weighting factors were the estimated number of each air taxi aircraft type as reported in Reference 3.

The emission factors for all pollutants except PM-10 for general aviation aircraft using FAA facilities were the weighted averages of the emission factors for each aviation aircraft type.[4] These emission factors are presented in Table 3.49-3. Weighting factors were the estimated number of flying hours for each aircraft type obtained from Reference 2a. It was assumed that the number of flying hours was proportional to the number of LTO cycles.

The emission factors for all pollutants except PM-10 for military aircraft using FAA facilities were the weighted averages of the emission factors for each military aircraft type.[4] These emission factors are presented in Table 3.48-4. Weighting factors were the estimated number of flying hours for each military aircraft type obtained from Reference 2b. It was assumed that the number of flying hours was proportional to the number of LTO cycles.

The emission factors for all pollutants except PM-10 for military aircraft using military facilities were the same factors as were used for military aircraft using FAA facilities.[4] The emission factors for all pollutants except PM-10 for general aviation aircraft using military facilities were the same factors as were used for general aviation aircraft using FAA facilities.

The emission factors for all pollutants except PM-10 for general aviation aircraft using other facilities were the same factors as were used for general aviation aircraft using FAA facilities.[4]

For the years 1940, 1950, and 1960, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.49.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate emissions from aircraft.

3.49.5 References

1. *FAA Air Traffic Activity FY 19xx*. Federal Aviation Administration, U.S. Department of Transportation, Washington, DC. Annual.
   a. Table 4, "Airport Operations at Airports with FAA-Operated Traffic Control Towers by Region and by State and Aviation Category."

2. *FAA Aviation Forecasts Fiscal Years 19xx-19xx*. Federal Aviation Administration, U.S. Department of Transportation, Washington, DC. Annual.
   a. Table 9
   b. Table 23

3. *Census of U.S. Civil Aircraft, Calendar Year 19xx*. Federal Aviation Administration, U.S. Department of Transportation, Washington, DC. Annual.
   a. Table 1.1. For Regional, use number of registered aircraft, Table 3.2.

4. *Compilation of Air Pollutant Emission Factors (AP-42), Volume II Mobile Sources, 4th Edition*, Motor Vehicle Emission Laboratory, U.S. Environmental Protection Agency, Ann Arbor, MI. September 1985.

Table 3.49-1. Emission Factors for Commercial Aircraft using FAA Facilities

	Emission Factors (lbs/LTO)				
Commercial Aircraft	CO	NO_x	VOC*	SO_2	TSP
BAC 111	103.63	15.04	71.19	1.7	1.46
Boeing 707	262.64	25.68	214.53	4.28	4.52
Boeing 727	55.95	29.64	13.21	3.27	1.17
Boeing 737	37.3	19.76	8.81	2.18	0.78
Boeing 747	145.1	10.52	42.37	7.55	5.2
L1011	124.7	78.98	71.71	5.3	3.9
DC8	262.64	25.68	214.53	3.27	1.17
DC9	37.3	19.76	8.81	2.18	0.78
DC10	116.88	49.59	46.3	4.98	0.21
General					1.0

* Reactive VOC (already adjusted).

Table 3.49-2. Emission Factors for Air Taxis using FAA Facilities

	Emission Factor (lbs/LTO)				
Air Taxi Aircraft	**CO**	**NO_x**	**VOC***	**SO_2**	**TSP**
Turbojets	50.26	26.63	11.87	2.94	1.05
Turboprops	7.16	0.82	4.99	0.18	0.46
Pistons	100 **	0.6**	3.2**	0.02**	0.3**
General					

* VOC adjustment factor is 0.983 for turbojets and 0.929 for pistons.

**Assumed values used for pistons.

Table 3.49-3. Emission Factors for General Aviation Aircraft using FAA Facilities

	Emission Factor (lbs/LTO)				
General Aviation Aircraft	**CO**	**NO_x**	**VOC***	**SO_2**	**TSP**
Piston:					
Single Engine	11.35	0.02	0.23	0	0.02
Multi-Engine	64.67	0.075	1.35	0	0.02
Turboprop	6.76	0.92	6.46	0.17	0.46
Turbojet	54.36	2.02	6.62	0.74	0.5**
Rotocraft Piston	11.35	0.02	0.23	0	0.02
Rotocraft Turbine	13.33	4.34	2.75	0.26	0.4
General					

* Reactive VOC (already adjusted),

**Particulate emission factor for Turbojet is best guess estimate.

Table 3.49-4. Emission Factors for Military Aircraft using FAA Facilities

	Emission Factor (lbs/LTO)				
Military Aircraft	**CO**	**NO_x**	**VOC***	**SO_2**	**TSP**
Jet (fixed wing)	52.4	9.65	29	1.56	28
Turboprop	23.2	14.1	11.6	0.74	0.46
Piston	53.2	0.29	5.5	0.033	0.28
Helicopter	13.33	4.34	2.75	0.26	0.4
General					

*Reactive VOC (already adjusted).

3.50 NON-ROAD ENGINES AND VEHICLES - MARINE VESSELS: 12-04

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(12) NON-ROAD ENGINES AND VEHICLES	(04) Marine Vessels	Residual Fuel Oil Diesel Oil Coal

3.50.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. For all pollutants except PM-10, the emissions were estimated from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/thousand gallons.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, and 1960 for CO, NO_x, SO_2, and VOC and for TSP the procedures were used for the years 1940, 1950, 1960, and 1970 through 1992.

The estimation of PM-10 emissions for the years 1940, 1950, and 1960 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.50-1.

$$PM-10\ \ Emissions_{year} = PM-10\ \ Emissions_{1975} \times \frac{TSP\ \ Emissions_{year}}{TSP\ \ Emissions_{1975}} \qquad \text{(Eq. 3.50-1)}$$

This calculation was used in place of estimating PM-10 emissions based on activity indicators and emission factors.

The 1975 PM-10 emissions were determined using the 1975 activity indicators as described in section 3.50.2 and the 1975 PM-10 emission factors obtained from Table 3.1-3 of this report.

3.50.2 Activity Indicator

The activity indicator for residual fuel oil was the "adjusted" quantity of residual fuel oil delivered for transportation use, vessel bunkering obtained from Reference 1a or Reference 2a.

The activity indicator for diesel oil was the "adjusted" quantity of distillate fuel oil (for diesel) delivered for transportation use, vessel bunkering obtained from Reference 1a or Reference 2a.

The procedure for determining the activity for the years 1940, 1950, and 1960 is currently unavailable. The activity indicator for coal was assumed to be zero after 1979.

3.50.3 Emission Factor

The emission factors for all pollutants except PM-10 for residual fuel oil were based on the emission factors for residual oil-fired commercial steamships obtained from Reference 3a. The emission factors were presented separately for three modes of operation; hotelling, cruise, and full power. Weighted averages of these emission factors were calculated for each pollutant based on the relative amount of time vessels spend operating under these different modes. It was assumed that 80 percent of the time was spent hotelling and 20 percent was spent under full power.

The VOC emission factor was converted to the reactive VOC emission factor by using the factor for profile 101004 obtained from Reference 4.

The emission factors for all pollutants except PM-10 for diesel oil were weighted averages of the emission factors for diesel-fired vessels operating underway and operating under auxiliary power. Weighting factors were based on the relative amount of time the ships spent operating in these modes: 20 percent under auxiliary power and 80 percent underway. The final VOC emission factor was converted to the reactive VOC emission factor by using the factor for profile 907021 obtained from Reference 4.

The emission factors for diesel-fired vessels under auxiliary power were the averages of the emission factors for diesel-fired vessels operating under auxiliary power at 50 percent load. The emission factors for all pollutants except for TSP were obtained from Reference 3b and were averaged over the four output ratings. The average TSP emission factor was obtained from Reference 3c.

The emission factors for diesel-fired vessels underway were the weighted averages of the emission factors for commercial motorships and distillate oil-fired commercial steamships. The emission factors were weighted by the relative population of motorships and steamships. It was assumed that of the overall fleet of diesel-fired vessels, 75 percent were motorships and 25 percent were steamships.

The emission factors for commercial motorships were the averages of the emission factors for the river, Great Lakes, and coastal waterway classifications. The emission factors for all pollutants except for TSP were obtained from Reference 3d and were averaged over the three waterway classifications. The average TSP emission factor was assumed to be equal to the emission factor railroad locomotive obtained from Reference 3e.

The emission factors for commercial distillate oil-fired steamships were the weighted averages of the emission factors for two modes of operations: hotelling and full power. These emission factors were obtained from Reference 3a. The emission factors were weighted by the relative time the steamship spent operating under these two modes. It was assumed that steamship spent 80 of the time hotelling and 20 percent at full power.

The emission factors for all pollutants for coal combustion by marine vessels after 1979 were assumed to have a value of zero. The procedure for determining the activity for the years 1940, 1950, and 1960 is currently unavailable.

For the years 1940, 1950, and 1960, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.50.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate emissions from marine vessels.

3.50.5 References

1. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table A13 and A14

2. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table A13 and A14

3. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume II, Table II-3-2
   b. Volume II, Table II-3-4
   c. Volume II, Table 3.3-1
   d. Volume II, Table II-3-1
   e. Volume II, Table II-2-1

4. *Volatile Organic Compound (VOC) Species Data Manual*. EPA-450/4-80-015. U.S. Environmental Protection Agency, Research Triangle Park, NC. July 1980.

3.51 NON-ROAD ENGINES AND VEHICLES - RAILROADS: 12-05

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source category.

Tier I Category	Tier II Category	Tier II Subcategory
(12) NON-ROAD ENGINES AND VEHICLES	(05) Railroads	Diesel Residual Fuel Oil Coal

3.51.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. For all pollutants except PM-10, the emissions were estimated from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/thousand gallons.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, and 1960 for CO, NO_x, SO_2, and VOC and for TSP the procedures were used for the years 1940, 1950, 1960, and 1970 through 1992.

The estimation of PM-10 emissions for the years 1940, 1950, and 1960 was based on the relative change in TSP emissions from the 1975 value according to Equation 3.51-1.

$$PM-10\ Emissions_{year} = PM-10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.51-1)}$$

This calculation was used in place of estimating emissions based on activity indicators and emission factors.

The 1975 PM-10 emissions were determined using the 1975 activity indicators as described in section 3.51.2 and the 1975 PM-10 emission factors obtained from Table 3.1-3 of this report.

3.51.2 Activity Indicator

The activity indicator for the combustion of diesel fuel by locomotives was the “adjusted” quantity of distillate fuel oil deliveries for transportation use (railroads) obtained from Reference 1 or Reference 2.

The activity indicator for the combustion of residual fuel oil by locomotives was based on the “adjusted” quantity of residual fuel oil sales to the “All Other” end use category from Reference 1 or Reference 2. It was assumed that the ratio of fuel consumption by railroads to the fuel consumption included in the “All Other” end use category (which includes railroads) is 8.83×10^{-4}. Therefore, the activity indicator was the value obtained from Reference 1 or Reference 2 multiplied by 8.83×10^{-4}.

The activity indicator for the combustion of coal was the quantity of U.S. coal distribution by "transportation" obtained from Reference 3a. It was assumed that "transportation" as defined in Reference 3 represented the locomotive category.

3.51.3 Emission Factor

The emission factors for diesel fuel combustion by locomotives were obtained from Reference 4a for all pollutants except PM-10. The VOC emission factor was multiplied by 0.952 to account for the reactive portion.

For the combustion of residual fuel oil, the emission factors for all pollutants except PM-10 and VOC were obtained from Reference 4a. The VOC emission factor was obtained from Reference 4b and was multiplied of 0.952 to account for the reactive portion. The SO_2 factor was multiplied by the sulfur content value of 1.34.

The emission factors for all pollutants except PM-10 for the combustion of coal were obtained from Reference 4c. In this reference, the TSP factor was listed as the spreader stoker emission factor. The SO_2 emission factor was multiplied by a sulfur content value of 2.0.

For the years 1940, 1950, and 1960, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.51.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate emissions from railroads.

3.51.5 References

1. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. January issue.

2. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

3. *Coal Distribution January-December 19xx*. DOE/EIA-0125(xx/4Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Distribution of U.S. Coal by Origin, Destination, and Consumer"

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume II, Table II-2-1
   b. Volume I, Table 1.3-1 (Industrial Residual Oil Boilers)
   c. Volume I, Table 1.1-1 (Bituminous Coal Hand-fired Units)

3.52 MISCELLANEOUS - OTHER COMBUSTION: 14-02

The emissions for this Tier II category were determined by the 1940-1984 Methodology for the following source categories.

Tier I Category	Tier II Category	Tier II Subcategory
(14) MISCELLANEOUS	(02) Other Combustion	Wildfires
		Prescribed Burning
		Agricultural Burning
		Structural Fires
		Coal Refuse Burning

3.52.1 Technical Approach

The CO, NO_x, PM-10, TSP, SO_2, and VOC emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and emission factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators for wildfires and prescribed burning were expressed in acres and emission factors were expressed in metric pounds/thousand short tons. For the other sources, activity indicators were expressed in thousand short tons and emission factors were expressed in metric pounds/short ton.

The procedures for determining activity indicators and emission factors were used for the years 1940, 1950, 1960, and 1970 through 1984 for all pollutants except TSP, for which the procedures were used for the years through 1992, and PM-10, for which the procedures were used for the years 1975 through 1984. For some source categories, the PM-10 emissions exceeded the TSP emissions as calculated by the procedures presented in this section. Because this represents a physical impossibility, a more realistic estimate of the PM-10 emissions was assumed to be the TSP emissions value.

The estimation of PM-10 emissions for the years prior to 1975 was based on the relative change in TSP emissions from the 1975 value according to the Equation 3.52-1.

$$PM\!-\!10\ Emissions_{year} = PM\!-\!10\ Emissions_{1975} \times \frac{TSP\ Emissions_{year}}{TSP\ Emissions_{1975}} \qquad \text{(Eq. 3.52-1)}$$

This calculation was used in place of estimating the emissions based on activity indicators and emission factors.

3.52.2 Activity Indicator

The activity indicator for wildfires is the sum of protected and unprotected land areas burned for each of the five regions. These regions are defined in Table 3.52-1. The area of protected land burned was obtained from Reference 1. Default values used for the unprotected land area burned are given in Table 3.52-2.

For the years 1978 through 1984, the activity indicator for prescribed burning was the acreage burned in 1978 reported in Reference 2. The data are reported for two regions: Southern and Western. It was assumed that the acreage burned remained constant for the years 1978 through 1984. No procedure for determining the acreage burned for the years prior to 1978 is currently available.

The activity indicator for agricultural burning was based on the total quantity of agricultural products burned in 1974 as reported in Reference 3. Because no data were available after 1974, the activity indicators for this category for the years after 1974 were assumed to be the same as that for 1974.

The activity indicator for structural fires was based on the total number of building fires as reported in Reference 4. It was assumed that 6.8 tons of material is burned for every building fire. Alternatively, an estimate of the quantity of material burned was obtained from Reference 5.

The activity indicator for coal refuse burning was based on the estimated total quantity of coal refuse in 1971 from Reference 6. It was assumed that this quantity had been steadily declining over the period after the report was published. A rough approximation was deemed sufficient.

3.52.3 Emission Factor

The emission factors for wildfires were composed of two factors: fuel loading and pollutant yield. The fuel loading related the area of land burned to the quantity of vegetation consumed by fire. The fuel loading data were specific to five regions of the United States. The States included in each region are listed in Table 3.52-1. The pollutant yield related the amount of a given pollutant emitted to the amount of vegetation consumed by fire. The information on these two factors was obtained from Reference 7a except the pollutant yield for PM-10 which was obtained from Table 3.1-2 of this report.

The emission factors for prescribed fires were composed of two factors: fuel loading and pollutant yield. These factors were defined in the same manner as for the wild fire category. The fuel loading was specific to two regions of the United States. The information on these two factor was obtained from Reference 6, except for the SO_2, NO_x, and PM-10 pollutant yield values. The SO_2 and NO_x pollutant yields were assumed to be the same as the pollutant yields for wildfires and, therefore, were obtained from Reference 7a. The PM-10 pollutant yield was obtained from Table 3.1-3 of this report.

The emission factors for all pollutants except PM-10 for agricultural burning were the average of the emission factors for burning sugar cane and field crops. These emission factors were obtained from Reference 7b, except for the NO_x emission factors which were obtained from Reference 7c. The PM-10 emission factor was obtained from Table 3.1-3 of this report.

The emission factors for all pollutants except PM-10 for structural burning were obtained from Reference 8. These emission factors were for open burning and were adjusted using engineering judgment. The PM-10 emission factor was obtained from Table 3.1-3 of this report.

The emission factors for all pollutants except PM-10 for coal refuse burning were obtained from Reference 9. These emission factors were for open burning and were adjusted using engineering judgment. The PM-10 emission factor was obtained from Table 3.1-3 of this report.

For the years prior to 1975, emission factors were not employed in the estimation of PM-10 emissions from the sources included in this Tier II category.

3.52.4 Control Efficiency

No control efficiencies were applied to the activity data to estimate emissions from the sources included in this Tier II category.

3.52.5 References

1. *The National Forest Fire Report*. Forest Service, U.S. Department of Agriculture. Annual.

2. *Source Assessment Prescribed Burning*. EPA-600/2-79-019H, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1979.

3. *Emissions Inventory from Forest Wildfires, Forest Managed Burns, and Agricultural Burns*. EPA-450/3-74-062. U.S. Environmental Protection Agency, Research Triangle Park, NC. November 1974.

4. *Statistical Abstract of the United States*. Bureau of the Census, U.S. Department of Commerce, Washington, DC. Annual.

5. National Fire Protection Association, Boston, MA.

6. *Information Circular 8515*. U.S. Bureau of Mines, U.S. Department of the Interior, Washington, DC. 1971.

7. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Volume I, Section 11.1
   b. Volume I, Table 2.4-5

8. *Compilation of Air Pollutant Emission Factors, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. February 1972.

9. *OAQPS Data File on National Emissions*. National Air Data Branch, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1984.

Table 3.52-1. States Comprising Regions for Wild Fires Acreage Burned Information

Rocky Mountain	Pacific	East	North Central	South
Arizona	Alaska	Connecticut	Illinois	Alabama
Colorado	California	Delaware	Indiana	Arkansas
Idaho	Guam	Maine	Iowa	Florida
Kansas	Hawaii	Maryland	Michigan	Georgia
Montana	Oregon	Massachusetts	Minnesota	Kentucky
Nebraska	Washington	New Hampshire	Missouri	Louisiana
Nevada		New Jersey	Ohio	Mississippi
New Mexico		New York	Wisconsin	North Carolina
North Dakota		Pennsylvania		Oklahoma
South Dakota		Rhode Island		South Carolina
Utah		Vermont		Tennessee
Wyoming		West Virginia		Texas
				Virginia

Table 3.52-2. Land Area Burned on Unprotected Lands

Region	Acreage (thousands of acres)
Rocky Mountain	198.1
Pacific	184.8
East	65.1
North Central	296.0
South	1,584.1

SECTION 4.0
NATIONAL CRITERIA POLLUTANT ESTIMATES
1985 - 1996 METHODOLOGY

Each year the U.S. Environmental Protection Agency (EPA) prepares national estimates for assessing trends in criteria pollutant emissions. In the past, the emissions were estimated using consistent top-down methodologies employing national statistics on economic activity, material flows, etc., for the years 1940 to the current year of the report. Although emissions prepared in this way were useful for evaluating changes from year to year, they did not provide a geographically detailed measure of emissions for any given year. Bottom-up inventories, where emissions are derived at the plant or county level, are extremely useful in many applications, such as inputs into atmospheric models. During the past several years, changes have been made to the methodologies in order to produce emissions for the *National Air Pollutant Emission Trends, 1900-1996*[1] *(Emission Trends)* report, starting at the county level, which both represent a bottom-up inventory and allow for an evaluation of changes in emissions from year to year. These methodological changes allowed for the incorporation of even more detailed state data. Starting with this year's *Emission Trends* report,[1] state data including emission estimates have been incorporated.

4.1 INTRODUCTION

The carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), and volatile organic compound (VOC) emissions presented in this report for the years 1985 through 1989 have been estimated according to the methodology for developing the *Interim* Inventories, with several exceptions. The *Interim* methodology was developed to produce the inventories for the years 1987 through 1991 and is presented in the *Regional Interim Emission Inventories (1987-1991)*.[2] A similar methodology was developed for the preparation of a national 1990 particulate matter inventory as documented in the *Development of the OPPE Particulate Programs Implementation Evaluation System.*[3] In order to generate the necessary emissions for the *Emission 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 particulate matter less than 10 microns (PM-10) emissions for the years 1985 through 1989.

The 1990 Interim Inventory has been revised with state emissions when available. The state non-utility point emissions were obtained from the Ozone Transport Assessment Group (OTAG), Grand Canyon Visibility Transport Commission (GCVTC), and Aerometric Information Retrieval System/Facility Subsystem (AIRS/FS). Area source emissions were also obtained from OTAG, California, and Oregon. On-road emissions were calculated by EPA from state-provided emission factor inputs and vehicle miles traveled (VMT). All gaps in emissions were filled with 1990 Interim Inventory emissions. The 1990 state emissions (hereafter referred to as the 1990 National Emission Trends [NET] inventory) is the basis for the 1991 through 1996 emissions.

Two pollutants, particulate matter less than 2.5 microns (PM-2.5) and ammonia (NH_3), have been added to the list of pollutants inventoried by EPA's Emission Factors and Inventory Group (EFIG). Emissions and associated data for these two pollutants are available for the years 1990 through 1996.

A detailed description of the methodologies used to generate the CO, NO_x, VOC, SO_2, and PM-10 emissions for the years 1985 through 1996 and PM-2.5 and NH_3 emissions for the years 1990 through 1996 are presented in this section. The description is divided into subsections based on similar approaches in estimating the emissions. The beginning of each subsection lists the Tier I category, and below, if necessary. Table 4.1-1 shows the subsection/tier category relationships. If a Tier II category is not listed, it is currently not estimated within the NET Inventory.

4.1.1 Lead Emissions

The lead (Pb) emissions for the years 1985 through 1995 have been estimated using the methodologies presented in section 5.0 of this report. The weighted emission factors and control efficiencies were assumed to be constant from 1990 to 1996. The 1996 preliminary estimates were projected by one of two methods applied to the appropriate source category. The first of these two methods used a quadratic regression with weighted 20-year specific source category activity data. The second method used a linear regression with weighted 7-year activity data. This second method was applied to source categories where the trend in the activity data has changed significantly over the past 10 years.

4.1.2 Carbon Monoxide, Nitrogen Oxides, Volatile Organic Compounds, Sulfur Dioxide, Particulate Matter (PM-10 and PM-2.5), and Ammonia Emissions

Emissions were developed at the county and Source Classification Code (SCC) level for most source categories. These emissions are then summed to the Tier level. There are four levels in the Tier categorization. The first and second level, referred to as Tier I and Tier II, respectively, are the same for each of the six criteria pollutants and are listed in Table 4.1-2. The third level, Tier III, is unique for each of the six pollutants. The fourth level, Tier 4, is the SCC level. Table 4.1-3 lists the Tier I and Tier II codes and names with the associated SCC and SCC description. Due to space limitations, the SCC descriptions have been truncated.

Although the emissions were derived at the SCC level, the growth indicators for the point sources for 1985 through 1996 were assigned at the Standard Industrial Classification (SIC) level for all sources except the stationary fuel combustion sources. A match-up between two digit SICs and SCCs, as well as Tier category, is impossible, since the SICs are defined at the plant level but the SCCs are defined at the process level. Therefore, the same SIC could be used in two or more Tier I categories. For example, Plant A produces and stores adipic acid. This plant would be assigned SIC code 28 (Chemical and Allied Products). The manufacturing section of the plant would be assigned an SCC of 3-01-001-03 and would be included in Tier I category 04, Chemical and Allied Product Manufacturing. The section of the plant where the adipic acid is stored would be assigned an SCC of 3-01-001-02 and would be included in Tier I category 09, Storage and Transport. As this example shows, in order to use the methodology for the years 1985 to 1996, both the SCC (to determine which Tier category methodology to apply) and the SIC (to know which growth indicator to choose) must be known.

4.1.3 References

1. *National Air Pollutant Emission Trends, 1900-1996*, under development. U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1997.

2. *Regional Interim Emission Inventories (1987-1991), Volume I: Development Methodologies*. EPA-454/R-93-021a. U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1993.

3. *Development of the OPPE Particulate Programs Implementation Evaluation System*, Final, Prepared for the Office of Policy, Planning and Evaluation/Office of Policy Analysis, U.S. Environmental Protection Agency, under EPA Contract No. 68-D3-0035, Work Assignment No. 0-10, Washington, DC. July 1994.

Table 4.1-1. Section 4.0 Structure

Subsection	Tier I	Tier II
4.1 Introduction		
4.2 Fuel Combustion - Electric Utility	Fuel Combustion - Electric Utility (01)	Majority of Coal (01), Oil (02), and Gas (03). The point level - steam generated fossil fuel sources.
4.3 Industrial	Fuel Combustion - Electric Utility (01)	Other [(04), mainly gas turbines], Internal Combustion (05), The area source level - steam generated Coal (01), Oil (02), Gas (03).
	Fuel Combustion - Industrial (02)	All
	Chemical & Allied Product Manufacturing (04)	All
	Metals Processing (05)	All
	Petroleum & Related Industries (06)	All
	Other Industrial Processes (07)	All
	Storage & Transport (09)	All
	Waste Disposal & Recycling (10)	All
	Miscellaneous (14)	Health services (05)
4.4 Other Combustion	Other Combustion (03)	All
	Miscellaneous (14)	Other combustion (02)
4.5 Solvents	Solvent Utilization (08)	All
4.6 On-road Vehicles	On-road Vehicles (11)	All
4.7 Non-road Sources	Non-road Sources (12)	All
4.8 Fugitive Dust	Natural Sources (13)	Geogenic [(02), wind erosion only]
	Miscellaneous (14)	Agriculture & Forestry [(01), agricultural crops and livestock only] Fugitive dust (07)

NOTE: Numbers in parentheses after Tier name are the Tier codes.

Table 4.1-2. Major Source Categories

Tier I Code	Tier I Category	Tier II Code	Tier II Category
01	FUEL COMBUSTION-ELECTRIC UTILITIES		
		01	Coal
		02	Oil
		03	Gas
		04	Other
		05	Internal Combustion
02	FUEL COMBUSTION-INDUSTRIAL		
		01	Coal
		02	Oil
		03	Gas
		04	Other
		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	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

Table 4.1-2. (continued)

Tier I Code	Tier I Category	Tier II Code	Tier II Category
		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 Gas Vehicles & Motorcycles
		02	Light-Duty Gas Trucks
		03	Heavy-Duty Gas Vehicles
		04	Diesels
12	NON-ROAD ENGINES AND VEHICLES		
		01	Non-road Gasoline
		02	Non-road Diesel
		03	Aircraft
		04	Marine Vessels
		05	Railroads
13	NATURAL SOURCES		
		01	Biogenic
		02	Geogenic
		03	Miscellaneous (lightning, freshwater, saltwater)
14	MISCELLANEOUS		
		01	Agriculture & Forestry
		02	Other Combustion (forest fires)
		03	Catastrophic / Accidental Releases
		04	Repair Shops
		05	Health Services
		06	Cooling Towers
		07	Fugitive Dust

NOTE(S): For the purposes of this report, forest fires are considered anthropogenic sources although many fires do occur naturally.

Table 4.1-3. Tier I and Tier II Match-up with Source Classification Codes

Tier I: 01 FUEL COMB. ELEC. UTIL.

Tier II: 01 Coal

10100101	- 10100306	External Combustion Boilers Electric Generation
2101001000	- 2101003000	Stationary Source Fuel Combustion Electric Utility

Tier II: 02 Oil

10100401	- 10100505	External Combustion Boilers Electric Generation
2101004000		Stationary Source Fuel Combustion Electric Utility Distillate Oil Total:
2101004001		Stationary Source Fuel Combustion Electric Utility Distillate Oil All Bo
2101005000		Stationary Source Fuel Combustion Electric Utility Residual Oil Total: A

Tier II: 03 Gas

10100601	- 10100702	External Combustion Boilers Electric Generation
2101006000		Stationary Source Fuel Combustion Electric Utility Natural Gas Total: Bo
2101006001		Stationary Source Fuel Combustion Electric Utility Natural Gas All Boile
2101010000		Stationary Source Fuel Combustion Electric Utility Process Gas Total: Al

Tier II: 04 Other

10100801	- 10101302	External Combustion Boilers Electric Generation
2101007000	- 2101009000	Stationary Source Fuel Combustion Electric Utility

Tier II: 05 Internal Combustion

20100101	- 20101031	Internal Combustion Engines Electric Generation
2101004002		Stationary Source Fuel Combustion Electric Utility Distillate Oil All I.
2101006002		Stationary Source Fuel Combustion Electric Utility Natural Gas All I.C.

Tier I: 02 FUEL COMB. INDUSTRIAL

Tier II: 01 Coal

10200101		Industrial Anthracite Coal Pulverized Coal
10500102		Space Heaters Industrial Coal **
2102001000		Stationary Source Fuel Combustion Industrial Anthracite Coal Total: All
2102002000		Stationary Source Fuel Combustion Industrial Bituminous/Subbituminous Coa
2390001000		Industrial Processes In-Process Fuel Use Anthracite Coal Total
2390002000		Industrial Processes In-Process Fuel Use Bituminous/Subbituminous Coal T
39000189		In-process Fuel Use In-process Fuel Use General

Tier II: 02 Oil

10200401		Industrial Residual Oil Grade 6 Oil
10201403		Industrial CO Boiler Distillate Oil
10201404		Industrial CO Boiler Residual Oil
10500105		Space Heaters Industrial Distillate Oil
2102004000		Stationary Source Fuel Combustion Industrial Distillate Oil Total: Boile
2102005000		Stationary Source Fuel Combustion Industrial Residual Oil Total: All Boi
2390004000		Industrial Processes In-Process Fuel Use Distillate Oil Total
2390005000		Industrial Processes In-Process Fuel Use Residual Oil Total
30190001		Chemical Manufacturing Fuel Fired Equipment Distillate Oil (No. 2): Distillate Hea
30190002		Chemical Manufacturing Fuel Fired Equipment Residual Oil: Process Heaters
30190011		Chemical Manufacturing Fuel Fired Equipment Distillate Oil (No. 2): Incinerators
30190012		Chemical Manufacturing Fuel Fired Equipment Residual Oil: Incinerators
30290001		Food and Agriculture Fuel Fired Equipment Distillate Oil (No. 2)
30290002		Food and Agriculture Fuel Fired Equipment Residual Oil
30390001		Primary Metal Production Fuel Fired Equipment Distillate Oil (No. 2): Process Heat
30390002		Primary Metal Production Fuel Fired Equipment Residual Oil: Process Heaters
30390011		Primary Metal Production Fuel Fired Equipment Distillate Oil (No. 2): Incinerators
30390012		Primary Metal Production Fuel Fired Equipment Residual Oil: Incinerators
30390021		Primary Metal Production Fuel Fired Equipment Distillate Oil (No. 2): Flares
30390022		Primary Metal Production Fuel Fired Equipment Residual Oil: Flares
30490001		Secondary Metal Production Fuel Fired Equipment Distillate Oil (No. 2): Process He
30490002		Secondary Metal Production Fuel Fired Equipment Residual Oil: Process Heaters
30490011		Secondary Metal Production Fuel Fired Equipment Distillate Oil (No. 2): Incinerato
30490012		Secondary Metal Production Fuel Fired Equipment Residual Oil: Incinerators
30490021		Secondary Metal Production Fuel Fired Equipment Distillate Oil (No.2)
30490022		Secondary Metal Production Fuel Fired Equipment Residual Oil
30490031		Secondary Metal Production Fuel Fired Equipment Distillate Oil: Furnaces
30490032		Secondary Metal Production Fuel Fired Equipment Residual Oil: Furnaces
30500207		Mineral Products Asphalt Concrete Asphalt Heater: Residual Oil (Use 3-05-050-21 fo
30500208		Mineral Products Asphalt Concrete Asphalt Heater: Distillate Oil (Use 3-05-050-22
30590001		Mineral Products Fuel Fired Equipment Distillate Oil (No. 2): Process Heaters
30590002		Mineral Products Fuel Fired Equipment Residual Oil: Process Heaters
30590011		Mineral Products Fuel Fired Equipment Distillate Oil (No. 2): Incinerators

Table 4.1-3 (continued)

30590012	Mineral Products Fuel Fired Equipment Residual Oil: Incinerators
30600101	Petroleum Industry Process Heaters Oil-fired **
30600103	Petroleum Industry Process Heaters Oil-fired
30600111	Petroleum Industry Process Heaters Oil-fired (No. 6 Oil) > 100 Million Btu Capacit
30600901	Petroleum Industry Flares Distillate Oil
30600902	Petroleum Industry Flares Residual Oil
30609901	Petroleum Industry Incinerators Distillate Oil (No. 2)
30609902	Petroleum Industry Incinerators Residual Oil
30790001	Pulp and Paper and Wood Products Fuel Fired Equipment Distillate Oil (No. 2): Proc
30790002	Pulp and Paper and Wood Products Fuel Fired Equipment Residual Oil: Process Heater
30790011	Pulp and Paper and Wood Products Fuel Fired Equipment Distillate Oil (No. 2): Inci
30790012	Pulp and Paper and Wood Products Fuel Fired Equipment Residual Oil: Incinerators
30790021	Pulp and Paper and Wood Products Fuel Fired Equipment Distillate Oil (No. 2)
30790022	Pulp and Paper and Wood Products Fuel Fired Equipment Residual Oil
30890001	Rubber and Miscellaneous Plastics Products Process Heaters Distillate Oil (No. 2)
30890002	Rubber and Miscellaneous Plastics Products Process Heaters Residual Oil
30890011	Rubber and Miscellaneous Plastics Products Process Heaters Distillate Oil (No. 2):
30890012	Rubber and Miscellaneous Plastics Products Process Heaters Residual Oil: Incinerat
30990001	Fabricated Metal Products Fuel Fired Equipment Distillate Oil (No. 2): Process Hea
30990002	Fabricated Metal Products Fuel Fired Equipment Residual Oil: Process Heaters
30990011	Fabricated Metal Products Fuel Fired Equipment Distillate Oil (No. 2): Incinerator
30990012	Fabricated Metal Products Fuel Fired Equipment Residual Oil: Incinerators
31000401	Oil and Gas Production Process Heaters Distillate Oil (No. 2)
31000411	Oil and Gas Production Process Heaters Distillate Oil (No. 2): Steam Generators
31390001	Electrical Equipment Process Heaters Distillate Oil (No. 2)
31390002	Electrical Equipment Process Heaters Residual Oil
39000402	In-process Fuel Use In-process Fuel Use Cement Kiln/Dryer
39990001	Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Dist
39990002	Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Resi
39990011	Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Dist
39990012	Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Resi
39990021	Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Dist
39990022	Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Resi
40201002	Surface Coating Operations Coating Oven Heater Distillate Oil
40201003	Surface Coating Operations Coating Oven Heater Residual Oil
40290011	Surface Coating Operations Fuel Fired Equipment Distillate Oil: Incinerator/Afterb
40290012	Surface Coating Operations Fuel Fired Equipment Residual Oil: Incinerator/Afterbur
49090011	Organic Solvent Evaporation Fuel Fired Equipment Distillate Oil (No. 2): Incinerat
49090012	Organic Solvent Evaporation Fuel Fired Equipment Residual Oil: Incinerators
49090021	Organic Solvent Evaporation Fuel Fired Equipment Distillate Oil (No. 2): Flares
49090022	Organic Solvent Evaporation Fuel Fired Equipment Residual Oil: Flares
50390005	Solid Waste Disposal - Industrial Auxillary Fuel/No Emissions Distillate Oil
Tier II: 03 Gas	
10200601	Industrial Natural Gas > 100 Million Btu/hr
10201401	Industrial CO Boiler Natural Gas
10201402	Industrial CO Boiler Process Gas
10500106	Space Heaters Industrial Natural Gas
2102006000	Stationary Source Fuel Combustion Industrial Natural Gas Total: Boilers
2102006001	Stationary Source Fuel Combustion Industrial Natural Gas All Boiler Type
2102010000	Stationary Source Fuel Combustion Industrial Process Gas Total: All Boil
2390006000	Industrial Processes In-Process Fuel Use Natural Gas Total
2390010000	Industrial Processes In-Process Fuel Use Process Gas Total
30190003	Chemical Manufacturing Fuel Fired Equipment Natural Gas: Distillate Heaters
30190004	Chemical Manufacturing Fuel Fired Equipment Process Gas
30190013	Chemical Manufacturing Fuel Fired Equipment Natural Gas: Incinerators
30290003	Food and Agriculture Fuel Fired Equipment Natural Gas
30390003	Primary Metal Production Fuel Fired Equipment Natural Gas: Process Heaters
30390004	Primary Metal Production Fuel Fired Equipment Process Gas: Process Heaters
30390013	Primary Metal Production Fuel Fired Equipment Natural Gas: Incinerators
30390014	Primary Metal Production Fuel Fired Equipment Process Gas: Incinerators
30390023	Primary Metal Production Fuel Fired Equipment Natural Gas: Flares
30390024	Primary Metal Production Fuel Fired Equipment Process Gas: Flares
30490003	Secondary Metal Production Fuel Fired Equipment Natural Gas
30490004	Secondary Metal Production Fuel Fired Equipment Process Gas: Process Heaters
30490013	Secondary Metal Production Fuel Fired Equipment Natural Gas: Incinerators

Table 4.1-3 (continued)

30490014		Secondary Metal Production Fuel Fired Equipment Process Gas: Incinerators
30490023		Secondary Metal Production Fuel Fired Equipment Natural Gas
30490024		Secondary Metal Production Fuel Fired Equipment Process Gas: Flares
30490033		Secondary Metal Production Fuel Fired Equipment Natural Gas: Furnaces
30490034		Secondary Metal Production Fuel Fired Equipment Process Gas: Furnaces
30490035		Secondary Metal Production Fuel Fired Equipment Propane
30500206		Mineral Products Asphalt Concrete Asphalt Heater: Natural Gas (Use 3-05-050-20 for
30590003		Mineral Products Fuel Fired Equipment Natural Gas: Process Heaters
30590013		Mineral Products Fuel Fired Equipment Natural Gas: Incinerators
30590023		Mineral Products Fuel Fired Equipment Natural Gas: Flares
30600102		Petroleum Industry Process Heaters Gas-fired **
30600104		Petroleum Industry Process Heaters Gas-fired
30600108		Petroleum Industry Process Heaters Landfill Gas-fired
30600903		Petroleum Industry Flares Natural Gas
30600904		Petroleum Industry Flares Process Gas
30609903		Petroleum Industry Incinerators Natural Gas
30609904		Petroleum Industry Incinerators Process Gas
30790003		Pulp and Paper and Wood Products Fuel Fired Equipment Natural Gas: Process Heaters
30790013		Pulp and Paper and Wood Products Fuel Fired Equipment Natural Gas: Incinerators
30790023		Pulp and Paper and Wood Products Fuel Fired Equipment Natural Gas: Flares
30890003		Rubber and Miscellaneous Plastics Products Process Heaters Natural Gas
30890013		Rubber and Miscellaneous Plastics Products Process Heaters Natural Gas: Incinerato
30890023		Rubber and Miscellaneous Plastics Products Process Heaters Natural Gas: Flares
30990003		Fabricated Metal Products Fuel Fired Equipment Natural Gas: Process Heaters
30990013		Fabricated Metal Products Fuel Fired Equipment Natural Gas: Incinerators
30990023		Fabricated Metal Products Fuel Fired Equipment Natural Gas: Flares
31000205		Oil and Gas Production Natural Gas Production Flares
31000404		Oil and Gas Production Process Heaters Natural Gas
31000405		Oil and Gas Production Process Heaters Process Gas
31000414		Oil and Gas Production Process Heaters Natural Gas: Steam Generators
31000415		Oil and Gas Production Process Heaters Process Gas: Steam Generators
31390003		Electrical Equipment Process Heaters Natural Gas
39000602		In-process Fuel Use In-process Fuel Use Cement Kiln/Dryer
39900601		Miscellaneous Manufacturing Industries Process Heater/Furnace Natural Gas
39990003		Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Natu
39990004		Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Proc
39990013		Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Natu
39990014		Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Proc
39990023		Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Natu
39990024		Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries Proc
40201001		Surface Coating Operations Coating Oven Heater Natural Gas
40290013		Surface Coating Operations Fuel Fired Equipment Natural Gas: Incinerator/Afterburn
40290023		Surface Coating Operations Fuel Fired Equipment Natural Gas: Flares
49090013		Organic Solvent Evaporation Fuel Fired Equipment Natural Gas: Incinerators
49090023		Organic Solvent Evaporation Fuel Fired Equipment Natural Gas: Flares
50390006		Solid Waste Disposal - Industrial Auxillary Fuel/No Emissions Natural Gas
Tier II: 04 Other		
10200801	- 10201302	External Combustion Boilers Industrial
10500110	- 10500114	External Combustion Boilers Space Heaters Industrial
2102007000	- 2102009000	Stationary Source Fuel Combustion Industrial
2390007000	- 2390009000	Industrial Processes In-Process Fuel Use
30290005		Food and Agriculture Fuel Fired Equipment Process Heaters: LPG
30500209		Mineral Products Asphalt Concrete Asphalt Heater: LPG (Use 3-05-050-23 for MACT)
30600107		Petroleum Industry Process Heaters LPG-fired
30600199		Petroleum Industry Process Heaters Other Not Classified
30600905		Petroleum Industry Flares Liquified Petroleum Gas
30600999		Petroleum Industry Flares Not Classified **
30609905		Petroleum Industry Incinerators Liquified Petroleum Gas
30890004		Rubber and Miscellaneous Plastics Products Process Heaters Liquified Petroleum Gas
39000801	- 39001399	In-Process Fuel Use In-Process Fuel Use
40201004		Surface Coating Operations Coating Oven Heater Liquified Petroleum Gas (LPG)
50390010		Solid Waste Disposal - Industrial Auxillary Fuel/No Emissions Liquified Petroleum
Tier II: 05 Internal Combustion		
20180001		Electric Generation Equipment Leaks Equipment Leaks
20200101	- 20201002	Internal Combustion Engines Industrial

Table 4.1-3 (continued)

2102006002		Stationary Source Fuel Combustion Industrial Natural Gas All I.C. Engine
27501001		Fixed Wing Aircraft L & TO Exhaust Military Piston Engine: Aviation Gas
27501014		Fixed Wing Aircraft L & TO Exhaust Military Jet Engine: JP-4
27501015		Fixed Wing Aircraft L & TO Exhaust Military Jet Engine: JP-5
27502001		Fixed Wing Aircraft L & TO Exhaust Commercial Piston Engine: Aviation Gas
27502011		Fixed Wing Aircraft L & TO Exhaust Commercial Jet Engine: Jet A
27505001		Fixed Wing Aircraft L & TO Exhaust Civil Piston Engine: Aviation Gas
27505011		Fixed Wing Aircraft L & TO Exhaust Civil Jet Engine: Jet A
27601014		Rotary Wing Aircraft L & TO Exhaust Military Jet Engine: JP-4
27601015		Rotary Wing Aircraft L & TO Exhaust Military Jet Engine: JP-5
28000211		Diesel Marine Vessels Commercial Crew Boats: Main Engine Exhaust: Idling
28000212		Diesel Marine Vessels Commercial Crew Boats: Main Engine Exhaust: Maneuvering
28000213		Diesel Marine Vessels Commercial Crew Boats: Auxiliary Generator Exhaust: Hotellin
28000216		Diesel Marine Vessels Commercial Supply Boats: Main Engine Exhaust: Idling
28000217		Diesel Marine Vessels Commercial Supply Boats: Main Engine Exhaust: Maneuvering
28000218		Diesel Marine Vessels Commercial Supply Boats: Auxiliary Generator Exhaust: Hotell
Tier I: 03 FUEL COMB. OTHER		
Tier II: 01 Commercial/Institutional Coal		
10300101	- 10300309	External Combustion Boilers Commercial/Institutional
10500202		Space Heaters Commercial/Institutional Coal **
2103001000		Stationary Source Fuel Combustion Commercial/Institutional Anthracite Coa
2103002000		Stationary Source Fuel Combustion Commercial/Institutional Bituminous/Sub
2199001000	- 2199003000	Stationary Source Fuel Combustion Total Area Source Fuel Combustion
Tier II: 02 Commercial/Institutional Oil		
10300401	- 10300504	External Combustion Boilers Commercial/Institutional
10500205		Space Heaters Commercial/Institutional Distillate Oil
20300101		Commercial/Institutional Distillate Oil (Diesel) Reciprocating
20300102		Commercial/Institutional Distillate Oil (Diesel) Turbine
20300107		Commercial/Institutional Distillate Oil (Diesel) Reciprocating: Exhaust
2103004000		Stationary Source Fuel Combustion Commercial/Institutional Distillate Oil
2103005000		Stationary Source Fuel Combustion Commercial/Institutional Residual Oil
2199004000	- 2199005000	Stationary Source Fuel Combustion Total Area Source Fuel Combustion
50190005		Solid Waste Disposal - Government Auxillary Fuel/No Emissions Distillate Oil
50290005		Solid Waste Disposal - Commercial/Institutional Auxillary Fuel/No Emissions Distil
Tier II: 03 Commercial/Institutional Gas		
10300601	- 10300799	External Combustion Boilers Commercial/Institutional
10500206		Space Heaters Commercial/Institutional Natural Gas
20300201	- 20300702	Internal Combustion Engines Commercial/Institutional
2103006000		Stationary Source Fuel Combustion Commercial/Institutional Natural Gas T
2199006000	- 2199006002	Stationary Source Fuel Combustion Total Area Source Fuel Combustion Natural Gas
27300320		Non-road Sources LPG-fueled Engines Industrial Equipment Industrial Fork Lift: Liquifie
50190006		Solid Waste Disposal - Government Auxillary Fuel/No Emissions Natural Gas
50290006		Solid Waste Disposal - Commercial/Institutional Auxillary Fuel/No Emissions Natura
Tier II: 04 Misc. Fuel Comb. (Except Residential)		
10300901	- 10301303	External Combustion Boilers Commercial/Institutional
10500209	- 10500214	External Combustion Boilers Space Heaters Commercial-Institutional
20190099		Electric Generation Flares Heavy Water
20301001	- 20400402	Internal Combustion Engines
2103007000	- 2103011010	Stationary Source Fuel Combustion Commercial/Institutional
2199007000		Stationary Source Fuel Combustion Total Area Source Fuel Combustion Liqui
2199009000	- 2199011000	Stationary Source Fuel Combustion Total Area Source Fuel Combustion
28888801	- 28888803	Internal Combustion Engines Fugitive Emissions Other Not ClassifiedSpecify in Co
50190010		Solid Waste Disposal - Government Auxillary Fuel/No Emissions Liquified Petroleum
50290010		Solid Waste Disposal - Commercial/Institutional Auxillary Fuel/No Emissions Liquif

Table 4.1-3 (continued)

Tier II: 05 Residential Wood

2104008000	- 2104008053	Stationary Source Fuel Combustion Residential Wood
2199008000		Stationary Source Fuel Combustion Total Area Source Fuel Combustion Wood

Tier II: 06 Residential Other

2104001000	- 2104007000	Stationary Source Fuel Combustion Residential
2104011000		Stationary Source Fuel Combustion Residential Kerosene Total: All Heater

Tier I: 04 CHEMICAL & ALLIED PRODUCT MFG

Tier II: 01 Organic Chemicals

2301000000		Industrial Processes Chemical Manufacturing: SIC 28 All Process Total
2301040000		Industrial Processes Chemical Manufacturing: SIC 28
30100101		Chemical Manufacturing Adipic Acid General
30100103	- 30100105	Chemical Manufacturing Chemical Manufacturing Adipic Acid
30100107	- 30100199	Chemical Manufacturing Chemical Manufacturing Adipic Acid
30100601	- 30100699	Chemical Manufacturing Chemical Manufacturing Charcoal Manufacture
30101901	- 30101907	Chemical Manufacturing Chemical Manufacturing Phthalic Anhydride
30103101	- 30103104	Chemical Manufacturing Chemical Manufacturing Terephthalic Acid/DimethylTerephth
30103180		Chemical Manufacturing Terephthalic Acid/Dimethyl Terephthalate Fugitive Emissions
30103199		Chemical Manufacturing Terephthalic Acid/Dimethyl Terephthalate Other Not Classifi
30103402	- 30103499	Chemical Manufacturing Chemical Manufacturing
30104201	- 30104203	Chemical Manufacturing Lead Alkyl Mfg. Na/Pb Alloy Process
30104301		Chemical Manufacturing Lead Alkyl Manufacturing (Electrolytic Process) General
30109101	- 30110099	Chemical Manufacturing Chemical Manufacturing
30112001	- 30112780	Chemical Manufacturing Chemical Manufacturing
30113201	- 30121009	Chemical Manufacturing
30121080	- 30130107	Chemical Manufacturing Chemical Manufacturing
30130110	- 30181001	Chemical Manufacturing Chemical Manufacturing
30184001		Chemical Manufacturing General Processes Distillation Units

Tier II: 02 Inorganic Chemicals

2301010000		Industrial Processes Chemical Manufacturing: SIC 28 Industrial Inorganic
2301010010		Industrial Processes Chemical Manufacturing: SIC 28 Industrial Inorganic
30100801		Chemical Manufacturing Chloro-alkali Production Liquefaction (Diaphragm Cell Proc
30100802		Chemical Manufacturing Chloro-alkali Production Liquefaction (Mercury Cell Proces
30100805		Chemical Manufacturing Chloro-alkali Production Air Blowing of Mercury Cell Brine
30100899		Chemical Manufacturing Chloro-alkali Production Other Not Classified
30101101		Chemical Manufacturing Hydrochloric Acid By-product Process
30101199	- 30101203	Chemical Manufacturing Chemical Manufacturing
30101206		Chemical Manufacturing Hydroflouric Acid Tail Gas Vent
30101299		Chemical Manufacturing Hydroflouric Acid Other Not Classified
30102101	- 30102319	Chemical Manufacturing
30102322		Chemical Manufacturing Sulfuric Acid (Contact Process) Process Equipment Leaks
30102399		Chemical Manufacturing Sulfuric Acid (Contact Process) Other Not Classified
30103201	- 30103299	Chemical Manufacturing Chemical Manufacturing Elemental Sulfur Production
30103501	- 30103553	Chemical Manufacturing Chemical Manufacturing Inorganic Pigments
30103599	- 30103903	Chemical Manufacturing Chemical Manufacturing
30107001		Chemical Manufacturing Inorganic Chemical Manufacturing (General) Fugitive Leaks
30111201	- 30111401	Chemical Manufacturing Chemical Manufacturing

Tier II: 03 Polymers & Resins

2301020000		Industrial Processes Chemical Manufacturing: SIC 28
30101801	- 30101807	Chemical Manufacturing Plastics Production Specific Products
30101809		Chemical Manufacturing Plastics Production Extruder
30101812	- 30101814	Chemical Manufacturing Plastics Production Specific Products
30101817	- 30101820	Chemical Manufacturing Plastics Production Specific Products
30101822	- 30101839	Chemical Manufacturing Plastics Production Specific Products
30101842	- 30101863	Chemical Manufacturing
30101870	- 30101882	Chemical Manufacturing Chemical Manufacturing
30101885	- 30101892	Chemical Manufacturing
30101899		Chemical Manufacturing Plastics Production Others Not Specified
30102401	- 30102424	Chemical Manufacturing Syn. Org. Fiber Mfg.
30102426		Chemical Manufacturing Synthetic Organic Fiber Manufacturing Equipment Cleanup (Us
30102499	- 30102611	Chemical Manufacturing
30102613	- 30102699	Chemical Manufacturing
64520011		Miscellaneous Resins Alkyd Resin Production, Solvent Process Polymerization Reacti
64630001		Vinyl-based Resins Polyvinyl Chloride and Copolymers Production - Suspension Proce
64630052		Vinyl-based Resins Polyvinyl Chloride and Copolymers Production - Suspension Proce

Table 4.1-3 (continued)

64920030		Fibers Production Processes Rayon Fiber Production Fiber Finishing
Tier II: 04 Agricultural Chemicals		
30100305	- 30100399	Chemical Manufacturing Chemical Manufacturing Ammonia Production
30101301	- 30101399	Chemical Manufacturing Chemical Manufacturing Nitric Acid
30101601		Chemical Manufacturing Phosphoric Acid: Wet Process Reactor
30101603	- 30101799	Chemical Manufacturing Chemical Manufacturing
30102701	- 30102708	Chemical Manufacturing Chemical Manufacturing Ammonium Nitrate Production
30102710	- 30102801	Chemical Manufacturing Chemical Manufacturing
30102806	- 30102820	Chemical Manufacturing Chemical Manufacturing Normal Superphosphate
30102822	- 30102825	Chemical Manufacturing Chemical Manufacturing Normal Superphosphate
30102906	- 30102920	Chemical Manufacturing Chemical Manufacturing Triple Superphosphate
30102922	- 30103002	Chemical Manufacturing Chemical Manufacturing
30103004	- 30103099	Chemical Manufacturing Chemical Manufacturing Ammonium Phosphates
30103301	- 30103399	Chemical Manufacturing Chemical Manufacturing Pesticides
30104001	- 30104006	Chemical Manufacturing Chemical Manufacturing Urea Production
30104008	- 30104013	Chemical Manufacturing Chemical Manufacturing Urea Production
30104501		Chemical Manufacturing Organic Fertilizer General: Mixing/Handling
30113004		Chemical Manufacturing Ammonium Sulfate (Use 3-01-210 for Caprolactum Production)
30113005		Chemical Manufacturing Ammonium Sulfate (Use 3-01-210 for Caprolactum Production)
Tier II: 05 Paints, Varnishs, Lacquers, Enamels		
30101401	- 30101403	Chemical Manufacturing Chemical Manufacturing Paint Manufacture
30101415		Chemical Manufacturing Paint Manufacture Premix/Preassembly
30101430		Chemical Manufacturing Paint Manufacture Pigment Grinding/Milling
30101450		Chemical Manufacturing Paint Manufacture Product Finishing
30101451		Chemical Manufacturing Paint Manufacture Product Finishing, Tinting: Mix Tank and
30101470		Chemical Manufacturing Paint Manufacture Equipment Cleaning
30101498		Chemical Manufacturing Paint Manufacture Other Not Classified
30101499	- 30101599	Chemical Manufacturing Chemical Manufacturing
Tier II: 06 Pharmaceuticals		
2301030000		Industrial Processes Chemical Manufacturing: SIC 28
30106001	- 30106009	Chemical Manufacturing Chemical Manufacturing Pharmaceutical Preparations
30106011	- 30106099	Chemical Manufacturing Chemical Manufacturing Pharmaceutical Preparations
Tier II: 07 Other Chemicals		
30100501	- 30100507	Chemical Manufacturing Chemical Manufacturing Carbon Black Production
30100509		Chemical Manufacturing Carbon Black Production Furnace Process: Fugitive Emissions
30100599		Chemical Manufacturing Carbon Black Production Other Not Classified
30100701	- 30100799	Chemical Manufacturing Chemical Manufacturing
30100901	- 30101014	Chemical Manufacturing
30101021		Chemical Manufacturing Explosives (Trinitrotoluene) Continuous Process: Nitration
30101022		Chemical Manufacturing Explosives (Trinitrotoluene) Continuous Process: Nitration
30101099		Chemical Manufacturing Explosives (Trinitrotoluene) Other Not Classified
30102001	- 30102099	Chemical Manufacturing Chemical Manufacturing Printing Ink Manufacture
30104101	- 30104199	Chemical Manufacturing Chemical Manufacturing Nitrocellulose
30105001		Chemical Manufacturing Adhesives General/Compound Unknown **
30111103		Chemical Manufacturing Asbestos Chemical Brake Line/Grinding **
30111199		Chemical Manufacturing Asbestos Chemical Not Classified **
30188801	- 30188805	Chemical Manufacturing Chemical Manufacturing Fugitive Emissions Specify inComme
30196099		Chemical Manufacturing
30199998		Chemical Manufacturing Other Not Classified Specify in Comments Field
30199999		Chemical Manufacturing Other Not Classified Specify in Comments Field
Tier I: 05 METALS PROCESSING		
Tier II: 01 Non-Ferrous Metals Processing		
2304050000		Industrial Processes Secondary Metal Production: SIC 33 Nonferrous Foundr
30300001		Primary Metal Production Aluminum Ore (Bauxite) Crushing/Handling
30300002		Primary Metal Production Aluminum Ore (Bauxite) Drying Oven
30300101	- 30300201	Primary Metal Production Primary Metal Production
30300502	- 30300518	Primary Metal Production Primary Metal Production Primary Copper Smelting
30300521	- 30300599	Primary Metal Production Primary Metal Production Primary Copper Smelting
30301001	- 30301010	Primary Metal Production Primary Metal Production Lead Production
30301014		Primary Metal Production Lead Production Sintering Charge Mixing
30301015		Primary Metal Production Lead Production Sinter Crushing/Screening
30301017	- 30301025	Primary Metal Production Primary Metal Production Lead Production
30301099	- 30301499	Primary Metal Production Primary Metal Production
30303002	- 30303008	Primary Metal Production Primary Metal Production Zinc Production

Table 4.1-3 (continued)

30303010		Primary Metal Production Zinc Production Sinter Breaking and Cooling
30303011		Primary Metal Production Zinc Production Zinc Casting
30303014	- 30303099	Primary Metal Production Primary Metal Production Zinc Production
30400101	- 30400299	Secondary Metal Production
30400401	- 30400699	Secondary Metal Production Secondary Metal Production
30400801	- 30400899	
30401001	- 30401099	Secondary Metal Production Secondary Metal Production Nickel Production
30404001		Secondary Metal Production Lead Cable Coating General
36000101		Printing and Publishing Typesetting (Lead Remelting) Remelting (Lead Emissions Onl
Tier II: 02 Ferrous Metals Processing		
2303020000		Industrial Processes Primary Metal Production: SIC 33 Iron & Steel Foundr
30300302	- 30300304	Primary Metal Production Primary Metal Production By-Product Coke Manufacturing
30300306	- 30300308	Primary Metal Production Primary Metal Production By-Product Coke Manufacturing
30300310	- 30300315	Primary Metal Production Primary Metal Production By-Product Coke Manufacturing
30300331	- 30300401	Primary Metal Production Primary Metal Production
30300601	- 30300611	Primary Metal Production Ferroalloy Open Furnace
30300615	- 30300802	Primary Metal Production
30300808		Primary Metal Production Iron Production (See 3-03-015 for Integrated Iron & Steel
30300813	- 30300819	Primary Metal Production Iron Production Sintering
30300824	- 30300826	Primary Metal Production Iron Production Blast Furnaces
30300899	- 30300914	Primary Metal Production
30300916	- 30300999	Primary Metal Production Primary Metal Production Steel Production
30302301	- 30302303	Primary Metal Production Primary Metal Production Taconite Iron Ore Processing
30302306		Primary Metal Production Taconite Iron Ore Processing Dry Grinding/Milling
30302308		Primary Metal Production Taconite Iron Ore Processing Bentonite Blending
30302311	- 30302315	Primary Metal Production Primary Metal Production Taconite Iron Ore Processing
30400301	- 30400355	Secondary Metal Production Secondary Metal Production Gray Iron Foundries
30400358	- 30400399	Secondary Metal Production Secondary Metal Production Gray Iron Foundries
30400701	- 30400720	Secondary Metal Production Secondary Metal Production Steel Foundries
30400722		Secondary Metal Production Steel Foundries Muller
30400724	- 30400799	Secondary Metal Production Secondary Metal Production Steel Foundries
30400901		Secondary Metal Production Malleable Iron Annealing
30400999		Secondary Metal Production Malleable Iron Other Not Classified
30405001		Secondary Metal Production Miscellaneous Casting Fabricating Other Not Classified
30405099		Secondary Metal Production Miscellaneous Casting Fabricating Other Not Classified
Tier II: 03 Metals Processing NEC		
2303000000		Industrial Processes Primary Metal Production: SIC 33 All Processes Tota
2304000000		Industrial Processes Secondary Metal Production: SIC 33 All Processes To
30302401	- 30302411	Primary Metal Production Metal Mining General Processes
30388801	- 30388805	Primary Metal Production Primary Metal Production Fugitive Emissions SpecifyiCom
30399999		Primary Metal Production Other Not Classified Other Not Classified
30402001	- 30402211	Secondary Metal Production Secondary Metal Production
30404901	- 30404999	Secondary Metal Production Secondary MetalProductsMiscellaneous Castingand
30488801	- 30488805	Secondary Metal Production Secondary Metal Production Fugitive Emissions Specif
30499999		Secondary Metal Production Other Not Classified Specify in Comments Field
Tier I: 06 PETROLEUM & RELATED INDUSTRIES		
Tier II: 01 Oil & Gas Production		
2310000000	- 2310030000	Industrial Processes Oil & Gas Production: SIC 13
31000101	- 31000103	Oil and Gas Production Oil and Gas Production Crude Oil Production
31000160		Oil and Gas Production Crude Oil Production Flares
31000199	- 31000204	Oil and Gas Production Oil and Gas Production
31000206	- 31000299	Oil and Gas Production Oil and Gas Production Natural Gas Production
31000301		Oil and Gas Production Natural Gas Processing Facilities Glycol Dehydrators: Reboi
31000302		Oil and Gas Production Natural Gas Processing Facilities Glycol Dehydrators: Reboi
31000303		Oil and Gas Production Natural Gas Processing Facilities Glycol Dehydrators: Phase
31000304		Oil and Gas Production Natural Gas Processing Facilities Glycol Dehydrators: Ethyl
31000305		Oil and Gas Production Natural Gas Processing Facilities Gas Sweeting: Amine Proce
31000306		Oil and Gas Production Natural Gas Processing Facilities Process Valves
31000309		Oil and Gas Production Natural Gas Processing Facilities Compressor Seals
31000310		Oil and Gas Production Natural Gas Processing Facilities Pump Seals
31000311		Oil and Gas Production Natural Gas Processing Facilities Flanges and Connections
31000406		Oil and Gas Production Process Heaters Propane/Butane
31088801	- 31088805	Oil and Gas Production Oil and Gas ProductionFugitive EmissionsSpecify in Comment
Tier II: 02 Petroleum Refineries & Related Industries		

Table 4.1-3 (continued)

2306000000		Industrial Processes Petroleum Refining: SIC 29 All Processes Total
30600201	- 30600822	Petroleum Industry Petroleum Industry
30601001	- 30601599	Petroleum Industry Petroleum Industry
30610001	- 30699999	Petroleum Industry Petroleum Industry

Tier II: 03 Asphalt Manufacturing

2306010000		Industrial Processes Petroleum Refining: SIC 29 Asphalt Paving/Roofing Ma
30500101	- 30500202	Mineral Products Mineral Products
30500204		Mineral Products Asphalt Concrete Cold Aggregate Handling
30500205		Mineral Products Asphalt Concrete Drum Dryer: Hot Asphalt Plants
30500211		Mineral Products Asphalt Concrete Rotary Dryer Conventional Plant with Cyclone
30500212		Mineral Products Asphalt Concrete Heated Asphalt Storage Tanks: Drum Mix
30500213		Mineral Products Asphalt Concrete Storage Silo
30500214		Mineral Products Asphalt Concrete Truck Load-out
30500221		Mineral Products Asphalt Concrete Elevators: Continuous Process
30500290		Mineral Products Asphalt Concrete Haul Roads: General
30500298		Mineral Products Asphalt Concrete Other Not Classified
30500299		Mineral Products Asphalt Concrete See Comment **

Tier I: 07 OTHER INDUSTRIAL PROCESSES

Tier II: 01 Agriculture, Food, & Kindred Products

2302000000	- 2302080000	Industrial Processes Food & Kindred Products: SIC 20
2801600000		Miscellaneous Area Sources Agriculture Production - Crops Country Grain E
30200101	- 30200504	Food and Agriculture Food and Agriculture
30200512	- 30200604	Food and Agriculture Food and Agriculture
30200611	- 30200705	Food and Agriculture Food and Agriculture
30200712	- 30200714	Food and Agriculture Food and Agriculture Durum Milling
30200722	- 30200730	Food and Agriculture Food and Agriculture
30200732	- 30200734	Food and Agriculture Food and Agriculture Wheat Milling
30200740		Food and Agriculture Grain Millings Dry Corn Milling: Silo Storage
30200742	- 30200745	Food and Agriculture Food and Agriculture Corn: Dry Milling
30200748		Food and Agriculture Grain Millings Dry Corn Milling: Grinding
30200752	- 30200754	Food and Agriculture Food and Agriculture Corn: Wet Milling
30200756		Food and Agriculture Grain Millings Wet Corn Milling: Milling
30200760		Food and Agriculture Grain Millings Oat: General
30200763		Food and Agriculture Grain Millings Gluten Feed Drying: Direct-fired Dryer - Produ
30200772	- 30200774	Food and Agriculture Food and Agriculture Rice Milling
30200782	- 30200790	Food and Agriculture Food and Agriculture Soybean Mills
30200799		Food and Agriculture Grain Millings See Comments **
30200801		Food and Agriculture Feed Manufacture General **
30200804	- 30201919	Food and Agriculture
30201945		Food and Agriculture Vegetable Oil Processing Oil Refining: Oil Stripping Column
30201998		Food and Agriculture Vegetable Oil Processing Soybean Oil Production: Complete Pro
30201999	- 30203104	Food and Agriculture
30203201	- 30288805	Food and Agriculture
30299998		Food and Agriculture Other Not Specified Other Not Classified
30299999		Food and Agriculture Other Not Specified Other Not Classified

Tier II: 02 Textiles, Leather, & Apparel Products

32099997	- 33088805	Textiles, Leather, & Apparel Products

Tier II: 03 Wood, Pulp & Paper, & Publishing Products

2307000000		Industrial Processes Wood Products: SIC 24 All Processes Total
2307020000	- 2307060000	Industrial Processes Wood Products: SIC 24
30700101	- 30702099	Pulp & Paper and Wood Products Pulp & Paper and Wood Products
30703003	- 30788898	Pulp & Paper and Wood Products Pulp & Paper and Wood Products
30799901		Pulp and Paper and Wood Products Other Not Classified Battery Separators
30799998		Pulp and Paper and Wood Products Other Not Classified Other Not Classified
30799999		Pulp and Paper and Wood Products Other Not Classified See Comment **

Tier II: 04 Rubber & Miscellaneous Plastic Products

2308000000		Industrial Processes Rubber/Plastics: SIC 30 All Processes Total
30800101	- 30800108	Rubber and Miscellaneous Plastics Products Rubber and Miscellaneous Plastics Prod
30800120	- 30800802	Rubber and Miscellaneous Plastics Products Rubber and Miscellaneous Plastics Prod
30800901		Rubber and Miscellaneous Plastics Products Plastic Miscellaneous Products Polystyr
30899999		Rubber and Miscellaneous Plastics Products Other Not Specified Other Not Classifie

Tier II: 05 Mineral Products

2305000000	- 2305080000	Industrial Processes Mineral Processes: SIC 32

Table 4.1-3 (continued)

30500231		Mineral Products Asphalt Concrete Hot Bins and Screens: Continuous Process
30500301		Mineral Products Brick Manufacture Raw Material Drying
30500302		Mineral Products Brick Manufacture Raw Material Grinding
30500304	- 30500405	Mineral Products Mineral Products
30500499	- 30500606	Mineral Products Mineral Products
30500609	- 30500611	Mineral Products Mineral Products Cement Manufacturing: Dry Process
30500613		Mineral Products Cement Manufacturing (Dry Process) Raw Material Grinding and Dryi
30500614		Mineral Products Cement Manufacturing (Dry Process) Clinker Cooler
30500617		Mineral Products Cement Manufacturing (Dry Process) Clinker Grinding
30500623		Mineral Products Cement Manufacturing (Dry Process) Preheater/Precalciner Kiln
30500624		Mineral Products Cement Manufacturing (Dry Process) Raw Mill Feed Belt
30500626		Mineral Products Cement Manufacturing (Dry Process) Raw Mill Air Separator
30500627		Mineral Products Cement Manufacturing (Dry Process) Finish Grinding Mill Feed Belt
30500629		Mineral Products Cement Manufacturing (Dry Process) Finish Grinding Mill Air Separ
30500699		Mineral Products Cement Manufacturing (Dry Process) Other Not Classified
30500706		Mineral Products Cement Manufacturing (Wet Process) Kilns
30500709	- 30500711	Mineral Products Mineral Products Cement Manufacturing: Wet Process
30500714		Mineral Products Cement Manufacturing (Wet Process) Clinker Cooler
30500717		Mineral Products Cement Manufacturing (Wet Process) Clinker Grinding
30500799	- 30500802	Mineral Products Mineral Products
30500806		Mineral Products Ceramic Clay/Tile Manufacture Raw Material Handling and Transfer
30500810	- 30500904	Mineral Products Mineral Products
30500907	- 30500909	Mineral Products Mineral Products Clay & Fly Ash Sintering
30500915	- 30501007	Mineral Products
30501010		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Crushin
30501012		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Screeni
30501013		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Air Tab
30501017		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Seconda
30501022		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Drillin
30501034		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Coal Se
30501035		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Blastin
30501099		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Other N
30501101		Mineral Products Concrete Batching General (Non-fugitive)
30501112		Mineral Products Concrete Batching Mixing: Wet
30501113		Mineral Products Concrete Batching Mixing: Dry
30501120	- 30501215	Mineral Products
30501223	- 30501503	Mineral Products
30501505	- 30501507	Mineral Products Mineral Products Gypsum Manufacture
30501511	- 30501513	Mineral Products Mineral Products Gypsum Manufacture
30501515	- 30501517	Mineral Products Mineral Products Gypsum Manufacture
30501519	- 30501606	Mineral Products Mineral Products
30501609		Mineral Products Lime Manufacture Hydrator: Atmospheric
30501611		Mineral Products Lime Manufacture Product Cooler
30501612		Mineral Products Lime Manufacture Pressure Hydrator
30501616	- 30501902	Mineral Products Mineral Products
30501905	- 30502006	Mineral Products Mineral Products
30502008	- 30502010	Mineral Products Mineral Products Stone Quarrying/Processing
30502012	- 30502105	Mineral Products Mineral Products
30502201	- 30502501	Mineral Products Mineral Products
30502508	- 30503103	Mineral Products Mineral Products
30503108		Mineral Products Asbestos Mining Overburden Stripping
30503109		Mineral Products Asbestos Mining Ventilation of Process Operations
30503199	- 30504010	Mineral Products Mineral Products
30504024		Mineral Products Mining and Quarrying of Nonmetallic Minerals Overburden Stripping
30504030	- 30504034	Mineral Products Mineral Products Mining & Quarrying of Nonmetallic Minerals
30504099	- 30509101	Mineral Products Mineral Products
30515001	- 30588805	Mineral Products Mineral Products
30599999		Mineral Products Other Not Defined Specify in Comments Field
Tier II: 06	**Machinery Products**	
2309000000	- 2309100260	Industrial Processes Fabricated Metals: SIC 34
30900198	- 30988805	Fabricated Metal Products Fabricated Metal Products
30988806		Fabricated Metal Products Fugitive Emissions Other Not Classified
30999997	- 30999999	Fabricated Metal Products Fabricated Metal Products Other Not Classified
Tier II: 07	**Electronic Equipment**	
31303502		Electrical Equipment Manufacturing - General Processes Cleaning

Table 4.1-3 (continued)

31306500		Electrical Equipment Semiconductor Manufacturing Integrated Circuit Manufacturing:
31306530		Electrical Equipment Semiconductor Manufacturing Etching Process: Wet Chemical: Sp
31399999		Electrical Equipment Other Not Classified Other Not Classified
Tier II: 08 Transportation Equipment		
31400901		Transportation Equipment Automobiles/Truck Assembly Operations Solder Joint Grindi
31401101	- 31499999	Transportation Equipment Transportation Equipment
Tier II: 09 Construction		
2311000020		Industrial Processes Construction: SIC 15 - 17 All Processes Demolition
2311000030		Industrial Processes Construction: SIC 15 - 17 All Processes Blasting
2311000080		Industrial Processes Construction: SIC 15 - 17 All Processes Welding Ope
2311010020		Industrial Processes Construction: SIC 15 - 17 General Building Construct
2311010030		Industrial Processes Construction: SIC 15 - 17 General Building Construct
2311010080		Industrial Processes Construction: SIC 15 - 17 General Building Construct
2311020020		Industrial Processes Construction: SIC 15 - 17 Heavy Construction Demoli
2311020030		Industrial Processes Construction: SIC 15 - 17 Heavy Construction Blasti
2311020080		Industrial Processes Construction: SIC 15 - 17 Heavy Construction Weldin
2311030020		Industrial Processes Construction: SIC 15 - 17 Road Construction Demolit
2311030030		Industrial Processes Construction: SIC 15 - 17 Road Construction Blastin
2311030080		Industrial Processes Construction: SIC 15 - 17 Road Construction Welding
2311040080		Industrial Processes Construction: SIC 15 - 17 Special Trade Construction
31100199	- 31100202	Building Construction Building Construction
31100299		Building Construction Demolitions/Special Trade Contracts Other Not Classified: Co
Tier II: 10 Miscellaneous Industrial Processes		
2312000000		Industrial Processes Machinery: SIC 35 All Processes Total
2312050000		Industrial Processes Machinery: SIC 35 Metalworking Machinery: Tool & Die
2399000000		Industrial Processes Industrial Processes: NEC Industrial Processes: NEC
31299999		Machinery, Miscellaneous Miscellaneous Machinery Other Not Classified
31501002		Photographic Equipment Photocopying Equipment Manufacturing Toner Classification
31501003		Photographic Equipment Photocopying Equipment Manufacturing Toner (Carbon Black) G
39999989	- 39999999	Miscellaneous Manufacturing Industries Miscellaneous Manufacturing Industries
Tier I: 08 SOLVENT UTILIZATION		
Tier II: 01 Degreasing		
2415000000	- 2415365999	Solvent Utilization Degreasing
40100201	- 40100399	Organic Solvent Evaporation Degreasing
40188801	- 40188898	Organic Solvent Evaporation Degreasing Fugitive Emissions Specify in Comments F
Tier II: 02 Graphic Arts		
2425000000	- 2425040999	Solvent Utilization Graphic Arts
40500101	- 40500601	Printing/Publishing Printing Process
40500801	- 40588805	Printing/Publishing Printing Process
Tier II: 03 Dry Cleaning		
2420000000	- 2420020999	Solvent Utilization Dry Cleaning
40100101	- 40100199	Organic Solvent Evaporation Dry Cleaning Dry Cleaning
41000102		Dry Cleaning Petroleum Solvent - Industrial Stoddard
41000201		Dry Cleaning Petroleum Solvent - Commercial Stoddard
41000202		Dry Cleaning Petroleum Solvent - Commercial Stoddard
68241030		Miscellaneous Processes Paint Stripper Users - Non-chemical Strippers Media Blasti
Tier II: 04 Surface Coating		
2401001000	- 2401990999	Solvent Utilization Surface Coating
2440020000		Solvent Utilization Miscellaneous Industrial Adhesive (Industrial) Applic
40200101	- 40200706	Surface Coating Operations Surface Coating Operations Surface Coating Applicatio
40200710	- 40200998	Surface Coating Operations Surface Coating Operations
40201101		Surface Coating Operations Fabric Coating/Printing Coating Operation (Also See Spe
40201103		Surface Coating Operations Fabric Coating/Printing Coating Mixing (Also See Specif
40201105	- 40201303	Surface Coating Operations Surface Coating Operations
40201305	- 40201403	Surface Coating Operations Surface Coating Operations
40201405	- 40201503	Surface Coating Operations Surface Coating Operations
40201505	- 40201603	Surface Coating Operations Surface Coating Operations
40201605	- 40201703	Surface Coating Operations Surface Coating Operations
40201705	- 40201803	Surface Coating Operations Surface Coating Operations
40201805	- 40201903	Surface Coating Operations Surface Coating Operations
40201999	- 40202003	Surface Coating Operations Surface Coating Operations
40202005	- 40202103	Surface Coating Operations Surface Coating Operations
40202105	- 40202203	Surface Coating Operations Surface Coating Operations

Table 4.1-3 (continued)

40202205	- 40202303	Surface Coating Operations Surface Coating Operations
40202305	- 40202403	Surface Coating Operations Surface Coating Operations
40202405	- 40202503	Surface Coating Operations Surface Coating Operations
40202505	- 40202603	Surface Coating Operations Surface Coating Operations
40202605	- 40288805	Surface Coating Operations
40288822		Surface Coating Operations Fugitive Emissions Coating
40288823		Surface Coating Operations Fugitive Emissions Cleartop Coat
40288824		Surface Coating Operations Fugitive Emissions Clean-up
40299995	- 40299999	Surface Coating Operations Surface Coating Operations Surface Coating - Miscella
Tier II: 05 Other Industrial		
2430000000	- 2440000999	Solvent Utilization
40100401		Organic Solvent Evaporation Knit Fabric Scouring with Chlorinated Solvent Perchlor
40100499		Organic Solvent Evaporation Knit Fabric Scouring with Chlorinated Solvent Other No
49000101	- 49000199	Organic Solvent Evaporation Miscellaneous Solvent Extraction Processes
49000202		Organic Solvent Evaporation Waste Solvent Recovery Operations Condenser Vent
49000206	- 49000599	Organic Solvent Evaporation Miscellaneous
49099998		Organic Solvent Evaporation Miscellaneous Volatile Organic Compound Evaporation Id
49099999		Organic Solvent Evaporation Miscellaneous Volatile Organic Compound Evaporation Id
Tier II: 06 Nonindustrial		
2460000000	- 2465900000	Solvent Utilization
Tier II: 07 Solvent Utilization NEC		
2495000000	- 2495000999	Solvent Utilization All Solvent User Categories All Processes
Tier I: 09 STORAGE & TRANSPORT		
Tier II: 01 Bulk Terminals & Plants		
2501050000	- 2501050900	Storage & Transport Petroleum & Petroleum Product Storage Bulk Stations/Terminal
40400101	- 40400271	Bulk Terminals/Plants Petroleum Storage Tanks
40400272		Bulk Terminals/Plants Bulk Plants Gasoline RVP 10: Standing Loss - Int. Floating R
40400278		Bulk Terminals/Plants Bulk Plants Gasoline RVP 10/13/7: Withdrawal Loss - Int. Flo
40400279		Bulk Terminals/Plants Bulk Plants Specify Liquid: Internal Floating Roof (Primary/
40400401	- 40400498	Bulk Terminals/Plants Petroleum Storage Tanks Underground Tanks
Tier II: 02 Petroleum & Petroleum Product Storage		
2275900000	- 2275900102	Mobile Sources Aircraft Refueling: All Fuels
2275900201		Mobile Sources Aircraft Refueling: All Fuels Underground Tank: Total
2501000000	- 2501010900	Storage & Transport Petroleum & Petroleum Product Storage
2501060000		Storage & Transport Petroleum & Petroleum Product Storage Gasoline Servic
2501060200		Storage & Transport Petroleum & Petroleum Product Storage Gasoline Servic
2501070000		Storage & Transport Petroleum & Petroleum Product Storage Diesel Service
2501070200		Storage & Transport Petroleum & Petroleum Product Storage Diesel Service
2501995000	- 2501995180	Storage & Transport Petroleum & Petroleum Product Storage All Storage Types: Wor
31000104		Oil and Gas Production Crude Oil Production Crude Oil Sumps
31000105		Oil and Gas Production Crude Oil Production Crude Oil Pits
31000108		Oil and Gas Production Crude Oil Production Evaporation from Liquid Leaks into Oil
31000132		Oil and Gas Production Crude Oil Production Atmospheric Wash Tank (2nd Stage of Ga
40300101	- 40399999	Petroleum Product Storage (Refineries Oil and Gas Fie
40400301	- 40400305	Bulk Terminals/Plants Petroleum Storage Tanks Oil Field Storage of Crude Oil
40400306		Bulk Terminals/Plants Oil Field Storage of Crude External Floating Roof Tank: With
40400307		Bulk Terminals/Plants Oil Field Storage of Crude Internal Floating Roof Tank: With
Tier II: 03 Petroleum & Petroleum Product Transport		
2505000000	- 2505040180	Storage & Transport Petroleum & Petroleum Product Transport
40600101	- 40600299	Transportation and Marketing of Petroleum Products
40688801	- 40688805	Transportation and Marketing of Petroleum Products Fugitive Emissions Specify in
Tier II: 04 Service Stations: Stage I		
2501060050	- 2501060053	Storage & Transport Petroleum & Petroleum Product Storage Gasoline Service Stati
2501070050	- 2501070053	Storage & Transport Petroleum & Petroleum Product Storage Diesel Service Station
40600301	- 40600399	Transportation and Marketing of Petroleum Products Gasoline Retail Operations St
40600503		Transportation and Marketing of Petroleum Products Pipeline Petroleum Transport -
40600706		Transportation and Marketing of Petroleum Products Consumer (Corporate) Fleet Refu
Tier II: 05 Service Stations: Stage II		
2501060100	- 2501060103	Storage & Transport Petroleum & Petroleum Product Storage Gasoline Service Stati
2501070100	- 2501070103	Storage & Transport Petroleum & Petroleum Product Storage Diesel Service Station
40600401	- 40600499	Transportation and Marketing of Petroleum Products Filling Vehicle Gas Tanks Sta
40600501		Transportation and Marketing of Petroleum Products Pipeline Petroleum Transport -
40600601		Transportation and Marketing of Petroleum Products Consumer (Corporate) Fleet Refu

Table 4.1-3 (continued)

Tier II: 06	**Service Stations: Breathing & Emptying**	
2275900202		Mobile Sources Aircraft Refueling: All Fuels Underground Tank: Breathing
2501060201		Storage & Transport Petroleum & Petroleum Product Storage Gasoline Servic
2501070201		Storage & Transport Petroleum & Petroleum Product Storage Diesel Service
42500101		Fixed Roof Tanks (210 Bbl Size) Breathing Loss
42500102		Fixed Roof Tanks (210 Bbl Size) Working Loss
Tier II: 07	**Organic Chemical Storage**	
2510000000	- 2510995405	Storage & Transport Organic Chemical Storage
30100102		Chemical Manufacturing Adipic Acid Raw Material Storage
30100106		Chemical Manufacturing Adipic Acid Drying, Loading, and Storage
30100508		Chemical Manufacturing Carbon Black Production Bagging/Loading
30101404		Chemical Manufacturing Paint Manufacture Raw Material Storage
30101602		Chemical Manufacturing Phosphoric Acid: Wet Process Gypsum Pond
30101808		Chemical Manufacturing Plastics Production Monomer and Solvent Storage
30101810		Chemical Manufacturing Plastics Production Conveying
30101811		Chemical Manufacturing Plastics Production Storage
30101815		Chemical Manufacturing Plastics Production Pellet Silo
30101816		Chemical Manufacturing Plastics Production Transferring/Handling/Loading/Packing
30101821		Chemical Manufacturing Plastics Production Extruding/Pelletizing/Conveying/Storage
30101840		Chemical Manufacturing Plastics Production Resin Storage Tank ** (Use 6-45-200-23
30101864		Chemical Manufacturing Plastics Production Pellet Silo/Storage
30101865		Chemical Manufacturing Plastics Production Transferring/Conveying
30101883		Chemical Manufacturing Plastics Production Transferring/Conveying/Storage (Polyure
30101893		Chemical Manufacturing Plastics Production Raw Material Storage
30101894		Chemical Manufacturing Plastics Production Solvent Storage
30102425		Chemical Manufacturing Synthetic Organic Fiber Manufacturing Fiber Storage (Use 6-
30102427		Chemical Manufacturing Synthetic Organic Fiber Manufacturing Solvent Storage (Use
30102612		Chemical Manufacturing Synthetic Rubber (Manufacturing Only) Pre-storage Tank
30102709		Chemical Manufacturing Ammonium Nitrate Production Bulk Loading (General)
30103003		Chemical Manufacturing Ammonium Phosphates Screening/Transfer
30103105		Chemical Manufacturing Terephthalic Acid/Dimethyl Terephthalate Product Transfer V
30104007		Chemical Manufacturing Urea Production Bulk Loading
30106010		Chemical Manufacturing Pharmaceutical Preparations Storage/Transfer
30130108		Chemical Manufacturing Chlorobenzene DCB Crystal Handling/Loading
30183001		Chemical Manufacturing General Processes Storage/Transfer
30201920		Food and Agriculture Vegetable Oil Processing Solvent Storage (Use 4-07-016-15 & -
30800109		Rubber and Miscellaneous Plastics Products Tire Manufacture Solvent Storage ** (Us
30800110		Rubber and Miscellaneous Plastics Products Tire Manufacture Solvent Storage (Use 4
30800803		Rubber and Miscellaneous Plastics Products Plastic Foam Products Bead Storage
31501001		Photographic Equipment Photocopying Equipment Manufacturing Resin Transfer/Storage
40200707		Surface Coating Operations Surface Coating Application - General Adhesive: Solvent
40201104		Surface Coating Operations Fabric Coating/Printing Coating Storage (Also See Speci
40201304		Surface Coating Operations Paper Coating Coating Storage
40201404		Surface Coating Operations Large Appliances Coating Storage
40201504		Surface Coating Operations Magnet Wire Surface Coating Coating Storage
40201604		Surface Coating Operations Automobiles and Light Trucks Coating Storage
40201704		Surface Coating Operations Metal Can Coating Coating Storage
40201804		Surface Coating Operations Metal Coil Coating Solvent Storage (Use 4-07-004-01 thr
40201904		Surface Coating Operations Wood Furniture Surface Coating Coating Storage
40202004		Surface Coating Operations Metal Furniture Operations Coating Storage
40202104		Surface Coating Operations Flatwood Products Coating Storage
40202204		Surface Coating Operations Plastic Parts Coating Storage
40202304		Surface Coating Operations Large Ships Coating Storage
40202404		Surface Coating Operations Large Aircraft Coating Storage
40202504		Surface Coating Operations Miscellaneous Metal Parts Coating Storage
40202604		Surface Coating Operations Steel Drums Coating Storage
40500701		Printing/Publishing General Solvent Storage
40700401	- 40799998	Organic Chemical Storage
42500201		Fixed Roof Tanks (500 Bbl Size) Breathing Loss
49000201		Organic Solvent Evaporation Waste Solvent Recovery Operations Storage Tank Vent
49000204		Organic Solvent Evaporation Waste Solvent Recovery Operations Solvent Spillage
49000205		Organic Solvent Evaporation Waste Solvent Recovery Operations Solvent Loading
Tier II: 08	**Organic Chemical Transport**	
2515000000	- 2515040405	Storage & Transport Organic Chemical Transport
30101866		Chemical Manufacturing Plastics Production Packing/Shipping

Table 4.1-3 (continued)

30101884		Chemical Manufacturing Plastics Production Packing/Shipping (Polyurethane)
40899995	- 40899999	Organic Chemical Transportation Organic Chemical Transportation Specify Liquid
Tier II: 09	**Inorganic Chemical Storage**	
2520000000	- 2520995040	Storage & Transport Inorganic Chemical Storage
30100804		Chemical Manufacturing Chloro-alkali Production Chlorine Loading: Storage Car Ven
30101198		Chemical Manufacturing Hydrochloric Acid Handling and Storage (99.9% Removal)
30101204		Chemical Manufacturing Hydroflouric Acid Fluorspar Handling Silos
30101205		Chemical Manufacturing Hydroflouric Acid Fluorspar Transfer
30102321		Chemical Manufacturing Sulfuric Acid (Contact Process) Storage Tank Vent
30102803	- 30102805	Chemical Manufacturing Chemical Manufacturing Normal Superphosphate
30102821		Chemical Manufacturing Normal Superphosphates Den
30102903	- 30102905	Chemical Manufacturing Chemical Manufacturing Triple Superphosphate
30102921		Chemical Manufacturing Triple Superphosphate Den
30103554		Chemical Manufacturing Inorganic Pigments Conveying/Storage/Packing
30104204		Chemical Manufacturing Lead Alkyl Manufacturing (Sodium/Lead Alloy Process) Sludge
30107002		Chemical Manufacturing Inorganic Chemical Manufacturing (General) Storage/Transfer
30121010		Chemical Manufacturing Caprolactum (Use 3-01-130 for Ammonium Sulfate By-product P
30187001	- 30188599	Chemical Manufacturing Inorganic Chemical Storage
Tier II: 10	**Inorganic Chemical Transport**	
2525000000	- 2525040040	Storage & Transport Inorganic Chemical Transport
30100803		Chemical Manufacturing Chloro-alkali Production Chlorine Loading: Tank Car Vent
30102320		Chemical Manufacturing Sulfuric Acid (Contact Process) Tank Car and Truck Unloadin
Tier II: 11	**Bulk Materials Storage**	
2530000000	- 2530050120	Storage & Transport Bulk Materials Storage
2650000004		Waste Disposal, Treatment, & Recovery Scrap & Waste Materials Scrap & Was
30200505	- 30200511	Food and Agriculture Food and Agriculture Feed and Grain Terminal Elevators
30200605	- 30200610	Food and Agriculture Food and Agriculture Feed and Grain Country Elevators
30200751		Food and Agriculture Grain Millings Wet Corn Milling: Grain Receiving
30200755		Food and Agriculture Grain Millings Wet Corn Milling: Bulk Loading
30200771		Food and Agriculture Grain Millings Rice: Grain Receiving
30200781		Food and Agriculture Grain Millings Soybean: Grain Receiving
30200791		Food and Agriculture Grain Millings Soybean: Bulk Loading
30200802		Food and Agriculture Feed Manufacture Grain Receiving
30200803		Food and Agriculture Feed Manufacture Shipping
30203105	- 30203111	Food and Agriculture Food and Agriculture Export Grain Elevators
30300003		Primary Metal Production Aluminum Ore (Bauxite) Fine Ore Storage
30300305		Primary Metal Production By-product Coke Manufacturing Coal Unloading
30300309		Primary Metal Production By-product Coke Manufacturing Coal Conveying
30300316		Primary Metal Production By-product Coke Manufacturing Coal Storage Pile
30300613		Primary Metal Production Ferroalloy, Open Furnace Raw Material Storage
30300614		Primary Metal Production Ferroalloy, Open Furnace Raw Material Transfer
30300804		Primary Metal Production Iron Production (See 3-03-015 for Integrated Iron & Steel
30300805		Primary Metal Production Iron Production (See 3-03-015 for Integrated Iron & Steel
30300809	- 30300812	Primary Metal Production Iron Production
30300820	- 30300823	Primary Metal Production Iron Production
30300827		Primary Metal Production Iron Production (See 3-03-015 for Integrated Iron & Steel
30300841		Primary Metal Production Iron Production (See 3-03-015 for Integrated Iron & Steel
30300842		Primary Metal Production Iron Production (See 3-03-015 for Integrated Iron & Steel
30300915		Primary Metal Production Steel Manufacturing (See 3-03-015 for Integrated Iron & S
30301011	- 30301013	Primary Metal Production Primary Metal Production Lead Production
30301016		Primary Metal Production Lead Production Sinter Transfer
30301026		Primary Metal Production Lead Production Sinter Dump Area
30302304		Primary Metal Production Taconite Iron Ore Processing Ore Transfer
30302305		Primary Metal Production Taconite Iron Ore Processing Ore Storage
30302307		Primary Metal Production Taconite Iron Ore Processing Bentonite Storage
30302309		Primary Metal Production Taconite Iron Ore Processing Traveling Grate Feed
30302310		Primary Metal Production Taconite Iron Ore Processing Traveling Grate Discharge
30302316		Primary Metal Production Taconite Iron Ore Processing Pellet Transfer
30303009		Primary Metal Production Zinc Production Raw Material Handling and Transfer
30303012		Primary Metal Production Zinc Production Raw Material Unloading
30400356		Secondary Metal Production Grey Iron Foundries Sand Silo
30400357		Secondary Metal Production Grey Iron Foundries Conveyors/Elevators
30400721		Secondary Metal Production Steel Foundries Sand Silo
30400723		Secondary Metal Production Steel Foundries Conveyors/Elevators
30500203		Mineral Products Asphalt Concrete Storage Piles

30500303		Mineral Products Brick Manufacture Storage of Raw Materials
30500406		Mineral Products Calcium Carbide Circular Charging: Conveyor
30500607		Mineral Products Cement Manufacturing (Dry Process) Raw Material Unloading
30500608		Mineral Products Cement Manufacturing (Dry Process) Raw Material Piles
30500612		Mineral Products Cement Manufacturing (Dry Process) Raw Material Transfer
30500615		Mineral Products Cement Manufacturing (Dry Process) Clinker Piles
30500616		Mineral Products Cement Manufacturing (Dry Process) Clinker Transfer
30500618		Mineral Products Cement Manufacturing (Dry Process) Cement Silos
30500619		Mineral Products Cement Manufacturing (Dry Process) Cement Load Out
30500707		Mineral Products Cement Manufacturing (Wet Process) Raw Material Unloading
30500708		Mineral Products Cement Manufacturing (Wet Process) Raw Material Piles
30500712		Mineral Products Cement Manufacturing (Wet Process) Raw Material Transfer
30500715		Mineral Products Cement Manufacturing (Wet Process) Clinker Piles
30500716		Mineral Products Cement Manufacturing (Wet Process) Clinker Transfer
30500718		Mineral Products Cement Manufacturing (Wet Process) Cement Silos
30500719		Mineral Products Cement Manufacturing (Wet Process) Cement Load Out
30500803		Mineral Products Ceramic Clay/Tile Manufacture Raw Material Storage
30500905		Mineral Products Clay and Fly Ash Sintering Raw Clay/Shale Transfer/Conveying
30500906		Mineral Products Clay and Fly Ash Sintering Raw Clay/Shale Storage Piles
30500910		Mineral Products Clay and Fly Ash Sintering Expanded Shale Storage
30501008		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Unloadi
30501009		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Raw Coa
30501011		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Coal Tr
30501014	- 30501016	Mineral Products Coal Cleaning Material Handling
30501021		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Overbur
30501023		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Loading
30501030		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Topsoil
30501032		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Topsoil
30501033		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Overbur
30501036	- 30501038	Mineral Products Mineral Products Surface Mining Operations
30501040	- 30501043	Mineral Products Mineral Products Surface Mining Operations
30501048		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Overbur
30501106	- 30501111	Mineral Products Mineral Products Concrete Batching
30501114		Mineral Products Concrete Batching Transferring: Conveyors/Elevators
30501115		Mineral Products Concrete Batching Storage: Bins/Hoppers
30501221		Mineral Products Fiberglass Manufacturing Raw Material: Unloading/Conveying
30501222		Mineral Products Fiberglass Manufacturing Raw Material: Storage Bins
30501504		Mineral Products Gypsum Manufacture Conveying
30501508	- 30501510	Mineral Products Mineral Products Gypsum Manufacture
30501514		Mineral Products Gypsum Manufacture Storage Bins: Stucco
30501518		Mineral Products Gypsum Manufacture Mixers/Conveyors
30501607		Mineral Products Lime Manufacture Raw Material Transfer and Conveying
30501608		Mineral Products Lime Manufacture Raw Material Unloading
30501610		Mineral Products Lime Manufacture Raw Material Storage Piles
30501613	- 30501615	Mineral Products Mineral Products Lime Manufacture
30501903		Mineral Products Phosphate Rock Transfer/Storage
30501904		Mineral Products Phosphate Rock Open Storage
30502007		Mineral Products Stone Quarrying - Processing (See also 305320) Open Storage
30502106		Mineral Products Salt Mining Conveying
30502502		Mineral Products Construction Sand and Gravel Aggregate Storage
30502503		Mineral Products Construction Sand and Gravel Material Transfer and Conveying
30502505	- 30502507	Mineral Products Mineral Products Sand/Gravel
30503104	- 30503107	Mineral Products Mineral Products Asbestos Mining
30503110		Mineral Products Asbestos Mining Stockpiling
30503111		Mineral Products Asbestos Mining Tailing Piles
30504020	- 30504023	Mineral Products Mineral Products Mining & Quarrying of Nonmetallic Minerals
30504025		Mineral Products Mining and Quarrying of Nonmetallic Minerals Stockpiling
30504036		Mineral Products Mining and Quarrying of Nonmetallic Minerals Tailing Piles
30510001	- 30510599	Mineral Products Mineral Products
30510604		Mineral Products Bulk Materials Screening/Size Classification Coke
30703001		Pulp and Paper and Wood Products Miscellaneous Wood Working Operations Wood Waste
30703002		Pulp and Paper and Wood Products Miscellaneous Wood Working Operations Wood Waste
Tier II: 12 Bulk Materials Transport		
2535000000	- 2535030140	Storage & Transport Bulk Materials Transport
30200711		Food and Agriculture Grain Millings Durum Milling: Grain Receiving

Table 4.1-3 (continued)

30200721		Food and Agriculture Grain Millings Rye: Grain Receiving
30200731		Food and Agriculture Grain Millings Wheat: Grain Receiving
30200741		Food and Agriculture Grain Millings Dry Corn Milling: Grain Receiving
30501044		Mineral Products Coal Mining, Cleaning, and Material Handling (See 305310) Train L
31100203		Building Construction Demolitions/Special Trade Contracts Debris Loading
31100204		Building Construction Demolitions/Special Trade Contracts Debris Loading
Tier I: 10 WASTE DISPOSAL & RECYCLING		
Tier II: 01 Incineration		
2601000000	- 2601030000	Waste Disposal, Treatment, & Recovery On-Site Incineration
30101015		Chemical Manufacturing Explosives (Trinitrotoluene) Batch Process: Red Water Incin
30101023		Chemical Manufacturing Explosives (Trinitrotoluene) Continuous Process: Red Water
31307001		Electrical Equipment Electrical Windings Reclamation Single Chamber Incinerator/Ov
31307002		Electrical Equipment Electrical Windings Reclamation Multiple Chamber Incinerator/
31401001		Transportation Equipment Brake Shoe Debonding Single Chamber Incinerator
31401002		Transportation Equipment Brake Shoe Debonding Multiple Chamber Incinerator
49000203		Organic Solvent Evaporation Waste Solvent Recovery Operations Incinerator Stack
50100101	- 50100103	Solid Waste Disposal Government Municipal Incineration
50100104		Solid Waste Disposal - Government Municipal Incineration Mass Burn Refractory Wall
50100105		Solid Waste Disposal - Government Municipal Incineration Mass Burn Waterwall Combu
50100505	- 50100517	Solid Waste Disposal Government Other Incineration
50200101	- 50200105	Solid Waste Disposal Commercial/Institutional Incineration: General
50200205		Solid Waste Disposal - Commercial/Institutional Open Burning Weeds
50200301	- 50200507	Solid Waste Disposal Commercial/Institutional
50300101	- 50300109	Solid Waste Disposal Industrial Incineration
50300501		Solid Waste Disposal - Industrial Incineration Hazardous Waste
50300503		Solid Waste Disposal - Industrial Incineration Hazardous Waste Incinerators: Liqu
50300505		Solid Waste Disposal - Industrial Incineration Hazardous Waste Incinerators: Mult
50300506		Solid Waste Disposal - Industrial Incineration Sludge
Tier II: 02 Open Burning		
2610000000	- 2610030000	Waste Disposal, Treatment, & Recovery Open Burning
50100201		Solid Waste Disposal - Government Open Burning Dump General Refuse
50100202		Solid Waste Disposal - Government Open Burning Dump Vegetation Only
50200201		Solid Waste Disposal - Commercial/Institutional Open Burning Wood
50200202		Solid Waste Disposal - Commercial/Institutional Open Burning Refuse
50300201	- 50300205	Solid Waste Disposal Industrial Open Burning
Tier II: 03 POTW		
2630000000		Waste Disposal, Treatment, & Recovery Wastewater Treatment All Categories
2630020000		Waste Disposal, Treatment, & Recovery Wastewater Treatment Public Owned
50100701	- 50100704	Solid Waste Disposal Government Sewage Treatment
50100793		Solid Waste Disposal - Government Sewage Treatment POTW: Sludge Drying Bed
Tier II: 04 Industrial Waste Water		
2630010000		Waste Disposal, Treatment, & Recovery Wastewater Treatment Industrial To
30182001	- 30182003	Chemical Manufacturing Chemical Manufacturing General Processes
31000506		Oil and Gas Production Liquid Waste Treatment Oil-Water Separation Wastewater Hold
50300702		Solid Waste Disposal - Industrial Liquid Waste Waste Treatment: General
68182599		Consumer Product Manufacturing Facilities Wastewater, Points of Generation Specify
68282599		Miscellaneous Processes Wastewater, Points of Generation Specify Point of Generati
Tier II: 05 TSDF		
2640000000	- 2640020004	Waste Disposal, Treatment, & Recovery TSDFs
50300801	- 50300899	Solid Waste Disposal Industrial Treatment, Storage, Disposal Facilities
Tier II: 06 Landfills		
2620000000	- 2620030000	Waste Disposal, Treatment, & Recovery Landfills
50100401		Solid Waste Disposal - Government Landfill Dump Unpaved Road Traffic
50100410		Solid Waste Disposal - Government Landfill Dump Waste Gas Destruction: Waste Gas
50200601		Solid Waste Disposal - Commercial/Institutional Landfill Dump Waste Gas Flares **
50200602		Solid Waste Disposal - Commercial/Institutional Landfill Dump Municipal: Fugitive
50300601	- 50300603	Solid Waste Disposal Industrial Landfill Dump
Tier II: 07 Other		
2630030000		Waste Disposal, Treatment, & Recovery Wastewater Treatment Residential/Su
2650000000	- 2650000003	Waste Disposal, Treatment, & Recovery Scrap & Waste Materials Scrap & Waste
2660000000		Waste Disposal, Treatment, & Recovery Leaking Underground Storage Tanks L
50100402		Solid Waste Disposal - Government Landfill Dump Fugitive Emissions
50100601	- 50100604	Solid Waste Disposal Government Fire Fighting

Table 4.1-3 (continued)

50200901		Solid Waste Disposal - Commercial/Institutional Asbestos Removal General
50282599		Solid Waste Disposal - Commercial/Institutional Wastewater, Points of Generation S
50300701		Solid Waste Disposal - Industrial Liquid Waste General
50300901		Solid Waste Disposal - Industrial Asbestos Removal General
50390002		Solid Waste Disposal - Industrial Auxillary Fuel/No Emissions Coal
50400101		Site Remediation General Processes Fixed Roof Tanks: Breathing Loss
50400102		Site Remediation General Processes Fixed Roof Tanks: Working Loss
50400103		Site Remediation General Processes Float Roof Tanks: Standing Loss
50400104		Site Remediation General Processes Float Roof Tanks: Withdrawal Loss
50400150		Site Remediation General Processes Storage Bins
50400151		Site Remediation General Processes: Liquid Waste: General: Transfer
50400301		Site Remediation General Processes Open Refuse Stockpiles : General
50400320		Site Remediation General Processes Storage Bins - Solid Waste
50410310		Site Remediation In Situ Venting/Venting of Soils Active Aeration
50410311		Site Remediation In Situ Venting/Venting of Soils Active Aeration: Vacuum
50410312		Site Remediation In Situ Venting/Venting of Soils Active Aeration, Vacuum: Vapor
50410313		Site Remediation In Situ Venting/Venting of Soils Active Aeration, Vacuum: Vacuum
50410405		Site Remediation Air Stripping of Groundwater Oil/Water Separator
50410408		Site Remediation Air Stripping of Groundwater Treatment Tanks
50410420		Site Remediation Air Stripping of Groundwater Air Stripping Tower
50410530		Site Remediation Thermal Destruction Combustion Unit
50410562		Site Remediation Thermal Destruction Waste Disposal: Chemical Stabilization
50410610		Site Remediation Thermal Desorption Pretreatment
50410622		Site Remediation Thermal Desorption Thermal Desorber: Kiln
50410645		Site Remediation Thermal Desorption Wastes: Containers
50490004		Site Remediation General Processes Incinerators: Process Gas
Tier I: 11 ON-ROAD VEHICLES		
Tier II: 01 Light-Duty Gas Vehicles & Motorcycles		
2201001000	- 2201001334	Mobile Sources On-road Vehicles - Gasoline Light Duty Gasoline Vehicles (LDGV)
2201080000	- 2201080334	Mobile Sources On-road Vehicles - Gasoline Motorcycles (MC)
Tier II: 02 Light-Duty Gas Trucks		
2201020000	- 2201060334	Mobile Sources On-road Vehicles - Gasoline
Tier II: 03 Heavy-Duty Gas Vehicles		
2201070000	- 2201070334	Mobile Sources On-road Vehicles - Gasoline (HDGV)
Tier II: 04 Diesels		
2230001000	- 2230070334	Mobile Sources On-road Vehicles - Diesel

Table 4.1-3 (continued)

Tier I: 12 NON-ROAD SOURCES

Tier II: 01 Non-Road Gasoline

2260000000	- 2265008010	Mobile Sources
2282005000	- 2282020025	Mobile Sources Marine Vessels, Recreational
26000320		Non-road Sources 2-stroke Gasoline Engines Industrial Equipment Industrial Fork Lift: G

Tier II: 02 Non-Road Diesel

2270000000	- 2270008010	Mobile Sources Non-road Sources Vehicle Diesel

Tier II: 03 Aircraft

2275000000	- 2275070000	Mobile Sources Aircraft

Tier II: 04 Marine Vessels

2280001000	- 2280004040	Mobile Sources Marine Vessels, Commercial
2283000000	- 2283004020	Mobile Sources Marine Vessels, Military

Tier II: 05 Railroads

2285002000	- 2285002010	Mobile Sources Railroads Diesel

Tier I: 13 NATURAL SOURCES

Tier II: 01 Biogenic

2701000000	- 2701480000	Natural Sources Biogenic
2740020000	- 2740040010	Natural Sources Miscellaneous

Tier II: 02 Geogenic

2730001000	- 2730100001	Natural Sources Geogenic

Tier II: 03 Miscellaneous

2740001000		Natural Sources Miscellaneous Lighting Total

Tier I: 14 MISCELLANEOUS

Tier II: 01 Agriculture & Forestry

2307010000		Industrial Processes Wood Products: SIC 24 Logging Operations Total
2801000001	- 2801000008	Miscellaneous Area Sources Agriculture Production - Crops Agriculture - Crops
2805000000	- 2805015001	Miscellaneous Area Sources Agriculture Production - Livestock

Tier II: 02 Other Combustion

2801500000		Miscellaneous Area Sources Agriculture Production - Crops Agricultural Fi
2801520000		Miscellaneous Area Sources Agriculture Production - Crops Orchard Heaters
2810001000	- 2810050000	Miscellaneous Area Sources Other Combustion
30101030		Chemical Manufacturing Explosives (Trinitrotoluene) Open Burning: Waste

Tier II: 03 Catastrophic/Accidental Releases

2275900103		Mobile Sources Aircraft Refueling: All Fuels Spillage
2830000000	- 2830010000	Miscellaneous Area Sources Catastrophic/Accidential Releases

Tier II: 04 Repair Shops

2840000000	- 2841010050	Miscellaneous Area Sources

Tier II: 05 Health Services

2850000000	- 2850000030	Miscellaneous Area Sources Health Services Hospitals
31502001	- 31502089	Health Services Health Services Hospitals

Tier II: 06 Cooling Towers

2820000000	- 2820020000	Miscellaneous Area Sources Cooling Towers
38500101	- 38500210	Cooling Tower Cooling Tower

Tier II: 07 Fugitive Dust

4.2 FUEL COMBUSTION - ELECTRIC UTILITY

The point and area source categories under the "Electric Utility" heading include the following Tier I and Tier II categories:

Tier I Category	Tier II Category
(01) FUEL COMBUSTION - ELECTRIC UTILITY	(01) Coal
	(02) Oil
	(03) Gas

The emissions from the combustion of fuel by electric utilities have been divided into two classifications: (1) steam generated fossil-fuel units (boiler) and (2) nonsteam generated fossil-fuel units such as gas turbines (GT) and internal combustion (IC) engines. Two very different methodologies have been used to estimate the emissions for these two classes; each is described separately in this report. The fossil-fuel steam generated methodology is described in this section; the GT and IC methodology is described in section 4.3.

The emissions from fossil-fuel steam electric utility units for the years 1985 through 1995 have been based on five basic factors: (1) fuel consumption, (2) emission factor, which relates the quantity of fuel consumed to the quantity of pollutant emitted, (3) fuel characteristics, such as sulfur content, ash content, and heating value of fuels, (4) control efficiency, which indicates the percent of pollutant emissions not removed through control methods, and (5) rule effectiveness (which, according to EPA, is the measure of the ability of a regulatory program to achieve all the emissions reductions that could be achieved by full compliance with the applicable regulations at all sources at all times). The fuel consumption characteristics and control efficiencies are obtained at the boiler-level, while the emission factors are specified at the SCC-level. The 1996 emissions and heat input are extrapolated from the 1995 boiler-level emissions based on the ratio of plant-level 1996 fuel consumption to 1995 fuel consumption.

The fossil-fuel steam electric utility emissions that are reported in the Trends Data Bases include VOC, NO_x, CO, SO_2, PM-10, and PM-2.5. Since there are no known utility emission factors for either NH_3 or sulfates (SO_4), they are not estimated. It should also be noted that these estimates do not include emissions from the combustion of anthracite coal because it accounts for a very small percentage (< 1 percent) of the overall emissions from fuel combustion by fossil-fuel steam electric utility units.

4.2.1 1985-1995 Steam Electric Utility Emission Inventories

The Energy Information Administration (EIA) of the Department of Energy (DOE) collects monthly boiler-level data on a yearly basis using Form EIA-767 (*Steam-Electric Plant Operation and Design Report*[1]). The EIA also collects plant-level fossil-fuel steam data from all electric utility plants filing Form EIA-759 (*Monthly Power Plant Report*[2]). Currently, Form EIA-767 data are available for the years 1985 through 1995, while Form EIA-759 data are available through the year 1996. The fossil-fuel steam electric utility component of the Trends emission inventories for 1985 through 1996 includes data derived from these two forms. These steam components include data from fossil-fuel steam boilers and not data from GT or IC engines (which account for a very small share of electric utility fuel use and corresponding emissions) unless they report it to EIA.

The steam emission inventory data for 1985 through 1995 are initially based on the aggregated monthly electric utility steam boiler-level data from Form EIA-767. All plants of at least 10 megawatts (MW) that have at least one operating boiler are required to provide this information to EIA, although the amount of data required from plants with less than 100 MW of steam-electric generating capacity is not as extensive as the amount required by those plants of at least 100 MW. For plants with a nameplate rating from 10 MW to less than 100 MW, only selected pages of the Form EIA-767, with ID, boiler fuel quantity and quality, and flue gas desulfurization (FGD) information, must be completed. Other sources of data for NO_x, SO_2, and heat input are used in place of the EIA/AP-42 calculated data when the data are known to be better; the sources are summarized in Table 4.2-1.

NO_x and SO_2 emissions as well as heat input are also available for affected acid rain utility boilers beginning in 1995 (the data are also available for Phase 1 units for 1994) from the Emissions Tracking System/Continuous Emissions Monitoring (ETS/CEM).[3] These data are also included in the 1994 through 1996 Trends fossil-fuel steam electric utility components.

4.2.1.1 Processing Computerized Raw Data

The basis for the fossil-fuel-fired steam electric utility component of the Emission Trends inventory is the reported primary utility data collected by EIA. The data from these EIA forms are transferred to data tapes that are not initially serviceable to the public. E.H. Pechan & Associates, Inc. (Pechan) has developed customized computer code to process these data and to account for the various characteristics of the data tapes.

4.2.1.1.1 Form EIA-767 —

Form EIA-767 data are reported by the operating utility for each plant with fossil-fuel steam boilers of 10 MW or greater. The written form is designed so that information for each plant is reported on separate pages that relate to different levels of data. The relevant data levels are as follows:

- Plant-level: One page for delineating the plant configuration, which establishes the number of boilers and the IDs for each boiler, as well as the associated generator(s), FGD unit(s) (SO_2 scrubbers), flue gas particulate collectors, flue(s) and stack(s). These do not necessarily have a one-to-one correspondence.

- Boiler-level: One page per boiler for monthly fuel consumption and quality data (for coal, oil, gas, and other), one page for regulatory data, and one page for design parameters.

- Generator-level: One page for generation and capacity data relating to up to five generators.

- FGD-level: One page for up to five FGD units for annual operating data and one page for each FGD unit for design parameter data.

- Flue gas particulate collector-level: One page each for (up to five) collectors with annual operating data and design specifications.

- Flue- and stack-level: One page per flue-stack for design parameter data.

Processing Form EIA-767 is accomplished in a series of steps aimed at converting the computerized data into data base form. Each "page" format is reproduced on the computer file exactly as it appears on the written page of the form. The data from each "page" must be extracted from the computer file, associated with the correct boiler, and combined with all corresponding data from the other pages for that boiler.

For example, fuel-related boiler data — monthly values for each fuel burned, along with the fuel's associated sulfur, ash, and heat content — are reported on page six. However, only coal, oil, and gas data are processed. These data must be aggregated for each fuel in order to produce annual estimates for each boiler before they are combined with the other data (such as control devices and efficiencies, plant location data, associated generator generation, and associated stack parameters).

After SCCs are assigned to each boiler's (possible three) reported fuels in a given plant, the SCC-specific data are then separated so that each data base record is on the plant-boiler-SCC level.

4.2.1.1.2 Form EIA-759 —

Form EIA-759 data are also processed in a series of steps, using a less intricate method, since the data for each plant are not reported at the boiler level, but instead are reported by prime mover (e.g., steam, hydro, IC, GT, combined cycle) and fuel type.

For each plant-prime mover combination (in this case, for the steam prime mover), plant ID data, as well as monthly fuel-specific generation and consumption data, are reported. The monthly plant steam prime mover data are aggregated to annual estimates for each fuel (that has been categorized as coal, residual oil, distillate oil, natural gas, or other) and combined to produce a single annual steam plant-level data observation. (Beginning in 1996, only annual, not monthly data, are collected for small plants, so the intermediate aggregation of monthly data is unnecessary.)

Since no actual 1996 data are presently available, these Form EIA-759 data were used to "grow" the 1995 fuel and emissions data for 1996, as described later in Section 4.2.2.

4.2.1.2 Emissions Algorithms

Data that were not obtained directly from the computerized data files (or converted to other measurement units) were developed by Pechan using algorithms that have been utilized since the 1980s. These variables include boiler capacity, SCC, heat input, pollutant emissions, and NO_x control efficiency.

Although generator nameplate capacity is reported on Form EIA-767, when there is not a one-to-one correspondence between boiler and generator (a multiheader situation -- for example, if one boiler is associated with two or more generators or if several boilers are reciprocally associated with several generators), this information in its present form cannot be used to represent the boiler size. Thus, a boiler design capacity variable (in MMBtu/hr) has been developed based on the reported maximum continuous steam flow at 100 percent load (in thousand pounds per hour) by multiplying the steam flow value by a units conversion of 1.25 to obtain boiler capacity,.

Emission factors from AP-42[4] were used in calculating emissions. The emission factor used depends upon the SCC and pollutant, as explained below.

- The appropriate SCC is assigned to each source based on its fuel and boiler characteristics. For sources using coal, the SCC is based on the American Society for Testing and Materials (ASTM) criteria for moisture, mineral-free matter basis (if greater than 11,500 Btu/lb, coal type is designated to be bituminous; if between 8,300 and 11,500 Btu/lb, coal type is designated to be subbituminous; and if less than 8,300 Btu/lb, coal type is designated to be lignite) and the boiler type (firing configuration and bottom type) as specified by AP-42. If both coal and oil were burned in the same boiler, it is assumed that the oil is distillate; otherwise, it is assumed to be residual. Based on the fuel and boiler type, the SCC is assigned. See Table 4.2-2 for a complete list of the relationships among fuel type, firing type, bottom type, and SCC.

Since the control efficiencies for NO_x, PM-10, and PM-2.5 were not available from the EIA-767 form, control efficiencies were derived using the following methods:

- NO_x control efficiency is based on the assumption that the unit would be controlled so that its emission rate would equal its emission limit, expressed on an annual equivalent basis. After calculating the heat input, controlled emissions assuming compliance with the applicable standard is back-calculated. After calculating the uncontrolled NO_x emissions, the presumed net control efficiency is calculated.

- Since only TSP control efficiency is reported on Form EIA-767, the PM-10 Calculator[5] was used to derive PM-10 and PM-2.5 control efficiencies. (The PM-10 Calculator estimates PM-10 and PM-2.5 control efficiencies based on the SCC and the primary and secondary control devices. The control efficiencies from the PM-10 Calculator are based on data from AP-42 for specific SCCs, where available).

The SO_2 emissions were computed as controlled emissions assuming 100 percent rule effectiveness and using the sulfur content of the fuel as specified in the EIA-767 data. The PM-10 and PM-2.5 emissions were computed as controlled emissions assuming 100 percent rule effectiveness. The ash content of the fuel used to calculate uncontrolled PM-10 and PM-2.5 emissions was also specified in the EIA-767 data. The NO_x emissions were computed as controlled emissions assuming 80 percent rule effectiveness from 1985-1994; beginning with 1995, NO_x rule effectiveness is assumed to be 100 percent. The CO and VOC emissions were calculated as uncontrolled emissions. The algorithms to compute emissions are presented in Table 4.2-3.

Since there are fewer required data elements (identification data, boiler fuel quantity and quality data, and FGD data, if applicable) for those plants with a total capacity between 10 MW and 100 MW, many values are missing for these situations. Most data elements are assigned a default value of zero; however, if variables for boiler firing and bottom type were missing (these are needed in the SCC assignment) the default values for wall-fired and dry bottom types are assigned. In the past, there have been discrepancies in the boiler bottom and firing type data as reported to EIA and EPA/Acid Rain Division (ARD). Based on a coordinated effort in 1996, all differences in bottom and firing types for coal boilers have been resolved and updated in the files for the years beginning with 1985.

4.2.1.3 National Allowance Data Base (NADB) SO_2 Emissions and Heat Input

The 1985 SO_2 emissions and heat input that were calculated from 1985 Form EIA-767 data were replaced by the corresponding boiler-level data (and disaggregated to the SCC level) from the National Allowance Data Base Version 2.11 (NADBV211).[6] These data underwent two public comment periods in 1991 and 1992 and are considered the best available data for 1985. Aggregations at the fuel levels (Tier III) are approximations only and are based on the methodology described in Section 4.2.1.

4.2.1.4 1985-1994 Acid Rain Division (ARD) NO_x Rates

In 1996, ARD completed research on utility coal boiler-level NO_x rates. Most (about 90 percent) of the rates were based on relative accuracy tests performed in 1993 and 1994 as a requirement for continuous emissions monitor (CEM) certification, while the remaining boilers' rates were obtained from utility stack tests from various years. 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.

Thus, whenever the new NO_x rates were available, NO_x coal emissions were recalculated, at the coal SCC level, using the heat input (EIA's 767 fuel throughput multiplied by the fuel heat content) and adjusting units, according to the following equation:

$$NOXCOAL_{SCC} = NOXRT_{coal} \ x \ HTI_{SCC} \ x \ \frac{1}{2000} \qquad \text{(Eq. 4.2-1)}$$

where:

where:	NOXCOAL	=	NO_x emissions for the boiler coal SCC (in tons)
	NOXRT	=	ARD's coal NO_x rate for the given boiler (in lbs/MMBtu)
	HTI	=	heat input for the boiler's coal SCC (in MMBtu)

These new NO_x SCC-level coal emissions replaced the AP-42 calculated emissions for most of the coal SCCs in the 1985-1994 data bases.

4.2.1.5 1994 and 1995 ETS/CEM Data

Beginning January 1, 1994, under Title IV (Acid Deposition Control) of the Clean Air Act Amendments of 1990 (CAAA) Phase I affected utility units were required to report heat input, SO_2 and NO_x data to EPA. Beginning January 1, 1995, all affected units were required to report heat input and SO_2 emissions; most also had to report NO_x emissions, although some units received extensions until July 1, 1995 or January 1, 1996 for NO_x reporting.

Since the ETS/CEM data are actual, rather than estimated, data, if there were a complete set of annual SO_2 and/or NO_x emissions and/or heat input data available for 1994 and 1995 from ETS/CEM, those data values replaced the data estimated from EIA-767 data. This process involved the following steps:

- Aggregation of ETS/CEM hourly or quarterly data to annual data.

- Assignment of ETS/CEM data, reported on a monitoring stack or pipe level, to the boiler level.

- Matching the ETS/CEM boiler-level annual data to the processed EIA-767 annual data.

- Disaggregating the boiler-level ETS/CEM data to the boiler SCC level based on each SCC's fractional share of the boiler heat input, SO_2, and NO_x, respectively. The algorithms used are included in Table 4.2-4.

For those records in which the ETS/CEM heat input replaces the EIA-calculated value, the heat input will not equal the product of the EIA-reported fuel throughput and heat content.

4.2.1.6 Ozone Season Daily Emissions Data

The ozone season daily (OSD) emissions for 1990-1995 are estimated by considering the day to be a typical or average summer July day. These emissions for VOC, NO_x, CO, SO_2, PM-10, and PM-2.5 (ammonia and sulfates are zero) are calculated at the SCC level using the ratio of the Form EIA-767 July monthly to annual heat input, dividing it by 31, and then multiplying this value by the already calculated annual emissions, according to the following equation:

$$EOSD_{SCC} = \frac{HTIJUL_{SCC}}{31 \ x \ HTIANN_{SCC}} \ x \ EANN_{SCC} \qquad \text{(Eq. 4.2-2)}$$

where:

where:	EOSD	=	Ozone season daily emissions for a given pollutant at the SCC level (in tons)
	HTIJUL	=	July monthly Form EIA-767 calculated heat input for the given boiler's SCC (in MMBtu)
	HTIANN	=	annual Form EIA-767 calculated heat input for the given boiler's SCC (in MMBtu)
	EANN	=	Trends annual emissions for a given pollutant at the SCC level (in tons) for that year

For the OSD for 1996, the 1996 projected annual Trends emissions is used, but the Form EIA-767 calculated 1995 July to annual heat input are used in the above equation (since the 1996 data are unknown).

4.2.2 1996 Steam Emission Inventory

The 1996 computerized fossil-fuel plant-level data from Form EIA-759 are used in conjunction with the 1995 fossil-fuel steam electric utility component to develop the 1996 steam emission inventory file, since the 1996 Form EIA-767 data are not available. The fuel quantity, heat input, and emissions values are grown by a factor based on the ratio of the 1996 Form EIA-759 plant-level, fuel-specific data to the data for 1995.

The 1996 steam inventory includes the same records that are in the 1995 file. That is, no new plants are added or subtracted from the 1995 steam inventory to produce the 1996 steam inventory. However, the 1996 Form EIA-759 plant-level data would reflect boiler retirement or additions for plants in 1996 and their fuel data would be incorporated in the growth ratios and would be reflected in the 1996 data for the other boilers in the plant. As a result, the 1996 figures should be considered to be preliminary estimates only.

4.2.3 Augmentation Process

The VOC emissions required an additional adjustment due to the underestimation of aldehydes which are not accounted for in the VOC emission factors for the following SCCs: 10100401, 10100404, 10100501, 10100601, and 10100604. The VOC emissions were augmented according to the methodology used in the Hydrocarbon Preprocessor (HCPREP) of the Flexible Regional Emissions Data System (FREDS).[7] This augmentation was performed on steam emission inventory for the years 1985 through 1995.

4.2.4 Sample Calculation

- 1995 boiler SCC data:

SCC	*thruput*	*heatcon*	*sulfcon*	*coneff4*
10100212	1300000	23.18 (*really* 23.1849046)	3.17 (*really* 3.1716)	89.30 (10.7)

emiss4	*htinpt*	*eiahti*	*eiaso2*	*emf4*	*so2ets*	*htiets*
93325590	31782453.38	30140376.00	8602.9316	39	9332.5590	31782453.38

- algorithm:

$$SO2_{coal} = \frac{coal\ tons * emission\ factor * sulfur\ content * (1 - control\ efficiency)}{2000} \quad \text{(Eq. 4.2-3)}$$

- calculation:

$$SO2_{coal} = \frac{(1300000)\ (39)\ (3.1716)\ (1 - .893)}{2000}$$

- result:

$$SO2_{coal} = 8602 \ \textit{to nearest integer}$$
$$\textit{But replace by}\ 1995\ ETS/CEM\ 9332.5590$$
$$\textit{Therefore}\ EIAS02 = 8603\ \textit{and}\ EMISS4\ (SO2_{coal}) = 9333\ \textit{in the Inventory}$$

Please note that only the EMISS4 ($SO2_{coal}$) value is available in the QUICREPTS or NET96 inventory files. The field variable EIASO2 is available by request from internal Pechan files.

4.2.5 References

1. *Monthly Power Plant Report*, Form EIA-759, data files for 1990 - 1996, U.S. Department of Energy, Energy Information Administration, Washington, DC, 1997.

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Table 4.2-1. 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 4.2-2. Steam Electric Utility Unit Source Classification Code Relationships

Fossil-Fuel	Firing Type	Bottom Type	SCC
Coal			
Bituminous	No data	No data	10100202
		Wet	10100201
		Dry	10100202
	Wall*	No data	10100202
		Wet	10100201
		Dry	10100202
	Opposed	No data	10100202
		Wet	10100201
		Dry	10100202
	Tangential	No data	10100212
		Wet	10100201
		Dry	10100212
	Stoker	All	10100204
	Cyclone	All	10100203
	Fluidized Bed	N/A	10100217
Subbituminous	No data	No data	10100222
		Wet	10100221
		Dry	10100222
	Wall	No data	10100222
		Wet	10100221
		Dry	10100222
	Opposed	No data	10100222
		Wet	10100221
		Dry	10100222
	Tangential	No data	10100226
		Wet	10100221
		Dry	10100226
	Stoker	All	10100224
	Cyclone	All	10100223

Table 4.2-2. (continued)

Fossil-Fuel	Firing Type	Bottom Type	SCC
Lignite	No data	All	10100301
	Wall	All	10100301
	Opposed	All	10100301
	Tangential	All	10100302
	Stoker	All	10100306
	Cyclone	All	10100303
Residual Oil	No data	All	10100401
	Wall	All	10100401
	Opposed	All	10100401
	Tangential	All	10100404
	Stoker	All	10100401
	Cyclone	All	10100401
Distillate Oil	No data	All	10100501
	Wall	All	10100501
	Opposed	All	10100501
	Tangential	All	10100501
	Stoker	All	10100501
	Cyclone	All	10100501
Natural Gas	No data	All	10100601
	Wall	All	10100601
	Opposed	All	10100601
	Tangential	All	10100604
	Stoker	All	10100601
	Cyclone	All	10100601

*Wall firing includes front, arch, concentric, rear, side, vertical, and duct burner firing.

Table 4.2-3. Algorithms Used to Estimate Emissions from Electric Utility Boilers

$$E_{NO_x,SCC} = FC_{SCC} \times EF_{NO_x,SCC} \times (1 - (RE_{NO_x} * CE_{NO_x,b})) \times UCF$$

$$E_{PM-10\,or\,PM-2.5,SCC} = FC_{SCC} \times EF_{PM-10\,or\,PM-2.5,SCC} \times A_f \times (1 - CE_{PM-10\,or\,PM-2.5,b}) \times UCF$$

where:	***E***	=	estimated emission (in tons)
	FC	=	fuel consumption (in $unit_f$)
	EF	=	emission factor (in lbs/$unit_f$)
	S	=	sulfur content (expressed as a decimal)
	A	=	ash content (expressed as a decimal)
	RE	=	rule effectiveness (expressed as a decimal)
	CE	=	control efficiency (expressed as a decimal)
	b	=	boiler
	f	=	fuel type (coal, oil, gas)
	UCF	=	units conversion factor (1 ton/2000 lbs)
	$unit_{coal}$	=	tons burned
	$unit_{oil}$	=	1000 gallons burned
	$unit_{gas}$	=	million cubic feet burned

Table 4.2-4. Algorithms Used to Disaggregate ETS/CEM Boiler Data to the Boiler-SCC Level

$$CEMSO2_{SCC} = \left(\frac{767SO2_{SCC,b}}{767SO2_b} \right) X \; CEMSO2_b$$

$$CEMNOX_{SCC} = \left(\frac{767NOX_{SCC,b}}{767NOX_b} \right) X \; CEMNOX_b$$

$$CEMHTI_{SCC} = \left(\frac{767HTI_{SCC,b}}{767HTI_b} \right) X \; CEMHTI_b$$

where: ***b***	=	boiler
CEMSO2, CEMNO$_x$, CEMHTI	=	ETS/CEM annual boiler data for given parameter
767SO2, 767NO$_x$, 767HTI	=	Form EIA-767-based calculated data for given parameter

4.3 INDUSTRIAL

The point and area source categories under the "Industrial" heading include the following Tier I and Tier II categories:

Tier I Category	Tier II Category
(01) FUEL COMBUSTION - ELECTRIC UTILITY	(05) Gas Turbines and Internal Combustion
(02) FUEL COMBUSTION - INDUSTRIAL	All
(03) CHEMICAL & ALLIED PRODUCT MANUFACTURING	All
(05) METALS PROCESSING	All
(06) PETROLEUM & RELATED INDUSTRIES	All
(07) OTHER INDUSTRIAL PROCESSES	All
(09) STORAGE & TRANSPORT	All
(10) WASTE DISPOSAL & RECYCLING	All
(13) NATURAL SOURCES	(01) Biogenic
(14) MISCELLANEOUS	(05) Health Services

Since the publication of the last version of this report,[1] EPA has made major changes to the 1990 emissions. The revised emissions are referred to in this document as the 1990 National Emission Trends (NET) emissions and are for the most part based on State submitted data and used as the base year inventory for the post-1990 emission inventory. Emission estimates for pre-1990 are based mainly on the "old" 1990 emissions which are referred to in this document as the Interim Inventory 1990 emissions. For most source categories, the methodology for the Interim Inventory 1990 emissions is the same as that previously published in the Procedures document.

The 1990 Interim Inventory emissions for these source categories were generated from both the non-utility point source and non-solvent area source portions of the 1985 National Acid Precipitation Assessment Program (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 data compiled by the Bureau of Economic Analysis (BEA)[2] or historic estimates of fuel consumption based on the DOE's State Energy Data System (SEDS).[3]

The 1990 NET emissions were revised to incorporate as much state- supplied data as possible. Sources of state data include the OTAG emission inventory, the GCVTC emission inventory, and AIRS/FS. For most non-utility point and non-mobile sources, these emissions were projected from the revised 1990 NET inventory to the years 1991 through 1996 using BEA and SEDS data. States were surveyed to determine whether EPA should project their 1990 non-utility point source emissions or extract them from AIRS/FS. For all states that selected AIRS/FS option, the emissions in the NET inventory reflect their AIRS/FS data for the years 1991 through 1995. Additional controls were added to the projected (or grown) emissions for the years 1995 and 1996.

This section describes the methods used to estimate both base year 1990 emission inventories and the emission estimates for the years 1985 through 1989 and 1991 through 1996. Emission estimates for PM-2.5 and NH_3 were only estimated for the years 1990 through 1996.

4.3.1 1990 Interim Inventory

The 1990 Interim Inventory is based on the 1985 NAPAP Inventory. The database includes annual and average summer day emission estimates for 48 States and the District of Columbia. Five pollutants (CO, NO_x, VOC, SO_2, and PM-10) were estimated for 1990.

The 1985 NAPAP Emission Inventory estimates for the **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 two-digit SIC code. In order to remove the effects of inflation, the earnings data were converted to 1982 constant dollars using the implicit price deflator for personal consumption expenditures (PCE).[4] State and SIC-level growth factors were calculated as the ratio of the 1990 earnings data to the 1985 earnings data. Additional details on point source growth indicators are presented in section 4.3.2.1.

The **area** source emissions from the 1985 NAPAP Emission Inventory have been projected to the year 1990 based on BEA historic earnings data, BEA historic population data, 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. Additional details on area source growth indicators are presented in section 4.3.2.2.

When creating the 1990 emission inventory, changes were made to emission factors, control efficiencies, and emissions from the 1985 inventory for all sources. The PM-10 control efficiencies were obtained from the *PM-10 Calculator*.[5] In addition, rule effectiveness, which was not applied in the 1985 NAPAP Emission Inventory, was applied to the 1990 emissions estimated for the 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, SO_2, and VOC 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. The 1990 uncontrolled PM-10 estimates were calculated from these TSP emissions by applying SCC-specific uncontrolled particle size distribution factors.[6] The controlled PM-10 emissions were estimated in the same manner as the other pollutants. Because the majority of area source emissions for all pollutants represented uncontrolled emissions, the second and third steps were not required to estimate the 1990 area source emissions.

4.3.1.1 Control Efficiency Revisions

In the 1985 NAPAP point source estimates, control efficiencies for VOC, NO_x, CO, and SO_2 sources in Texas were judged to be too high for their process/control device combination. These high control efficiencies occurred because Texas did not ask for control efficiency information, and simply applied the maximum efficiency for the reported control device.[7] High control efficiencies lead to high future growth in modeling scenarios based on uncontrolled emissions (which are based on the control efficiency and reported actual emissions). High control efficiencies also lead to extreme increases in emissions when rule effectiveness is incorporated.

Revised VOC control efficiencies were developed for Texas from the Emission Reduction and Cost Analysis Model for VOC (ERCAM-VOC).[8] For this analysis, revised efficiencies were also developed by SCC and control device combination for NO_x, SO_2, and CO using engineering judgement. These revised control efficiencies were applied to sources in Texas. A large number of point sources outside of Texas had VOC and CO control efficiencies that were also judged to be too high. The VOC and CO control efficiencies used for Texas were also applied to these sources.

Control efficiencies not applied in the 1985 NAPAP Emission Inventory were incorporated in the data files for VOC emissions from gasoline marketing (Stage I and vehicle refueling) and bulk gasoline plants and terminals, since many areas already have regulations in place for controlling Stage I and Stage II gasoline marketing emissions. Many current state regulations require the use of Stage I controls (except at small volume service stations) to reduce emissions by 95 percent. Emissions were revised to reflect these controls in areas designated as having these requirements as part of their SIPs.[9] Stage II vapor recovery systems are estimated to reduce emissions by 84 percent.[10] Stage II controls are already in place in the District of Columbia, St. Louis, Missouri, and parts of California. Stage II controls also reduce underground tank breathing/emptying losses. Emissions in these area were revised to reflect these controls.

Gasoline bulk plants and terminals are covered by existing Control Techniques Guidelines (CTGs) and are included in many state regulations. Emissions were revised to reflect these controls in areas with regulations.[9] Control efficiencies assumed for these area source categories were 51 percent for gasoline bulk plants and terminals. 1985 NAPAP area source estimates have control levels built into these emissions. These control levels were first backed out of the emissions. In areas with no controls, the emissions remained at uncontrolled levels. In areas with regulation, the uncontrolled emissions were reduced to reflect the above efficiencies.

4.3.1.2 Rule Effectiveness Assumptions

Controlled emissions for each inventory year were recalculated, assuming that reported VOC, NO_x, and CO controls were 80 percent effective. Sulfur dioxide and PM-10 controls were assumed to be 100 percent effective. The 80 percent rule effectiveness assumption was judged to be unreasonable for several VOC and CO source categories. The VOC rule effectiveness was changed to 100 percent for bulk storage tank sources that had VOC control devices codes 90, 91, or 92. These three codes represent conversion to variable vapor space tank, conversion to floating roof tank, and conversion to pressurized tank, respectively. These controls were judged to be irreversible process modifications (there are SCCs which represent these type of tanks), and therefore 100 percent rule effectiveness was applied. VOC and CO rule effectiveness was changed to 100 percent for all Petroleum Industry - Fluid Catalytic Cracking Units (FCCs), SCC 30600201. AP-42 lists CO waste heat boilers as a control for these units with both CO and hydrocarbon emissions reduced to negligible levels. Since these boilers handle VOC and CO as fuels rather than as emissions, they are treated as a process instead of as control device, and therefore are not subject to rule effectiveness.

There is no control device code for CO boilers in the 1985 NAPAP Inventory. To implement this set of revisions, all FCCs were assumed to have CO boilers. In addition, the CO rule effectiveness was changed to 100 percent for sources in five other SCCs that burn CO as a fuel. The CO rule effectiveness was also changed to 100 percent for sources with In-Process Fuel Use SCCs. According to AP-42, there should be no CO emissions from these sources. Emissions were not deleted from the inventory, however applying 80 percent rule effectiveness resulted in CO emissions of up to 36,000 short tons from some In-Process Fuel Use sources. Changing the rule effectiveness to 100 percent for sources in these SCCs retains the emissions, but at more reasonable levels. Table 4.3-1 lists the SCCs for which the CO rule effectiveness was changed to 100 percent.

Rule effectiveness was also adjusted for all chemical and allied product point sources from 80 to 100 percent.

4.3.1.3 Emission Factor Changes

The VOC emission factors for vehicle refueling were updated to reflect changes in gasoline Reid vapor pressure (RVP). The 1985 NAPAP gasoline marketing service station emissions were divided into two components: evaporative losses from underground tanks (Stage I) and Stage II vehicle refueling (including spillage). The 1985 NAPAP emissions were derived based on gasoline usage combined with the following uncontrolled emissions factors from AP-42:

Stage I: 7.3 lbs/1,000 gallons
Stage II: 11.0 lbs/1,000 gallons
Spillage: 0.7 lbs/1,000 gallons

These emission factors were used to calculate the fraction of total emissions attributable to each of the components above. The total percentage is 38.4 percent for Stage I emissions and 61.6 percent for Stage II emissions, plus spillage.

The Stage II emissions were also revised to reflect changes in emission factors. Stage II emission factors are a function of gasoline RVP and temperature. Gasoline RVPs have decreased since 1985 in response to the phase I and phase II RVP regulations. MOBILE5 was used to calculate Stage II emission factors for five sample states (Maryland, Illinois, New York, Texas, and North Carolina). Factors for each season were calculated based on the seasonal RVP and temperature (see Tables 4.3-2 to 4.3-4) based on engineering judgement. The national average annual factors for each inventory year are shown in Table 4.3-5. The 1987 value was used to estimate the 1985 and 1986 emissions.

In addition to updating the emission factor for Stage II, underground tank breathing/emptying losses were also added to the inventory. The AP-42 emission factor of 1.0 lbs/1,000 gallons was used to estimate emissions for each inventory year. Gasoline usage was back-calculated from the Stage II VOC emissions and emission factor.

4.3.1.4 Emissions Calculations

A three-step process was used to calculate emissions incorporating rule effectiveness. First, base year controlled emissions are projected to the inventory year using the following formula (Equation 4.3-1):

$$CE_i = CE_{BY} + (CE_{BY} \times EG_i) \qquad \text{(Eq. 4.3-1)}$$

where: CE_i = controlled emissions for inventory year i
CE_{BY} = controlled emissions for base year
EG_i = earnings growth for inventory year i

Earnings growth (EG) is calculated using Equation 4.3-2:

$$EG_i = 1 - \frac{DAT_i}{DAT_{BY}} \qquad \text{(Eq. 4.3-2)}$$

where: DAT_i = earnings data for inventory year i
DAT_{BY} = earnings data in the base year

Second, uncontrolled emissions in the inventory year are back-calculated from the controlled emissions based on the control efficiency with the following formula (Equation 4.3-3):

$$UE_i = \frac{CE_i}{\left(1 - \frac{CEFF}{100}\right)} \qquad \text{(Eq. 4.3-3)}$$

where: UE_i = uncontrolled emissions for inventory year i
CE_i = controlled emissions for inventory year I
CEFF = control efficiency (%)

Third, controlled emissions are recalculated incorporating rule effectiveness using the following equation (Equation 4.3-4):

$$CER_i = UC_i \times \left(1- \left(\frac{REFF}{100}\right) \times \left(\frac{CEFF}{100}\right)\right) \times \left(\frac{EF_i}{EF_{BY}}\right) \qquad \text{(Eq. 4.3-4)}$$

where: CER_i = controlled emissions incorporating rule effectiveness
UC_i = uncontrolled emissions
REFF = rule effectiveness (%)
CEFF = control efficiency (%)

EF_i = emission factor for inventory year i
EF_{BY} = emission factor for base year

In many cases, the PM-10 emissions calculated based on the particle size distribution and PM-10 control efficiency were higher than the total suspended particulate (TSP) emissions. The source problem is inconsistency between the TSP control efficiencies from the 1985 NAPAP inventory and the control efficiencies determined using the PM-10 calculator. This error may have been compounded in the following steps with the values selected for particle size distribution and efficiency. In the instances where the controlled PM-10 emissions were calculated to be higher than the controlled TSP emissions, the controlled PM-10 emissions were replaced with the controlled TSP emissions. The uncontrolled PM-10 was then recalculated using the revised PM-10 emissions and the control efficiency from the PM-10 calculator. In other words, it is assumed that in these instances, virtually all of the particles above 10 microns are being controlled and that particles emitted after the control device are all particles of 10 microns or less.

The basis for replacing the PM-10 emissions with the TSP emissions in these cases is the assumption that the controlled TSP emissions from the 1985 NAPAP inventory are the best data that are available as a measure of point source particulate emissions. If it is assumed that the uncontrolled emissions were the best data available, then an adjustment to the TSP control efficiency (resulting in an increase to actual TSP emissions) would be performed rather than replacing the PM-10 emissions.

4.3.1.5 Revised Emissions

Hazardous waste treatment, storage, and disposal facility (TSDF) emissions were updated using an April 1989 file from EPA's Emission Standards Division (ESD).[11a] This file provided estimates of TSDF emissions with longitude and latitude as the geographical indicator for each facility. The longitude and latitude were used to match each emission to the appropriate state and county. The emissions were generated by using the Hazardous Waste Data Management System (HWDMS)[11b] which includes data on facility-specific process descriptions, waste characterization and quantities, and VOC speciation. HWDMS generated national emissions estimates by summing emissions from each plant process at a TSDF. Speciated emissions from each plant process were calculated as the quantity of a specific waste handled, multiplied by a process-specific emission factor. Emission factors were taken from the *Background Information Documents for TSDFs*.[11c] The emission estimates displayed in Table 4.3-6 for eight counties were removed based on comments EPA has received during the last year from various State and Regional Emission Inventory personnel.

Area source petroleum refinery fugitive emissions were re-estimated based on a revised estimate of national petroleum refinery emissions. The national petroleum refinery emissions used to estimate area source emission in the 1985 NAPAP were obtained from the Emissions Trends report.[12] The emissions for blowdown systems were revised to reflect the high level of control as shown in the point source inventory.

The area source petroleum refinery fugitive emissions were re-estimated using the revised national emission total by applying the methodology used to develop the 1985 NAPAP estimate.[13] Total county fugitive petroleum refinery emissions were determined by distributing the revised Emission Trends estimate (excluding process heaters and catalytic cracking units) based on 1985 county refinery capacity from the DOE Petroleum Supply Annual.[14] Refinery capacity from this publication was allocated to counties based on the designated location of the refinery. The 1985 NAPAP Emission Inventory was used to aid in the matching of refineries to location.

Total area source petroleum refinery fugitive emissions were then estimated by subtracting the point source emissions (SCCs 3-06-004 through 3-06-888) from the total county-level emissions. Negative values (indicating higher point source emissions than the totals shown for the county), were re-allocated to counties exhibiting positive emission values based on the proportion of total refinery capacity for each county to avoid double-counting of emissions. This resulted in an estimate of 351 thousand short tons for 1985 compared with the earlier 1985 NAPAP estimate of 728 thousand short tons (area source refinery fugitives). This revised 1985 estimate was projected to the inventory years, as described in section 4.3.2.1.

The SO_2 emissions for 1987 through 1989 were adjusted to correct for the permanent closing of the Phelps Dodge copper smelter in Arizona in January 1987. This adjustment was made by subtracting the 1985 emissions for State=04, County=003, and NEDS ID =0013 from the inventory for 1987 through 1989.

4.3.2 Emissions, 1985 to 1989

As described in section 4.3.1.4, the 1990 Interim Inventory controlled emissions were projected from the 1985 NAPAP Emissions Inventory using Equations 4.3-1 through 4.3-4. For all other years (1985 to 1989) the emissions were projected from the 1990 Interim Inventory emissions using Equations 4.3-1 and 4.3-2. Therefore, the 1985 emissions estimated by this method do not match the 1985 NAPAP Emission Inventory due to the changes made in control efficiencies and emission factors and the addition of rule effectiveness when creating the 1990 Interim Inventory. For refueling sources, the emissions were adjusted to account for the updated emission factors for all years as described in section 4.3.1.3.

4.3.2.1 Point Source Growth

The changes in the point source emissions were equated with the changes in historic earnings by state and industry. Emissions from each point source in the 1985 NAPAP Emissions Inventory were projected to the years 1985 through 1991 based on the growth in earnings by industry (2-digit SIC code). Historical annual state and industry earnings data from BEA's Table SA-5[2] were used to represent growth in earnings from 1985 through 1990.

The 1985 through 1990 earnings data in Table SA-5 are expressed in nominal dollars. 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 1982 constant dollars using the implicit price deflator for PCE.[4] The PCE deflators used to convert each year's earnings data to 1982 dollars are:

Year	1982 PCE Deflator
1985	111.6
1987	114.3
1988	124.2
1989	129.6
1990	136.4

Several BEA categories did not contain a complete time series of data for the years 1985 through 1990. Because the SA-5 data must contain 1985 earnings and earnings for each inventory year (1985 through 1990) to be useful for estimating growth, a log linear regression equation was used where possible to fill in missing data elements. This regression procedure was performed on all categories that were missing at least one data point and which contained at least three data points in the time series.

Each record in the point source inventory was matched to the BEA earnings data based on the state and the 2-digit SIC. Table 4.3.7 shows the BEA earnings category used to project growth for each of the 2-digit SICs found in the 1985 NAPAP Emission Inventory. No growth in emissions was assumed for all point sources for which the matching BEA earnings data were not complete. Table 4.3.7 also shows the national average growth and earnings by industry from Table SA-5.

4.3.2.2 Area Source Growth

Emissions from the 1985 NAPAP Inventory were grown to the Emission Trends years based on historical BEA earnings data (section 4.3.2.1), historical estimates of fuel consumption, or other category-specific growth indicators. Table 4.3-8 shows the growth indicators used for each area source by 1985 NAPAP category.

The SEDS data were used as an indicator of emissions growth for the area source fuel combustion categories and for the gasoline marketing categories shown in Table 4.3-9. (SEDS reports fuel consumption by sector and fuel type.) Since fuel consumption was the activity level used to estimate emissions for these categories, fuel consumption was a more accurate predictor of changes in emissions, compared to other surrogate indicators such as earnings or population. SEDS fuel consumption data were available through 1989 at the time the emission estimates were developed. The 1990 values were extrapolated from the 1985 through 1989 data using a log linear regression technique. In addition to projecting 1990 data for all fuel consumption categories, the regression procedure was used to fill in missing data points for fuel consumption categories if at least three data points in the time series (1985 to 1989) were available.

The last step in the creation of the area source inventory was matching the 1985 NAPAP categories to the new Area and Mobile Source Subsystem (AMS) categories. This matching is provided in Table 4.3-10. Note that there is not always a one-to-one correspondence between 1985 NAPAP and AMS categories. For example, the gasoline marketing NAPAP category was split into two separate AMS categories representing Stage I and Stage II emissions. In addition, three 1985 NAPAP SCCs are not included in the AMS system of codes. Therefore, AMS codes were created for process emissions from pharmaceutical manufacture and synthetic fiber manufacture and for SOCMI fugitive emissions.

4.3.3 1990 National Emission Trends

The 1990 National Emission Trends is based primarily on state data, with the 1990 interim data filling in the gaps. The database houses U.S. annual and average summer day emission estimates for the 50 states and the District of Columbia. Seven pollutants (CO, NO_x, VOC, SO_2, PM-10, PM-2.5, and NH_3) were estimated in 1990. The state data were extracted from three sources, the OTAG inventory, the GCVTC inventory, and AIRS/FS. Sections 4.3.3.1, 4.3.3.2, and 4.3.3.3 give brief descriptions of these efforts. Section 4.3.3.4 describes the efforts necessary to supplement the inventory gaps that are either temporal, spacial, or pollutant.

Since EPA did not receive documentation on how these inventories were developed, this section only describes the effort to collect the data and any modifications or additions made to the data.

4.3.3.1 OTAG

The OTAG inventory for 1990 was completed in December 1996. The database 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 ozone pollutants (VOC, NO_x, and CO). This section gives a background of the OTAG emission inventory and the data collection process.

4.3.3.1.1 Inventory Components —
The OTAG inventory contains data for all states that are partially or fully in the SUPROXA modeling domain. The SUPROXA domain was developed in the late 1980s as part of the EPA regional oxidant modeling (ROM) applications. EPA had initially used three smaller regional domains (Northeast, Midwest, and Southeast) for ozone modeling, but wanted to model the full effects of transport in the eastern United States without having to deal with estimating boundary conditions along relatively high emission areas. Therefore, these three domains were combined and expanded to form the Super Domain. The western extent of the domain was designed to allow for coverage of the largest urban areas in the eastern United States without extending too far west to encounter terrain difficulties associated with the Rocky Mountains. The Northern boundary was designed to include the major urban areas of eastern Canada. The southern boundary was designed to include as much of the United States as possible, but was limited to latitude 26°N, due to computational limitations of the photochemical models. (Emission estimates for Canada were not extracted from OTAG for inclusion in the NET inventory.)

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 ozone precursor inventory. It includes emission estimates of VOC, NO_x, and CO 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 ozone precursor data.

No quality assurance (QA) was performed on the SO_2 and PM-10 emission estimates for the OTAG inventory effort.

Since the underlying purpose of the OTAG inventory is to support photochemical modeling for ozone, it is primarily an average summer day inventory. Emission estimates that were submitted as annual emission estimates were converted to average summer day estimates using operating schedule data and default temporal profiles and vice versa.

The OTAG inventory is made up of three major components: (1) the point source component, which includes segment/pollutant level emission estimates and other relevant data (e.g., stack parameters, geographic coordinates, and base year control information) for all stationary point sources in the domain; (2) the area source component, which includes county level emission estimates for all stationary area sources and non-road engines; and (3) the on-road vehicle component, which includes county/roadway functional class/vehicle type estimates of VMT and MOBILE5a input files for the entire domain. Of these three components, the NET inventory extracted all but the utility emissions. (See section 4.2 for a description of the utility NET emissions and section 4.6 for the on-road mobile NET emissions.)

4.3.3.1.2 Interim Emissions Inventory (OTAG Default) —

The primary data sources for the OTAG inventory were the individual states. Where states were unable to provide data, the 1990 Interim Inventory [15] was used for default inventory data. A more detailed description of the 1990 Interim Inventory is presented in section 4.3.1.

4.3.3.1.3 State Data Collection Procedures —

Since the completion of the Interim Inventory in 1992, many states had completed 1990 inventories for ozone nonattainment areas as required for preparing SIPs. In addition to these SIP inventories, many states had developed more comprehensive 1990 emission estimates covering their entire state. Since these state inventories were both more recent and more comprehensive than the Interim Inventory, a new inventory was developed based on state inventory data (where available) in an effort to develop the most accurate emission inventory to use in the OTAG modeling.

On May 5, 1995, a letter from John Seitz (Director of EPA's Office of Air Quality Planning and Standards [OAQPS]) and Mary Gade (Vice President of ECOS) to State Air Directors, states were requested to supply available emission inventory data for incorporation into the OTAG inventory.[16] Specifically, states were requested to supply all available point and area source emissions data for VOC, NO_x, CO, SO_2, and PM-10, with the primary focus on emissions of ozone precursors. Some emission inventory data were received from 36 of the 38 states in the OTAG domain. To minimize the burden to the states, there was no specified format for submitting State data. The majority of the state data was submitted in one of three formats:

1) an Emissions Preprocessor System Version 2.0 (EPS2.0) Workfile
2) an ad hoc report from AIRS/FS
3) data files extracted from a state emission inventory database

The origin of data submitted by each state is described in section 4.3.3.1.4.1 for point sources and 4.3.3.1.4.2 for area sources.

4.3.3.1.4. 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 two-digit SIC code.[2] 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 using the following equation:

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} * SUMTHRU * 1/(13 * DPW) \qquad \text{(Eq. 4.3-5)}$$

where:

$EMISSIONS_{ASD}$	=	average summer day emissions
$EMISSIONS_{ANNUAL}$	=	annual emissions
SUMTHRU	=	summer throughput percentage
DPW	=	days per week in operation

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. This computer file contains default seasonal and daily temporal profiles by SCC. The following equation was used:

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} / (SUMFAC_{SCC} * WDFAC_{SCC}) \qquad \text{(Eq. 4.3-6)}$$

where:

$EMISSIONS_{ASD}$	=	average summer day emissions
$EMISSIONS_{ANNUAL}$	=	annual emissions
$SUMFAC_{SCC}$	=	default summer season temporal factor for SCC
$WDFAC_{SCC}$	=	default summer weekday temporal factor for 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 and were calculated using the following equation:

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} / 365 \qquad \text{(Eq. 4.3-7)}$$

where:

$EMISSIONS_{ASD}$	=	average summer day emissions
$EMISSIONS_{ANNUAL}$	=	annual emissions

4.3.3.1.4.1 ***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 4.3-11 provides a brief description of the point source data supplied by each state. Figure 4.3-1 shows the states that supplied point source data and whether the data were for 1990 or a later year.

4.3.3.1.4.2 ***Area.*** For area sources, 17 of the 38 states in the OTAG domain supplied 1990 emission estimates covering the entire state, and an additional nine states supplied 1990 emission estimates covering part of their state (partial coverage was mostly in ozone nonattainment areas). 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 4.3-12 provides a brief description of the area source data supplied by each state. Figure 4.3-2 shows the states that supplied area source data.

4.3.3.1.4.3 ***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.

The use of rule effectiveness in estimating emissions can result in emission estimates that are much higher than estimates for the same source calculated without using rule effectiveness, especially for sources with high control efficiencies (95 percent or above). Because of this problem, there was concern that the OTAG emission estimates for states that used rule effectiveness would be biased to larger estimates relative to states that did not include rule effectiveness in their computations.

To test if this bias existed, county level maps of point source emissions were developed for the OTAG domain. If this bias did exist, one would expect to see sharp differences at state borders between states using rule effectiveness and states not using rule effectiveness. Sharp state boundaries were not evident in any of the maps created. Based on this analysis, it was determined that impact of rule effectiveness inconsistencies was not causing large biases in the inventory.

4.3.3.2 Grand Canyon Visibility Transport Commission Inventory

The GCVTC inventory includes detailed emissions data for eleven states: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.[17] This inventory was developed by compiling and merging existing inventory databases. The primary data sources used were state inventories for California and Oregon, AIRS/FS for VOC, NO_x, and SO_2 point source data for the other nine states, the 1990 Interim Inventory for area source data for the other nine states, and the 1985 NAPAP inventory for NH_3 and TSP data. In addition to these existing data, the GCVTC inventory includes newly developed emission estimates for forest wildfires and prescribed burning.

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

- complete point and area source data for California
- complete point and area source data for Oregon
- forest wildfire data for the entire eleven state region
- prescribed burning data for the entire eleven 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 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.

Non-utility point source emission estimates in the GCVTC inventory from states other than California and Oregon came from AIRS/FS. Corrections were made to this inventory to the VOC and PM emissions. The organic emissions reported in GCVTC inventory for California are total organics (TOG). These emissions were converted to VOC using the profiles from EPA's SPECIATE[18] database. Since the PM emissions in the GCVTC were reported as both TSP and PM-2.5, EPA estimated PM-10 from the TSP in a similar manner as described in section 4.3.1.4.

4.3.3.3 AIRS/FS

SO_2 and PM-10 (or PM-10 estimated from TSP) sources of greater than 250 tons per year as reported to AIRS/FS that were not included in either the OTAG or GCVTC inventories were appended to the NET inventory. The data were extracted from AIRS/FS using the data criteria set listed in table 4.3-13. The data elements extracted are also listed in Table 4.3-13. The data were extracted in late November 1996. It is important to note that *estimated* emissions were extracted.

4.3.3.4 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 SO2, PM-10, PM-2.5, and NH_3, as well as annual or ozone season daily (depending on the inventory) emission estimates for all pollutants. This section describes the steps taken to fill in the gaps from the other inventories.

4.3.3.4.1 SO_2 and PM Emissions —

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, OTAG data for these pollutants were not available. For point sources, data for plants over 250 tons per year for SO_2 and PM-10 were added from AIRS/FS. The AIRS/FS data were also 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 to the inventory. For OTAG plants where there were no matching data in AIRS/FS 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 unmatched point and area sources involved using uncontrolled emission factor ratios to calculate uncontrolled emissions. This method used SO_2 or PM-10 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 VOC, NO_x, and CO 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 Inventory 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 FIPS code, along with the plant and point IDs.

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/FS for 1990 and using the emission factor ratios resulted in unrealistically high PM-10 emissions.

There were no PM-2.5 data in either OTAG or AIRS/FS. Therefore, the point and area PM-2.5 emission estimates were developed based on the PM-10 estimates using source-specific uncontrolled particle size distributions and particle size specific control efficiencies for sources with PM-10 controls. To estimate PM-2.5, uncontrolled PM-10 was first estimated by removing the impact of any PM-10 controls on sources in the inventory. Next, the uncontrolled PM-2.5 was calculated by multiplying the uncontrolled PM-10 emission estimates by the ratio of the PM-2.5 particle size multiplier to the PM-10 particle size multiplier. (These particle size multipliers represent the percentage to total particulates below the specified size.) Finally, controls were reapplied to sources with PM-10 controls by multiplying the uncontrolled PM-2.5 by source/control device particle size specific control efficiencies.

4.3.3.4.2 NH_3 Emissions —

All NH_3 emission estimates incorporated into the NET Inventory came directly from EPA's National Particulate Inventory (NPI).[19] This methodology is the same as that reported in section 4.3.1 for the 1990 Interim, with the exception of agricultural sources. The NPI contained the only NH_3 emissions inventory available. (Any NH_3 estimates included in the OTAG or AIRS/FS inventory were eliminated due to sparseness of data.) As with SO_2 and PM-10, plant matching was performed for point sources.

Emissions were attached to existing plants where there was a match. New plants were added for plants where there was no match.

4.3.3.4.3 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 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 and PM-2.5 utility emissions were deleted.
- A correction was made to a point (state 13/county 313/plant 0084) where the ozone season daily value had been revised but not the annual value.
- Tier assignments were made for all SCCs.
- Checked and fixed sources with PM-2.5 emissions which were greater than their PM-10 emissions.
- Checked and fixed sources with PM-10 emissions greater than zero and PM-2.5 emissions equal to zero.
- TSDFs - The 1990 TSDF emission estimates provided by the States through the OTAG effort were replaced with the 1990 emission estimates modified as described in section 4.3.1.5.

4.3.4 Emissions, 1991 to 1994

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/FS data used. (The list of states are detailed in the AIRS/FS subsection, 4.3.4.2.) For those states requesting that EPA extract their data from AIRS/FS, 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/FS until July 1997.

4.3.4.1 Grown Estimates

The 1991 through 1994 point and area source emissions were grown using the 1990 NET inventory as the basis. The algorithm for determining the estimates is detailed in section 4.3.1.4. The 1990 through 1996 SEDS and BEA data are presented in Tables 4.3-14 and 4.3-15. The 1996 BEA and SEDS data were determined based on linear interpretation 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. Table 4.3-16 lists the SCC and the source for growth.

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 PCE. The PCE deflators used to convert each year's earnings data to 1992 dollars are:

Year	1992 PCE Deflator
1990	93.6
1991	97.3
1992	100.0
1993	102.6
1994	104.9
1995	107.6
1996	109.7

4.3.4.2 AIRS/FS

Several states responded to EPA's survey and requested that their 1991 through 1995 estimates reflect their emissions as reported in AIRS/FS. The list of these states, along with the years available in AIRS/FS is given in Table 4.3-17. As described in section 4.3.3.3, default estimated annual and ozone season daily emissions (where available) were extracted from AIRS/FS. Some changes were made to these AIRS/FS 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/FS and replaced the previously high estimates. The changes made to select state and/or plant AIRS/FS 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 4.3-17, 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 two years worth of emissions at the plant level. If only one year of emissions data were 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.

As described in section 4.3.3.4.1, many 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 PM-10 emissions are then converted to PM-2.5 in the same manner as described in section 4.3.1.4. The State of South Carolina provided its own conversion factor for estimating PM-10 from TSP.[19]

For all sources that did not report ozone season daily emissions, these emissions were estimated using the algorithm described in section 4.3.3.1.4 and equations 4.3-5 through 4.3-7.

4.3.5 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/FS for 1995, estimated using AIRS/FS 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. A description of the AIRS/FS methodology is described in section 4.3.4. The following two subsections describe the projected emissions.

In addition to projecting the 1990 inventory to 1995, EPA has added the source category cotton ginning. The methodology is detailed in section 4.3.5.4.

4.3.5.1 Grown Estimate

The 1995 point and area source emissions were grown using the 1990 NET inventory as the basis. The algorithm for determining the estimates is detailed in section 4.3.3.1.4 and equations 4.3-5 through 4.3-7. The 1990 through 1996 SEDS and BEA data are presented in Tables 4.3-14 and 4.3-15.

4.3.5.2 NO_x RACT

Major stationary source NO_x emitters in marginal and above nonattainment areas and in ozone transport regions (OTRs) are required to install RACT-level controls under the ozone nonattainment related provisions of Title I of the CAAA. The definition of major stationary source for NO_x differs by the severity of the ozone problem as shown in Table 4.3-18.

NO_x RACT controls for non-utility sources that were modeled for the 1995 NET emissions are shown in Table 4.3-19. These RACT-level controls were applied to point source emitters with emissions at or above the major source size definition for each area. The application of NO_x RACT controls was only applied to grown sources.

4.3.5.3 Rule Effectiveness

Rule effectiveness was revised in 1995 for all grown sources using the information in the 1990 database 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 calculated 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.

4.3.5.4 Cotton Ginning

Cotton ginning estimates for 1995 and 1996 were calculated using the following methodology. Ginning activity occurs from August/September through March, covering parts of two calendar years,[20] 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.

The general equation for estimating emissions from this category is given below.

$$E = (P_c * B) * EF_c + (P_f * B) * EF_f \quad \text{(Eq. 4.3-8)}$$

Where:
- E = annual county emissions (lbs/year)
- B = number of bales ginned in the county
- P_c = fraction of total bales at gins with conventional controls
- EF_c = emission factor for gins with conventional controls (lbs/bale)
- P_f = fraction of total bales at gins with full controls
- EF_f = emission factor for gins with full controls (lbs/bale)

4.3.5.4.1 Activity Indicator —

The activity factor for this category is the number of 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.[21] (A crop year runs from September through March.) These reports are published once or twice per month during the crop year and give the amount of cotton ginned as running totals.

The number of bales ginned in a county can be obtained from Reference 20. However, since these data are reported as running totals for the growing season (which spans parts of two calendar years), the number of bales ginned for a calendar year will need to be determined using data from two crop years. The amount of cotton ginned from January 1 to the end of the season (March) for calendar year *x* (crop year *x*) and the amount of cotton ginned from the beginning of the season (August/ September) for calendar year *x* (crop year *y*) should be summed to get the calendar year *x* total. To determine the amount ginned from January 1 to the end of the season, subtract the amount ginned by January 1 (in the early January *Cotton Ginnings* report) from the total reported in the March or end of season *Cotton Ginnings* report. To determine the amount ginned from the beginning of the season to January 1, use the total recorded by January 1 in the early January *Cotton Ginnings* report.

It should be noted that for confidentiality purposes, the *Cotton Ginnings* report may not show detailed data for a county, but may include those data in the district, state, or U.S. totals. Data for a gin may be considered confidential if (1) there are fewer than three gins operating in the county, or (2) more than 60 percent of the cotton ginned in the county is ginned at one mill. The standard *Cotton Ginnings* report lists the following four footnotes to its table of running bales ginned:

1/ withheld to avoid disclosing individual gins
2/ withheld to avoid disclosing individual gins, but included in state total
3/ excludes some gins' data to avoid disclosing individual gins, but included in the state total
4/ withheld to avoid disclosing individual gins but included in the U.S. total

The following methodology can be used for estimating the number of bales ginned from those counties with confidential data.

(1) If all counties in the district show confidentiality, but there is a district total, divide district total by the number of counties to get individual county estimates.

(2) If some (but not all) counties in a district show confidentiality and there is a district total, subtract county totals from district total and divide the remainder by the number of counties showing confidentiality to get estimates for the "confidential" counties.

(3) If both county and district totals are considered confidential within a state, divide the state total by the number of counties to get individual county estimates.

(4) If some (but not all) districts show confidentiality, subtract recorded district totals from the state total and divide the remainder by the number of counties showing confidentiality to get estimates for the "confidential" counties.

Although this method of apportioning is time consuming, it is preferable to using the ginning distribution from previous years to determine current estimates of number of bales ginned in confidential counties. The variability of the cotton harvest from year to year, the possibility of past claims of confidentiality, and the industry trend from numerous small gins to fewer, large gins makes distribution based on past activity unreliable. In addition, if the estimates generated by the methodology above does not meet with state approval, the state may submit more accurate data for those counties and the apportioning methodology can be revised.

The March report, produced at the end of the crop year, contains the final totals (including revisions and updates) for the crop year. Data in the report may differ from earlier reports for the crop year in both total number of bales ginned and counties where ginning occurred. In fact, for crop year 1995, the January reports showed higher totals for some counties than did the final report. Subtracting the January totals from the March totals for these counties yielded a negative number. In these cases, the activity for the county for that time period was considered zero. For this methodology, in instances where counties are recorded in the March final report, but not in earlier (e.g., January) reports, the activity is assumed to have occurred sometime before January. These counties were then added to the January listing as confidential counties, and distribution of ginning activity was then performed.

Kansas has only one small gin operating in the state, and this gin does not operate every year. Since the amount of cotton ginned at this facility is considered insignificant (less than 0.005 percent of the total cotton ginned in the United States in 1995), no emissions for Kansas were calculated.

4.3.5.4.2 Emission Factor —

AP-42[22] presents total PM and PM-10 emission factors (in lbs/bale) for gins with high-efficiency cyclones on all exhaust streams (i.e., full controls) and for gins with screened drums or cages on the lint cleaners and battery condenser and high-efficiency cyclones on all other exhaust streams (i.e., conventional controls). PM-2.5 emissions were assumed to be one percent of the total PM emissions, as given in Table B.2.2. in AP-42 for Grain Handling. Table 4.3-30 shows the AP-42 emission factors. Additional information obtained from EPA includes the estimated percent of cotton baled at gins using each type of control by state. These data were developed by the National Cotton Council and are shown in Table 4.3-21.[23] Emission factors are controlled emissions factors as indicated.

4.3.5.4.3 Sample Calculation —

Using the data for Alabama from the 03/25/96 *Cotton Ginnings* report:

- District 10 shows data for three counties, confidential data for two counties and a district total.

(1) Subtract District 10 county data from District 10 total.

144,250 - (35,200 + 59,300 + 25,750) = 24,000 bales

(2) Divide the remaining total by two (two counties claimed confidentiality) to estimate amount for each confidential county.

24,000/2 = 12,000 bales per confidential county

This procedure can also be used for District 40.

- Districts 50 and 60 show district totals only (i.e., all counties within these districts claim confidentiality). To estimate individual county totals, divide each district total by the number of counties within that district.

District 50	District 60
122,300/4 = 30,575 bales per county	153,650/6 = 25,608 bales per county

- Districts 20 and 30 claim county and district confidentiality. To estimate county totals,

(1) Subtract available district totals from state total.

491,150 - (144,250 + 34,650 + 122,300 + 153,650) = 36,300 bales

(2) Divide remainder by the number of counties claiming confidentiality in the two remaining districts.

36,300/8 = 4,538 bales per confidential county

Using the data in Table 4.3-22 and data from *Cotton Ginnings* reports, PM-10 emissions can be calculated for Madison County, Alabama, as shown in the following example.

(1) Determine total running bales ginned in Madison County in 1996

(a) For the period January 1, 1996 until the end of the crop season, subtract the running total as of January 1, 1996 from the 01/25/96 *Cotton Ginnings* report from the final crop season total from the 03/25/96 *Cotton Ginnings* report.

25,750 bales - 25,700 bales = 50 bales

(b) For the period from the beginning of the 1996 crop year until the end of calendar year 1996, use the running total as of January 1, 1997 from the 01/24/97 *Cotton Ginnings* report. Add this to the total from (a) above to get calendar year 1996 total.

50 bales + 40,500 bales = 40,550 bales ginned in calendar year 1996

(2) Determine the percent of crop ginned by emission control method using Table 4.3-22.

(3) Use the emission factors from AP-42 as shown in Table 4.3-20, the results of (1) and (2) above, and the general equation to estimate emissions.

$$E = [(P_c * B) * EF_c] + [(P_f * B) * EF_f] \quad \text{(Eq. 4.3-9)}$$

Where: P_c = 0.8
P_f = 0.2
B = 40,550 bales
EF_c = 1.2 lb/bale PM-10
EF_f = 0.82 lb/bale PM-10

Emissions = [(0.8 * 40,550 bales) * 1.2 lb/bale] + [(0.2 * 40,550 bales) * 0.82 lb/bale]
= 38,928 lbs + 6,650 lbs
= 45,578 lbs or 23 tons of PM-10

4.3.6 1996 Emissions

The 1996 emission estimates were derived in a similar manner as the 1995 emissions. For the non-utility point sources, the 1995 AIRS/FS emissions and 1995 emissions grown from 1990 emissions were merged. The following three subsections describes the projected 1996 emissions.

4.3.6.1 Grown Estimates

The 1996 point and area source emissions were grown using the 1995 NET inventory as the basis. The algorithm for determining the estimates is detailed in section 4.3.1.4 and is described by the equation below. The 1990 through 1996 SEDS and BEA data are presented in Tables 4.3-14 and 4.3-15. The

1996 BEA and SEDS data were determined using linear interpretation of the 1988 through 1995 data. Rule effectiveness was updated to 100 percent as described in section 4.3.5.3 for the AIRS/FS sources that reported rule effectiveness of less than 100 percent in 1995.

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

$$CER_{1996} = UC_{1995} \times \frac{GS_{1996}}{GS_{1995}} \times \left(1- \left(\frac{REFF}{100} \right) \times \left(\frac{CEFF}{100} \right) \times \left(\frac{RP}{100} \right) \right) \qquad \text{(Eq. 4.3-10)}$$

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 detailed in the following subsections.

4.3.6.2 1996 VOC Controls

This section discusses VOC stationary source controls (except those for electric utilities). These controls were developed to represent the measures mandated by the CAAA and in place in 1996. Title I (specifically the ozone nonattainment provisions) affects VOC stationary sources. Title III hazardous air pollutant regulations will also affect VOC source categories. The discussion for each source category-specific control measure includes the regulatory authority, CAAA provisions relating to the control measure, and relevant EPA guidance.

Table 4.3-23 list the point source controls by pod. (A pod is a group of SCCs with similar emissions and process characteristics for which common control measures, i.e., cost and emission reductions, can be applied. It is used for control measure application/costing purposes.) Table 4.3-24 lists the POD to SCC match. Table 4.3-25 lists the area source control efficiencies, and rule effectiveness and rule penetration if not 100 percent. A description of the controls is detailed below by measure.

4.3.6.2.1 Hazardous Waste Treatment, Storage, and Disposal Facilities —
Control assumptions for TSDF reflect application of Phase I and Phase II standards, as described below. Regulatory authority for these rules falls under the Resource Conservation and Recovery Act (RCRA). The Phase I rule for hazardous waste TSDFs restricts emissions from equipment leaks and process vents.[24] Process vent emissions must be below 3 lb/hr and 3.1 tons per year (tpy) or control devices must be installed. The control device must reduce emissions by 95 percent from uncontrolled levels or, if enclosed combustion devices are used, reduce the vent stream to 20 parts per million (ppm) by volume. The choice of control is not limited; condensers, absorbers, incinerators, and flares are demonstrated control techniques.

The equipment leak standards apply to emissions from valves, pumps, compressors, pressure relief devices, sampling connection systems, and open-ended valves or lines. Streams with organic concentrations equal to or greater than ten percent by weight are subject to the standards. Record keeping and monitoring are required for affected devices, in addition to the equipment standards, such as dual mechanical seals for compressors.

The Phase II rule will restrict emissions from tanks, containers, and surface impoundments.[25] The rule will affect an estimated 2,300 TSDFs. The proposed rule also requires generators with 90-day accumulation tanks (tanks holding waste for a period of 90 days or more) to install controls in order to retain RCRA permit exempt status. An estimated 7,200 generators will be affected. Controls specified for the Phase II rule are covers vented to a 95 percent destruction device, such as incinerators or carbon absorbers.

4.3.6.2.2 Municipal Solid Waste Landfills —

Emission reductions for landfills reflect the proposed rule and guidelines published in the *Federal Register*.[26] Regulatory authority for this control measure falls under RCRA. The proposed rule requires installation of gas collection systems and combustion (open flare) of the captured gases for all existing landfills emitting greater than 150 mg/year, or 167 tpy, of nonmethane organic compounds. A new source performance standard (NSPS) requires the same controls on all new facilities. The control device efficiency is estimated to be 82 percent. A rule effectiveness of 100 percent was applied. The penetration rate for existing facilities is estimated at 84 percent. A 100 percent penetration was applied to new sources.

4.3.6.2.3 New Control Technique Guidelines (CTGs) —

Section 183 of the CAAA mandated EPA to establish 11 new CTGs by November 1993. Controls following these guidelines must be implemented in moderate, serious, severe, and extreme nonattainment areas. The majority of these documents are in draft form or still in the analysis stages. Clean-up solvents will also be regulated through a negotiated rulemaking; however, implementation is not expected by 1996. Both of these control measures would apply nationwide. Control efficiency information was not available for many of the source categories, so default assumptions have been made.

4.3.6.2.4 Existing CTGs —

EPA has issued three groups of CTG documents to be implemented in ozone nonattainment areas. These controls should already be included in areas designated as nonattainment prior to 1990. These controls, however, must also be implemented in newly designated nonattainment areas and over the entire OTR. Not all CTGs are included in Table 4.3-25 because of the difficulty, in some cases, of matching the document to the appropriate sources within the inventory. It is assumed that all existing CTGs are implemented by 1996.

4.3.6.2.5 Reasonably Available Control Technology —

The CAAA direct moderate and above ozone nonattainment areas to require reasonably available control technology (RACT)-level controls to VOC major stationary sources. The definition of major source varies, depending on the severity of the ozone nonattainment classification, as listed in Table 4.3-18.

Point source RACT control assumptions are based on EPA documents, including background documents for New Source Performance Standards (NSPSs) and National Emission Standards for Hazardous Air Pollutants (NESHAPs), Alternative Control Technology (ACT) documents, and other compilations of VOC control techniques.

Area source RACT control information was taken from similar sources. The complicating factor for area source RACT controls is the major stationary source size cutoff. A penetration factor was developed that accounts for the fraction of emissions within the area source category that are expected to be emitted from major stationary sources. The penetration rate varies according to the major stationary source size cutoff and, therefore, the ozone nonattainment classification.

4.3.6.2.6 Vehicle Refueling Controls-Stage II Vapor Recovery —

The CAAA and Title I General Preamble include the following specifications for Stage II vapor recovery programs.

- Stage II is required in serious and above nonattainment areas. Moderate areas must implement Stage II if onboard is not promulgated, and are also encouraged to implement Stage II (regardless of whether onboard is promulgated) in order to achieve early reductions. (Onboard controls require fleet turnover to become fully effective.)

- Stage II must be installed at facilities that sell more than 10,000 gallons of gasoline per month (the cutoff is 50,000 gallons per month for independent small business marketers). There is nothing to preclude states from adopting lower source size cutoffs.[27]

- A study must be conducted to analyze comparable measures in the OTR. Implementation plans for OTRs must be modified within one year after issuance of the comparability study to include Stage II or comparable measures.[28]

- States must prescribe the use of Stage II systems that are certified to achieve at least 95 percent control of VOC and that are properly installed and operated.[29]

EPA has issued two guidance documents related to Stage II:

- *Technical Guidance - Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities - Volume 1* (EPA-450/3-91-022, November 1991)[30]

- *Enforcement Guidance for Stage II Vehicle Refueling Programs* (December 1991)[31]

Table 4.3-26 list the areas with Stage II programs in place as of January 1996.

4.3.6.2.7 New Source Performance Standards —

For new sources subject to NSPS controls, these standards apply regardless of location.[32] New sources in nonattainment areas are also subject to New Source Review (NSR)/offsets. A 100 percent rule effectiveness is assumed, consistent with that for other VOC stationary source controls.

4.3.6.2.8 *Title III —*

The source categories affected by Title III maximum achievable control technology (MACT) standards were identified by using EPA's timetable for regulation development under Title III.[33] Applicability of the anticipated regulations in various projection years was also derived from this draft timetable.

Control technology efficiencies were estimated for the expected MACT standards based on available information. The information used depended on the status of specific standards in their development timetable. For standards that have already been proposed or promulgated, efficiencies were estimated using information presented in preambles to the appropriate regulations.

Rule effectiveness was estimated at 100 percent for all Title III standards, in accordance with current EPA guidelines for rule effectiveness. Rule penetration is not applicable for any of the MACT categories, since it is included in the average "control technology efficiency" parameter.

4.3.6.3 NO_x Controls

For the 1996 emissions, reductions were made in areas of the country that did not put RACT controls into place until January 1996. Area combustion sources were reduced in 1996 according to the control efficiencies and rule penetration values listed in Table 4.3-27.

4.3.7 References

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31. *Enforcement Guidance for Stage II Vehicle Refueling Programs*, U.S. Environmental Protection Agency, Office of Air and Radiation, Washington, DC, December 1991.

Table 4.3-1. SCCs With 100 Percent CO Rule Effectiveness

SCC	Process
30300801	Primary Metals Production - Iron Production - Blast Furnaces
30300913	Primary Metals Production -Steel Production - Basic Oxygen Furnace: Open Hood-Stack
30300914	Primary Metals Production -Steel Production - Basic Oxygen Furnace: Closed Hood-Stack
30500401	Mineral Products - Calcium Carbide - Electric Furnace (Hoods and Main Stack)
30600201	Petroleum Industry - Fluid Catalytic Cracking Units
31000205	Oil and Gas Production - Natural Gas Production - Flares
31000299	Oil and Gas Production - Natural Gas Production - Other Not Classified
39000689	In-Process Fuel Use - Natural Gas - General
39000797	In-Process Fuel Use - Process Gas - General

Table 4.3-2. July RVPs Used to Model Motor Vehicle Emission Factors

State	State Reid Vapor Pressure (psi) 1987	1988	1989	1990	1991
AL	10.8	10.9	8.9	8.5	8.5
AZ	8.6	8.3	8.2	8.1	8.2
AR	10.2	9.8	9.4	8.7	8.5
CA	8.6	8.5	8.4	8.1	8.2
CO	9.7	9.4	8.7	8.3	8.4
CT	10.9	11.0	8.6	8.3	8.3
DE	11.3	10.8	9.2	8.4	8.3
DC	11.0	10.8	9.1	8.2	8.1
FL	10.2	10.5	9.0	9.1	9.1
GA	10.5	10.7	8.6	8.5	8.3
ID	10.1	9.9	9.5	9.1	9.4
IL	11.1	10.6	9.5	8.6	8.8
IN	11.6	11.1	9.6	8.7	9.0
IA	10.5	10.3	9.7	9.6	9.8
KS	9.8	9.6	9.1	8.5	8.6
KY	11.3	10.9	9.5	8.7	8.8
LA	10.4	11.0	8.6	8.3	8.4
ME	10.8	11.0	8.6	8.3	8.3
MD	11.2	10.8	9.1	8.3	8.2
MA	10.8	11.0	8.6	8.3	8.3
MI	11.7	11.0	9.8	9.1	9.3
MN	10.5	10.3	9.7	9.6	9.8
MS	10.2	9.8	9.4	8.7	8.5
MO	10.0	9.7	9.3	8.6	8.6
MT	9.3	9.5	9.3	8.6	9.2
NE	10.2	9.9	9.4	9.1	9.2
NV	8.6	8.5	8.3	8.2	8.3
NH	10.8	11.0	8.6	8.3	8.3
NJ	11.3	10.9	9.0	8.4	8.3
NM	9.0	8.5	8.2	8.1	8.1
NY	11.2	11.0	8.7	8.3	8.4
NC	10.5	10.7	8.6	8.5	8.3
ND	10.5	10.3	9.7	9.6	9.8
OH	11.6	11.4	9.8	9.6	9.7
OK	9.9	9.7	8.7	8.2	8.4
OR	9.7	9.4	9.1	8.9	9.0
PA	11.4	10.9	9.3	8.6	8.5
RI	10.8	11.0	8.6	8.3	8.3
SC	10.5	10.7	8.6	8.5	8.3
SD	10.5	10.3	9.7	9.6	9.8
TN	10.4	10.5	8.8	8.5	8.3
TX	9.8	9.6	8.4	8.0	8.2
UT	9.7	9.4	8.7	8.3	8.4
VT	10.8	11.0	8.6	8.3	8.3
VA	10.9	10.8	9.0	8.3	8.1
WA	10.8	10.2	9.7	9.6	9.7
WV	11.4	11.2	9.6	9.1	9.1
WI	11.4	10.9	9.6	8.8	9.0
WY	9.5	9.4	9.0	8.4	8.8

Source: Developed from July MVMA Fuel Volatility Surveys

Table 4.3-3. 1990 Seasonal RVP (psi) by State

State	Winter	Spring	Summer	Fall
AL	12.8	10.3	9.1	9.7
AZ	10.1	8.5	8.1	8.3
AR	13.4	10.7	8.7	10.9
CA	12.3	10.1	8.1	8.7
CO	11.5	9.6	8.5	9.3
CT	13.2	10.2	8.3	10.2
DE	13.9	10.5	8.4	9.4
DC	12.2	9.1	8.2	9.1
FL	11.9	9.1	9.1	9.1
GA	12.5	10.2	9.1	9.6
ID	12.5	10.5	9.1	9.5
IL	13.7	10.5	8.6	9.6
IN	13.8	10.6	8.7	9.7
IA	13.4	11.2	10.0	11.2
KS	12.5	9.5	8.5	9.0
KY	12.9	9.6	8.7	9.6
LA	12.2	10.0	8.9	9.4
ME	13.1	10.1	8.3	10.1
MD	13.4	10.2	8.3	9.3
MA	13.1	10.1	8.3	10.1
MI	13.8	10.9	9.1	10.9
MN	13.4	11.0	9.6	10.3
MS	13.4	10.7	9.4	10.0
MO	12.4	10.7	8.6	10.2
MT	13.1	10.1	8.6	10.1
NE	13.0	10.5	9.1	9.5
NV	10.9	8.8	8.2	8.5
NH	13.1	10.1	8.3	10.1
NJ	13.8	10.5	8.4	10.5
NM	11.6	9.0	8.1	9.3
NY	13.4	10.2	8.3	10.2
NC	12.5	11.0	9.1	10.4
ND	13.4	11.8	9.6	10.9
OH	13.9	11.2	9.6	10.4
OK	13.1	9.6	8.2	8.9
OR	12.4	10.4	8.8	9.6
PA	13.9	10.6	8.6	10.6
RI	13.1	10.1	8.3	10.1
SC	12.5	11.0	9.1	10.4
SD	13.0	10.9	9.6	10.0
TN	12.7	11.1	9.1	10.5
TX	12.4	9.9	8.0	8.6
UT	11.5	10.0	8.5	9.3
VT	13.1	10.1	8.3	10.1
VA	12.1	9.1	8.2	9.1
WA	13.6	11.1	9.6	10.4
WV	13.5	10.8	9.1	9.9
WI	13.7	10.7	8.8	9.7
WY	12.2	9.8	8.4	8.8

Source: Based on RVPs from the January and July MVMA Fuel Volatility Surveys interpolated to spring and fall.

Table 4.3-4. Seasonal Maximum and Minimum Temperatures (°F) by State

State	Winter Min	Winter Max	Spring Min	Spring Max	Summer Min	Summer Max	Fall Min	Fall Max
AL	42	62	57	78	72	91	58	79
AK	20	31	32	46	46	63	36	47
AZ	41	67	54	83	76	103	59	86
AR	32	53	50	73	70	92	51	75
CA	45	61	50	67	59	78	54	73
CO	18	45	34	61	56	85	37	66
CT	19	36	38	59	60	83	42	63
DE	25	42	42	62	64	84	47	66
DC	29	45	47	66	68	86	51	69
FL	52	72	62	77	73	89	65	82
GA	34	54	50	72	68	87	52	73
HI	66	81	69	83	73	87	71	86
ID	25	40	37	61	56	86	39	64
IL	17	33	39	59	62	83	43	63
IN	21	37	41	62	63	84	44	65
IA	15	31	39	59	64	84	42	63
KS	23	44	44	67	68	91	47	69
KY	27	44	45	66	66	86	47	68
LA	44	64	59	78	73	90	60	79
ME	14	33	33	52	55	76	38	59
MD	26	43	43	64	65	85	47	68
MA	25	38	41	56	63	79	48	62
MI	14	30	33	53	55	77	39	57
MN	5	24	32	51	56	78	36	54
MS	36	59	53	77	70	92	53	78
MO	22	40	44	65	66	87	52	67
MT	14	33	31	54	52	80	35	58
NE	15	35	40	62	64	86	42	65
NV	21	47	31	64	45	87	31	69
NH	12	33	32	56	54	80	36	60
NJ	25	43	41	61	62	82	46	66
NM	24	49	40	70	62	91	43	71
NY	21	36	39	57	61	81	45	62
NC	32	54	48	72	67	88	51	73
ND	1	23	30	53	54	82	31	57
OH	22	38	40	61	61	82	44	64
OK	28	50	48	71	69	91	50	73
OR	35	47	42	61	55	77	45	64
PA	24	39	41	61	62	83	45	65
RI	22	38	38	57	61	80	44	63
SC	34	58	51	76	69	91	52	76
SD	7	27	34	56	59	84	36	60
TN	31	50	50	71	69	89	51	73
TX	37	61	54	78	71	95	55	79
UT	22	40	37	62	58	89	40	66
VT	11	28	33	52	56	78	39	57
VA	31	49	47	68	67	86	51	71
WA	30	42	39	57	53	76	41	59
WV	26	44	43	66	62	84	45	67
WI	15	29	35	53	59	78	41	59
WY	17	40	30	54	52	80	34	60

U.S. NOAA "Climatology of the United States", 1982[12].

Table 4.3-5. Average Annual Service Station Stage II VOC Emission Factors

	Emission Factor	
Year	**grams/gallon**	**lbs/1,000 gallons**
1985	4.6	10.0
1986	4.6	10.0
1987	4.6	10.0
1988	4.6	10.0
1989	3.9	8.5
1990	3.6	8.0
1991	3.6	8.0
1992	3.6	8.0
1993	3.6	8.0

Table 4.3-6. TSDF Area Source Emissions Removed from the Inventory (1985-1996)

State		County		VOC Annual Emissions
48	Texas	071	Chambers	372,295
45	South Carolina	005	Allendale	364,227
54	West Virginia	073	Pleasants	252,128
22	Louisiana	047	Iberville	100,299
13	Georgia	051	Chatham	84,327
54	West Virginia	079	Putnum	60,568
48	Texas	039	Brazoria	59,951
01	Alabama	129	Washington	49,296

Table 4.3-7. Bureau of Economic Analysis's SA-5 National Changes in Earnings by Industry

Industry	SIC	Percent Growth from: 1985 to 1987	1987 to 1988	1988 to 1989	1989 to 1990
				14.58	-3.11
Farm	01, 02	14.67	-2.73		
Agricultural services, forestry, fisheries, and other	07, 08, 09	23.58	5.43	1.01	2.48
Coal mining	11	-17.46	-6.37	-4.16	4.73
Metal mining	10	-3.03	18.01	8.94	4.56
Nonmetallic minerals, except fuels	14	2.33	3.74	-2.79	-0.45
Construction	15	7.27	4.81	-1.36	-3.80
Food and kindred products	20	1.67	1.34	-1.20	-0.24
Textile mill products	22	8.50	-0.64	-1.39	-4.97
Apparel and other textile products	23	-1.72	1.25	-1.62	-4.22
Paper and allied products	26	2.62	0.94	-0.14	-0.39
Printing and publishing	27	7.44	5.67	-0.81	0.43
Chemicals and allied products	28	1.75	6.94	0.32	1.61
Petroleum and coal products	29	-10.82	-3.22	-3.02	1.06
Tobacco manufactures	21	-1.97	2.43	-2.43	-5.01
Rubber and miscellaneous plastic products	30	5.27	5.51	0.68	-0.14
Leather and leather products	31	-9.39	-1.64	-3.58	-2.55
Lumber and wood products	24	10.03	5.15	-3.54	-3.71
Furniture and fixtures	25	6.82	2.35	-1.46	-2.98
Primary metal industries	33	-9.09	5.32	-0.34	-3.03
Fabricated metal products	34	-4.72	2.55	-0.86	-1.91
Machinery, except electrical	35	-5.72	6.02	-0.32	-1.92
Electric and electronic equipment	36	-3.17	-18.01	-1.91	-3.22
Transportation equipment, excluding motor vehicles	37	8.44	-1.57	0.55	-1.07
Motor vehicles and equipment	371	-6.45	2.20	-2.96	-5.43
Stone, clay, and glass products	32	-0.23	-1.61	-1.96	-3.19
Instruments and related products	38	-0.04	60.65	-0.82	-2.91
Miscellaneous manufacturing industries	39	1.84	6.92	-2.21	-2.54
Railroad transportation	40	-14.13	-2.53	-3.83	-6.03
Trucking and warehousing	42	5.63	3.26	-0.20	0.99
Water transportation	44	-8.92	0.07	-1.02	2.83
Local and interurban passenger transit	41	13.45	0.51	2.14	1.44
Transportation by air	45	12.01	4.63	4.94	4.36
Pipelines, except natural gas	46	-5.21	3.67	-4.93	3.53
Transportation services	47	15.92	8.52	4.60	4.97
Communication	48	1.94	0.68	-2.81	2.07
Electric, gas, and sanitary services	49	0.07	3.05	0.63	0.39

Table 4.3-8. Area Source Growth Indicators

NAPAP SCC	Category Description	Data Source	Growth Indicator
13	Industrial Fuel - Anthracite Coal	SEDS	Ind - Anthracite
14	Industrial Fuel - Bituminous Coal	SEDS	Ind - Bituminous
15	Industrial Fuel - Coke	BEA	Total Manufacturing
16	Industrial Fuel - Distillate Oil	SEDS	Ind - Distillate oil
17	Industrial Fuel - Residual Oil	SEDS	Ind - Residual oil
18	Industrial Fuel - Natural Gas	SEDS	Ind - Natural gas
19	Industrial Fuel - Wood	BEA	Total Manufacturing
20	Industrial Fuel - Process Gas	SEDS	Ind - LPG
21	On-Site Incineration - Residential	BEA	Population
22	On-Site Incineration - Industrial	BEA	Total Manufacturing
23	On-Site Incineration-Commercial/Institutional	BEA	Services
24	Open Burning - Residential	BEA	Population
25	Open Burning - Industrial	BEA	Total Manufacturing
26	Open Burning - Commercial/Institutional	BEA	Services
54	Gasoline Marketed	SEDS	Trans - Motor gasoline
63	Frost Control - Orchard Heaters	BEA	Farm
99	Minor Point Sources	BEA	Population
100	Publicly Owned Treatment Works	BEA	Electric, Gas, and Sanitary Services
102	Fugitive Emissions From Synthetic Organic Chemical Manufacturing	BEA	Mfg - Chemicals and Allied Products
103	Bulk Terminal and Bulk Plants	BEA	Trucking and Warehousing
104	Fugitive Emissions From Petroleum Refinery		Refinery operating cap
105	Process Emissions From Bakeries	BEA	Mfg - Food and Kindred Products
106	Process Emissions From Pharmaceutical Manufacturing	BEA	Mfg - Chemicals and Allied Products
107	Process Emissions From Synthetic Fiber Manufacturing	BEA	Mfg - Textile Mill Products
108	Crude Oil and Natural Gas Production Fields	BEA	Oil and Gas Extraction
109	Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDFs)	BEA	Total Manufacturing

Table 4.3-9. SEDS National Fuel Consumption

Category	1985	1986	1987	1988	1989	1990
Anthracite Coal (thousand short tons)						
Industrial	575	470	437	434	392	387
Bituminous Coal (thousand short tons)						
Industrial	115,854	111,119	111,695	117,729	117,112	118,322
Distillate Fuel (thousand barrels)						
Industrial	203,659	206,108	210,699	209,553	197,035	205,856
Liquefied Petroleum Gases (thousand barrels)						
Industrial	437,964	411,451	447,120	453,599	441,784	457,013
Motor Gasoline (thousand barrels)						
Transportation	2,433,592	2,507,936	2,570,047	2,627,331	2,617,450	2,703,666
All Sectors	2,493,361	2,567,436	2,630,089	2,685,145	2,674,669	2,760,414
Natural Gas (million cubic feet)						
Industrial	6,867	6,502	7,103	7,479	7,887	8,120
Residual Fuel (thousand barrels)						
Industrial	120,002	132,249	107,116	105,448	95,646	118,122

Table 4.3-10. AMS to NAPAP Source Category Correspondence

AMS		NAPAP	
SCC	Category	SCC	Category
Stationary Source Fuel Combustion			
2102001000	Industrial - Anthracite Coal (Total: All Boiler Types)	13	Industrial Fuel - Anthracite Coal
2102002000	Industrial - Bituminous/Subbituminous Coal (Total: All Boiler Types)	14	Industrial Fuel - Bituminous Coal
2102004000	Industrial - Distillate Oil (Total: Boilers & IC Engines)	16	Industrial Fuel - Distillate Oil
2102005000	Industrial - Residual Oil (Total: All Boiler Types)	17	Industrial Fuel - Residual Oil
2102006000	Industrial - Natural Gas (Total: Boilers & IC Engines)	18	Industrial Fuel - Natural Gas
2102008000	Industrial - Wood (Total: All Boiler Types)	19	Industrial Fuel - Wood
2102009000	Industrial - Coke (Total: All Boiler Types)	15	Industrial Fuel - Coke
2102010000	Industrial - Process Gas (Total: All Boiler Types)	20	Industrial Fuel - Process Gas
Industrial Processes			
2301020000	Process Emissions from Pharmaceuticals (PECHAN)	106	Process Emissions from Pharmaceutical Manufacturing
2301030000	Process Emissions from Synthetic Fiber (PECHAN)	107	Process Emissions from Synthetic Fibers Manufacturing
2301040000	SOCMI Fugitives (PECHAN)	102	Fugitive Emissions From Synthetic Organic Chemical Manufacturing
2302050000	Food & Kindred Products: SIC 20 - Bakery Products (Total)	105	Process Emissions From Bakeries
2306000000	Petroleum Refining: SIC 29 - All Processes (Total)	104	Fugitive Emissions From Petroleum Refinery Operations
2310000000	Oil & Gas Production: SIC 13 - All Processes (Total)	108	Crude Oil and Natural Gas Production Fields
2399000000	Industrial Processes: NEC	99	Minor point sources
Storage & Transport			
2501050120	Petroleum & Petroleum Product Storage - Bulk Stations/Terminals: Breathing Loss (Gasoline)	103	Bulk Terminal and Bulk Plants
2501060050	Petroleum & Petroleum Product Storage - Gasoline Service Stations (Stage I: Total)	54	Gasoline Marketed (Stage I)
2501060100	Petroleum & Petroleum Product Storage - Gasoline Service Stations (Stage II: Total)	54	Gasoline Marketed (Stage II)
2501060201	Petroleum & Petroleum Product Storage - Gasoline Service Stations (Underground Tank: Breathing & Emptying)	54	Gasoline Marketed (Breathing & Emptying)

(continued)

Table 4.3-10 (continued)

AMS		NAPAP	
SCC	**Category**	**SCC**	**Category**
Waste Disposal, Treatment, & Recovery			
2601010000	On-Site Incineration - Industrial (Total)	22	On-Site Incineration - Industrial
2601020000	On-Site Incineration - Commercial/Institutional (Total)	23	On-Site Incineration - Commercial/Institutional
2601030000	On-Site Incineration - Residential (Total)	21	On-Site Incineration - Residential
2610010000	Open Burning - Industrial (Total)	25	Open Burning - Industrial
2610020000	Open Burning - Commercial/Institutional (Total)	26	Open Burning - Commercial/Institutional
2610030000	Open Burning - Residential (Total)	24	Open Burning - Residential
2630020000	Wastewater Treatment - Public Owned (Total)	100	Publicly-Owned Treatment Works (POTWs)
2640000000	TSDFs - All TSDF Types (Total: All Processes)	109	Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)

Table 4.3-11. 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
South Carolina	AIRS-AFS - Ad hoc retrievals	Annual	1991	Average Summer Day estimated using default temporal factors.

Table 4.3-11 (continued)

State	Data Source/Format	Temporal Resolution	Year of Data	Adjustments to Data
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 4.3-12. 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 4.3-13. Ad Hoc Report

Criteria		Plant Output		Point Output		Stack Output		Segment Output General		Segment Output Pollutant	
Regn	GT 0	YINV	YEAR OF INVENTORY	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE
PLL4	CE VOC	STTE	STATE FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE
PLL4	CE CO	CNTY	COUNTY FIPS CODE	PNED	NEDS POINT ID	PNED	NEDS POINT ID	PNED	NEDS POINT ID	PNED	NEDS POINT ID
PLL4	CE SO2	CYCD	CITY CODE	PNUM	POINT NUMBER	STNB	STACK NUMBER	STNB	STACK NUMBER	STNB	STACK NUMBER
PLL4	CE NO2	ZIPC	ZIP CODE	CAPC	DESIGN CAPACITY	LAT2	LATITUDE STACK	PNUM	POINT NUMBER	PNUM	POINT NUMBER
PLL4	CE PM-10	PNED	NEDS POINT ID	CAPU	DESIGN CAPACITY UNITS	LON2	LONGITUDE STACK	SEGN	SEGMENT NUMBER	SEGN	SEGMENT NUMBER
PLL4	CE PT	PNME	PLANT NAME	PAT1	WINTER THROUGHPUT	STHT	STACK HEIGHT	SCC8	SCC	SCC8	SCC
DES4	GE 0	LAT1	LATITUDE PLANT	PAT2	SPRING THROUGHPUT	STDM	STACK DIAMETER	HEAT	HEAT CONTENT	PLL4	POLLUTANT CODE
DUE4	ME TY	LON1	LONGITUDE PLANT	PAT3	SUMMER THROUGHPUT	STET	STACK EXIT TEMPERATURE	FPRT	ANNUAL FUEL THROUGHPUT	D034	OSD EMISSIONS
YINV	ME 90	SIC1	STANDARD INDUSTRIAL CODE	PAT4	FALL THROUGHPUT	STEV	STACK EXIT VELOCITY	SULF	SULFUR CONTENT	DU04	OSD EMISSION UNITS
		OPST	OPERATING STATUS	NOHD	NUMBER HOURS/DAY	STFR	STACK FLOW RATE	ASHC	ASH CONTENT	DES4	DEFAULT ESTIMATED EMISSIONS
		STRS	STATE REGISTRATION NUMBER	NODW	NUMBER DAYS/WEEK	PLHT	PLUME HEIGHT	PODP	PEAK OZONE SEASON DAILY PROCESS RATE	DUE4	DEFAULT ESTIMATED EMISSIONS UNITS
				NOHY	NUMBER HOURS/YEAR					CLEE	CONTROL EFFICIENCY
										CLT1	PRIMARY CONTROL DEVICE CODE
										CTL2	SECONDARY CONTROL DEVICE CODE
										REP4	RULE EFFECTIVENESS
										DME4	METHOD CODE
										Emfa	Emission factor

Table 4.3-14. SEDS National Fuel Consumption, 1990-1996 (trillion Btu)

Fuel Type	End-User	Code	1990	1991	1992	1993	1994	1995	1996
Anthracite Coal									
	Commercial	ACCCB	12	11	11	11	11	11	11
	Electric utility	ACEUB	17	16	17	16	15	15	15
	Industrial	ACICB	10	8	7	11	10	10	10
	Residential	ACRCB	19	17	17	16	16	16	16
Bituminous Coal									
	Commercial	BCCCB	80	72	75	72	70	69	68
	Electric utility	BCEUB	16,071	15,997	16,175	16,825	16,995	17,164	17,333
	Industrial	BCICB	2,744	2,592	2,505	2,489	2,434	2,379	2,333
	Residential	BCRCB	43	39	40	40	40	39	39
Distillate Fuel									
	Commercial	DFCCB	487	482	464	464	450	435	422
	Industrial	DFICB	1,181	1,139	1,144	1,100	1,090	1,080	1,071
	Residential	DFRCB	837	832	865	913	887	862	836
	Total	DFTCB	6,422	6,210	6,351	6,466	6,417	6,368	6,319
Distillate Fuel including Kerosene jet fuel									
	Electric utility	DKEUB	86	80	67	77	64	58	54
Kerosene									
	Commercial	KSCCB	12	12	11	14	13	12	11
	Industrial	KSICB	12	11	10	13	10	9	9
	Residential	KSRCB	64	72	65	76	67	59	51
	Total	KSTCB	88	96	86	103	89	76	65
Liquid Petroleum Gas									
	Commercial	LGCCB	64	69	67	70	70	70	70
	Industrial	LGICB	1,608	1,749	1,860	1,794	1,804	1,813	1,823
	Residential	LGRCB	365	389	382	399	398	397	397
	Total	LGTCB	2,059	2,227	2,328	2,282	2,290	2,298	2,306
Natural Gas									
	Commercial	NGCCB	2,698	2,808	2,884	2,996	3,035	3,074	3,114
	Electric utility	NGEUB	2,861	2,854	2,829	2,744	2,720	2,698	2,675
	Industrial	NGICB	8,520	8,637	8,996	9,387	9,635	9,883	10,131
	Residential	NGRCB	4,519	4,685	4,821	5,097	5,132	5,166	5,201
	Total	NGTCB	19,280	19,605	20,139	20,868	21,164	21,461	21,757
Residual Fuel									
	Commercial	RFCCB	233	213	191	175	170	168	167
	Electric utility	RFEUB	1,139	1,076	854	939	823	726	650
	Industrial	RFICB	417	336	391	452	459	469	481
	Total	RFTCB	2,820	2,657	2,518	2,479	2,346	2,213	2,080
Population									
		TPOPP	248,709	252,131	255,025	257,785	259,693	261,602	263,510

Table 4.3-15. BEA SA-5 National Earnings by Industry, 1990-1996 (million $)

Industry	LNUM	SIC	1990	1991	1992	1993	1994	1995	1996
Total population as of July 1 (thousands)	020	999	0	0	0	0	0	0	0
Total population as of July 1 (thousands)	030	999	1	1	1	1	1	1	1
Total population as of July 1 (thousands)	040	999	3,634	3,593	3,732	3,785	3,891	4,011	4,086
Total population as of July 1 (thousands)	041	999	238	242	248	253	265	273	280
Total population as of July 1 (thousands)	045	999	3,395	3,350	3,483	3,531	3,626	3,737	3,805
Total population as of July 1 (thousands)	046	999	971	947	907	914	934	980	981
Total population as of July 1 (thousands)	047	999	735	791	858	888	912	951	994
Total population as of July 1 (thousands)	050	999	2,932	2,891	2,975	3,003	3,082	3,182	3,231
Total population as of July 1 (thousands)	060	999	321	331	351	371	383	394	408
Total population as of July 1 (thousands)	070	999	381	370	405	410	426	436	447
Total population as of July 1 (thousands)	071	999	34	28	34	32	29	18	16
Total population as of July 1 (thousands)	072	999	347	342	372	378	396	418	432
Farm	081	1, 2	48	41	46	45	42	31	29
Farm	082	1, 2	3,586	3,552	3,686	3,740	3,849	3,980	4,058
Farm	090	1, 2	3,001	2,957	3,079	3,126	3,228	3,353	3,423
Agricultural services, forestry, fisheries, and other	100	7-9	24	24	24	24	26	27	27
Agricultural services, forestry, fisheries, and other	110	7-9	20	20	21	22	23	24	25
Agricultural services, forestry, fisheries, and other	120	7-9	4	3	3	3	3	3	3
Agricultural services, forestry, fisheries, and other	121	7-9	1	1	1	0	1	1	1
Agricultural services, forestry, fisheries, and other	122	7-9	2	2	2	2	2	2	1
Agricultural services, forestry, fisheries, and other	123	7-9	1	1	1	1	1	1	1
Agricultural services, forestry, fisheries, and other	200	7-9	36	37	36	34	35	35	35
Metal mining	210	10	2	3	3	2	2	2	3
Coal mining	220	11, 12	8	8	8	6	6	6	6
Oil and gas extraction	230	13	20	22	21	21	21	21	21
Nonmetallic minerals, except fuels	240	14	4	4	4	4	4	4	4
Construction	300	15-17	218	197	195	199	216	219	219
Construction	310	15-17	54	47	46	47	51	51	50
Construction	320	15-17	29	28	28	27	29	29	29
Construction	330	15-17	135	123	121	125	136	138	139
Manufacturing	400	998	710	690	705	705	725	740	747
Durable goods	410	996	437	418	423	424	440	452	456
Lumber and wood products	413	24	22	21	22	22	24	25	25
Furniture and fixtures	417	25	13	12	13	13	14	14	14
Stone, clay, and glass products	420	32	20	18	19	19	20	20	20
Primary metal industries	423	33	33	30	31	30	32	33	32
Fabricated metal products	426	34	51	48	49	49	51	53	53
Machinery, except electrical	429	35	86	83	83	84	86	90	91
Electric and electronic equipment	432	36	63	62	62	63	65	68	69
Motor vehicles and equipment	435	371	41	38	42	46	53	56	60
Transportation equipment, excluding motor vehicles	438	37	54	52	50	45	43	42	39
Instruments and related products	441	38	43	42	42	40	40	40	39
Miscellaneous manufacturing industries	444	39	11	11	11	12	12	12	12
Nondurable goods	450	997	273	272	281	282	285	288	291
Food and kindred products	453	20	51	51	52	52	53	53	54
Tobacco manufactures	456	21	3	3	3	2	2	3	3
Textile mill products	459	22	16	16	17	17	17	17	17
Apparel and other textile products	462	23	20	20	20	19	19	19	19
Paper and allied products	465	26	28	27	28	28	29	29	29
Printing and publishing	468	27	54	54	55	56	57	58	59
Chemicals and allied products	471	28	61	63	66	65	65	67	68
Petroleum and coal products	474	29	9	9	10	9	10	9	9
Rubber and miscellaneous plastic products	477	30	27	26	28	29	30	31	31

Table 4.3-15 (continued)

Industry	LNUM	SIC	1990	1991	1992	1993	1994	1995	1996
Leather and leather products	480	31	3	3	2	3	3	2	2
Leather and leather products	500	31	243	245	251	260	269	277	283
Railroad transportation	510	40	12	12	13	12	12	12	12
Trucking and warehousing	520	42	59	58	60	62	66	69	71
Water transportation	530	44	7	7	7	6	6	6	6
Water transportation	540	44	48	49	50	51	50	52	53
Local and interurban passenger transit	541	41	8	8	9	9	9	10	10
Transportation by air	542	45	30	30	31	31	31	31	31
Pipelines, except natural gas	543	46	1	1	1	1	1	1	1
Transportation services	544	47	12	13	14	14	15	16	17
Communication	560	48	63	63	64	67	71	75	78
Electric, gas, and sanitary services	570	49	49	52	53	56	56	56	57
Wholesale trade	610	50, 51	236	231	238	235	242	255	258
Retail trade	620	52-59	342	335	342	347	359	372	378
Retail trade	621	52-59	18	18	18	19	20	21	21
Retail trade	622	52-59	40	38	39	39	40	41	41
Retail trade	623	52-59	56	56	57	56	57	58	58
Retail trade	624	52-59	55	54	54	56	60	62	64
Retail trade	625	52-59	18	18	18	18	18	18	18
Retail trade	626	52-59	22	20	19	19	21	22	22
Retail trade	627	52-59	76	78	80	82	85	88	90
Retail trade	628	52-59	57	54	57	57	59	62	63
Retail trade	700	52-59	246	247	280	290	291	302	313
Banking and credit agencies	710	60, 61	82	81	86	89	89	90	91
Banking and credit agencies	730	60, 61	163	166	194	201	202	212	221
Banking and credit agencies	731	60, 61	38	40	50	53	51	55	58
Insurance	732	63, 64	56	59	61	62	63	63	65
Insurance	733	63, 64	34	33	33	34	36	37	38
Real estate	734	65, 66	28	25	36	43	44	47	51
Holding companies and investment services	736	62, 67	8	10	14	10	9	10	10
Services	800	995	946	951	1,008	1,032	1,066	1,128	1,164
Hotels and other lodging places	805	70	31	31	32	33	33	35	36
Personal services	810	72	33	32	33	36	36	36	37
Private households	815	88	10	9	10	10	10	11	11
Business and miscellaneous repair services	820	76	170	162	175	180	191	213	221
Auto repair, services, and garages	825	75	29	28	28	30	31	33	34
Auto repair, services, and garages	830	75	15	13	13	14	14	15	15
Amusement and recreation services	835	78, 79	29	30	34	33	35	37	39
Amusement and recreation services	840	78, 79	16	16	16	17	18	20	20
Health services	845	80	290	304	325	330	341	355	368
Legal services	850	81	80	80	85	84	84	85	86
Educational services	855	82	39	41	42	44	45	46	48
Social services and membership organizations	860	83, 86	29	31	34	35	38	40	42
Social services and membership organizations	865	83, 86	1	1	1	1	2	2	2
Social services and membership organizations	870	83, 86	35	36	36	38	40	41	42
Social services and membership organizations	875	83, 86	125	121	127	130	132	141	145
Miscellaneous professional services	880	84, 87, 89	14	14	15	15	17	18	19
Government and government enterprises	900	995	585	594	607	613	621	626	635
Federal, civilian	910	43, 91, 97	118	120	123	124	125	123	124
Federal, military	920	992	50	50	51	48	45	44	43
State and local	930	92-96	417	425	433	441	451	459	468
State and local	931	92-96	125	128	128	130	134	136	138
State and local	932	92-96	292	297	305	311	317	323	330

Table 4.3-16. Area Source Listing by SCC and Growth Basis

SCC	FILE	CODE *	SCC	FILE	CODE	SCC	FILE	CODE	SCC	FILE	CODE	SCC	FILE	CODE
2101002000	SEDS	ACEUB	2199005000	SEDS	RFTCB	2260008010	BEA	542	2265004035	SEDS	TPOPP	2270002015	BEA	300
2101004001	SEDS	DKEUB	2199006000	SEDS	NGTCB	2265000000	SEDS	TPOPP	2265004040	SEDS	TPOPP	2270002018	BEA	300
2101004002	SEDS	DKEUB	2199007000	SEDS	LGTCB	2265001000	SEDS	TPOPP	2265004045	SEDS	TPOPP	2270002021	BEA	300
2101006001	SEDS	NGEUB	2199011000	SEDS	KSTCB	2265001010	SEDS	TPOPP	2265004050	SEDS	TPOPP	2270002027	BEA	300
2101006002	SEDS	NGEUB	2260000000	SEDS	TPOPP	2265001030	SEDS	TPOPP	2265004055	SEDS	TPOPP	2270002030	BEA	300
2102001000	SEDS	ACICB	2260001000	SEDS	TPOPP	2265001040	SEDS	TPOPP	2265004060	SEDS	TPOPP	2270002033	BEA	300
2102002000	SEDS	BCICB	2260001010	SEDS	TPOPP	2265001050	SEDS	TPOPP	2265004065	SEDS	TPOPP	2270002036	BEA	300
2102004000	SEDS	DFICB	2260001020	SEDS	TPOPP	2265001060	SEDS	TPOPP	2265004070	SEDS	TPOPP	2270002039	BEA	300
2102005000	SEDS	RFICB	2260001030	SEDS	TPOPP	2265002000	BEA	300	2265004075	SEDS	TPOPP	2270002042	BEA	300
2102006000	SEDS	NGICB	2260001050	SEDS	TPOPP	2265002003	BEA	300	2265005000	BEA	81	2270002045	BEA	300
2102006001	SEDS	NGICB	2260001060	SEDS	TPOPP	2265002006	BEA	300	2265005010	BEA	81	2270002048	BEA	300
2102006002	SEDS	NGICB	2260002000	BEA	300	2265002009	BEA	300	2265005015	BEA	81	2270002051	BEA	300
2102007000	SEDS	LGICB	2260002006	BEA	300	2265002015	BEA	300	2265005020	BEA	81	2270002054	BEA	300
2102008000	BEA	400	2260002009	BEA	300	2265002021	BEA	300	2265005030	BEA	81	2270002057	BEA	300
2102010000	SEDS	LGICB	2260002021	BEA	300	2265002024	BEA	300	2265005035	BEA	81	2270002060	BEA	300
2102011000	SEDS	KSICB	2260002033	BEA	300	2265002027	BEA	300	2265005040	BEA	81	2270002063	BEA	300
2103001000	SEDS	ACCCB	2260003000	BEA	400	2265002030	BEA	300	2265005045	BEA	81	2270002066	BEA	300
2103002000	SEDS	BCCCB	2260003010	BEA	400	2265002033	BEA	300	2265005050	BEA	81	2270002069	BEA	300
2103004000	SEDS	DFCCB	2260003020	BEA	400	2265002039	BEA	300	2265005055	BEA	81	2270002072	BEA	300
2103005000	SEDS	RFCCB	2260003030	BEA	400	2265002042	BEA	300	2265006000	BEA	400	2270002075	BEA	300
2103006000	SEDS	NGCCB	2260003040	BEA	400	2265002045	BEA	300	2265006005	BEA	400	2270002078	BEA	300
2103007000	SEDS	LGCCB	2260004000	SEDS	TPOPP	2265002054	BEA	300	2265006010	BEA	400	2270002081	BEA	300
2103008000	BEA	400	2260004010	SEDS	TPOPP	2265002057	BEA	300	2265006015	BEA	400	2270003000	BEA	400
2103011000	SEDS	KSCCB	2260004015	SEDS	TPOPP	2265002060	BEA	300	2265006025	BEA	400	2270003010	BEA	400
2104001000	SEDS	ACRCB	2260004020	SEDS	TPOPP	2265002066	BEA	300	2265006030	BEA	400	2270003020	BEA	400
2104002000	SEDS	BCRCB	2260004025	SEDS	TPOPP	2265002072	BEA	300	2265007000	BEA	100	2270003030	BEA	400
2104004000	SEDS	DFRCB	2260004030	SEDS	TPOPP	2265002078	BEA	300	2265007010	BEA	100	2270003040	BEA	400
2104005000	NG		2260004035	SEDS	TPOPP	2265002081	BEA	300	2265008000	BEA	542	2270003050	BEA	400
2104006000	SEDS	NGRCB	2260004050	SEDS	TPOPP	2265003000	BEA	400	2265008005	BEA	542	2270004000	SEDS	TPOPP
2104007000	SEDS	LGRCB	2260004075	SEDS	TPOPP	2265003010	BEA	400	2265008010	BEA	542	2270004010	SEDS	TPOPP
2104008000	SEDS	TPOPP	2260005000	BEA	81	2265003020	BEA	400	2270000000	SEDS	TPOPP	2270004040	SEDS	TPOPP
2104008001	SEDS	TPOPP	2260006000	BEA	400	2265003030	BEA	400	2270001000	SEDS	TPOPP	2270004055	SEDS	TPOPP
2104008010	SEDS	TPOPP	2260006005	BEA	400	2265003040	BEA	400	2270001010	SEDS	TPOPP	2270004060	SEDS	TPOPP
2104008030	SEDS	TPOPP	2260006010	BEA	400	2265003050	BEA	400	2270001050	SEDS	TPOPP	2270004065	SEDS	TPOPP
2104008050	SEDS	TPOPP	2260006015	BEA	400	2265004000	SEDS	TPOPP	2270001060	SEDS	TPOPP	2270004070	SEDS	TPOPP
2104008051	SEDS	TPOPP	2260006020	BEA	400	2265004010	SEDS	TPOPP	2270002000	BEA	300	2270004075	SEDS	TPOPP
2104011000	SEDS	KSRCB	2260007000	BEA	100	2265004015	SEDS	TPOPP	2270002003	BEA	300	2270005000	BEA	81
2110030000	NG		2260007005	BEA	100	2265004025	SEDS	TPOPP	2270002009	BEA	300	2270005015	BEA	81

Table 4.3-16 (continued)

SCC	FILE	CODE *	SCC	FILE	CODE	SCC	FILE	CODE	SCC	FILE	CODE	SCC	FILE	CODE
2199004000	SEDS	DFTCB	2260008000	BEA	542	2265004030	SEDS	TPOPP	2270002012	BEA	300	2270005020	BEA	81
2270005025	BEA	81	2282005000	SEDS	TPOPP	2306010000	BEA	474	2401990000	BEA	400	2420010055	SEDS	TPOPP
2270005035	BEA	81	2282005010	SEDS	TPOPP	2308000000	BEA	477	2415000000	BEA	400	2420010370	SEDS	TPOPP
2270005045	BEA	81	2282005015	SEDS	TPOPP	2309000000	BEA	426	2415000385	BEA	400	2420010999	SEDS	TPOPP
2270005050	BEA	81	2282005025	SEDS	TPOPP	2309100230	BEA	426	2415000999	BEA	400	2420020000	SEDS	TPOPP
2270005055	BEA	81	2282010000	SEDS	TPOPP	2310000000	BEA	230	2415035000	BEA	438	2420020055	SEDS	TPOPP
2270006000	BEA	400	2282010005	SEDS	TPOPP	2310010000	BEA	230	2415045000	BEA	444	2425000000	BEA	820
2270006005	BEA	400	2282010010	SEDS	TPOPP	2310020000	BEA	230	2415065000	BEA	413	2425000999	BEA	820
2270006010	BEA	400	2282010015	SEDS	TPOPP	2312000000	BEA	429	2415100000	BEA	400	2425010000	BEA	820
2270006015	BEA	400	2282010020	SEDS	TPOPP	2325030000	BEA	210	2415105000	BEA	417	2425030000	BEA	820
2270006025	BEA	400	2282010025	SEDS	TPOPP	2390004000	BEA	400	2415110000	BEA	423	2425040000	BEA	820
2270006030	BEA	400	2282020000	SEDS	TPOPP	2390005000	BEA	400	2415120000	BEA	426	2430000000	BEA	477
2270007000	BEA	100	2282020005	SEDS	TPOPP	2390006000	BEA	400	2415125000	BEA	429	2440000000	BEA	444
2270007015	BEA	100	2282020010	SEDS	TPOPP	2390007000	BEA	400	2415130000	BEA	432	2440000999	BEA	444
2270007020	BEA	100	2282020020	SEDS	TPOPP	2390010000	BEA	400	2415135000	BEA	438	2440020000	BEA	444
2270008000	BEA	542	2282020025	SEDS	TPOPP	2399000000	BEA	400	2415140000	BEA	441	2460000000	SEDS	TPOPP
2270008005	BEA	542	2283002000	BEA	920	2401000000	SEDS	TPOPP	2415145000	BEA	444	2460000385	SEDS	TPOPP
2270008010	BEA	542	2285000000	BEA	510	2401001000	SEDS	TPOPP	2415200000	BEA	438	2461000000	BEA	300
2275000000	BEA	542	2285002000	BEA	510	2401002000	NG		2415230000	BEA	432	2461020000	BEA	300
2275001000	BEA	920	2285002005	BEA	510	2401005000	BEA	825	2415245000	BEA	444	2461021000	BEA	300
2275020000	BEA	542	2285002010	BEA	510	2401008000	SEDS	TPOPP	2415260000	BEA	825	2461022000	BEA	300
2275020021	BEA	542	2301000000	BEA	471	2401015000	BEA	413	2415300000	BEA	438	2461023000	BEA	300
2275050000	BEA	542	2301010000	BEA	471	2401020000	BEA	417	2415305000	BEA	417	2461050000	BEA	300
2275060000	BEA	542	2301020000	BEA	471	2401025000	BEA	417	2415310000	BEA	423	2461160000	BEA	300
2275070000	BEA	542	2301030000	BEA	471	2401030000	BEA	465	2415315000	BEA	423	2461600000	BEA	300
2275900000	BEA	542	2301040000	BEA	471	2401035000	BEA	477	2415320000	BEA	426	2461800000	BEA	300
2275900101	BEA	542	2302000000	BEA	453	2401040000	BEA	426	2415325000	BEA	429	2461850000	BEA	300
2275900102	BEA	542	2302002000	BEA	453	2401045000	BEA	426	2415330000	BEA	432	2465000000	SEDS	TPOPP
2280000000	BEA	530	2302010000	BEA	453	2401045999	BEA	426	2415335000	BEA	438	2465100000	SEDS	TPOPP
2280001000	BEA	530	2302050000	BEA	453	2401050000	BEA	426	2415340000	BEA	441	2465200000	SEDS	TPOPP
2280002000	BEA	530	2302070000	BEA	453	2401055000	BEA	429	2415345000	BEA	444	2465400000	SEDS	TPOPP
2280002010	BEA	530	2302070001	BEA	453	2401060000	BEA	432	2415350000	BEA	510	2465600000	SEDS	TPOPP
2280002020	BEA	530	2302070005	BEA	453	2401065000	BEA	432	2415355000	BEA	620	2465800000	SEDS	TPOPP
2280002040	BEA	530	2302070010	BEA	453	2401070000	BEA	435	2415360000	BEA	825	2465900000	SEDS	TPOPP
2280003000	BEA	530	2303020000	BEA	423	2401075000	BEA	438	2415365000	BEA	820	2500000000	NG	
2280003010	BEA	530	2304000000	BEA	423	2401080000	BEA	438	2420000000	SEDS	TPOPP	2501000000	BEA	230
2280003020	BEA	530	2304050000	BEA	423	2401085000	BEA	438	2420000055	SEDS	TPOPP	2501000030	BEA	230
2280003030	BEA	530	2305000000	BEA	240	2401090000	BEA	444	2420000370	SEDS	TPOPP	2501000090	BEA	230
2280004020	BEA	530	2305070000	BEA	240	2401100000	BEA	400	2420000999	SEDS	TPOPP	2501000150	BEA	230
2282000000	SEDS	TPOPP	2306000000	BEA	474	2401200000	BEA	400	2420010000	SEDS	TPOPP	2501010000	BEA	230
2501050000	BEA	610	2501995000	BEA	230	2601020000	BEA	570	2810015000	SEDS	TPOPP	2495000000	SEDS	TPOPP

Table 4.3-16 (continued)

SCC	FILE	CODE *	SCC	FILE	CODE	SCC	FILE	CODE	SCC	FILE	CODE	SCC	FILE	CODE
2501050030	BEA	610	2501995030	BEA	230	2601030000	BEA	570	2810025000	SEDS	TPOPP	2505010000	BEA	474
2501050060	BEA	610	2501995060	BEA	230	2610000000	BEA	570	2810030000	SEDS	TPOPP	2710020030	BEA	81
2501050090	BEA	610	2501995090	BEA	230	2610010000	BEA	570	2810035000	SEDS	TPOPP	2730050000	NG	
2501050120	BEA	610	2501995120	BEA	230	2610020000	BEA	570	2810050000	SEDS	TPOPP	2730100000	NG	
2501050150	BEA	610	2501995150	BEA	230	2610030000	SEDS	TPOPP	2810060000	SEDS	TPOPP	2801000003	BEA	81
2501050180	BEA	610	2501995180	BEA	230	2620000000	BEA	570	2830000000	NG		2801520000	BEA	81
2501060000	BEA	620	2505000000	BEA	474	2620030000	BEA	570	2830001000	NG		2801700001	BEA	81
2501060050	BEA	620	2505000120	BEA	474	2630000000	BEA	570	2850000010	NG		2801700002	BEA	81
2501060051	BEA	620	2505010120	BEA	474	2630010000	BEA	570	2102009000	BEA	400	2801700003	BEA	81
2501060052	BEA	620	2505020000	BEA	474	2630020000	BEA	570	2275085000	BEA	542	2801700004	BEA	81
2501060053	BEA	620	2505020030	BEA	474	2630030000	BEA	570	2280004000	BEA	530	2801700005	BEA	81
2501060100	BEA	620	2505020060	BEA	474	2640000000	BEA	570	2294000000	NG		2801700006	BEA	81
2501060101	BEA	620	2505020090	BEA	474	2640000001	BEA	570	2296000000	NG		2801700007	BEA	81
2501060102	BEA	620	2505020120	BEA	474	2640000004	BEA	570	2302080000	BEA	453	2801700008	BEA	81
2501060103	BEA	620	2505020150	BEA	474	2640010001	BEA	570	2307060000	BEA	413	2801700009	BEA	81
2501060200	BEA	620	2505020180	BEA	474	2640010004	BEA	570	2309100010	BEA	426	2801700010	BEA	81
2501060201	BEA	620	2505020900	BEA	474	2660000000	BEA	570	2310030000	BEA	230	2805000000	BEA	81
2501070000	BEA	620	2505030000	BEA	474	2801000005	BEA	100	2311000100	NG		2805001000	BEA	81
2501070051	BEA	620	2505030120	BEA	474	2801500000	BEA	100	2325000000	NG		2805020000	BEA	81
2501070052	BEA	620	2510000000	BEA	471	2810001000	NG		2401010000	BEA	459	2805025000	BEA	81
2501070101	BEA	620	2510995000	BEA	471	2810003000	SEDS	TPOPP	2415045999	BEA	400	2805030000	BEA	81
2501070103	BEA	620	2601000000	BEA	570	2810005000	BEA	100	2415060000	BEA	400	2805040000	BEA	81
2501070201	BEA	620	2601010000	BEA	570	2810010000	BEA	100	2461800999	SEDS	TPOPP	2805045001	BEA	81

NOTE(S): * BEA Code is equal to LNUM on previous table.

Table 4.3-17. Emission Estimates Available from AIRS/FS 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).

Table 4.3-18. NO_x and VOC Major Stationary Source Definition

Ozone Nonattainment Status	Major Stationary Source (tons)
Marginal/Moderate	100
Serious	50
Severe	25
Extreme	10
Ozone Transport Region	50

Table 4.3-19. Summary of Revised NO_x Control Efficiencies

Pod ID	Pod Name	Estimated Efficiency	Control	Reference
55	Industrial Process Heat	74	ULNB	ACT (EPA,1993d)
58	Commercial/Institutional - Coal	50	LNB	ACT (EPA,1993e)
59	Commercial/Institutional - Oil	50	LNB	ACT (EPA,1993e)
60	Commercial/Institutional - Gas	50	LNB	ACT (EPA,1993e)
70	Industrial Oil Fired Turbines	70	WI	ACT (EPA,1993f)
71	Industrial Oil Fired Reciprocating Engines	25	IR	ACT (EPA,1993g)
72	Industrial Gas Fired Turbines	84	LNB	ACT (EPA,1993f)
73	Industrial Gas Fired Reciprocating Engines	30	AF + IR	ACT (EPA,1993g)
74	Utility Oil Fired Turbines	70	WI	ACT (EPA,1993f)
75	Utility Oil Fired Reciprocating Engines	25	IR	ACT (EPA,1993g)
76	Utility Gas Fired Turbines	84	LNB	ACT (EPA,1993f)
77	Utility Gas Fired Reciprocating Engines	30	AF + IR	ACT (EPA,1993g)
84	Industrial External Combustion - Coal	50	LNB	ACT (EPA,1993e)
85	Industrial External Combustion - Oil - < 100 MMBtu/hr	50	LNB	ACT (EPA,1993e)
86	Industrial External Combustion - Oil -Cogeneration	50	LNB	ACT (EPA,1993e)
87	Industrial External Combustion - Oil -General	50	LNB	ACT (EPA,1993e)
88	Industrial External Combustion - Gas - < 100 MMBtu/hr	50	LNB	ACT (EPA,1993e)
89	Industrial External Combustion - Gas - Cogeneration	50	LNB	ACT (EPA,1993e)
90	Industrial External Combustion - Gas - General	50	LNB	ACT (EPA,1993e)

Controls:
AF - Air/Fuel Adjustment
IR - Ignition Time Retardation
LNB - Low NO_x Burner
ULNB - Ultra-low NO_x Burner
WI - Water Injection

Table 4.3-20. Cotton Ginning Emission Factors[22]

Control Type	Total PM (lb/bale)	PM-10 (lb/bale)	PM-2.5 (lb/bale)
Full controls (high-efficiency cyclone)	2.4	0.82	0.024
Conventional controls (screened drums or cages)	3.1	1.2	0.031

Table 4.3-21. Estimated Percentage of Crop By Emission Control Method (By State and U.S. Average)[29]

State	Percent Crop - Full Controls	Percent Crop - Conventional Controls
Alabama	20	80
Arizona	50	50
Arkansas	30	70
California	72	28
Florida	20	80
Georgia	30	70
Louisiana	20	80
Mississippi	20	80
Missouri	20	80
New Mexico	20	80
North Carolina	30	70
Oklahoma	20	80
South Carolina	20	80
Tennessee	20	80
Texas	30	70
Virginia	20	80
U.S. Average[a]	**35**	**65**

[a]Average is based on the average crop (average total bales ginned per year) from 1991 to 1995 for these states.

Table 4.3-22. Cotton Ginnings: Running Bales Ginned By County, District, State, and United States[a]

State/County/ District	Running Bales Ginned
UNITED STATES	17,498,800
Alabama	
Colbert 1/	*12,000*
Lauderdale 1/	*12,000*
Lawrence	35,200
Limestone	59,300
Madison	25,750
District 10	144,250
Blount 1/	*4,538*
Cherokee 1/	*4,538*
District 20	
Chilton 1/	*4,538*
Fayette 1/	*4,538*
Pickens 1/	*4,538*
Shelby 1/	*4,538*
Tallapoosa 1/	*4,538*
Tuscaloosa 1/	*4,538*
District 30 2/	
Autauga 1/	*4,079*
Dallas 1/	*4,079*
Elmore	6,100
Greene 1/	*4,079*
Hale 1/	*4,079*
Lowndes 1/	*4,079*
Macon 1/	*4,079*
Marengo 1/	*4,079*
District 40	34,650
Alabama (Cont'd)	
Baldwin 1/	*30,575*
Escambia 1/	*30,575*
Mobile 1/	*30,575*
Monroe 1/	*30,575*
District 50	122,300
Covington 1/	*25,608*
Crenshaw 1/	*25,608*
Geneva 1/	*25,608*
Henry 1/	*25,608*
Houston 1/	*25,608*
Russell 1/	*25,608*
District 60	153,650
AL Total	491,150
Arizona	
Mohave 1/	
District 20 2/	
Maricopa	354,050
Pinal	266,900
District 50	620,950
La Paz 1/	
Yuma	74,100

[a]The data in and format of this table were taken from the 03/25/96 *Cotton Ginnings* report.
1/ Withheld to avoid disclosing individual gins.
2/ Withheld to avoid disclosing individual gins, but included in state total.
3/ Excludes some gins' data to avoid disclosing individual gins, but included in state total.
4/ Withheld to avoid disclosing individual gins, but included in U.S. total.

Table 4.3-23. Point Source Controls by Pod and Measure

POD	PODNAME	MEASNAME	SOURCE	PTFYCE
4	Fixed roof petroleum product tanks	CTG	Fixed roof petroleum tanks	98
5	Fixed roof gasoline tanks	CTG	Fixed roof gasoline tanks	96
6	EFR petroleum product tanks	CTG	EFR petroleum tanks	90
7	EFR gasoline tanks	CTG	EFR gasoline tanks	95
15	Ethylene oxide manufacture	SOCMI HON	Ethylene oxide manufacture	79
16	Phenol manufacture	SOCMI HON	Phenol manufacture	79
17	Terephthalic acid manufacture	Incineration (RACT)	Terephthalic acid manufacture	98
18	Acrylonitrile manufacture	SOCMI HON	Acrylonitrile manufacture	79
21	Cellulose acetate manufacture	Carbon adsorber (RACT)	Cellulose acetate manufacture	54
23	Polypropylene manufacture	Flare (RACT)	Polypropylene manufacture	98
24	Polyethylene manufacture	Flare (RACT)	Polyethylene manufacture	98
25	Ethylene manufacture	Flare (RACT)	Ethylene manufacture	98
26	Petroleum refinery wastewater treatment	Benzene NESHAP/CTG	Petroleum ref wastewater treatment	95
27	Petroleum refinery vacuum distillation	CTG	Petroleum ref vacuum distillation	100
28	Vegetable oil manufacture	Stripper and equipment (RACT)	Vegetable oil manufacture	42
29	Paint and varnish manufacture	RACT	Paint and varnish manufacture	70
32	Carbon black manufacture	Flare (RACT)	Carbon black manufacture	90
42	Surface coating - thinning solvents	RACT	Surface coating - thinning solvents	90
47	Ferrosilicon production	RACT	Ferrosilicon production	88
48	By-product coke manufacture - other	NESHAP	By-product coke manufacture - other	94
49	By-product coke manufacture - oven charging	NESHAP	By-product coke mfg - oven charging	94
50	Coke ovens - door and topside leaks	NESHAP	Coke ovens - door and topside leaks	94
51	Coke oven by-product plants	NESHAP	Coke oven by-product plants	94
53	Whiskey fermentation - aging	Carbon adsorption (RACT)	Whiskey fermentation - aging	85
54	Charcoal manufacturing	Incineration (RACT)	Charcoal manufacturing	80
56	SOCMI reactor	New CTG	SOCMI reactor	98
57	SOCMI distillation	New CTG	SOCMI distillation	98
61	Open top degreasing	MACT	Open top degreasing	63
62	In-line degreasing	MACT	In-line degreasing	63
63	Cold cleaning	MACT	Cold cleaning	63
65	Open top degreasing - halogenated	MACT	Open top degreasing - halogenated	63
66	In-line degreasing - halogenated	MACT	In-line degreasing - halogenated	63
68	SOCMI fugitives	HON - Equipment Leak and Detec	SOCMI fugitives	79

Table 4.3-23 (continued)

POD	PODNAME	MEASNAME	SOURCE	PTFYCE
69	SOCMI wastewater	SOCMI HON	SOCMI wastewater	79
71	SOCMI processes - pharmaceutical	SOCMI HON/Pharmaceuticals	SOCMI processes - pharmaceutical	79
73	SOCMI processes - gum and wood	SOCMI reactor CTG	SOCMI processes - gum and wood	98
74	SOCMI processes - cyclic crudes	SOCMI HON	SOCMI processes - cyclic crudes	79
75	SOCMI processes - industrial chemicals	SOCMI HON	SOCMI processes - industrial chem	79
77	SOCMI processes - crudes & agricultural	SOCMI reactor CTG	SOCMI processes - crudes & agricul	98
80	SOCMI fugitives - cyclic crudes	SOCMI HON	SOCMI fugitives - cyclic crudes	79
81	SOCMI fugitives - industrial organics	SOCMI HON	SOCMI fugitives - ind organics	79
82	SOCMI - process vents	SOCMI HON	SOCMI - process vents	79
84	VOL storage	SOCMI HON	VOL storage	79
85	Misc organic solvent evaporation	SOCMI HON	Misc organic solvent evaporation	79
86	Single chamber incinerators	RACT	Single chamber incinerators	90
91	Dry cleaning - perchloroethylene	MACT	Dry cleaning - perchloroethylene	44
93	Dry cleaning - other	MACT	Dry cleaning - other	44
95	Bakeries	Incineration (RACT)	Bakeries	95
96	Urea resins - general	RACT	Urea resins - general	90
97	Organic acids manufacture	RACT	Organic acids manufacture	90
98	Leather products	RACT	Leather products	90
114	Petroleum refineries - Blowdown w/o control	RACT/CTG	Petoleum ref - blowdown	98
199	Miscellaneous non-combustion	RACT	Miscellaneous non-combustion	90
401	By-product coke mfg	Benzene NESHAP	By-product coke mfg	85
402	By-product coke - flushing-liquor circulation tank	Benzene NESHAP	By-prod coke - flush-liq circ tank	95
403	By-product coke - excess-ammonia liquor tank	Benzene NESHAP	By-prod coke - ex nh3 liquor tank	98
404	By-product coke mfg - tar storage	Benzene NESHAP	By-product coke mfg - tar storage	98
405	By-product coke mfg - light oil sump	Benzene NESHAP	By-product coke - light oil sum	98
406	By-product coke mfg - light oil dec/cond vents	Benzene NESHAP	By-prod coke - oil dec/cond vents	98
407	By-product coke mfg - tar bottom final cooler	Benzene NESHAP	By-prod coke - tar bottom cooler	81
408	By-product coke mfg - naphthalene processing	Benzene NESHAP	By-prod coke - naphth processing	100
409	By-product coke mfg - equipment leaks	Benzene NESHAP	By-product coke - equipment leaks	83

NOTE: A pod is a group of SCCs with similar emissions and process characteristics for which common control measures (i.e., cost and emission reductions) can be applied.

Table 4.3-24. Point Source SCC to Pod Match-up

SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD
30100101	75	30101842	70	30102630	22	30112021	56	30116780	81	30125003	82	30181001	77
30100103	17	30101847	136	30102699	22	30112099	75	30116799	75	30125004	81	30182001	69
30100104	56	30101849	143	30103101	134	30112199	56	30116901	74	30125005	56	30182002	69
30100180	81	30101852	70	30103102	134	30112480	81	30116906	74	30125010	56	30182003	69
30100199	75	30101860	24	30103103	134	30112501	75	30116980	80	30125015	56	30182004	69
30100504	32	30101861	24	30103104	134	30112502	75	30117401	15	30125020	56	30182005	69
30100509	68	30101863	24	30103105	134	30112509	81	30117421	15	30125099	56	30182006	69
30100601	54	30101864	24	30103199	134	30112510	75	30117480	15	30125101	75	30182007	69
30100603	54	30101865	24	30103301	76	30112512	82	30117617	75	30125180	81	30182008	69
30100604	54	30101866	24	30103311	76	30112514	75	30117680	75	30125201	56	30182009	69
30100699	73	30101870	136	30103312	76	30112520	75	30118101	74	30125301	75	30182010	69
30101012	116	30101872	136	30103399	78	30112524	81	30118102	74	30125302	82	30182011	69
30101013	116	30101880	136	30103402	75	30112525	75	30118103	74	30125306	82	30183001	68
30101021	116	30101881	136	30103405	82	30112526	82	30118110	74	30125315	75	30184001	57
30101022	116	30101882	136	30103406	82	30112533	75	30118180	80	30125325	75	30188801	68
30101030	116	30101885	136	30103410	75	30112534	81	30119001	74	30125326	82	30188802	68
30101099	116	30101890	104	30103412	75	30112535	75	30119013	74	30125380	81	30188803	68
30101401	29	30101891	104	30103420	75	30112540	75	30119014	74	30125401	75	30188804	68
30101402	29	30101892	104	30103425	75	30112541	75	30119080	80	30125405	18	30188805	68
30101403	29	30101893	104	30103499	75	30112547	75	30119501	75	30125406	75	30190001	88
30101404	29	30101894	104	30104204	75	30112550	81	30119580	81	30125409	81	30190002	88
30101499	29	30101899	104	30106001	71	30112599	75	30119701	25	30125413	75	30190003	88
30101501	29	30101901	74	30106002	71	30112699	75	30119705	25	30125415	75	30190004	88
30101502	29	30101902	74	30106003	71	30112701	75	30119707	75	30125420	81	30201003	53
30101503	29	30101904	74	30106004	71	30112702	75	30119708	75	30125499	56	30201401	94
30101505	29	30101907	57	30106005	71	30112730	75	30119709	75	30125801	75	30201902	28
30101599	29	30102001	29	30106006	71	30112780	81	30119710	75	30125802	75	30201903	28
30101603	145	30102002	29	30106007	71	30113201	75	30119741	75	30125803	57	30201906	28
30101801	140	30102003	29	30106008	71	30113210	75	30119742	75	30125805	75	30201907	28
30101802	23	30102004	29	30106009	71	30113221	75	30119743	75	30125807	57	30201908	28
30101803	23	30102005	29	30106010	71	30113227	75	30119744	75	30125810	75	30201911	28

Table 4.3-24 (continued)

SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD
30101805	137	30102099	29	30106011	71	30113299	97	30119745	75	30125815	75	30201912	28
30101807	24	30102401	142	30106012	71	30113301	75	30119749	75	30125880	75	30201914	28
30101808	24	30102402	104	30106099	79	30113302	75	30119799	25	30125899	75	30201915	28
30101809	24	30102410	141	30109101	75	30113701	75	30120201	16	30130101	74	30201916	28
30101810	24	30102416	21	30109105	75	30113710	75	30120202	16	30130102	74	30201917	28
30101811	24	30102423	21	30109151	75	30113799	75	30120204	82	30130103	74	30201918	28
30101812	24	30102424	21	30109152	75	30114001	75	30120205	16	30130104	74	30201919	28
30101813	24	30102426	21	30109153	57	30114005	56	30120206	16	30130105	74	30201999	28
30101814	24	30102427	21	30109154	57	30115201	75	30120280	81	30130106	82	30203201	95
30101815	136	30102499	21	30109180	81	30115301	75	30120501	75	30130107	74	30203202	95
30101816	136	30102501	139	30109199	75	30115311	82	30120502	75	30130108	74	30203299	95
30101817	138	30102505	21	30110002	75	30115380	81	30120521	82	30130180	80	30300302	49
30101818	136	30102601	22	30110003	82	30115601	74	30120530	82	30130301	75	30300303	48
30101819	136	30102602	22	30110080	81	30115604	74	30120545	82	30130380	81	30300304	48
30101820	136	30102608	22	30110099	75	30115701	74	30120580	81	30130402	75	30300306	48
30101821	136	30102609	22	30112001	75	30115704	74	30120601	74	30130480	81	30300308	50
30101822	138	30102612	22	30112002	75	30115780	80	30120603	74	30130501	75	30300313	48
30101827	136	30102613	22	30112005	82	30115802	75	30120680	80	30130502	75	30300314	50
30101832	96	30102614	22	30112006	82	30115803	75	30121001	75	30130580	81	30300315	51
30101837	144	30102615	22	30112007	81	30115822	57	30121002	82	30180001	68	30300331	401
30101838	143	30102616	22	30112011	75	30116701	75	30121101	75	30180002	68	30300332	402
30101839	143	30102617	22	30112013	82	30116703	82	30125001	75	30180003	68	30300333	403
30101840	143	30102625	22	30112014	82	30116704	75	30125002	75	30180006	68	30300334	402
30300335	402	30600811	20	30700703	117	31000205	112	40100101	91	40188898	63	40201505	37
30300336	404	30600812	20	30700704	117	31000206	112	40100102	92	40199999	63	40201531	37
30300341	405	30600813	20	30700705	117	31000207	112	40100103	91	40200101	33	40201599	37
30300342	406	30600814	20	30700706	117	31000299	112	40100104	92	40200110	33	40201601	33
30300343	406	30600815	20	30700707	117	31000401	88	40100105	93	40200301	34	40201602	33
30300344	406	30600816	20	30700708	117	31000403	88	40100198	93	40200310	34	40201603	33
30300351	401	30600817	20	30700709	117	31000404	88	40100201	61	40200401	33	40201604	33
30300353	408	30600818	20	30700711	117	31000405	88	40100202	65	40200410	40	40201605	33
30300361	409	30600819	20	30700713	117	31088801	112	40100203	65	40200501	33	40201606	33
30300813	46	30600821	20	30700715	117	31088802	112	40100204	65	40200510	33	40201607	33

Table 4.3-24 (continued)

SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD
30300825	46	30600903	110	30700798	117	31088803	112	40100205	65	40200601	33	40201608	33
30390003	88	30600904	110	30700799	117	31088804	112	40100206	61	40200610	33	40201609	33
30390004	88	30600905	110	30701199	36	31088805	112	40100207	65	40200701	36	40201619	33
30490001	88	30600999	110	30790001	88	32099997	98	40100221	62	40200706	36	40201620	33
30490003	88	30601001	110	30790002	88	32099998	98	40100222	66	40200707	36	40201621	33
30490004	88	30601101	110	30790003	88	32099999	98	40100223	66	40200710	36	40201622	33
30490031	88	30601201	110	30800101	30	39000201	87	40100224	66	40200801	35	40201623	33
30490033	88	30601401	110	30800102	30	39000203	87	40100225	66	40200802	35	40201625	33
30490034	88	30609902	110	30800103	30	39000289	87	40100235	62	40200803	35	40201626	33
30600101	88	30609903	110	30800104	30	39000299	87	40100236	62	40200810	35	40201627	33
30600102	88	30609904	110	30800105	30	39000402	87	40100251	61	40200898	35	40201628	33
30600103	88	30610001	110	30800106	31	39000403	87	40100252	65	40200998	33	40201629	33
30600104	88	30688801	20	30800107	30	39000489	87	40100253	65	40201001	88	40201631	33
30600105	88	30688802	20	30800108	30	39000499	87	40100254	65	40201002	88	40201632	33
30600106	88	30688803	20	30800109	30	39000501	87	40100255	65	40201003	88	40201699	33
30600107	88	30688804	20	30800120	30	39000502	87	40100256	61	40201004	88	40201702	34
30600111	88	30688805	20	30800121	30	39000503	87	40100257	65	40201101	41	40201703	34
30600201	109	30700101	60	30800122	30	39000589	87	40100258	61	40201103	41	40201704	34
30600202	109	30700102	60	30800123	31	39000598	87	40100259	61	40201105	41	40201705	34
30600204	109	30700103	60	30800197	30	39000599	87	40100275	61	40201112	41	40201721	34
30600301	109	30700104	60	30800198	30	39000602	87	40100295	62	40201113	41	40201722	34
30600401	113	30700105	60	30800199	30	39000603	87	40100296	62	40201114	41	40201723	34
30600402	114	30700106	60	30800501	30	39000605	87	40100297	61	40201115	41	40201724	34
30600503	26	30700107	60	30800699	123	39000689	87	40100298	62	40201116	41	40201725	34
30600504	26	30700108	60	30800701	123	39000699	87	40100299	61	40201199	41	40201726	34
30600505	26	30700109	60	30800702	123	39000701	87	40100301	63	40201201	41	40201727	34
30600506	26	30700110	60	30800703	123	39000702	87	40100302	63	40201210	41	40201728	34
30600508	26	30700199	60	30800704	123	39000789	87	40100303	63	40201301	36	40201731	34
30600514	26	30700203	60	30800705	123	39000797	87	40100304	63	40201303	36	40201732	34
30600516	26	30700214	60	30800720	123	39000799	87	40100305	63	40201304	36	40201734	34
30600517	26	30700215	60	30800721	123	39000801	87	40100306	61	40201305	36	40201735	34
30600519	26	30700221	60	30800722	123	39000889	87	40100307	63	40201399	36	40201799	34
30600520	26	30700222	60	30800723	123	39000899	87	40100308	63	40201401	37	40201801	37

Table 4.3-24 (continued)

SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD
30600602	27	30700223	60	30800724	123	39000989	87	40100309	63	40201404	37	40201803	37
30600603	27	30700234	60	30800799	123	39000999	87	40100310	63	40201405	37	40201805	37
30600701	111	30700299	60	30800901	123	39001089	87	40100335	63	40201406	37	40201806	37
30600702	111	30700301	60	30901601	108	39001099	87	40100336	63	40201431	37	40201899	37
30600801	20	30700303	60	31000104	112	39001299	98	40100398	63	40201432	37	40201901	39
30600802	20	30700401	60	31000105	112	39001389	87	40100399	63	40201433	37	40201903	39
30600803	20	30700402	60	31000199	112	39001399	87	40100499	63	40201435	37	40201904	39
30600804	20	30700501	115	31000201	112	39990001	88	40100550	63	40201499	37	40201999	39
30600805	20	30700597	115	31000202	112	39990002	88	40188801	63	40201501	37	40202001	37
30600806	20	30700599	115	31000203	112	39990003	88	40188802	63	40201502	37	40202002	37
30600807	20	30700701	117	31000204	112	39990004	88	40188805	63	40201503	37	40202005	37
40202031	37	40300106	4	40301068	4	40388802	110	40400240	173	40500510	186	40600243	55
40202033	37	40300107	4	40301078	4	40388803	110	40400241	173	40500511	183	40600244	55
40202099	37	40300108	4	40301097	4	40388804	110	40400250	155	40500512	183	40600245	55
40202101	40	40300109	4	40301098	4	40388805	110	40400251	155	40500513	183	40600246	55
40202103	40	40300111	4	40301099	4	40399999	110	40400254	155	40500514	183	40600248	55
40202104	40	40300112	4	40301101	7	40400101	150	40400260	174	40500598	183	40600249	55
40202105	40	40300115	4	40301102	7	40400102	150	40400261	174	40500599	183	40600250	55
40202106	40	40300116	4	40301103	7	40400103	150	40400271	174	40500601	184	40600251	55
40202107	40	40300150	4	40301104	7	40400104	150	40400301	156	40500701	187	40600253	55
40202108	40	40300151	4	40301105	7	40400105	150	40400302	157	40500801	188	40600257	55
40202109	40	40300152	4	40301106	7	40400106	150	40400303	158	40500811	188	40600259	55
40202131	40	40300153	4	40301107	7	40400107	151	40400304	158	40500812	188	40600298	55
40202132	40	40300154	4	40301108	7	40400108	151	40400305	158	40588801	188	40600299	55
40202133	40	40300156	4	40301109	6	40400109	151	40400401	159	40588802	188	40600301	168
40202199	40	40300157	4	40301110	6	40400110	152	40400402	160	40588803	188	40600302	169
40202201	38	40300159	4	40301111	6	40400111	152	40400403	159	40588804	188	40600306	170
40202202	38	40300160	4	40301112	6	40400112	152	40400404	160	40588805	188	40600307	171
40202203	38	40300161	4	40301113	6	40400113	152	40400406	160	40600101	161	40600399	170
40202205	38	40300198	4	40301114	6	40400114	152	40400408	160	40600126	163	40700401	84
40202299	38	40300199	4	40301115	6	40400115	152	40400410	160	40600130	166	40700402	84
40202301	132	40300201	7	40301116	6	40400116	153	40400412	160	40600131	163	40700497	84
40202302	132	40300202	7	40301117	6	40400117	153	40400413	159	40600132	166	40700498	84

Table 4.3-24 (continued)

SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD
40202305	132	40300203	6	40301118	6	40400118	154	40400414	160	40600133	166	40700801	84
40202306	132	40300204	6	40301119	6	40400119	154	40400497	159	40600134	166	40700802	84
40202399	132	40300205	6	40301120	6	40400120	154	40400498	160	40600135	166	40700803	84
40202401	52	40300207	6	40301130	6	40400130	173	40500101	189	40600136	161	40700805	84
40202402	52	40300208	6	40301131	7	40400131	173	40500199	189	40600137	164	40700806	84
40202403	52	40300209	6	40301132	6	40400140	173	40500201	180	40600138	164	40700807	84
40202405	52	40300210	6	40301133	6	40400141	173	40500202	186	40600139	164	40700808	84
40202406	52	40300212	6	40301134	6	40400150	155	40500203	186	40600140	164	40700809	84
40202499	52	40300216	6	40301135	6	40400151	155	40500211	180	40600141	162	40700810	84
40202501	37	40300299	6	40301140	8	40400152	155	40500212	180	40600143	165	40700811	84
40202502	37	40300302	6	40301141	9	40400153	155	40500299	180	40600144	165	40700812	84
40202503	37	40301001	5	40301142	8	40400154	155	40500301	181	40600145	165	40700813	84
40202504	37	40301002	5	40301143	8	40400160	174	40500303	186	40600146	165	40700814	84
40202505	37	40301003	5	40301144	8	40400161	174	40500304	186	40600147	163	40700815	84
40202531	37	40301004	5	40301145	8	40400170	174	40500305	186	40600148	166	40700816	84
40202532	37	40301005	5	40301150	8	40400171	174	40500306	186	40600149	166	40700817	84
40202533	37	40301006	5	40301151	9	40400178	174	40500307	186	40600161	166	40700818	84
40202534	37	40301007	5	40301152	8	40400199	155	40500311	181	40600162	167	40700897	84
40202537	37	40301008	5	40301153	8	40400201	150	40500312	181	40600163	167	40700898	84
40202598	37	40301009	5	40301154	8	40400202	150	40500314	181	40600197	172	40701605	84
40202599	37	40301010	4	40301155	8	40400203	150	40500401	182	40600198	172	40701606	84
40202601	37	40301011	4	40301197	6	40400204	151	40500411	182	40600199	172	40701608	84
40202605	37	40301012	4	40301198	6	40400205	151	40500412	182	40600231	55	40701611	84
40202606	37	40301013	4	40301199	6	40400206	151	40500413	182	40600232	55	40701612	84
40202607	37	40301014	4	40301201	7	40400207	152	40500414	182	40600233	55	40701613	84
40202699	37	40301015	4	40301202	7	40400208	152	40500416	182	40600234	55	40701614	84
40290013	88	40301016	4	40301203	7	40400209	152	40500418	182	40600235	55	40701697	84
40300101	5	40301017	4	40301204	6	40400210	154	40500501	183	40600236	55	40701698	84
40300102	4	40301018	4	40301205	6	40400211	154	40500502	183	40600237	55	40702003	84
40300103	5	40301019	4	40301206	6	40400212	154	40500503	186	40600238	55	40702097	84
40300104	4	40301020	4	40301299	6	40400230	173	40500506	186	40600239	55	40702098	84
40300105	4	40301021	4	40388801	110	40400231	173	40500507	186	40600240	55	40703201	84
40703202	84	40704498	84	40707698	84	40787201	84	50200301	89				

Table 4.3-24 (continued)

SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD
40703203	84	40704801	84	40708097	84	40787299	84	50200302	89				
40703204	84	40704802	84	40708098	84	40799997	84	50200505	89				
40703205	84	40704897	84	40708401	84	40799998	84	50200506	89				
40703206	84	40704898	84	40708403	84	40899995	85	50200601	128				
40703297	84	40705203	84	40708404	84	40899997	55	50200602	128				
40703298	84	40705208	84	40708497	84	40899999	85	50290005	88				
40703601	84	40705210	84	40708498	84	49000101	85	50290006	88				
40703602	84	40705211	84	40715809	84	49000103	85	50290099	88				
40703603	84	40705213	84	40717205	84	49000105	85	50300101	89				
40703605	84	40705216	84	40717206	84	49000199	85	50300102	89				
40703606	84	40705297	84	40717207	84	49000201	85	50300103	89				
40703608	84	40705298	84	40717208	84	49000202	85	50300104	89				
40703609	84	40705603	84	40717209	84	49000203	85	50300105	89				
40703610	84	40705604	84	40717211	84	49000204	85	50300106	89				
40703613	84	40705605	84	40717297	84	49000205	85	50300201	89				
40703614	84	40705606	84	40717298	84	49000206	85	50300202	89				
40703615	84	40705607	84	40717601	84	49000299	85	50300204	89				
40703616	84	40705609	84	40717602	84	49000399	85	50300501	89				
40703617	84	40705610	84	40717603	84	49000401	85	50300506	89				
40703618	84	40705697	84	40717604	84	49000499	85	50300599	89				
40703619	84	40705698	84	40717697	84	49000501	85	50300601	128				
40703620	84	40706005	84	40717698	84	49000599	85	50300602	128				
40703622	84	40706006	84	40718097	84	49090013	85	50300603	128				
40703623	84	40706007	84	40720801	84	49090023	85	50300701	89				
40703624	84	40706008	84	40720897	84	49099998	85	50300801	129				
40703697	84	40706009	84	40720898	84	49099999	85	50300810	129				
40703698	84	40706010	84	40722001	84	50100101	89	50300820	129				
40704001	84	40706011	84	40722003	84	50100103	89	50300830	129				
40704002	84	40706012	84	40722005	84	50100201	89	50300899	129				
40704003	84	40706013	84	40722009	84	50100401	89	50390005	89				
40704004	84	40706015	84	40722010	84	50100505	89	50390006	89				
40704008	84	40706017	84	40722097	84	50100506	89	50390010	89				
40704009	84	40706018	84	40722098	84	50100507	89	62540010	138				

Table 4.3-24 (continued)

SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD
40704097	84	40706019	84	40722801	84	50100510	89	62540020	138				
40704098	84	40706020	84	40722802	84	50100515	89	62540022	138				
40704401	84	40706021	84	40722803	84	50100516	89	64630016	138				
40704402	84	40706022	84	40722804	84	50100601	88	64630040	138				
40704403	84	40706023	84	40722805	84	50100603	89						
40704404	84	40706024	84	40722806	84	50100701	127						
40704405	84	40706097	84	40722897	84	50100702	127						
40704406	84	40706098	84	40722898	84	50100703	127						
40704407	84	40706401	84	40781602	84	50100704	127						
40704408	84	40706402	84	40781605	84	50190005	87						
40704411	84	40706403	84	40781699	84	50190006	87						
40704412	84	40706497	84	40782001	84	50200101	89						
40704414	84	40706801	84	40782003	84	50200103	89						
40704416	84	40706802	84	40782006	84	50200104	89						
40704418	84	40706814	84	40782009	84	50200105	89						
40704419	84	40706897	84	40782099	84	50200106	89						
40704420	84	40706898	84	40783203	84	50200116	89						
40704421	84	40707601	84	40784899	84	50200117	89						
40704422	84	40707602	84	40786004	84	50200201	89						
40704497	84	40707697	84	40786099	84	50200202	89						

NOTE: A pod is a group of SCCs with similar emissions and process characteristics for which common control measures (i.e., cost and emission reductions) can be applied.

Table 4.3-25. Area Source VOC Controls by SCC and Pod

POD	SCC	SOURCE	MEASURE	PCTRD96
211	2420010055	Dry Cleaning - perchloroethylene	MACT	44.0
211	2420000055	Dry Cleaning - perchloroethylene	MACT	44.0
217	2501050120	Bulk Terminals	RACT	51.0
217	2501050000	Bulk Terminals	RACT	51.0
217	2501995000	Bulk Terminals	RACT	51.0
241	2415305000	Cold cleaning	MACT	35.0
241	2415310000	Cold cleaning	MACT	35.0
241	2415320000	Cold cleaning	MACT	35.0
241	2415325000	Cold cleaning	MACT	35.0
241	2415330000	Cold cleaning	MACT	35.0
241	2415335000	Cold cleaning	MACT	35.0
241	2415340000	Cold cleaning	MACT	35.0
241	2415345000	Cold cleaning	MACT	35.0
241	2415355000	Cold cleaning	MACT	35.0
241	2415360000	Cold cleaning	MACT	35.0
241	2415365000	Cold cleaning	MACT	35.0
250	2401075000	Aircraft surface coating	MACT	0.0
251	2401080000	marine surface coating	MACT	0.0
259	2301040001	SOCMI batch reactor processes	New CTG	78.0
270	2640000000	TSDFs	Phase I & II rules	94.0
270	2640000004	TSDFs	Phase I & II rules	94.0
272	2461021000	Cutback Asphalt	Switch to emulsified (CTG)	100.0
272	2461020000	Cutback Asphalt	Switch to emulsified (CTG)	100.0
274	2301040000	SOCMI fugitives	RACT	37.0
276	2306000000	Petroleum refinery fugitives	RACT	43.0
277	2301030000	Pharmaceutical manufacture	RACT	37.0
278	2301020000	Synthetic fiber manufacture	RACT (adsorber)	54.0
279	2310000000	Oil & natural gas fields	RACT (equipment/maintenance)	37.0
279	2310010000	Oil & natural gas fields	RACT (equipment/maintenance)	37.0
279	2310020000	Oil & natural gas fields	RACT (equipment/maintenance)	37.0
279	2310030000	Oil & natural gas fields	RACT (equipment/maintenance)	37.0
280	2501060050	Service stations - stage I	Vapor balance (CTG)	95.0
281	2501060101	Service stations - stage II	Vapor balance (stage II)	70.0
281	2501060103	Service stations - stage II	Vapor balance (stage II)	70.0
283	2501060201	Service stations - underground tank	Vapor balance (stage II)	84.0
283	2501060201	Service stations - underground tank	Vapor balance (stage II)	86.0
284	2620000000	Municipal solid waste landfills	RCRA standards	82.0
284	2620030000	Municipal solid waste landfills	RCRA standards	82.0

POD_VOC	PODNAME	APPLICABLE
211	Dry Cleaning - perchloroethylene	National
217	Bulk Terminals	National
241	Cold cleaning	National
250	Aircraft surface coating	National
251	marine surface coating	National
259	SOCMI batch reactor processes	Moderate+
270	Treatment, stroage and disposal facilities	National
272	Cutback Asphalt	Marginal+
274	SOCMI fugitives	National
276	Petroleum refinery fugitives	National
277	Pharmaceutical manufacture	National
278	Synthetic fiber manufacture	National
279	Oil and natural gas production fields	Moderate+
280	Service stations - stage I-truck unloading	National
284	Municipal solid waste landfills	National

NOTE: A pod is a group of SCCs with similar emissions and process characteristics for which common control measures (i.e., cost and emission reductions) can be applied.

Table 4.3-26. Counties in the United States with Stage II Programs that use Reformulated Gasoline

State		County		State		County		State		County	
6	California	19	Fresno Co	24	Maryland	510	Baltimore	42	Pennsylvania	91	Montgomery Co
6	California	29	Kern Co	25	Massachusetts	1	Barnstable Co	42	Pennsylvania	101	Philadelphia Co
6	California	37	Los Angeles Co	25	Massachusetts	3	Berkshire Co	44	Rhode Island	1	Bristol Co
6	California	55	Napa Co	25	Massachusetts	5	Bristol Co	44	Rhode Island	3	Kent Co
6	California	67	Sacramento Co	25	Massachusetts	7	Dukes Co	44	Rhode Island	5	Newport Co
6	California	73	San Diego Co	25	Massachusetts	9	Essex Co	44	Rhode Island	7	Providence Co
6	California	75	San Francisco Co	25	Massachusetts	11	Franklin Co	44	Rhode Island	9	Washington Co
9	Connecticut	1	Fairfield Co	25	Massachusetts	13	Hampden Co	48	Texas	39	Brazoria Co
9	Connecticut	3	Hartford Co	25	Massachusetts	15	Hampshire Co	48	Texas	71	Chambers Co
9	Connecticut	5	Litchfield Co	25	Massachusetts	17	Middlesex Co	48	Texas	85	Collin Co
9	Connecticut	7	Middlesex Co	25	Massachusetts	19	Nantucket Co	48	Texas	113	Dallas Co
9	Connecticut	9	New Haven Co	25	Massachusetts	21	Norfolk Co	48	Texas	121	Denton Co
9	Connecticut	11	New London Co	25	Massachusetts	23	Plymouth Co	48	Texas	157	Fort Bend Co
9	Connecticut	13	Tolland Co	25	Massachusetts	25	Suffolk Co	48	Texas	167	Galveston Co
9	Connecticut	15	Windham Co	25	Massachusetts	27	Worcester Co	48	Texas	201	Harris Co
10	Delaware	1	Kent Co	33	New Hampshire	11	Hillsborough Co	48	Texas	291	Liberty Co
10	Delaware	3	New Castle Co	33	New Hampshire	13	Merrimack Co	48	Texas	339	Montgomery Co
10	Delaware	5	Sussex Co	33	New Hampshire	15	Rockingham Co	48	Texas	439	Tarrant Co
11	Dist. Columbia	1	Washington	33	New Hampshire	17	Strafford Co	48	Texas	473	Waller Co
17	Illinois	31	Cook Co	34	New Jersey	1	Atlantic Co	51	Virginia	13	Arlington Co
17	Illinois	43	Du Page Co	34	New Jersey	3	Bergen Co	51	Virginia	36	Charles City Co
17	Illinois	63	Grundy Co	34	New Jersey	5	Burlington Co	51	Virginia	41	Chesterfield Co
17	Illinois	89	Kane Co	34	New Jersey	7	Camden Co	51	Virginia	85	Hanover Co
17	Illinois	93	Kendall Co	34	New Jersey	9	Cape May Co	51	Virginia	87	Henrico Co
17	Illinois	97	Lake Co	34	New Jersey	11	Cumberland Co	51	Virginia	95	James City Co
17	Illinois	111	McHenry Co	34	New Jersey	13	Essex Co	51	Virginia	107	Loudoun Co
17	Illinois	197	Will Co	34	New Jersey	15	Gloucester Co	51	Virginia	153	Prince William Co
18	Indiana	89	Lake Co	34	New Jersey	17	Hudson Co	51	Virginia	159	Richmond Co
18	Indiana	127	Porter Co	34	New Jersey	19	Hunterdon Co	51	Virginia	179	Stafford Co
21	Kentucky	15	Boone Co	34	New Jersey	21	Mercer Co	51	Virginia	199	York Co
21	Kentucky	29	Bullitt Co	34	New Jersey	23	Middlesex Co	51	Virginia	510	Alexandria
21	Kentucky	37	Campbell Co	34	New Jersey	25	Monmouth Co	51	Virginia	550	Chesapeake
21	Kentucky	111	Jefferson Co	34	New Jersey	27	Morris Co	51	Virginia	570	Colonial Heights
21	Kentucky	117	Kenton Co	34	New Jersey	29	Ocean Co	51	Virginia	600	Fairfax
21	Kentucky	185	Oldham Co	34	New Jersey	31	Passaic Co	51	Virginia	610	Falls Church
23	Maine	1	Androscoggin Co	34	New Jersey	33	Salem Co	51	Virginia	650	Hampton
23	Maine	5	Cumberland Co	34	New Jersey	35	Somerset Co	51	Virginia	670	Hopewell
23	Maine	11	Kennebec Co	34	New Jersey	37	Sussex Co	51	Virginia	683	Manassas
23	Maine	13	KNO_x Co	34	New Jersey	39	Union Co	51	Virginia	685	Manassas Park
23	Maine	15	Lincoln Co	34	New Jersey	41	Warren Co	51	Virginia	700	Newport News
23	Maine	23	Sagadahoc Co	36	New York	5	Bronx Co	51	Virginia	710	Norfolk
23	Maine	31	York Co	36	New York	27	Dutchess Co	51	Virginia	735	Poquoson
24	Maryland	3	Anne Arundel Co	36	New York	47	Kings Co	51	Virginia	740	Portsmouth
24	Maryland	5	Baltimore Co	36	New York	59	Nassau Co	51	Virginia	760	Richmond
24	Maryland	9	Calvert Co	36	New York	61	New York Co	51	Virginia	800	Suffolk
24	Maryland	13	Carroll Co	36	New York	71	Orange Co	51	Virginia	810	Virginia Beach
24	Maryland	15	Cecil Co	36	New York	79	Putnam Co	51	Virginia	830	Williamsburg
24	Maryland	17	Charles Co	36	New York	81	Queens Co	55	Wisconsin	59	Kenosha Co
24	Maryland	21	Frederick Co	36	New York	85	Richmond Co	55	Wisconsin	79	Milwaukee Co
24	Maryland	25	Harford Co	36	New York	87	Rockland Co	55	Wisconsin	89	Ozaukee Co
24	Maryland	27	Howard Co	36	New York	103	Suffolk Co	55	Wisconsin	101	Racine Co
24	Maryland	29	Kent Co	36	New York	119	Westchester Co	55	Wisconsin	131	Washington Co
24	Maryland	31	Montgomery Co	42	Pennsylvania	17	Bucks Co	55	Wisconsin	133	Waukesha Co
24	Maryland	33	Prince George's Co	42	Pennsylvania	29	Chester Co				
24	Maryland	35	Queen Annes Co	42	Pennsylvania	45	Delaware Co				

Table 4.3-27. VOC Area Source RACT

SCC	POD	PODNAME	ATTAINMENT	RULPEN96	CONEFF96
2102001000	22	Industrial Bituminous Coal Combustion	Moderate	23	21
2102001000	22	Industrial Bituminous Coal Combustion	Serious	45	21
2102001000	22	Industrial Bituminous Coal Combustion	Severe	45	21
2102001000	22	Industrial Bituminous Coal Combustion	Extreme	45	21
2102002000	22	Industrial Anthracite Coal Combustion	Moderate	23	21
2102002000	22	Industrial Anthracite Coal Combustion	Serious	45	21
2102002000	22	Industrial Anthracite Coal Combustion	Severe	45	21
2102002000	22	Industrial Anthracite Coal Combustion	Extreme	45	21
2102004000	23	Industrial Distillate Oil Combustion	Moderate	8	36
2102004000	23	Industrial Distillate Oil Combustion	Serious	16	36
2102004000	23	Industrial Distillate Oil Combustion	Severe	16	36
2102004000	23	Industrial Distillate Oil Combustion	Extreme	16	36
2102005000	23	Industrial Residual Oil Combustion	Moderate	8	42
2102005000	23	Industrial Residual Oil Combustion	Serious	16	42
2102005000	23	Industrial Residual Oil Combustion	Severe	16	42
2102005000	23	Industrial Residual Oil Combustion	Extreme	16	42
2102006000	24	Industrial Natural Gas Combustion	Moderate	11	31
2102006000	24	Industrial Natural Gas Combustion	Serious	22	31
2102006000	24	Industrial Natural Gas Combustion	Severe	22	31
2102006000	24	Industrial Natural Gas Combustion	Extreme	22	31

Figure 4.3-1. OTAG Inventory Data Source - Area Sources.

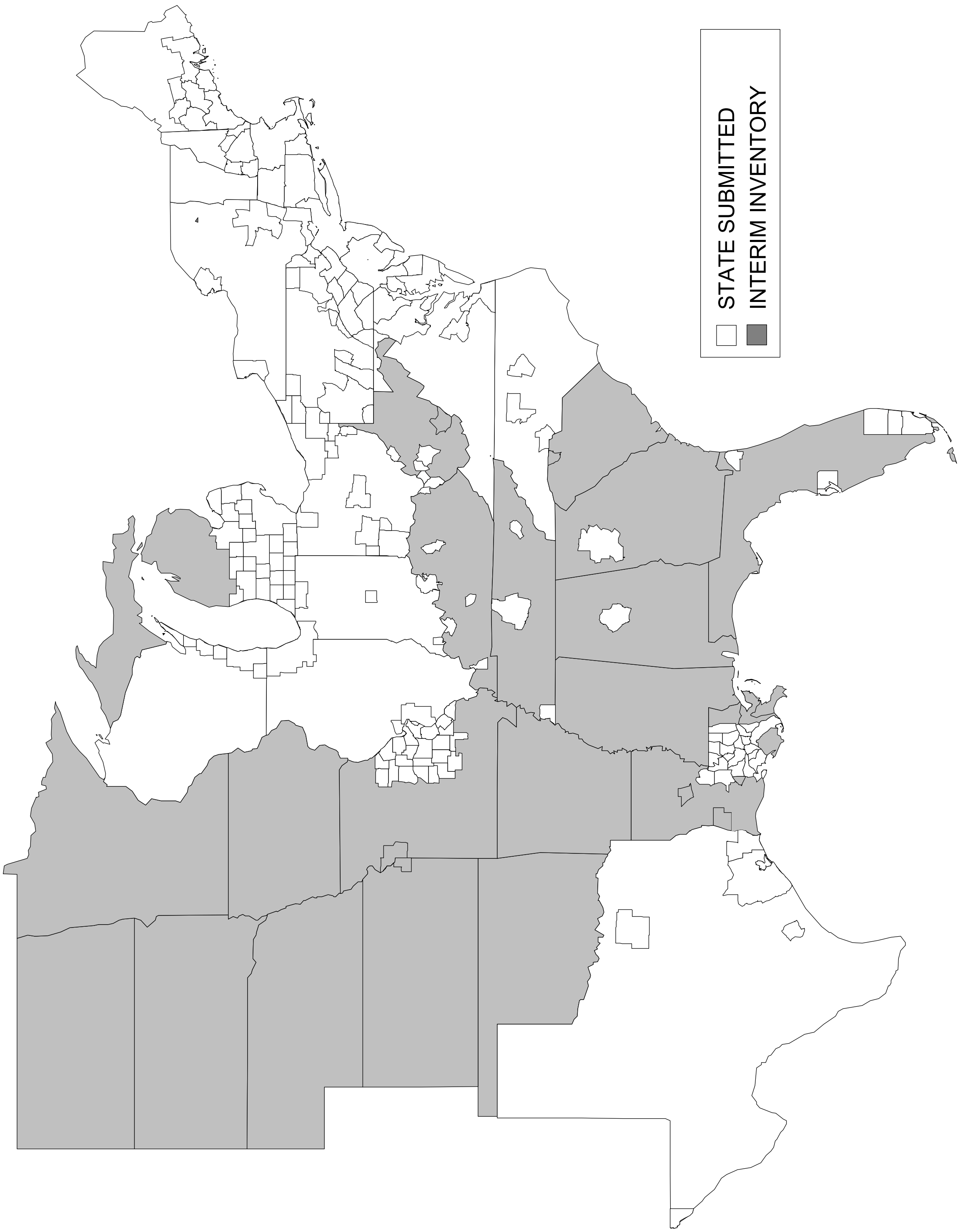
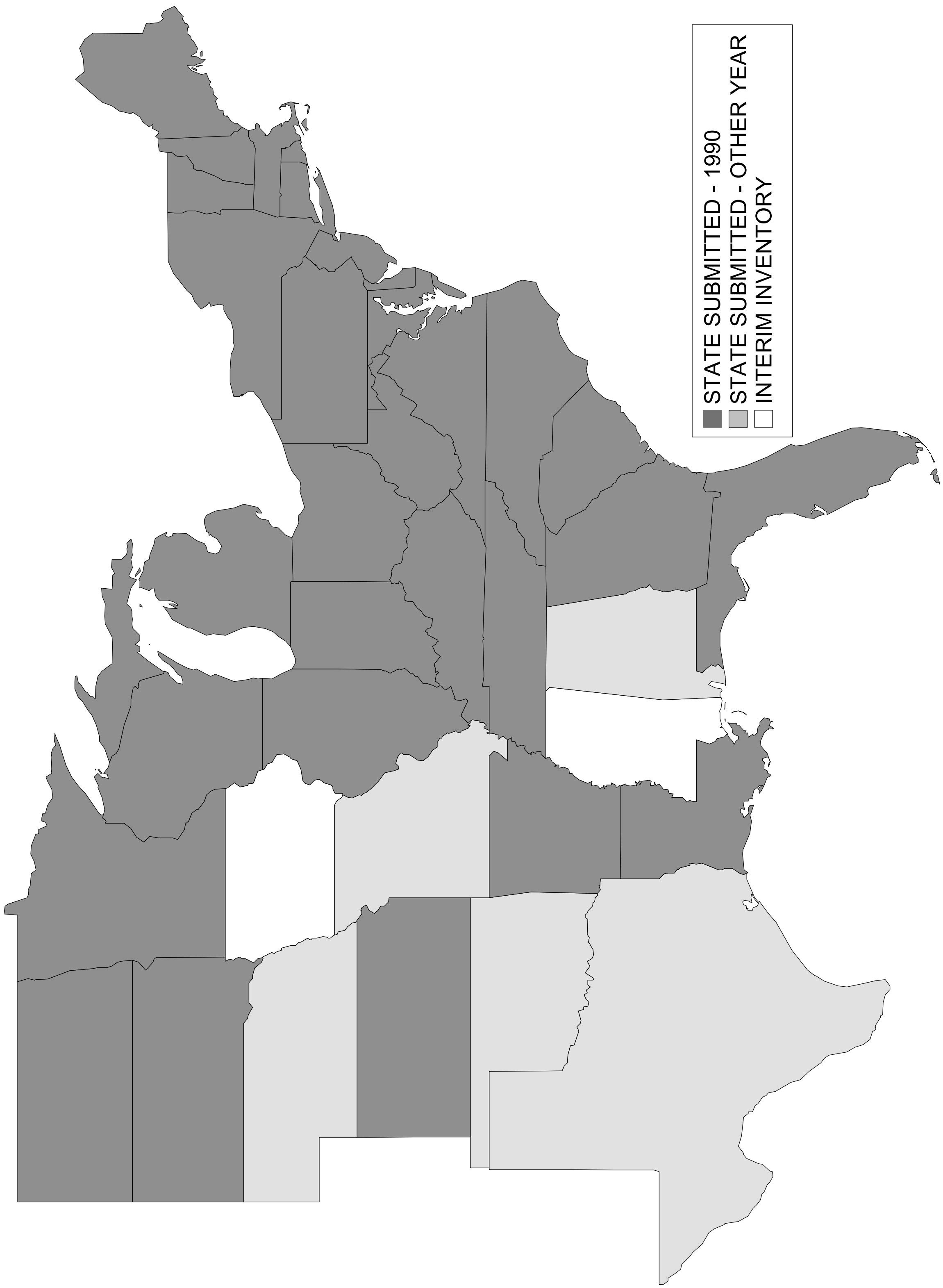


Figure 4.3-2. OTAG Inventory Data Source - Point Sources.



4.4 OTHER COMBUSTION

The source categories falling under "Other Combustion" include the following Tier I and Tier II categories:

Tier I Category	Tier II Category
OTHER COMBUSTION	All
MISCELLANEOUS	Other Combustion

Since the publication of the last version of this report,[1] Environmental Protection Agency (EPA) has made major changes to the 1990 emissions. The revised emissions are referred to in this document as the 1990 National Emission Trends (NET) emissions and are for the most part based on State submitted data and used as the base year inventory for the post-1990 emission inventory. Emission estimates for pre-1990 are based mainly on the "old" 1990 emissions which are referred to in this document as the Interim Inventory 1990 emissions. For most source categories, the methodology for the Interim Inventory 1990 emissions is the same as that previously published in the Procedures document.

The Tier I, Other Combustion emissions include residential and commercial/institutional burning of all fuels except solid waste. The emissions for the miscellaneous, other combustion category include agricultural burning, forest fires/wildfires, prescribed/slash and managed burning, and structural fires. The emissions from agricultural burning, open burning, and structural fires were produced using the methodology described in section 4.4.1. The methodologies used to estimate the emissions for forest fires/wildfires, residential wood combustion, and prescribed/slash and managed burning are described in section 4.4.7.

The 1990 Interim Inventory emissions for the majority of the source categories were generated from both the point source and area source portions of the 1985 National Acid Precipitation Assessment Program (NAPAP) inventory, except for emissions from wildfires, residential wood combustion, and prescribed burning. The 1990 Interim Inventory 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 data compiled by the BEA[2] or historic estimates of fuel consumption based on the DOE's SEDS.[3]

The 1990 NET emissions were revised to incorporate as much state- supplied data as possible. Sources of state data include the Ozone Transport Assessment Group (OTAG) emission inventory, the Grand Canyon Visibility Transport Commission (GCVTC) emission inventory, and Aerometric Information Retrieval System/Facility Subsystem (AIRS/FS). For most point sources, these emissions were projected from the revised 1990 NET inventory to the years 1991 through 1996 using BEA and SEDS data. States were surveyed to determine whether EPA should project their 1990 non-utility point source emissions or extract them from AIRS/FS. For all states that selected AIRS/FS option, the emissions in the NET inventory reflect their AIRS/FS data for the years 1991 through 1995. Additional controls were added to the projected (or grown) emissions for the year 1996.

This section describes the methods used to estimate both base year 1990 emission inventories and the emission estimates for the years 1985 through 1989 and 1991 through 1996. Point and area source emissions for the years 1985-1996 were estimated for the pollutants VOC, CO, NO_x, SO_2, and PM-10. Area source emissions were estimated for only 1985 through 1989 for VOC. Point source emission estimates for PM-2.5 were only estimated for the years 1990 through 1996. PM-2.5 and NH_3 were estimated for the years 1990 through 1996.

4.4.1 1990 Interim Inventory

The 1985 NAPAP inventory estimates for the **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 two-digit SIC code. To remove the effects of inflation, the earnings data were converted to 1982 constant dollars using the implicit price deflator for personal consumption expenditures.[4] State and SIC-level growth factors were calculated as the ratio of the 1990 earnings data to the 1985 earnings data. Additional information on point source growth indicators is presented in section 4.4.2.1.

For the 1990 Interim inventory, the emissions from agricultural burning, open burning, and structural fires were based on the 1985 NAPAP inventory. The emissions estimation methodologies for these categories are described individually below.

The **agricultural burning** category includes emissions from burning practices routinely used to clear and/or prepare land for planting. Specific operations include grass stubble burning, burning of agricultural crop residues, and burning of standing field corps as part of harvesting activities (e.g., sugar cane). Emissions are estimated by multiplying the number of acres burned in each county by a fuel loading factor and the an emission factor for each pollutant.

The original emissions estimation methodology for agricultural burning was developed by IIT Research[5] and estimated the 1974 activity level in terms of acres burned per state. It was assumed that the total quantity of agricultural products burned in 1974 was the same quantity which was consumed by fire each year. If no specific crop data were available, it was assumed that the number of acres burned annually was divided equally between sugar cane and other field crops.[6] Fuel loadings for grass burning were 1 to 2 tons per acre; fuel loadings for sugar cane burning were 6 to 12 tons per acre.[7] Emission factors were taken from the 1985 *Procedures Document*[6] and AP-42.[8]

NAPAP defined **open burning** as the uncombined burning of wastes such as leaves, landscape refuse, and other rubbish. The activity factor for open burning was the quantity of solid waste burned, which was computed for the year of interest by updating the previous year's waste generation for each sector. The update factor was determined using engineering judgement. Estimates of the quantity of solid waste burned in the most recent year were obtained from the National Emissions Data System (NEDS) point source data.[9] Generation factors were originally obtained from data in the *1968 Survey of Solid Waste Practices, Interim Report*[10] and the *Preliminary Data Analysis*.[11] Allocations were based on county population and emission factors for open burning or refuse and organic materials were taken directly from AP-42.[8]

Structural fires were included in NAPAP because these fires can be sources of high-level, short-term emissions of air contaminants. The activity factor for this category was the total number of fires per county, and was multiplied by a loading factor and emission factors to obtain emission estimates. For the 1985 NAPAP inventory, the total national number of building fires was obtained from the 1985 statistics from the National Fire Protection Association.[12] Since there were no data available to allocate the number of fires to the county level, an average of four fires per 1,000 population was assumed to occur each year (based on nationwide figures given in Reference 12). The fuel loading factor was 6.8 tons per fire[6] and emission factors were taken from the OAQPS Technical Tables.[6]

The **area** source emissions from the 1985 NAPAP inventory have been projected to the year 1990 based on BEA historic earnings data, BEA historic population data, 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. Additional information on area source growth indicators is presented in section 4.4.2.2.

When creating the 1990 emission inventory, changes were made to emission factors, control efficiencies, and emissions from the 1985 inventory for some sources. The PM-10 control efficiencies were obtained from the *PM-10 Calculator*.[13] In addition, rule effectiveness, which was not applied in the 1985 NAPAP inventory, was applied to the 1990 emissions estimated for the 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, SO_2, NH_3, and VOC 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 and PM-2.5 emissions were calculated using the TSP emissions from the 1985 NAPAP inventory. The 1990 uncontrolled TSP emissions were estimated in the same manner as the other pollutants. The 1990 uncontrolled PM-10 estimates were calculated from these TSP emissions 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 source emissions for all pollutants represented uncontrolled emissions, the second and third steps were not required to estimate the 1990 area source emissions.

4.4.1.1 Control Efficiency Revisions

In the 1985 NAPAP point source estimates, control efficiencies for VOC, NO_x, CO, and SO_2 sources in Texas were judged to be too high for their process/control device combination. These high control efficiencies occurred because Texas did not ask for control efficiency information, and simply applied the maximum efficiency for the reported control device.[14] High control efficiencies lead to high future growth in modeling scenarios based on uncontrolled emissions (which are based on the control efficiency and reported actual emissions). High control efficiencies also lead to extreme increases in emissions when rule effectiveness is incorporated.

Revised VOC control efficiencies were developed for Texas for the ERCAM-VOC.[15] For this analysis, revised efficiencies were also developed by SCC and control device combination for NO_x, SO_2, and CO using engineering judgement. These revised control efficiencies were applied to sources in Texas. A large number of point sources outside of Texas had VOC and CO control efficiencies that were also judged to be too high. The VOC and CO control efficiencies used for Texas were also applied to these sources.

4.4.1.2 Rule Effectiveness Assumptions

Controlled emissions for each inventory year were recalculated, assuming that reported VOC, NO_x, and CO controls were 80 percent effective. Sulfur dioxide and PM-10 controls were assumed to be 100 percent effective.

4.4.1.3 Emissions Calculations

A three-step process was used to calculate emissions incorporating rule effectiveness. First, base year controlled emissions are projected to the inventory year using Equation 4.4-1.

$$CE_i = CE_{BY} + (CE_{BY} \times EG_i) \qquad \text{(Eq. 4.4-1)}$$

where: CE_i = controlled emissions for inventory year I
CE_{BY} = controlled emissions for base year
EG_i = earnings growth for inventory year I

Earnings growth is calculated using Equation 4.4-2:

$$EG_i = 1 - \frac{DAT_i}{DAT_{BY}} \qquad \text{(Eq. 4.4-2)}$$

where: EG = earnings growth
DAT_i = earnings data for inventory year I
DAT_{BY} = earnings data in the base year

Second, uncontrolled emissions in the inventory year are back-calculated from the controlled emissions based on the control efficiency with Equation 4.4-3.

$$UE_i = \frac{CE_i}{\left(1 - \frac{CEFF}{100}\right)} \qquad \text{(Eq. 4.4-3)}$$

where: UE_i = uncontrolled emissions for inventory year I
CE_i = controlled emissions for inventory year I
CEFF = control efficiency (percent)

Third, controlled emissions are recalculated incorporating rule effectiveness using Equation 4.4-4:

$$CER_i = UC_i \times \left(1 - \left(\frac{REFF}{100}\right) \times \left(\frac{CEFF}{100}\right)\right) \times \left(\frac{EF_i}{EF_{BY}}\right) \qquad \text{(Eq. 4.4-4)}$$

where:
CER_i	=	controlled emissions incorporating rule effectiveness
UC_i	=	uncontrolled emissions
REFF	=	rule effectiveness (percent)
CEFF	=	control efficiency (percent)
EF_i	=	emission factor for inventory year I
EF_{BY}	=	emission factor for base year

4.4.2 Emissions, 1985 to 1989

As explained in section 4.4.1, the 1990 controlled emissions were projected from the 1985 NAPAP inventory using Equations 4.4-1 through 4.4-4. For all other years (1985 to 1989) the emissions were projected from the 1990 emissions using Equations 4.4-1 and 4.4-2. Therefore, the 1985 emissions estimated by this method do not match the 1985 NAPAP inventory due to the changes made in control efficiencies and emission factors and the addition of rule effectiveness when creating the 1990 base year inventory.

4.4.2.1 Point Source Growth

The changes in the point source emissions were equated with the changes in historic earnings by state and industry. Emissions from each point source in the 1985 NAPAP inventory were projected to the years 1985 through 1990 based on the growth in earnings by industry (two-digit SIC code). Historical annual state and industry earnings data from BEA's Table SA-5 (Reference 2) were used to represent growth in earnings from 1985 through 1990.

The 1985 through 1990 earnings data in Table SA-5 are expressed in nominal dollars. To estimate growth, these values were converted to constant dollars to remove the effects of inflation. Earnings data for each year were converted to 1982 constant dollars using the implicit price deflator for PCE. The PCE deflators used to convert each year's earnings data to 1982 dollars are:

Year	1982 PCE Deflator
1985	111.6
1987	114.3
1988	124.2
1989	129.6
1990	136.4

Several BEA categories did not contain a complete time series of data for the years 1985 through 1990. Because the SA-5 data must contain 1985 earnings and earnings for each inventory year (1985 through 1990) to be useful for estimating growth, a log linear regression equation was used where possible to fill in missing data elements. This regression procedure was performed on all categories that were missing at least one data point and which contained at least three data points in the time series.

Each record in the point source inventory was matched to the BEA earnings data based on the state and the two-digit SIC. Table 4.4-1 shows the BEA earnings category used to project growth for each of the two-digit SICs found in the 1985 NAPAP inventory. No growth in emissions was assumed for all point sources for which the matching BEA earnings data were not complete. Table 4.4-1 also shows the national average growth and earnings by industry from Table SA-5.

4.4.2.2 Area Source Growth

Emissions from the 1985 NAPAP inventory were grown to the Emission Trends years based on historical BEA earnings data section 4.4.2.1, historical estimates of fuel consumption (SEDS), or other category-specific growth indicators. Table 4.4-2 shows the growth indicators used for each area source by NAPAP category.

The SEDS data were used as an indicator of emissions growth for the area source fuel combustion categories shown in Table 4.4-3. (SEDS reports fuel consumption by sector and fuel type.) Since fuel consumption was the activity level used to estimate emissions for these categories, fuel consumption was a more accurate predictor of changes in emissions, compared to other surrogate indicators such as earnings or population. SEDS fuel consumption data were available through 1989. The 1990 values were extrapolated from the 1985 through 1989 data using a log linear regression technique. In addition to projecting 1990 data for all fuel consumption categories, the regression procedure was used to fill in missing data points for fuel consumption categories if at least three data points in the time series (1985 to 1989) were available.

Due to the year-to-year volatility in the SEDS fuel consumption data for the commercial residual oil fuel use category, the regression technique used above did not yield realistic projections for 1990 for this category. Therefore, a different procedure was used to project 1990 data for commercial residual oil fuel use. State-level sales volumes of residual fuel to the commercial sector were obtained from *Fuel Oil and Kerosene Sales 1990*[16] for 1989 and 1990. Each state's growth in sales of residual fuel to the commercial sector from 1989 to 1990 was applied to that state's 1989 SEDS commercial residual fuel consumption to yield a 1990 consumption estimate. A summary of SEDS national fuel consumption by fuel and sector can be found in Table 4.4-3.

The last step in the creation of the area source inventory was matching the NAPAP categories to the new AMS categories. This matching is provided in Table 4.4-4. Note that there is not always a one-to-one correspondence between NAPAP and AMS categories.

4.4.3 1990 National Emission Trends

The 1990 National Emission Trends is based primarily on state data, with the 1990 Interim 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. Seven pollutants (CO, NO_x, VOC, SO_2, PM-10, PM-2.5, and NH_3) were estimated in 1990. The state data were extracted from three sources, the OTAG inventory, the GCVTC inventory, and AIRS/FS. Sections 4.4.3.1, 4.4.3.2, and 4.4.3.3 give brief descriptions of these efforts. Section 4.4.3.4 describes the efforts necessary to supplement the inventory gaps that are either temporal, spacial, or pollutant.

Since EPA did not receive documentation on how these inventories were developed, this section only describes the effort to collect the data and any modifications or additions made to the data.

4.4.3.1 OTAG

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 ozone pollutants (VOC, NO_x, and CO). This section gives a background of the OTAG emission inventory and the data collection process.

4.4.3.1.1 Inventory Components —
The OTAG inventory contains data for all states that are partially or fully in the SUPROXA modeling domain. The SUPROXA domain was developed in the late 1980s as part of the EPA regional oxidant modeling (ROM) applications. EPA had initially used three smaller regional domains (Northeast, Midwest, and Southeast) for ozone modeling, but wanted to model the full effects of transport in the eastern United States without having to deal with estimating boundary conditions along relatively high emission areas. Therefore, these three domains were combined and expanded to form the Super Domain. The western extent of the domain was designed to allow for coverage of the largest urban areas in the eastern United States without extending too far west to encounter terrain difficulties associated with the Rocky Mountains. The Northern boundary was designed to include the major urban areas of eastern Canada. The southern boundary was designed to include as much of the United States as possible, but was limited to latitude 26°N, due to computational limitations of the photochemical models. (Emission estimates for Canada were not extracted from OTAG for inclusion in the NET inventory.)

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 ozone precursor inventory. It includes emission estimates of VOC, NO_x, and CO 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 ozone precursor data. No quality assurance (QA) was performed on the SO_2 and PM-10 emission estimates for the OTAG inventory effort.

Since the underlying purpose of the OTAG inventory is to support photochemical modeling for ozone, it is primarily an average summer day inventory. Emission estimates that were submitted as annual emission estimates were converted to average summer day estimates using operating schedule data and default temporal profiles and vice versa.

The OTAG inventory is made up of three major components: (1) the point source component, which includes segment/pollutant level emission estimates and other relevant data (e.g., stack parameters, geographic coordinates, and base year control information) for all stationary point sources in the domain; (2) the area source component, which includes county level emission estimates for all stationary area sources and non-road engines; and (3) the on-road vehicle component, which includes county/roadway functional class/vehicle type estimates of VMT and MOBILE5a input files for the entire domain. Of these three components, the NET inventory extracted all but the utility emissions. (See section 4.2 for a description of the utility NET emissions and section 4.6 for the on-road mobile NET emissions.)

4.4.3.1.2 Interim Emissions Inventory (OTAG Default) —

The primary data sources for the OTAG inventory were the individual states. Where states were unable to provide data, the 1990 Interim Inventory [17, 18] was used for default inventory data. A more detailed description of the 1990 Interim Inventory is presented in section 4.4.1.

4.4.3.1.3 State Data Collection Procedures —

Since the completion of the Interim Inventory in 1992, many states had completed 1990 inventories for ozone nonattainment areas as required for preparing SIPs. In addition to these SIP inventories, many states had developed more comprehensive 1990 emission estimates covering their entire state. Since these state inventories were both more recent and more comprehensive than the 1990 Interim Inventory, a new inventory was developed based on state inventory data (where available) in an effort to develop the most accurate emission inventory to use in the OTAG modeling.

On May 5, 1995, a letter from John Seitz (Director of EPA's Office of Air Quality Planning and Standards [OAQPS]) and Mary Gade (Vice President of ECOS) to State Air Directors, states were requested to supply available emission inventory data for incorporation into the OTAG inventory.[19] Specifically, states were requested to supply all available point and area source emissions data for VOC, NO_x, CO, SO_2, and PM-10, with the primary focus on emissions of ozone precursors. Some emission inventory data were received from 36 of the 38 states in the OTAG domain. To minimize the burden to the states, there was no specified format for submitting State data. The majority of the state data was submitted in one of three formats:

1) an Emissions Preprocessor System Version 2.0 (EPS2.0) Workfile
2) an ad hoc report from AIRS/FS
3) data files extracted from a state emission inventory data base

The origin of data submitted by each state is described in section 4.4.3.1.4.1 for point sources and 4.4.3.1.4.2 for area sources.

4.4.3.1.4. 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 two-digit SIC code. 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 using Equation 4.4-5

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} * SUMTHRU * 1/(13 * DPW) \qquad \text{(Eq. 4.4-5)}$$

where:

$EMISSIONS_{ASD}$	=	average summer day emissions
$EMISSIONS_{ANNUAL}$	=	annual emissions
SUMTHRU	=	summer throughput percentage
DPW	=	days per week in operation

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. This computer file contains default seasonal and daily temporal profiles by SCC. Equation 4.4-6 was used.

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} / (SUMFAC_{SCC} * WDFAC_{SCC}) \qquad \text{(Eq. 4.4-6)}$$

where:

$EMISSIONS_{ASD}$	=	average summer day emissions
$EMISSIONS_{ANNUAL}$	=	annual emissions
$SUMFAC_{SCC}$	=	default summer season temporal factor for SCC
$WDFAC_{SCC}$	=	default summer weekday temporal factor for 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 and were calculated using Equation 4.4-7.

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} / 365 \qquad \text{(Eq. 4.4-7)}$$

where:

$EMISSIONS_{ASD}$	=	average summer day emissions
$EMISSIONS_{ANNUAL}$	=	annual emissions

4.4.3.1.4.1 ***Point.*** For stationary point sources, 36 of the 38 states in the OTAG domain supplied emission estimates covering the entire state. Data from the 1990 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 4.4-5 provides a brief description of the point source data supplied by each state.

4.4.3.1.4.2 ***Area.*** For area sources, 17 of the 38 states in the OTAG domain supplied 1990 emission estimates covering the entire state, and an additional nine states supplied 1990 emission estimates covering part of their state (partial coverage was mostly in ozone nonattainment areas). 1990 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 4.4-6 provides a brief description of the area source data supplied by each state.

4.4.3.1.4.4 ***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.

The use of rule effectiveness in estimating emissions can result in emission estimates that are much higher than estimates for the same source calculated without using rule effectiveness, especially for sources with high control efficiencies (95 percent or above). Because of this problem, there was concern that the OTAG emission estimates for states that used rule effectiveness would be biased to larger estimates relative to states that did not include rule effectiveness in their computations.

To test if this bias existed, county level maps of point source emissions were developed for the OTAG domain. If this bias did exist, one would expect to see sharp differences at state borders between states using rule effectiveness and states not using rule effectiveness. Sharp state boundaries were not evident in any of the maps created. Based on this analysis, it was determined that impact of rule effectiveness inconsistencies was not causing large biases in the inventory.

4.4.3.2 GCVTC Inventory

The GCVTC inventory includes detailed emissions data for eleven states: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.[20] 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/FS for VOC, NO_x, and SO_2 point source data for the other nine states, the 1990 Interim Inventory for area source data for the other nine states, and the 1985 NAPAP inventory for NH_3 and TSP data. In addition to these existing data, the GCVTC inventory includes newly developed emission estimates for forest wildfires and prescribed burning.

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

- complete point and area source data for California
- complete point and area source data for Oregon
- forest wildfire data for the entire eleven state region
- prescribed burning data for the entire eleven 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 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.

Point source emission estimates in the GCVTC inventory from states other than California and Oregon came from AIRS/FS. Corrections were made to this inventory to the VOC and PM emissions. The organic emissions reported in GCVTC inventory for California are total organics (TOG). These emissions were converted to VOC using the profiles from EPA's SPECIATE[18] data base. Since the PM emissions in the GCVTC were reported as both TSP and PM-2.5, EPA estimated PM-10 from the TSP in a similar manner as described in section 4.4.1.

4.4.3.3 AIRS/FS

SO_2 and PM-10 (or PM-10 estimated from TSP) sources of greater than 250 tons per year as reported to AIRS/FS that were not included in either the OTAG or GCVTC inventories were appended to the NET inventory. The data were extracted from AIRS/FS using the data criteria set listed in table 4.4-7. The data elements extracted are also listed in Table 4.4-7. The data were extracted in late November 1996. It is important to note that *default estimated* emissions were extracted.

4.4.3.4 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 SO2, PM-10, PM-2.5, and NH_3, as well as annual or ozone season daily (depending on the inventory) emission estimates for all pollutants. This section describes the steps taken to fill in the gaps from the other inventories.

4.4.3.4.1 SO_2 and PM Emissions —
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, OTAG data for these pollutants were not available. For point sources, data for plants over 250 tons per year for SO_2 and PM-10 were added from AIRS/FS. The AIRS/FS data were also 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 to the inventory. For OTAG plants where there were no

matching data in AIRS/FS 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 unmatched point and area sources involved using uncontrolled emission factor ratios to calculate uncontrolled emissions. This method used SO_2 or PM-10 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 VOC, NO_x, and CO 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 Inventory 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 FIPS code, along with the plant and point IDs.

There were two exceptions to the procedures used to develop the SO_2 and 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/FS for 1990 and using the emission factor ratios resulted in unrealistically high PM-10 emissions. The residential nonwood SO_2 and PM emissions were also deemed too high for all states based on the above calculation. The emission estimates reverted to an earlier method as outlined in section 4.4.7.4.

There were no PM-2.5 data in either OTAG or AIRS/FS. Therefore, the point and area PM-2.5 emission estimates were developed based on the PM-10 estimates using source-specific uncontrolled particle size distributions and particle size specific control efficiencies for sources with PM-10 controls. To estimate PM-2.5, uncontrolled PM-10 was first estimated by removing the impact of any PM-10 controls on sources in the inventory. Next, the uncontrolled PM-2.5 was calculated by multiplying the uncontrolled PM-10 emission estimates by the ratio of the PM-2.5 particle size multiplier to the PM-10 particle size multiplier. (These particle size multipliers represent the percentage to total particulates below the specified size.) Finally, controls were reapplied to sources with PM-10 controls by multiplying the uncontrolled PM-2.5 by source/control device particle size specific control efficiencies.

4.4.3.4.2 NH_3 Emissions —

All NH_3 emission estimates incorporated into the NET Inventory came directly from EPA's National Particulate Inventory (NPI).[18] This methodology is the same as that reported in section 4.4.1 for the 1990 Interim Inventory. The NPI contained the only NH_3 emissions inventory available. (Any NH_3 estimates included in the OTAG or AIRS/FS inventory were eliminated due to sparseness of data.) As with SO_2 and PM-10, plant matching was performed for point sources. Emissions were attached to existing plants where there was a match. New plants were added for plants where there was no match.

4.4.3.4.4 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 (detailed in sections 4.4.7.3 and 4.4.7.2).

Additional 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.
- Tier assignments were made for all SCCs.
- Checked and fixed sources with PM-2.5 emissions which were greater than their PM-10 emissions.
- Checked and fixed sources with PM-10 emissions greater than zero and PM-2.5 emissions equal to zero.

4.4.4 Emissions, 1991 to 1994

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/FS data used. (The list of states are detailed in the AIRS/FS subsection, 4.4.4.2.) For those states requesting that EPA extract their data from AIRS/FS, 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/FS until July 1997.

4.4.4.1 Grown Estimates

The 1991 through 1994 point and area source emissions were grown using the 1990 NET inventory as the basis. The algorithm for determining the estimates is detailed in section 4.4.1.3. The 1990 through 1996 SEDS and BEA data are presented in Tables 4.4-8 and 4.4-9. The 1996 BEA and SEDS data were determined based on linear interpretation 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. Table 4.4-10 lists the SCC and the source for growth.

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 PCE. The PCE deflators used to convert each year's earnings data to 1992 dollars are:

Year	1992 PCE Deflator
1990	93.6
1991	97.3
1992	100.0
1993	102.6
1994	104.9
1995	107.6
1996	109.7

4.4.4.2 AIRS/FS

Several states responded to EPA's survey and requested that their 1991 through 1995 estimates reflect their emissions as reported in AIRS/FS. The list of these states, along with the years available in AIRS/FS is given in Table 4.4-11. As described in section 4.4.3.3, default estimated annual and ozone season daily emissions (where available) were extracted from AIRS/FS. Some changes were made to these AIRS/FS 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/FS and replaced the previously high estimates. The changes made to select state and/or plant AIRS/FS 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 4.4-11, 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 two years worth of emissions at the plant level. If only one year of emissions data were 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.

As described in section 4.4.3.4.1, many 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 PM-10 emissions are then converted to PM-2.5 in the same manner as described in section 4.4.1.3. The State of South Carolina provided its own conversion factor for estimating PM-10 from TSP.[22]

For all sources that did not report ozone season daily emissions, these emissions were estimated using the algorithm described in section 4.4.3.1.4 and equations 4.4-5 through 4.4-7.

4.4.5 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/FS for 1995, estimated using AIRS/FS 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. A description of the AIRS/FS methodology is described in section 4.4.4. The following three subsections describe the projected emissions.

4.4.5.1 Grown Estimate

The 1995 point and area source emissions were grown using the 1990 NET inventory as the basis. The algorithm for determining the estimates is detailed in section 4.4.1.3 and equations 4.4-1 through 4.4-4. The 1990 through 1996 SEDS and BEA data are presented in Tables 4.4-8 and 4.4-9.

4.4.5.2 NO_x RACT

Major stationary source NO_x emitters in marginal and above nonattainment areas and in ozone transport regions (OTRs) are required to install Reasonably Available Control Technology (RACT)-level controls under the ozone nonattainment related provisions of Title I of the 1990 Clean Air Act Amendments (CAAA). The definition of major stationary source for NO_x differs by the severity of the ozone problem as shown in Table 4.4-12.

NO_x RACT controls for non-utility sources that were modeled for the 1995 NET emissions are shown in Table 4.4-13. These RACT-level controls were applied to point source emitters with emissions at or above the major source size definition for each area. The application of NO_x RACT controls was only applied to grown sources.

4.4.5.3 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 calculated 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.

4.4.6 1996 Emissions

The 1996 emission estimates were derived in a similar manner as the 1995 emissions. For point sources, the 1995 AIRS/FS emissions and 1995 emissions grown from 1990 emissions were merged. The following describes the projected 1996 emissions. No controls were added to the 1996 emissions.

The 1996 point and area source emissions were grown using the 1995 NET inventory as the basis. The algorithm for determining the estimates is described by Equation 4.4-8. The 1990 through 1996 SEDS and BEA data are presented in Tables 4.4-8 and 4.4-9. The 1996 BEA and SEDS data were determined using linear interpretation of the 1988 through 1995 data. Rule effectiveness was updated to

100 percent as described in section 4.4.5.3 for the AIRS/FS sources that reported rule effectiveness of less than 100 percent in 1995.

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

$$CER_{1996} = UC_{1995} \times \frac{GS_{1996}}{GS_{1995}} \times \left(1- \left(\frac{REFF}{100}\right) \times \left(\frac{CEFF}{100}\right) \times \left(\frac{RP}{100}\right) \right) \qquad \text{(Eq. 4.4-8)}$$

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 100 percent since no additional controls were applied.

4.4.7 Alternative Base Inventory Calculations

For three combustion sources, the 1985 NAPAP inventory was not used as the base year for some or all other years. The 1985 to 1990 wildfire estimates were extracted from the GCVTC inventory.[20] The wildfire emissions for 1985 through 1990 for non-GCVTC states or missing years are based on AP-42 emission factors and fuel loading values. The activity data were derived from the U.S. Department of Agriculture (USDA) Forest Service and the U.S. Department of Interior (DOI). The prescribed burning estimates for the years 1985 to 1990 are the same and were obtained from the USDA. Residential wood combustion estimates are also based on AP-42 emission factors and EPA-generated activity.

4.4.7.1 Forest Fires/Wildfires

Forest fire/wildfire emissions were generated for the years 1985 through 1995 using the data on number of acres burned (obtained from the Department of the Interior [DOI][23, 24] and the USDA Forest Service [USFS][25, 26]), AP-42 emission factors, and AP-42 fuel loading factors.[27] Equation 4.4-9 summarizes the calculation.

$$E_{state} = Activity \times Fuel\ Loading \times EF \times UCF \qquad \text{(Eq. 4.4-9)}$$

where:
- E_{state} = annual state emissions (tons)
- Activity = sum of DOI, USFS, and state and private land acres burned (acres)
- Fuel Loading = average fuel loading for state (tons/acre)
- EF = emission factor (lbs/ton)
- UCF = unit conversion factor (1 ton /2,000 lbs)

Table 4.4-14 shows the emission factors and fuel loading for wildfires developed from AP-42. PM-2.5 emissions for 1990 through 1995 were calculated by multiplying the PM-10 emissions by 0.23.[18] Since complete data for 1996 were not available, 1996 emissions were assumed to be the same as 1995 emissions.

4.4.7.1.1 Grand Canyon States —

4.4.7.1.1.1 ***Grand Canyon States (1986-1993).*** For the years 1986 through 1993, for the states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, the CO, NO_x, VOC, and PM-10 emissions calculated using the methodology described above were replaced by those included in the GCVTC inventory.[20] The GCVTC inventory provided county level emissions for forest fires in this source category. PM-2.5 emissions for 1990 were also replaced by those in the GCVTC inventory. PM-2.5 emissions for 1991 through 1995 were calculated by multiplying the PM-10 emissions by 0.23.[18] The SO_2 emissions for these states were calculated using the AP-42 emission factor ratio equation shown below. The emission factors are shown in Table 4.4-10.

$$SO_2\ Emissions = \frac{SO_2\ EF}{NO_x\ EF} \times NO_x\ Emissions \qquad \text{(Eq. 4.4-10)}$$

where:	SO_2 Emissions	=	annual county SO_2 emissions (tons)
	SO_2 EF	=	AP-42 emission factor for SO_x (lbs/ton)
	NO_x EF	=	AP-42 emission factor for NO_x (lbs/ton)
	NO_x Emissions	=	annual NO_x emissions (tons)

4.4.7.1.1.2 ***Grand Canyon States (1985, 1994, 1995).*** For the years 1985, 1994, and 1995, for the states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, CO, NO_x, VOC, PM-10 and PM-2.5 emissions were calculated using Equation 4.4-11.

$$County\ Emissions_{year} = \frac{State\ Activity_{year}}{State\ Activity_{1990}} \times County\ Emissions_{1990} \qquad \text{(Eq. 4.4-11)}$$

where:	$\text{County Emissions}_{year}$	=	annual county emissions (tons)
	State Activity	=	DOI, state and private, and National Forest Lands burned (acres)
	$\text{County Emissions}_{1990}$	=	annual county emissions provided by the GCVTC (tons)

4.4.7.1.2 Activity —

The activity factor for wildfires is land acres burned. There are three sources of data for this activity: National Forest Service lands burned, state and private acres burned,[25, 26] and U.S. DOI acres burned.[23, 24] Data from these three sources were summed to get the total acres burned for each state.

4.4.7.1.3 Fuel Loading and Emission Factors —

AP-42 fuel loading and emission factors are shown in Table 4.4-14.[27] An average fuel loading was determined for five regions in the United States. Emission factors for SO_2, NO_x, VOC, CO, and PM-10 were used. PM-2.5 emissions were calculated by multiplying the PM-10 emissions by 0.23.[18]

4.4.7.1.4 County Distribution —

All non-GCVTC states were distributed to the county-level using the same county-level distribution as was used in the 1985 NAPAP Inventory. GCVTC provided county-level emissions for 1986 through 1993. GCVTC emissions were calculated for 1985, 1994, and 1995 using the 1990 GCVTC emissions, as described above.

4.4.7.2 Prescribed/Slash and Managed Burning

The prescribed burning emissions were based on a 1989 USDA Forest Service inventory of particulate matter and air toxics from prescribed burning.[28] The Forest Service inventory contained state-level totals for total particulate matter, PM-10, PM-2.5, CO, carbon dioxide, methane, non-methane, and several air toxics.

The emissions for all pollutants were based on the 1989 Forest Service inventory of particulate matter from prescribed burning. This inventory contains county-level emissions for PM-10, and VOC. The NO_x, CO, and SO_2 emissions were calculated by assuming the ratio between the VOC emissions to either the NO_x, CO or SO_2 emissions in the Forest Service inventory was equal to the corresponding ratio using the 1985 NAPAP inventory. Equation 4.4-12 was used.

$$FS_{POL} = FS_{VOC} \times \left(\frac{NAPAP_{POL}}{NAPAP_{VOC}} \right) \qquad \text{(Eq. 4.4-12)}$$

where: FS_{POL} = prescribed burning (NO_x, CO, or SO_2) emissions from Forest Service
FS_{VOC} = prescribed burning VOC emissions from Forest Service
$NAPAP_{POL}$ = prescribed burning (NO_x, CO, or SO_2) emissions from 1985 NAPAP
$NAPAP_{VOC}$ = prescribed burning VOC emissions from 1985 NAPAP

The resulting 1989 emissions for CO, NO_x, PM-10, SO_2, and VOC have been used for all years between 1985 and 1990.

4.4.7.3 Residential Wood

Emissions from residential wood combustion were estimated for 1985 through 1996 using annual wood consumption and an emission factor. The following general equation (Equation 4.4-13) was used to calculate emissions:

$$E_{year} = Activity \times EF \times \left(1 - \frac{CE}{100} \right) \qquad \text{(Eq. 4.4-13)}$$

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.[29] This model was adjusted with heating degree day information,[30] and normalized with annual wood consumption estimates.[31] AP-42 emission factors for CO, NO_x, PM-10, PM-2.5, SO_2 and VOC were used. A control efficiency was applied nationally to PM-10 and PM-2.5 emissions for the years 1991 through 1996.[32]

4.4.7.3.1 Activity - County Model —

EPA's County Wood Consumption Estimation Model is based on 1990 data and provides county level estimates of wood consumption, in cords. Model F of the overall Model was used to estimate the amount of residential wood consumed per county, using a sample set of 91 counties in the northeast and northwestern United States. Model F calculates estimates of cords of wood consumed per household as a function of the number of homes heating primarily with wood with a forced intercept of zero. Using the Model F results, the percentage of the population heating with wood, the number of households in a county, land area per county, and heating degree days, county-level wood consumption for 1990 was estimated.

The counties listed below show no residential wood consumption activity. The emissions for these 18 counties for the years 1985 through 1996 are zero.

State	County
Alaska	Aleutians East Borough
Hawaii	Kalawao
Kansas	Kearny
	Stanton
Montana	Yellowstone National Park
Texas	Cochran
	Crockett
	Crosby
	Garza
	Hartley
	Jim Hogg
	Loving
	Moore
	Reagan
	Sterling
	Swisher
	Terrell
	Yoakum

4.4.7.3.2 Heating Degree Days —

A heating degree day is the number of degrees per day the daily average temperature is below 65 degrees Fahrenheit. These data were collected for one site in all states (except Texas and California where data were collected for two sites) for each month and summed for the year. An average of the two sites was used for Texas and California. This information is used to adjust the model, which is partially based on 1990 heating degree days, to the appropriate year's heating degree data. Equation 4.4-14 was used.

$$Adjusted\ Model_{year} = \frac{State\ hdd\ Total_{year}}{State\ hdd\ Total_{1990}} \times County\ Model_{1990} \qquad \text{(Eq. 4.4-14)}$$

where: Adjusted Model = county wood consumption (cords)
State hdd Total = total heating degree days (degrees Fahrenheit)
County Model = EPA model consumption (cords)

4.4.7.3.3 National Wood Consumption —

The Adjusted Model wood consumption estimate was normalized on a national level using the U.S. Department of Energy (DOE) estimate of residential U.S. wood consumption. This value is reported in trillion British thermal units (Btu) and is converted to cords by multiplying by 500,000. Consumption for the years 1985, 1986, and 1988 were unavailable from the DOE. Known year's consumption and heating degree days were used to estimate these years. The 1985 DOE estimate was calculated using the ratio of 1985 total heating degree days to 1984 total heating degree days multiplied by the 1984 DOE wood consumption estimate. The 1986 DOE estimate was calculated using the ratio of 1986 total heating degree days to 1985 total heating degree days multiplied by the "calculated" 1985 DOE wood consumption estimate. The 1988 DOE estimate was calculated using the ratio of 1988 total heating degree days to 1987 total heating degree days multiplied by the 1987 DOE wood consumption estimate.

Equation 4.4-15 shows the normalization of the Adjusted Model.

$$Activity = Adjusted\ Model_{year} \times \frac{DOE_{year}}{\sum Adjusted\ Model_{year}} \qquad \text{(Eq. 4.4-15)}$$

where: Activity = normalized county consumption (cords)
Adjusted Model = county wood consumption (cords)
DOE = DOE national estimate of residential wood consumption (cords)

4.4.7.3.4 Emission Factors —

Emission factors were obtained from Table 1.10-1 of AP-42, *Emission Factors for Residential Wood Combustion*, for conventional wood stoves,[27] and are shown here in Table 4.4-15. Table 4.4-15 also shows the emission factors expressed in tons per cord consumed.

4.4.7.3.5 Control Efficiency —

A control efficiency was applied nationally to PM-10 and PM-2.5 residential wood combustion for the years 1991 through 1996.[32] The control efficiency for all pollutants for the years 1985 through 1990, and for VOC, NO_x, CO, and SO_2 for 1991 through 1996 is zero. Table 4.4-16 shows the control efficiencies for PM-10 and PM-2.5 for 1991 through 1996.

4.4.7.4 SO_2 and PM Residential Nonwood Combustion

The 1990 SO_2 and PM NET emissions are the same as the 1990 Interim Inventory emissions. The 1991 through 1994 emissions were estimated by applying growth factors to the 1990 Interim Inventory emissions. The growth factors were obtained from the prereleased E-GAS, version 2.0.[33] The E-GAS generates growth factors at the SCC-level for counties representative of all counties within each ozone nonattainment area classified as serious and above and for counties representative of all counties within both the attainment portions and the marginal and moderate nonattainment areas within each state. The appropriate growth factors were applied by county and SCC to the 1990 emissions as shown by Equation 4.5-16.

$$Emissions_{(county,SCC,year)} = Growth_{(county,SCC,year)} \times Emissions_{(county,SCC,1990)} \qquad \text{(Eq. 4.5-16)}$$

There are approximately 150 representative counties in E-GAS and 2000 SCCs present in the base year inventory. This yields a matrix of 300,000 growth factors generated to determine a single year's inventory. To list all combinations would be inappropriate.

4.4.8 References

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Table 4.4-1. Bureau of Economic Analysis's SA-5 National Changes in Earnings by Industry

Industry	SIC	Percent Growth from: 1985 to 1987	1987 to 1988	1988 to 1989	1989 to 1990
Wholesale trade	50, 51	5.01	5.87	2.44	-1.02
Retail trade	52 to 59	5.19	4.39	0.65	-0.94
Banking and credit agencies	60, 61	12.44	2.45	-0.33	-0.49
Insurance	63, 64	14.09	4.20	1.52	2.71
Real estate	65, 66	92.14	-6.98	-7.87	-0.48
Holding companies and investment services	67	39.05	-34.86	-12.18	16.91
Hotels and other lodging places	70	12.65	5.59	1.71	2.29
Personal services	72	7.17	2.35	7.44	5.41
Private households	88	-5.68	2.41	0.83	-3.69
Business and miscellaneous repair services	76	17.05	-17.34	5.79	4.34
Auto repair, services, and garages	75	6.65	2.46	3.00	3.93
Amusement and recreation services and motion pictures	78, 79	17.93	16.43	4.06	7.59
Health services	80	15.15	7.08	5.11	6.28
Legal services	81	20.14	9.92	4.09	4.80
Educational services	82	9.35	7.17	3.88	2.60
Social services and membership organizations	83	17.39	8.45	7.95	7.37
Miscellaneous professional services	84	11.28	5.04	7.08	4.12
Federal, civilian	91	-0.54	3.79	1.21	1.96
Federal, military	97	1.96	-1.07	-1.58	-3.19
State and local government	92 to 96	7.88	3.63	3.19	3.04

Table 4.4-2. Area Source Growth Indicators

NAPAP SCC	Category Description	Data Source	Growth Indicator
1	Residential Fuel - Anthracite Coal	SEDS	Res - Anthracite
2	Residential Fuel - Bituminous Coal	SEDS	Res - Bituminous
3	Residential Fuel - Distillate Oil	SEDS	Res - Distillate oil
4	Residential Fuel - Residual Oil		Zero growth
5	Residential Fuel - Natural Gas	SEDS	Res - Natural gas
6	Residential Fuel - Wood	BEA	Population
7	Commercial/Institutional Fuel - Anthracite Coal	SEDS	Comm - Anthracite
8	Commercial/Institutional Fuel - Bituminous Coal	SEDS	Comm - Bituminous
9	Commercial/Institutional - Distillate Oil	SEDS	Comm - Distillate oil
10	Commercial/Institutional - Residual Oil	SEDS	Comm - Residual oil
11	Commercial/Institutional - Natural Gas	SEDS	Comm - Natural gas
12	Commercial/Institutional - Wood	BEA	Services
60	Forest Wild Fires		Zero growth
61	Managed Burning - Prescribed		Zero growth
62	Agricultural Field Burning	BEA	Farm
64	Structural Fires		Zero growth
99	Minor Point Sources	BEA	Population

Table 4.4-3. SEDS National Fuel Consumption

Category	1985	1986	1987	1988	1989	1990
Anthracite Coal (thousand short tons)						
Commercial	524	494	478	430	422	410
Residential	786	740	717	646	633	615
Bituminous Coal (thousand short tons)						
Commercial	4,205	4,182	3,717	3,935	3,323	3,470
Residential	2,264	2,252	2,002	2,119	1,789	1,869
Distillate Fuel (thousand barrels)						
Commercial	107,233	102,246	101,891	98,479	91,891	95,385
Residential	171,339	173,736	176,822	182,475	178,629	184,501
Motor Gasoline (thousand barrels)						
All Sectors	2,493,361	2,567,436	2,630,089	2,685,145	2,674,669	2,760,414
Natural Gas (million cubic feet)						
Commercial	2,432	2,318	2,430	2,670	2,719	2,810
Residential	4,433	4,314	4,315	4,630	4,777	4,805
Residual Fuel (thousand barrels)						
Commercial	30,956	39,480	41,667	42,256	35,406	27,776

Table 4.4-4. AMS to NAPAP Source Category Correspondence

AMS		NAPAP	
SCC	**Category**	**SCC**	**Category**
Stationary Source Fuel Combustion			
2103001000	Commercial/Institutional - Anthracite Coal (Total: All Boiler Types)	7	Commercial/Institutional Fuel - Anthracite Coal
2103002000	Commercial/Institutional - Bituminous/Subbituminous Coal (Total: All Boiler Types)	8	Commercial/Institutional Fuel - Bituminous Coal
2103004000	Commercial/Institutional - Distillate Oil (Total: Boilers & I.C. Engines)	9	Commercial/Institutional - Distillate Oil
2103005000	Commercial/Institutional - Residual Oil (Total: All Boiler Types)	10	Commercial/Institutional - Residual Oil
2103006000	Commercial/Institutional - Natural Gas (Total: Boilers & I.C. Engines)	11	Commercial/Institutional - Natural Gas
2103008000	Commercial/Institutional - Wood (Total: All Boiler Types)	12	Commercial/Institutional - Wood
2104001000	Residential - Anthracite Coal (Total: All Combustor Types)	1	Residential Fuel - Anthracite Coal
2104002000	Residential - Bituminous/Subbituminous Coal (Total: All Combustor Types)	2	Residential Fuel - Bituminous Coal
2104004000	Residential - Distillate Oil (Total: All Combustor Types)	3	Residential Fuel - Distillate Oil
2104005000	Residential - Residual Oil (Total: All Combustor Types)	4	Residential Fuel - Residual Oil
2104006000	Residential - Natural Gas (Total: All Combustor Types)	5	Residential Fuel - Natural Gas
2104008000	Residential - Wood (Total: Woodstoves and Fireplaces)	6	Residential Fuel - Wood
Miscellaneous Area Sources			
2801500000	Agriculture Production - Crops - Agricultural Field Burning (Total)	62	Agricultural Field Burning
2801520000	Agriculture Production - Crops - Orchard Heaters (Total)	63	Frost Control - Orchard Heaters
2810001000	Other Combustion - Forest Wildfires (Total)	60	Forest Wild Fires
2810015000	Other Combustion - Managed (Slash/Prescribed) Burning (Total)	61	Managed Burning - Prescribed
2810030000	Other Combustion - Structure Fires	64	Structural Fires

Table 4.4-5. 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
South Carolina	AIRS-AFS - Ad hoc retrievals	Annual	1991	Average Summer Day estimated using default temporal factors.

Table 4.4-5 (continued)

State	Data Source/Format	Temporal Resolution	Year of Data	Adjustments to Data
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 4.4-6. 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 4.4-7. Ad Hoc Report

Criteria		Plant Output		Point Output		Stack Output		Segment Output General		Segment Output Pollutant	
Regn	GT 0	YINV	YEAR OF INVENTORY	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE
PLL4	CE VOC	STTE	STATE FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE
PLL4	CE CO	CNTY	COUNTY FIPS CODE	PNED	NEDS POINT ID	PNED	NEDS POINT ID	PNED	NEDS POINT ID	PNED	NEDS POINT ID
PLL4	CE SO2	CYCD	CITY CODE	PNUM	POINT NUMBER	STNB	STACK NUMBER	STNB	STACK NUMBER	STNB	STACK NUMBER
PLL4	CE NO2	ZIPC	ZIP CODE	CAPC	DESIGN CAPACITY	LAT2	LATITUDE STACK	PNUM	POINT NUMBER	PNUM	POINT NUMBER
PLL4	CE PM-10	PNED	NEDS POINT ID	CAPU	DESIGN CAPACITY UNITS	LON2	LONGITUDE STACK	SEGN	SEGMENT NUMBER	SEGN	SEGMENT NUMBER
PLL4	CE PT	PNME	PLANT NAME	PAT1	WINTER THROUGHPUT	STHT	STACK HEIGHT	SCC8	SCC	SCC8	SCC
DES4	GE 0	LAT1	LATITUDE PLANT	PAT2	SPRING THROUGHPUT	STDM	STACK DIAMETER	HEAT	HEAT CONTENT	PLL4	POLLUTANT CODE
DUE4	ME TY	LON1	LONGITUDE PLANT	PAT3	SUMMER THROUGHPUT	STET	STACK EXIT TEMPERATURE	FPRT	ANNUAL FUEL THROUGHPUT	D034	OSD EMISSIONS
YINV	ME 90	SIC1	STANDARD INDUSTRIAL CODE	PAT4	FALL THROUGHPUT	STEV	STACK EXIT VELOCITY	SULF	SULFUR CONTENT	DU04	OSD EMISSION UNITS
		OPST	OPERATING STATUS	NOHD	NUMBER HOURS/DAY	STFR	STACK FLOW RATE	ASHC	ASH CONTENT	DES4	DEFAULT ESTIMATED EMISSIONS
		STRS	STATE REGISTRATION NUMBER	NODW	NUMBER DAYS/WEEK	PLHT	PLUME HEIGHT	PODP	PEAK OZONE SEASON DAILY PROCESS RATE	DUE4	DEFAULT ESTIMATED EMISSIONS UNITS
				NOHY	NUMBER HOURS/YEAR					CLEE	CONTROL EFFICIENCY
										CLT1	PRIMARY CONTROL DEVICE CODE
										CTL2	SECONDARY CONTROL DEVICE CODE
										REP4	RULE EFFECTIVENESS
										DME4	METHOD CODE
										Emfa	Emission factor

Table 4.4-8. SEDS National Fuel Consumption, 1990-1996 (trillion Btu)

Fuel Type	End-User	Code	1990	1991	1992	1993	1994	1995	1996
Anthracite Coal									
	Commercial	ACCCB	12	11	11	11	11	11	11
	Residential	ACRCB	19	17	17	16	16	16	16
Bituminous Coal									
	Commercial	BCCCB	80	72	75	72	70	69	68
	Residential	BCRCB	43	39	40	40	40	39	39
Distillate Fuel									
	Commercial	DFCCB	487	482	464	464	450	435	422
	Residential	DFRCB	837	832	865	913	887	862	836
Kerosene									
	Commercial	KSCCB	12	12	11	14	13	12	11
	Residential	KSRCB	64	72	65	76	67	59	51
Liquid Petroleum Gas									
	Commercial	LGCCB	64	69	67	70	70	70	70
	Residential	LGRCB	365	389	382	399	398	397	397
Natural Gas									
	Commercial	NGCCB	2,698	2,808	2,884	2,996	3,035	3,074	3,114
	Residential	NGRCB	4,519	4,685	4,821	5,097	5,132	5,166	5,201
Residual Fuel									
	Commercial	RFCCB	233	213	191	175	170	168	167
Population									
		TPOPP	248,709	252,131	255,025	257,785	259,693	261,602	263,510

Table 4.4-9. BEA SA-5 National Earnings by Industry, 1990-1996 (million $)

Industry	LNUM	SIC	1990	1991	1992	1993	1994	1995	1996
Total population as of July 1 (thousands)	020	999	0	0	0	0	0	0	0
Total population as of July 1 (thousands)	030	999	1	1	1	1	1	1	1
Total population as of July 1 (thousands)	040	999	3,634	3,593	3,732	3,785	3,891	4,011	4,086
Total population as of July 1 (thousands)	041	999	238	242	248	253	265	273	280
Total population as of July 1 (thousands)	045	999	3,395	3,350	3,483	3,531	3,626	3,737	3,805
Total population as of July 1 (thousands)	046	999	971	947	907	914	934	980	981
Total population as of July 1 (thousands)	047	999	735	791	858	888	912	951	994
Total population as of July 1 (thousands)	050	999	2,932	2,891	2,975	3,003	3,082	3,182	3,231
Total population as of July 1 (thousands)	060	999	321	331	351	371	383	394	408
Total population as of July 1 (thousands)	070	999	381	370	405	410	426	436	447
Total population as of July 1 (thousands)	071	999	34	28	34	32	29	18	16
Total population as of July 1 (thousands)	072	999	347	342	372	378	396	418	432
Farm	081	1, 2	48	41	46	45	42	31	29
Farm	082	1, 2	3,586	3,552	3,686	3,740	3,849	3,980	4,058
Farm	090	1, 2	3,001	2,957	3,079	3,126	3,228	3,353	3,423
Agricultural services, forestry, fisheries, and other	100	7-9	24	24	24	24	26	27	27
Agricultural services, forestry, fisheries, and other	110	7-9	20	20	21	22	23	24	25
Agricultural services, forestry, fisheries, and other	120	7-9	4	3	3	3	3	3	3
Agricultural services, forestry, fisheries, and other	121	7-9	1	1	1	0	1	1	1
Agricultural services, forestry, fisheries, and other	122	7-9	2	2	2	2	2	2	1
Agricultural services, forestry, fisheries, and other	123	7-9	1	1	1	1	1	1	1
Agricultural services, forestry, fisheries, and other	200	7-9	36	37	36	34	35	35	35
Metal mining	210	10	2	3	3	2	2	2	3
Coal mining	220	11, 12	8	8	8	6	6	6	6
Oil and gas extraction	230	13	20	22	21	21	21	21	21
Nonmetallic minerals, except fuels	240	14	4	4	4	4	4	4	4
Construction	300	15-17	218	197	195	199	216	219	219
Construction	310	15-17	54	47	46	47	51	51	50
Construction	320	15-17	29	28	28	27	29	29	29
Construction	330	15-17	135	123	121	125	136	138	139
Manufacturing	400	998	710	690	705	705	725	740	747
Durable goods	410	996	437	418	423	424	440	452	456
Lumber and wood products	413	24	22	21	22	22	24	25	25
Furniture and fixtures	417	25	13	12	13	13	14	14	14
Stone, clay, and glass products	420	32	20	18	19	19	20	20	20
Primary metal industries	423	33	33	30	31	30	32	33	32
Fabricated metal products	426	34	51	48	49	49	51	53	53
Machinery, except electrical	429	35	86	83	83	84	86	90	91
Electric and electronic equipment	432	36	63	62	62	63	65	68	69
Motor vehicles and equipment	435	371	41	38	42	46	53	56	60
Transportation equipment, excluding motor vehicles	438	37	54	52	50	45	43	42	39
Instruments and related products	441	38	43	42	42	40	40	40	39
Miscellaneous manufacturing industries	444	39	11	11	11	12	12	12	12
Nondurable goods	450	997	273	272	281	282	285	288	291
Food and kindred products	453	20	51	51	52	52	53	53	54
Tobacco manufactures	456	21	3	3	3	2	2	3	3
Textile mill products	459	22	16	16	17	17	17	17	17
Apparel and other textile products	462	23	20	20	20	19	19	19	19
Paper and allied products	465	26	28	27	28	28	29	29	29
Printing and publishing	468	27	54	54	55	56	57	58	59
Chemicals and allied products	471	28	61	63	66	65	65	67	68
Petroleum and coal products	474	29	9	9	10	9	10	9	9
Rubber and miscellaneous plastic products	477	30	27	26	28	29	30	31	31

Table 4.4-9 (continued)

Industry	LNUM	SIC	1990	1991	1992	1993	1994	1995	1996
Leather and leather products	480	31	3	3	2	3	3	2	2
Leather and leather products	500	31	243	245	251	260	269	277	283
Railroad transportation	510	40	12	12	13	12	12	12	12
Trucking and warehousing	520	42	59	58	60	62	66	69	71
Water transportation	530	44	7	7	7	6	6	6	6
Water transportation	540	44	48	49	50	51	50	52	53
Local and interurban passenger transit	541	41	8	8	9	9	9	10	10
Transportation by air	542	45	30	30	31	31	31	31	31
Pipelines, except natural gas	543	46	1	1	1	1	1	1	1
Transportation services	544	47	12	13	14	14	15	16	17
Communication	560	48	63	63	64	67	71	75	78
Electric, gas, and sanitary services	570	49	49	52	53	56	56	56	57
Wholesale trade	610	50, 51	236	231	238	235	242	255	258
Retail trade	620	52-59	342	335	342	347	359	372	378
Retail trade	621	52-59	18	18	18	19	20	21	21
Retail trade	622	52-59	40	38	39	39	40	41	41
Retail trade	623	52-59	56	56	57	56	57	58	58
Retail trade	624	52-59	55	54	54	56	60	62	64
Retail trade	625	52-59	18	18	18	18	18	18	18
Retail trade	626	52-59	22	20	19	19	21	22	22
Retail trade	627	52-59	76	78	80	82	85	88	90
Retail trade	628	52-59	57	54	57	57	59	62	63
Retail trade	700	52-59	246	247	280	290	291	302	313
Banking and credit agencies	710	60, 61	82	81	86	89	89	90	91
Banking and credit agencies	730	60, 61	163	166	194	201	202	212	221
Banking and credit agencies	731	60, 61	38	40	50	53	51	55	58
Insurance	732	63, 64	56	59	61	62	63	63	65
Insurance	733	63, 64	34	33	33	34	36	37	38
Real estate	734	65, 66	28	25	36	43	44	47	51
Holding companies and investment services	736	62, 67	8	10	14	10	9	10	10
Services	800	995	946	951	1,008	1,032	1,066	1,128	1,164
Hotels and other lodging places	805	70	31	31	32	33	33	35	36
Personal services	810	72	33	32	33	36	36	36	37
Private households	815	88	10	9	10	10	10	11	11
Business and miscellaneous repair services	820	76	170	162	175	180	191	213	221
Auto repair, services, and garages	825	75	29	28	28	30	31	33	34
Auto repair, services, and garages	830	75	15	13	13	14	14	15	15
Amusement and recreation services	835	78, 79	29	30	34	33	35	37	39
Amusement and recreation services	840	78, 79	16	16	16	17	18	20	20
Health services	845	80	290	304	325	330	341	355	368
Legal services	850	81	80	80	85	84	84	85	86
Educational services	855	82	39	41	42	44	45	46	48
Social services and membership organizations	860	83, 86	29	31	34	35	38	40	42
Social services and membership organizations	865	83, 86	1	1	1	1	2	2	2
Social services and membership organizations	870	83, 86	35	36	36	38	40	41	42
Social services and membership organizations	875	83, 86	125	121	127	130	132	141	145
Miscellaneous professional services	880	84, 87, 89	14	14	15	15	17	18	19
Government and government enterprises	900	995	585	594	607	613	621	626	635
Federal, civilian	910	43, 91, 97	118	120	123	124	125	123	124
Federal, military	920	992	50	50	51	48	45	44	43
State and local	930	92-96	417	425	433	441	451	459	468
State and local	931	92-96	125	128	128	130	134	136	138
State and local	932	92-96	292	297	305	311	317	323	330

Table 4.4-10. Area Source Listing by SCC and Growth Basis

SCC	FILE	CODE
2103001000	SEDS	ACCCB
2103002000	SEDS	BCCCB
2103004000	SEDS	DFCCB
2103005000	SEDS	RFCCB
2103006000	SEDS	NGCCB
2103007000	SEDS	LGCCB
2103008000	BEA	400
2103011000	SEDS	KSCCB
2199004000	SEDS	DFTCB
2199005000	SEDS	RFTCB
2199006000	SEDS	NGTCB
2199007000	SEDS	LGTCB
2199011000	SEDS	KSTCB
2810001000	NG	
2810003000	SEDS	TPOPP
2810005000	BEA	100
2810010000	BEA	100
2810015000	SEDS	TPOPP
2810025000	SEDS	TPOPP
2810030000	SEDS	TPOPP
2810035000	SEDS	TPOPP
2810050000	SEDS	TPOPP
2810060000	SEDS	TPOPP

NOTE(S): * BEA Code is equal to LNUM on previous table.

Table 4.4-11. Emission Estimates Available from AIRS/FS 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).

Table 4.4-12. NO_x and VOC Major Stationary Source Definition

Ozone Nonattainment Status	Major Stationary Source (tons)
Marginal/Moderate	100
Serious	50
Severe	25
Extreme	10
Ozone Transport Region	50

Table 4.4-13. Summary of Revised NO_x Control Efficiencies

Pod ID	Pod Name	Estimated Efficiency	Control
58	Commercial/Institutional - Coal	50	LNB
59	Commercial/Institutional - Oil	50	LNB
60	Commercial/Institutional - Gas	50	LNB

Controls: LNB - Low NO_x Burner

Table 4.4-14. Wildfires

Region	Fuel loading Tons/Acre Burned
Rocky Mountain	37
Pacific	19
North Central	11
South	9
East	11

Pollutant	Emission Factor lbs/ton
TSP	17
SO_2	0.15
NO_x	4
VOC	19.2
CO	140
PM-10	13

States Comprising Regions

South	East	Rocky Mountain	North Central	Pacific
Alabama	Connecticut	Arizona	Illinois	Alaska
Arkansas	Delaware	Colorado	Indiana	California
Florida	Maine	Idaho	Iowa	Guam
Georgia	Maryland	Kansas	Michigan	Hawaii
Kentucky	Massachusetts	Montana	Minnesota	Oregon
Louisiana	New Hampshire	Nebraska	Missouri	Washington
Mississippi	New Jersey	Nevada	Ohio	
North Carolina	New York	New Mexico	Wisconsin	
Oklahoma	Pennsylvania	North Dakota		
South Carolina	Rhode Island	South Dakota		
Tennessee	Vermont	Utah		
Texas	West Virginia	Wyoming		
Virginia				

Table 4.4-15. Emission Factors for Residential Wood Combustion by Pollutant

Pollutant	Emission Factor (lbs/ton)	Emission Factor (tons/cord)
CO	230.80	1.342 E-1
NO_x	2.80	1.628 E-3
VOC	43.80	2.547 E-2
SO_2	0.40	2.326 E-4
PM-10[a]	30.60	1.779 E-2
PM-2.5[a]	30.60	1.779 E-2

[a]All PM is considered to be less than 2.5 microns.

Table 4.4-16. PM Control Efficiencies for 1991 through 1996

Year	Control Efficiency (%)
1991	1.4
1992	2.8
1993	4.8
1994	6.8
1995	8.8
1996	10.8

4.5 SOLVENT UTILIZATION

The point and area source categories under the “Solvent Utilization” heading include the following Tier I and Tier II categories:

Tier I Category	Tier II Category
(08) SOLVENT UTILIZATION	All subcategories

Since the publication of the last version of this report,[1] EPA has made major changes to the 1990 emissions. The revised emissions are referred to in this document as the 1990 National Emission Trends (NET) emissions and are for the most part based on State submitted data and used as the base year inventory for the post-1990 emission inventory. Emission estimates for pre-1990 are based mainly on the “old” 1990 emissions which are referred to in this document as the Interim Inventory 1990 emissions. For most source categories, the methodology for the Interim Inventory 1990 emissions is the same as that previously published in the Procedures document.

The 1990 Interim Inventory emissions for these source categories were generated from the point source source portions of the 1985 National Acid Precipitation Assessment Program (NAPAP) Emissions Inventory. The VOC area source emissions were based on a national mass balance as described in section 4.5.1.1. 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 data compiled by the Bureau of Economic Analysis (BEA).[2]

The 1990 NET emissions were revised to incorporate as much state- supplied data as possible. Sources of state data include the OTAG emission inventory (EPA used the 1990 Interim Inventory data inplace of state submitted VOC area source emissions), the GCVTC emission inventory, and AIRS/FS. For most point sources, these emissions were projected from the revised 1990 NET inventory to the years 1991 through 1996 using BEA and SEDS data. States were surveyed to determine whether EPA should project their 1990 non-utility point source emissions or extract them from AIRS/FS. For all states that selected AIRS/FS option, the emissions in the NET inventory reflect their AIRS/FS data for the years 1991 through 1995. Additional controls were added to the projected (or grown) emissions for the year 1996.

This section describes the methods used to estimate both base year 1990 emission inventories and the emission estimates for the years 1985 through 1989 and 1991 through 1996. Point Source emissions for the years 1985-1996 were estimated for the pollutants VOC, CO, NO_x, SO_2, and PM-10. Area source emissions were estimated for only 1985 through 1989 for VOC. Area source emissions for the years 1990 through 1996 were estimated for VOC, NO_x, and CO. Point source emission estimates for PM-2.5 were only estimated for the years 1990 through 1996.

4.5.1 1990 Interim Inventory

Solvent utilization emissions are included as both point and area sources in the Emission Trends inventory. Point source emissions were based on the 1985 NAPAP inventory (see section 4.5.1.2). The basis for the VOC area source component is a material balance on total nationwide solvent consumption.

(There are no area source CO, NO_x, SO_2, and PM emissions in the NET inventory for the years 1985 through 1989. The 1990 through 1996 area source CO and NO_x emissions estimates were not estimated with this methodology.) Total nationwide solvent emissions by end-use category are estimated from national consumption figures with some adjustments to account for air pollution controls and waste management practices. The nationwide emissions are then apportioned to states and counties using census data and information on state and local regulations pertaining to solvent emissions. County- and category-level point source emissions are then subtracted from the emission totals, and the remaining emissions are included in the area source solvent inventory. Section 4.5.1.1 describes the development of national solvent emissions and apportionment to states and counties.

4.5.1.1 Area Source Emissions, VOC Only

Volatile organic compound emissions are estimated for area sources by first estimating national total emissions that are distributed to county and end user, described in this section, and then subtracting the point source emissions, described in section 4.5.1.2.

4.5.1.1.1 Overall National Emissions Estimates —

The overall national solvents material balance can be summarized as follows:

$$\textit{National solvent emissions (by end-use category)} = \textit{National solvent consumption} - \textit{Solvents destroyed by air pollution controls} - \textit{Solvents conveyed to waste management operations} \quad \text{(Eq. 4.5-1)}$$

Note that this overall national material balance yields total solvent emissions, including both point and area sources.

National solvent usage estimates by end-use category were obtained from three main sources. For paints and coatings, the main source was the U.S. Paint Industry Data Base, prepared by SRI International for the National Paint and Coatings Association.[3] Solvent usage estimates for other categories were obtained from industrial solvent marketing reports.[4,5] The base year for this activity data and for the total solvent emissions is 1989.

The solvent emission methodology is designed to incorporate pollution control and waste management information at the source category level. However, the timeframe for the NET inventory effort was too tight to permit development of category-specific information. The mass balance term for waste management was based on the EPA's data base[6] for TSDFs, which also forms the basis for the TSDF portion of the NET inventory. (See section 4.3.1.5 for details on TSDF emissions.) In essence, the portion of the TSDF inventory that is attributable to solvents is deducted from the current solvents inventory in order to avoid double-counting. The TSDF deduction was apportioned evenly to all industrial categories, and amounts to about 21 percent of total solvent usage in these categories.

Solvent destruction adjustments in the nationwide material balance were based on the same assumptions used for the 1985 National Emissions Data System (NEDS) and the 1985 NAPAP inventory. According to the data in NEDS and 1985 NAPAP inventory, approximately 16 percent of industrial surface coating emissions are assumed to be destroyed in air pollution controls.

Table 4.5-1 lists the elements in the national solvent material balance by emission source category. As discussed above, these elements are: national solvent consumption, solvent destroyed in air pollution controls, solvent sent to waste management operations, and net solvent emissions. Table 4.5-1 also summarizes the major sources of these data.

4.5.1.1.2 Distribution of Solvent Emissions to States and Counties —

The primary tools used to distribute national solvent emissions to states and counties are 1988 census data bases.[7,8,9] For each of the source categories listed in Table 4.5-1, state- and county-level solvent usage is assumed to be proportional to a particular census measure. For consumer end-use categories, solvent usage was distributed based on population. County-level employment data were used for commercial and industrial end-use categories. Census data on the number of farm acres treated with chemical sprays were used to distribute pesticide solvent usage. Table 4.5-2 lists the specific census data used for each emission category.

State and local regulations covering solvent emissions were also incorporated in the spatial distribution step for the solvent inventories. For an industrial or commercial end-use category, the overall spatial distribution calculation can be summarized as follows:

$$\text{County emissions (by end-use category)} = \text{National emissions} \times \frac{\text{County employment}}{\text{National employment}} \times \frac{\text{Estimated control efficiency for county}}{\text{Nationwide average control efficiency for category}} \qquad \text{(Eq. 4.5-2)}$$

Quantitative information on state- and county-level control efficiency, rule effectiveness, and rule penetration was obtained primarily from surveys carried out under EPA's ROM modeling effort.[10] For states outside the ROM domain, these parameters were estimated using Bureau of National Affairs regulation summaries.

4.5.1.1.3 Deduction of Point Source Emissions —

The area source inventory is produced by deducting point source emissions from the county-level category emission totals produced in Equation 4.5-3. The calculation is performed as follows:

$$\text{County-level area source emissions (by end-use category)} = \text{Total county-level emissions (equation 2)} - \text{County-level point source emissions} \qquad \text{(Eq. 4.5-3)}$$

The AIRS/AMS solvent categories were first matched to the corresponding point source SCCs. Using the 1990 Interim Inventory, point source totals by county for each corresponding AMS SCC were calculated. These emissions were then subtracted from the total solvent emissions (the 1989 total solvent emissions were projected to 1990 as described below) to yield the area source emissions. In the cases of negative emissions (higher point source emissions than total estimated solvent emissions), the 1985 NAPAP methodology[11] was followed — area source emissions were set to zero.

Then the non-zero county values were readjusted so that the sum of all county area source emissions equal the difference between the total national emissions and the national point source emissions; otherwise, area source emissions are underestimated.

$$\sum \begin{matrix} \text{All County} \\ \text{Area Source} \\ \text{Emissions} \end{matrix} = \begin{matrix} \text{National} \\ \text{Total} \\ \text{Emissions} \end{matrix} - \begin{matrix} \text{National} \\ \text{Point Source} \\ \text{Emissions} \end{matrix} \qquad \text{(Eq. 4.5-4)}$$

4.5.1.2 Point Sources, All Pollutants

The 1985 NAPAP inventory estimates for the point sources have been projected to the year 1990 based on the growth in BEA historic earnings for the appropriate state and industry,[2] as identified by the two-digit SIC code. To remove the effects of inflation, the earnings data were converted to 1982 constant dollars using the implicit price deflator for PCE.[12] State and SIC-level growth factors were calculated as the ratio of the 1990 earnings data to the 1985 earnings data. Additional information on point source growth indicators is presented in section 4.5.1.2.2.

When creating the 1990 emission inventory, changes were made to emission factors, control efficiencies, and emissions from the 1985 inventory for all sources. The PM-10 control efficiencies were obtained from the *PM-10 Calculator*.[13] In addition, rule effectiveness which was not applied in the 1985 NAPAP inventory, was applied to the 1990 emissions estimated for the 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, SO_2, and VOC 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 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 inventory. The 1990 uncontrolled TSP emissions were estimated in the same manner as the other pollutants. The 1990 uncontrolled PM-10 estimates were calculated from these TSP emissions by applying SCC-specific uncontrolled particle size distribution factors.[14] The controlled PM-10 emissions were estimated in the same manner as the other pollutants.

4.5.1.2.1 Control Efficiency Revisions —
In the 1985 NAPAP point source estimates, control efficiencies for VOC, NO_x, CO, and SO_2 sources in Texas were judged to be too high for their process/control device combination. These high control efficiencies occurred because Texas did not ask for control efficiency information, and simply applied the maximum efficiency for the reported control device. High control efficiencies lead to high future growth in modeling scenarios based on uncontrolled emissions (which are based on the control efficiency and reported actual emissions). High control efficiencies also lead to extreme increases in emissions when rule effectiveness is incorporated.

Revised VOC control efficiencies were developed for Texas for the ERCAM-VOC.[15] For this analysis, revised efficiencies were also developed by SCC and control device combination for NO_x, SO_2, and CO using engineering judgement. These revised control efficiencies were applied to sources in Texas. A large number of point sources outside of Texas had VOC and CO control efficiencies that were also judged to be too high. The VOC and CO control efficiencies used for Texas were also applied to these sources.

4.5.1.2.2 Rule Effectiveness Assumptions —

Controlled emissions for each inventory year were recalculated, assuming that reported VOC, NO_x, and CO controls were 80 percent effective. Sulfur dioxide and PM-10 controls were assumed to be 100 percent effective.

4.5.1.2.3 Emissions Calculations —

A three-step process was used to calculate emissions incorporating rule effectiveness. First, base year controlled emissions are projected to the inventory year using the following equation (Equation 4.5-5):

$$CE_i = CE_{BY} + (CE_{BY} \times EG_i) \qquad \text{(Eq. 4.5-5)}$$

where:
- CE_i = controlled emissions for inventory year i
- CE_{BY} = controlled emissions for base year
- EG_i = earnings growth for inventory year i

Earnings growth is calculated using Equation 4.5-6.

$$EG_i = 1 - \frac{DAT_i}{DAT_{BY}} \qquad \text{(Eq. 4.5-6)}$$

where:
- EG_i = earnings growth for year i
- DAT_i = earnings data for inventory year i
- DAT_{BY} = earnings data in the base year

Second, uncontrolled emissions in the inventory year are back-calculated from the controlled emissions based on the control efficiency using Equation 4.5-7:

$$UE_i = \frac{CE_i}{\left(1 - \frac{CEFF}{100}\right)} \qquad \text{(Eq. 4.5-7)}$$

where:
- UE_i = uncontrolled emissions for inventory year i
- CE_i = controlled emissions for inventory year i
- CEFF = control efficiency (percent)

Third, controlled emissions are recalculated incorporating rule effectiveness using the following equation (Equation 4.5-8):

$$CER_i = UC_i \times \left(1 - \left(\frac{REFF}{100}\right) \times \left(\frac{CEFF}{100}\right)\right) \qquad \text{(Eq. 4.5-8)}$$

where: CER_i = controlled emissions incorporating rule effectiveness
UC_i = uncontrolled emissions
REFF = rule effectiveness (percent)
CEFF = control efficiency (percent)

4.5.2 Emissions, 1985 to 1989

As explained in section 4.5.1.2.3, the 1990 controlled point source emissions were projected from the 1985 NAPAP inventory using Equations 4.5-4 through 4.5-7. For all other years (1985 to 1989), the emissions were projected from the 1990 emissions using Equations 4.5-4 and 4.5-7. Therefore, the 1985 emissions estimated by this method do not match the 1985 NAPAP inventory due to the changes made in control efficiencies and emission factors and the addition of rule effectiveness when creating the 1990 base year inventory. Area source emissions are detailed in section 4.5.2.1.

4.5.2.1 Area Sources

The total solvent inventory was based on 1989 activity- level data. (Spatial allocations for the solvent area source inventory were based on the 1988 census, which provides the most recent data available at the county level.) Projections to other years (1985 to 1990) are based on state-level earnings data for major industrial categories, which generally correspond to two-digit SICs. The following algorithm is used for the emission projection:

$$\textit{Projection year emissions (by county and end-use category)} = \textit{Base year emissions} \times \frac{\textit{Projection year earnings (by state and 2-digit SIC)}}{\textit{Base year earnings}} \qquad \text{(Eq. 4.5-9)}$$

In this equation, the projection year represents the appropriate calendar year for the Emission Trends inventory (ranging from 1985 to 1990). The total solvent inventory was first projected to 1990 to complete the point source deduction described above. After deducting the point source solvents, this 1990 area source solvent data base was then scaled-back/projected to the other inventory years.

The county/source category emissions predicted using changes in BEA earnings data were then scaled according to expected changes in national solvent emissions. Annual changes in national solvent usage (by end-use category) were taken from the solvent marketing reports.[4,5] All county-level emissions within an end-use category were scaled by a factor so that total national emissions would be equivalent to the national solvent emissions reported in the literature.

4.5.2.2 Point Sources

The changes in the point source emissions were equated with the changes in historic earnings by state and industry. Emissions from each point source in the 1985 NAPAP inventory were projected to the years 1985 through 1990 based on the growth in earnings by industry (two-digit SIC code). Historical annual state and industrial earnings data from BEA's Table SA-5 (Reference 2) were used to represent growth in earnings from 1985 through 1990.

The 1985 through 1990 earnings data in Table SA-5 are expressed in nominal dollars. To estimate growth, these values were converted to constant dollars to remove the effects of inflation. Earnings data for each year were converted to 1982 constant dollars using the implicit price deflator for PCE.[12] The PCE deflators used to convert each year's earnings data to 1982 dollars are:

Year	1982 PCE Deflator
1985	111.6
1987	114.3
1988	124.2
1989	129.6
1990	136.4

Several BEA categories did not contain a complete time series of data for the years 1985 through 1990. Because the SA-5 data must contain 1985 earnings and earnings for each inventory year (1985 through 1990) to be useful for estimating growth, a log linear regression equation was used where possible to fill in missing data elements. This regression procedure was performed on all categories that were missing at least one data point and which contained at least three data points in the time series.

Each record in the point source inventory was matched to the BEA earnings data based on the state and the two-digit SIC. Table 4.5-3 shows the BEA earnings category used to project growth for each of the two-digit SICs found in the 1985 NAPAP inventory. No growth in emissions was assumed for all point sources for which the matching BEA earnings data were not complete. Table 4.5-3 also shows the national average growth and earnings by industry from Table SA-5.

4.5.3 1990 National Emission Trends

The 1990 National Emission Trends is based primarily on state data, with the 1990 interim 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. Seven pollutants (CO, NO_x, VOC, SO_2, PM-10, PM-2.5, and NH_3) were estimated in 1990. The state data were extracted from three sources, the OTAG inventory, the GCVTC inventory, and AIRS/FS. Sections 4.5.3.1, 4.5.3.2, and 4.5.3.3 give brief descriptions of these efforts. Section 4.5.3.4 describes the efforts necessary to supplement the inventory gaps that are either temporal, spacial, or pollutant. 1990 area source VOC emissions are detailed in section 4.5.1.

Since EPA did not receive documentation on how these inventories were developed, this section only describes the effort to collect the data and any modifications or additions made to the data.

4.5.3.1 OTAG

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 ozone pollutants (VOC, NO_x, and CO). This section gives a background of the OTAG emission inventory and the data collection process.

4.5.3.1.1 Inventory Components —

The OTAG inventory contains data for all states that are partially or fully in the SUPROXA modeling domain. The SUPROXA domain was developed in the late 1980s as part of the EPA regional oxidant modeling (ROM) applications. EPA had initially used three smaller regional domains (Northeast, Midwest, and Southeast) for ozone modeling, but wanted to model the full effects of transport in the eastern United States without having to deal with estimating boundary conditions along relatively high emission areas. Therefore, these three domains were combined and expanded to form the Super Domain. The western extent of the domain was designed to allow for coverage of the largest urban areas in the eastern United States without extending too far west to encounter terrain difficulties associated with the Rocky Mountains. The Northern boundary was designed to include the major urban areas of eastern Canada. The southern boundary was designed to include as much of the United States as possible, but was limited to latitude 26°N, due to computational limitations of the photochemical models. (Emission estimates for Canada were not extracted from OTAG for inclusion in the NET inventory.)

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 ozone precursor inventory. It includes emission estimates of VOC, NO_x, and CO 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 ozone precursor data. No quality assurance (QA) was performed on the SO_2 and PM-10 emission estimates for the OTAG inventory effort.

Since the underlying purpose of the OTAG inventory is to support photochemical modeling for ozone, it is primarily an average summer day inventory. Emission estimates that were submitted as annual emission estimates were converted to average summer day estimates using operating schedule data and default temporal profiles and vice versa.

The OTAG inventory is made up of two major components: (1) the point source component, which includes segment/pollutant level emission estimates and other relevant data (e.g., stack parameters, geographic coordinates, and base year control information) for all stationary point sources in the domain; (2) the area source component, which includes county level emission estimates for all stationary area sources. The NET inventory extracted all point sources except utility emissions.

4.5.3.1.2 Interim Emissions Inventory (OTAG Default) —

The primary data sources for the OTAG inventory were the individual states. Where states were unable to provide data, the 1990 Interim Inventory [16] was used for default inventory data. A more detailed description of the 1990 Interim Inventory is presented in section 4.5.1.

4.5.3.1.3 State Data Collection Prodedures —

Since the completion of the Interim Inventory in 1992, many states had completed 1990 inventories for ozone nonattainment areas as required for preparing SIPs. In addition to these SIP inventories, many states had developed more comprehensive 1990 emission estimates covering their entire state. Since these state inventories were both more recent and more comprehensive than the Interim Inventory, a new inventory was developed based on state inventory data (where available) in an effort to develop the most accurate emission inventory to use in the OTAG modeling.

On May 5, 1995, a letter from John Seitz (Director of EPA's Office of Air Quality Planning and Standards [OAQPS]) and Mary Gade (Vice President of ECOS) to State Air Directors, states were requested to supply available emission inventory data for incorporation into the OTAG inventory.[17] Specifically, states were requested to supply all available point and area source emissions data for VOC, NO_x, CO, SO_2, and PM-10, with the primary focus on emissions of ozone precursors. Some emission inventory data were received from 36 of the 38 states in the OTAG domain. To minimize the burden to the states, there was no specified format for submitting State data. The majority of the state data was submitted in one of three formats:

1) an Emissions Preprocessor System Version 2.0 (EPS2.0) Workfile
2) an ad hoc report from AIRS/FS
3) data files extracted from a state emission inventory data base

The origin of data submitted by each state is described in section 4.5.3.1.4.1 for point sources and 4.5.3.1.4.2 for area sources.

4.5.3.1.4. 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 two-digit SIC code.[2] 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 using Equation 4.5-10.

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} * SUMTHRU * 1/(13 * DPW) \qquad \text{(Eq. 4.5-10)}$$

where: $EMISSIONS_{ASD}$ = average summer day emissions
$EMISSIONS_{ANNUAL}$ = annual emissions
SUMTHRU = summer throughput percentage
DPW = days per week in operation

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. This computer file contains default seasonal and daily temporal profiles by SCC. Equation 4.5-11 was used.

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} / (SUMFAC_{SCC} * WDFAC_{SCC}) \quad \text{(Eq. 4.5-11)}$$

where: $EMISSIONS_{ASD}$ = average summer day emissions
$EMISSIONS_{ANNUAL}$ = annual emissions
$SUMFAC_{SCC}$ = default summer season temporal factor for SCC
$WDFAC_{SCC}$ = default summer weekday temporal factor for 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 and were calculated using Equation 4.5-12.

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} / 365 \quad \text{(eq. 4.5-12)}$$

where: $EMISSIONS_{ASD}$ = average summer day emissions
$EMISSIONS_{ANNUAL}$ = annual emissions

4.5.3.1.4.1 ***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 4.5-4 provides a brief description of the point source data supplied by each state.

4.5.3.1.4.2 ***Area.*** For area sources, 17 of the 38 states in the OTAG domain supplied 1990 emission estimates covering the entire state, and an additional nine states supplied 1990 emission estimates covering part of their state (partial coverage was mostly in ozone nonattainment areas). 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 4.5-5 provides a brief description of the area source data supplied by each state.

<u>4.5.3.1.4.5</u> ***<u>Rule Effectiveness</u>.*** 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.

The use of rule effectiveness in estimating emissions can result in emission estimates that are much higher than estimates for the same source calculated without using rule effectiveness, especially for sources with high control efficiencies (95 percent or above). Because of this problem, there was concern that the OTAG emission estimates for states that used rule effectiveness would be biased to larger estimates relative to states that did not include rule effectiveness in their computations.

To test if this bias existed, county-level maps of point source emissions were developed for the OTAG domain. If this bias did exist, one would expect to see sharp differences at state borders between states using rule effectiveness and states not using rule effectiveness. Sharp state boundaries were not evident in any of the maps created. Based on this analysis, it was determined that impact of rule effectiveness inconsistencies was not causing large biases in the inventory.

4.5.3.2 Grand Canyon Visibility Transport Commission Inventory

The 1990 GCVTC inventory includes detailed emissions data for 11 states: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.[18] 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/FS for VOC, NO_x, and SO_2 point source data for the other nine states, the 1990 Interim Inventory for area source data for the other nine states, and the 1985 NAPAP inventory for NH_3 and TSP data. In addition to these existing data, the GCVTC inventory includes newly developed emission estimates for forest wildfires and prescribed burning.

After a detailed analysis of the GCVTC inventory, it was determined that the following portions of the GCVTC inventory would be incorporated into the 1990 NET inventory:

- complete point and area source data for California
- complete point and area source data for Oregon
- forest wildfire data for the entire11-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 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.

Non-utility point source emission estimates in the GCVTC inventory from states other than California and Oregon came from AIRS/FS. Corrections were made to this inventory to the VOC and PM emissions. The organic emissions reported in GCVTC inventory for California are total organics (TOG). These emissions were converted to VOC using the profiles from EPA's SPECIATE[19] data base. Since the PM emissions in the GCVTC were reported as both TSP and PM-2.5, EPA estimated PM-10 from the TSP in a similar manner as described in section 4.5.1.2.

4.5.3.3 AIRS/FS

SO_2 and PM-10 (or PM-10 estimated from TSP) sources of greater than 250 tons per year as reported to AIRS/FS that were not included in either the OTAG or GCVTC inventories were appended to the NET inventory. The data were extracted from AIRS/FS using the data criteria set listed in table 4.5-6. The data elements extracted are also listed in Table 4.5-6. The data were extracted in late November 1996. It is important to note that *estimated* emissions were extracted.

4.5.3.4 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, PM-10, PM-2.5, and NH_3, as well as annual or ozone season daily (depending on the inventory) emission estimates for all pollutants. This section describes the steps taken to fill in the gaps from the other inventories.

4.5.3.4.1 SO_2 and PM Emissions —
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, OTAG data for these pollutants were not available. For point sources, data for plants over 250 tons per year for SO_2 and PM-10 were added from AIRS/FS. The AIRS/FS data were also 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 to the inventory. For OTAG plants where there were no matching data in AIRS/FS 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 unmatched point and area sources involved using uncontrolled emission factor ratios to calculate uncontrolled emissions. This method used SO_2 or PM-10 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 VOC, NO_x, and CO 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 Inventory 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 FIPS code, along with the plant and point IDs.

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/FS for 1990 and using the emission factor ratios resulted in unrealistically high PM-10 emissions.

There were no PM-2.5 data in either OTAG or AIRS/FS. Therefore, the point and area PM-2.5 emission estimates were developed based on the PM-10 estimates using source-specific uncontrolled particle size distributions and particle size specific control efficiencies for sources with PM-10 controls. To estimate PM-2.5, uncontrolled PM-10 was first estimated by removing the impact of any PM-10 controls on sources in the inventory. Next, the uncontrolled PM-2.5 was calculated by multiplying the uncontrolled PM-10 emission estimates by the ratio of the PM-2.5 particle size multiplier to the PM-10 particle size multiplier. (These particle size multipliers represent the percentage to total particulates below the specified size.) Finally, controls were reapplied to sources with PM-10 controls by multiplying the uncontrolled PM-2.5 by source/control device particle size specific control efficiencies.

4.5.3.4.5 Other Modifications —
Additional 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.
- Checked and fixed sources with PM-2.5 emissions which were greater than their PM-10 emissions.
- Checked and fixed sources with PM-10 emissions greater than zero and PM-2.5 emissions equal to zero.

4.5.4 Emissions, 1991 to 1994

The 1991 through 1994 area VOC source emissions were grown using the Economic Growth Analysis System (E-GAS). The point source and NO_x and CO area source inventory was also grown for those states that did not want their AIRS/FS data used. (The list of states are detailed in the AIRS/FS subsection, 4.5.4.2.) For those states requesting that EPA extract their data from AIRS/FS, 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/FS until July 1997.

4.5.4.1 Grown Estimates

The 1991 through 1994 point and area source emissions were grown using the 1990 NET inventory as the basis. The algorithm for determining the estimates is detailed in section 4.5.1.2.3. The 1990 through 1996 SEDS[20] and BEA data are presented in Tables 4.5-7 and 4.5-8. The 1996 BEA and SEDS data were determined based on linear interpretation 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. Table 4.5-9 lists the SCC and the source for growth.

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 PCE. The PCE deflators used to convert each year's earnings data to 1992 dollars are:

Year	1992 PCE Deflator
1990	93.6
1991	97.3
1992	100.0
1993	102.6
1994	104.9
1995	107.6
1996	109.7

The 1991through 1994 emissions for VOC area source emissions were estimated by applying growth factors to the 1990 emissions using a modified version of Equation 4.5-13. The growth factors were obtained from the prereleased E-GAS, version 2.0.[21] The E-GAS generates growth factors at the SCC-level for counties representative of all counties within each ozone nonattainment area classified as serious and above and for counties representative of all counties within both the attainment portions and the marginal and moderate nonattainment areas within each state. The appropriate growth factors were applied by county and SCC to the 1990 emissions as shown by Equation 4.5-13.

$$Emissions_{(county,SCC,year)} = Growth_{(county,SCC,year)} \times Emissions_{(county,SCC,1990)} \qquad \text{(Eq. 4.5-13)}$$

There are approximately 150 representative counties in E-GAS and 2000 SCCs present in the base year inventory. This yields a matrix of 300,000 growth factors generated to determine a single year's inventory. To list all combinations would be inappropriate.

4.5.4.2 AIRS/FS

Several states responded to EPA's survey and requested that their 1991 through 1995 estimates reflect their emissions as reported in AIRS/FS. The list of these states, along with the years available in AIRS/FS is given in Table 4.5-10. As described in section 4.5.3.3, default estimated annual and ozone season daily emissions (where available) were extracted from AIRS/FS. Some changes were made to these AIRS/FS 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/FS and replaced the previously high estimates. The changes made to select state and/or plant AIRS/FS 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 4.5-10, 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 two years worth of emissions at the plant level. If only one year of emissions data were 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.

As described in section 4.5.3.4.1, many 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 PM-10 emissions are then converted to PM-2.5 in the same manner as described in section 4.5.1.4. The State of South Carolina provided its own conversion factor for estimating PM-10 from TSP.[22]

For all sources that did not report ozone season daily emissions, these emissions were estimated using the algorithm described in section 4.5.3.1.4 and equations 4.5-10 through 4.5-12.

4.5.5 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/FS for 1995, estimated using AIRS/FS data for the years 1990 through 1994, projected using the 1990 NET inventory or for VOC area sources projected using E-GAS factors and the 1990 Interim Inventory. The method used depended on states' responses to a survey conducted by EPA early in 1997. A description of the AIRS/FS methodology is described in section 4.5.4. The following two subsections describe the projected emissions.

4.5.5.1 Grown Estimate

The 1995 point and CO and NO_x area source emissions were grown using the 1990 NET inventory as the basis. The algorithm for determining the estimates is detailed in section 4.5.1.2.3 and equations 4.5-5 through 4.5-8. The 1990 through 1996 SEDS and BEA data are presented in Tables 4.5-7 and 4.5-8.

4.5.5.2 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 calculated 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.

4.5.6 1996 Emissions

The 1996 emission estimates were derived in a similar manner as the 1995 emissions. For the point sources, the 1995 AIRS/FS emissions and 1995 emissions grown from 1990 emissions were merged. (This section also applies to the VOC area source emissions.) The following three subsections describes the projected 1996 emissions.

4.5.6.1 Grown Estimates

The 1996 point and area source emissions were grown using the 1995 NET inventory as the basis. The algorithm for determining the estimates is detailed in section 4.5.1.4 and is described by the equation below. The 1990 through 1996 SEDS and BEA data are presented in Tables 4.5-7 and 4.5-8. The 1996 BEA and SEDS data were determined using linear interpretation of the 1988 through 1995 data. Rule effectiveness was updated to 100 percent as described in section 4.5.5.3 for the AIRS/FS sources that reported rule effectiveness of less than 100 percent in 1995.

Equation 4.5-14 describes the calculation used to estimate the 1996 emissions.

$$CER_{1996} = UC_{1995} \times \frac{GS_{1996}}{GS_{1995}} \times \left(1 - \left(\frac{REFF}{100}\right) \times \left(\frac{CEFF}{100}\right) \times \left(\frac{RP}{100}\right)\right) \qquad \text{(Eq. 4.5-14)}$$

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 detailed in the following subsections.

4.5.6.2 1996 VOC Controls

This section discusses VOC stationary source controls (except those for electric utilities). These controls were developed to represent the measures mandated by the CAAA and in place in 1996. Title I (specifically the ozone nonattainment provisions) affects VOC stationary sources. Title III hazardous air pollutant regulations will also affect VOC source categories. The discussion for each source category-specific control measure includes the regulatory authority, CAAA provisions relating to the control measure, and relevant EPA guidance.

Table 4.5-11 list the point source controls by pod. (A pod is a group of SCCs with similar emissions and process characteristics for which common control measures, i.e., cost and emission reductions, can be applied. It is used for control measure application/costing purposes.) Table 4.5-12 lists the POD to SCC match. Table 4.5-13 lists the area source control efficiencies, and rule effectiveness and rule penetration if not 100 percent. A description of the controls is detailed below.

EPA has issued three groups of CTG documents to be implemented in ozone nonattainment areas. These controls should already be included in areas designated as nonattainment prior to 1990. These controls, however, must also be implemented in newly designated nonattainment areas and over the entire OTR. Not all CTGs are included in Table 4.5-13 because of the difficulty, in some cases, of matching the document to the appropriate sources within the inventory. It is assumed that all existing CTGs are implemented by 1996.

The source categories affected by Title III maximum achievable control technology (MACT) standards were identified by using EPA's timetable for regulation development under Title III.[23] Applicability of the anticipated regulations in various projection years was also derived from this draft timetable.

Control technology efficiencies were estimated for the expected MACT standards based on available information. The information used depended on the status of specific standards in their development timetable. For standards that have already been proposed or promulgated, efficiencies were estimated using information presented in preambles to the appropriate regulations.

Rule effectiveness was estimated at 100 percent for all Title III standards, in accordance with current EPA guidelines for rule effectiveness. Rule penetration is not applicable for any of the MACT categories, since it is included in the average "control technology efficiency" parameter.

4.5.7 References

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Table 4.5-1. National Material Balance for Solvent Emissions

Category	Description	Solvent Usage (1,000 tpy)	Percent Destroyed by Air Pollution Controls[1]	Percent Sent to TSDFs[2]	Estimated Emissions (1,000 tpy)	Source
Surface Coating						
2401001	Architectural	503	0	0	503	SRI International/
2401005	Auto refinishing	133	0	0	133	National Paint and
2401008	Traffic markings	106	0	0	106	Coatings Institute
2401015	Flat wood coating	5	16	21	3	
2401020	Wood furniture	221	16	21	139	
2401025	Metal furniture	70	16	21	44	
2401030	Paper coating	33	16	21	21	
2401040	Can coating	156	16	21	99	
2401045	Coil coating	58	16	21	37	
2401055	Electrical insulation	48	16	21	30	
2401060	Appliances	34	16	21	21	
2401065	Machinery	130	16	21	82	
2401070	Motor vehicles (new)	134	16	21	85	
2401075	Aircraft coating	11	16	21	7	
2401080	Marine paints	29	16	21	18	
2401085	Rail equip. coating	6	16	21	4	
2401090	Misc. manufacturing	210	16	21	132	
2401100	Industrial maintenance	99	0	21	78	
2401200	Aerosols, spec. purpose	173	0	21	137	
Vapor Degreasing (Conveyorized and Open-Top)						
2415105	Furniture	9	0	21	7	Total category
2415110	Metallurgical proc.	29	0	21	23	number from Frost
2415120	Fabricated metals	97	0	21	76	& Sullivan. Industry
2415125	Industrial machinery	100	0	21	79	breakdowns from
2415130	Electrical equipment	98	0	21	77	EPA BDAT Report
2415135	Transportation equip.	36	0	21	28	for spent solvents.
2415140	Instrument mfg.	48	0	21	38	
2415145	Misc. manufacturing	17	0	21	13	
Cold Cleaner Degreasing						
2415305	Furniture	12	0	21	9	Total category
2415310	Metallurgical proc.	8	0	21	7	number from Frost
2415320	Fabricated metals	38	0	21	30	& Sullivan. Industry
2415325	Industrial machinery	52	0	21	41	breakdowns from
2415330	Electrical equipment	16	0	21	12	EPA BDAT Report
2415335	Transportation equip.	12	0	21	9	for spent solvents.
2415340	Instruments	8	0	21	6	
2415345	Misc. manufacturing	19	0	21	15	
2415355	Automobile dealers	191	0	21	151	
2415360	Automobile repair	70	0	21	55	
2415365	Other	5	0	21	4	
Other Categories						
2420010	Drycleaning (perc.)	135	0	21	107	Frost & Sullivan
2420010	Drycleaning (petroleum)	134	0	21	105	Frost & Sullivan
2420020	Coin-op drycleaning	2	0	21	1	Frost & Sullivan
2425000	Graphic arts	276	16	21	174	Frost & Sullivan
2430000	Rubber/plastics	48	16	21	30	Frost & Sullivan
2440020	Adhesives - industrial	460	0	21	363	Freedonia Group
2461021	Cutback asphalt	200	0	0	200	Asphalt Institute
2461800	Pesticides - farm	260	0	0	260	Freedonia Group
2465100	Personal products	228	0	0	228	Frost & Sullivan
2465200	Household products	186	0	0	186	Frost & Sullivan
2465400	Automotive products	650	0	0	650	Freedonia Group
2465600	Adhesives - Comml.	350	0	0	350	Frost & Sullivan

[1]Based on the 1985 NEDS methodology. Does not include solvents that are captured and recycled.
[2]Calculated based on the TSDF sector of the 1985 NAPAP Inventory.

Table 4.5-2. Data Bases Used for County Allocation

AMS Category	Description	Allocation Data (from the Census)
Surface Coating		
2401001	Architectural	Population
2401005	Auto refinishing	Employment in SIC 7532
2401008	Traffic markings	Population
2401015	Flat wood coating	Employment in SIC 2430
2401020	Wood furniture	Employment in SIC 25
2401025	Metal furniture	Employment in SIC 25
2401030	Paper coating	Employment in SIC 26
2401040	Can coating	Employment in SIC 341
2401045	Coil coating	Employment in SIC 344
2401055	Electrical insulation	Employment in SIC 36
2401060	Appliances	Employment in SIC 363
2401065	Machinery	Employment in SIC 35
2401070	Motor vehicles (new)	Employment in SIC 371
2401075	Aircraft coating	Employment in SIC 372
2401080	Marine paints	Employment in SIC 373
2401085	Rail equip. coating	Employment in SIC 374
2401090	Misc. manufacturing	Employment in SIC 20-39
2401100	Industrial maintenance	Employment in SIC 20-39
2401200	Aerosols, spec. purpose	Population
Vapor Degreasing (Conveyorized and Open-Top)		
2415105	Furniture	Employment in SIC 25
2415110	Metallurgical proc.	Employment in SIC 33
2415120	Fabricated metals	Employment in SIC 34
2415125	Industrial machinery	Employment in SIC 35
2415130	Electrical equipment	Employment in SIC 36
2415135	Transportation equip.	Employment in SIC 37
2415140	Instrument mfg.	Employment in SIC 38
2415145	Misc. manufacturing	Employment in SIC 39
Cold Cleaner Degreasing		
2415305	Furniture	Employment in SIC 25
2415310	Metallurgical proc.	Employment in SIC 33
2415320	Fabricated metals	Employment in SIC 34
2415325	Industrial machinery	Employment in SIC 35
2415330	Electrical equipment	Employment in SIC 36
2415335	Transportation equip.	Employment in SIC 37
2415340	Instruments	Employment in SIC 38
2415345	Misc. manufacturing	Employment in SIC 39
2415355	Automobile dealers	Employment in SIC 55
2415360	Automobile repair	Employment in SIC 75
2415365	Other	Employment in SIC 22
Other Categories		
2420010	Drycleaning (perc.)	Employment in SIC 7216
2420010	Drycleaning (petroleum)	Employment in SIC 7216
2420020	Coin-op drycleaning	Employment in SIC 7215
2425000	Graphic arts	Employment in SIC 27
2430000	Rubber/plastics	Employment in SIC 30
2440020	Adhesives - industrial	Employment in SIC 20-39
2461021	Cutback asphalt	Population
2461800	Pesticides - farm	Farm acres treated with sprays
2465100	Personal products	Population
2465200	Household products	Population
2465400	Automotive products	Population
2465600	Adhesives - Comml.	Population

Table 4.5-3. Bureau of Economic Analysis's SA-5 National Changes in Earnings by Industry

Industry	SIC	Percent Growth from: 1985 to 1987	1987 to 1988	1988 to 1989	1989 to 1990
Farm	01, 02	14.67	-2.73	14.58	-3.11
Agricultural services, forestry, fisheries, and other	07, 08, 09	23.58	5.43	1.01	2.48
Coal mining	11	-17.46	-6.37	-4.16	4.53
Metal mining	10	-3.03	18.01	8.94	4.56
Nonmetallic minerals, except fuels	14	2.33	3.74	-2.79	-0.45
Construction	15	7.27	4.81	-1.36	-3.80
Food and kindred products	20	1.67	1.34	-1.20	-0.24
Textile mill products	22	8.50	-0.64	-1.39	-4.97
Apparel and other textile products	23	-1.72	1.25	-1.62	-4.22
Paper and allied products	26	2.62	0.94	-0.14	-0.39
Printing and publishing	27	7.44	5.67	-0.81	0.43
Chemicals and allied products	28	1.75	6.94	0.32	1.61
Petroleum and coal products	29	-10.82	-3.22	-3.02	1.06
Tobacco manufactures	21	-1.97	2.43	-2.43	-5.01
Rubber and miscellaneous plastic products	30	5.27	5.51	0.68	-0.14
Leather and leather products	31	-9.39	-1.64	-3.58	-2.55
Lumber and wood products	24	10.03	5.15	-3.54	-3.71
Furniture and fixtures	25	6.82	2.35	-1.46	-2.98
Primary metal industries	33	-9.09	5.32	-0.34	-3.03
Fabricated metal products	34	-4.52	2.55	-0.86	-1.91
Machinery, except electrical	35	-5.72	6.02	-0.32	-1.92
Electric and electronic equipment	36	-3.17	-18.01	-1.91	-3.22
Transportation equipment, excluding motor vehicles	37	8.44	-1.57	0.55	-1.07
Motor vehicles and equipment	371	-6.45	2.20	-2.96	-5.43
Stone, clay, and glass products	32	-0.23	-1.61	-1.96	-3.19
Instruments and related products	38	-0.04	60.65	-0.82	-2.91
Miscellaneous manufacturing industries	39	1.84	6.92	-2.21	-2.54
Railroad transportation	40	-14.13	-2.53	-3.83	-6.03
Trucking and warehousing	42	5.63	3.26	-0.20	0.99
Water transportation	44	-8.92	0.07	-1.02	2.83
Local and interurban passenger transit	41	13.45	0.51	2.14	1.44
Transportation by air	45	12.01	4.63	4.94	4.36
Pipelines, except natural gas	46	-5.21	3.67	-4.93	3.53
Transportation services	47	15.92	8.52	4.60	4.97
Communication	48	1.94	0.68	-2.81	2.07
Electric, gas, and sanitary services	49	0.07	3.05	0.63	0.39

Table 4.5-4. 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
South Carolina	AIRS-AFS - Ad hoc retrievals	Annual	1991	Average Summer Day estimated using default temporal factors.

Table 4.5-4 (continued)

State	Data Source/Format	Temporal Resolution	Year of Data	Adjustments to Data
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 4.5-5. 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 Nonroad 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	Nonroad emissions submitted were county totals. Nonroad 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	Nonroad emissions submitted were county totals. Nonroad 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 nonroad data submitted. Nonroad 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 4.5-6. Ad Hoc Report

Critera		Plant Output		Point Output		Stack Output		Segment Output General		Segment Output Pollutant	
Regn	GT 0	YINV	YEAR OF INVENTORY	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE
PLL4	CE VOC	STTE	STATE FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE
PLL4	CE CO	CNTY	COUNTY FIPS CODE	PNED	NEDS POINT ID	PNED	NEDS POINT ID	PNED	NEDS POINT ID	PNED	NEDS POINT ID
PLL4	CE SO_2	CYCD	CITY CODE	PNUM	POINT NUMBER	STNB	STACK NUMBER	STNB	STACK NUMBER	STNB	STACK NUMBER
PLL4	CE NO_2	ZIPC	ZIP CODE	CAPC	DESIGN CAPACITY	LAT2	LATITUDE STACK	PNUM	POINT NUMBER	PNUM	POINT NUMBER
PLL4	CE PM-10	PNED	NEDS POINT ID	CAPU	DESIGN CAPACITY UNITS	LON2	LONGITUDE STACK	SEGN	SEGMENT NUMBER	SEGN	SEGMENT NUMBER
PLL4	CE PT	PNME	PLANT NAME	PAT1	WINTER THROUGHPUT	STHT	STACK HEIGHT	SCC8	SCC	SCC8	SCC
DES4	GE 0	LAT1	LATITUDE PLANT	PAT2	SPRING THROUGHPUT	STDM	STACK DIAMETER	HEAT	HEAT CONTENT	PLL4	POLLUTANT CODE
DUE4	ME TY	LON1	LONGITUDE PLANT	PAT3	SUMMER THROUGHPUT	STET	STACK EXIT TEMPERATURE	FPRT	ANNUAL FUEL THROUGHPUT	D034	OSD EMISSIONS
YINV	ME 90	SIC1	STANDARD INDUSTRIAL CODE	PAT4	FALL THROUGHPUT	STEV	STACK EXIT VELOCITY	SULF	SULFUR CONTENT	DU04	OSD EMISSION UNITS
		OPST	OPERATING STATUS	NOHD	NUMBER HOURS/DAY	STFR	STACK FLOW RATE	ASHC	ASH CONTENT	DES4	DEFAULT ESTIMATED EMISSIONS
		STRS	STATE REGISTRATION NUMBER	NODW	NUMBER DAYS/WEEK	PLHT	PLUME HEIGHT	PODP	PEAK OZONE SEASON DAILY PROCESS RATE	DUE4	DEFAULT ESTIMATED EMISSIONS UNITS
				NOHY	NUMBER HOURS/YEAR					CLEE	CONTROL EFFICIENCY
										CLT1	PRIMARY CONTROL DEVICE CODE
										CTL2	SECONDARY CONTROL DEVICE CODE
										REP4	RULE EFFECTIVENESS
										DME4	METHOD CODE
										Emfa	Emission factor

Table 4.5-7. SEDS National Fuel Consumption, 1990-1996 (trillion Btu)

Fuel Type	End-User	Code	1990	1991	1992	1993	1994	1995	1996
Population									
		TPOPP	248,709	252,131	255,025	257,785	259,693	261,602	263,510

Table 4.5-8. BEA SA-5 National Earnings by Industry, 1990-1996 (million $)

Industry	LNUM	SIC	1990	1991	1992	1993	1994	1995	1996
Total population as of July 1 (thousands)	020	999	0	0	0	0	0	0	0
Total population as of July 1 (thousands)	030	999	1	1	1	1	1	1	1
Total population as of July 1 (thousands)	040	999	3,634	3,593	3,732	3,785	3,891	4,011	4,086
Total population as of July 1 (thousands)	041	999	238	242	248	253	265	273	280
Total population as of July 1 (thousands)	045	999	3,395	3,350	3,483	3,531	3,626	3,737	3,805
Total population as of July 1 (thousands)	046	999	971	947	907	914	934	980	981
Total population as of July 1 (thousands)	047	999	735	791	858	888	912	951	994
Total population as of July 1 (thousands)	050	999	2,932	2,891	2,975	3,003	3,082	3,182	3,231
Total population as of July 1 (thousands)	060	999	321	331	351	371	383	394	408
Total population as of July 1 (thousands)	070	999	381	370	405	410	426	436	447
Total population as of July 1 (thousands)	071	999	34	28	34	32	29	18	16
Total population as of July 1 (thousands)	072	999	347	342	372	378	396	418	432
Farm	081	1, 2	48	41	46	45	42	31	29
Farm	082	1, 2	3,586	3,552	3,686	3,740	3,849	3,980	4,058
Farm	090	1, 2	3,001	2,957	3,079	3,126	3,228	3,353	3,423
Agricultural services, forestry, fisheries, and other	100	7-9	24	24	24	24	26	27	27
Agricultural services, forestry, fisheries, and other	110	7-9	20	20	21	22	23	24	25
Agricultural services, forestry, fisheries, and other	120	7-9	4	3	3	3	3	3	3
Agricultural services, forestry, fisheries, and other	121	7-9	1	1	1	0	1	1	1
Agricultural services, forestry, fisheries, and other	122	7-9	2	2	2	2	2	2	1
Agricultural services, forestry, fisheries, and other	123	7-9	1	1	1	1	1	1	1
Agricultural services, forestry, fisheries, and other	200	7-9	36	37	36	34	35	35	35
Metal mining	210	10	2	3	3	2	2	2	3
Coal mining	220	11, 12	8	8	8	6	6	6	6
Oil and gas extraction	230	13	20	22	21	21	21	21	21
Nonmetallic minerals, except fuels	240	14	4	4	4	4	4	4	4
Construction	300	15-17	218	197	195	199	216	219	219
Construction	310	15-17	54	47	46	47	51	51	50
Construction	320	15-17	29	28	28	27	29	29	29
Construction	330	15-17	135	123	121	125	136	138	139
Manufacturing	400	998	710	690	705	705	725	740	747
Durable goods	410	996	437	418	423	424	440	452	456
Lumber and wood products	413	24	22	21	22	22	24	25	25
Furniture and fixtures	417	25	13	12	13	13	14	14	14
Stone, clay, and glass products	420	32	20	18	19	19	20	20	20
Primary metal industries	423	33	33	30	31	30	32	33	32
Fabricated metal products	426	34	51	48	49	49	51	53	53
Machinery, except electrical	429	35	86	83	83	84	86	90	91
Electric and electronic equipment	432	36	63	62	62	63	65	68	69
Motor vehicles and equipment	435	371	41	38	42	46	53	56	60
Transportation equipment, excluding motor vehicles	438	37	54	52	50	45	43	42	39
Instruments and related products	441	38	43	42	42	40	40	40	39
Miscellaneous manufacturing industries	444	39	11	11	11	12	12	12	12
Nondurable goods	450	997	273	272	281	282	285	288	291
Food and kindred products	453	20	51	51	52	52	53	53	54
Tobacco manufactures	456	21	3	3	3	2	2	3	3
Textile mill products	459	22	16	16	17	17	17	17	17
Apparel and other textile products	462	23	20	20	20	19	19	19	19
Paper and allied products	465	26	28	27	28	28	29	29	29
Printing and publishing	468	27	54	54	55	56	57	58	59
Chemicals and allied products	471	28	61	63	66	65	65	67	68
Petroleum and coal products	474	29	9	9	10	9	10	9	9
Rubber and miscellaneous plastic products	477	30	27	26	28	29	30	31	31
Leather and leather products	480	31	3	3	2	3	3	2	2
Leather and leather products	500	31	243	245	251	260	269	277	283

Table 4.5-8 (continued)

Industry	LNUM	SIC	1990	1991	1992	1993	1994	1995	1996
Railroad transportation	510	40	12	12	13	12	12	12	12
Trucking and warehousing	520	42	59	58	60	62	66	69	71
Water transportation	530	44	7	7	7	6	6	6	6
Water transportation	540	44	48	49	50	51	50	52	53
Local and interurban passenger transit	541	41	8	8	9	9	9	10	10
Transportation by air	542	45	30	30	31	31	31	31	31
Pipelines, except natural gas	543	46	1	1	1	1	1	1	1
Transportation services	544	47	12	13	14	14	15	16	17
Communication	560	48	63	63	64	67	71	75	78
Electric, gas, and sanitary services	570	49	49	52	53	56	56	56	57
Wholesale trade	610	50, 51	236	231	238	235	242	255	258
Retail trade	620	52-59	342	335	342	347	359	372	378
Retail trade	621	52-59	18	18	18	19	20	21	21
Retail trade	622	52-59	40	38	39	39	40	41	41
Retail trade	623	52-59	56	56	57	56	57	58	58
Retail trade	624	52-59	55	54	54	56	60	62	64
Retail trade	625	52-59	18	18	18	18	18	18	18
Retail trade	626	52-59	22	20	19	19	21	22	22
Retail trade	627	52-59	76	78	80	82	85	88	90
Retail trade	628	52-59	57	54	57	57	59	62	63
Retail trade	700	52-59	246	247	280	290	291	302	313
Banking and credit agencies	710	60, 61	82	81	86	89	89	90	91
Banking and credit agencies	730	60, 61	163	166	194	201	202	212	221
Banking and credit agencies	731	60, 61	38	40	50	53	51	55	58
Insurance	732	63, 64	56	59	61	62	63	63	65
Insurance	733	63, 64	34	33	33	34	36	37	38
Real estate	734	65, 66	28	25	36	43	44	47	51
Holding companies and investment services	736	62, 67	8	10	14	10	9	10	10
Services	800	995	946	951	1,008	1,032	1,066	1,128	1,164
Hotels and other lodging places	805	70	31	31	32	33	33	35	36
Personal services	810	72	33	32	33	36	36	36	37
Private households	815	88	10	9	10	10	10	11	11
Business and miscellaneous repair services	820	76	170	162	175	180	191	213	221
Auto repair, services, and garages	825	75	29	28	28	30	31	33	34
Auto repair, services, and garages	830	75	15	13	13	14	14	15	15
Amusement and recreation services	835	78, 79	29	30	34	33	35	37	39
Amusement and recreation services	840	78, 79	16	16	16	17	18	20	20
Health services	845	80	290	304	325	330	341	355	368
Legal services	850	81	80	80	85	84	84	85	86
Educational services	855	82	39	41	42	44	45	46	48
Social services and membership organizations	860	83, 86	29	31	34	35	38	40	42
Social services and membership organizations	865	83, 86	1	1	1	1	2	2	2
Social services and membership organizations	870	83, 86	35	36	36	38	40	41	42
Social services and membership organizations	875	83, 86	125	121	127	130	132	141	145
Miscellaneous professional services	880	84, 87, 89	14	14	15	15	17	18	19
Government and government enterprises	900	995	585	594	607	613	621	626	635
Federal, civilian	910	43, 91, 97	118	120	123	124	125	123	124
Federal, military	920	992	50	50	51	48	45	44	43
State and local	930	92-96	417	425	433	441	451	459	468
State and local	931	92-96	125	128	128	130	134	136	138
State and local	932	92-96	292	297	305	311	317	323	330

Table 4.5-9. Area Source Listing by SCC and Growth Basis

SCC	FILE	CODE	SCC	FILE	CODE	SCC	FILE	CODE
2401100000	BEA	400	2270002012	BEA	300	2270005020	BEA	81
2401200000	BEA	400	2401990000	BEA	400	2420010055	SEDS	TPOPP
2420000999	SEDS	TPOPP	2415000000	BEA	400	2420010370	SEDS	TPOPP
2420010000	SEDS	TPOPP	2415000385	BEA	400	2420010999	SEDS	TPOPP
2401010000	BEA	459	2415000999	BEA	400	2420020000	SEDS	TPOPP
2415045999	BEA	400	2415035000	BEA	438	2420020055	SEDS	TPOPP
2415060000	BEA	400	2415045000	BEA	444	2425000000	BEA	820
2461800999	SEDS	TPOPP	2415065000	BEA	413	2425000999	BEA	820
2495000000	SEDS	TPOPP	2415100000	BEA	400	2425010000	BEA	820
2401085000	BEA	438	2415105000	BEA	417	2425030000	BEA	820
2401090000	BEA	444	2415110000	BEA	423	2425040000	BEA	820
2420000055	SEDS	TPOPP	2415120000	BEA	426	2430000000	BEA	477
2420000370	SEDS	TPOPP	2415125000	BEA	429	2440000000	BEA	444
2401080000	BEA	438	2415130000	BEA	432	2440000999	BEA	444
2415365000	BEA	820	2415135000	BEA	438	2440020000	BEA	444
2420000000	SEDS	TPOPP	2415140000	BEA	441	2460000000	SEDS	TPOPP
2401000000	SEDS	TPOPP	2415145000	BEA	444	2460000385	SEDS	TPOPP
2401001000	SEDS	TPOPP	2415200000	BEA	438	2461000000	BEA	300
2401002000	NG		2415230000	BEA	432	2461020000	BEA	300
2401005000	BEA	825	2415245000	BEA	444	2461021000	BEA	300
2401008000	SEDS	TPOPP	2415260000	BEA	825	2461022000	BEA	300
2401015000	BEA	413	2415300000	BEA	438	2461023000	BEA	300
2401020000	BEA	417	2415305000	BEA	417	2461050000	BEA	300
2401025000	BEA	417	2415310000	BEA	423	2461160000	BEA	300
2401030000	BEA	465	2415315000	BEA	423	2461600000	BEA	300
2401035000	BEA	477	2415320000	BEA	426	2461800000	BEA	300
2401040000	BEA	426	2415325000	BEA	429	2461850000	BEA	300
2401045000	BEA	426	2415330000	BEA	432	2465000000	SEDS	TPOPP
2401045999	BEA	426	2415335000	BEA	438	2465100000	SEDS	TPOPP
2401050000	BEA	426	2415340000	BEA	441	2465200000	SEDS	TPOPP
2401055000	BEA	429	2415345000	BEA	444	2465400000	SEDS	TPOPP
2401060000	BEA	432	2415350000	BEA	510	2465600000	SEDS	TPOPP
2401065000	BEA	432	2415355000	BEA	620	2465800000	SEDS	TPOPP
2401070000	BEA	435	2415360000	BEA	825	2465900000	SEDS	TPOPP
2401075000	BEA	438						

NOTE(S): * BEA Code is equal to LNUM on previous table.

Table 4.5-10. Emission Estimates Available from AIRS/FS 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).

Table 4.5-11. Point Source Controls by Pod and Measure

POD	PODNAME	MEASNAME	SOURCE	PTFYCE
42	Surface coating - thinning solvents	RACT	Surface coating - thinning solvents	90
61	Open top degreasing	MACT	Open top degreasing	63
62	In-line degreasing	MACT	In-line degreasing	63
63	Cold cleaning	MACT	Cold cleaning	63
65	Open top degreasing - halogenated	MACT	Open top degreasing - halogenated	63
66	In-line degreasing - halogenated	MACT	In-line degreasing - halogenated	63
85	Misc organic solvent evaporation	SOCMI HON	Misc organic solvent evaporation	79
91	Dry cleaning - perchloroethylene	MACT	Dry cleaning - perchloroethylene	44
93	Dry cleaning - other	MACT	Dry cleaning - other	44

Note(s): A pod is a group of SCCs with similar emissions and process characteristics for which common control measures (i.e., cost and emission reductions) can be applied.

Table 4.5-12. Point Source SCC to Pod Match-up

SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD
40100101	91	40188898	63	40201505	37	40202031	37	40500211	180
40100102	92	40199999	63	40201531	37	40202033	37	40500212	180
40100103	91	40200101	33	40201599	37	40202099	37	40500299	180
40100104	92	40200110	33	40201601	33	40202101	40	40500301	181
40100105	93	40200301	34	40201602	33	40202103	40	40500303	186
40100198	93	40200310	34	40201603	33	40202104	40	40500304	186
40100201	61	40200401	33	40201604	33	40202105	40	40500305	186
40100202	65	40200410	40	40201605	33	40202106	40	40500306	186
40100203	65	40200501	33	40201606	33	40202107	40	40500307	186
40100204	65	40200510	33	40201607	33	40202108	40	40500311	181
40100205	65	40200601	33	40201608	33	40202109	40	40500312	181
40100206	61	40200610	33	40201609	33	40202131	40	40500314	181
40100207	65	40200701	36	40201619	33	40202132	40	40500401	182
40100221	62	40200706	36	40201620	33	40202133	40	40500411	182
40100222	66	40200707	36	40201621	33	40202199	40	40500412	182
40100223	66	40200710	36	40201622	33	40202201	38	40500413	182
40100224	66	40200801	35	40201623	33	40202202	38	40500414	182
40100225	66	40200802	35	40201625	33	40202203	38	40500416	182
40100235	62	40200803	35	40201626	33	40202205	38	40500418	182
40100236	62	40200810	35	40201627	33	40202299	38	40500501	183
40100251	61	40200898	35	40201628	33	40202301	132	40500502	183
40100252	65	40200998	33	40201629	33	40202302	132	40500503	186
40100253	65	40201001	88	40201631	33	40202305	132	40500506	186
40100254	65	40201002	88	40201632	33	40202306	132	40500507	186
40100255	65	40201003	88	40201699	33	40202399	132	40500510	186
40100256	61	40201004	88	40201702	34	40202401	52	40500511	183
40100257	65	40201101	41	40201703	34	40202402	52	40500512	183
40100258	61	40201103	41	40201704	34	40202403	52	40500513	183
40100259	61	40201105	41	40201705	34	40202405	52	40500514	183
40100275	61	40201112	41	40201721	34	40202406	52	40500598	183
40100295	62	40201113	41	40201722	34	40202499	52	40500599	183
40100296	62	40201114	41	40201723	34	40202501	37	40500601	184
40100297	61	40201115	41	40201724	34	40202502	37	40500701	187
40100298	62	40201116	41	40201725	34	40202503	37	40500801	188
40100299	61	40201199	41	40201726	34	40202504	37	40500811	188
40100301	63	40201201	41	40201727	34	40202505	37	40500812	188
40100302	63	40201210	41	40201728	34	40202531	37	40588801	188
40100303	63	40201301	36	40201731	34	40202532	37	40588802	188
40100304	63	40201303	36	40201732	34	40202533	37	40588803	188
40100305	63	40201304	36	40201734	34	40202534	37	40588804	188
40100306	61	40201305	36	40201735	34	40202537	37	40588805	188
40100307	63	40201399	36	40201799	34	40202598	37	49000101	85
40100308	63	40201401	37	40201801	37	40202599	37	49000103	85
40100309	63	40201404	37	40201803	37	40202601	37	49000105	85
40100310	63	40201405	37	40201805	37	40202605	37	49000199	85

Table 4.5-12 (continued)

SCC	POD	SCC	POD	SCC	POD	SCC	POD	SCC	POD
40100335	63	40201406	37	40201806	37	40202606	37	49000201	85
40100336	63	40201431	37	40201899	37	40202607	37	49000202	85
40100398	63	40201432	37	40201901	39	40202699	37	49000203	85
40100399	63	40201433	37	40201903	39	40290013	88	49000204	85
40100499	63	40201435	37	40201904	39	40500101	189	49000205	85
40100550	63	40201499	37	40201999	39	40500199	189	49000206	85
40188801	63	40201501	37	40202001	37	40500201	180	49000299	85
40188802	63	40201502	37	40202002	37	40500202	186	49000399	85
40188805	63	40201503	37	40202005	37	40500203	186	49000401	85
49000499	85	49000599	85	49090023	85	49099998	85	49099999	85
49000501	85	49090013	85						

Table 4.5-13. Area Source VOC Controls by SCC and Pod

POD	SCC	SOURCE	MEASURE	PCTRD96
211	2420010055	Dry Cleaning - perchloroethylene	MACT	44.0
211	2420000055	Dry Cleaning - perchloroethylene	MACT	44.0
241	2415305000	Cold cleaning	MACT	35.0
241	2415310000	Cold cleaning	MACT	35.0
241	2415320000	Cold cleaning	MACT	35.0
241	2415325000	Cold cleaning	MACT	35.0
241	2415330000	Cold cleaning	MACT	35.0
241	2415335000	Cold cleaning	MACT	35.0
241	2415340000	Cold cleaning	MACT	35.0
241	2415345000	Cold cleaning	MACT	35.0
241	2415355000	Cold cleaning	MACT	35.0
241	2415360000	Cold cleaning	MACT	35.0
241	2415365000	Cold cleaning	MACT	35.0
250	2401075000	Aircraft surface coating	MACT	0.0
251	2401080000	marine surface coating	MACT	0.0
272	2461021000	Cutback Asphalt	Switch to emulsified (CTG)	100.0
272	2461020000	Cutback Asphalt	Switch to emulsified (CTG)	100.0

POD_VOC	PODNAME	APPLICABLE
211	Dry Cleaning - perchloroethylene	National
241	Cold cleaning	National
250	Aircraft surface coating	National
251	marine surface coating	National
272	Cutback Asphalt	Marginal+

Note(s): A pod is a group of SCCs with similar emissions and process characteristics for which common control measures (i.e., cost and emission reductions) can be applied.

4.6 ON-ROAD VEHICLES

The "On-road Vehicle" heading includes the following Tier I and Tier II categories:

Tier I Category	Tier II Category
(11) On-road Vehicles	All

On-road vehicle emissions were calculated using a consistent methodology for all years from 1970 through 1996. Emissions were calculated by month, county, road type, and vehicle type for each of these years. Emissions of volatile organic compounds (VOC), nitrogen oxides (NO_x), and carbon monoxide (CO) were calculated using monthly state-level emission factors from MOBILE5a for the years 1970 to 1994 and MOBILE5b for the years 1995 and 1996 by vehicle type while particulate matter less than 10 microns in aerodynamic diameter (PM-10), ammonia (NH_3) and particulate matter less than 2.5 microns in aerodynamic diameter (PM-2.5) (1990 to 1996), and sulfur dioxide (SO_2) emissions were calculated using national annual emission factors by vehicle type. This section of the procedures document discusses the methodology used for calculating on-road vehicle emissions.

The activity factor that is used to estimate on-road vehicle emissions is vehicle miles traveled (VMT). The first section of this chapter discusses the development of the VMT data base. The next section of this chapter discusses the development of the inputs used for the MOBILE modeling. Estimation of the PM-10, PM-2.5, and SO_2 emission factors are discussed next followed by NH_3. Finally, the emission calculation procedure is discussed.

4.6.1 VMT

Using state totals for each year, VMT were allocated by county, roadway type, and vehicle type for each year between 1970 and 1996. Each state and county combination in the output files has 96 assigned source classification codes (SCCs) representing the 6 rural and 6 urban roadway types, and 8 vehicles types. The methodology used for calculating VMT from (1) 1980 to 1995 differs from the methodology used for calculation of mileage totals from (2) 1970 to 1979 and for (3) 1996. Each of the three approaches is described separately below.

4.6.1.1 Background on Highway Performance Monitoring System

The following sections describe the information contained within Highway Performance Monitoring System (HPMS)[1] which is used to create the county/roadway type/vehicle type level VMT data file, and the problems with using this information.

4.6.1.1.1 Description of HPMS —
The HPMS is a national data collection and reporting system administered by the U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) in cooperation with state highway programs. The HPMS contains data on the mileage, extent, and usage of the various functional road systems, the condition and performance of pavements, physical attributes of roads, road capacity and improvement needs, and other data important to the structural integrity and operation of the nation's road systems. The data that make up HPMS are submitted to FHWA annually by each state highway program.

The HPMS has three main data components: (1) the universe data base, (2) the sample data base (a subset of the universe data base), and (3) the areawide data base. The universe data base contains a complete inventory of all mileage for all functional systems, except local roads. The sample data base contains more detailed information for a subset of the highway sections in the universe data base. Each record in the sample data base is part of a sample panel which can be expanded to represent the universe of highway mileage. The areawide data base contains annual state-level summaries of the major components of HPMS. Most of the state-level data in the areawide data base are divided into rural, small urban, and individualized urban area components. Table 4.6-1 illustrates the main data components of HPMS and the type of data they contain.

The travel data in HPMS are of great interest in estimating VMT. HPMS travel data are based on samples of daily traffic counts taken at various points in a state's roadway network. These daily traffic counts are expanded to annual average daily traffic (AADT). To calculate VMT for a specific section of road, the AADT for that section of road is multiplied by the road length.[2]

4.6.1.1.2 Problems with Using HPMS to Estimate VMT —
There are several complexities associated with using HPMS data to estimate VMT for this inventory. The county is the basic geographic unit in the 1990 Emission Trends inventory, while all data in HPMS are divided into rural, small urban, and individualized urban geographic areas. In order to use the HPMS data, a mechanism to distribute VMT from a rural, small urban, and individual urban area level to a county level had to be developed. In addition, the level of detail of reporting in the sample data base (the most detailed data base which contained VMT information) varied from state to state. Some states reported data for each individual urban area, some states reported data for all individual urban areas together, and some states reported data separately for some individual urban areas and reported data for the remaining individual urban areas together. This made distributing VMT from the sample data base to counties a difficult task. In the areawide data base, however, all states reported data for individual urban areas separately. Finally, travel data for local road systems were only contained in the areawide data base. Therefore, the areawide data base was used to generate county-level VMT estimates. The methodology used to generate county-level VMT estimates is described below.

4.6.1.2 Distribution of HPMS VMT, 1980 to 1995

The FHWA supplied the latest mileage and daily travel summary areawide records that were reported for the HPMS for the period 1980 through 1995. The HPMS files contain state-level summaries of miles of daily travel by functional system and by rural, small urban (population of 5,000 to 49,999), and individual urban (population of 50,000 and more) areas. Rural daily VMT (DVMT) is provided on a state level for the following six roadway types: principal arterial-interstate, other principal arterial, minor arterial, major collector, minor collector, and local. Small urban and urban area DVMT are provided for the following six roadway types: principal arterial - interstate, principal arterial - other freeways and expressways, other principal arterial, minor arterial, collector, and local.

VMT from the HPMS areawide data base was distributed to counties based on each county's rural, small urban, and urban area population. Two tables in the Bureau of the Census 1980 Number of Inhabitants (CNOI) documents[3] were used as the source for population data for the years 1980 to 1994. The 1980 population data had to be used to allocate the VMT because the Census Urbanized Area boundaries were changed for the 1990 census. Although not exactly the same, the large urban area boundaries used in HPMS are based on the 1980 Census Urbanized Area boundaries. Use of the 1990 Census Urbanized Area boundaries would prevent a one-to-one match between HPMS large, urban-area VMT and urbanized area population, making VMT distribution difficult.

The two CNOI tables used to distribute VMT to counties are:

Table 3: **Population of Counties by Urban and Rural Residence**. This table lists the urban population living inside census-defined urban areas, the urban population living outside census-defined urban areas, and the rural population for each county.

Table 13: **Population of Urban Areas**. This table divides an urban area's population among the counties that contain portions of that urban area.

County-level rural VMT, small urban VMT, and urbanized area VMT were calculated separately using the following methodology. The methodology described below was performed for each functional road system.

4.6.1.2.1 Rural VMT —

To calculate rural VMT by county, two steps were followed. First, the percentage of the state's rural population in each county was calculated using county rural population data from CNOI Table 3. Next, each county's rural VMT was calculated by distributing state rural VMT from the HPMS areawide data base, based on the percentage of the state's rural population in each county using Equation 4.6-1.

$$VMT_{R,C} = VMT_{R,S} \times \frac{POP_{R,C}}{POP_{R,S}} \qquad \text{(Eq. 4.6-1)}$$

where:
- $VMT_{R,C}$ = Rural VMT in county C (calculated)
- $VMT_{R,S}$ = Rural VMT, state total (HPMS)
- $POP_{R,C}$ = Rural population in county C (CNOI)
- $POP_{R,S}$ = Rural population, state total (CNOI)

4.6.1.2.2 Small Urban VMT —

A similar methodology was used to calculate each county's small urban VMT. First, the percentage of the state's small urban population in each county was calculated using county urban population living outside census-defined urbanized areas from CNOI Table 3. Next, each county's small urban VMT was calculated by distributing state small urban VMT from the HPMS areawide data base based on the percentage of the state's small urban population in each county using Equation 4.6-2.

$$VMT_{SU,C} = VMT_{SU,S} \times \frac{POP_{SU,C}}{POP_{SU,S}} \qquad \text{(Eq. 4.6-2)}$$

where: $VMT_{SU,C}$ = Small urban VMT in county C (calculated)
$VMT_{SU,S}$ = Small urban VMT, state total (HPMS)
$POP_{SU,C}$ = Small urban population in county C (CNOI)
$POP_{SU,S}$ = Small urban population, state total (CNOI)

4.6.1.2.3 Urban Area VMT —

The approach for allocating HPMS daily VMT (DVMT) reported for individual urban areas was slightly different than the approach used to allocate rural and small urban DVMT. Each urban area in the HPMS file is assigned a unique 3-digit code. To allocate DVMT totals by road type for each individual urban area, an urban area population file was used which links a given urban area code to the corresponding population in each component county. Because the boundaries of urban and small urban areas changed from year to year, there were urban areas in the HPMS input files for which the population for component counties was not available. In these cases, the VMT for this urban area was added to the HPMS small urban VMT total by road category and allocated by small urban population ratios.

For each urban area, the percentage of its population in each county containing a portion of the urban area was calculated using data from CNOI Table 13. Next, each county's share of an urban area's VMT was calculated by distributing urban area VMT from the HPMS areawide data base based on the percentage of the urban area's population in each county using Equation 4.6-3.

$$VMT_{UA,C} = VMT_{UA,S} \times \frac{POP_{UA,C}}{POP_{UA,S}} \qquad \text{(Eq. 4.6-3)}$$

where: $VMT_{UA,C}$ = Urban area's VMT in county C (calculated)
$VMT_{UA,S}$ = Urban area's VMT, state total (HPMS)
$POP_{UA,C}$ = Urban area's population in county C (CNOI)
$POP_{UA,S}$ = Urban area's population, state total (CNOI)

In a few cases, a single county contained parts of more than one urban area. For those counties, urban VMT was calculated as the sum of the county's proportion of VMT from each of the large urban areas in the county and the county's small urban VMT.

4.6.1.2.4 Determining VMT by Roadway Type and Vehicle Type —

The next step in calculating VMT at the county/roadway type/vehicle type level was to allocate the DVMT totals in 12 rural and urban roadway categories among the 8 MOBILE model vehicle type categories. For each year between 1980 and 1995, a percentage distribution was calculated for each vehicle type for both the rural and urban classifications. The first step in the development of this percentage distribution was to obtain the most recent VMT totals by vehicle type and by year from FHWA's Highway Statistics.[4] Rural and urban VMT in this publication are provided for the following vehicles types: passenger cars, motorcycles, buses, two-axle/four-tire single-unit trucks, other single-unit trucks, and combination trucks. (In the years prior to 1990, a VMT breakdown between passenger cars and motorcycles was not provided. A total VMT for Personal Passenger Vehicles is provided. It was assumed that the division between passenger car VMT and motorcycle VMT is the same in earlier years as was reported for 1990.) For each of the six vehicle type categories for which VMT is reported in Highway Statistics, a percentage of the total was calculated for both rural and urban VMT. To convert these percentages for the six HPMS categories to the eight MOBILE vehicle type categories, a breakdown provided by the United States (U.S.) Environmental Protection Agency (EPA) was used which reconciles the vehicle class categories used in the HPMS to those used in EPA's MOBILE model.[5] This method of conversion from HPMS categories to MOBILE categories is based on a matching scheme that allows states to apportion VMT as it is reported in HPMS categories to the eight MOBILE model vehicle class categories. The apportionment percentages supplied by EPA are shown in table 4.6-2.

After allocating HPMS DVMT totals by county, roadway category, and vehicle type, the values were converted to millions of annual VMT. This conversion was done by simply multiplying the DVMT values by 365, since the DVMT values represent VMT for an average day. Quality assurance was performed on the output files for each of the years by comparing state totals to the HPMS data provided by state. (It is important to note that for certain years, slight discrepancies exist between the HPMS totals and the totals reported in Highway Statistics.) The resulting annual county-level, vehicle, and roadway type-specific VMT data were temporally allocated to months. Seasonal 1985 National Acid Precipitation Assessment Program (NAPAP) temporal allocation factors[7] were used to apportion the VMT to the four seasons. Monthly VMT data were obtained using a ratio between the number of days in a month and the number of days in the corresponding season. These temporal factors are shown in table 4.6-3.

4.6.1.3 Distribution of VMT, 1970 to 1979 and 1996

The methodology for allocating VMT totals for 1970 through 1979 was based on state totals which were published in FHWA's Highway Statistics 1985. For each year, state totals were allocated by county, roadway type, and vehicle type using a ratio from the 1980 VMT file for each state/county/SCC combination expressed as a percentage of the 1980 state total. Quality assurance was performed by comparing statewide totals for each year's output to the FHWA's state totals.

The 1995 VMT data base was grown to 1996 using preliminary State/roadway type totals for 1996 provided by FHWA.[6] To accomplish this, the 1995 VMT data base was first totaled to the State and roadway type level. Next, the preliminary 1996 State and roadway type VMT totals provided by FHWA were divided by the corresponding 1995 VMT totals from the Trends 1995 VMT data base. This resulted in 1995 and 1996 VMT growth factors at the State and roadway type level. The final step was to multiply these growth factors by each VMT data point in the 1995 VMT data base, matching by State and road type. This process is illustrated by Equation 4.6-4.

$$TRVMT96_{S,C,RT,VT} = TRVMT95_{S,C,RT,VT} * \frac{FHVMT96_{S,RT}}{TRVMT95_{S,RT}} \qquad \text{(Eq. 4.6-4)}$$

where:	$TRVMT96_{S,C,RT,VT}$	=	Trends 1996 VMT for State S, county C, roadway type RT, and vehicle type VT (millions of miles per year);
	$TRVMT95_{S,C,RT,VT}$	=	Trends 1995 VMT for State S, county C, roadway type RT, and vehicle type VT (millions of miles per year);
	$FHVMT96_{S,RT}$	=	Federal Highway Administration preliminary 1996 VMT for State S and roadway type RT (millions of miles per year); and
	$TRVMT95_{S,RT}$	=	Trends 1995 VMT total for State S and roadway type RT (millions of miles per year).

Table 4.6-4 shows the resulting 1995 to 1996 VMT growth factors by State and roadway type calculated as $FHVMT96_{S,RT}/TRVMT95_{S,RT}$.

The resulting annual county-level vehicle and roadway type specific VMT data were temporally allocated to months. Seasonal 1985 NAPAP temporal allocation factors[7] were used to apportion the VMT to the four seasons. Monthly VMT data were obtained using a ratio between the number of days in a month and the number of days in the corresponding season.

4.6.1.4 State-Provided 1990 VMT

Thirteen of the 38 states supplied VMT estimates covering the entire state, an additional 3 states supplied VMT estimates covering part of their state, and Emission Trends VMT was used for the remaining 25 states. Fifteen of the 38 states in the Ozone Transport Assessment Group (OTAG) Domain supplied MOBILE5a input files for all or part of their state and input files developed for the Interim Inventory were used for the remaining 23 states. Table 4.6-5 lists the state-level daily VMT totals in the OTAG Inventory. Figure 4.6-1 is a map that displays which states supplied VMT.

4.6.2 Development of VOC, NO_x, and CO Emission Factors

EPA's MOBILE5a for the years 1970 through 1994 and MOBILE5b for the years 1995 and 1996 mobile source emission factor model was used to calculate all emission factors.[8] The pollutants modeled were exhaust VOC, evaporative VOC (which includes resting loss, running loss, and evaporative emissions), exhaust NO_x, and exhaust CO. VOC emissions include aldehydes and hydrocarbons measured by Flame Ionization Detector (FID) testing.

4.6.2.1 Temperature

The temperature data used for Emission Trends inventory included an average daily maximum and minimum temperature for each state for each month for each year from 1970 to 1996. The data were obtained on diskette from the National Climatic Data Center.[9] A single city was selected from each state to represent the state's temperature conditions. The cities were selected to be the most representative of the average conditions within the state, generally either centrally located cities or, in states with a majority of VMT clustered in one area, the most populous cities. Because of the great variations of temperature and the wide distribution of VMT throughout California, California was divided into two geographic regions, with Los Angeles representing the southern and interior portions of the state and San Francisco representing the northern coastal region of the state. Table 4.6-6 shows the cities that were used to represent each state's temperature conditions. In cases where temperature data were missing for a month or more, 30-year average monthly maximum and minimum temperature values were used from Statistical Abstracts.[10] The allowable temperature range for input to the MOBILE model is 0°F to 100°F for the minimum daily temperatures and 10°F to 110°F for the maximum daily temperatures. In the few cases where the temperatures fell outside of these ranges, the endpoint of the range was substituted for the actual temperatures.

4.6.2.2 RVP

This section describes the methodology used to apportion Reid vapor pressure (RVP) values to each state by month. The steps involved in making these calculations were as follows: (1) assigning a January and July RVP to each state, and (2) estimating the RVP for the other months for each state. In some cases, adjustments were then made to the calculated RVP values to eliminate the effects of lower RVP due to reformulated gasoline in areas not receiving reformulated gasoline. In addition, some states provided summer RVP data to OTAG that differed from the values calculated here. The procedures used to account for these factors are described below.

4.6.2.2.1 Apportioning RVP Data to Each State —
The first step in the process of determining monthly RVP values for each state was to assign a weighted January and July RVP for each year to every state. EPA's Office of Mobile Sources (OMS) provided spreadsheets of historic RVP data that included the average January and July RVP values weighted by the market share of each type of gasoline (regular unleaded, intermediate unleaded, premium unleaded, etc.) from each of the 23 cities included in the American Automobile Manufacturer's Association (AAMA) fuel surveys.[11] These data were provided for each year from 1970 through 1996. Using these data, January and July RVP values were assigned to each state for each year. This was done using a listing, provided by OMS, matching each nonattainment area and many Metropolitan Statistical Areas (MSAs) throughout the United States with the corresponding AAMA survey city whose RVP should be used to represent that nonattainment area. These assignments were based on pipeline distribution maps and are shown in table 4.6-7. The corresponding January and July weighted RVP values were then assigned to each of these nonattainment areas. The January or July RVP values for a given year for all nonattainment areas and listed MSAs within a state were then averaged to estimate a single statewide January or July RVP value. Several states had no nonattainment areas or MSAs included in the OMS cross reference listing. Survey cities were assigned to these states by OMS based on a combination of location and pipeline maps. These assignments were as follows:

State	Survey City
Idaho	Billings, MT and Seattle, WA
Iowa	Minneapolis, MN
Nebraska	Kansas City, MO and Minneapolis, MN
North Dakota	Minneapolis, MN
South Dakota	Minneapolis, MN
Wyoming	Billings, MT and Denver, CO

For states where two survey cities are listed, the average of the RVP values for the two survey cities was used. Alaska and Hawaii were not matched with survey cities but were assigned winter and summer RVP values based on guidance from OMS. Alaska was assigned a winter RVP value of 14.5 psi and a summer

RVP value of 12.5 psi while Hawaii was assigned a winter RVP value of 10.0 psi and a summer RVP value of 9.5 psi. These assignments applied for each year from 1970 through 1996.

4.6.2.2.2 Estimating Monthly RVP for Each State —

The next step in the process of allocating RVP values was to estimate statewide RVP values for the remaining months based on the January and July RVP values. The ASTM schedule of seasonal and geographical volatility classes was used as the basis for the RVP allocation by month.[12] This schedule assigns one or two volatility classes to each state for each month of the year. Volatility classes are designated by a letter (A through E), with A being the least volatile. Several states are divided into two or more regions, with each region having its own set of volatility class guidelines. The MOBILE4 *User's Guide*[13] provides guidance on which ASTM class to assign to each state for each month when more than one region is included for a state, or when two ASTM classes are listed for a given state in a given month. This guidance was followed here to select a single ASTM class for each state and month. The MOBILE4 *User's Guide* also lists RVP limits that correspond to each ASTM class. These RVP limits are as follows:

- ASTM class A = 9.0 psi
- ASTM class B = 10.0 psi
- ASTM class C = 11.5 psi
- ASTM class D = 13.5 psi
- ASTM class E = 15.0 psi

The January ASTM class designation was assigned to the January RVP value calculated for each state and the July ASTM class designation was assigned to the July RVP value calculated for each state. Other months with the same ASTM class designation as either January or July were assigned the January or July RVP value for that state. The RVP values for months with intermediate ASTM class designations were calculated by interpolation using the January and July RVP values and the ASTM class RVP limits. Equation 4.6-5 was used for this interpolation.

$$IM = [(IA - SA) \times (WM - SM) / (WA - SA)] + SM \qquad \text{(Eq. 4.6-5)}$$

where:

where:	IM	=	Intermediate month's (not January or July) RVP value
	WM	=	Winter (January) RVP value
	SM	=	Summer (July) RVP value
	IA	=	Intermediate month's (not-January or July) ASTM RVP limit
	WA	=	Winter (January) ASTM RVP limit
	SA	=	Summer (July) ASTM RVP limit

Calculations were made for each intermediate month for each state. Starting in 1989, summer RVP values were limited by EPA's Phase I RVP limits and in 1995 by the Phase II RVP limits. After the May through September RVP values were calculated for each state using the procedure above, the values were replaced by the state-specific monthly Phase I (for 1989 to 1991) or the Phase II (for 1992 through 1996) limit if the corresponding limit was lower than the calculated monthly RVP value.

4.6.2.2.3 Eliminating RVP Effects of Reformulated Gasoline, 1995 and 1996 —

Several of the AAMA survey cities are areas that received reformulated gasoline in 1995 and 1996. Because the July RVP of reformulated gasoline is almost always lower than the July RVP values of regular gasoline that would be sold in the same geographic area, using a reformulated gasoline survey city to represent RVP values for areas receiving regular gasoline would give inappropriately low RVP values for these areas. To rectify this situation, for each of the AAMA survey cities receiving reformulated gasoline in 1995 and 1996, OMS provided a substitute survey city to use when calculating the July RVP values of areas without reformulated gasoline.[14] This substitute survey city assignment is shown in table 4.6-8. The procedure discussed above for determining state-level July RVP values in states that receive both reformulated gasoline and regular gasoline was modified to determine separate RVP values for both types of areas. To calculate the July RVP of regular gasoline in the state, the RVP of the substitute survey cities replaced the RVP of the original survey cities and the RVP was recalculated. This value was then used for areas in the state that did not receive reformulated gasoline.

4.6.2.2.4 State-Supplied RVP Data —

Some states supplied summer 1995 RVP data for OTAG that differed from the values calculated using the methodology discussed above. In these cases, the calculated 1995 and 1996 RVP values for the months from May through September were replaced by the state-supplied data. In some cases, the state-supplied data varied within a state. These distinctions were maintained in the Trends modeling. The resultant 1995 and 1996 monthly RVP data for all areas are shown in tables 4.6-9 and 4.6-10, respectively.

4.6.2.3 Speed

Representative national speeds were developed for each vehicle type/roadway type combination. Average overall speed data, output from the HPMS impact analysis were obtained for the years 1987 through 1990.[1] The average overall speed for each vehicle type varied less than one mile per hour (MPH) over the four-year span. Therefore, the speed data from 1990 were used for all years from 1970 to 1996. Table 4.6-11 lists the average overall speed output for 1990 from the HPMS impact analysis. To determine the actual speeds to use in modeling the emission factors, HPMS vehicle types were chosen to represent the speeds for each MOBILE vehicle type:

- passenger cars — used for light-duty gasoline vehicles (LDGVs), light-duty diesel vehicles (LDDVs) and motorcycles (speeds for small and large cars were the same)
- pickup trucks and vans — used for light-duty gasoline truck 1 (LDGT1 [trucks less than 6,000 lbs in weight]), LDGT2 (6,000 to 8,500 lbs in weight), light-duty diesel trucks (LDDTs)
- multi-trailer trucks with five or more axles — used for heavy-duty gasoline vehicles (HDGVs) and heavy-duty diesel vehicles (HDDVs)

To reduce the number of speeds to be modeled, the HPMS speeds were rounded to the nearest 5 MPH. Local speeds, which were not included in the HPMS impact analysis output, were assumed to be the same as minor collector speeds for rural roads and collector speeds for urban roads. Table 4.6-12 lists the average speed used for each road type/vehicle type combination. No state-supplied speed data were used in the Trends calculations.

It is recognized that the abolition of the national speed limit in 1995 may have caused overall speeds to increase, particularly on rural interstates. However, little data are currently available to assess the impacts of the change in speed limits on actual travel speeds. In addition, the maximum speed that can be modeled in MOBILE 5b is 65 MPH, so that even if the speed data were available, emission factors for these higher speeds could not currently be modeled with MOBILE5b.

4.6.2.4 Operating Mode

All MOBILE runs at all speeds were made using the operating mode assumptions of the Federal Test Procedure (FTP) with the exception of Maryland and Texas, as described below. With the FTP, 20.6 percent of all VMT is accumulated in the cold start mode (or Bag 1 of the FTP), 27.3 percent of all VMT is accumulated in the hot start mode (or Bag 3 of the FTP), and 52.1 percent of all VMT is accumulated in the hot stabilized mode (or Bag 2 of the FTP).

Two states supplied their own data on operating modes—Maryland and Texas. These state-supplied operating modes were substituted for the default FTP operating mode in the 1995 and 1996 MOBILE5b input files for these states. The operating mode data modeled for these two states are shown in table 4.6-13.

4.6.2.5 Altitude

The entire states of Colorado, Nevada, New Mexico, and Utah were modeled as high altitude areas. All other states were modeled as low altitude areas.

4.6.2.6 Registration Distribution/Month

A national registration distribution was included in all of the MOBILE input files. These registration distributions varied by calendar year and show the fraction of vehicles registered in the given calendar year by model year. Separate registration distributions are developed for each vehicle type (with a single registration distribution for light duty gasoline and diesel vehicles and a single registration distribution for light duty gasoline trucks I and light duty diesel trucks). Registration distributions developed under earlier Emission Trends work assignments were used for calendar years 1970 through 1994. New registration distributions were developed under this assignment for 1995 and 1996.

The main difference between the 1991 registration distribution and those of previous years is the expansion from a 20-year distribution to a 25-year distribution. In addition to the development of the 1991 distribution, data used in the development of the 1990 registration distribution were updated with more current vehicle sales figures. All registration distributions for the years 1980 through 1990 were also expanded to a 25-year range.

The specific procedures used in each of the steps outlined above are discussed in detail in the following sections. In some cases, the methods used for this version of Emission Trends inventory correspond to procedures used in previous years, while in other cases, improvements have been made to the estimation procedure. Both old and new methods are documented below.

Vehicle registration distributions for 1991 through 1996 were developed using a dBase computer program. (This program was developed to perform the computations that had been done for earlier Emission Trends inventory in a spreadsheet model.) This registration distribution program estimates the distribution of vehicles operating by model year in 1991 through 1996 for each of the eight MOBILE vehicle types. For automobiles, the registration distribution is based on the number of cars in operation by model year as reported in AAMA's *Facts and Figures 1996*[11] and sales data from Automotive News' *Market Data Book 1996*.[15] For each of the five MOBILE truck classes, the distribution is based on sales figures from AAMA and Automotive News, as well as the number of trucks in operation by model year from AAMA. For motorcycles, the registration distribution for these three years did not change from previous years; this distribution was taken from the default distribution from the previous Emission Trends procedures, which covered a 12-model-year range. The specific procedure used to calculate the registration distribution for automobiles and trucks is discussed below.

4.6.2.6.1 Automobiles —

AAMA's *Facts and Figures 1996* lists the number of cars in operation by model year. The most recent calendar year for which data are available from this source is 1995. The number of cars in operation in 1995 for each model year from 1980 through 1995 was used as a preliminary estimate of the number of cars from these model years operating in 1995. (These will be updated in the next version of Emission Trends inventory by AAMA's actual estimates for the 1996 calendar year.)

The earliest model year for which data were given on the number of cars operating in 1995 was the 1980 model year. The figure given for the number of model year 1980 cars operating in 1995 is actually an aggregate figure of the number of cars from 1980 and all earlier model years still operating in 1995. A methodology was developed to distribute the cars operating from model year 1980 and earlier years over the remaining 9 years required for developing a 25-year registration distribution. To do this, a formula was derived using automobile survival rates to project estimates of operation for these older cars by model year to 1996.[16] Based on AAMA data for previous years, the number of cars from each model year from 1971 through 1980 still in operation in 1996 was estimated using Equation 4.6-6.

$$Model\ Year_N\ Cars\ in\ Operation\ in\ Year_{1996} = A \times \frac{C}{B} \qquad \text{(Eq. 4.6-6)}$$

where:

where:	A	=	AAMA number of Model $Year_N$ Cars Operating in $Year_Y$
	B	=	Survival rate for age_{Y-N}
	C	=	Survival rate for age_{1996-N}
	Year	=	Last calendar year for which an estimate is available for this particular model year (as of July 1)
	N	=	Most current model year for which *'Number of Automobiles in Operation'* are available

For example, in calculating the 1995 registration distribution, the most recent calendar year for which data on the number of 1976 model year cars still in operation is available is 1990. *Facts and Figures* indicates that 2.981 million 1976 model year cars were operating in 1990. The car survival rate from 1976 to 1995 (19 years of survival) is 0.10130.[16] The car survival rate from 1976 to 1990 (14 years of survival) is 0.32221.[16] Thus, of the 2.981 million 1976 model year cars that survived to 1990, it is expected that 31 percent (0.10130/0.32221) or 0.937 million will survive to 1995.

To develop an estimate of the number of 1996 model year cars operating in 1996, the number of 1995 registrations of model year 1995 automobiles was multiplied by 0.75, since by July 1, three-quarters of the car model year had passed (new model year automobiles are generally released in October).

Using this complete set of automobile registrations by model year for the 25-year period from 1972 to 1996, the registration distribution was calculated by dividing the number of cars in operation by model year by the total number of cars operating over the 25-year period. This process was repeated to develop a registration distribution for 1991 through 1995. The only difference for these years is that the number of cars in operation in the most recent model year was available from AAMA for these previous years and therefore, no projections of the number of cars in operation were made for the latest model year.

4.6.2.6.2 Trucks —

For each truck type, the 1995 registration distribution was calculated with truck sales figures by type and model year, which were weighted by the distribution of truck registrations (the total over all truck types) from AAMA's *Facts and Figures 1996*. The basic methodology for calculating this distribution is outlined below.

The first step was to determine 1995 truck sales by MOBILE5b truck category. (Sales figures for years prior to 1995 were not changed from those used in calculating previous years' registration distributions.) Because AAMA's truck categories do not directly correspond to the categories used in MOBILE5b. The method described below was used for allocating sales from AAMA's weight class categories to the MOBILE truck categories. The data needed for the 1995 model year for each of the formulas listed below were obtained from *Facts and Figures 1996*. The sales data for the earlier model years needed for a 1995 registration distribution were already calculated for registration distributions prepared for previous Trends inventories, and used similar data from earlier versions of *Facts and Figures*. The equations used to estimate sales for each MOBILE5b truck category are listed below. The formulas used for the 1991 through 1996 distribution are shown in Equations 4.6-7 through 4.6-11.

$$LDGT1 = Retail\,Sales\,(domestic + import)_{(0-6{,}000 lbs)} - Diesel\,Factory\,Sales_{(0-6{,}000 lbs)} \qquad \text{(Eq. 4.6-7)}$$

$$LDGT2 = \left(\begin{matrix} Retail \\ Sales \end{matrix} - VCC - M - (0.05 \times CP) - \begin{matrix} Diesel \\ Factory \\ Sales \end{matrix} \right)_{(6{,}000-10{,}000 lbs)} \qquad \text{(Eq. 4.6-8)}$$

where: VCC = Retail sales of van cutaway chassis
M = Retail sales of multi-stops
CP = Retail sales of conventional pickups

$$HDGT = \left(VCC + M + [0.05 \times CP]\right)_{(6{,}000-10{,}000 lbs)} - \left(\begin{matrix} Heavy-Duty \\ Diesel\,Trucks \end{matrix} \right) + \left(\begin{matrix} Retail \\ Sales \end{matrix} \right)_{(>10{,}000 lbs)} \qquad \text{(Eq. 4.6-9)}$$

$$LDDT = Diesel\,Factory\,Sales_{(0-6{,}000lbs)} + (0.10 \times Diesel\,Factory\,Sales)_{(6{,}000-10{,}000lbs)} \quad \text{(Eq. 4.6-10)}$$

$$HDDT = \left[0.9 \times \left(Diesel\,Factory\,Sales\right)_{(6{,}000-10{,}000lbs)}\right] + \Sigma \left(Diesel\,Factory\,Sales\right)_{(>10Klbs)} \quad \text{(Eq. 4.6-11)}$$

Once AAMA sales data for the 1995 model year were converted into sales data by MOBILE5b truck categories, the fraction of total 1995 truck sales in each of these five MOBILE5b truck categories was calculated. This was done for each model year from 1971 through 1994, using data from earlier versions of *Facts and Figures*.

Next, a full 25-year distribution of trucks in operation in 1995 by model year from the 1971 through the 1995 model years was calculated. AAMA listed the total number of trucks (of all types) in operation by model year in 1995 back to 1981. All trucks in operation from model years 1980 and earlier were provided as an aggregate figure. The total number of trucks in operation from 1980 and earlier model years was distributed to each model year from 1971 to 1980 using the method described above for distributing the figure of cars in operation from the 1980 and earlier model years to the same set of model years. The survival rates used for distributing the number of trucks in operation were specific to trucks, rather than cars.

Using the fraction of truck sales by truck type for each of the 25 model years needed and the number of total trucks in operation in 1995 for each of the 25 model years needed, separate 1995 registration distributions were calculated for each truck type. This was accomplished by multiplying the total number of trucks in operation in 1995 in a given model year by the fraction of truck sales of the specified truck type in the given model year. For example, Equation 4.6-12 shows how the number of 1990 model year LDGT1s operating in 1995 was calculated.

$$\begin{matrix} 1990 \; Model \; Year \; LDGT1s \\ Operating \; in \; 1995 \end{matrix} = \begin{matrix} Total \; Model \; Year \; 1990 \\ Trucks \; Operating \; in \; 1995 \end{matrix} \times \frac{1990 \; Model \; Year \; LDGT1s \; Sold}{Total \; 1990 \; Model \; Year \; Trucks \; Sold} \quad \text{(Eq. 4.6-12)}$$

This process was applied to all five truck types for model years 1971 through 1995. With the number of trucks in operation 1995 by truck type and model year, the 1995 registration distribution for each truck type was calculated by dividing the number of trucks operating in 1995 from a given model year by the total number of trucks operating in 1995 for that particular truck category.

The 1996 truck registration distributions were projected from the data calculated for the 1995 truck registration distributions. The calculated numbers of trucks in operation in 1995 for each truck class by model year were projected to the numbers of trucks in operation in 1996 for each truck class by model year by multiplying the number of trucks in operation in 1995 by truck survival rates (Miaou, 1990) to obtain the corresponding numbers that would have survived to 1996. This is the same as the process used to project the 1995 car registration distribution to 1996. As with the procedure for cars, estimates of the number of 1995 and 1996 model year trucks operating in 1996 were calculated separately. All of the 1995 model year trucks would not have been sold by the end of the 1995 calendar year. Therefore, the number of 1995 model year trucks operating in 1996 should represent an increase over the number of 1995 trucks operating in 1995, and a survival rate of 1995 cars to 1996 should be factored in. Truck sales for 1996 were estimated as 50 percent of the 1995 sales figures for each of the truck categories. (The truck model year is assumed to start in January, so half of the model year trucks would be sold by July 1.) As with the development of the 1995 truck registration distributions, the last step in calculating the 1996 truck registration distribution was to divide the number of trucks in operation in each model year by the total number of estimated trucks in operation in 1996.

The PART5 modeling requires that user-supplied registration distributions include a separate distribution for each of the five HDDV subcategories (Class2B HDDVs, Light HDDVs, Medium HDDVs, Heavy HDDVs, and Buses). The procedures described above were used to calculate the distributions for these additional vehicle subcategories. The table below shows how the sales for each of these five HDDV categories were calculated. All of the relevant sales data came from *Facts and Figures*. Once the sales data were extracted for each of these HDDV categories, the above procedures were applied individually to each category to obtain the five separate HDDV registration distributions required by PART5.

Truck Class	Data Used to Calculate Truck Sales
2B HDDVs	0.90 *U.S. Factory Sales of Diesel Trucks 6,001 to 10,000 lb GVWR
Light HDDVs	U.S. Factory Sales of Diesel Trucks 10,001 to 19,500 lb GVWR
Medium HDDVs	U.S. Factory Sales of Diesel Trucks 19,501 to 33,000 lb GVWR
Heavy HDDVs	U.S. Factory Sales of Diesel Trucks 33,001 lb GVWR - Factory Bus Sales
Buses	Factory Bus Sales

Registration distributions input to MOBILE5a should be expressed as a July 1 registration distribution. Internally, the model can than adjust this registration distribution to represent either a January 1 or a July 1 registration distribution, depending on the user selected setting of the month flag. When modeling months from January through June, the month flag within the MOBILE5a input files was set to “1” to simulate January registration distributions. For months from July through December, the flag was set to “2” to model July registration distribution.

4.6.2.6.3 Local Registration Distributions for 1990, 1995, and 1996 —

For the 1990, 1995, and 1996 MOBILE5b modeling, the national registration distributions were replaced in some states by state-provided data. The state-provided data were extracted from the registration distributions provided by the states for the OTAG modeling. In some states, a single registration distribution applied to the entire state. In other states, different registration distributions applied to different groupings of counties, such as nonattainment areas or MSAs. Since these state-provided registration distributions did not vary by year, the same distributions were applied in 1995 and 1996. All of the state-supplied registration distributions included only a single distribution for HDDVs, since they were all created for use with MOBILE. To use the state-supplied distributions in PART5, the HDDV distributions were replicated for each of the PART5 HDDV subcategories. Figure 4.6-1 shows each state-supplied registration distribution used in the Trends modeling, in MOBILE5b format. Along with each distribution is a list of the state or counties that the distribution was applied to.

4.6.2.7 MONTH Flag

Registration distributions input to MOBILE5b are expressed as July 1 registration distributions. Internally, the model then adjusts this registration distribution to represent either a January 1 or a July 1 registration distribution, depending on the user selected setting of the MONTH flag. When modeling months from January through June, the MONTH flag within the MOBILE5b input files was set to “1” to simulate January registration distributions. For months from July through December, the flag was set to “2” to model July registration distributions.

4.6.2.8 Additional Area Specific Inputs from OTAG

In addition to the inputs discussed above, several additional MOBILE5b inputs were supplied by the states for the OTAG modeling and incorporated into the Trends MOBILE5b input files. These inputs are listed below followed by the states that provided the inputs:

- trip length distributions (DC, MD, TX, and VA)
- alcohol fuel market shares (GA, IL, IN, MI, MO, and WI)
- diesel sales shares (DE, MD, and VA)

The state-supplied trip length distribution data were applied in 1995, 1996, and the projection years. Table 4.6-17 summarizes the state-supplied trip length distribution data. The alcohol fuel market share data were applied only in the 1995 and 1996 modeling. Table 4.6-18 lists the alcohol fuel market share data supplied by and modeled for the listed states. As with the alcohol fuel data, the state-supplied diesel sales shares were modeled only in 1995 and 1996. Table 4.6-19 shows the diesel sales data modeled for the listed states. For all other states, the MOBILE5b model defaults were assumed for these variables.

4.6.2.9 Control Program Inputs

4.6.2.9.1 Inspection and Maintenance (I/M) Programs —

Modeling an I/M program in MOBILE requires the most complex set of inputs of any highway vehicle control program. The sources used for developing the necessary I/M program inputs included the I/M program inputs supplied by states to the OTAG process, a summary prepared by OMS showing the basic characteristics of I/M programs planned by the states,[17] past OMS I/M program summaries showing characteristics of historical or current I/M programs in each state, and inputs prepared for previous Trends inventories.

For states that had an I/M program in place in one or more counties in the year being modeled, at least one additional MOBILE input file was created that modeled the characteristics of the I/M program in that state. All other inputs (such as temperature, RVP, speeds, etc.) were identical to the no I/M input file modeled for the state in the year being analyzed. The determination of whether or not a county had an I/M program in place in a given year was based on a series of I/M program summaries released by OMS. Emission factors calculated with I/M benefits in a given inventory year were applied only to counties having an I/M program in place in December of the prior year. I/M program characteristics were also included in the I/M program summaries. These program characteristics vary by state and in some cases by nonattainment area or county within a particular state. The effectiveness statistics used as MOBILE5 inputs varied by state based on the characteristics of representative I/M programs in that state.

For states where I/M programs varied within a given state, a single set of effectiveness statistics, based on a combination of characteristics of all the I/M programs within the state, was used as an I/M input to the model. In some cases, the characteristics of the different programs within a specific state could not be adequately modeled using some average of the I/M program characteristics. In these cases, multiple I/M programs were modeled for these states, with the appropriate I/M programs applied to the corresponding counties.

A number of states provided data to OTAG that included MOBILE I/M program inputs and the counties that these inputs should be applied to. These state-provided I/M inputs replaced the OMS I/M program data for 1995 and 1996. states with I/M programs outside of the OTAG domain were modeled according to the I/M program parameters supplied by OMS. The specific inputs modeled for each area's I/M program in 1995 and 1996 are shown in table 4.6-14. This table also indicates whether the inputs applied in 1995, 1996, or both years. Table 4.6-15 shows which counties each set of I/M programs inputs were applied to.

4.6.2.9.2 Reformulated Gasoline —

Phase I of the Federal reformulated gasoline program began on January 1 of 1995. Phase I reformulated gasoline provides year-round toxic emission reductions and additional VOC emission reductions during the ozone season (May through September). The Clean Air Act Amendments of 1990 (CAAA) mandates that reformulated gasoline be applied in the nine most severe ozone nonattainment areas and allows additional nonattainment areas to opt in to the program. OMS provided a list of areas that participated in this program, which is included as table 4.6-20.

Reformulated gasoline was modeled in the appropriate MOBILE5b input files by setting the reformulated gasoline flag to "2", including the appropriate ASTM class of the area being modeled (B or C), and setting WINFLG (a hidden MOBILE5b flag) to "2". Setting WINFLG to "1" guarantees that the summer reformulated gasoline reductions are modeled regardless of the setting of the MONTH flag. For all other months, and for areas not included in the reformulated gasoline program, WINFLG is either set to "2" or not included (in which case the model defaults to a setting of "2").

4.6.2.9.3 Oxygenated Fuels —

The oxygenated fuel requirements of the 1990 CAAA took effect beginning in late 1992. Therefore, oxygenated fuel was modeled in the areas indicated by OMS, using the oxygenated fuel flag and the oxygenated fuel market share and oxygen content inputs in MOBILE. OMS provided a listing of areas participating in the oxygenated fuel program,[18] the months that each area used oxygenated fuel, and market share data indicating the percentage of ether blends versus alcohol blends in each oxygenated fuel area. The average oxygen content of ether blend fuels for all areas, except California, was assumed to be 2.7 percent while alcohol blend fuels were assumed to have an oxygen content of 3.5 percent. For California, the oxygen content of both ether blends and alcohol blends was modeled as 2 percent, based on documentation from OMS on how to model reformulated and oxygenated fuels in the CALI5 model. Table 4.6-16 lists the areas modeled with oxygenated fuels and the corresponding inputs used for these areas.

4.6.2.9.4 National Low Emission Vehicle (NLEV) Program —

A National Low Emission Vehicle (NLEV) program was modeled in the projection years, using EPA's most current, at the time the modeling was performed, assumptions about the characteristics of the proposed NLEV program. This program was modeled as starting in the Northeast Ozone Transport Commission (OTC) states in 1999, and the remaining (non-California) states in 2001. States in the OTC that had already adopted a LEV program on their own were modeled with the characteristics of the OTC-LEV program until the start date of the NLEV program. These states included Massachusetts, New York, and Connecticut. The implementation schedule of the NLEV program is shown below.

Model Year	Federal Tier I Standards	Transitional LEV Standards	LEV Standards
1999	30%	40%	30%
2000		40%	60%
2001 and later			100%

States in the OTC states that had already adopted a LEV program on their own at this time were modeled with the characteristics of the OTC-LEV program until the start date of the NLEV program. The states included Massachusetts, New York, and Connecticut (the program start years varied). The programs in Massachusetts and New York began with the 1996 model year. The Connecticut program began with the 1998 model year. The implementation schedule followed by these states prior to 1999 (the start year of the NLEV program) are based on the implementation schedule of the OTC-LEV program, and is shown below. Only the 1998 model year is applicable in Connecticut.

Model Year	Federal Tier I Standards	TLEV Standards	Intermediate LEV Standards	LEV Standards	Intermediate ULEV Standards	ULEV Standards
1996	80%	20%				
1997	73%		25%		2%	
1998	47%			51%		2%

These LEV implementation schedules differ from the MOBILE5b default LEV implementation schedule, which was designed to model the California LEV program. For the model to access the implementation schedule of the NLEV program, the PROMPT flag in the applicable MOBILE5b input files was set to '5' and the name of the file containing the NLEV implementation schedule was entered when prompted by MOBILE5b. In addition to setting the PROMPT flag, the REGION flag was set to '4' to properly model the NLEV program in the MOBILE5b input files. The setting of '4' for the REGION flag indicates that an additional line is being added to the input file to model a LEV program. The necessary inputs for this additional program line include the start year of the LEV program and whether an "appropriate" I/M program will be implemented in conjunction with the LEV program. The start year of the LEV program was set to "96" for input files modeling Massachusetts and New York, "98" for input files modeling Connecticut, "99" for input files modeling all other states within the OTC (including the Washington DC nonattainment area portion of Virginia), and "01" for all remaining states (including the remainder of Virginia), excepting California. With an "appropriate" I/M program, maximum benefits of the LEV program are modeled by MOBILE5b, implementing a lower set of deterioration rates.

The following table shows the emission standards of the Federal Tier I program, the transitional LEV (TLEV) standards, and LEV standards, and the Ultra-Low Emission Vehicle (ULEV) standards. These standards apply to the LDGV and LDGT1a classes of vehicles. The LDGT1b category is also included in the NLEV program, but the emission standards for these vehicles are slightly less stringent than those listed below for the lighter vehicles.

Emission Standard	Nonmethane Organic Gas (NMOG)	CO	NO_x
Federal Tier 1	0.250 grams/mile NMHC	3.4 grams/mile	0.40 grams/mile
Transitional LEV (TLEV)	0.125 grams/mile	3.4 grams/mile	0.40 grams/mile
LEV	0.075 grams/mile	3.4 grams/mile	0.20 grams/mile
Ultra-Low Emission Vehicle (ULEV)	0.040 grams/mile	1.7 grams/mile	0.20 grams/mile

4.6.2.9.5 Heavy-Duty Diesel Engine Corrections and Controls —

A correction was made to the basic emission rates (BERs) for HDDVs and 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 DR (the DR reflects how quickly the emission rate of a vehicle increases with time) for NO_x for HDDVs and NO_x and VOC for HDGVs. EPA believes that these default ZMLs and DRs in MOBILE5b are not reflective of actual heavy-duty vehicle emissions.[19] The corrected BERs input to MOBILE5b are shown below. These inputs were included in all of the 1995, 1996, and projection year input files, for both low and high altitude areas. In addition, the NEWFLG in the MOBILE5b input files was set to "2" to incorporate these additional input lines.

		NO_x		VOC	
Vehicle Category	Model Year	ZML (g/bhp-hr)	DR (g/bhp-hr/10k mi)	ZML (g/bhp-hr)	DR (g/bhp-hr/10k mi)
HDGV	1998 +	3.19	0.045		
HDGV	1994 +			0.364	0.023
HDDV	1994 - 2003			0.283	0.000

Note(s): g/bhp-hr = grams per brake horsepower-hour; k = 1,000

4.6.2.9.6 California —

California's highway vehicle fleet has been subject to different emission standards than the rest of the country. To account for these differences in basic emission rates, an EPA-modified version of MOBILE5a, referred to as CALI5, was used for California. Input files used with this model are essentially identical to MOBILE5a input files. The model internally handles the different emission standards. Temperature, RVP, speed, registration distribution, and operating mode inputs were developed for California in the same manner as they were for the rest of the nation. The primary difference in inputs is the earlier start date (1995) of the reformulated gasoline program in California. Using CALI5, this was modeled in the summer months for 1995 by setting the reformulated gasoline flag to "4". Phase II of California's reformulated gasoline program began on June 1, 1996. This was modeled by setting the reformulated gasoline flag to "5" starting with the June 1996 scenarios in the CALI5 input files and in all of the projection year files. In addition, California was also divided into two temperature regions to account for the differences in climate throughout the state.

California's low emission vehicle (LEV) program began in 1994. This was modeled in the CALI5 input files indicating a start year of 1994 for this program and minimum LEV credits. Because MOBILE5a did not include LDGT2s in the LEV modeling, this was carried forward to CALI5. However, California's LEV program does include LDGT2s. To model the LDGT2s in the LEV program, additional BER input lines were added that model the zero mile level (ZML) and deterioration rate (DR) of the California LEV program standard for LDGT2s. Two sets of basic emission rates (BERs) were developed—one modeling the maximum LEV benefits for LDGT2s and the other modeling the minimum benefits. (The maximum LEV benefits were applied in areas modeled with the high enhanced I/M program beginning in 2005.)

4.6.3 Development of PM and SO_2 Emission Factors

In 1994, EPA released a computer model, with the acronym PART5, that can be used to estimate particulate emission rates from in-use gasoline and diesel-fueled motor vehicles.[20] It calculates particle emission factors in grams per mile from on-road automobiles, trucks, and motorcycles, for particle sizes up to 10 microns. PART5 was used to calculate on-road vehicle PM-10 and PM-2.5 (PM-2.5 for the years 1990-1996 only) emission factors from vehicle exhaust, brake wear, tire wear, and reentrained road dust from paved and unpaved roads (see sections 4.8.2.3 and 4.8.2.4 for details on road dust emissions), and SO_2 vehicle exhaust emission factors.

Basic assumptions regarding inputs to PART5 were made that apply to all PART5 model runs, and include the following:

- The transient speed cycle was used.

- Any county with an existing I/M program was given I/M credit from PART5, regardless of the details of the I/M program. PART5 gives credit based on the assumption that high emitting vehicles will be forced to make emission reducing repairs and that an existing I/M program will deter tampering. This only affects lead and sulfate emissions from gasoline-powered vehicles.

- Using the input parameter BUSFLG, bus emission factors for all rural road types, urban interstates, and other freeways and expressways road types were modeled using the PART5 transit bus emission factors, while bus emission factors for all other urban road types were modeled using the PART5 Central Business District bus emission factors.

4.6.3.1 Registration Distribution

The vehicle registration distribution used was also common to all PART5 model runs. PART5 uses the same vehicle classifications as the MOBILE model, except that the MOBILE HDDV class is broken into five subclasses in PART5. Table 4.6-21 lists each vehicle class in PART5 along with its FHWA class and gross vehicle weight.

To maintain consistency with the NET Inventory, the year specific vehicle registration distribution used in the MOBILE modeling for the NET Inventory was adapted for this analysis. This registration distribution was modified by distributing the MOBILE HDDV vehicle class distribution among the five PART5 HDDV subclasses (2BHDDV, LHDDV, MHDDV, HHDDV, and BUSES). This was accomplished using HDDV subclass-specific sales, survival rates, and diesel market shares.

4.6.3.2 Speed

The speed inputs documented in Section 4.6.2.3 were used in the PART5 modeling as well, with the exception that the maximum allowable speed in PART5 is 55 mph, so the rural interstate speed was changed from 60 mph to 55 mph for the PART5 modeling (see table 4.6-22). Emission factors were calculated for each combination of state, I/M status, month, vehicle type, and speed. VMT data for each county/month/vehicle type/road type were mapped to the appropriate emission factor.

4.6.3.3 HDDV Vehicle Class Weighting

After PART5 emission factors are generated, the PART5 HDDV subclass emission factors (2BHDDV, LHDDV, MHDDV, HHDDV, and BUSES) are weighted together to develop a single HDDV emission factor, to correspond with the VMT data already developed for the NET Inventory. These weighting factors are based on truck VMT by weight and truck class from the *Truck Inventory and Use Survey*[21] and FHWA's *Highway Statistics*.[4]

4.6.3.4 Exhaust PM Emissions

Monthly, county-level, SCC-specific PM emissions from on-road vehicle exhaust components were calculated by multiplying year specific monthly county-level, SCC-specific VMT by year specific state-level, SCC-specific exhaust PM emission factors generated using PART5. Since none of the inputs affecting the calculation of the PM exhaust emission factors vary by month, only annual PM exhaust emission factors were calculated. PART5 total exhaust emission factors are the sum of lead, soluble organic fraction, remaining carbon portion, and direct SO_4 (sulfates) emission factors.

4.6.3.5 Exhaust SO_2 Emissions

National annual SO_2 on-road vehicle exhaust emission factors by vehicle type and speed were calculated using PART5. These emission factors calculated within PART5 vary according to fuel density, the weight percent of sulfur in the fuel, and the fuel economy of the vehicle (which varies by speed). None of these parameters vary by month or state. Monthly/county/SCC-specific SO_2 emissions were then calculated by multiplying each county's monthly VMT at the road type and vehicle type level by the SO_2 emission factor (calculated for each vehicle type and speed) that corresponds to the vehicle type and road type.

4.6.3.6 PM Brake Wear Emissions

The PART5 PM emission factors for brake wear are 0.013 grams per mile for PM-10 and ? grams per mile for PM-2.5. This value was applied to estimate brake wear emissions for all vehicle types.

4.6.3.7 PM Tire Wear Emissions

PART5 emission factors for tire wear are proportional to the average number of wheels per vehicle. The emission factor is 0.002 grams per mile per wheel for PM-10 and ? grams per mile per wheel for PM-2.5. Therefore, separate tire wear emission factors were calculated for each vehicle type. Estimates of the average number of wheels per vehicle by vehicle class were developed using information from the *Truck Inventory and Use Survey*.[21] Tire wear PM emissions were then calculated at the monthly/county/SCC level by multiplying the monthly/county/SCC level VMT by the tire wear emission factor for the appropriate vehicle type.

4.6.3.8 1970 to 1984 PM and SO_2 Emissions

Emission factors for 1970 to 1984 PM-10 and SO_2 were not calculated with PART5. Therefore, PM-10 and SO_2 emission factors using data from AP-42 and other applicable EPA documents. Emission factors for both of these pollutants were developed on a national basis by vehicle type for each year. The procedure followed for developing these emission factors is discussed below.

4.6.3.8.1 PM-10 Emission Factors —

On-road vehicle PM-10 emission factors were calculated using the methodology to develop the Regional Particulate Inventory for 1990.[22] National annual 1990 PM-10 emission factors were calculated for this inventory by vehicle type. Gasoline PM-10 exhaust emission factors were based on exhaust particulate emission factors specific to the technology type of the vehicle (i.e., catalyst vs. no catalyst) and model year group.[23] These basic exhaust emission factors were then applied within a spreadsheet to the corresponding portion of the vehicle fleet for each model year from age 1 to 25 comprising the 1990 fleet. Model year specific data indicating the fraction of vehicles with catalysts were obtained from the MOBILE5a source code.[8] After obtaining the model year weighted emission factor for each of the gasoline vehicle types, the model year specific emission factors were then weighted by the model year travel fraction, obtained using the by-model-year option in MOBILE5a that lists VMT fractions for each model year for the calendar year specified. These model year-weighted emission factors were then summed to obtain the fleet average exhaust particulate emission factor for each of the gasoline vehicle types. These particulate emission factors were then multiplied by the PM-10 particle size multiplier from AP-42. The PM-10 emission factors calculated for LDGVs were also applied to motorcycles.

The same procedure was applied to obtain 1970 and 1984 PM-10 exhaust emission factors for gasoline-fueled vehicles. PM-10 exhaust emission factors for the intermediate years were calculated by straight line interpolation. Total PM-10 emission factors were then calculated by adding the brake and tire wear PM-10 emission factors from AP-42 (which do not vary by year).

PM-10 emission factors from diesel vehicles were calculated using a similar methodology, but using data by model year and vehicle type for diesel particulate emission factors and diesel travel fractions.[24] Again, the particulate emission factors were multiplied by the AP-42 particle size multipliers to obtain PM-10 exhaust emission factors, and PM-10 brake and tire wear emission factors were added to the exhaust emission factors.

The PM-10 emission factors by vehicle type and year used in Emission Trends inventory are shown in table 4.6-23. These emission factors include the exhaust, brake, and tire wear components of PM-10.

4.6.3.8.2 SO_2 Emission Factors —

Equation 4.6-13 was used to calculate the on-road vehicle SO_2 emission factors by vehicle type.

$$SO_2EF_{x,y} = SULFCONT_{y,z} \times 0.98 \times FUELDENS_z \times 453.59 \times \frac{2}{FUELECON_{x,y}} \qquad \text{(Eq. 4.6-13)}$$

where:
- $SO_2EF_{x,y}$ = SO_2 emission factor for vehicle type x in year y (grams per mile)
- $SULFCONT_{y,z}$ = Sulfur content in year y for fuel type z (fractional value)
- $FUELDENS_z$ = Fuel density of fuel type z (pounds per gallon)
- $FUELECON_{x,y}$ = Fuel economy for vehicle type x in year y (miles per gallon)

The factor of 0.98 in the above equation represents the fraction of sulfur in the fuel that is converted to SO_2[25] while the 2 represents the weight molecular ratio of sulfur to SO_2. The remaining term (453.59) is the conversion from pounds to grams.

The value used for sulfur content of the fuel depends only on whether is gasoline-fueled or diesel-fueled. A fuel sulfur content of 0.000339 was used for gasoline-fueled vehicles based on the fuel sulfur content of EPA baseline fuel while a fuel sulfur content of 0.002[26] was used for diesel-fueled vehicles through September 1993. Fuel density values of 6.17 pounds per gallon for gasoline and 7.05 pounds per gallon for diesel were used in all years.[26]

Fleet average fuel economy varies slightly from year to year for each vehicle type. The values used for fuel economy from 1982 to 1984 were obtained from output from the draft MOBILE4.1 Fuel Consumption Model[27] for all vehicle types except motorcycles. 1982 was the earliest model year included in this output. Fuel economy values for 1970 through 1981 were estimated using fuel economy data from Highway Statistics.[4] Adjustments were made to the Highway Statistics fuel economy data since the vehicle classes included in Highway Statistics differ from the MOBILE vehicle classes and to smooth out the discontinuity in fuel economy estimates between the two sources from 1981 to 1982. This was done using Equation 4.6-14.

$$FE_{x,y} = FE(HS)_{x,y} \times \frac{FE(FCM)_{x,1982}}{FE(HS)_{x,1982}} \qquad \text{(Eq. 4.6-14)}$$

where:
- $FE_{x,y}$ = Fuel economy value for vehicle type x in year y used SO_2 emission factor calculations (mpg)
- $FE(HS)_{x,y}$ = Highway Statistics fuel economy for vehicle type x in year y (mpg)
- $FE(FCM)_{x,1982}$ = MOBILE4.1 Fuel Consumption Model fuel economy for vehicle type x in 1982
- $FE(HS)_{x,1982}$ = Highway Statistics fuel economy for vehicle type x in 1982

This equation was complicated by the differences in vehicle class definitions used in the MOBILE4.1 Fuel Consumption Model versus those used in Highway Statistics. Therefore, a singe light duty vehicle and a single light duty truck fuel economy value were calculated for each year. The weighing of gasoline and diesel vehicles was made using the same OMS apportionment as was used for allocating the HPMS VMT to the diesel and gasoline categories. Motorcycles were not included in the MOBILE4.1 Fuel consumption Model. Therefore, a fuel economy value of 50 mpg was used for motorcycles in all years from 1970 through 1984 based on AAMA motorcycle fuel economy data.[11] The fuel economy values used for each vehicle type and year are shown in table 4.6-24.

The resulting SO_2 emission factors by vehicle type and year are shown in table 4.6-25.

4.6.4 Calculation of Ammonia (NH_3) Emission Factors

Little research has been done to date on ammonia (NH_3) emission factors from motor vehicles. The most comprehensive vehicle testing including NH_3 emission factors available for use in this analysis is summarized in a report by Volkswagen AG.[19] In the testing program described in this report, 18 different Volkswagen/Audi vehicles from the 1978 through 1986 model years were tested. The vehicles were selected to represent a cross-section of the Volkswagen/Audi passenger car production program. The vehicles all had either 4 or 5 cylinder gasoline or diesel engines. Seven of the gasoline vehicles were equipped with 3-way catalysts with oxygen sensors, seven of the vehicles were diesel-fueled, and the remaining four vehicles were gasoline vehicles with no catalysts.

Emissions from each of these vehicles were measured using a chassis dynamometer over three different test procedures: the U.S. FTP, the U.S. Sulfate Emission Test (SET), and the U.S. Highway Driving Test. The FTP includes both cold and hot engine starts with a cumulative mileage of 11.1 miles over 505 seconds. The SET simulates 13.5 miles of travel on a freeway in Los Angeles with heavy traffic over a time of 1,398 seconds. The Highway Driving Test, also known as the Highway Fuel Economy Test (HFET), results in an average speed of 48.1 mph over 10.2 miles with a maximum speed of 59.9 mph. Both the SET and the HFET are hot start tests (no cold starts are included). Each vehicle was tested on all three test cycles on the same day, with three to five repeated measurements carried out for each vehicle on consecutive days.

The mean results of Volkswagen's emission testing program were reported for each of the 18 vehicles tested and for each of the test cycles. The report also shows the total mean value over all three tests by engine type (gasoline with catalyst, gasoline without catalyst, and diesel). These values accounting for all three test cycles were used in this analysis to calculate NH_3 emission since most types of driving would be included in one of the three test cycles (i.e., urban driving would be represented by the FTP; stop and go driving on expressways would be represented by the SET; and freeway driving would be represented by the HFET). These mean emission factors are shown below.

Engine Type	Mean NH_3 Emission Factor (grams/mile)
Gasoline Engine without Catalyst	0.00352
Gasoline Engine with 3-Way Catalyst	0.13743
Diesel Engine	0.00188

Using the NH_3 emission factors listed above, emission factors by vehicle type and model year were calculated using MOBILE5b data listing the fraction of vehicles with 3-way catalysts by vehicle type and travel fractions from MOBILE5b output by model year and vehicle type. For the Trends analysis, motorcycles were assigned the non-catalyst gasoline engine emission factor while all diesel vehicle types were assigned the diesel engine emission factor listed above.

To calculate the LDGV emission factor for 1995, a MOBILE5b run was made to produce by-model-year output for LDGVs in 1995. The by-model-year travel fractions were extracted from the resulting MOBILE5b output file. Then, for each of the 25 model years included in the by-model-year output, a weighted emission factor was calculated by multiplying the fraction of LDGVs with 3-way catalysts in that model year by the emission factor listed above for gasoline engines with 3-way catalysts (i.e., 0.13743 g/mi) and adding to this the product of the fraction of LDGVs without 3-way catalysts in that model year and the emission factor for gasoline engines without 3-way catalysts (i.e., 0.00352 g/mi). This weighted emission factor was then multiplied by the LDGV travel fraction for that model year, giving a model year-weighted emission factor. This procedure was repeated for each of the 25 model years included in the by-model-year output for 1995 and the 25 model-year weighted emission factors were then summed to give the composite 1995 LDGV NH_3 emission factor.

The above procedure was repeated for 1995, 1996, and each projection year for LDGVs, LDGT1s, LDGT2s, and HDGVs. Table 4.6-26 summarizes the catalyst fractions used in this analysis by model year and vehicle type. The resulting NH_3 emission factors by year and vehicle type are shown in table 4.6-27. These emission factors were used in calculating NH_3 highway vehicle emissions for all counties in the United States without exception. Note that the NH_3 emission factors for each gasoline vehicle type increase with time as the fraction of vehicles with 3-way catalysts increases, since the Volkswagen study showed that NH_3 emission factors for gasoline vehicles with catalysts are significantly higher than those for vehicles without catalysts.

4.6.5 Calculation of Emissions

Once the emission factors for all pollutants and VMT were calculated at the level of detail described above for 1995, 1996, and each of the projection years, emissions were calculated by multiplying the appropriate emission factors by the corresponding VMT values. Emissions for the MOBILE5b pollutants (VOC, NO_x, and CO) were calculated with emission factors and VMT at the month, county, roadway type, and vehicle type (for the eight MOBILE5b vehicle types) level of detail. The emission factors for the PART5 pollutants (PM-10, PM-2.5, and SO_2) did not vary by month, so the same emission factors were multiplied by the monthly VMT at the county, roadway type, and vehicle type (for the 12 PART5 vehicle types) level of detail. Ammonia emission factors varied only by vehicle type, so the eight emission factors by vehicle type were multiplied by VMT representing the same vehicle type at the monthly, county, and roadway type level of detail. Emissions for all pollutants were calculated by multiplying the appropriate emission factor in grams per mile by the corresponding VMT in millions of miles, and then converting the answer to units of tons of emissions.

Emission factors were not calculated separately for each county. To determine the emission factor sets to be modeled in each State, a county-level database was prepared for each year modeled. For each county, the control programs applicable in that year were indicated. The data base also included information on non-default inputs to be modeled, such as registration distributions and other State-supplied data from OTAG, for each county. Next, for each State, all unique combinations of control programs and other non-default inputs were determined for each modeled year. MOBILE5b model runs were then made modeling each of these unique combinations. Each combination was identified using the county code of one of the counties with this combination of controls and inputs. To apply the emission factors to the appropriate counties, a county correspondence file was developed which mapped all counties with the same unique set of input data and control programs to the MOBILE5b emission factors modeled for the county representing that unique combination of inputs and control programs. In some States, a single set of emission factors was applied to all counties in the State, while in other States, a separate set of emission factors was calculated for each county. Most States, however, fell in between these two extremes with several sets of emission factors calculated for the State, with each set applying to one or more counties within the State. A similar process was followed in mapping the PART5 emission factors to the appropriate counties.

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Table 4.6-1. Data Components of HPMS

Universe - All Road Mileage	
Identification	Contains state, county, and rural/small urbanized codes and a unique identification of location reference. Optionally, the latitude and longitude coordinates for the beginning and ending points of universe and sample sections are provided.
System	Provides for coding of functional system and federal-aid system.
Jurisdiction	Provides for coding of state or local highway system and special funding category.
Operation	Includes type of facility, truck prohibition, and toll.
Other	Contains length of highway section and fields for the coding of AADT and the number of through lanes.
Sample - Statistical Sample of Universe	
Identification	Contains unique identification for the sample section portion of the record.
Computational Elements	Provides data items used to expand sample information to universe values.
Pavement Attributes	Contains data items used to evaluate the physical characteristics of pavement, pavement performance, and the need for pavement overlays.
Improvements	Describes the improvement type for the year of the improvement completion.
Geometrics/ Configuration	Describes the physical attributes used to evaluate the capacity and operating characteristics of the facility.
Traffic/Capacity	Provides operational data items used to calculate the capacity of a section and the need for improvements.
Environment	Contains items that marginally affect the operation of a facility but are important to its structural integrity.
Supplemental Data	Provides linkage to existing structure and railroad crossing information systems.
Areawide - State Summaries	
Mileage	Road mileage
Travel	Vehicle miles traveled, percent travel by vehicle type
Accidents	Number of accidents
Injuries	Number of injuries
Population	Area population

Table 4.6-2. Apportionment Percentages for Conversion of HPMS Vehicle Type Categories to MOBILE5a Categories

HPMS Vehicle Type Category	MOBILE5a Vehicle Type Category and Apportionment Percentages	
Motorcycle	MC	1.0000
Passenger Car	LDGV	0.9864
	LDDV	0.0136
Other 2-Axle, 4-tire	LDGT1	0.6571
	LDGT2	0.3347
	LDDT	0.0082
Buses	HDGV	0.1028
	HDDV	0.8972
Other Single Unit Trucks	HDGV	0.7994
	HDDV	0.2006
Combination Trucks	HDDV	1.0000

Table 4.6-3. VMT Seasonal and Monthly Temporal Allocation Factors

	Roadway	Seasonal VMT Factors			
Vehicle Type	Type	Winter	Spring	Summer	Fall
LDV, LDT, MC	Rural	0.2160	0.2390	0.2890	0.2560
LDV, LDT, MC	Urban	0.2340	0.2550	0.2650	0.2450
HDV	All	0.2500	0.2500	0.2500	0.2500

	Roadway	Monthly VMT Factors: Non-Leap Years--1995, 1999, 2002, 2005, 2007, 2010											
Vehicle Type	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LDV, LDT, MC	Rural	0.0744	0.0672	0.0805	0.0779	0.0805	0.0942	0.0974	0.0974	0.0844	0.0872	0.0844	0.0744
LDV, LDT, MC	Urban	0.0806	0.0728	0.0859	0.0832	0.0859	0.0864	0.0893	0.0893	0.0808	0.0835	0.0808	0.0806
HDV	All	0.0861	0.0778	0.0842	0.0815	0.0842	0.0815	0.0842	0.0842	0.0824	0.0852	0.0824	0.0861

	Roadway	Monthly VMT Factors: Leap Years--1996, 2000, 2008											
Vehicle Type	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LDV, LDT, MC	Rural	0.0736	0.0688	0.0805	0.0779	0.0805	0.0942	0.0974	0.0974	0.0844	0.0872	0.0844	0.0736
LDV, LDT, MC	Urban	0.0797	0.0746	0.0859	0.0832	0.0859	0.0864	0.0893	0.0893	0.0808	0.0835	0.0808	0.0797
HDV	All	0.0852	0.0797	0.0842	0.0815	0.0842	0.0815	0.0842	0.0842	0.0824	0.0852	0.0824	0.0852

Table 4.6-4. 1995 to 1996 VMT Growth Factors by State and Roadway Type

State	Rural Roadway Type	Growth Factor	Urban Roadway Type	Growth Factor
Alabama	INTERSTATE	1.021	INTERSTATE	1.000
Alabama	OTHER PRINCIPAL ARTERIAL	0.986	OTH FREEWAYS & EXPRESSWAYS	1.006
Alabama	MINOR ARTERIAL	1.005	OTHER PRINCIPAL ARTERIAL	0.999
Alabama	MAJOR COLLECTOR	1.035	MINOR ARTERIAL	0.989
Alabama	MINOR COLLECTOR	0.999	COLLECTOR	0.983
Alabama	LOCAL	1.005	LOCAL	1.005
Alaska	INTERSTATE	0.993	INTERSTATE	1.018
Alaska	OTHER PRINCIPAL ARTERIAL	0.991	OTH FREEWAYS & EXPRESSWAYS	NA
Alaska	MINOR ARTERIAL	1.026	OTHER PRINCIPAL ARTERIAL	1.010
Alaska	MAJOR COLLECTOR	1.022	MINOR ARTERIAL	0.993
Alaska	MINOR COLLECTOR	1.001	COLLECTOR	1.046
Alaska	LOCAL	1.007	LOCAL	1.008
Arizona	INTERSTATE	1.023	INTERSTATE	1.013
Arizona	OTHER PRINCIPAL ARTERIAL	0.981	OTH FREEWAYS & EXPRESSWAYS	1.031
Arizona	MINOR ARTERIAL	1.006	OTHER PRINCIPAL ARTERIAL	1.015
Arizona	MAJOR COLLECTOR	1.011	MINOR ARTERIAL	1.014
Arizona	MINOR COLLECTOR	1.017	COLLECTOR	1.015
Arizona	LOCAL	1.013	LOCAL	1.015
Arkansas	INTERSTATE	1.033	INTERSTATE	1.009
Arkansas	OTHER PRINCIPAL ARTERIAL	1.028	OTH FREEWAYS & EXPRESSWAYS	1.031
Arkansas	MINOR ARTERIAL	1.011	OTHER PRINCIPAL ARTERIAL	1.005
Arkansas	MAJOR COLLECTOR	1.009	MINOR ARTERIAL	1.024
Arkansas	MINOR COLLECTOR	0.970	COLLECTOR	1.028
Arkansas	LOCAL	1.012	LOCAL	1.017
California	INTERSTATE	1.041	INTERSTATE	1.023
California	OTHER PRINCIPAL ARTERIAL	1.009	OTH FREEWAYS & EXPRESSWAYS	1.033
California	MINOR ARTERIAL	1.028	OTHER PRINCIPAL ARTERIAL	1.028
California	MAJOR COLLECTOR	1.028	MINOR ARTERIAL	1.028
California	MINOR COLLECTOR	1.028	COLLECTOR	1.028
California	LOCAL	1.028	LOCAL	1.028
Colorado	INTERSTATE	1.034	INTERSTATE	1.032
Colorado	OTHER PRINCIPAL ARTERIAL	1.010	OTH FREEWAYS & EXPRESSWAYS	1.063
Colorado	MINOR ARTERIAL	1.025	OTHER PRINCIPAL ARTERIAL	1.006
Colorado	MAJOR COLLECTOR	0.977	MINOR ARTERIAL	1.015
Colorado	MINOR COLLECTOR	1.020	COLLECTOR	1.001
Colorado	LOCAL	1.013	LOCAL	1.003
Connecticut	INTERSTATE	1.029	INTERSTATE	1.012
Connecticut	OTHER PRINCIPAL ARTERIAL	1.026	OTH FREEWAYS & EXPRESSWAYS	1.001
Connecticut	MINOR ARTERIAL	1.014	OTHER PRINCIPAL ARTERIAL	1.036
Connecticut	MAJOR COLLECTOR	0.986	MINOR ARTERIAL	1.015
Connecticut	MINOR COLLECTOR	1.016	COLLECTOR	1.016
Connecticut	LOCAL	1.016	LOCAL	1.016
DC	INTERSTATE	NA	INTERSTATE	1.041
DC	OTHER PRINCIPAL ARTERIAL	NA	OTH FREEWAYS & EXPRESSWAYS	0.956
DC	MINOR ARTERIAL	NA	OTHER PRINCIPAL ARTERIAL	0.969
DC	MAJOR COLLECTOR	NA	MINOR ARTERIAL	0.983

Table 4.6-4 (continued)

State	Rural Roadway Type	Growth Factor	Urban Roadway Type	Growth Factor
DC	MINOR COLLECTOR	NA	COLLECTOR	0.985
DC	LOCAL	NA	LOCAL	0.987
Delaware	INTERSTATE	NA	INTERSTATE	1.013
Delaware	OTHER PRINCIPAL ARTERIAL	1.015	OTH FREEWAYS & EXPRESSWAYS	1.066
Delaware	MINOR ARTERIAL	1.001	OTHER PRINCIPAL ARTERIAL	1.017
Delaware	MAJOR COLLECTOR	1.007	MINOR ARTERIAL	1.004
Delaware	MINOR COLLECTOR	1.036	COLLECTOR	0.975
Delaware	LOCAL	1.011	LOCAL	1.011
Florida	INTERSTATE	1.041	INTERSTATE	1.043
Florida	OTHER PRINCIPAL ARTERIAL	1.010	OTH FREEWAYS & EXPRESSWAYS	1.028
Florida	MINOR ARTERIAL	1.030	OTHER PRINCIPAL ARTERIAL	1.029
Florida	MAJOR COLLECTOR	1.009	MINOR ARTERIAL	1.016
Florida	MINOR COLLECTOR	1.031	COLLECTOR	1.051
Florida	LOCAL	1.028	LOCAL	1.031
Georgia	INTERSTATE	1.041	INTERSTATE	1.050
Georgia	OTHER PRINCIPAL ARTERIAL	1.044	OTH FREEWAYS & EXPRESSWAYS	1.061
Georgia	MINOR ARTERIAL	1.047	OTHER PRINCIPAL ARTERIAL	1.014
Georgia	MAJOR COLLECTOR	1.029	MINOR ARTERIAL	1.048
Georgia	MINOR COLLECTOR	1.010	COLLECTOR	1.017
Georgia	LOCAL	1.057	LOCAL	1.011
Hawaii	INTERSTATE	NA	INTERSTATE	0.980
Hawaii	OTHER PRINCIPAL ARTERIAL	0.971	OTH FREEWAYS & EXPRESSWAYS	0.935
Hawaii	MINOR ARTERIAL	1.018	OTHER PRINCIPAL ARTERIAL	0.974
Hawaii	MAJOR COLLECTOR	0.980	MINOR ARTERIAL	0.979
Hawaii	MINOR COLLECTOR	0.984	COLLECTOR	0.979
Hawaii	LOCAL	0.981	LOCAL	0.979
Idaho	INTERSTATE	1.022	INTERSTATE	1.041
Idaho	OTHER PRINCIPAL ARTERIAL	0.999	OTH FREEWAYS & EXPRESSWAYS	NA
Idaho	MINOR ARTERIAL	1.015	OTHER PRINCIPAL ARTERIAL	1.005
Idaho	MAJOR COLLECTOR	1.025	MINOR ARTERIAL	0.997
Idaho	MINOR COLLECTOR	1.012	COLLECTOR	0.988
Idaho	LOCAL	1.013	LOCAL	1.014
Illinois	INTERSTATE	1.021	INTERSTATE	1.020
Illinois	OTHER PRINCIPAL ARTERIAL	1.042	OTH FREEWAYS & EXPRESSWAYS	1.018
Illinois	MINOR ARTERIAL	1.014	OTHER PRINCIPAL ARTERIAL	1.005
Illinois	MAJOR COLLECTOR	0.997	MINOR ARTERIAL	1.032
Illinois	MINOR COLLECTOR	1.018	COLLECTOR	1.019
Illinois	LOCAL	1.019	LOCAL	1.019
Indiana	INTERSTATE	1.001	INTERSTATE	1.010
Indiana	OTHER PRINCIPAL ARTERIAL	1.004	OTH FREEWAYS & EXPRESSWAYS	1.037
Indiana	MINOR ARTERIAL	1.006	OTHER PRINCIPAL ARTERIAL	0.991
Indiana	MAJOR COLLECTOR	0.998	MINOR ARTERIAL	0.988
Indiana	MINOR COLLECTOR	1.001	COLLECTOR	1.009
Indiana	LOCAL	1.001	LOCAL	1.001
Iowa	INTERSTATE	1.020	INTERSTATE	1.041
Iowa	OTHER PRINCIPAL ARTERIAL	1.024	OTH FREEWAYS & EXPRESSWAYS	NA
Iowa	MINOR ARTERIAL	1.009	OTHER PRINCIPAL ARTERIAL	1.015

Table 4.6-4 (continued)

State	Rural Roadway Type	Growth Factor	Urban Roadway Type	Growth Factor
Iowa	MAJOR COLLECTOR	1.009	MINOR ARTERIAL	0.991
Iowa	MINOR COLLECTOR	1.036	COLLECTOR	1.090
Iowa	LOCAL	0.913	LOCAL	1.001
Kansas	INTERSTATE	1.034	INTERSTATE	1.041
Kansas	OTHER PRINCIPAL ARTERIAL	1.023	OTH FREEWAYS & EXPRESSWAYS	1.091
Kansas	MINOR ARTERIAL	1.009	OTHER PRINCIPAL ARTERIAL	0.996
Kansas	MAJOR COLLECTOR	0.988	MINOR ARTERIAL	0.991
Kansas	MINOR COLLECTOR	1.012	COLLECTOR	0.947
Kansas	LOCAL	1.011	LOCAL	0.956
Kentucky	INTERSTATE	1.030	INTERSTATE	1.016
Kentucky	OTHER PRINCIPAL ARTERIAL	1.012	OTH FREEWAYS & EXPRESSWAYS	0.991
Kentucky	MINOR ARTERIAL	1.005	OTHER PRINCIPAL ARTERIAL	1.025
Kentucky	MAJOR COLLECTOR	1.013	MINOR ARTERIAL	1.006
Kentucky	MINOR COLLECTOR	1.018	COLLECTOR	0.992
Kentucky	LOCAL	1.015	LOCAL	1.009
Louisiana	INTERSTATE	1.043	INTERSTATE	1.023
Louisiana	OTHER PRINCIPAL ARTERIAL	1.050	OTH FREEWAYS & EXPRESSWAYS	1.029
Louisiana	MINOR ARTERIAL	1.033	OTHER PRINCIPAL ARTERIAL	1.013
Louisiana	MAJOR COLLECTOR	1.014	MINOR ARTERIAL	1.043
Louisiana	MINOR COLLECTOR	1.046	COLLECTOR	1.007
Louisiana	LOCAL	1.022	LOCAL	1.029
Maine	INTERSTATE	1.035	INTERSTATE	1.039
Maine	OTHER PRINCIPAL ARTERIAL	1.017	OTH FREEWAYS & EXPRESSWAYS	0.998
Maine	MINOR ARTERIAL	1.011	OTHER PRINCIPAL ARTERIAL	1.000
Maine	MAJOR COLLECTOR	1.012	MINOR ARTERIAL	1.000
Maine	MINOR COLLECTOR	1.028	COLLECTOR	1.062
Maine	LOCAL	1.034	LOCAL	1.021
Maryland	INTERSTATE	1.015	INTERSTATE	1.016
Maryland	OTHER PRINCIPAL ARTERIAL	1.018	OTH FREEWAYS & EXPRESSWAYS	1.021
Maryland	MINOR ARTERIAL	1.007	OTHER PRINCIPAL ARTERIAL	1.009
Maryland	MAJOR COLLECTOR	1.021	MINOR ARTERIAL	1.016
Maryland	MINOR COLLECTOR	1.061	COLLECTOR	0.998
Maryland	LOCAL	1.016	LOCAL	1.016
Massachusetts	INTERSTATE	1.028	INTERSTATE	1.015
Massachusetts	OTHER PRINCIPAL ARTERIAL	1.012	OTH FREEWAYS & EXPRESSWAYS	1.020
Massachusetts	MINOR ARTERIAL	0.992	OTHER PRINCIPAL ARTERIAL	1.022
Massachusetts	MAJOR COLLECTOR	1.015	MINOR ARTERIAL	1.000
Massachusetts	MINOR COLLECTOR	1.013	COLLECTOR	1.015
Massachusetts	LOCAL	1.014	LOCAL	1.014
Michigan	INTERSTATE	1.013	INTERSTATE	1.010
Michigan	OTHER PRINCIPAL ARTERIAL	1.013	OTH FREEWAYS & EXPRESSWAYS	1.001
Michigan	MINOR ARTERIAL	1.015	OTHER PRINCIPAL ARTERIAL	0.965
Michigan	MAJOR COLLECTOR	1.014	MINOR ARTERIAL	1.021
Michigan	MINOR COLLECTOR	1.001	COLLECTOR	1.001
Michigan	LOCAL	1.001	LOCAL	0.960
Minnesota	INTERSTATE	1.012	INTERSTATE	1.025
Minnesota	OTHER PRINCIPAL ARTERIAL	1.022	OTH FREEWAYS & EXPRESSWAYS	1.010

Table 4.6-4 (continued)

State	Rural Roadway Type	Growth Factor	Urban Roadway Type	Growth Factor
Minnesota	MINOR ARTERIAL	1.016	OTHER PRINCIPAL ARTERIAL	1.013
Minnesota	MAJOR COLLECTOR	1.002	MINOR ARTERIAL	1.014
Minnesota	MINOR COLLECTOR	1.015	COLLECTOR	1.026
Minnesota	LOCAL	0.988	LOCAL	1.018
Mississippi	INTERSTATE	1.042	INTERSTATE	1.034
Mississippi	OTHER PRINCIPAL ARTERIAL	1.044	OTH FREEWAYS & EXPRESSWAYS	1.149
Mississippi	MINOR ARTERIAL	0.999	OTHER PRINCIPAL ARTERIAL	1.005
Mississippi	MAJOR COLLECTOR	0.983	MINOR ARTERIAL	1.008
Mississippi	MINOR COLLECTOR	1.018	COLLECTOR	1.018
Mississippi	LOCAL	1.021	LOCAL	1.019
Missouri	INTERSTATE	1.042	INTERSTATE	1.011
Missouri	OTHER PRINCIPAL ARTERIAL	1.029	OTH FREEWAYS & EXPRESSWAYS	1.026
Missouri	MINOR ARTERIAL	1.004	OTHER PRINCIPAL ARTERIAL	0.987
Missouri	MAJOR COLLECTOR	1.022	MINOR ARTERIAL	1.017
Missouri	MINOR COLLECTOR	1.016	COLLECTOR	1.019
Missouri	LOCAL	1.016	LOCAL	1.017
Montana	INTERSTATE	0.981	INTERSTATE	1.010
Montana	OTHER PRINCIPAL ARTERIAL	0.998	OTH FREEWAYS & EXPRESSWAYS	NA
Montana	MINOR ARTERIAL	0.997	OTHER PRINCIPAL ARTERIAL	0.984
Montana	MAJOR COLLECTOR	1.013	MINOR ARTERIAL	1.000
Montana	MINOR COLLECTOR	1.000	COLLECTOR	0.886
Montana	LOCAL	1.044	LOCAL	1.000
Nebraska	INTERSTATE	1.042	INTERSTATE	1.053
Nebraska	OTHER PRINCIPAL ARTERIAL	0.998	OTH FREEWAYS & EXPRESSWAYS	1.020
Nebraska	MINOR ARTERIAL	1.040	OTHER PRINCIPAL ARTERIAL	1.028
Nebraska	MAJOR COLLECTOR	0.958	MINOR ARTERIAL	1.027
Nebraska	MINOR COLLECTOR	0.969	COLLECTOR	1.051
Nebraska	LOCAL	1.022	LOCAL	1.022
Nevada	INTERSTATE	1.022	INTERSTATE	1.034
Nevada	OTHER PRINCIPAL ARTERIAL	0.981	OTH FREEWAYS & EXPRESSWAYS	1.081
Nevada	MINOR ARTERIAL	1.071	OTHER PRINCIPAL ARTERIAL	0.983
Nevada	MAJOR COLLECTOR	1.076	MINOR ARTERIAL	0.981
Nevada	MINOR COLLECTOR	1.014	COLLECTOR	1.013
Nevada	LOCAL	1.014	LOCAL	1.013
New Hampshire	INTERSTATE	1.031	INTERSTATE	1.028
New Hampshire	OTHER PRINCIPAL ARTERIAL	1.027	OTH FREEWAYS & EXPRESSWAYS	1.059
New Hampshire	MINOR ARTERIAL	0.997	OTHER PRINCIPAL ARTERIAL	1.011
New Hampshire	MAJOR COLLECTOR	0.994	MINOR ARTERIAL	1.031
New Hampshire	MINOR COLLECTOR	1.021	COLLECTOR	1.021
New Hampshire	LOCAL	1.018	LOCAL	1.021
New Jersey	INTERSTATE	1.076	INTERSTATE	1.008
New Jersey	OTHER PRINCIPAL ARTERIAL	1.004	OTH FREEWAYS & EXPRESSWAYS	1.008
New Jersey	MINOR ARTERIAL	0.962	OTHER PRINCIPAL ARTERIAL	1.003
New Jersey	MAJOR COLLECTOR	0.985	MINOR ARTERIAL	0.970
New Jersey	MINOR COLLECTOR	1.010	COLLECTOR	1.002
New Jersey	LOCAL	1.001	LOCAL	1.001
New Mexico	INTERSTATE	1.031	INTERSTATE	1.044

Table 4.6-4 (continued)

State	Rural Roadway Type	Growth Factor	Urban Roadway Type	Growth Factor
New Mexico	OTHER PRINCIPAL ARTERIAL	0.988	OTH FREEWAYS & EXPRESSWAYS	0.694
New Mexico	MINOR ARTERIAL	1.006	OTHER PRINCIPAL ARTERIAL	1.002
New Mexico	MAJOR COLLECTOR	0.994	MINOR ARTERIAL	1.023
New Mexico	MINOR COLLECTOR	1.040	COLLECTOR	1.014
New Mexico	LOCAL	1.014	LOCAL	1.014
New York	INTERSTATE	1.019	INTERSTATE	1.018
New York	OTHER PRINCIPAL ARTERIAL	1.020	OTH FREEWAYS & EXPRESSWAYS	1.015
New York	MINOR ARTERIAL	1.004	OTHER PRINCIPAL ARTERIAL	1.011
New York	MAJOR COLLECTOR	0.977	MINOR ARTERIAL	1.011
New York	MINOR COLLECTOR	1.013	COLLECTOR	1.010
New York	LOCAL	1.012	LOCAL	1.011
North Carolina	INTERSTATE	1.043	INTERSTATE	1.037
North Carolina	OTHER PRINCIPAL ARTERIAL	1.031	OTH FREEWAYS & EXPRESSWAYS	1.033
North Carolina	MINOR ARTERIAL	1.011	OTHER PRINCIPAL ARTERIAL	1.004
North Carolina	MAJOR COLLECTOR	1.039	MINOR ARTERIAL	1.026
North Carolina	MINOR COLLECTOR	1.015	COLLECTOR	1.038
North Carolina	LOCAL	1.040	LOCAL	1.025
North Dakota	INTERSTATE	1.016	INTERSTATE	1.001
North Dakota	OTHER PRINCIPAL ARTERIAL	1.007	OTH FREEWAYS & EXPRESSWAYS	NA
North Dakota	MINOR ARTERIAL	0.996	OTHER PRINCIPAL ARTERIAL	1.062
North Dakota	MAJOR COLLECTOR	0.977	MINOR ARTERIAL	1.013
North Dakota	MINOR COLLECTOR	NA	COLLECTOR	1.010
North Dakota	LOCAL	1.017	LOCAL	1.010
Ohio	INTERSTATE	1.043	INTERSTATE	1.029
Ohio	OTHER PRINCIPAL ARTERIAL	1.017	OTH FREEWAYS & EXPRESSWAYS	1.034
Ohio	MINOR ARTERIAL	1.032	OTHER PRINCIPAL ARTERIAL	1.018
Ohio	MAJOR COLLECTOR	1.044	MINOR ARTERIAL	0.979
Ohio	MINOR COLLECTOR	0.985	COLLECTOR	0.976
Ohio	LOCAL	1.010	LOCAL	1.019
Oklahoma	INTERSTATE	1.047	INTERSTATE	1.018
Oklahoma	OTHER PRINCIPAL ARTERIAL	1.044	OTH FREEWAYS & EXPRESSWAYS	1.029
Oklahoma	MINOR ARTERIAL	1.044	OTHER PRINCIPAL ARTERIAL	1.016
Oklahoma	MAJOR COLLECTOR	1.023	MINOR ARTERIAL	1.045
Oklahoma	MINOR COLLECTOR	1.050	COLLECTOR	0.996
Oklahoma	LOCAL	1.024	LOCAL	1.016
Oregon	INTERSTATE	0.997	INTERSTATE	1.028
Oregon	OTHER PRINCIPAL ARTERIAL	0.995	OTH FREEWAYS & EXPRESSWAYS	1.037
Oregon	MINOR ARTERIAL	1.017	OTHER PRINCIPAL ARTERIAL	1.039
Oregon	MAJOR COLLECTOR	0.988	MINOR ARTERIAL	0.998
Oregon	MINOR COLLECTOR	1.011	COLLECTOR	1.010
Oregon	LOCAL	1.010	LOCAL	1.010
Pennsylvania	INTERSTATE	1.021	INTERSTATE	1.011
Pennsylvania	OTHER PRINCIPAL ARTERIAL	1.007	OTH FREEWAYS & EXPRESSWAYS	0.998
Pennsylvania	MINOR ARTERIAL	1.012	OTHER PRINCIPAL ARTERIAL	0.991
Pennsylvania	MAJOR COLLECTOR	1.018	MINOR ARTERIAL	1.015
Pennsylvania	MINOR COLLECTOR	1.077	COLLECTOR	0.987
Pennsylvania	LOCAL	1.010	LOCAL	1.010

Table 4.6-4 (continued)

State	Rural Roadway Type	Growth Factor	Urban Roadway Type	Growth Factor
Rhode Island	INTERSTATE	1.021	INTERSTATE	1.037
Rhode Island	OTHER PRINCIPAL ARTERIAL	1.018	OTH FREEWAYS & EXPRESSWAYS	1.002
Rhode Island	MINOR ARTERIAL	1.047	OTHER PRINCIPAL ARTERIAL	0.985
Rhode Island	MAJOR COLLECTOR	1.051	MINOR ARTERIAL	0.999
Rhode Island	MINOR COLLECTOR	1.013	COLLECTOR	1.013
Rhode Island	LOCAL	1.026	LOCAL	1.014
South Carolina	INTERSTATE	1.036	INTERSTATE	1.041
South Carolina	OTHER PRINCIPAL ARTERIAL	1.057	OTH FREEWAYS & EXPRESSWAYS	1.037
South Carolina	MINOR ARTERIAL	1.038	OTHER PRINCIPAL ARTERIAL	1.034
South Carolina	MAJOR COLLECTOR	1.058	MINOR ARTERIAL	1.025
South Carolina	MINOR COLLECTOR	1.042	COLLECTOR	1.041
South Carolina	LOCAL	1.042	LOCAL	1.042
South Dakota	INTERSTATE	1.035	INTERSTATE	1.020
South Dakota	OTHER PRINCIPAL ARTERIAL	1.019	OTH FREEWAYS & EXPRESSWAYS	1.024
South Dakota	MINOR ARTERIAL	1.005	OTHER PRINCIPAL ARTERIAL	1.004
South Dakota	MAJOR COLLECTOR	0.970	MINOR ARTERIAL	1.004
South Dakota	MINOR COLLECTOR	0.954	COLLECTOR	0.937
South Dakota	LOCAL	1.009	LOCAL	1.010
Tennessee	INTERSTATE	1.043	INTERSTATE	1.012
Tennessee	OTHER PRINCIPAL ARTERIAL	1.021	OTH FREEWAYS & EXPRESSWAYS	1.017
Tennessee	MINOR ARTERIAL	0.984	OTHER PRINCIPAL ARTERIAL	1.015
Tennessee	MAJOR COLLECTOR	1.049	MINOR ARTERIAL	1.017
Tennessee	MINOR COLLECTOR	0.893	COLLECTOR	1.061
Tennessee	LOCAL	1.017	LOCAL	1.017
Texas	INTERSTATE	1.042	INTERSTATE	1.023
Texas	OTHER PRINCIPAL ARTERIAL	1.052	OTH FREEWAYS & EXPRESSWAYS	1.016
Texas	MINOR ARTERIAL	1.044	OTHER PRINCIPAL ARTERIAL	1.013
Texas	MAJOR COLLECTOR	1.030	MINOR ARTERIAL	1.045
Texas	MINOR COLLECTOR	1.059	COLLECTOR	1.007
Texas	LOCAL	1.030	LOCAL	1.031
Utah	INTERSTATE	1.041	INTERSTATE	1.028
Utah	OTHER PRINCIPAL ARTERIAL	1.035	OTH FREEWAYS & EXPRESSWAYS	1.019
Utah	MINOR ARTERIAL	1.032	OTHER PRINCIPAL ARTERIAL	1.010
Utah	MAJOR COLLECTOR	0.994	MINOR ARTERIAL	1.041
Utah	MINOR COLLECTOR	1.029	COLLECTOR	1.029
Utah	LOCAL	1.030	LOCAL	1.029
Vermont	INTERSTATE	1.024	INTERSTATE	1.022
Vermont	OTHER PRINCIPAL ARTERIAL	1.008	OTH FREEWAYS & EXPRESSWAYS	1.008
Vermont	MINOR ARTERIAL	1.009	OTHER PRINCIPAL ARTERIAL	1.025
Vermont	MAJOR COLLECTOR	1.006	MINOR ARTERIAL	1.005
Vermont	MINOR COLLECTOR	1.012	COLLECTOR	1.013
Vermont	LOCAL	1.012	LOCAL	1.012
Virginia	INTERSTATE	1.006	INTERSTATE	1.000
Virginia	OTHER PRINCIPAL ARTERIAL	1.004	OTH FREEWAYS & EXPRESSWAYS	0.994
Virginia	MINOR ARTERIAL	0.988	OTHER PRINCIPAL ARTERIAL	1.004
Virginia	MAJOR COLLECTOR	1.000	MINOR ARTERIAL	0.999
Virginia	MINOR COLLECTOR	0.993	COLLECTOR	1.006

Table 4.6-4 (continued)

State	Rural Roadway Type	Growth Factor	Urban Roadway Type	Growth Factor
Virginia	LOCAL	0.998	LOCAL	1.002
Washington	INTERSTATE	1.000	INTERSTATE	1.017
Washington	OTHER PRINCIPAL ARTERIAL	1.000	OTH FREEWAYS & EXPRESSWAYS	1.013
Washington	MINOR ARTERIAL	0.984	OTHER PRINCIPAL ARTERIAL	1.024
Washington	MAJOR COLLECTOR	0.980	MINOR ARTERIAL	1.008
Washington	MINOR COLLECTOR	1.008	COLLECTOR	1.008
Washington	LOCAL	1.008	LOCAL	1.008
West Virginia	INTERSTATE	1.024	INTERSTATE	1.018
West Virginia	OTHER PRINCIPAL ARTERIAL	1.011	OTH FREEWAYS & EXPRESSWAYS	1.005
West Virginia	MINOR ARTERIAL	1.013	OTHER PRINCIPAL ARTERIAL	1.006
West Virginia	MAJOR COLLECTOR	1.024	MINOR ARTERIAL	0.999
West Virginia	MINOR COLLECTOR	1.031	COLLECTOR	0.986
West Virginia	LOCAL	1.009	LOCAL	1.013
Wisconsin	INTERSTATE	1.012	INTERSTATE	1.047
Wisconsin	OTHER PRINCIPAL ARTERIAL	1.030	OTH FREEWAYS & EXPRESSWAYS	1.018
Wisconsin	MINOR ARTERIAL	1.035	OTHER PRINCIPAL ARTERIAL	1.020
Wisconsin	MAJOR COLLECTOR	1.015	MINOR ARTERIAL	1.042
Wisconsin	MINOR COLLECTOR	1.029	COLLECTOR	1.028
Wisconsin	LOCAL	1.028	LOCAL	1.027
Wyoming	INTERSTATE	1.018	INTERSTATE	1.032
Wyoming	OTHER PRINCIPAL ARTERIAL	1.011	OTH FREEWAYS & EXPRESSWAYS	0.968
Wyoming	MINOR ARTERIAL	1.014	OTHER PRINCIPAL ARTERIAL	1.003
Wyoming	MAJOR COLLECTOR	1.006	MINOR ARTERIAL	0.999
Wyoming	MINOR COLLECTOR	1.048	COLLECTOR	0.976
Wyoming	LOCAL	1.015	LOCAL	1.008

Table 4.6-5. State-level Daily VMT Totals in the OTAG Inventory

STATE	1990 VMT (VMT/SUMMER DAY)
Alabama	130,293,139
Arkansas	64,893,375
Connecticut	80,795,439
Delaware	21,688,232
District of Columbia	9,512,227
Florida	301,401,066
Georgia	215,733,554
Illinois	254,405,708
Indiana	146,238,700
Iowa	70,914,717
Kansas	70,274,093
Kentucky	103,468,764
Louisiana	85,036,022
Maine	36,687,471
Maryland	124,790,087
Massachusetts	128,906,395
Michigan	244,651,250
Minnesota	119,486,368
Mississippi	75,306,141
Missouri	144,836,950
Nebraska	42,949,068
New Hampshire	30,337,965
New Jersey	177,882,767
New York	327,206,333
North Carolina	159,748,582
North Dakota	18,241,880
Ohio	249,268,477
Oklahoma	101,777,917
Pennsylvania	262,877,528
Rhode Island	22,482,474
South Carolina	106,001,636
South Dakota	21,648,546
Tennessee	143,924,247
Texas	456,338,143
Vermont	18,055,581
Virginia	184,879,090
West Virginia	47,716,623
Wisconsin	116,510,029
TOTAL	**4,917,166,586**

Table 4.6-6. Cities Used for Temperature Data Modeling from 1970 through 1996

State	City
Alabama	Birmingham
Alaska	Anchorage
Arizona	Phoenix
Arkansas	Little Rock
California	Los Angeles
California	San Francisco
Colorado	Denver
Connecticut	Hartford
Delaware	Dover
District of Columbia	Washington
Florida	Orlando (1974-1993)
Georgia	Atlanta
Hawaii	Honolulu
Idaho	Boise
Illinois	Springfield
Indiana	Indianapolis
Iowa	Des Moines
Kansas	Topeka
Kentucky	Louisville
Louisiana	Baton Rouge
Maine	Portland
Maryland	Baltimore
Massachusetts	Boston
Michigan	Detroit
Minnesota	Minneapolis
Mississippi	Jackson
Missouri	Springfield
Montana	Billings
Nebraska	Lincoln
Nevada	Las Vegas
New Hampshire	Concord
New Jersey	Newark
New Mexico	Albuquerque
New York	New York City
North Carolina	Greensboro
North Dakota	Bismarck
Ohio	Columbus
Oklahoma	Oklahoma City
Oregon	Eugene
Pennsylvania	Harrisburg (1970-1991), Middletown (1991-1993)
Rhode Island	Providence
South Carolina	Columbia
South Dakota	Pierre
Tennessee	Nashville
Texas	Dallas/Fort Worth (1974-1993)
Utah	Salt Lake City
Vermont	Montpelier
Virginia	Richmond
Washington	Seattle
West Virginia	Charleston
Wisconsin	Milwaukee
Wyoming	Casper

Table 4.6-7. Surrogate City Assignment

Nonattainment Area/MSA	State	Survey City
Albany-Schenectady-Troy, NY MSA	NY	New York City
Albuquerque, NM MSA	NM	Albuquerque
Allentown-Bethlehem, PA-NJ MSA	PA-NJ	Philadelphia
Altoona, PA MSA	PA	Philadelphia
Anchorage, AK MSA	AK	Cleveland
Anderson, SC MSA	SC	Atlanta
Appleton-Oshkosh-Neenah, WI MSA	WI	Chicago
Atlanta	GA	Atlanta
Atlantic City, NJ MSA	NJ	Philadelphia
Bakersfield, CA MSA	CA	San Francisco
Baltimore, MD MSA	MD	Washington, DC
Baton Rouge	LA	New Orleans
Beaumont-Port Arthur, TX MSA	TX	Dallas
Bennington Co., VT	VT	Boston
Birmingham, AL MSA	AL	Atlanta
Boston Metropolitan Area	MA	Boston
Boston Metropolitan Area	MA-NH	Boston
Bowling Green, KY	KY	Chicago
Buffalo-Niagara Falls, NY CMSA	NY	New York City
Canton, OH MSA	OH	Cleveland
Charleston, WV MSA	WV	Washington, DC
Charlotte-Gastonia-Rock Hill, NC-SC MSA	NC	Atlanta
Chattanooga, TN-GA MSA	GA-TN	Atlanta
Cherokee Co., SC	SC	Atlanta
Chester Co., SC	SC	Atlanta
Chicago-Gary-Lake County, IL-IN-WI CMSA	IL-IN-WI	Chicago
Chico, CA MSA	CA	San Francisco
Cincinnati-Hamilton, OH-KY-IN CMSA	OH-KY-IN	Cleveland
Cleveland Metropolitan Area	OH	Cleveland
Clinton Co., OH	OH	Cleveland
Colorado Springs, CO MSA	CO	Denver
Columbia, SC MSA	SC	Atlanta
Columbus, OH MSA	OH	Cleveland
Dallas-Ft. Worth, TX CMSA	TX	Dallas
Dayton-Springfield, OH MSA	OH	Cleveland
Denver-Boulder, CO CMSA	CO	Denver
Detroit-Ann Arbor, MI CMSA	MI	Detroit
Door Co., WI	WI	Chicago
Duluth, MN-WI MSA	MN	Minneapolis
Edmonson Co., KY	KY	Chicago
El Paso, TX MSA	TX	Albuquerque
Erie, PA MSA	PA	Cleveland
Essex Co., NY	NY	New York City
Evansville, IN-KY MSA	IN-KY	Chicago
Fairbanks, AK	AK	Cleveland
Fayetteville, NC MSA	NC	Atlanta
Flint, MI MSA	MI	Detroit

Table 4.6-7 (continued)

Nonattainment Area/MSA	State	Survey City
Fort Collins-Loveland, CO MSA	CO	Denver
Fresno, CA MSA	CA	San Francisco
Glens Falls, NY MSA	NY	New York City
Grand Rapids, MI MSA	MI	Chicago
Great Falls, MT MSA	MT	Billings
Greater Connecticut Metropolitan Area	CT	Boston
Greeley, CO MSA	CO	Denver
Greenbrier Co., WV	WV	Washington, DC
Greensboro-Winston-Salem-High Point PMSA	NC	Atlanta
Greenville-Spartanburg, SC MSA	SC	Atlanta
Hancock Co., ME	ME	Boston
Harrisburg-Lebanon-Carlisle, PA MSA	PA	Philadelphia
Hartford-New Britain-Middletown, CT	CT	Boston
Houston-Galveston-Brazoria, TX CMSA	TX	Dallas
Huntington-Ashland, WV-KY-OH MSA	WV-KY-OH	Washington, DC
Huntsville, AL MSA	AL	Chicago
Indianapolis, IN MSA	IN	Chicago
Jacksonville, FL MSA	FL	Miami
Janesville-Beloit, WI MSA	WI	Chicago
Jefferson Co., NY	NY	Philadelphia
Jersey Co., IL	IL	Chicago
Johnson City-Kingsport-Bristol, TN-VA MSA	TN	Atlanta
Johnstown, PA MSA	PA	Philadelphia
Josephine Co., OR	OR	Seattle
Kansas City, MO-KS MSA	MO	Kansas City
Kent and Queen Anne’s Cos., MD	MD	Philadelphia
Kewaunee Co., WI	WI	Chicago
Kings Co., CA	CA	San Francisco
Klamath Co., OR	OR	San Francisco
Knox Co., ME	ME	Boston
Knoxville, TN MSA	TN	Atlanta
Lafayette-West Lafayette, IN MSA	IN	Chicago
Lake Charles, LA MSA	LA	New Orleans
Lake Tahoe South Shore, CA	CA	San Francisco
Lancaster, PA MSA	PA	Philadelphia
Las Vegas, NV MSA	NV	Las Vegas
Lawrence Co., PA	PA	Cleveland
Lewiston, ME	ME	Boston
Lexington-Fayette, KY MSA	KY	Chicago
Lincoln Co., ME	ME	Boston
Livingston Co., KY	KY	St. Louis
Longmont, CO	CO	Denver
Longview-Marshall, TX MSA	TX	Dallas
Los Angeles-Anaheim-Riverside, CA CMSA	CA	Los Angeles
Los Angeles-South Coast Air Basin, CA	CA	Los Angeles
Louisville, KY-IN MSA	KY-IN	Chicago
Manchester, NH MSA	NH	Boston

Table 4.6-7 (continued)

Nonattainment Area/MSA	State	Survey City
Manitowoc Co., WI	WI	Chicago
Medford, OR MSA	OR	San Francisco
Memphis, TN-AR-MS MSA	TN-AR-MS	St. Louis
Miami-Fort Lauderdale, FL CMSA	FL	Miami
Milwaukee Metropolitan Area	WI	Chicago
Minneapolis-St. Paul, MN-WI MSA	MN-WI	Minneapolis
Missoula, MT	MT	Billings
Mobile, AL MSA	AL	New Orleans
Modesto, CA MSA	CA	San Francisco
Montgomery, AL MSA	AL	Atlanta
Muskegon, MI MSA	MI	Chicago
Nashville, TN MSA	TN	Atlanta
New Orleans, LA MSA	LA	New Orleans
New York-Northern New Jersey-Long Island CMSA	NY-NJ-CT	New York City
Norfolk-Virginia Beach-Newport News, VA MSA	VA	Washington, DC
Northampton Co., VA	VA	Washington, DC
Oklahoma City, OK MSA	OK	Dallas
Owensboro, KY MSA	KY	Atlanta
Paducah, KY	KY	Chicago
Parkersburg, WV	WV	Cleveland
Parkersburg-Marietta, WV-OH MSA	OH-WV	Cleveland
Philadelphia Metropolitan Area	PA-NJ-DE-MD	Philadelphia
Phoenix, AZ MSA	AZ	Phoenix
Pittsburgh-Beaver Valley, PA CMSA	PA	Philadelphia
Portland, ME	ME	Boston
Portland-Vancouver, OR-WA CMSA	OR-WA	Seattle
Portsmouth-Dover-Rochester, NH-ME MSA	ME-NH	Boston
Poughkeepsie, NY MSA	NY	New York City
Providence-Pawtucket-Fall River, RI-MA CMSA	MA-RI	Boston
Provo-Orem, UT MSA	UT	Denver
Raleigh-Durham, NC MSA	NC	Atlanta
Reading, PA MSA	PA	Philadelphia
Reno, NV MSA	NV	San Francisco
Richmond-Petersburg	VA	Washington, DC
Rochester, NY MSA	NY	Philadelphia
Sacramento, CA MSA	CA	San Francisco
Salt Lake City-Ogden, UT MSA	UT	Denver
San Antonio, TX MSA	TX	San Antonio
San Diego, CA MSA	CA	Los Angeles
San Francisco-Oakland-San Jose, CA CMSA	CA	San Francisco
San Joaquin Valley, CA	CA	San Francisco
Santa Barbara-Santa Maria-Lompoc, CA MSA	CA	Los Angeles
Scranton-Wilkes-Barre, PA MSA	PA	Philadelphia
Seattle-Tacoma, WA	WA	Seattle
Sheboygan, WI MSA	WI	Chicago
Smyth Co., VA	VA	Washington, DC
South Bend-Elkhart, IN	IN	Chicago

Table 4.6-7 (continued)

Nonattainment Area/MSA	State	Survey City
South Bend-Mishawaka, IN MSA	IN	Chicago
Southeast Desert Modified AQMA, CA	CA	Los Angeles
Spokane, WA MSA	WA	Seattle
Springfield, MA MSA	MA	Boston
St. Louis, MO-IL MSA	MO-IL	St. Louis
Steubenville-Weirton, OH-WV MSA	OH-WV	Cleveland
Stockton, CA MSA	CA	San Francisco
Sussex Co., DE	DE	Philadelphia
Syracuse, NY MSA	NY	New York City
Tampa-St. Petersburg-Clearwater, MSA	FL	Miami
Toledo, OH MSA	OH	Detroit
Tulsa, OK MSA	OK	Kansas City
Ventura Co., CA	CA	Los Angeles
Visalia-Tulare-Porterville, CA MSA	CA	San Francisco
Waldo Co., ME	ME	Boston
Walworth Co., WI	WI	Chicago
Washington, DC-MD-VA MSA	DC-MD-VA	Washington, DC
Wheeling, WV-OH MSA	WV-OH	Cleveland
Winnebago Co., WI	WI	Chicago
Winston-Salem, NC	NC	Atlanta
Worcester, MA MSA	MA	Boston
Yakima, WA MSA	WA	Seattle
York, PA MSA	PA	Philadelphia
Youngstown-Warren, OH MSA	OH	Cleveland
Yuba City, CA MSA	CA	San Francisco

Table 4.6-8. Substitute Survey City Assignment

Nonattainment Area/MSA	State	Original Survey City	New Survey City
Albany-Schenectady-Troy, NY MSA	NY	New York City	Cleveland
Allentown-Bethlehem, PA-NJ MSA	PA-NJ	Philadelphia	Cleveland
Altoona, PA MSA	PA	Philadelphia	Cleveland
Appleton-Oshkosh-Neenah, WI MSA	WI	Chicago	Minneapolis
Beaumont-Port Arthur, TX MSA	TX	Dallas	New Orleans
Bennington Co., VT	VT	Boston	Minneapolis
Bowling Green, KY	KY	Chicago	Cleveland
Buffalo-Niagara Falls, NY CMSA	NY	New York City	Cleveland
Charleston, WV MSA	WV	Washington, DC	Cleveland
Door Co., WI	WI	Chicago	Minneapolis
Edmonson Co., KY	KY	Chicago	Cleveland
Essex Co., NY	NY	New York City	Cleveland
Evansville, IN-KY MSA	IN-KY	Chicago	Cleveland
Glens Falls, NY MSA	NY	New York City	Cleveland
Grand Rapids, MI MSA	MI	Chicago	Detroit
Greenbrier Co., WV	WV	Washington, DC	Cleveland
Harrisburg-Lebanon-Carlisle, PA MSA	PA	Philadelphia	Cleveland
Huntington-Ashland, WV-KY-OH MSA	WV-KY-OH	Washington, DC	Cleveland
Huntsville, AL MSA	AL	Chicago	Atlanta
Indianapolis, IN MSA	IN	Chicago	Cleveland
Jefferson Co., NY	NY	Philadelphia	Cleveland
Jersey Co., IL	IL	Chicago	Cleveland
Johnstown, PA MSA	PA	Philadelphia	Cleveland
Kewaunee Co., WI	WI	Chicago	Minneapolis
Lafayette-West Lafayette, IN MSA	IN	Chicago	Cleveland
Lancaster, PA MSA	PA	Philadelphia	Cleveland
Longview-Marshall, TX MSA	TX	Dallas	New Orleans
Louisville, KY-IN MSA	KY-IN	Chicago	Cleveland
Manitowoc Co., WI	WI	Chicago	Minneapolis
Muskegon, MI MSA	MI	Chicago	Detroit
Northampton Co., VA	VA	Washington, DC	Atlanta
Oklahoma City, OK MSA	OK	Dallas	St. Louis
Paducah, KY	KY	Chicago	Cleveland
Pittsburgh-Beaver Valley, PA CMSA	PA	Philadelphia	Cleveland
Reading, PA MSA	PA	Philadelphia	Cleveland
Rochester, NY MSA	NY	Philadelphia	Cleveland
Sheboygan, WI MSA	WI	Chicago	Minneapolis
Smyth Co., VA	VA	Washington, DC	Atlanta
South Bend-Elkhart, IN	IN	Chicago	Cleveland
South Bend-Mishawaka, IN MSA	IN	Chicago	Cleveland
Syracuse, NY MSA	NY	New York City	Cleveland
Waldo Co., ME	ME	Boston	Minneapolis
Walworth Co., WI	WI	Chicago	Minneapolis
York, PA MSA	PA	Philadelphia	Cleveland

Table 4.6-9. Monthly RVP Values Modeled in 1995

State	Applicable Counties	1995 Monthly RVP (psi)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AL	Entire State	12.1	12.1	9.3	9.3	7.8	7.8	7.8	7.8	7.8	9.3	9.3	12.1
AK	Entire State	14.1	14.1	14.1	14.1	13.0	13.0	13.0	13.0	13.0	14.1	14.1	14.1
AZ	Entire State	8.7	7.9	7.2	7.2	6.8	6.8	6.8	6.8	6.8	6.8	7.2	7.9
AR	Entire State	13.8	13.8	10.0	10.0	7.1	7.1	7.1	7.1	7.1	10.0	13.8	13.8
CA	Los Angeles Region	11.5	11.5	11.5	9.2	7.5	7.5	7.5	7.5	7.5	7.4	9.2	11.5
CA	San Francisco Region	11.3	11.3	11.3	11.3	9.0	7.5	7.5	7.5	7.5	7.4	9.1	11.3
CO	Entire State	13.4	12.4	11.1	11.1	9.0	7.8	7.8	7.8	7.8	10.1	11.1	12.4
CT	Entire State	12.4	12.4	10.5	10.5	8.6	8.6	8.6	8.6	8.6	10.5	10.5	12.4
DE	Entire State	12.3	12.3	10.5	10.5	8.5	8.5	8.5	8.5	8.5	8.1	10.5	12.3
DC	Entire State	12.9	10.5	10.5	7.2	7.5	7.5	7.5	7.5	7.5	7.2	10.5	12.9
FL	Entire State	11.7	11.7	7.5	7.5	7.4	7.4	7.4	7.4	7.4	7.5	7.5	11.7
GA	Entire State	12.0	12.0	9.2	9.2	7.6	7.6	7.6	7.6	7.6	9.2	9.2	12.0
HI	Entire State	10.0	10.0	10.0	10.0	10.0	10.0	9.5	10.0	10.0	10.0	10.0	10.0
ID	Entire State	14.1	12.5	12.5	10.3	8.7	8.7	8.7	8.7	8.7	8.7	10.3	12.5
IL	Madison, Monroe, St. Clair	13.9	13.9	11.5	11.5	7.1	7.1	7.1	7.1	7.1	8.2	11.5	13.9
IL	Rest of State	13.9	13.9	11.5	11.5	8.4	8.4	8.4	8.4	8.4	8.2	11.5	13.9
IN	Entire State	14.3	14.3	12.2	12.2	9.0	9.0	9.0	9.0	9.0	9.3	12.2	14.3
IA	Entire State	15.0	15.0	13.4	11.2	9.0	9.0	9.0	9.0	9.0	11.2	13.4	15.0
KS	Entire State	13.2	11.5	9.3	9.3	7.4	7.4	7.4	7.4	7.4	7.6	9.3	11.5
KY	Boone, Campbell, Kenton	14.0	11.8	11.8	8.9	9.3	9.3	9.3	9.3	9.3	8.9	11.8	14.0
KY	Rest of State	14.0	11.8	11.8	8.9	8.6	8.6	8.6	8.6	8.6	8.9	11.8	14.0
LA	Entire State	12.4	12.4	9.7	9.7	7.3	7.3	7.3	7.3	7.3	9.7	9.7	12.4
ME	Entire State	12.5	12.5	10.6	10.6	8.6	8.6	8.6	8.6	8.6	10.6	10.6	12.5
MD	Entire State	12.6	12.6	10.5	10.5	7.8	7.8	7.8	7.8	7.8	7.7	10.5	12.6
MA	Entire State	12.1	12.1	10.3	10.3	8.6	8.6	8.6	8.6	8.6	10.3	10.3	12.1
MI	Macomb, Oakland, Wayne	14.0	14.0	11.8	11.8	8.7	8.7	8.7	8.7	8.7	11.8	11.8	14.0
MI	Rest of State	14.0	14.0	11.8	11.8	8.9	8.9	8.9	8.9	8.9	11.8	11.8	14.0
MN	Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, Washington, Wright	15.0	15.0	12.6	12.6	9.3	9.3	9.3	9.3	9.3	9.5	12.6	15.0
MN	Rest of State	15.0	15.0	12.6	12.6	9.0	9.0	9.0	9.0	9.0	9.5	12.6	15.0
MS	Entire State	13.8	13.8	10.0	10.0	7.1	7.1	7.1	7.1	7.1	10.0	10.0	13.8
MO	Franklin, Jefferson, St. Charles, St. Louis, St. Louis City	13.5	11.7	11.7	9.2	7.1	7.1	7.1	7.1	7.1	9.2	11.7	11.7
MO	Rest of State	13.5	11.7	11.7	9.2	7.3	7.3	7.3	7.3	7.3	9.2	11.7	11.7
MT	Entire State	13.6	13.6	12.1	10.1	8.6	8.6	8.6	8.6	8.6	10.1	12.1	13.6
NE	Entire State	14.1	14.1	12.5	10.3	8.4	8.4	8.4	8.4	8.4	8.6	10.3	12.5
NV	Entire State	10.7	9.4	8.4	8.4	7.8	7.8	7.8	7.8	7.8	7.8	8.4	9.4
NH	Entire State	12.1	12.1	10.3	10.3	8.6	8.6	8.6	8.6	8.6	10.3	10.3	12.1
NJ	Entire State	13.0	13.0	11.1	11.1	8.6	8.6	8.6	8.6	8.6	11.1	11.1	13.0
NM	Entire State	11.3	11.3	10.0	9.0	8.4	7.8	7.8	7.8	7.8	9.0	10.0	11.3
NY	Entire State	14.1	14.1	12.0	12.0	8.7	8.7	8.7	8.7	8.7	12.0	12.0	14.1
NC	Entire State	12.0	12.0	12.0	9.2	7.6	7.6	7.6	7.6	7.6	9.2	12.0	12.0
ND	Entire State	15.0	15.0	13.4	13.4	9.0	9.0	9.0	9.0	9.0	11.2	13.4	15.0

Table 4.6-9 (continued)

State	Applicable Counties	1995 Monthly RVP (psi)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
OH	Butler, Cuyahoga, Hamilton, Lake, Lorain	14.4	14.4	12.3	12.3	9.3	9.3	9.3	9.3	9.3	9.4	12.3	14.4
OH	Rest of State	14.4	14.4	12.3	12.3	9.0	9.0	9.0	9.0	9.0	9.4	12.3	14.4
OK	Entire State	13.5	13.5	10.0	10.0	7.4	7.4	7.4	7.4	7.4	7.4	10.0	13.5
OR	Entire State	13.2	11.0	11.0	11.0	8.1	7.8	7.8	7.8	7.8	8.1	11.0	13.2
PA	Clarion, Crawford, Elk, Erie, Forest, Jefferson, Lawrence, McKean, Mercer, Venango, Warren	14.1	14.1	12.0	12.0	9.3	9.3	9.3	9.3	9.3	12.0	12.0	14.1
PA	Rest of State	14.1	14.1	12.0	12.0	8.5	8.5	8.5	8.5	8.5	12.0	12.0	14.1
RI	Entire State	12.1	12.1	10.3	10.3	8.6	8.6	8.6	8.6	8.6	10.3	10.3	12.1
SC	Entire State	12.0	12.0	12.0	9.2	7.6	7.6	7.6	7.6	7.6	9.2	12.0	12.0
SD	Entire State	15.0	15.0	13.4	11.2	9.0	9.0	9.0	9.0	9.0	9.5	11.2	13.4
TN	Entire State	12.4	12.4	12.4	9.4	7.5	7.5	7.5	7.5	7.5	9.4	12.4	12.4
TX	El Paso	11.6	11.6	9.4	9.4	8.2	8.2	8.2	8.2	8.2	7.8	9.4	11.6
TX	Hardin, Harris, Jefferson, Orange	11.6	11.6	9.4	9.4	7.4	7.4	7.4	7.4	7.4	7.8	9.4	11.6
TX	Rest of State	11.6	11.6	9.4	9.4	7.7	7.7	7.7	7.7	7.7	7.8	9.4	11.6
UT	Entire State	13.4	12.4	12.4	11.1	9.0	7.8	7.8	7.8	7.8	10.1	11.1	12.4
VT	Entire State	15.0	15.0	12.6	12.6	8.6	8.6	8.6	8.6	8.6	12.6	12.6	15.0
VA	Entire State	12.5	10.2	10.2	7.2	7.5	7.5	7.5	7.5	7.5	7.2	10.2	12.5
WA	Entire State	14.5	14.5	12.0	12.0	8.7	8.7	8.7	8.7	8.7	8.7	12.0	14.5
WV	Entire State	14.4	14.4	12.3	12.3	8.5	8.5	8.5	8.5	8.5	9.5	12.3	14.4
WI	Entire State	14.5	14.5	12.1	12.1	9.0	9.0	9.0	9.0	9.0	9.0	12.1	14.5
WY	Entire State	13.5	13.5	12.2	10.4	9.0	9.0	9.0	9.0	9.0	9.0	10.4	12.2

Note: May through September RVP values modeled for areas receiving reformulated gasoline are set within MOBILE5b and are not reflected here.

Table 4.6-10. Monthly RVP Values Modeled in 1996

State	Applicable Counties	1996 Monthly RVP (psi)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AL	Entire State	12.4	12.4	9.5	9.5	7.8	7.8	7.8	7.8	7.8	9.5	9.5	12.4
AK	Entire State	14.1	14.1	14.1	14.1	13.0	13.0	13.0	13.0	13.0	14.1	14.1	14.1
AZ	Entire State	8.7	7.9	7.2	7.2	6.8	6.8	6.8	6.8	6.8	6.8	7.2	7.9
AR	Entire State	13.7	13.7	9.8	9.8	7.1	7.1	7.1	7.1	7.1	9.8	13.7	13.7
CA	Los Angeles Region	11.9	11.9	11.9	9.0	6.9	6.9	6.9	6.9	6.9	6.9	9.0	11.9
CA	San Francisco Region	11.7	11.7	11.7	11.7	9.0	6.9	6.9	6.9	6.9	7.0	9.0	11.7
CO	Entire State	13.2	12.1	10.7	10.7	9.0	7.8	7.8	7.8	7.8	9.6	10.7	12.1
CT	Entire State	13.0	13.0	10.8	10.8	8.6	8.6	8.6	8.6	8.6	10.8	10.8	13.0
DE	Entire State	13.5	13.5	11.1	11.1	8.5	8.5	8.5	8.5	8.5	7.9	11.1	13.5
DC	Entire State	12.8	10.3	10.3	7.0	7.5	7.5	7.5	7.5	7.5	7.0	10.3	12.8
FL	Entire State	11.8	11.8	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	11.8
GA	Entire State	12.4	12.4	9.4	9.4	7.6	7.6	7.6	7.6	7.6	9.4	9.4	12.4
HI	Entire State	10.0	10.0	10.0	10.0	10.0	10.0	9.5	10.0	10.0	10.0	10.0	10.0
ID	Entire State	13.9	12.3	12.3	10.2	8.6	8.6	8.6	8.6	8.6	8.6	10.2	12.3
IL	Madison, Monroe, St. Clair	14.1	14.1	11.4	11.4	7.1	7.1	7.1	7.1	7.1	7.8	11.4	14.1
IL	Rest of State	14.1	14.1	11.4	11.4	8.4	8.4	8.4	8.4	8.4	7.8	11.4	14.1
IN	Entire State	14.5	14.5	12.0	12.0	9.0	9.0	9.0	9.0	9.0	8.7	12.0	14.5
IA	Entire State	14.9	14.9	13.3	11.2	9.0	9.0	9.0	9.0	9.0	11.2	13.3	14.9
KS	Entire State	14.0	12.1	9.5	9.5	7.4	7.4	7.4	7.4	7.4	7.6	9.5	12.1
KY	Boone, Campbell, Kenton	14.2	11.7	11.7	8.4	9.3	9.3	9.3	9.3	9.3	8.4	11.7	14.2
KY	Rest of State	14.2	11.7	11.7	8.4	8.6	8.6	8.6	8.6	8.6	8.4	11.7	14.2
LA	Entire State	12.4	12.4	9.6	9.6	7.3	7.3	7.3	7.3	7.3	9.6	9.6	12.4
ME	Entire State	13.2	13.2	11.0	11.0	8.6	8.6	8.6	8.6	8.6	11.0	11.0	13.2
MD	Entire State	13.2	13.2	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.5	10.8	13.2
MA	Entire State	12.9	12.9	10.7	10.7	8.6	8.6	8.6	8.6	8.6	10.7	10.7	12.9
MI	Entire State	14.1	14.1	11.2	11.2	8.9	8.9	8.9	8.9	8.9	11.2	11.2	14.1
MN	Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, Washington, Wright	14.9	14.9	12.6	12.6	9.3	9.3	9.3	9.3	9.3	9.6	12.6	14.9
MN	Rest of State	14.9	14.9	12.6	12.6	9.0	9.0	9.0	9.0	9.0	9.6	12.6	14.9
MS	Entire State	13.7	13.7	9.8	9.8	7.1	7.1	7.1	7.1	7.1	9.8	9.8	13.7
MO	Franklin, Jefferson, St. Charles, St. Louis, St. Louis City	13.9	11.9	11.9	9.2	7.1	7.1	7.1	7.1	7.1	9.2	11.9	11.9
MO	Rest of State	13.9	11.9	11.9	9.2	7.3	7.3	7.3	7.3	7.3	9.2	11.9	11.9
MT	Entire State	13.8	13.8	12.3	10.2	8.7	8.7	8.7	8.7	8.7	10.2	12.3	13.8
NE	Entire State	14.5	14.5	12.7	10.4	8.4	8.4	8.4	8.4	8.4	8.6	10.4	12.7
NV	Entire State	10.5	9.2	8.2	8.2	7.6	7.6	7.6	7.6	7.6	7.6	8.2	9.2
NH	Entire State	12.9	12.9	10.7	10.7	8.6	8.6	8.6	8.6	8.6	10.7	10.7	12.9
NJ	Entire State	13.7	13.7	11.3	11.3	8.6	8.6	8.6	8.6	8.6	11.3	11.3	13.7
NM	Entire State	11.7	11.7	10.2	9.1	8.4	7.8	7.8	7.8	7.8	9.1	10.2	11.7
NY	Entire State	14.3	14.3	11.9	11.9	8.7	8.7	8.7	8.7	8.7	11.9	11.9	14.3
NC	Entire State	12.4	12.4	12.4	9.4	7.6	7.6	7.6	7.6	7.6	9.4	12.4	12.4
ND	Entire State	14.9	14.9	13.3	13.3	9.0	9.0	9.0	9.0	9.0	11.2	13.3	14.9
OH	Butler, Cuyahoga, Hamilton, Lake, Lorain	14.6	14.6	12.1	12.1	9.3	9.3	9.3	9.3	9.3	8.7	12.1	14.6

Table 4.6-10 (continued)

State	Applicable Counties	1996 Monthly RVP (psi)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
OH	Rest of State	14.6	14.6	12.1	12.1	9.0	9.0	9.0	9.0	9.0	8.7	12.1	14.6
OK	Entire State	13.9	13.9	10.1	10.1	7.4	7.4	7.4	7.4	7.4	7.2	10.1	13.9
OR	Entire State	13.1	10.8	10.8	10.8	7.7	7.7	7.7	7.7	7.7	7.7	10.8	13.1
PA	Clarion, Crawford, Elk, Erie, Forest, Jefferson, Lawrence, McKean, Mercer, Venango, Warren	14.4	14.4	12.0	12.0	9.3	9.3	9.3	9.3	9.3	12.0	12.0	14.4
PA	Rest of State	14.4	14.4	12.0	12.0	8.5	8.5	8.5	8.5	8.5	12.0	12.0	14.4
RI	Entire State	12.9	12.9	10.7	10.7	8.6	8.6	8.6	8.6	8.6	10.7	10.7	12.9
SC	Entire State	12.4	12.4	12.4	9.4	7.6	7.6	7.6	7.6	7.6	9.4	12.4	12.4
SD	Entire State	14.9	14.9	13.3	11.2	9.0	9.0	9.0	9.0	9.0	9.6	11.2	13.3
TN	Entire State	12.7	12.7	12.7	9.5	7.5	7.5	7.5	7.5	7.5	9.5	12.7	12.7
TX	El Paso	12.2	12.2	10.0	10.0	8.2	8.2	8.2	8.2	8.2	8.3	10.0	12.2
TX	Hardin, Harris, Jefferson, Orange	12.2	12.2	10.0	10.0	7.4	7.4	7.4	7.4	7.4	8.3	10.0	12.2
TX	Rest of State	12.2	12.2	10.0	10.0	7.7	7.7	7.7	7.7	7.7	8.3	10.0	12.2
UT	Entire State	13.2	12.1	12.1	10.7	9.0	7.8	7.8	7.8	7.8	9.6	10.7	12.1
VT	Entire State	14.9	14.9	12.6	12.6	9.0	9.0	9.0	9.0	9.0	12.6	12.6	14.9
VA	Entire State	12.6	10.2	10.2	7.1	7.5	7.5	7.5	7.5	7.5	7.1	10.2	12.6
WA	Entire State	14.0	14.0	11.6	11.6	8.5	8.5	8.5	8.5	8.5	8.5	11.6	14.0
WV	Entire State	14.6	14.6	12.1	12.1	8.8	8.8	8.8	8.8	8.8	8.8	12.1	14.6
WI	Entire State	14.6	14.6	12.2	12.2	9.0	9.0	9.0	9.0	9.0	9.0	12.2	14.6
WY	Entire State	13.5	13.5	12.1	10.2	8.8	8.8	8.8	8.8	8.8	8.8	10.2	12.1

Note: May through September RVP values modeled for areas receiving reformulated gasoline are set within MOBILE5b and are not reflected here.

Table 4.6-11. HPMS Average Overall Travel Speeds for 1990 (MPH)

	Rural					Urban				
Vehicle Type	Interstate	Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Interstate	Other Freeways Expressways	Principal Arterial	Minor Arterial	Collector
Small Pass. Cars	58.4	46.5	40.1	35.4	30.3	46.3	42.4	18.7	19.3	19.5
Large Pass. Cars	58.4	46.5	40.1	35.4	30.3	46.3	42.4	18.7	19.3	19.5
Pickups & Vans	56.7	45.6	39.7	35.3	30.5	45.4	41.9	19.5	20.1	20.3
Single 2 Axle	55.7	44.5	38.8	32.6	24.1	47.1	42.9	18.1	18.2	18.0
Single 3+ Axle	53.3	43.0	37.6	33.1	29.8	45.4	41.5	18.0	18.1	18.1
Multi 4+ Axle	43.0	34.0	30.7	27.9	25.7	37.2	34.4	14.7	14.6	14.5
Multi 5+ Axle	41.8	33.4	30.2	26.9	22.5	36.4	33.8	14.6	14.5	14.3

Table 4.6-12. Average Speeds by Road Type and Vehicle Type (MPH)

Rural

	Interstate	Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local
LDV	60	45	40	35	30	30
LDT	55	45	40	35	30	30
HDV	40	35	30	25	25	25

Urban

	Interstate	Other Freeways & Expressways	Principal Arterial	Minor Arterial	Collector	Local
LDV	45	45	20	20	20	20
LDT	45	45	20	20	20	20
HDV	35	35	15	15	15	15

Table 4.6-13. State-Supplied Operating Mode Inputs

		Percent of VMT Accumulated by:		
State	County	Non-catalyst Vehicles in Cold Start Mode	Catalyst Equipped Vehicles in Hot Start Mode	Catalyst Equipped Vehicles in Cold Start Mode
Texas	Brazoria Co	16.0	14.3	23.3
	Chambers Co			
	Fort Bend Co			
	Galveston Co			
	Harris Co			
	Liberty Co			
	Montgomery Co			
	Waller Co			
Texas	Collin Co	16.5	14.6	24.9
	Dallas Co			
	Denton Co			
	Tarrant Co			
Maryland	Allegany Co	22.3	14.6	22.3
	Anne Arundel Co			
	Baltimore Co			
	Caroline Co			
	Carroll Co			
	Cecil Co			
	Dorchester Co			
	Garrett Co			
	Harford Co			
	Howard Co			
	Kent Co			
	Queen Annes Co			
	St. Mary’s Co			
	Somerset Co			
	Talbot Co			
	Washington Co			
	Wicomico Co			
	Worcester Co			
	Baltimore			

Table 4.6-14. I/M Program Documentation (1995 and 1996)

I/M Program Name	AK1IMATP	AKIMATP	AZPIMATP	AZTIMATP
I/M Program Parameters				
Program Start Year	1986	1986	1978	1978
Stringency Level (Percent)	20	20	20	31
Model Years Covered	1968-2020	1975-2020	1967-1980	1967-2020
Waiver Rate For Pre-1981 Model Years (%)	15	15	3	8
Waiver Rate For 1981 and Later Models (%)	15	15	3	8
Compliance Rate (%)	95	95	96	96
Program Type	TRC	TRC	TO	TO
Inspection Frequency	Biennial	Biennial	Annual	Biennial
Vehicle Types Inspected				
LDGV	YES	YES	YES	YES
LDGT1	YES	YES	YES	YES
LDGT2	YES	YES	YES	YES
HDGV	NO	NO	YES	YES
Test Type	2500/Idle Test	2500/Idle Test	Idle Test	Idle Test
I/M Cutpoints	220/1.2/999	220/1.2/999	220/1.2/999	220/1.2/999
Effectiveness Rates (% HC/CO/NOx)	0.85/0.85/0.85	0.85/0.85/0.85	1.00/1.00/1.00	1.00/1.00/1.00
I/M Program Parameters				
Program Start Year			1978	
Stringency Level (Percent)			20	
Model Years Covered			1981-2020	
Waiver Rate For Pre-1981 Model Years (%)			3	
Waiver Rate For 1981 and Later Models (%)			3	
Compliance Rate (%)			96	
Program Type			TO	
Inspection Frequency			Biennial	
Vehicle Types Inspected				
LDGV			YES	
LDGT1			YES	
LDGT2			YES	
HDGV			YES	
Test Type			Transient Test	
I/M Cutpoints			1.20/20.0/3.00	
Effectiveness Rates (% HC/CO/NOx)	0.85/0.85/0.85	0.85/0.85/0.85	1.00/1.00/1.00	1.00/1.00/1.00
Anti-Tampering Program Parameters				
Program Start Year	1986	1986	1988	1988
Model Years Covered	1968-2020	1975-2020	1984-2020	1967-2020
Vehicle Types Inspected				
LDGV	YES	YES	YES	YES
LDGT1	YES	YES	YES	YES
LDGT2	YES	YES	YES	YES
HDGV	NO	NO	YES	YES
Program Type	TRC	TRC	TO	TO
Effectiveness Rate	0.85	0.85	1.00	1.00
Inspection Frequency	Biennial	Biennial	Biennial	Biennial
Compliance Rate (%)	95	95	96	96
Inspections Performed				
Air Pump System	YES	YES	YES	YES

Table 4.6-14 (continued)

I/M Program Name	AK1IMATP	AKIMATP	AZPIMATP	AZTIMATP
Catalyst	YES	YES	YES	YES
Fuel Inlet Restrictor	NO	NO	NO	NO
Tailpipe Lead Deposit Test	NO	NO	NO	NO
EGR System	YES	YES	NO	NO
Evaporative Emission Control System	YES	YES	YES	NO
PCV System	YES	YES	YES	NO
Gas Cap	YES	YES	YES	NO
Functional Pressure Test Program Parameters				
Program Start Year			1995	1995
Model Years Covered			1983-2020	1967-2020
Effectiveness Rate			1.00	0.40
Vehicle Types Tested				
LDGV			YES	YES
LDGT1			YES	YES
LDGT2			YES	YES
HDGV			YES	YES
Program Type			TO	TRC
Inspection Frequency			Biennial	Biennial
Compliance Rate (%)			96	96
Purge Test Program Parameters				
Program Start Year			1995	
Model Years Covered			1986-2020	
Effectiveness Rate			1.00	
Vehicle Types Tested				
LDGV			YES	
LDGT1			YES	
LDGT2			YES	
HDGV			YES	
Program Type			TO	
Inspection Frequency			Biennial	
Compliance Rate (%)			96	
Years of Program Usage	95,96	95,96	95,96	95,96

Notes:
TO=Test Only
TRC=Test And Repair (Computerized)

Table 4.6-15. Counties Included in 1995 and 1996 I/M Programs

I/M Program Name	Included Counties
AK1IMATP	Anchorage Ed
AKIMATP	Fairbanks Ed
AZPIMATP	Maricopa Co
AZTIMATP	Pima Co
CAIMATP	Fresno Co, Kern Co, Los Angeles Co, Napa Co, Sacramento Co, San Diego Co, San Francisco Co
CODIMATP	Adams Co, Arapahoe Co, Boulder Co, Denver Co, Douglas Co, Jefferson Co
COSIMATP	El Paso Co, Larimer Co, Teller Co, Weld Co,
CTIMATP	Fairfield Co, Hartford Co, Litchfield Co, Middlesex Co, New Haven Co, New London Co, Tolland Co, Windham Co
DCIMATP	Washington
DEIMATP1	Kent Co, Sussex Co
DEIMATP2	New Castle Co
FLIMATP	Broward Co, Dade Co, Duval Co, Hillsborough Co, Palm Beach Co, Pinellas Co
GAIM95	Cobb Co, De Kalb Co, Fulton Co, Gwinnett Co
GAIM96	Cobb Co, De Kalb Co, Fulton Co, Gwinnett Co
IDIMATP	Ada Co
ILIM95	Cook Co, Du Page Co, Lake Co, Madison Co, St. Clair Co
ILIM952	Grundy Co, Kane Co, Kendall Co, McHenry Co, Will Co
INIMATP	Clark Co, Floyd Co, Lake Co, Porter Co
KYIMATP1	Boone Co, Campbell Co, Kenton Co
KYIMATP2	Jefferson Co
LAIMATP	Ascension Par, Calcasieu Par, East Baton Rouge Par, Iberville Par, Livingston Par, Pointe Coupee Par, West Baton Rouge Par

Table 4.6-15 (continued)

I/M Program Name	Included Counties
MAIM95	Barnstable Co, Berkshire Co, Bristol Co, Dukes Co, Essex Co, Franklin Co, Hampden Co, Hampshire Co, Middlesex Co, Nantucket Co, Norfolk Co, Plymouth Co, Suffolk Co, Worcester Co
MDIM95	Calvert Co, Cecil Co, Charles Co, Frederick Co, Queen Annes Co, Washington Co
MDIMATP	Anne Arundel Co, Baltimore, Baltimore Co, Carroll Co, Harford Co, Howard Co, Montgomery Co, Prince Georges Co
MIIM95	Macomb Co, Oakland Co, Wayne Co
MNIMATP	Anoka Co, Carver Co, Dakota Co, Hennepin Co, Ramsey Co, Scott Co, Washington Co, Wright Co
MOIMATP1	Jefferson Co, St. Charles Co, St. Louis, St. Louis Co
MOIMATP2	Franklin Co
NCIM931	Wake Co
NCIM932	Mecklenburg Co
NCIMATP3	Davidson Co, Davie Co, Durham Co, Forsyth Co, Gaston Co, Granville Co, Guilford Co
NHIM95	Hillsborough Co, Rockingham Co
NJIMATP	Atlantic Co, Bergen Co, Burlington Co, Camden Co, Cape May Co, Cumberland Co, Essex Co, Gloucester Co, Hudson Co, Hunterdon Co, Mercer Co, Middlesex Co, Monmouth Co, Morris Co, Ocean Co, Passaic Co, Salem Co, Somerset Co, Sussex Co, Union Co, Warren Co
NMIMATP	Bernalillo Co
NVIMATP	Clark Co, Washoe Co
NYIMATP2	Albany Co, Allegany Co, Broome Co, Cattaraugus Co, Cayuga Co, Chautauqua Co, Chemung Co, Chenango Co, Clinton Co, Columbia Co, Cortland Co, Delaware Co, Dutchess Co, Erie Co, Essex Co, Franklin Co, Fulton Co, Genesee Co, Greene Co, Hamilton Co, Herkimer Co, Jefferson Co, Lewis Co, Livingston Co, Madison Co, Monroe Co, Montgomery Co, Niagara Co, Oneida Co, Onondaga Co, Ontario Co, Orange Co, Orleans Co, Oswego Co, Otsego Co, Putnam Co, Rensselaer Co, Saratoga Co, Schenectady Co, Schoharie Co, Schuyler Co, Seneca Co, St. Lawrence Co, Steuben Co, Sullivan Co, Tioga Co, Tompkins Co, Ulster Co, Warren Co, Washington Co, Wayne Co, Wyoming Co, Yates Co
NYIMATP3	Bronx Co, Kings Co, Nassau Co, New York Co, Queens Co, Richmond Co, Rockland Co, Suffolk Co, Westchester Co
OHIM96	Butler Co, Cuyahoga Co, Hamilton Co, Lake Co, Lorain Co
OHIMATP1	Butler Co, Hamilton Co, Lake Co, Lorain Co
OHIMATP2	Cuyahoga Co

Table 4.6-15 (continued)

I/M Program Name	Included Counties
OKIMATP1	Creek Co, Osage Co, Rogers Co, Tulsa Co, Wagoner Co
OKIMATP2	Canadian Co, Cleveland Co, Kingfisher Co, Lincoln Co, Logan Co, McClain Co, Oklahoma Co, Pottawatomie Co
ORIMATP	Clackamas Co, Jackson Co, Multnomah Co, Washington Co
PAIMATP	Allegheny Co, Beaver Co, Bucks Co, Chester Co, Delaware Co, Lehigh Co, Montgomery Co, Northampton Co, Philadelphia Co, Washington Co, Westmoreland Co
RIIMATP	Bristol Co, Kent Co, Newport Co, Providence Co, Washington Co
TNIM951	Davidson Co
TNIM952	Shelby Co
TXIMATP2	Harris Co
TXIMATP3	Collin Co, Denton Co, Ellis Co, Johnson Co, Kaufman Co, Parker Co, Rockwall Co
TXIMATP4	Dallas Co, Tarrant Co
UT1IMATP	Utah Co
UT2IMATP	Weber Co
UT3IMATP	Davis Co
UT4IMATP	Salt Lake Co
VAIM95	Alexandria, Arlington Co, Fairfax, Fairfax Co, Falls Church, Manassas, Manassas Park, Prince William Co
WAIMATP	King Co, Snohomish Co, Spokane Co
WIIM93	Kenosha Co, Milwaukee Co, Ozaukee Co, Racine Co, Washington Co, Waukesha Co
WIIM96	Kenosha Co, Milwaukee Co, Ozaukee Co, Racine Co, Sheboygan Co, Washington Co, Waukesha Co
WIIMSHEB	Sheboygan Co

Table 4.6-16. Oxygenated Fuel Modeling Parameters

		Market Shares (%)		Oxygen Content (%)		Oxygenated
State	County	MTBE	Alcohol Blends	MTBE	Alcohol Blends	Fuel Season
Alaska	Anchorage Ed	0	100	2.7	2.0	NOV - FEB
Arizona	Maricopa Co	80	20	2.7	2.0	OCT - FEB
Colorado	Adams Co	75	25	2.7	2.0	NOV - FEB
Colorado	Arapahoe Co	75	25	2.7	2.0	NOV - FEB
Colorado	Boulder Co	75	25	2.7	2.0	NOV - FEB
Colorado	Douglas Co	75	25	2.7	2.0	NOV - FEB
Colorado	Jefferson Co	75	25	2.7	2.0	NOV - FEB
Colorado	Denver Co	75	25	2.7	2.0	NOV - FEB
Colorado	El Paso Co	75	25	2.7	2.0	NOV - FEB
Colorado	Larimer Co	75	25	2.7	2.0	NOV - FEB
Connecticut	Fairfield Co	90	10	2.7	2.0	NOV - FEB
Minnesota	Anoka Co	10	90	2.7	2.0	OCT - JAN
Minnesota	Carver Co	10	90	2.7	2.0	OCT - JAN
Minnesota	Dakota Co	10	90	2.7	2.0	OCT - JAN
Minnesota	Hennepin Co	10	90	2.7	2.0	OCT - JAN
Minnesota	Ramsey Co	10	90	2.7	2.0	OCT - JAN
Minnesota	Scott Co	10	90	2.7	2.0	OCT - JAN
Minnesota	Washington Co	10	90	2.7	2.0	OCT - JAN
Minnesota	Wright Co	10	90	2.7	2.0	OCT - JAN
Minnesota	Chisago Co	10	90	2.7	2.0	OCT - JAN
Minnesota	Isanti Co	10	90	2.7	2.0	OCT - JAN
Montana	Missoula Co	0	100	2.7	2.0	NOV - FEB
Nevada	Clark Co	0	100	2.7	2.0	OCT - MAR
Nevada	Washoe Co	95	5	2.7	2.0	OCT - JAN
New Jersey	Bergen Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Essex Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Hudson Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Hunterdon Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Middlesex Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Monmouth Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Morris Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Ocean Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Passaic Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Somerset Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Sussex Co	95	5	2.7	2.0	NOV - FEB
New Jersey	Union Co	95	5	2.7	2.0	NOV - FEB
New York	Bronx Co	95	5	2.7	2.0	NOV - FEB
New York	Kings Co	95	5	2.7	2.0	NOV - FEB
New York	Nassau Co	95	5	2.7	2.0	NOV - FEB
New York	New York Co	95	5	2.7	2.0	NOV - FEB
New York	Queens Co	95	5	2.7	2.0	NOV - FEB
New York	Richmond Co	95	5	2.7	2.0	NOV - FEB
New York	Rockland Co	95	5	2.7	2.0	NOV - FEB
New York	Suffolk Co	95	5	2.7	2.0	NOV - FEB
New York	Westchester Co	95	5	2.7	2.0	NOV - FEB
New York	Orange Co	95	5	2.7	2.0	NOV - FEB
New York	Putnam Co	95	5	2.7	2.0	NOV - FEB
Oregon	Clackamas Co	1	99	2.7	2.0	NOV - FEB
Oregon	Jackson Co	1	99	2.7	2.0	NOV - FEB
Oregon	Multnomah Co	1	99	2.7	2.0	NOV - FEB
Oregon	Washington Co	1	99	2.7	2.0	NOV - FEB
Oregon	Josephine Co	1	99	2.7	2.0	NOV - FEB
Oregon	Klamath Co	1	99	2.7	2.0	NOV - FEB
Oregon	Yamhill Co	1	99	2.7	2.0	NOV - FEB
Texas	El Paso Co	15	85	2.7	2.0	NOV - FEB
Utah	Utah Co	20	80	2.7	2.0	NOV - FEB
Washington	Clark Co	1	99	2.7	2.0	NOV - FEB
Washington	Spokane Co	1	99	2.7	2.0	SEP - FEB
Wisconsin	St. Croix Co	10	90	2.7	2.0	OCT - JAN

Table 4.6-17. State-Supplied Trip Length Distribution Inputs

Nonattainment Area	Percentage of Total VMT Accumulated in Trips of: < 10 Minutes	11 to 20 Minutes	21 to 30 Minutes	31 to 40 Minutes	41 to 50 Minutes	> 50 Minutes
Washington, DC/MD/VA	16.6	33.9	23.4	13.3	6.1	6.7
Baltimore	15.1	31.7	26	13.3	6.5	7.4
Houston	14.8	27.9	22.4	14.3	8.5	12.1
Dallas	9.8	19	23.8	19.4	13.6	14.4

Table 4.6-18. State-Supplied Alcohol Fuels Data

State	Applicable Area	Ether Blends Market Share (%)	Alcohol Blends Market Share (%)	Oxygen Content of Ether Blends (%)	Oxygen Content of Alcohol Blends (%)	1.0 psi RVP Waiver
Georgia	Entire State	0.0	2.5		3.5	No
Illinois	Chicago Nonattainment Area	17.0	83.0	2.1	3.5	Yes
Illinois	Rest of State	0.0	33.0		3.5	Yes
Indiana	Entire State excluding RFG Counties	0.0	19.0		3.5	Yes
Michigan	Entire State	0.0	12.7		3.5	Yes
Missouri	Entire State	0.0	33.0		3.5	Yes
Wisconsin	Milwaukee Nonattainment Area	17.0	83.0	2.1	3.5	Yes
Wisconsin	Rest of State excluding St. Croix County	0.0	10.0		3.5	Yes

Table 4.6.19. State-Provided Diesel Sales Inputs

Delaware--Kent County
.000.000.000.000.000.000.000.000.000.000.000.000.001.032.001.015.004.015.001.009
.002.005.000.008.003.005.002.004.004.009.010.007.011.015.020.017.033.020.004.003
.001.000.002.003.001.002.002.000.006.000

Delaware--New Castle County
.000.000.000.000.000.000.000.000.000.000.000.000.001.011.002.010.002.009.001.009
.001.003.000.006.001.004.001.005.003.005.004.005.008.009.014.014.019.014.000.000
.001.000.000.000.000.000.000.000.000.000

Delaware--Sussex County
.000.050.000.050.000.050.000.050.000.050.000.050.001.022.002.010.005.008.001.010
.001.005.000.008.003.003.002.005.005.010.007.010.009.011.019.022.020.036.014.002
.000.000.000.000.000.000.000.000.000.000

Maryland--Baltimore, Carroll, Harford, and Howard Counties, and Baltimore City
.000.001.000.001.000.001.000.001.000.001.000.001.001.007.000.006.003.007.004.012
.014.015.018.024.021.027.040.074.055.055.048.028.023.012.011.005.008.001.010.001
.014.001.007.001.003.000.004.000.001.001

Maryland--Calvert County
.001.002.001.002.001.002.001.002.001.002.001.002.000.005.000.004.002.003.003.016
.019.032.020.051.027.042.025.145.041.122.031.106.015.019.009.000.004.000.005.000
.005.038.000.000.000.000.000.000.000.000

Maryland--Charles County
.000.003.000.003.000.003.000.003.000.003.000.003.000.003.000.005.003.010.002.009
.007.007.008.030.006.031.017.085.020.055.013.051.006.011.004.000.000.000.000.000
.006.000.003.000.003.000.000.000.004.048

Maryland--Frederick County
.000.005.000.005.000.005.000.005.000.005.000.005.001.003.000.002.001.006.004.011
.008.020.009.032.005.046.014.082.022.142.021.057.007.016.005.009.003.000.005.000
.003.000.002.000.000.000.000.000.000.023

Maryland--Montgomery County
.001.004.001.004.001.004.001.004.001.004.001.004.001.009.000.008.006.009.006.026
.019.027.026.053.033.059.052.207.065.174.056.130.044.022.021.019.018.006.023.006
.022.006.011.000.003.006.003.000.002.000

Maryland--Prince Georges County
.001.010.001.010.001.010.001.010.001.010.001.010.001.019.000.013.005.019.005.033
.013.044.018.064.022.076.038.195.050.146.039.108.019.025.012.021.006.005.005.018
.010.008.006.000.001.005.003.000.001.000

Virginia--Alexandria City
.001.000.001.000.001.000.001.000.001.000.001.000.001.000.000.000.003.002.005.005
.014.017.019.029.022.067.041.193.046.172.038.010.019.009.011.000.007.000.009.024
.009.017.006.000.001.000.002.000.004.019

Virginia--Arlington County
.000.006.000.006.000.006.000.006.000.006.000.006.001.002.000.001.002.007.004.014
.013.017.021.057.020.068.038.221.049.248.032.070.023.013.015.007.009.000.010.000
.010.000.004.009.002.000.005.013.006.000

Table 4.6-19 (continued)

Virginia--Fairfax County and Fairfax City
.001.002.001.002.001.002.001.002.001.002.001.002.001.005.000.002.003.006.005.013
.015.014.022.032.028.041.048.124.062.154.054.035.030.011.015.005.009.002.013.006
.017.000.007.000.005.000.004.000.005.008

Virginia--Prince William County
.001.003.001.003.001.003.001.003.001.003.001.003.001.003.000.003.001.005.005.011
.011.014.019.029.022.048.046.114.062.154.043.021.020.020.010.003.004.004.004.000
.010.000.004.009.001.000.003.000.003.007

Virginia--Loudoun County
.002.003.002.003.002.003.002.003.002.003.002.003.002.001.001.001.004.006.007.010
.013.024.023.029.029.033.049.101.066.134.043.033.027.009.012.009.006.006.008.007
.010.070.008.000.006.009.002.000.003.000

Virginia--Stafford County
.003.002.003.002.003.002.003.002.003.002.003.002.002.003.000.000.002.003.007.008
.016.007.022.032.030.045.060.155.063.080.045.018.017.005.005.004.005.005.004.000
.005.000.004.014.001.000.006.000.002.000

Table 4.6-20. Counties Modeled with Federal Reformulated Gasoline

State (ASTM Class)/ Nonattainment Area	County	State (ASTM Class)/ Nonattainment Area	County
Arizona (B)		Maine ©	
Phoenix		Knox & Lincoln Counties	
	Maricopa Co		Knox Co
Connecticut ©			Lincoln Co
Greater Connecticut		Lewiston-Auburn	
	Hartford Co		Androscoggin Co
	Litchfield Co		Kennebec Co
	Middlesex Co	Portland	
	New Haven Co		Cumberland Co
	New London Co		Sagadahoc Co
	Tolland Co		York Co
	Windham Co	Maryland (B)	
New York-Northern New Jersey-Long Island		Baltimore	
	Fairfield Co		Anne Arundel Co
District of Columbia (B)			Baltimore
Washington DC			Baltimore Co
	Washington		Carroll Co
Delaware ©			Harford Co
Philadelphia-Wilmington-Trenton			Howard Co
	Kent Co	Kent & Queen Annes Counties	
	New Castle Co		Kent Co
Sussex County			Queen Annes Co
	Sussex Co	Philadelphia-Wilmington-Trenton	
Illinois ©			Cecil Co
Chicago-Gary-Lake County		Washington DC	
	Cook Co		Calvert Co
	Du Page Co		Charles Co
	Grundy Co		Frederick Co
	Kane Co		Montgomery Co
	Kendall Co		Prince Georges Co
	Lake Co	Massachusetts ©	
	McHenry Co	Boston-Lawrence-Worcester-Eastern MA	
	Will Co		Barnstable Co
Indiana ©			Bristol Co
Chicago-Gary-Lake County			Dukes Co
	Lake Co		Essex Co
	Porter Co		Middlesex Co
Kentucky ©			Nantucket Co
Cincinnati-Hamilton			Norfolk Co
	Boone Co		Plymouth Co
	Campbell Co		Suffolk Co
	Kenton Co		Worcester Co

Table 4.6-20 (continued)

State (ASTM Class)/ Nonattainment Area	County	State (ASTM Class)/ Nonattainment Area	County
Louisville		Springfield/Pittsfield-Western MA	
	Bullitt Co		Berkshire Co
	Jefferson Co		Franklin Co
	Oldham Co		Hampden Co
			Hampshire Co
New Hampshire ©		New York ©	
Manchester		Poughkeepsie	
	Hillsborough Co		Dutchess Co
	Merrimack Co		Putnam Co
Portsmouth-Dover-Rochester		Pennsylvania ©	
	Rockingham Co	Philadelphia-Wilmington-Trenton	
	Strafford Co		Bucks Co
New Jersey ©			Chester Co
Allentown-Bethlehem-Easton			Delaware Co
	Warren Co		Montgomery Co
Atlantic City			Philadelphia Co
	Atlantic Co	Rhode Island ©	
	Cape May Co	Providence	
New York-Northern New Jersey-Long Island			Bristol Co
	Bergen Co		Kent Co
	Essex Co		Newport Co
	Hudson Co		Providence Co
	Hunterdon Co		Washington Co
	Middlesex Co	Texas (B)	
	Monmouth Co	Dallas-Fort Worth	
	Morris Co		Collin Co
	Ocean Co		Dallas Co
	Passaic Co		Denton Co
	Somerset Co		Tarrant Co
	Sussex Co	Houston-Galveston-Brazoria	
	Union Co		Brazoria Co
Philadelphia-Wilmington-Trenton			Chambers Co
	Burlington Co		Fort Bend Co
	Camden Co		Galveston Co
	Cumberland Co		Harris Co
	Gloucester Co		Liberty Co
	Mercer Co		Montgomery Co
	Salem Co		Waller Co
New York ©		Virginia (B)	
New York-Northern New Jersey-Long Island		Norfolk-Virginia Beach-Newport News	
	Bronx Co		Chesapeake
	Kings Co		Hampton
	Nassau Co		James City Co
	New York Co		Newport News

Table 4.6-20 (continued)

State (ASTM Class)/ Nonattainment Area	County	State (ASTM Class)/ Nonattainment Area	County
	Orange Co		Norfolk
	Queens Co		Poquoson
	Richmond Co		Portsmouth
	Rockland Co		Suffolk
	Suffolk Co		Virginia Beach
	Westchester Co		Williamsburg
			York Co
Virginia (B)		Wisconsin ©	
Richmond-Petersburg		Milwaukee-Racine	
	Charles City Co		Kenosha Co
	Chesterfield Co		Milwaukee Co
	Colonial Heights		Ozaukee Co
	Hanover Co		Racine Co
	Henrico Co		Washington Co
	Hopewell		Waukesha Co
	Richmond		
Washington DC			
	Alexandria		
	Arlington Co		
	Fairfax		
	Fairfax Co		
	Falls Church		
	Loudoun Co		
	Manassas		
	Manassas Park		
	Prince William Co		
	Stafford Co		

Notes: Reformulated gasoline was only modeled in Phoenix beginning with the projection years, as the opt-in date for Phoenix was 1997. California reformulated gasoline was modeled statewide in California.

Table 4.6-21 PART5 Vehicle Classes

Vehicle Class		FHWA Class	Gross Vehicle Weight (lbs)
LDGV	light-duty gasoline vehicles		
LDGT1	light-duty gasoline trucks, I	1	<6,000
LDGT2	light-duty gasoline trucks, II	2A	6,001-8,500
HDGV	heavy-duty gasoline trucks	2B - 8B	>8,500
MC	motorcycles		
LDDV	light-duty diesel vehicles	1	<6,000
LDDT	light-duty diesel trucks	2A	6,001-8,500
2BHDDV	class 2B heavy-duty diesel vehicles	2B	8,501-10,000
LHDDV	light heavy-duty diesel vehicles	3,4,5	10,001-19,500
MHDDV	medium heavy-duty diesel vehicles	6,7,8A	19,501-33,000
HHDDV	heavy heavy-duty diesel vehicles	8B	33,000+
BUSES	buses		

Table 4.6-22 Average Speeds by Road Type and Vehicle Type

	Rural Road Speeds (mph)					
Vehicle Type	Interstate	Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local
LDV	60	45	40	35	30	30
LDT	55	45	40	35	30	30
HDV	40	35	30	25	25	25

	Urban Road Speeds (mph)					
Vehicle Type	Interstate	Other Freeways & Expressways	Principal Arterial	Minor Arterial	Collector	Local
LDV	45	45	20	20	20	20
LDT	45	45	20	20	20	20
HDV	35	35	15	15	15	15

Table 4.6-23. PM-10 Emission Factors used in the Emission Trends Inventory

	Emission Factor (grams per mile)							
Year	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC
1970	0.070	0.069	0.070	0.062	0.615	0.615	2.367	0.070
1971	0.066	0.066	0.067	0.062	0.615	0.615	2.367	0.066
1972	0.063	0.063	0.064	0.062	0.615	0.615	2.367	0.063
1973	0.060	0.060	0.062	0.062	0.615	0.615	2.367	0.060
1974	0.057	0.057	0.059	0.062	0.615	0.615	2.351	0.057
1975	0.054	0.054	0.057	0.062	0.615	0.615	2.335	0.054
1976	0.051	0.051	0.054	0.062	0.615	0.615	2.319	0.051
1977	0.048	0.049	0.052	0.062	0.585	0.583	2.303	0.048
1978	0.045	0.046	0.049	0.062	0.555	0.552	2.287	0.045
1979	0.042	0.043	0.047	0.062	0.525	0.520	2.271	0.042
1980	0.039	0.040	0.044	0.062	0.495	0.489	2.255	0.039
1981	0.036	0.037	0.042	0.062	0.465	0.457	2.239	0.036
1982	0.033	0.034	0.039	0.062	0.435	0.426	2.223	0.033
1983	0.030	0.032	0.037	0.062	0.405	0.395	2.207	0.030
1984	0.026	0.029	0.034	0.062	0.375	0.363	2.191	0.026

Table 4.6-24. Fuel Economy Values Used in Calculation of SO_2 Emission Factors for the Emission Trends Inventory

	Fuel Economy (miles/gallon)						
Year	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
1970	12.68	10.18	6.79	12.68	10.18	5.05	50.00
1971	12.70	10.39	6.85	12.70	10.39	5.17	50.00
1972	12.57	10.51	6.86	12.57	10.51	5.27	50.00
1973	12.48	10.69	6.90	12.48	10.69	5.32	50.00
1974	12.59	11.15	7.11	12.59	11.15	5.47	50.00
1975	12.68	11.40	7.16	12.68	11.40	5.62	50.00
1976	12.69	11.39	7.05	12.69	11.39	5.47	50.00
1977	12.94	11.63	7.05	12.94	11.63	5.47	50.00
1978	13.17	11.81	6.97	13.17	11.81	5.45	50.00
1979	13.52	12.00	6.94	13.52	12.00	5.45	50.00
1980	14.50	12.54	7.13	14.50	12.54	5.64	50.00
1981	14.95	12.72	7.07	14.95	12.72	5.56	50.00
1982	15.49	12.96	7.65	24.90	24.59	5.30	50.00
1983	16.13	13.42	7.96	25.10	24.85	5.44	50.00
1984	16.78	13.90	8.15	25.21	24.96	5.57	50.00

Table 4.6-25. SO_2 Emission Factors used in the Emission Trends Inventory

	Emission Factor (grams per mile)							
Year	**LDGV**	**LDGT1**	**LDGT2**	**HDGV**	**LDDV**	**LDDT**	**HDDV**	**MC**
1970	0.147	0.183	0.183	0.274	0.989	1.231	2.482	0.037
1971	0.146	0.179	0.179	0.272	0.987	1.207	2.425	0.037
1972	0.148	0.177	0.177	0.271	0.997	1.193	2.379	0.037
1973	0.149	0.174	0.174	0.270	1.004	1.173	2.356	0.037
1974	0.148	0.167	0.167	0.262	0.996	1.124	2.292	0.037
1975	0.147	0.163	0.163	0.260	0.989	1.100	2.231	0.037
1976	0.147	0.163	0.163	0.264	0.988	1.101	2.292	0.037
1977	0.144	0.160	0.160	0.264	0.969	1.078	2.292	0.037
1978	0.141	0.158	0.158	0.267	0.952	1.061	2.300	0.037
1979	0.138	0.155	0.155	0.268	0.927	1.045	2.300	0.037
1980	0.128	0.148	0.148	0.261	0.865	1.000	2.223	0.037
1981	0.124	0.146	0.146	0.263	0.839	0.986	2.255	0.037
1982	0.120	0.144	0.144	0.243	0.503	0.510	2.365	0.037
1983	0.115	0.139	0.139	0.234	0.499	0.504	2.304	0.037
1984	0.111	0.134	0.134	0.228	0.497	0.502	2.251	0.037

Table 4.6-26. Fractions of Vehicles Equipped with 3-Way Catalysts by Vehicle Type and Model Year

	LDGVs		LDGT1		LDGT2		HDGVs	
Model Year	With Catalyst	Without Catalyst	With Catalyst	Without Catalyst	With Catalyst	Without Catalyst	With Catalyst	Without Catalyst
1990 and later	1.00	0.00	0.95	0.05	0.85	0.15	0.25	0.75
1989	1.00	0.00	0.95	0.05	0.85	0.15	0.15	0.85
1988	1.00	0.00	0.95	0.05	0.85	0.15	0.15	0.85
1987	1.00	0.00	0.95	0.05	0.85	0.15	0.15	0.85
1986	1.00	0.00	0.50	0.50	0.50	0.50	0.00	1.00
1985	1.00	0.00	0.40	0.60	0.40	0.60	0.00	1.00
1984	1.00	0.00	0.30	0.70	0.30	0.70	0.00	1.00
1983	0.88	0.12	0.20	0.80	0.10	0.90	0.00	1.00
1982	0.86	0.14	0.10	0.90	0.00	1.00	0.00	1.00
1981	0.07	0.93	0.05	0.95	0.00	1.00	0.00	1.00
1980	0.07	0.93	0.00	1.00	0.00	1.00	0.00	1.00
1979 and earlier	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00

Table 4.6-27. Ammonia Emission Factors by Year and Vehicle Type

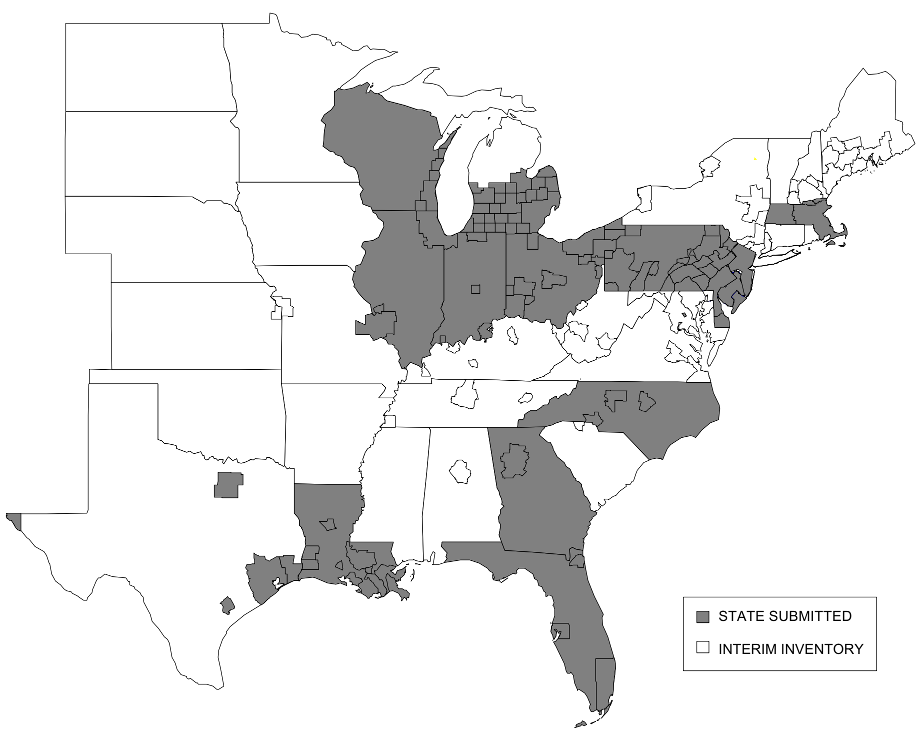
	Ammonia Emission Factor (g/mi)							
Year	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC
1999	0.13429	0.11845	0.10175	0.02425	0.00188	0.00188	0.00188	0.00352
2000	0.13510	0.12135	0.10505	0.02579	0.00188	0.00188	0.00188	0.00352
2002	0.13610	0.12513	0.10967	0.02881	0.00188	0.00188	0.00188	0.00352
2005	0.13691	0.12816	0.11352	0.03216	0.00188	0.00188	0.00188	0.00352
2007	0.13738	0.12925	0.11497	0.03356	0.00188	0.00188	0.00188	0.00352
2008	0.13744	0.12959	0.11575	0.03411	0.00188	0.00188	0.00188	0.00352
2010	0.13746	0.13019	0.11660	0.03486	0.00188	0.00188	0.00188	0.00352

Figure 4.6-1. State-Provided Registration Distributions

```
State: Delaware
Counties: Kent Co
```

.0020.0630.0690.0720.0750.0810.0860.0840.0820.0750
.0680.0440.0320.0280.0240.0250.0190.0140.0090.0050
.0050.0050.0050.0040.0240
.0010.0550.0720.0730.0710.0900.0900.0870.0810.0600
.0540.0370.0260.0210.0210.0310.0260.0200.0140.0090
.0080.0070.0070.0060.0330
.0070.0360.0560.0620.0790.0820.0820.0540.0770.0590
.0430.0380.0330.0280.0220.0470.0330.0310.0220.0150
.0170.0150.0110.0090.0420
.0020.0480.0430.0440.0590.0590.0600.0560.0720.0590
.0490.0320.0250.0370.0230.0420.0300.0340.0240.0290
.0320.0300.0200.0150.0760
.0020.0630.0690.0720.0750.0810.0860.0840.0820.0750
.0680.0440.0320.0280.0240.0250.0190.0140.0090.0050
.0050.0050.0050.0040.0240
.0010.0550.0720.0730.0710.0900.0900.0870.0810.0600
.0540.0370.0260.0210.0210.0310.0260.0200.0140.0090
.0080.0070.0070.0060.0330
.0030.0260.0320.0400.0370.0660.0710.0560.0610.0580
.0570.0310.0400.0270.0520.0780.0590.0260.0140.0350
.0210.0270.0130.0070.0630
.0060.0490.0580.0590.0470.0770.0350.0530.0820.0570
.0370.4400.0000.0000.0000.0000.0000.0000.0000.0000
.0000.0000.0000.0000.0000.

Figure 4.6-2. OTAG Inventory Source of Data - VMT



4.7 NON-ROAD ENGINES AND VEHICLES

The "Non-road Engines and Vehicles" heading includes the following Tier I and Tier II categories:

Tier 1 Category	Tier II Category
(11) Non-road Engines and Vehicles	All

The Tier II category includes the estimated emissions from aircraft, commercial marine vessels, railroads, and all other non-road vehicles and equipment. The methodology used to generate the emissions for these sources is described in this section.

4.7.1 1990 Interim Inventory

The 1990 emissions from aircraft, commercial marine vessels, and railroads have been estimated from the area source portion of the 1985 National Acid Precipitation Assessment Program (NAPAP) inventory by the process described in section 4.7.1.2. The bases for the remaining non-road categories are the emission inventories[1] prepared by the United States (U.S.) Environmental Protection Agency's (EPA) Office of Mobile Sources (OMS) for 27 nonattainment areas (NAAs). These inventories were combined and used to create national county-level emissions. These emissions are detailed in section 4.7.1.1.

4.7.1.1 Non-road Engines and Vehicle Emissions

Non-road engines and vehicles include motorized vehicles and equipment that are not normally operated on public roadways to provide transportation. The non-road mobile source emissions in the 1990 Interim inventory are based on 1990 non-road emissions[2] compiled by EPA's Emission Factors and Inventory Group (EFIG). The EFIG non-road data contains total emissions for non-road sources at the county level. These emissions include all non-road sources except aircraft, commercial marine vessels, and railroads. The EFIG non-road emissions were developed from non-road emission inventories for 27 ozone NAAs by OMS. The OMS inventories contained 1990 emissions at the SCC-level for each county within one of the 27 NAAs. These non-road data do not include emissions for sulfur dioxide (SO_2). The SO_2 emissions in the 1985 NAPAP inventory from the non-road sources were approximately 92,000 short tons and are not included in the NET inventory.

A two step process was used to convert the OMS NAA emissions to county-SCC-level emissions needed for the NET inventory. The first step, performed by EFIG, used the OMS 1990 non-road emissions for the 27 ozone NAAs to estimate non-road emissions for the rest of the country. The second step used the EFIG total non-road emissions for each county to create 1990 county-SCC-level non-road emissions.

Step 1. Creation of National County-Level 1990 Non-road Emissions

OMS prepared 1990 non-road emission inventories for 27 ozone and six carbon monoxide (CO) NAAs. (Data from the CO NAAs were not used because it did not include VOC and NO_x emissions.) Table 4.7-1 lists the 27 ozone NAAs for which non-road inventories were compiled. Each NAA inventory contained county-level emissions for 279 different equipment/engine type combinations for each county in the NAA. For this information to be useful for the 1990 Interim inventory, non-road emissions were needed for the entire country (excluding Alaska and Hawaii). The following methodology was used to create 1990 non-road emissions for the entire country:

(a) volatile organic compounds (VOC), nitrogen oxides (NO_x), and CO per capita emission factors were developed for each NAA by summing each pollutant's emissions for all equipment/engine categories for all counties within the NAA and dividing by the NAA population

(b) for counties entirely within one of the 27 NAAs, the emissions in the OMS inventories were used

(c) for counties partially in one of the 27 NAAs, emissions were calculated by multiplying the NAA per capita emission factor by the total county population

(d) all other counties were assigned a “surrogate NAA” based on geography and climate, emissions were calculated by multiplying the surrogate NAA per capita emission factors by the total county population. Figure 4.7-1 shows the surrogate NAA each area of the country was assigned.

Step 2. Distribution of Total Non-road Emissions to SCCs

The resulting emissions from step 1 above, represent total county non-road emissions. To be incorporated into the 1990 Interim inventory, these emissions must be distributed to the appropriate SCCs. The following methodology was used to distribute total non-road emissions to SCCs:

(a) an SCC was assigned to each of the 279 equipment/engine type combinations in the OMS inventories; the 27 SCCs used are listed in Table 4.7-2

(b) for each of the 27 OMS inventories, the percentage of emissions from sources assigned to each of the 27 SCCs was calculated

(c) each county's total non-road emissions were distributed to the 27 SCCs using the SCC percentages from its surrogate NAA.

4.7.1.2 Aircraft, Marine Vessels and Railroads

The **area** source emissions from the 1985 NAPAP inventory have been projected to the year 1990 based on BEA historic earnings data or other growth indicators. The specific growth indicator was assigned based on the source category. The Bureau of Economic Analysis (BEA) earnings data were converted to 1982 dollars as described in section 4.7.1.2.2. 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 from the 1985 inventory for some sources. The 1990 emissions for CO, NO_x, SO_2, and VOC 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 inventory, and

(3) calculated the final 1990 controlled emissions using revised emission factors. The 1990 PM-10 emissions were calculated using the total suspended particulates (TSP) emissions from the 1985 NAPAP inventory. The 1990 uncontrolled TSP emissions were estimated in the same manner as the other pollutants. The 1990 uncontrolled particulate matter less than 10 microns in aerodynamic diameter (PM-10) estimates were calculated from these TSP emissions by applying source classification code- (SCC-) specific uncontrolled particle size distribution factors.[3] The controlled PM-10 emissions were estimated in the same manner as the other pollutants.

4.7.1.2.1 Emission Factor Changes —

Emission factors for several sources were updated to reflect recent technical improvements in AP-42 and other emission inventory guidance documents. Emission factors for all four pollutants were updated for railroads. The SO_2 emission factors for aircraft were also updated.

Railroad emission factors in NAPAP were derived from data in AP-42. Improved emission factors for railroad locomotives have recently been developed in a revision to EPA's mobile source emission inventory guidance.[4] These updated emission factors were incorporated into the 1990 Interim estimates. Railroad emission factors are summarized in Table 4.7-3 for line-haul locomotives and yard (switch) locomotives. Because only one set of emission factors is required for railroads, the separate emission factors for line-haul and yard locomotives were weighted by fuel usage. The Association of American Railroads (AAR) provided data on fuel consumption by line-haul and yard locomotives for Class I railroads for 1985 through 1990, as shown in Table 4.7-4.

AP-42 SO_2 emission rates were compared with emission rates published in EPA's emission inventory guidance.[5] SO_2 rates were on average 54 percent lower, due to changes in fuel sulfur content. This change was incorporated into the aircraft emissions for the 1990 Interim inventory. (Although new data were available only for civil aircraft, the emission factor change was incorporated for all aircraft). Aircraft emission factors for VOC, NO_x, and CO have not changed. Table 4.7-5 compares SO_2 emission rates from aircraft.

4.7.1.2.2 1990 Growth Indicators for Aircraft, Marine Vessels, and Railroads —

Emissions from the 1985 NAPAP inventory were grown to the 1990 Interim inventory years based on historical BEA earnings data or other category-specific growth indicators. Table 4.7-6 shows the growth indicators used for each area source by NAPAP category.

Activity levels for aircraft are measured by the number of landing-takeoff operations (LTOs). Annual LTO totals are compiled by the Federal Aviation Administration (FAA) on a regional basis. Commercial aircraft growth is derived by summing the air carrier and air taxi regional totals of LTOs from FAA-operated control towers and FAA traffic control centers.[6] Since these data are compiled on a regional basis, the regional trends were applied to each state. Civil aircraft growth indicators were also developed from regional LTO totals. Civil aircraft activity levels were determined from terminal area activity for the years 1985 through 1989, and from a 1990 forecast of terminal area activity.[7a] Since military aircraft LTO totals were not available, BEA data were used.

The changes in the military aircraft emissions were equated with the changes in historic earnings by state and industry. Emissions in the 1985 NAPAP inventory were projected to the years 1985 through 1991 based on the growth in earnings by industry (two-digit SIC code). Historical annual state and industry earnings data from BEA's Table SA-5 (Reference 8) were used to represent growth in earnings from 1985 through 1990.

The 1985 through 1990 earnings data in Table SA-5 are expressed in nominal dollars. To estimate growth, these values were converted to constant dollars to remove the effects of inflation. Earnings data for each year were converted to 1982 constant dollars using the implicit price deflator for PCE.[9] The PCE deflators used to convert each year's earnings data to 1982 dollars are:

Year	1982 PCE Deflator
1985	111.6
1987	114.3
1988	124.2
1989	129.6
1990	136.4

Several BEA categories did not contain a complete time series of data for the years 1985 through 1990. Because the SA-5 data must contain 1985 earnings and earnings for each inventory year (1985 through 1990) to be useful for estimating growth, a log linear regression equation was used where possible to fill in missing data elements. This regression procedure was performed on all categories that were missing at least one data point and which contained at least three data points in the time series.

Each record in the point source inventory was matched to the BEA earnings data based on the state and the two-digit SIC. Table 4.7-7 shows the BEA earnings category used to project growth for each of the two-digit SICs found in the 1985 NAPAP inventory. No growth in emissions was assumed for all point sources for which the matching BEA earnings data were not complete. Table 4.7-7 also shows the national average growth and earnings by industry from BEA Table SA-5.

Railroad data are provided by the Association of American Railroads (AAR). National totals of revenue-ton-miles for the years 1985 through 1990 are used to estimate changes in activity during this period. The national growth is therefore applied to each state and county.[10]

Marine vessel activity is recorded annually by the U.S. Army Corp of Engineers. Cargo tonnage national totals are used to determine growth in diesel- and residual-fueled vessel use through the year 1989.[11] Since gasoline-powered vessels are used predominantly for recreation, growth for this category is therefore based on population.

4.7.1.2.3 Emissions Calculations —
A four-step process was used to calculate emissions incorporating rule effectiveness. First, base year controlled emissions are projected to the inventory year using the following equation (Equation 4.7-1).

$$CE_i = CE_{BY} + (CE_{BY} \times EG_i) \qquad \text{(Eq. 4.7-1)}$$

where: CE_i = Controlled Emissions for inventory year I
CE_{BY} = Controlled Emissions for base year
EG_i = Earnings Growth for inventory year I

Earnings growth is calculated using Equation 4.7-2.

$$EG_i = 1 - \frac{DAT_i}{DAT_{BY}} \quad \text{(Eq. 4.7-2)}$$

where: EG_i = Earnings growth for year I
DAT_i = Earnings data for inventory year I
DAT_{BY} = Earnings data in the base year

Second, uncontrolled emissions in the inventory year are back-calculated from the controlled emissions based on the control efficiency using Equation 4.7-3.

$$UE_i = \frac{CE_i}{\left(1 - \frac{CEFF}{100}\right)} \quad \text{(Eq. 4.7-3)}$$

where: UE_i = Uncontrolled Emissions for inventory year I
CE_i = Controlled Emissions for inventory year I
CEFF = Control Efficiency (percent)

For aircraft, marine vessels, and railroads this equation reduces to Equation 4.7-4 since the control efficiency is equal to zero.

$$UE_i = CE_i \quad \text{(Eq. 4.7-4)}$$

Third, controlled emissions are recalculated incorporating revised emission factors using the following equation (Equation 4.7-5).

$$CER_i = UC_i \times \left(\frac{EF_i}{EF_{BY}}\right) \quad \text{(Eq. 4.7-5)}$$

where: CER_i = Controlled Emissions Incorporating Rule Effectiveness
UC_i = Uncontrolled Emissions
EF_i = Emission factor for inventory year I
EF_{BY} = Emission factor for base year

The last step in the creation of the inventory was matching the NAPAP categories to the new AMS categories. This matching is provided in Table 4.7-8. Note that there is not always a one-to-one correspondence between NAPAP and AMS categories.

4.7.2 Emissions, 1970 through 1989

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[12] were obtained by representative NAA and rest of state counties and by Bureau of Labor Statistics (BLS) codes and then correlated to the non-road SCCs and counties.

$$Emissions_{(county,SCC,year)} = Growth_{(county,SCC,year)} \times Emissions_{(county,SCC,1990)} \qquad \text{(Eq. 4.7-6)}$$

4.7.3 1990 National Emissions Trends

The 1990 National Emission Trends (NET) data base is based primarily on state data, with the Interim data filling in the data gaps. The state data were extracted from the Ozone Transport Assessment Group (OTAG) inventory. As part of the OTAG Inventory development, 24 states submitted emission estimates for non-road sources. Of these states, 17 submitted emission estimates for the entire state and 7 submitted emission estimates for a portion of their state. Since the goal of the OTAG Inventory development effort was to create an inventory of ozone season daily (OSD), daily emission estimates were submitted by all states, except Texas which submitted annual emissions. Daily emissions were converted to annual emissions using EPA's default SCC-specific temporal allocation factors. Table 4.6-7 shows which states submitted non-road estimates for the OTAG Inventory and what type of data they submitted.

The actual incorporation of emission estimates from the OTAG Inventory was performed by determining the counties for which state submitted data was available from the OTAG Inventory. Emission estimates for those counties were then removed from the Trends Inventory. Then the county/ SCC-level emission estimates from the OTAG Inventory were added to the Trends Inventory. Since the OTAG Inventory was primarily an inventory of VOC, NO_x, and CO, very little SO_2 or PM emission estimates were included in the state submissions. In cases where SO_2 and/or PM emission estimates were submitted they were used, otherwise the SO_2 and PM emission estimates from the Interim Inventory were kept.

The final 1990 non-road diesel emission estimates were adjusted so that the national emissions in the Trends report would be consistent with national emissions estimated by OMS as part of the EPA Notice of Proposed Rulemaking (NPRM) for non-road diesel engine.[13] The methods used for developing 1995 emission estimates are documented in the next section of this chapter. Making this adjustment for 1995 resulted in a large discontinuity in the emission estimates between 1995 and the years preceding it. To remove this large discontinuity, emission estimates for years prior to 1995 (including the base year, 1990) were adjusted to be consistent with the final 1995 emissions. This adjustment was implemented by multiplying the emissions for each county by the following ratio:

$$\frac{Final National 1995 Estimates}{Preliminary National 1995 Estimates} \quad \text{(Eq. 4.7-7)}$$

The final 1995 national estimates are after adjusting for emissions for consistency with the NPRM emissions and the preliminary 1995 national estimates are prior to adjusting to the NPRM emissions. Applying this ratio maintains the geographic distribution of the base year estimates while adjusting the size of the emission estimates to be consistent with the 1995 emissions from the NPRM.

4.7.4 Emissions, 1991 through 1994

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.

Base year emission estimates were projected to 1991 through 1994 using BEA historical earnings data as a surrogate for growth. Historical earnings for the years 1990 through 1995 were obtained from BEA's Table SA-5 - Total Personal Income by Major Sources.[8] The BEA earnings data is by state and 2-digit SIC. There were three steps taken in using the BEA data to project growth: (1) BEA data was converted from nominal dollars to constant dollars, (2) 1996 growth factors were developed based on the 1990 through 1995 normalized data, and (3) growth factors were applied to 1990 emissions based on a SIC to SCC crosswalk.

The earnings data in BEA Table SA-5 is in nominal dollars. In order to use the data to generate growth factors it was converted to 1992 constant dollars to remove the effects of inflation. Earnings data for each year was converted to 1992 constant dollars using the implicit price deflator for PCE. The PCE deflators used to convert earnings to 1992 dollars are:

Year	1992 PCE Deflator
1990	93.6
1991	97.3
1992	100.0
1993	102.6
1994	104.9
1995	107.6

The BEA earnings data for 1996 were not published or available for use on this project. 1996 earnings data were estimated by linear growth in earnings from 1990 to 1995. The following equation was used to estimate the 1996 earnings:

$$1996\,Earnings = 1995\,Earnings + \frac{1995\,Earnings - 1990\,Earnings}{5} \quad \text{(Eq. 4.7-8)}$$

1995 and 1996 growth factors were calculated based on the change in earnings from the base year (1990) to the year emissions were being estimated for (1995 or 1996). For each county-level emission estimate, the appropriate growth factor was selected based on the state and SCC. The crosswalk between SCC and growth factors is displayed in Table 4.7-10. The growth factor was then multiplied by the 1990 emissions resulting in the 1995 or 1996 emissions. The following equation was used.

$$Emissions_{95\ or\ 96} = Emissions_{90} * \frac{Earnings_{90}}{Earnings_{95\ or\ 96}} \qquad \text{(Eq. 4.7-9)}$$

Tables 4.7-11 and 4.7-12 lists the 1990 through 1996 growth indicators by BEA earnings and population. Commercial aircraft emissions were projected using FAA estimates of LTOs for the years 1990 through 1996.[7b,7c]

The 1991 through 1995 emissions for NO_x locomotive and all commercial aircraft emission estimates were developed using 1990 Interim Inventory emissions and applying growth factors using Equation 4.7-5. The growth factors were obtained from the prereleased E-GAS, version 2.0.[12] The E-GAS generates growth factors at the SCC-level for counties representative of all counties within each ozone nonattainment area classified as serious and above and for counties representative of all counties within both the attainment portions and the marginal and moderate nonattainment areas within each state. The appropriate growth factors were applied by county and SCC to the 1990 emissions as shown by Equation 4.7-5.

There are approximately 150 representative counties in E-GAS and 2000 SCCs present in the base year inventory. This yields a matrix of 300,000 growth factors generated to determine a single year's inventory. To list all combinations would be inappropriate.

The final 1991-1994 non-road diesel emission estimates were adjusted so that the national emissions in the Trends report would be consistent with national emissions estimated by OMS as part of the EPA NPRM for non-road diesel engines.[13] The methods used for developing 1995 emission estimates are documented in the next section of this chapter. Making this adjustment for 1995 resulted in a large discontinuity in the emission estimates between 1995 and the years preceding it. To remove this large discontinuity, emission estimates for years prior to 1995 (including the base year, 1990) were adjusted to be consistent with the final 1995 emissions. This adjustment was implemented by multiplying the emissions for each county by the following ratio:

$$\frac{Final\ National\ 1995\ Estimates}{Preliminary\ National\ 1995\ Estimates} \qquad \text{(Eq. 4.7-10)}$$

The final 1995 national estimates are after adjusting for emissions for consistency with the NPRM emissions and the preliminary 1995 national estimates are prior to adjusting to the NPRM emissions. Applying this ratio maintains the geographic distribution of the base year estimates while adjusting the size of the emission estimates to be consistent with the 1995 emissions from the NPRM.

4.7.5 1995 Emissions

The 1995 emission estimates were derived in a similar manner as the 1991 through 1994 estimates. Exceptions are noted in section 4.7.7.

4.7.6 1996 Emissions

The 1996 emission estimates were derived in a similar manner as the 1995 emissions. The following three subsections describe the projected 1996 emissions.

4.7.6.1 Grown Estimates

The 1996 area source emissions were grown using the 1995 NET inventory as the basis. The algorithm for determining the estimates is detailed in section 4.7.1.2.3 and is described by the equation below. The 1990 through 1996 SEDS and BEA data are presented in Tables 4.7-11 and 4.7-12. The 1996 BEA and SEDS data were determined using linear interpretation of the 1988 through 1995 data.

Equation 4.7-11 describes the calculation used to estimate the 1996 emissions.

$$CER_{1996} = UC_{1995} \times \frac{GS_{1996}}{GS_{1995}} \times \left(1 - \left(\frac{REFF}{100} \right) \times \left(\frac{CEFF}{100} \right) \times \left(\frac{RP}{100} \right) \right) \qquad \text{(Eq. 4.7-11)}$$

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 detailed in the following subsections.

4.7.6.2 Non-road Engine Controls-Spark-Ignition Engines < 25 hp

EPA is currently in the process of developing regulations for spark ignition engines less than 25 horsepower (hp) that are designed to reduce hydrocarbons (HC), NO_x, and CO emissions. Expected to be included under these rules are most general utility equipment (i.e., lawn and garden and light commercial/industrial equipment), as well as farm and construction engines less than 25 hp.

A 3 percent reduction to the VOC emissions was applied nationally for all two-stroke gasoline engines (SCC = 2260xxxxxx) and all four-stroke gasoline engines (SCC = 2265xxxxxx). An additional 3.3 percent reduction was added to areas with reformulated gasoline. The counties with reformulated gasoline programs are listed in Table 4.7-13.

4.7.6.3 Non-road Diesel Engines

A 37 percent reduction to the NO_x emissions was applied nationally to all diesel compression ignition engines. 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. Table 4.7-14 lists the reductions by SCC.

4.7.7 1995 and 1996 Emission Revisions

As an update to portions of the NET non-road inventory, OMS agreed to provide emission estimates from their models and analyses being used for the Regulatory Impact Analysis (RIA) documents. Categories for which OMS provided data are non-road diesel engines, non-road spark-ignition marine engines, and locomotives. For each of these categories OMS provided national/SCC level emission estimates. For the diesel non-road engines the pollutants covered included VOC, NO_x, CO, PM-10, and PM-2.5. For the non-road spark-ignition marine engines, only VOC and NO_x were provided. For locomotives, only NO_x and PM-10 were provided

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. Listed below is the procedure used to incorporate the national OMS emission estimates.

1. 1995 and 1996 county/SCC level emission estimates were developed from the 1990 NET emissions using the normal procedure (i.e., BEA growth factors were applied and applicable credits for control programs were accounted for.)

2. The 1995 and 1996 county/SCC level emission estimates developed in Step 1 were aggregated to national/SCC level emission estimates. This was done at the equipment level (e.g., construction, agriculture, lawn and garden, etc.) rather than the specific engine level; although the OMS data was supplied at the specific engine level, a large portion of the NET emission estimates are at the engine category level.

3. Pollutant-specific adjustment factors for each applicable engine category were developed by calculating the ratio of the OMS estimate to the NET estimate.

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

For locomotives, the national OMS estimates were close to the national NET estimates prior to any adjustments for all pollutants except PM-10. Therefore, only PM-10 and PM-2.5 (calculated as 92 percent of the revised PM-10) were adjusted for locomotives. For non-road diesel engines and non-road spark-ignition marine engines, adjustments were made to all pollutants for which OMS provided information (VOC, NO_x, CO, PM-10, and PM-2.5 for non-road diesel, VOC and NO_x for non-road spark-ignition marine engines.)

Tables 4.7-15 through 4.7-17 show the national NET estimates prior to adjustments and the OMS provided estimates for non-road diesel engines, non-road spark-ignition marine engines, and locomotives, respectively.

One final adjustment was made to the 1995 and 1996 emission estimates. Emissions from non-road agricultural engines were re-allocated to the county level based on county level acres of crops harvested in the 1992 Census of Agriculture.[14] This adjustment was performed because the methods used to allocated emissions from non-road agricultural engines for the Interim Inventory were thought to be deficient. Since the geographic allocation of the non-road emissions in the Interim Inventory were based on emissions in 27 urban nonattainment areas and most farm equipment usage occurs in rural areas, the Interim Inventory allocation of emissions from non-road farm may not be accurate. This adjustment was performed by aggregating the emissions from non-road farm equipment to the national level for each pollutant. The national level emissions were then allocated to the county level based on the numbers of acres harvested in that county. This adjustment was made for both gasoline and diesel engines.

4.7.8 References

1. *Documentation for Estimation of Non-road Emission Estimates for the United States*, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1992.

2. *Non-road Engine Emission Inventories for CO and Ozone Nonattainment Boundaries*, U.S. Environmental Protection Agency, Ann Arbor, MI, October 1992.

3. Barnard, W.R., and P. Carlson, *PM-10 Emission Calculation, Tables 1 and 4*, E.H. Pechan & Associates, Inc. Contract No. 68-D0-1020, U.S. Environmental Protection Agency, Emission Factor and Methodologies Section, Research Triangle Park, NC. June 1992.

4. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*, Draft revision, Chapter 6, U.S. Environmental Protection Agency, Office of Mobile Sources, Ann Arbor, MI, 1991.

5. *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*, Draft revision, Chapter 5, U.S. Environmental Protection Agency, Office of Mobile Sources, Ann Arbor, MI, November 1991.

6. *Air Traffic Activity*, U.S. Department of Transportation, Federal Aviation Administration, Washington, DC, 1991.

7. *Terminal Area Forecasts, FY 1991-2005*, FAA-APO-91-5, U.S. Department of Transportation, Federal Aviation Administration, Washington, DC, July 1991.
   a. July 1991
   b. February 1992, Table 27
   c. March 1997, Table 28

8. *Table SA-5 — Total Personal Income by Major Sources 1969-1990*, data files, U.S. Department of Commerce, Bureau of Economic Analysis, Washington, DC, September 1991.

9. *Survey of Current Business*, U.S. Department of Commerce, Bureau of Economic Analysis, Washington, DC, July 1986, July 1987, July 1988, July 1989, July 1990, July 1991.

10. *Railroad Ten-Year Trends 1981-1990*, Association of American Railroads, Washington, DC, 1991.

11. *Waterborne Commerce of the United States, Calendar Year 1989*, WRSC-WCUS-89, Part 5, U.S. Army Corp of Engineers, New Orleans, LA, June 1991.

12. *E-GAS Growth Factors and BLS to SCC Cross Reference*. Computer PC model and files received by E.H. Pechan & Associates, Inc. from TRC Environmental Corporation, Chapel Hill, NC. June 1994.

13. "Emission Inventories Used in the Nonroad Diesel Proposed Rule," Office of Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, MI. E-mail to Sharon Nizich, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 27, 1997.

14. "1994 Census of Agriculture - Geographic Area Series 1A, 1B, and 1C," (CD-ROM), Bureau of the Census, U.S. Department of Commerce, 1995.

Table 4.7-1. Ozone Nonattainment Areas with OMS-Prepared Non-road Emissions

Atlanta, GA	Hartford, CT	Providence, RI
Baltimore, MD	Houston, TX	San Diego, CA
Baton Rouge, LA	Miami, FL	San Joaquin, CA
Beaumont, TX	Milwaukee, WI	Seattle, WA
Boston, MA	Muskegon, MI	Sheboygan, WI
Chicago, IL	New York, NY	South Coast, CA
Cleveland, OH	Philadelphia, PA	Springfield, MA
Denver, CO	Phoenix, AZ	St. Louis, MO
El Paso, TX	Portsmouth, NH	Washington, DC

Figure 4.7-1. Assignment of Surrogate Nonattainment Areas

Table 4.7-2. Source Categories Used for Nonroad Emissions

AMS SCC	Category Description
2260001000	Recreational Vehicles: Gasoline, 2-Stroke
2260002000	Construction Equipment: Gasoline, 2-Stroke
2260003000	Industrial Equipment: Gasoline, 2-Stroke
2260004000	Lawn & Garden Equipment: Gasoline, 2-Stroke
2260005000	Farm Equipment: Gasoline, 2-Stroke
2260006000	Light Commercial: Gasoline, 2-Stroke
2260007000	Logging Equipment: Gasoline, 2-Stroke
2260008000	Airport Service Equipment: Gasoline, 2-Stroke
2265001000	Recreational Vehicles: Gasoline, 4-Stroke
2265002000	Construction Equipment: Gasoline, 4-Stroke
2265003000	Industrial Equipment: Gasoline, 4-Stroke
2265004000	Lawn & Garden Equipment: Gasoline, 4-Stroke
2265005000	Farm Equipment: Gasoline, 4-Stroke
2265006000	Light Commercial: Gasoline, 4-Stroke
2265007000	Logging Equipment: Gasoline, 4-Stroke
2265008000	Airport Service Equipment: Gasoline, 4-Stroke
2270001000	Recreational Vehicles: Diesel
2270002000	Construction Equipment: Diesel
2270003000	Industrial Equipment: Diesel
2270004000	Lawn & Garden Equipment: Diesel
2270005000	Farm Equipment: Diesel
2270006000	Light Commercial: Diesel
2270007000	Logging Equipment: Diesel
2270008000	Airport Service Equipment: Diesel
2282005000	Recreational Marine Vessels: Gasoline, 2-Stroke
2282010000	Recreational Marine Vessels: Gasoline, 4-Stroke
2282020000	Recreational Marine Vessels: Diesel

Table 4.7-3. Railroad Locomotives Diesel Fuel Consumption, 1985 to 1990 (million gallons)

Year	Line-Haul	Switch
1985	2,889	255
1990	2,876	258

Source: "Railroad Ten-Year Trends 1981-1990," Association of American Railroads, Washington, DC, 1991.

Table 4.7-4. Railroad Emission Factors (lbs/1,000 gallons)

	Wtg. Factor	NO_x	CO	HC	SO_2
NAPAP		370	130	90	57
Revised					
Line-haul	2,876	493.1	62.6	20.1	36.0
Yard	258	504.4	89.4	48.2	36.0
New Wtd. Avg.		494	65	22	36

Source: "Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," Draft revision, Chapter 5, Office of Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, MI, November 1991.

Table 4.7-5. Civil Aircraft SO_2 Emission Factors

Engine Type	Fuel Rate (lbs/hr)	AP-42 SO_2 Emission Factor (lbs/hr)	New SO_2 Emission Factor (lbs/hr)	Engine Type	Fuel Rate (lbs/hr)	AP-42 SO_2 Emission Factor (lbs/hr)	New SO_2 Emission Factor (lbs/hr)
250B17B	63	0.06	0.03	PT6A-41	147	0.15	0.08
	265	0.27	0.14		510	0.51	0.28
	245	0.25	0.13		473	0.47	0.26
	85	0.09	0.05		273	0.27	0.15
501D22A	610	0.61	0.33	Dart RDa7	411	0.41	0.22
	2376	2.38	1.28		1409	1.41	0.76
	2198	2.2	1.19		1248	1.25	0.67
	1140	1.14	0.62		645	0.65	0.35
TPE-331-3	112	0.11	0.06	0-200	8.24	0	0.00
	458	0.46	0.25		45.17	0.01	0.00
	409	0.41	0.22		45.17	0.01	0.00
	250	0.25	0.14		25.5	0.01	0.00
JT3D-7	1013	1.01	0.55	TSIO-360C	11.5	0	0.00
	9956	9.96	5.38		133	0.03	0.01
	8188	8.19	4.39		99.5	0.02	0.01
	3084	3.08	1.67		61	0.01	0.01
JT9D-7	1849	1.85	1.00	O-320	9.48	0	0.00
	16142	16.14	8.72		89.1	0.02	0.01
	13193	13.19	7.12		66.7	0.01	0.01
	4648	4.65	2.51		46.5	0.01	0.01
PT6A-27	115	0.12	0.06				
	425	0.43	0.23				
	400	0.4	0.22				
	215	0.22	0.12				

Source: "Supplement D to Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources," AP-42, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1991.

Table 4.7-6. Area Source Growth Indicators

NAPAP SCC	Category Description	Data Source	Growth Indicator
45	Railroad Locomotives	AAR	Railroad ton-miles (national)
46	Aircraft LTOs - Military	BEA	Military
47	Aircraft LTOs - Civil	FAA	Aircraft - civil
48	Aircraft LTOs - Commercial	FAA	Aircraft - commercial
49	Vessels - Coal	Corp of Engineers	Cargo tonnage (national)
50	Vessels - Diesel Oil		Cargo tonnage (national)
51	Vessels - Residual Oil		Cargo tonnage (national)

Table 4.7-7. Bureau of Economic Analysis's SA-5 National Changes in Earnings by Industry

Industry	SIC	Percent Growth			
		1985 to 1987	1987 to 1988	1988 to 1989	1989 to 1990
Federal, military	97	1.96	- 1.07	- 1.58	-3.19

Table 4.7-8. AMS to NAPAP Source Category Correspondence

AMS SCC	AMS Category	NAPAP SCC	NAPAP Category
Mobile Sources			
2275001001	Aircraft - Military Aircraft (LTOs)	46	Aircraft LTOs - Military
2275020000	Aircraft - Commercial Aircraft (LTOs)	48	Aircraft LTOs - Commercial
2275050000	Aircraft - Civil Aircraft (LTOs)	47	Aircraft LTOs - Civil
2280001000	Marine Vessels - Coal	49	Vessels - Coal
2280002000	Marine Vessels - Diesel	50	Vessels - Diesel Oil
2280003000	Marine Vessels - Residual Oil	51	Vessels - Residual Oil
2285002000	Railroads - Diesel	45	Railroad Locomotives
2260001000	Recreational Vehicles: Gasoline, 2-Stroke	39	Non-road Sources Gasoline Vehicles
2260002000	Construction Equipment: Gasoline, 2-Stroke	39	Non-road Sources Gasoline Vehicles
2260003000	Industrial Equipment: Gasoline, 2-Stroke	39	Non-road Sources Gasoline Vehicles
2260004000	Lawn & Garden Equipment: Gasoline, 2-Stroke	39	Non-road Sources Gasoline Vehicles
2260005000	Farm Equipment: Gasoline, 2-Stroke	39	Non-road Sources Gasoline Vehicles
2260006000	Light Commercial: Gasoline, 2-Stroke	39	Non-road Sources Gasoline Vehicles
2260007000	Logging Equipment: Gasoline, 2-Stroke	39	Non-road Sources Gasoline Vehicles
2260008000	Airport Service Equipment: Gasoline, 2-Stroke	39	Non-road Sources Gasoline Vehicles
2265001000	Recreational Vehicles: Gasoline, 4-Stroke	39	Non-road Sources Gasoline Vehicles
2265002000	Construction Equipment: Gasoline, 4-Stroke	39	Non-road Sources Gasoline Vehicles
2265003000	Industrial Equipment: Gasoline, 4-Stroke	39	Non-road Sources Gasoline Vehicles
2265004000	Lawn & Garden Equipment: Gasoline, 4-Stroke	39	Non-road Sources Gasoline Vehicles
2265005000	Farm Equipment: Gasoline, 4-Stroke	39	Non-road Sources Gasoline Vehicles
2265006000	Light Commercial: Gasoline, 4-Stroke	39	Non-road Sources Gasoline Vehicles
2265007000	Logging Equipment: Gasoline, 4-Stroke	39	Non-road Sources Gasoline Vehicles
2265008000	Airport Service Equipment: Gasoline, 4-Stroke	39	Non-road Sources Gasoline Vehicles
2270001000	Recreational Vehicles: Diesel	44	Non-road Sources Diesel Vehicles
2270002000	Construction Equipment: Diesel	44	Non-road Sources Diesel Vehicles
2270003000	Industrial Equipment: Diesel	44	Non-road Sources Diesel Vehicles
2270004000	Lawn & Garden Equipment: Diesel	44	Non-road Sources Diesel Vehicles
2270005000	Farm Equipment: Diesel	44	Non-road Sources Diesel Vehicles
2270006000	Light Commercial: Diesel	44	Non-road Sources Diesel Vehicles
2270007000	Logging Equipment: Diesel	44	Non-road Sources Diesel Vehicles
2270008000	Airport Service Equipment: Diesel	44	Non-road Sources Diesel Vehicles
2282005000	Recreational Marine Vessels: Gasoline, 2-Stroke	52	Marine Vessels - Gasoline
2282010000	Recreational Marine Vessels: Gasoline, 4-Stroke	52	Marine Vessels - Gasoline
2282020000	Recreational Marine Vessels: Diesel	N/A	

Table 4.7-9. Non-road Data Submitted for OTAG Inventory

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 Nonroad 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	Nonroad emissions submitted were county totals. Nonroad 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
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	Daily	Entire State	None
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	Nonroad emissions submitted were county totals. Nonroad emissions distributed to specific SCCs based on Int. Inventory
Rhode Island	State - EPS Workfile	Daily	Entire State	None
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 4.7-10. Area Source Listing by SCC and Growth Basis

SCC	FILE	CODE	SCC	FILE	CODE	SCC	FILE	CODE
2260000000	SEDS	TPOPP	2265002021	BEA	300	2265006015	BEA	400
2260001000	SEDS	TPOPP	2265002024	BEA	300	2265006025	BEA	400
2260001010	SEDS	TPOPP	2265002027	BEA	300	2265006030	BEA	400
2260001020	SEDS	TPOPP	2265002030	BEA	300	2265007000	BEA	100
2260001030	SEDS	TPOPP	2265002033	BEA	300	2265007010	BEA	100
2260001050	SEDS	TPOPP	2265002039	BEA	300	2265008000	BEA	542
2260001060	SEDS	TPOPP	2265002042	BEA	300	2265008005	BEA	542
2260002000	BEA	300	2265002045	BEA	300	2265008010	BEA	542
2260002006	BEA	300	2265002054	BEA	300	2270000000	SEDS	TPOPP
2260002009	BEA	300	2265002057	BEA	300	2270001000	SEDS	TPOPP
2260002021	BEA	300	2265002060	BEA	300	2270001010	SEDS	TPOPP
2260002033	BEA	300	2265002066	BEA	300	2270001050	SEDS	TPOPP
2260003000	BEA	400	2265002072	BEA	300	2270001060	SEDS	TPOPP
2260003010	BEA	400	2265002078	BEA	300	2270002000	BEA	300
2260003020	BEA	400	2265002081	BEA	300	2270002003	BEA	300
2260003030	BEA	400	2265003000	BEA	400	2270002009	BEA	300
2260003040	BEA	400	2265003010	BEA	400	2270002012	BEA	300
2260004000	SEDS	TPOPP	2265003020	BEA	400	2270002015	BEA	300
2260004010	SEDS	TPOPP	2265003030	BEA	400	2270002018	BEA	300
2260004015	SEDS	TPOPP	2265003040	BEA	400	2270002021	BEA	300
2260004020	SEDS	TPOPP	2265003050	BEA	400	2270002027	BEA	300
2260004025	SEDS	TPOPP	2265004000	SEDS	TPOPP	2270002030	BEA	300
2260004030	SEDS	TPOPP	2265004010	SEDS	TPOPP	2270002033	BEA	300
2260004035	SEDS	TPOPP	2265004015	SEDS	TPOPP	2270002036	BEA	300
2260004050	SEDS	TPOPP	2265004025	SEDS	TPOPP	2270002039	BEA	300
2260004075	SEDS	TPOPP	2265004030	SEDS	TPOPP	2270002042	BEA	300
2260005000	BEA	081	2265004035	SEDS	TPOPP	2270002045	BEA	300
2260006000	BEA	400	2265004040	SEDS	TPOPP	2270002048	BEA	300
2260006005	BEA	400	2265004045	SEDS	TPOPP	2270002051	BEA	300
2260006010	BEA	400	2265004050	SEDS	TPOPP	2270002054	BEA	300
2260006015	BEA	400	2265004055	SEDS	TPOPP	2270002057	BEA	300
2260006020	BEA	400	2265004060	SEDS	TPOPP	2270002060	BEA	300
2260007000	BEA	100	2265004065	SEDS	TPOPP	2270002063	BEA	300
2260007005	BEA	100	2265004070	SEDS	TPOPP	2270002066	BEA	300
2260008000	BEA	542	2265004075	SEDS	TPOPP	2270002069	BEA	300
2260008010	BEA	542	2265005000	BEA	081	2270002072	BEA	300
2265000000	SEDS	TPOPP	2265005010	BEA	081	2270002075	BEA	300
2265001000	SEDS	TPOPP	2265005015	BEA	081	2270002078	BEA	300
2265001010	SEDS	TPOPP	2265005020	BEA	081	2270002081	BEA	300
2265001030	SEDS	TPOPP	2265005030	BEA	081	2270003000	BEA	400
2265001040	SEDS	TPOPP	2265005035	BEA	081	2270003010	BEA	400
2265001050	SEDS	TPOPP	2265005040	BEA	081	2270003020	BEA	400
2265001060	SEDS	TPOPP	2265005045	BEA	081	2270003030	BEA	400
2265002000	BEA	300	2265005050	BEA	081	2270003040	BEA	400

Table 4.7-10. (continued)

SCC	FILE	CODE	SCC	FILE	CODE	SCC	FILE	CODE
2265002003	BEA	300	2265005055	BEA	081	2270003050	BEA	400
2265002006	BEA	300	2265006000	BEA	400	2270004000	SEDS	TPOPP
2265002009	BEA	300	2265006005	BEA	400	2270004010	SEDS	TPOPP
2265002015	BEA	300	2265006010	BEA	400	2270004040	SEDS	TPOPP
2270004055	SEDS	TPOPP	2270008000	BEA	542	2280003030	BEA	530
2270004060	SEDS	TPOPP	2270008005	BEA	542	2280004020	BEA	530
2270004065	SEDS	TPOPP	2270008010	BEA	542	2282000000	SEDS	TPOPP
2270004070	SEDS	TPOPP	2275000000	BEA	542	2282005000	SEDS	TPOPP
2270004075	SEDS	TPOPP	2275001000	BEA	920	2282005010	SEDS	TPOPP
2270005000	BEA	081	2275020000	BEA	542	2282005015	SEDS	TPOPP
2270005015	BEA	081	2275020021	BEA	542	2282005025	SEDS	TPOPP
2270005020	BEA	081	2275050000	BEA	542	2282010000	SEDS	TPOPP
2270005025	BEA	081	2275060000	BEA	542	2282010005	SEDS	TPOPP
2270005035	BEA	081	2275070000	BEA	542	2282010010	SEDS	TPOPP
2270005045	BEA	081	2275900000	BEA	542	2282010015	SEDS	TPOPP
2270005050	BEA	081	2275900101	BEA	542	2282010020	SEDS	TPOPP
2270005055	BEA	081	2275900102	BEA	542	2282010025	SEDS	TPOPP
2270006000	BEA	400	2280000000	BEA	530	2282020000	SEDS	TPOPP
2270006005	BEA	400	2280001000	BEA	530	2282020005	SEDS	TPOPP
2270006010	BEA	400	2280002000	BEA	530	2282020010	SEDS	TPOPP
2270006015	BEA	400	2280002010	BEA	530	2282020020	SEDS	TPOPP
2270006025	BEA	400	2280002020	BEA	530	2282020025	SEDS	TPOPP
2270006030	BEA	400	2280002040	BEA	530	2283002000	BEA	920
2270007000	BEA	100	2280003000	BEA	530	2285000000	BEA	510
2270007015	BEA	100	2280003010	BEA	530	2285002000	BEA	510
2270007020	BEA	100	2280003020	BEA	530	2285002005	BEA	510
						2285002010	BEA	510

Table 4.7-11. SEDS National Fuel Consumption, 1990-1996 (trillion Btu)

Fuel Type	End-User	Code	1990	1991	1992	1993	1994	1995	1996
Population									
		TPOPP	248,709	252,131	255,025	257,785	259,693	261,602	263,510

Table 4.7-12. BEA SA-5 National Earnings by Industry, 1990-1996 (million $)

Industry	LNUM	SIC	1990	1991	1992	1993	1994	1995	1996
Farm	81	1, 2	48	41	46	45	42	31	29
Agricultural services, forestry, fisheries, and other	100	7-9	24	24	24	24	26	27	27
Construction	300	15-17	218	197	195	199	216	219	219
Manufacturing	400	998	710	690	705	705	725	740	747
Railroad transportation	510	40	12	12	13	12	12	12	12
Water transportation	530	44	7	7	7	6	6	6	6
Transportation by air	542	45	30	30	31	31	31	31	31
Federal, military	920	992	50	50	51	48	45	44	43

Table 4.7-13. Counties in the United States with Stage II Programs that use Reformulated Gasoline

State		County	
6	California	19	Fresno Co
6	California	29	Kern Co
6	California	37	Los Angeles Co
6	California	55	Napa Co
6	California	67	Sacramento Co
6	California	73	San Diego Co
6	California	75	San Francisco Co
9	Connecticut	1	Fairfield Co
9	Connecticut	3	Hartford Co
9	Connecticut	5	Litchfield Co
9	Connecticut	7	Middlesex Co
9	Connecticut	9	New Haven Co
9	Connecticut	11	New London Co
9	Connecticut	13	Tolland Co
9	Connecticut	15	Windham Co
10	Delaware	1	Kent Co
10	Delaware	3	New Castle Co
10	Delaware	5	Sussex Co
11	Dist. Columbia	1	Washington
17	Illinois	31	Cook Co
17	Illinois	43	Du Page Co
17	Illinois	63	Grundy Co
17	Illinois	89	Kane Co
17	Illinois	93	Kendall Co
17	Illinois	97	Lake Co
17	Illinois	111	McHenry Co
17	Illinois	197	Will Co
18	Indiana	89	Lake Co
18	Indiana	127	Porter Co
21	Kentucky	15	Boone Co
21	Kentucky	29	Bullitt Co
21	Kentucky	37	Campbell Co
21	Kentucky	111	Jefferson Co
21	Kentucky	117	Kenton Co
21	Kentucky	185	Oldham Co
23	Maine	1	Androscoggin Co
23	Maine	5	Cumberland Co
23	Maine	11	Kennebec Co
23	Maine	13	KNO_x Co
23	Maine	15	Lincoln Co
23	Maine	23	Sagadahoc Co
23	Maine	31	York Co
24	Maryland	3	Anne Arundel Co
24	Maryland	5	Baltimore Co
24	Maryland	9	Calvert Co
24	Maryland	13	Carroll Co
24	Maryland	15	Cecil Co
24	Maryland	17	Charles Co
24	Maryland	21	Frederick Co
24	Maryland	25	Harford Co
24	Maryland	27	Howard Co
24	Maryland	29	Kent Co
24	Maryland	31	Montgomery Co
24	Maryland	33	Prince George's Co
24	Maryland	35	Queen Annes Co
24	Maryland	510	Baltimore
25	Massachusetts	1	Barnstable Co
25	Massachusetts	3	Berkshire Co
25	Massachusetts	5	Bristol Co
25	Massachusetts	7	Dukes Co
25	Massachusetts	9	Essex Co
25	Massachusetts	11	Franklin Co
25	Massachusetts	13	Hampden Co
25	Massachusetts	15	Hampshire Co
25	Massachusetts	17	Middlesex Co
25	Massachusetts	19	Nantucket Co
25	Massachusetts	21	Norfolk Co
25	Massachusetts	23	Plymouth Co
25	Massachusetts	25	Suffolk Co
25	Massachusetts	27	Worcester Co
33	New Hampshire	11	Hillsborough Co
33	New Hampshire	13	Merrimack Co
33	New Hampshire	15	Rockingham Co
33	New Hampshire	17	Strafford Co
34	New Jersey	1	Atlantic Co
34	New Jersey	3	Bergen Co
34	New Jersey	5	Burlington Co
34	New Jersey	7	Camden Co
34	New Jersey	9	Cape May Co
34	New Jersey	11	Cumberland Co
34	New Jersey	13	Essex Co
34	New Jersey	15	Gloucester Co
34	New Jersey	17	Hudson Co
34	New Jersey	19	Hunterdon Co
34	New Jersey	21	Mercer Co
34	New Jersey	23	Middlesex Co
34	New Jersey	25	Monmouth Co
34	New Jersey	27	Morris Co
34	New Jersey	29	Ocean Co
34	New Jersey	31	Passaic Co
34	New Jersey	33	Salem Co
34	New Jersey	35	Somerset Co
34	New Jersey	37	Sussex Co
34	New Jersey	39	Union Co
34	New Jersey	41	Warren Co
36	New York	5	Bronx Co
36	New York	27	Dutchess Co
36	New York	47	Kings Co
36	New York	59	Nassau Co
36	New York	61	New York Co
36	New York	71	Orange Co
36	New York	79	Putnam Co
36	New York	81	Queens Co
36	New York	85	Richmond Co
36	New York	87	Rockland Co
36	New York	103	Suffolk Co
36	New York	119	Westchester Co
42	Pennsylvania	17	Bucks Co
42	Pennsylvania	29	Chester Co
42	Pennsylvania	45	Delaware Co
42	Pennsylvania	91	Montgomery Co
42	Pennsylvania	101	Philadelphia Co
44	Rhode Island	1	Bristol Co
44	Rhode Island	3	Kent Co
44	Rhode Island	5	Newport Co
44	Rhode Island	7	Providence Co
44	Rhode Island	9	Washington Co
48	Texas	39	Brazoria Co
48	Texas	71	Chambers Co
48	Texas	85	Collin Co
48	Texas	113	Dallas Co
48	Texas	121	Denton Co
48	Texas	157	Fort Bend Co
48	Texas	167	Galveston Co
48	Texas	201	Harris Co
48	Texas	291	Liberty Co
48	Texas	339	Montgomery Co
48	Texas	439	Tarrant Co
48	Texas	473	Waller Co
51	Virginia	13	Arlington Co
51	Virginia	36	Charles City Co
51	Virginia	41	Chesterfield Co
51	Virginia	85	Hanover Co
51	Virginia	87	Henrico Co
51	Virginia	95	James City Co
51	Virginia	107	Loudoun Co
51	Virginia	153	Prince William Co
51	Virginia	159	Richmond Co
51	Virginia	179	Stafford Co
51	Virginia	199	York Co
51	Virginia	510	Alexandria
51	Virginia	550	Chesapeake
51	Virginia	570	Colonial Heights
51	Virginia	600	Fairfax
51	Virginia	610	Falls Church
51	Virginia	650	Hampton
51	Virginia	670	Hopewell
51	Virginia	683	Manassas
51	Virginia	685	Manassas Park
51	Virginia	700	Newport News
51	Virginia	710	Norfolk
51	Virginia	735	Poquoson
51	Virginia	740	Portsmouth
51	Virginia	760	Richmond
51	Virginia	800	Suffolk
51	Virginia	810	Virginia Beach
51	Virginia	830	Williamsburg
55	Wisconsin	59	Kenosha Co
55	Wisconsin	79	Milwaukee Co
55	Wisconsin	89	Ozaukee Co
55	Wisconsin	101	Racine Co
55	Wisconsin	131	Washington Co
55	Wisconsin	133	Waukesha Co

Table 4.7-14. NO_x Nonroad Control Efficiencies by SCC

SCC	POD	PODNAME	ATTAINMENT	CONTROL	RULPEN96	CONEFF96
2270002xxx	48	Construction Equipment - Diesel	Attainment	Phase 1 compression ign. std	1.0	37
2270003xxx	48	Industrial Equipment - Diesel	Attainment	Phase 1 compression ign. std	0.9	37
2270004xxx	48	Lawn And Garden - Diesel	Attainment	Phase 1 compression ign. std	0.5	37
2270005xxx	48	Farm Equipment - Diesel	Attainment	Phase 1 compression ign. std	1.0	37
2270006xxx	48	Commercial Equipment - Diesel	Attainment	Phase 1 compression ign. std	1.0	37
2270007xxx	48	Logging Equipment - Diesel	Attainment	Phase 1 compression ign. std	1.0	37
2270008xxx	48	Airport Service Equipment - Diesel	Attainment	Phase 1 compression ign. std	1.0	37

Table 4.7-15. National Nonroad Diesel Emissions (tons)

Engine Type		1995 NET	1995 OMS	1996 NET	1996 OMS
Recreational Vehicles	VOC	1	1,160	1	1,170
	NO_x	547	7,672	547	7,747
	CO	7	4,795	7	4,876
	PM-10	0	959	0	975
	PM-2.5	0	882	0	897
Construction	VOC	98,658	166,439	100,161	167,115
	NO_x	794,859	1,389,600	804,137	1,385,862
	CO	477,757	767,523	484,772	775,071
	PM-10	145,900	163,983	148,235	166,034
	PM-2.5	134,228	150,865	136,376	152,752
Industrial	VOC	233,948	32,255	23,797	32,667
	NO_x	216,66	260,134	214,30`	262,874
	CO	98,727	126,916	98,080	129,074
	PM-10	24,866	30,527	24,921	31,047
	PM-2.5	22,877	28,085	22,929	28,563
Lawn and Garden	VOC	723	9,568	730	9,706
	NO_x	5,946	63,250	5,983	64,184
	CO	3,351	39,532	3,380	40,174
	PM-10	898	7,906	906	8,034
	PM-2.5	827	7,273	834	7,392
Agricultural	VOC	23,691	219,496	32,625	219,594
	NO_x	118,414	1,105,995	164,323	1,111,779
	CO	113,801	830,206	149,409	842,638
	PM-10	20,076	204,237	21,158	207,506
	PM-2.5	18,470	187,898	19,466	190,905
Light Commercial	VOC	2,284	14,393	2,314	14,609
	NO_x	15,386	95,148	15,532	96,607
	CO	9,884	59,467	10,011	60,478
	PM-10	2,953	11,893	2,989	12,095
	PM-2.5	2,717	10,941	2,750	11,127
Logging	VOC	654	12,002	670	11,652
	NO_x	8,665	74,186	8,844	72,616
	CO	3,999	29,365	4,095	29,688
	PM-10	1,165	7,727	1,180	7,812
	PM-2.5	1,072	7,109	1,086	7,187
Airport Service	VOC	12,045	10,273	12,201	10,001
	NO_x	100,442	90,835	101,350	86,672
	CO	46,446	39,318	46,959	39,987
	PM-10	17,971	10,381	18,316	10,557
	PM-2.5	16,534	9,550	16,851	9,713

Table 4.7-16. National Spark Ignition Marine Engine Emissions (tons)

Pollutant	1995 NET	1995 OMS	1996 NET	1996 OMS
VOC	492,248	431,504	495,491	459,072
NO_x	27,731	41,756	27,945	41,968

Table 4.7-17. National Locomotive Emissions (tons)

Pollutant	1995 NET	1995 OMS
PM-10	50,000	26,900

4.8 FUGITIVE DUST

The "Fugitive Dust" grouping includes the estimated emissions for several Tier II source categories. These Tier II source categories are components of two Tier I source categories: Natural Sources and Miscellaneous Sources. The PM-10 and PM-2.5 emissions from the Natural Sources category discussed here are from geogenically derived wind erosion. PM-10 and PM-2.5 emissions in the Miscellaneous Sources category are divided into two Tier II subcategories: agriculture and forestry, and fugitive dust. This section presents a description of the methodology used to estimate the emissions for the following tier categories:

Tier I Category	Tier II Category
(13) Natural Sources	(02) Geogenic (agricultural wind erosion)
(14) Miscellaneous	(01) Agriculture and Forestry
	(07) Fugitive Dust

PM-2.5 emissions were calculated only for the years 1990 through 1996. Although several of the source categories listed above have information concerning the PM-2.5 particle size multiplier that should be applied to the AP-42 emission factor to calculate PM-2.5 emissions, much of that data is fairly old. As a consequence, EPA, Pechan, and Midwest Research Institute (MRI) performed an evaluation of more recent particle size distribution information.[1] That review indicated that the PM-2.5/PM-10 ratio for several of the source categories listed above should be reduced. Table 4.8-1 shows the particle size ratios used to calculate PM-2.5 particle size multipliers from the PM-10 particles size multipliers used to develop PM-10 emissions for each fugitive dust category in this section.

4.8.1 Natural Sources, Geogenic, Wind Erosion

The wind erosion emissions were estimated for the years 1985 through 1996 using the following methodology. PM-10 and PM-2.5 wind erosion emissions estimates for agricultural lands were made using a modification of the methodology used by Gillette and Passi[2] to develop wind erosion emissions for 1985 NAPAP. Several simplifying assumptions were made in order to perform the calculations using a spreadsheet model.[3]

The NAPAP methodology and the method used to develop the wind erosion estimates presented here both develop an expectation of the dust flux based on the probability distribution of wind energy. The methodology uses the mean wind speed coupled with information concerning the threshold friction velocity for the soil and information on precipitation to predict the wind erosion flux potential for soils.

The basic equation used to determine the expected dust flux is given by Equation 4.8-1.

$$I = k \times C_2 \times C_d^2 \times \left(\frac{u^4}{0.886^4} \right) \times \Gamma(3,x) \qquad \text{(Eq. 4.8-1)}$$

where: I = dust flux ($gm/cm^2/sec$)
k = PM-10 particle size multiplier (= 0.9)
PM-2.5 particle size multiplier (= 0.135)
C = constant (= 4×10^{-14} $gm/cm^2/sec$)
C_d = drag coefficient
u = mean wind speed (cm/sec)
$\Gamma(3,x)$ = incomplete gamma function

To evaluate $\Gamma(3,x)$, x must be determined from Equation 4.8-2.

$$x = \left(u_t \times \left(\frac{0.886}{u} \right) \right)^2 \qquad \text{(Eq. 4.8-2)}$$

The threshold velocity (u_t) can be determined from the threshold friction velocity (u_{*t} - which is a function of soil type and precipitation) from Equation 4.8-3.

$$u_t = \frac{u_{*_t}}{C_d^{0.5}} \qquad \text{(Eq. 4.8-3)}$$

Values of the threshold friction velocity for different soil types both before and after rain to account for crusting of the soil surface have been reported by Gillette and Passi.[2]

4.8.1.1 Determination of Correction Parameters

In order to calculate the flux of emissions from wind erosion using the above equation, information concerning the average monthly wind speed, total monthly precipitation and anemometer height for the wind speed was necessary. Values for monthly wind speed, total monthly precipitation and anemometer height were obtained from the Local Climatological Data[4] for several meteorological stations within each state. For most states, several meteorological stations data were obtained and an overall average was determined for the state. The anemometer height was utilized to determine the drag coefficient (C_d) from Equation 4.8-4.

$$C_d = \left(\frac{0.23}{\ln z_s} \right)^2 \qquad \text{(Eq. 4.8-4)}$$

where: z_s = anemometer height

Information concerning the average soil type for each state was determined from the USDA surface soil map.[5] A single soil type was assigned to each state in order to determine a single value for the threshold friction velocity (u_{*t}). The threshold friction velocity (u_{*t}) utilized represented either a before or after rain value, depending upon whether or not precipitation exceeded 5.08 cm during a month. If precipitation exceeded this amount, the after rain u_{*t} value was utilized for all succeeding months until the time of a significant tillage operation or plant emergence. The value of u_t was then calculated using the value of u_{*t} determined and C_d. Once u_t was determined, then x could be calculated and the incomplete gamma function could be evaluated using an asymptotic expansion. Following evaluation of the incomplete gamma function, the flux for each month was determined.

Wind erosion was assumed to be zero from the time of plant emergence until harvest. Separate flux estimates were made for fall planted crops and spring planted crops. This meant that flux estimates were only calculated from July to October for fall planted crops and from September until May for spring planted crops. This approach is consistent with the methodology utilized by Gillette and Passi.[2] For the years 1985 through 1989, the before rain u_{*t} value was always utilized for January for spring planted crops rather than evaluating whether or not any month between September and December of the previous year had more than 5.08 cm of precipitation.

4.8.1.2 1990-1996 Modification

The method for estimating 1990 through 1996 emissions from geogenic wind erosion is similar to the above wind erosion methodology with the exception that previous years rain data for September through December was used. This data was used to determine whether or not any month between September and December of the previous year had more than 5.08 cm of precipitation. Gillette and Passi utilized previous year precipitation information to assign the threshold friction velocity to an area.

4.8.1.3 Activity Data

Once the emission flux potential for each month for each crop type (fall or spring planted) for each state was calculated, then the acres of spring or fall planted crops in each state were required (and the number of seconds per month) to determine the emissions. The acres of crops planted in each state was obtained for each of the 11 years from the USDA.[6] Evaluation of which crops were spring planted or fall planted for each state was made using information available from the USDA.[7] The emissions calculated were then estimated for each state.

4.8.1.4 County Distribution (1985-1989)

State-level PM-10 estimates were distributed to the county-level using estimates of county rural land area from the U.S. Census Bureau.[8] Equation 4.8-5 was used.

$$County\ Emissions = \left(\frac{County\ Rural\ Land}{State\ Rural\ Land}\right) \times State\ Emissions \qquad \text{(Eq. 4.8-5)}$$

4.8.1.5 County Distribution (1990-1996)

State-level PM-10 estimates were distributed to the county-level using estimates of acres of land tilled from the Conservation Information Technology Center.[9] Equation 4.8-6 was used.

$$County\ Emissions = \left(\frac{County\ Cropland\ Tilled}{State\ Croplant\ Tilled}\right) \times State\ Emissions \qquad \text{(Eq. 4.8-6)}$$

4.8.2 Miscellaneous Sources

The methodology used to estimate the emissions from agricultural crops, agricultural livestock, and fugitive dust are described in this section. The PM-10 and PM-2.5 emissions arise from construction activities, mining and quarrying, paved road resuspension, and unpaved roads. The general methodology used for these categories estimated the emissions by using an activity indicator and an emission factor with one or more correction factors. The activity indicator for a given category varied from year to year as may the correction factors.

4.8.2.1 Agricultural Crops (1985-1989)

The PM-10 emissions for the years 1985 through 1989 were estimated using the AP-42 emission factor equation for agricultural tilling.[10] The activity data for this calculation were the acres of land planted. The emission factor, developed to estimate of the mass of TSP produced per acre-tilled was adjusted to estimate PM-10 using the following constant parameters: the silt content of the surface soil, a particle size multiplier, and the number of tillings per year.

The following AP-42 particulate emission factor equation (Equation 4.8-7) was used to determine state PM-10 emissions from agricultural tilling for 1985 through 1989:

$$E = c \times k \times s^{0.6} \times p \times a \qquad \text{(Eq. 4.8-7)}$$

where:

where:	E	=	PM-10 emissions
	c	=	constant 4.8 lbs/acre-pass
	k	=	dimensionless particle size multiplier (PM-10=0.21)
	s	=	silt content of surface soil, defined as the mass fraction of particles smaller than 75 µm diameter found in soil to a depth of 10 cm (%)
	p	=	number of passes or tillings in a year (assumed to be 3 passes)
	a	=	acres of land planted

4.8.2.1.1 Determination of Correction Parameters —

4.8.2.1.1.1 Silt content (s). By comparing the USDA[5] surface soil map with the USDA[11] 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.[12] For those counties with organic material as its soil type, Pechan used the previous silt percentages presented by Cowherd.[13] The weighted mean state silt values were determined by weighing the county value by the number of hectares within the county and summing across the entire state. Table 4.8-2 shows the silt percentages used for 1985 through 1989. These silt values were assumed constant for the 5-year period examined.

4.8.2.1.1.2 Number of Tillings per year (p). Cowherd et al.[13] reported that crops are tilled three times each year, on average, and this value was used for p.

4.8.2.1.2 Activity Data —
The acres of crops planted (a) in each state was obtained for each of the 5 years from the USDA.[6]

4.8.2.1.3 County Distribution —

State-level PM-10 estimates were distributed to the county-level using county estimates of cropland harvested from the 1987 Census of Agriculture.[14] Equation 4.8-8 was used.

$$County\ Emissions = \left(\frac{County\ Cropland\ Harvested}{State\ Croplant\ Harvested}\right) \times State\ Emissions \qquad \text{(Eq. 4.8-8)}$$

4.8.2.2 Agricultural Crops (1990-1996)

The methodology to determine agricultural crop emissions for the years 1990 through 1996 was similar to the methodology for the years 1985 through 1989, with several exceptions. The PM-10 and PM-2.5 emissions for the years 1990 through 1996 were also estimated using the AP-42 emission factor equation for agricultural tilling.[10] The activity data for this calculation were the acres of land tilled. The emission factor, developed to estimate the mass of TSP produced per acre-tilled was adjusted to estimate PM-10 and PM-2.5 using the following constant parameters: the silt content of the surface soil, a particle size multiplier, and the number of tillings per year.

The following AP-42 particulate emission factor equation (Equation 4.8-9) was used to determine regional PM-10 emissions from agricultural tilling for 1990 through 1996:

$$E = c \times k \times s^{0.6} \times p \times a \qquad \text{(Eq. 4.8-9)}$$

where:

where:	E	=	PM emissions
	c	=	constant 4.8 lbs/acre-pass
	k	=	dimensionless particle size multiplier (PM-10=0.21; PM-2.5=0.042)
	s	=	silt content of surface soil, defined as the mass fraction of particles smaller than 75 µm diameter found in soil to a depth of 10 cm (%)
	p	=	number of passes or tillings in a year
	a	=	acres of land tilled

4.8.2.2.1 Determination of Correction Parameters —

4.8.2.2.1.1 ***Silt content (s).*** By comparing the USDA[5] surface soil map with the USDA[11] county map, soil types were assigned to all counties of the continental U.S. Silt percentages were determined by using a soil texture classification triangle.[12] For those counties with organic material as its soil type, Pechan used the previous silt percentages presented by Cowherd.[13] These silt factors were then corrected using information from Spatial Distribution of PM-10 emissions from Agricultural Tilling in the San Joaquin Valley.[15] Information in that report indicates that silt contents determined from the classification triangle are typically based on wet sieving techniques. The AP-42 silt content is based on dry sieving techniques. Wet sieving tends to desegregate finer materials thus leading to a higher than expected silt content based on the soil triangle estimates. The overestimation is dependent upon the soil type. As a consequence, the values for silt loam and loam were reduced by a factor of 1.5. The values for clay loam and clay were reduced by a factor of 2.6. The values for sand, loamy sand, sandy loam and organic material remained the same. Table 4.8-3 shows the percent silt used for each soil type for 1990 through 1996. These silt values were assumed constant for the 6-year period examined. This differs from the 1989 through 1985 methodology in that the silt factors are applied on the county level, and are corrected values.

4.8.2.2.1.2 Number of Tillings per year (p). The number of tillings for 1990 through 1996 were determined for each crop type, and for conservational and conventional use using information from Agricultural Activities Influencing Fine Particulate Matter Emissions.[16] The tillage emission factor ratio column in the tables in that report were totaled by crop type when the agricultural implement code was not blank. Harvesting was not included in this total. When the tilling instrument was felt to deeply disturb the soil, the value of the tillage emission factor ratio was equal to one. However, other field instruments were not felt to disturb the soil to the extent of the instruments used to develop the original AP-42 emission factor and thus had an emission factor ratio of less than one. Discussions with the organization that developed the original emission factor and the report referenced above indicated that these values should be used to calculate the number of tillings rather than a single value for each implement usage.[17] Where there were data from more than one region for a single crop, an average value was used. Information for both conservation and convention tillage methods were developed. The tallies were rounded to the nearest whole number, since it is not physically possible to have a partial tillage event.

These totals were tallied for corn, cotton, rice, sorghum, soybeans, spring wheat, and winter wheat. Table 4.8-4 shows the number of tilling used for each crop type, and for conservational and conventional use included in the database provided by the Conservation Information Technology Center (CTIC).[9] The number of tillings for categories not included in Agricultural Activities Influencing Fine Particulate Matter Emissions were determined by contact with the CTIC.[18]

Rice and spring wheat are included in the category "spring-seeded small grain" in the database provided by the CTIC.[9] Winter wheat was assumed to prevail in all states except Arkansas, Louisiana, Mississippi, and Texas. Rice was assumed to prevail in these four states, and the number of tillings for rice were applied to the acres harvested in these states. Both rice and winter wheat are grown in California. A ratio of rice to winter wheat acres harvested for 1990 through 1996 was obtained from the U.S. Land Use Summary.[6] This ratio was used to calculate a modified number of tillings for spring-seeded small grain in California for each year.

Acres reported in the CTIC database for no till, mulch till, and ridge till were considered conservation tillage. Those with 0 to 15 percent residue, and 15 to 30 percent residue were considered conventional tillage.

4.8.2.2.2 Activity Data —

The acres of crops tilled (a) in each county for each crop type and tilling method was obtained for each of the 6 years from the CTIC.[9]

4.8.2.2.3 County Distribution —

All emissions for agricultural crops for 1990-1996 were calculated on a county basis.

4.8.2.3 Agricultural Livestock

The 1990 emissions from agricultural livestock were determined from activity data, expressed in terms of the number of heads of cattle[14] and a national PM-10 emission factor.[19] Equation 4.8-10 was used.

$$County\ Emissions = \left(\frac{County\ Head\ of\ Cattle}{1{,}000} \right) \times 17 \qquad \text{(Eq. 4.8-10)}$$

The emissions for the years 1985 through 1989 were produced using the methodology described in section 4.8.2.8.3. The emissions for the years 1991 through 1996 were produced using the method described in section 4.8.2.8.4.1. The PM-2.5 emissions for agricultural livestock for the years 1990 through 1996 were determined by multiplying the PM-10 emission for that year by the size adjustment factor of 0.15, shown in table 4.8-1.

Due to double counting in the NPI, emissions for the following SCCs were deleted: 2805001000, 2805010000, 2805015000, and 2805005000.

Agricultural sources (i.e., livestock operations and fertilizer application) make up approximately 90 percent of NH_3 emissions in current inventories. Because of the high relative contribution from these sources, efforts were made to use the most recent information available to estimate their emissions. Sections 4.8.2.3.1 and 4.8.2.3.2 describe the methodology used to estimate NH_3 emissions from livestock operations and fertilizer application, respectively.

4.8.2.3.1 Livestock Operations —
The livestock NH_3 emissions in the inventory were estimated using activity data from the 1992 Census of Agriculture.[20] These data included county-level estimates of number of head for the following livestock: cattle and calves, hogs and pigs, poultry, sheep, horses, goats, and minks. The emission factors used to calculate emissions were taken from a study of NH_3 emissions conducted in the Netherlands,[21] and are listed in table 4.8-5.

4.8.2.3.2 Fertilizer Application —
NH_3 emissions from fertilizer application may comprise up to ten percent of total NH_3 emissions nationally. The activity data used to estimate emissions were obtained from the Commercial Fertilizers Data Base compiled by TVA and now maintained by Association of American Plant Food Control Officials.[22] This database includes county-level usage of over 100 different types of fertilizers, including those that emit NH_3.

The emission factors used for fertilizer application were also obtained from the Netherlands NH_3 study.[21] This source lists emission factors for ten different types of fertilizers including the following:

- Anhydrous ammonia
- Aqua ammonia
- Nitrogen solutions
- Ammonium sulfate
- Ammonium thiosulfate
- Other straight nitrogen

- Urea
- Ammonium nitrate
- Ammonium phosphates
- N-P-K

4.8.2.4 PM Emissions from Reentrained Road Dust from Unpaved Roads

Estimates of PM emissions from reentrained road dust on unpaved roads were developed for each county. PART5 reentrained road dust emission factors depend on the average weight, speed, and number of wheels of the vehicles traveling on the unpaved roadways, the silt content of the roadway surface material, and the percentage of days in the year with minimal (less than 0.01 inches) or no precipitation. Emissions were calculated by month at the state/road type level for the average vehicle fleet and then allocated to the county/road type level by land area. The activity factor for calculating reentrained road dust emissions on unpaved roads is the VMT accumulated on these roads. The specifics of the emission estimates for reentrained road dust from unpaved roads are discussed in more detail below.

4.8.2.4.1 PM Emission Factor Calculation —

Equation 4.8-11, used in PART5 to calculate PM emission factors from Reentrained road dust on unpaved roads, is based on an empirical formula from AP-42.[23]

$$UNPVD = PSUNP_{PS} * 5.9 * (SILT/12) * (SPD/30) * (WEIGHT/3)^{0.7} * (WHEELS/4)^{0.5} * (365 - IPDAYS)/365 * 453.392 \qquad \text{(Eq. 4.8-11)}$$

where:

UNPVD	=	unpaved road dust emission factor for all vehicle classes combined (grams per mile)
$PSUNP_{PS}$	=	fraction of particles less than 10 or 2.5 microns from unpaved road dust (0.36 for PM-10 and ? For PM-2.5)
SILT	=	percentage silt content of the surface material
SPD	=	average speed of all vehicle types combined (miles per hour [mph])
WEIGHT	=	average weight of all vehicle types combined (tons)
WHEELS	=	average number of wheels per vehicle for all vehicle types combined
IPDAYS	=	number of precipitation days per year with greater than 0.01 inches of rain
493.592	=	number of grams per pound

The above equation is based on roadside measurements of ambient particulate matter, and is therefore representative of a fleet average emission factor rather than a vehicle-specific emission factor. In addition, because this equation is based on ambient measurements, it includes particulate matter from tailpipe exhaust, brake wear, tire wear, and ambient background particulate concentrations. Therefore, the PART5 fleet average PM emission factors for the tailpipe, tire wear, and brake wear components were subtracted from the unpaved road fugitive dust emission factors before calculating emissions from Reentrained road dust on unpaved roads.

4.8.2.4.1.1 ***Silt Content Inputs.*** Average state-level, unpaved road silt content values developed as part of the 1985 NAPAP Inventory, were obtained from the Illinois State Water Survey.[24] Silt contents of over 200 unpaved roads from over 30 states were obtained. Average silt contents of unpaved roads were calculated for each state that had three or more samples for that state. For states that did not have three or more samples, the average for all samples from all states was substituted.

4.8.2.4.1.2 ***Precipitation Inputs.*** Rain data input to the emission factor equation above is in the form of the total number of rain days in the year. However, the equation uses the number of days simply to calculate a percentage of rain days. Therefore, to calculate unpaved road dust emission factors that represent monthly conditions, data from the National Climatic Data Center[4] showing the number of days per month with more than 0.01 inches of rain were used. Precipitation event accumulation data were collected for several meteorological stations within each state.

4.8.2.4.1.3 ***Vehicle Wheel, Weight, and Speed Inputs.*** The speeds shown in table 4.8-6 for light duty vehicles and trucks were also assumed to be the average unpaved road speeds for the corresponding unpaved road classification. However, because the fugitive dust emission factors are representative of the entire vehicle fleet, these speeds for each road type were weighted by vehicle-specific VMT to obtain road type-specific speeds. These speeds are shown in table 4.8-6. Estimates of average vehicle weight and average number of wheels per vehicle over the entire vehicle fleet were based on data provided in the *Truck Inventory and Use Survey*,[25] *MVMA Motor Vehicle Facts and Figures '91*,[26] and the *1991 Market Data Book*.[27] Using these data sources, a fleet average vehicle weight of 6,358 pounds was modeled with a fleet average number of wheels per vehicle of five.

4.8.2.4.2 Unpaved Road VMT —

The calculation of unpaved road VMT was performed in two parts. Separate calculations were performed for county and noncounty (state or federally) maintained roadways. The 1995 unpaved VMT was also used for 1996, as unpaved growth is very uncertain, but expected to be minimum.

Equation 4.8-12 is used to calculate unpaved road VMT.

$$VMTUP = ADTV * FSRM * DPY \qquad \text{(Eq. 4.8-12)}$$

where:
- VMTUP = VMT on unpaved roads (miles/year)
- ADTV = average daily traffic volume (vehicles/day/mile)
- FSRM = functional system roadway mileage (miles)
- DPY = number of days in a year

4.8.2.4.2.1 ***Estimating Local Unpaved VMT.*** Unpaved roadway mileage estimates were retrieved from the FHWA's annual *Highway Statistics*[28] report. State-level, county-maintained roadway mileage estimates are organized by surface type, traffic volume, and population category. From these data, state-level unpaved roadway mileage estimates were derived for the volume and population categories listed in table 4.8-7. This was done by first assigning an average daily traffic volume (ADTV) to each volume category, as shown in table 4.8-7.

The above equation was then used to calculate state-level unpaved road VMT estimates for the volume and population categories listed in table 4.8-7. These detailed VMT data were then summed to develop state-level, county-maintained unpaved roadway VMT.

4.8.2.4.2.2 Estimation of Federal and State-Maintained Unpaved Roadway VMT. The calculation of noncounty (state or federally) maintained unpaved road VMT differed from the calculation of county-maintained unpaved road VMT. This was required since noncounty unpaved road mileage was categorized by arterial classification, not roadway traffic volume.

To calculate noncounty, unpaved road VMT, state-level ADTV values for urban and rural roads were multiplied by state-level, rural and urban roadway mileage estimates. Assuming the ADTV does not vary by roadway maintenance responsibility, the county-maintained ADTV values were assumed to apply to noncounty-maintained roadways as well. To develop noncounty unpaved road ADTV estimates, county-maintained roadway VMT was divided by county-maintained roadway mileage estimates, as shown in Equation 4.8-13.

$$ADTV = VMT \ / \ MILEAGE \qquad \text{(Eq. 4.8-13)}$$

where:
ADTV = average daily traffic volume for state and federally maintained roadways
VMT = VMT on county-maintained roadways (miles/year)
MILEAGE = state-level roadway mileage of county-maintained roadways (miles)

Federal and state-maintained roadway VMT was calculated by multiplying the state-level roadway mileage of federal and state-maintained unpaved roads[28] by the state-level ADTV values calculated as discussed above for locally-maintained roadways. Equation 4.8-14 illustrates.

$$VMT = ADTV * RM * 365 \qquad \text{(Eq. 4.8-14)}$$

where:
VMT = VMT at the state level for federally and state-maintained unpaved roadways (miles/year)
ADTV = average daily traffic volume derived from local roadway data
RM = state-level federally and state-maintained roadway mileage (mi)

4.8.2.4.2.3 Unpaved VMT For 1993 and Later Years. The calculation of unpaved VMT differs for years before 1993 and for the year 1993 and later years. This split in methodology is due a difference in the data reported by states in the annual Highway Statistics. In both instances the calculation was performed in two stages.

Unpaved VMT for 1993 and later years was calculated by multiplying the total number of miles of unpaved road by state and functional class by the annualized traffic volume, where the annualized traffic volume is calculated as the average daily traffic volume multiplied by the total number of days per year. This calculation is illustrated in Equation 4.8-15.

$$UnpavedVMT_{Roadtype} = Mileage_{Roadtype} * ADTV * DPY \qquad \text{(Eq. 4.8-15)}$$

where:
Unpaved VMT = road type specific unpaved Vehicle Miles Traveled (miles/year)
Mileage = total number of miles of unpaved roads by functional class (miles)

ADTV	=	Average daily traffic volume (vehicle/day)
DPY	=	number of days per year

The total number of unpaved road miles by state and functional class was retrieved from the federal Highway Administrations Highway Statistics.[28] In Highway Statistics, state level Local functional class unpaved mileage is broken out by ADTV category. The ADTV categories differed for urban and rural areas. Table MV-1 of Highway Statistics shows the ADTV categories for rural and urban local functional classes and the assumed traffic volume for each category. Local functional class unpaved VMT was calculated for each of these ADTV categories using the equation illustrated above.

Unpaved road mileage for functional classes other than Local (rural minor collector, rural major collector, rural minor arterial, rural other principal arterial, urban collector, urban minor arterial, urban other principal arterial) are not broken out by ADTV in Highway Statistics. An average ADTV was calculated for these functional classes by dividing state level unpaved Local VMT by the total number of miles of Local unpaved road. Separate calculations were preformed for urban and rural areas. The resulting state level urban and rural ADTV was then multiplied by the total number of unpaved miles in each of the non-local functional classes.

One modification was made to the Local functional class mileage reported in Highway Statistics. The distribution of mileage between the ADTV categories for Mississippi resulted in unrealistic emissions. Total unpaved road mileage in Mississippi was redistribute within the ADTV categories based on the average distributions found in Alabama, Georgia, and Louisiana.

4.8.2.4.3 Calculation of State-Level Emissions —

The state and federally maintained unpaved road VMT were added to the county- maintained VMT for each state and road type to determine each state's total unpaved road VMT by road type. The state-level unpaved road VMT by road type were then temporally allocated by month using the same NAPAP temporal allocation factors used to allocate total VMT. These monthly state-level, road type-specific VMT were then multiplied by the corresponding monthly, state-level, road type-specific emission factors developed as discussed above. These state-level emission values were then allocated to the county level using the procedure discussed below.

4.8.2.4.4 Allocation of State-Level Emissions to Counties —

The state/road type-level unpaved road PM emission estimates were then allocated to each county in the state using estimates of county rural and urban land area from the U.S. Census Bureau[29] for the years 1985 through 1989. Equation 4.8-16 was used for this allocation.

$$PM_{X,Y} = (CNTYLAND_{URB,X}/STATLAND_{URB}) * PM_{ST,URB,Y} + (CNTYLAND_{RUR,X}/STATLAND_{RUR}) * PM_{ST,RUR,Y} \quad \text{(Eq. 4.8-16)}$$

where:	$PM_{x,y}$	=	unpaved road PM emissions (tons) for county x and road type y
	$CNTYLAND_{URB,X}$	=	urban land area in county x
	$STATLAND_{URB}$	=	urban land area in entire state
	$PM_{ST,URB,Y}$	=	unpaved road PM emissions in entire state for urban road type y
	$CNTYLAND_{RUR,X}$	=	rural land area in county x

$STATLAND_{RUR}$	=	rural land area in entire state
$PM_{ST,RUR,Y}$	=	unpaved road PM emissions in entire state for rural road type y

For the years 1990 through 1996, 1990 county-level rural and urban population was used to distribution the state-level emissions instead of land area.

4.8.2.4.5 Nonattainment Area 1995 and 1996 Unpaved Road Controls —
PM control measures were applied to the unpaved road emission estimates for the years 1995 and 1996 and for the projection years. The level of control assumed varied by PM nonattainment area classification and by rural and urban areas. On urban unpaved roads in moderate PM nonattainment areas, the assumed control was paving the unpaved roads. This control was applied with a 96 percent control efficiency and a 50 percent penetration rate. On rural roads in serious PM nonattainment areas, chemical stabilization was the assumed control. This control was applied with a 75 percent control efficiency and a 50 percent penetration rate. On urban unpaved roads in serious PM nonattainment areas, paving and chemical stabilization were the controls assumed to be applied. This combination of controls was applied with an overall control efficiency of 90 percent and a penetration rate of 75 percent.

4.8.2.5 PM Emissions from Reentrained Road Dust from Paved Roads

Estimates of PM emissions from reentrained road dust on paved roads were developed at the county level in a manner similar to that for unpaved roads. PART5 reentrained road dust emission factors for paved roads depend on the road surface silt loading and the average weight of all of the vehicles traveling on the paved roadways. The equation used in PART5 to calculate PM emission factors from reentrained road dust on paved roads is a generic paved road dust calculation formula from AP-42, shown in Equation 4.8-17.[30]

$$PAVED = PSDPVD * (PVSILT/2)^{0.65} * (WEIGHT/3)^{1.5} \qquad \text{(Eq. 4.8-17)}$$

where:	PAVED	=	paved road dust emission factor for all vehicle classes combined (grams per mile)
	PSDPVD	=	base emission factor for particles of less than 10 or 2.5 microns in diameter from paved road dust (7.3 g/mi for PM-10 and ? for PM-2.5)
	PVSILT	=	road surface silt loading (g/m^2)
	WEIGHT	=	average weight of all vehicle types combined (tons)

Paved road silt loadings were assigned to each of the twelve functional roadway classifications (six urban and six rural) based on the average annual traffic volume of each functional system by state. One of three values were assigned to each of these road classes, 1 (gm/m^2) was assigned Local functional class roads, and either 0.20 (gm/m^2) or 0.04 (gm/m^2) were assigned to each of the other functional class roads. A silt loading of 0.20 (gm/m^2) was assigned to a road types that had an ADTV less than 5000 and 0.04 (gm/m^2) was assigned to road types that had an ADTV greater than or equal to 5000. ADTV was calculated by dividing annual VMT by state and functional class by state specific functional class roadway mileage.

As with the PART5 emission factor equation for unpaved roads, the above PM emission factor equation for paved roads is representative of a fleet average emission factor rather than a vehicle-specific emission factor and it includes particulate matter from tailpipe exhaust, brake wear, tire wear, and ambient background particulate concentrations. Therefore, the PART5 fleet average PM emission factors for the tailpipe, tire wear, and brake wear components were subtracted from the paved road fugitive dust emission factors before calculating emissions from reentrained road dust on paved roads.

The emission factors obtained from PART5 were modified to account for the number of days with a sufficient amount of precipitation to prevent road dust resuspension. The PART5 emission factors were multiplied by the fraction of days in a month with less than 0.01 inches of precipitation. This was done by subtracting data from the National Climatic Data Center showing the number of days per month with more than 0.01 inches of precipitation from the number of days in each month and dividing by the total number of days in the month. These emission factors were developed by month at the state and road type level for the average vehicle fleet.

For the years 1990 to 1996 the rain correction factor applied to the paved road fugitive dust emission factors was reduced by 50 percent.

VMT from paved roads was calculated at the state/road type level by subtracting the state/road type-level unpaved road VMT from total state/road type-level VMT. Because there are differences in methodology between the calculation of total and unpaved VMT there are instances where unpaved VMT is higher than total VMT. For these instances, unpaved VMT was reduced to total VMT and paved road VMT was assigned a value of zero. The paved road VMT were then temporally allocated by month using the NAPAP temporal allocation factors for VMT. These monthly/state/road type-level VMT were then multiplied by the corresponding paved road emission factors developed at the same level.

These paved road emissions were allocated to the county level according to the fraction of total VMT in each county for the specific road type. Equation 4.8-18 illustrates this allocation.

$$PVDEMIS_{X,Y} = PVDEMIS_{ST,Y} * VMT_{X,Y}/VMT_{ST,Y} \qquad \text{(Eq. 4.8-18)}$$

where:

$PVDEMIS_{X,Y}$	=	paved road PM emissions (tons) for county x and road type y
$PVDEMIS_{ST,Y}$	=	paved road PM emissions (tons) for the entire state for road type y
$VMT_{X,Y}$	=	total VMT (million miles) in county x and road type y
$VMT_{ST,Y}$	=	total VMT (million miles) in entire state for road type y

PM control measures were applied to the paved road emission estimates for the years 1995 and 1996. The control assumed was vacuum sweeping on paved roads twice per month to achieve an control level of 79 percent. This control was applied to urban and rural roads in serious PM nonattainment areas and to urban roads in moderate PM nonattainment areas. The penetration factor used varied by road type and NAA classification (serious or moderate).

4.8.2.6 Calculation of PM-2.5 Emissions from Paved and Unpaved Roads

EPA, Pechan, and Midwest Research Institute (MRI) performed an evaluation of more recent particle size distribution information.[1] That review indicated that the PM-2.5/PM-10 ratio for reentrained road dust from paved and unpaved roads should be reduced from the older AP-42 particle size multipliers. The table 4.8-1 shows the particle size ratios used to calculate PM-2.5 emissions from the PM-10 emissions for these sources.

Thus, all PM-2.5 emission from paved and unpaved roads were calculated by multiplying the final PM10 emissions at the county/road type/month level by 0.25 for paved roads and by 0.15 for unpaved roads.

4.8.2.7 Other Fugitive Dust Sources

The other fugitive dust sources are from construction and mining and quarrying activities. Construction sources are explained in section 4.8.2.7.1 and mining and quarrying methodology is detailed in section 4.8.2.7.2.

4.8.2.7.1 Construction Activities —

The PM-10 emissions for the years 1985 through 1995, and the PM-2.5 emission for the years 1990 through 1995 were calculated from an emission factor, an estimate of the acres of land under construction, and the average duration of construction activity.[31] The acres of land under construction were estimated from the dollars spent on construction.[32] The PM-10 emission factor for the years 1985 through 1989 was calculated from the TSP emission factor for construction obtained from AP-42 and data on the PM-10/TSP ratio for various construction activities.[19] The PM-10 emission factor for the years 1990 through 1995 was obtained from Improvement of Specific Emission Factors.[33] 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.[32] A control efficiency was applied to emissions for 1995 and 1996 for counties classified as PM nonattainment areas.[34]

4.8.2.7.1.1 1985- 1989 Emission Factor Equation. The following AP-42 particulate emission factor equation (Equation 4.8-19) for heavy construction was used to determine regional PM-10 emissions from construction activities for 1985 through 1989.

$$E = T \times \$ \times f \times m \times P \qquad \text{(Eq. 4.8-19)}$$

where:
- E = PM-10 emissions
- T = TSP emission factor (1.2 ton/acre of construction/month of activity)
- $ = dollars spent on construction ($ million)
- f = factor for converting dollars spent on construction to acres of construction (varies by type of construction, acres/$ million)
- m = months of activity (varies by type of construction)
- P = dimensionless PM-10/TSP ratio (0.22).

4.8.2.7.1.2 1990 through 1995 Emission Factor Equation . Equation 4.8-20 is a variation of the AP-42 particulate emission factor equation for heavy construction and was used to determine regional PM-10 and PM-2.5 emissions from construction activities for 1990 through 1995. The PM-2.5 emission factor used for the years 1990 through 1995 was the PM-10 emission factor multiplied by the particle size adjustment factor of 0.2, shown in table 4.8-1. A control efficiency was applied to PM nonattainment areas for 1995 and 1996.

$$E = P \times \$ \times f \times m \times \left(1 - \frac{CE}{100}\right) \qquad \text{(Eq. 4.8-20)}$$

where:
- E = PM emissions
- P = PM emission factor (ton/acre of construction/month of activity) (PM-10 = 0.11; PM-2.5 = 0.022)
- \$ = dollars spent on construction (\$ million)
- f = factor for converting dollars spent on construction to acres of construction (varies by type of construction, acres/\$ million)
- m = months of activity (varies by type of construction)
- CE = control efficiency (percent)

4.8.2.7.1.2.1 Dollars spent on construction ($). Estimates of the dollars spent on the various types of construction by EPA region for 1987 were obtained from the Census Bureau.[35] The fraction of total U.S. dollars spent in 1987 for each region for each construction type was calculated. Since values from the Census Bureau are only available every five years, the Census dollars spent for the United States for construction were normalized using estimates of the dollars spent on construction for the United States as estimated by the F.W. Dodge[32] corporation for the other years. This normalized Census value was distributed by region and construction type using the above calculated fractions. An example of how this procedure was applied for SIC 1521 (general contractor, residential building: single family) is shown in Equation 4.8-21.

$$\$_{1988,Region\,I,SIC_{1521}} = \frac{\$_{1987,Nation,Census}}{\$_{1987,Nation,Dodge}} \times \$_{1988,Nation,Dodge} \times \frac{\$_{1987,Region\,1,Census,SIC_{1521}}}{\$_{1987,Nation,Census,SIC_{1521}}} \qquad \text{(Eq. 4.8-21)}$$

where:
- \$ = dollar amount of construction spent
- 1988 = year 1988
- 1987 = year 1987
- Region I = U.S. EPA Region I
- SIC 1521 = Standard Industrial Code for general contractor, residential building; single family
- Nation = United States
- Census = Census Bureau
- Dodge = F.W. Dodge

4.8.2.7.1.2.2 Determination of construction acres (f). Information developed by Cowherd et al.[31] determined that for different types of construction, the number of acres was proportional to dollars spent on that type construction. This information (proportioned to constant dollars using the method developed by Heisler[36]) was utilized along with total construction receipts to determine the total number of acres of each construction type.

4.8.2.7.1.2.3 Months of construction (m). Estimates of the duration (in months) for each type construction were derived from Cowherd et al.[31]

4.8.2.7.1.2.4 PM-10/TSP Ratio (P) (1985-1989). The PM-10/TSP ratio for construction activities was derived from Midwest Research Institute [MRI].[19] In MRI's report, the data in Table 9, "Net Particulate Concentrations and Ratios" is cited from Kinsey et al.[37] That table included the ratios of PM-10/TSP for 19 test sites for three different construction activities. MRI suggests averaging the ratios for the construction activity of interest. Since Pechan was looking at total construction emissions from all sources, Pechan averaged the PM-10/TSP ratios for all test sites and construction activities.

4.8.2.7.1.2.5 PM-10 and PM-2.5 Ratio (P) (1990-1995). The PM-10 emission factor used for the years 1990 through 1995 for construction activities was obtained from Improvement of Specific Emission Factors.[33] This study reported an emission factor of 0.11 ton PM-10/acre-month. This value is the geometric mean of emission factors for 7 different sites considered in the study. Emission inventories for the sites were prepared for the construction activities observed at each site. The PM-2.5 emission factor used for the years 1990-1995 was the PM-10 emission factor (0.11 ton PM-10/acre-month) multiplied by the particle size adjustment factor of 0.2, shown in table 4.8-1.

4.8.2.7.1.2.6 Control Efficiency (1990-1996). A control efficiency was applied to emissions for 1995 and 1996 for counties classified as PM nonattainment areas.[34] Therefore, the control efficiency for the years 1990 through 1994 is zero for all counties. The PM-10 control efficiency used for 1995 and 1996 PM nonattainment areas is 62.5. The PM-2.5 control efficiency for these years and areas is 37.5.

4.8.2.7.1.2.7 County Distribution. Regional-level PM-10 estimates were distributed to the county-level using county estimates of payroll for construction (SICs 15, 16, 17) from County Business Patterns.[38] Equation 4.8-22 was used.

$$County\ Emissions = \frac{County\ Construction\ Payroll}{Regional\ Construction\ Payroll} \times Regional\ Emissions \qquad \text{(Eq. 4.8-22)}$$

4.8.2.7.2 Mining and Quarrying —

The PM-10 emissions for the years 1985 through 1995 were the sum of the emissions from metallic ore, nonmetallic ore, and coal mining operations. The 1996 PM-10 emissions were produced through a linear projection of the emissions for the years 1990 through 1995.The PM-2.5 emissions for the years 1990 through 1996 were determined by multiplying the PM-10 emissions for that year by the particle size adjustment factor of 0.2, represented in table 4.8-1.

PM-10 emissions estimates from mining and quarrying operations include only the following sources of emissions: 1) overburden removal, 2) drilling and blasting, 3) loading and unloading and 4) overburden replacement. Transfer and conveyance operations, crushing and screening operations and storage were not included. Travel on haul roads was also omitted. These operations were not included in order to be consistent with previous TSP emissions estimates from these sources (i.e., Evans and Cooper[39]), because they represent activities necessary for ore processing, but not necessary for actual extraction of ore from the earth, and because these activities are the most likely to have some type of control implemented.

Pechan's emissions of mining and quarrying operations is a summation of three types of mining (metallic, non-metallic and coal) which are expressed in Equation 4.8-23.

$$E = E_m + E_n + E_c \qquad \text{(Eq. 4.8-23)}$$

where:

where:	E	=	PM-10 emissions from mining and quarrying operations
	E_m	=	PM-10 emissions from metallic mining operations
	E_n	=	PM-10 emissions from non-metallic mining operations
	E_c	=	PM-10 emissions from coal mining operations

4.8.2.7.2.1 Determination of Correction Parameters. It was assumed that, for the four operations listed above, the TSP emission factors utilized in developing copper ore processing Emission Trends estimates applied to all metallic minerals. PM-10 emission factors were determined for each of the four operations listed above by making the following assumptions. Table 11.2.3-2 of AP-42[10] was used to determine that 35 percent of overburden removal TSP emissions were PM-10. For drilling and blasting and truck dumping, 81 percent of the TSP emissions were assumed to be PM-10.[40] For loading operations, 43 percent of TSP emissions were assumed to be PM-10.[40]

Non-metallic mineral emissions were calculated by assuming that the PM-10 emission factors for western surface coal mining[41] applied to all non-metallic minerals.

Coal mining includes two additional sources of PM-10 emissions compared to the sources considered for metallic and non-metallic minerals. The two additional sources are overburden replacement and truck loading and unloading of that overburden. Pechan assumed that tons of overburden was equal to ten times the tons of coal mined.[39]

4.8.2.7.2.2 Activity Data. The regional metallic and non-metallic crude ore handled at surface mines for 1985 through 1995 were obtained from the U.S. Geological Survey.[42] Some state-level estimates are withheld by the U.S. Geological Survey to avoid disclosing proprietary data. Known distributions from past years were used to estimate these withheld data.

The regional production figures for surface coal mining operations were obtained from the Coal Industry Annual[43] for 1985 through 1995.

4.8.2.7.2.2.1 ***<u>Metallic Mining Operations</u>***. The following PM-10 emissions estimate equation (Equation 4.8-24) calculates the emissions from overburden removal, drilling and blasting, and loading and unloading during metallic mining operations.

$$E_m = A_m \times EF_o + B \times EF_b + EF_l + EF_d \qquad \text{(Eq. 4.8-24)}$$

where:
- A_m = metallic crude ore handled at surface mines (1000 short tons)
- EF_o = PM-10 open pit overburden removal emission factor for copper ore processing (lbs/ton)
- B = fraction of total ore production that is obtained by blasting at metallic mines
- EF_b = PM-10 drilling/blasting emission factor for copper ore processing (lbs/ton)
- EF_l = PM-10 loading emission factor for copper ore processing (lbs/ton)
- EF_d = PM-10 truck dumping emission factor for copper ore processing (lbs/ton)

4.8.2.7.2.2.2 ***<u>Non-metallic Mining Operations</u>***. The following PM-10 emissions estimate equation (Equation 4.8-25) calculates the emissions from overburden removal, drilling and blasting, and loading and unloading during non-metallic mining operations.

$$E_n = A_n \times \left(EF_v + D \times EF_r + EF_a + ½ \times \left(EF_e + EF_t\right)\right) \qquad \text{(Eq. 4.8-25)}$$

where:
- A_n = non-metallic crude ore handled at surface mines (1000 short tons)
- EF_v = PM-10 open pit overburden removal emission factor at western surface coal mining operations (lbs/ton)
- D = fraction of total ore production that is obtained by blasting at non-metallic mines
- EF_r = PM-10 drilling/blasting emission factor at western surface coal mining operations (lbs/ton)
- EF_a = PM-10 loading emission factor at western surface coal mining operations (lbs/ton)
- EF_e = PM-10 truck unloading: end dump-coal emission factor at western surface coal mining operations (lbs/ton)
- EF_t = PM-10 truck unloading: bottom dump-coal emission factor at western surface coal mining operations (lbs/ton)

4.8.2.7.2.2.3 ***<u>Coal Mining</u>***. The following PM-10 emissions estimate equation (Equation 4.8-26) calculates the emissions from overburden removal, drilling and blasting, loading and unloading, and overburden replacement during coal mining operations.

$$E_c = A_c \times \left(10 \times \left(EF_{to} + EF_{or} + EF_{dt}\right) + EF_v + EF_r + EF_a + ½ \times \left(EF_e + EF_t\right)\right) \qquad \text{(Eq. 4.8-26)}$$

where: A_c = coal production at surface mines (1000 short tons)
Ef_{to} = PM-10 emission factor for truck loading overburden at western surface coal mining operations (lbs/ton of overburden)
Ef_{or} = PM-10 emission factor for overburden replacement at western surface coal mining operations (lbs/ton of overburden)
Ef_{dt} = PM-10 emission factors for truck unloading: bottom dump-overburden at western surface coal mining operations (lbs/ton of overburden)
EF_v = PM-10 open pit overburden removal emission factor at western surface coal mining operations (lbs/ton)
EF_r = PM-10 drilling/blasting emission factor at western surface coal mining operations (lbs/ton)
EF_a = PM-10 loading emission factor at western surface coal mining operations (lbs/ton)
EF_e = PM-10 truck unloading: end dump-coal emission factor at western surface coal mining operations (lbs/ton)
EF_t = PM-10 truck unloading: bottom dump-coal emission factor at western surface coal mining operations (lbs/ton)

4.8.2.7.2.3 ***1996 Emissions Methodology.*** For the year 1996 PM-10 emissions from mining and quarrying operations were projected based on linear regression of the previous 5 years. Pechan was unable to obtain regional metallic and non-metallic crude ore handled at surface mines for 1996. The U.S. Geological Survey publishes summary statistics on mining and quarrying with a one year delay.

4.8.2.7.2.4 ***County Distribution.*** Regional-level emissions were distributed equally among counties within each region (Equation 4.8-27).

$$County\ Emissions = \frac{1}{Number\ of\ Counties\ in\ Region} \times Regional\ Emissions \qquad \text{(Eq. 4.8-27)}$$

4.8.2.8 Grown Emissions

Point source fugitive dust sources in the 1990 NET inventory were wind erosion, unpaved roads, and paved roads. (A complete list of source categories is presented in table 4.8-9.) Emissions from these sources were grown from the 1990 NET inventory based on BEA earnings. The cattle feedlot emissions estimated above were also grown from year to year.

4.8.2.8.1 Emissions Calculations —

Base year controlled emissions are projected to the inventory year using Equation 4.8-28.

$$CE_i = CE_{BY} + (CE_{BY} \times EG_i) \qquad \text{(Eq. 4.8-28)}$$

where: CE_i = Controlled Emissions for inventory year I
CE_{BY} = Controlled Emissions for base year
EG_i = Earnings Growth for inventory year I

Earnings growth (EG) is calculated as shown in Equation 4.8-29.

$$EG_i = 1 - \frac{DAT_i}{DAT_{BY}} \qquad \text{(Eq. 4.8-29)}$$

where: DAT_i = Earnings data for inventory year I
DAT_{BY} = Earnings data in the base year

4.8.2.8.2 1990 Emissions —

The 1990 National Emission Trends is based primarily on state data, with the 1990 interim data filling in the gaps. The database houses U.S. annual and average summer day emission estimates for the 50 states and the District of Columbia. Seven pollutants (CO, NO_x, VOC, SO_2, PM-10, PM-2.5, and NH_3) were estimated in 1990. The state data were extracted from three sources, the OTAG inventory, the GCVTC inventory, and AIRS/FS.

Since EPA did not receive documentation on how these inventories were developed, this section only describes the effort to collect the data and any modifications or additions made to the data.

4.8.2.8.2.1 ***OTAG.*** The OTAG inventory for 1990 was completed in December 1996. The database 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 ozone pollutants (VOC, NO_x, and CO). This section gives a background of the OTAG emission inventory and the data collection process.

4.8.2.8.2.1.1 Inventory Components. The OTAG inventory contains data for all states that are partially or fully in the SUPROXA modeling domain. The SUPROXA domain was developed in the late 1980s as part of the EPA regional oxidant modeling (ROM) applications. EPA had initially used three smaller regional domains (Northeast, Midwest, and Southeast) for ozone modeling, but wanted to model the full effects of transport in the eastern United States without having to deal with estimating boundary conditions along relatively high emission areas. Therefore, these three domains were combined and expanded to form the Super Domain. The western extent of the domain was designed to allow for coverage of the largest urban areas in the eastern United States without extending too far west to encounter terrain difficulties associated with the Rocky Mountains. The Northern boundary was designed to include the major urban areas of eastern Canada. The southern boundary was designed to include as much of the United States as possible, but was limited to latitude 26°N, due to computational limitations of the photochemical models. (Emission estimates for Canada were not extracted from OTAG for inclusion in the NET inventory.)

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 ozone precursor inventory. It includes emission estimates of VOC, NO_x, and CO 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 ozone precursor data. No quality assurance (QA) was performed on the SO_2 and PM-10 emission estimates for the OTAG inventory effort.

Since the underlying purpose of the OTAG inventory is to support photochemical modeling for ozone, it is primarily an average summer day inventory. Emission estimates that were submitted as annual emission estimates were converted to average summer day estimates using operating schedule data and default temporal profiles and vice versa.

The OTAG inventory is made up of three major components: (1) the point source component, which includes segment/pollutant level emission estimates and other relevant data (e.g., stack parameters, geographic coordinates, and base year control information) for all stationary point sources in the domain; (2) the area source component, which includes county level emission estimates for all stationary area sources and non-road engines; and (3) the on-road vehicle component, which includes county/roadway functional class/vehicle type estimates of VMT and MOBILE5a input files for the entire domain.

4.8.2.8.2.1.2 Interim Emissions Inventory (OTAG Default). The primary data sources for the OTAG inventory were the individual states. Where states were unable to provide data, the 1990 Interim Inventory [44] was used for default inventory data.

4.8.2.8.2.1.3 State Data Collection Procedures. Since the completion of the Interim Inventory in 1992, many states had completed 1990 inventories for ozone nonattainment areas as required for preparing SIPs. In addition to these SIP inventories, many states had developed more comprehensive 1990 emission estimates covering their entire state. Since these state inventories were both more recent and more comprehensive than the Interim Inventory, a new inventory was developed based on state inventory data (where available) in an effort to develop the most accurate emission inventory to use in the OTAG modeling.

On May 5, 1995, a letter from John Seitz (Director of EPA's Office of Air Quality Planning and Standards [OAQPS]) and Mary Gade (Vice President of ECOS) to State Air Directors, states were requested to supply available emission inventory data for incorporation into the OTAG inventory.[45] Specifically, states were requested to supply all available point and area source emissions data for VOC, NO_x, CO, SO_2, and PM-10, with the primary focus on emissions of ozone precursors. Some emission inventory data were received from 36 of the 38 states in the OTAG domain. To minimize the burden to the states, there was no specified format for submitting state data. The majority of the state data was submitted in one of three formats:

1) an Emissions Preprocessor System Version 2.0 (EPS2.0) Workfile
2) an ad hoc report from AIRS/FS
3) data files extracted from a state emission inventory database

4.8.2.8.2.1.4 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 two-digit SIC code. 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 using the following equation:

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} * SUMTHRU * 1/(13 * DPW) \qquad \text{(Eq. 4.8-30)}$$

where:

$EMISSIONS_{ASD}$	=	average summer day emissions
$EMISSIONS_{ANNUAL}$	=	annual emissions
SUMTHRU	=	summer throughput percentage
DPW	=	days per week in operation

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. This computer file contains default seasonal and daily temporal profiles by SCC. The following equation was used:

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} / (SUMFAC_{SCC} * WDFAC_{SCC}) \qquad \text{(Eq. 4.8-31)}$$

where:

$EMISSIONS_{ASD}$	=	average summer day emissions
$EMISSIONS_{ANNUAL}$	=	annual emissions
$SUMFAC_{SCC}$	=	default summer season temporal factor for SCC
$WDFAC_{SCC}$	=	default summer weekday temporal factor for 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 and were calculated using the following equation:

$$EMISSIONS_{ASD} = EMISSIONS_{ANNUAL} / 365 \qquad \text{(Eq. 4.8-32)}$$

where:

$EMISSIONS_{ASD}$ = average summer day emissions
$EMISSIONS_{ANNUAL}$ = annual emissions

4.8.2.8.2.1.5 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 4.8-10 provides a brief description of the point source data supplied by each state.

4.8.2.8.2.1.6 Area. For area sources, 17 of the 38 states in the OTAG domain supplied 1990 emission estimates covering the entire state, and an additional nine states supplied 1990 emission estimates covering part of their state (partial coverage was mostly in ozone nonattainment areas). 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 4.8-11 provides a brief description of the area source data supplied by each state.

4.8.2.8.2.1.7 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.

The use of rule effectiveness in estimating emissions can result in emission estimates that are much higher than estimates for the same source calculated without using rule effectiveness, especially for sources with high control efficiencies (95 percent or above). Because of this problem, there was concern that the OTAG emission estimates for states that used rule effectiveness would be biased to larger estimates relative to states that did not include rule effectiveness in their computations.

To test if this bias existed, county level maps of point source emissions were developed for the OTAG domain. If this bias did exist, one would expect to see sharp differences at state borders between states using rule effectiveness and states not using rule effectiveness. Sharp state boundaries were not evident in any of the maps created. Based on this analysis, it was determined that impact of rule effectiveness inconsistencies was not causing large biases in the inventory.

4.8.2.8.2.2 Grand Canyon Visibility Transport Commission Inventory. The GCVTC inventory includes detailed emissions data for eleven states: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.[46] This inventory was developed by compiling and merging existing inventory databases. The primary data sources used were state inventories for California and Oregon, AIRS/FS for VOC, NO_x, and SO_2 point source data for the other nine states, the 1990 Interim Inventory for area source data for the other nine states, and the 1985

NAPAP inventory for NH_3 and TSP data. In addition to these existing data, the GCVTC inventory includes newly developed emission estimates for forest wildfires and prescribed burning.

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

- complete point and area source data for California
- complete point and area source data for Oregon
- forest wildfire data for the entire eleven state region
- prescribed burning data for the entire eleven 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 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.

Non-utility point source emission estimates in the GCVTC inventory from states other than California and Oregon came from AIRS/FS. Corrections were made to this inventory to the VOC and PM emissions. The organic emissions reported in GCVTC inventory for California are total organics (TOG). These emissions were converted to VOC using the profiles from EPA's SPECIATE[47] database.

4.8.2.8.2.3 AIRS/FS. SO_2 and PM-10 (or PM-10 estimated from TSP) sources of greater than 250 tons per year as reported to AIRS/FS that were not included in either the OTAG or GCVTC inventories were appended to the NET inventory. The data were extracted from AIRS/FS using the data criteria set listed in table 4.8-12. The data elements extracted are also listed in table 4.8-12. The data were extracted in late November 1996. It is important to note that *estimated* emissions were extracted.

4.8.2.8.2.4 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 SO2, PM-10, PM-2.5, and NH_3, as well as annual or ozone season daily (depending on the inventory) emission estimates for all pollutants. This section describes the steps taken to fill in the gaps from the other inventories.

4.8.2.8.2.4.1 SO_2 and PM Emissions. 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, OTAG data for these pollutants were not available. For point sources, data for plants over 250 tons per year for SO_2 and PM-10 were added from AIRS/FS. The AIRS/FS data were also 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 to the inventory. For OTAG plants where there were no matching data in AIRS/FS 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 unmatched point and area sources involved using uncontrolled emission factor ratios to calculate uncontrolled emissions. This method used SO_2 or PM-10 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 VOC, NO_x, and CO 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 Inventory 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 FIPS code, along with the plant and point IDs.

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/FS for 1990 and using the emission factor ratios resulted in unrealistically high PM-10 emissions.

There were no PM-2.5 data in either OTAG or AIRS/FS. Therefore, the point and area PM-2.5 emission estimates were developed based on the PM-10 estimates using source-specific uncontrolled particle size distributions and particle size specific control efficiencies for sources with PM-10 controls. To estimate PM-2.5, uncontrolled PM-10 was first estimated by removing the impact of any PM-10 controls on sources in the inventory. Next, the uncontrolled PM-2.5 was calculated by multiplying the uncontrolled PM-10 emission estimates by the ratio of the PM-2.5 particle size multiplier to the PM-10 particle size multiplier. (These particle size multipliers represent the percentage to total particulates below the specified size.) Finally, controls were reapplied to sources with PM-10 controls by multiplying the uncontrolled PM-2.5 by source/control device particle size specific control efficiencies.

4.8.2.8.3 Growth Indicators, 1985-1989 —

The changes in the point and area source emissions were equated with the changes in historic earnings by state and industry. Emissions from each point source in the 1985 NAPAP inventory were projected to the years 1985 through 1990 based on the growth in earnings by industry (two-digit SIC code). Historical annual state and industry earnings data from BEA's Table SA-5[48] were used to represent growth in earnings from 1985 through 1990.

The 1985 through 1990 earnings data in Table SA-5 are expressed in nominal dollars. To estimate growth, these values were converted to constant dollars to remove the effects of inflation. Earnings data for each year were converted to 1982 constant dollars using the implicit price deflator for PCE.[49] The PCE deflators used to convert each year's earnings data to 1982 dollars are:

Year	1982 PCE Deflator
1985	111.6
1987	114.8
1988	124.2
1989	129.6
1990	136.4

Several BEA categories did not contain a complete time series of data for the years 1985 through 1990. Because the SA-5 data must contain 1985 earnings and earnings for each inventory year (1985 through 1990) to be useful for estimating growth, a log linear regression equation was used where possible to fill in missing data elements. This regression procedure was performed on all categories that were missing at least one data point and which contained at least three data points in the time series.

Each record in the inventory was matched to the BEA earnings data based on the state and the two-digit SIC. Table 4.8-13 shows the BEA earnings category used to project growth for each of the two-digit SICs found in the 1985 NAPAP Emission Inventory. No growth in emissions was assumed for all point sources for which the matching BEA earnings data were not complete. Table 4.8-13 also shows the national average growth and earnings by industry from Table SA-5.

4.8.2.8.4 Growth Indicators, 1991 through 1996 —

The 1991 through 1996 area source emissions were grown in a similar manner as the 1985 through 1989 estimates, except for using a different base year inventory. The point source inventory was also grown for those states that did not want their AIRS/FS data used. (See Table 14 for a list of states that chose AIRS/FS.) For those states requesting that EPA extract their data from AIRS/FS, 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/FS until July 1997.

<u>4.8.2.8.4.1</u> ***<u>Grown Estimates</u>.*** The 1991 through 1996 point and area source emissions were grown using the 1990 NET inventory as the basis. The algorithm for determining the estimates is detailed in section 4.8.2.8. The 1990 through 1996 SEDS and BEA data are presented in tables 4.8-15 and 4.8-16. The 1996 BEA and SEDS data were determined based on linear interpretation 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. Table 4.8-17 lists the SCC and the source for growth.

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 PCE. The PCE deflators used to convert each year's earnings data to 1992 dollars are:

Year	1992 PCE Deflator
1990	93.6
1991	97.3
1992	100.0
1993	102.6
1994	104.9
1995	107.6
1996	109.7

4.8.2.8.4.2 AIRS/FS. Several states responded to EPA's survey and requested that their 1991 through 1995 estimates reflect their emissions as reported in AIRS/FS. The list of these states, along with the years available in AIRS/FS is given in table 4.8-14.

As noted in table 4.8-14, 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 two years worth of emissions at the plant level. If only one year of emissions data were 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.

Many 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 PM-10 emissions are then converted to PM-2.5 in the same manner as described in section 4.8.2.8.2.4.1. The State of South Carolina provided its own conversion factor for estimating PM-10 from TSP.[50]

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Table 4.8-1. Particle Size Ratios

Source Category	Ratio of PM-2.5 to PM-10
Wind Erosion - Agricultural Land	0.15
Agricultural Crops	0.20
Agricultural Livestock	0.15
Wind Erosion - Non-Agricultural Land	0.15
Paved Roads	0.25
Unpaved Roads	0.15
Construction Activities	0.20
Mining and Quarrying	0.20

Table 4.8-2. Silt Content by Soil Type, 1985 to 1989

Soil Type	Silt Content (%)
Silt Loam	78
Sandy Loam	33
Sand	12
Loamy Sand	12
Clay	75
Clay Loam	75
Organic Material	10-82
Loam	60

Table 4.8-3. Silt Content by Soil Type, 1990 to 1996

Soil Type	Silt Content (%)
Silt Loam	52
Sandy Loam	33
Sand	12
Loamy Sand	12
Clay	29
Clay Loam	29
Organic Material	10-82
Loam	40

Table 4.8-4. Number of Tillings by Crop Type

Crop	Number of Tillings Conservational Use	 Conventional Use
Corn	2	6
Spring Wheat	1	4
Rice	5	5
Fall-Seeded Small Grain	3	5
Soybeans	1	6
Cotton	5	8
Sorghum	1	6
Forage	3	3
Permanent Pasture	1	1
Other Crops	3	3
Fallow	1	1
Annual Conservation Use	(No method, not used after 1995; number of tillings = 1)	

Table 4.8-5. Livestock Operations Ammonia Emission Factors

Category	AMS SCC	Emission Factor (lb NH_3/Head)
Cattle and Calves	2805020000	50.5
Pigs and Hogs	2805025000	20.3
Poultry	2805030000	0.394
Sheep	2805040000	7.43
Horses	2710020030	26.9
Goats	2805045001	14.1
Mink	2205045002	1.28

Table 4.8-6 Speeds Modeled for Unpaved Roads

Rural Roads	Speed (mph)	Urban Roads	Speed (mph)
Minor Arterial	39	Other Principal Arterial	20
Major Collector	34	Minor Arterial	20
Minor Collector	30	Collector	20
Local	30	Local	20

Table 4.8-7 Assumed Values for Average Daily Traffic Volume by Volume Group

	Vehicles Per Day Per Mile			
Volume Category for Rural Roads	**Less than 50**	**50 - 199**	**200 - 499**	**500 and over**
Assumed ADTV Value for Rural Roads	5*	125**	350**	550***
Volume Category for Urban Roads	**Less than 200**	**200 - 499**	**500 - 1999**	**2000 and over**
Assumed ADTV Value for Urban Roads	20*	350**	1250**	2200***

NOTE(S): *10% of volume group's maximum range endpoint.
**Average of volume group's range endpoints.
***110% of volume group's minimum.

Table 4.8-8. PM-2.5 to PM-10 Ratios for Paved and Unpaved Roads

Source Category	Ratio of PM-2.5 to PM-10
Paved Roads	0.25
Unpaved Roads	0.15

Table 4.8-9. List of Grown Sources

SCC	SCC Description	TIER1	TIER2
2307010000	Industrial Processes Wood Products: SIC 24 Logging Operations Total	14	01
2710020030	Natural Sources Biogenic Horses and Ponies	14	01
2801000001	Miscellaneous Area Sources Agriculture Production - Crops Agriculture - Crops Land Breaking	14	01
2801000002	Miscellaneous Area Sources Agriculture Production - Crops Agriculture - Crops Planting	14	01
2801000003	Miscellaneous Area Sources Agriculture Production - Crops Agriculture - Crops Tilling	14	01
2801000004	Miscellaneous Area Sources Agriculture Production - Crops Agriculture - Crops Defoliation	14	01
2801000005	Miscellaneous Area Sources Agriculture Production - Crops Agriculture - Crops Harvesting	14	01
2801000006	Miscellaneous Area Sources Agriculture Production - Crops Agriculture - Crops Drying	14	01
2801000007	Miscellaneous Area Sources Agriculture Production - Crops Agriculture - Crops Loading	14	01
2801000008	Miscellaneous Area Sources Agriculture Production - Crops Agriculture - Crops Transport	14	01
2801700001	Miscellaneous Area Sources Agriculture Production - Crops Fertilizer Application	14	01
2801700002	Miscellaneous Area Sources Agriculture Production - Crops Fertilizer Application	14	01
2801700003	Miscellaneous Area Sources Agriculture Production - Crops Fertilizer Application	14	01
2801700004	Miscellaneous Area Sources Agriculture Production - Crops Fertilizer Application	14	01
2801700005	Miscellaneous Area Sources Agriculture Production - Crops Fertilizer Application	14	01
2801700006	Miscellaneous Area Sources Agriculture Production - Crops Fertilizer Application	14	01
2801700007	Miscellaneous Area Sources Agriculture Production - Crops Fertilizer Application	14	01
2801700008	Miscellaneous Area Sources Agriculture Production - Crops Fertilizer Application	14	01
2801700009	Miscellaneous Area Sources Agriculture Production - Crops Fertilizer Application	14	01
2801700010	Miscellaneous Area Sources Agriculture Production - Crops Fertilizer Application	14	01
2805000000	Miscellaneous Area Sources Agriculture Production - Livestock Agriculture - Livestock Total	14	01
2805001000	Miscellaneous Area Sources Agriculture Production - Livestock Beef Cattle Feedlots Total	14	01
2805001001	Miscellaneous Area Sources Agriculture Production - Livestock Beef Cattle Feedlots Feed Preparation	14	01
2805005000	Miscellaneous Area Sources Agriculture Production - Livestock Poultry Operations Total	14	01
2805005001	Miscellaneous Area Sources Agriculture Production - Livestock Poultry Operations Feed Preparation	14	01
2805010000	Miscellaneous Area Sources Agriculture Production - Livestock Dairy Operations Total	14	01
2805010001	Miscellaneous Area Sources Agriculture Production - Livestock Dairy Operations Feed Preparation	14	01
2805015000	Miscellaneous Area Sources Agriculture Production - Livestock Hog Operations Total	14	01
2805015001	Miscellaneous Area Sources Agriculture Production - Livestock Hog Operations Feed Preparation	14	01
2805020000	Miscellaneous Area Sources Agriculture Production - Animal Husbandry Cattle and Calves Composite	14	01
2805025000	Miscellaneous Area Sources Agriculture Production - Animal Husbandry Hogs and Pigs Composite	14	01
2805030000	Miscellaneous Area Sources Agriculture Production - Animal Husbandry Poultry - Chickens Composite	14	01
2805040000	Miscellaneous Area Sources Agriculture Production - Animal Husbandry Sheep and Lambs Composite	14	01
2805045001	Miscellaneous Area Sources Agriculture Production - Animal Husbandry Goats	14	01
2275085000	Mobile Sources Aircraft Unpaved Airstrips Total	14	07
2650000005	Waste Disposal, Treatment, & Recovery Scrap & Waste Materials Scrap & Waste Materials Storage Piles	14	07
30300519	Primary Metal Production Primary Metal Production Primary Copper Smelting Unpaved Road Traffic: Fugitive Emissions	14	07
30300831	Primary Metal Production Iron Production Fugitive Emissions: Roads Unpaved Roads: LDV	14	07
30300832	Primary Metal Production Iron Production Fugitive Emissions: Roads Unpaved Roads: MDV	14	07
30300833	Primary Metal Production Iron Production Fugitive Emissions: Roads Unpaved Roads: HDV	14	07
30300834	Primary Metal Production Iron Production Fugitive Emissions: Roads Paved Roads: All Vehicle Types	14	07
30302321	Primary Metal Production Primary Metal Production Taconite Iron Ore Processing Haul Road: Rock	14	07
30302322	Primary Metal Production Primary Metal Production Taconite Iron Ore Processing Haul Road: Taconite	14	07
30501024	Mineral Products Mineral Products Surface Mining Operations Hauling	14	07
30501031	Mineral Products Mineral Products Surface Mining Operations Scrapers: Travel Mode	14	07
30501039	Mineral Products Mineral Products Surface Mining Operations Hauling: Haul Trucks	14	07
30501045	Mineral Products Mineral Products Surface Mining Operations Bulldozing: Overburden	14	07
30501046	Mineral Products Mineral Products Surface Mining Operations Bulldozing: Coal	14	07
30501047	Mineral Products Mineral Products Surface Mining Operations Grading	14	07
30501049	Mineral Products Mineral Products Surface Mining Operations Wind Erosion: Exposed Areas	14	07
30501050	Mineral Products Mineral Products Surface Mining Operations Vehicle Traffic: Light/Medium Vehicles	14	07
30501090	Mineral Products Mineral Products Surface Mining Operations Haul Roads: General	14	07
30502011	Mineral Products Mineral Products Stone Quarrying/Processing Hauling	14	07
30502504	Mineral Products Mineral Products Sand/Gravel Hauling	14	07
31100101	Building Construction Building Construction Construction: Building Contractors Site Preparation: Topsoil Removal	14	07
31100102	Building Construction Building Construction Construction: Building Contractors Site Preparation: Earth Moving (Cut & Fill)	14	07
31100103	Building Construction Building Construction Construction: Building Contractors Site Preparation: Aggregate Hauling (on dirt)	14	07
31100205	Building Construction Building Construction Construction: Demolition of Structures On-Site Truck Traffic	14	07
31100206	Building Construction Building Construction Construction: Demolition of Structures On-Site Truck Traffic	14	07

Table 4.8-10. 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
South Carolina	AIRS-AFS - Ad hoc retrievals	Annual	1991	Average Summer Day estimated using default temporal factors.

Table 4.8-10 (continued)

State	Data Source/Format	Temporal Resolution	Year of Data	Adjustments to Data
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 4.8-11. 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 4.8-12. Ad Hoc Report

Criteria		Plant Output		Point Output		Stack Output		Segment Output General		Segment Output Pollutant	
Regn	GT 0	YINV	YEAR OF INVENTORY	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE	STTE	STATE FIPS CODE
PLL4	CE VOC	STTE	STATE FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE	CNTY	COUNTY FIPS CODE
PLL4	CE CO	CNTY	COUNTY FIPS CODE	PNED	NEDS POINT ID	PNED	NEDS POINT ID	PNED	NEDS POINT ID	PNED	NEDS POINT ID
PLL4	CE SO2	CYCD	CITY CODE	PNUM	POINT NUMBER	STNB	STACK NUMBER	STNB	STACK NUMBER	STNB	STACK NUMBER
PLL4	CE NO2	ZIPC	ZIP CODE	CAPC	DESIGN CAPACITY	LAT2	LATITUDE STACK	PNUM	POINT NUMBER	PNUM	POINT NUMBER
PLL4	CE PM-10	PNED	NEDS POINT ID	CAPU	DESIGN CAPACITY UNITS	LON2	LONGITUDE STACK	SEGN	SEGMENT NUMBER	SEGN	SEGMENT NUMBER
PLL4	CE PT	PNME	PLANT NAME	PAT1	WINTER THROUGHPUT	STHT	STACK HEIGHT	SCC8	SCC	SCC8	SCC
DES4	GE 0	LAT1	LATITUDE PLANT	PAT2	SPRING THROUGHPUT	STDM	STACK DIAMETER	HEAT	HEAT CONTENT	PLL4	POLLUTANT CODE
DUE4	ME TY	LON1	LONGITUDE PLANT	PAT3	SUMMER THROUGHPUT	STET	STACK EXIT TEMPERATURE	FPRT	ANNUAL FUEL THROUGHPUT	D034	OSD EMISSIONS
YINV	ME 90	SIC1	STANDARD INDUSTRIAL CODE	PAT4	FALL THROUGHPUT	STEV	STACK EXIT VELOCITY	SULF	SULFUR CONTENT	DU04	OSD EMISSION UNITS
		OPST	OPERATING STATUS	NOHD	NUMBER HOURS/DAY	STFR	STACK FLOW RATE	ASHC	ASH CONTENT	DES4	DEFAULT ESTIMATED EMISSIONS
		STRS	STATE REGISTRATION NUMBER	NODW	NUMBER DAYS/WEEK	PLHT	PLUME HEIGHT	PODP	PEAK OZONE SEASON DAILY PROCESS RATE	DUE4	DEFAULT ESTIMATED EMISSIONS UNITS
				NOHY	NUMBER HOURS/YEAR					CLEE	CONTROL EFFICIENCY
										CLT1	PRIMARY CONTROL DEVICE CODE
										CTL2	SECONDARY CONTROL DEVICE CODE
										REP4	RULE EFFECTIVENESS
										DME4	METHOD CODE
										Emfa	Emission factor

Table 4.8-13. Bureau of Economic Analysis's SA-5 National Changes in Earnings by Industry

Industry	SIC	Percent Growth from: 1985 to 1987	1987 to 1988	1988 to 1989	1989 to 1990
Farm	01, 02	14.67	-2.73	14.58	-3.11
Agricultural services, forestry, fisheries, and other	07, 08, 09	23.58	5.43	1.01	2.48
Coal mining	11, 12	-17.46	-6.37	-4.16	4.73
Metal mining	10	-3.03	18.01	8.94	4.56
Nonmetallic minerals, except fuels	14	2.33	3.74	-2.79	-0.45
Construction	15, 16, 17	7.27	4.81	-1.36	-3.80

Table 4.8-14. Emission Estimates Available from AIRS/FS 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).

Table 4.8-15. SEDS National Fuel Consumption, 1990-1996 (trillion Btu)

Fuel Type	End-User	Code	1990	1991	1992	1993	1994	1995	1996
Population									
		TPOPP	248,709	252,131	255,025	257,785	259,693	261,602	263,510

Table 4.8-16. BEA SA-5 National Earnings by Industry, 1990-1996 (million $)

Industry	LNUM	SIC	1990	1991	1992	1993	1994	1995	1996
Farm	81	1, 2	48	41	46	45	42	31	29
Farm	82	1, 2	3,586	3,552	3,686	3,740	3,849	3,980	4,058
Farm	90	1, 2	3,001	2,957	3,079	3,126	3,228	3,353	3,423
Agricultural services, forestry, fisheries, and other	100	7-9	24	24	24	24	26	27	27
Agricultural services, forestry, fisheries, and other	110	7-9	20	20	21	22	23	24	25
Agricultural services, forestry, fisheries, and other	120	7-9	4	3	3	3	3	3	3
Agricultural services, forestry, fisheries, and other	121	7-9	1	1	1	0	1	1	1
Agricultural services, forestry, fisheries, and other	122	7-9	2	2	2	2	2	2	1
Agricultural services, forestry, fisheries, and other	123	7-9	1	1	1	1	1	1	1
Agricultural services, forestry, fisheries, and other	200	7-9	36	37	36	34	35	35	35
Nonmetallic minerals, except fuels	240	14	4	4	4	4	4	4	4
Construction	300	15-17	218	197	195	199	216	219	219
Construction	310	15-17	54	47	46	47	51	51	50
Construction	320	15-17	29	28	28	27	29	29	29
Construction	330	15-17	135	123	121	125	136	138	139
Primary metal industries	423	33	33	30	31	30	32	33	32
Transportation by air	542	45	30	30	31	31	31	31	31

Table 4.8-17 Area Source Listing by SCC and Growth Basis

SCC	FILE	CODE	SCC	FILE	CODE
2275000000	BEA	542	2801000005	BEA	100
2275001000	BEA	920	2801700001	BEA	081
2275020000	BEA	542	2801700002	BEA	081
2275020021	BEA	542	2801700003	BEA	081
2275050000	BEA	542	2801700004	BEA	081
2275060000	BEA	542	2801700005	BEA	081
2275070000	BEA	542	2801700006	BEA	081
2275085000	BEA	542	2801700007	BEA	081
2275900000	BEA	542	2801700008	BEA	081
2275900101	BEA	542	2801700009	BEA	081
2275900102	BEA	542	2801700010	BEA	081
2301000000	BEA	471	2805000000	BEA	081
2301010000	BEA	471	2805001000	BEA	081
2301020000	BEA	471	2805020000	BEA	081
2301030000	BEA	471	2805025000	BEA	081
2301040000	BEA	471	2805030000	BEA	081
2710020030	BEA	081	2805040000	BEA	081
2801000003	BEA	081	2805045001	BEA	081

SECTION 5.0
LEAD EMISSIONS METHODOLOGY

5.1 INTRODUCTION

The methodology used to estimate the lead emissions presented in the *Trends* reports for the years 1970 to 1996 was based on the 1940-1984 Methodology. This section describes, in detail, the procedures used to create these estimates.

5.1.1 Background

The lead emissions methodology was based on a "top-down" approach where national information was used to create a national inventory of lead emissions. The emissions were estimated based on the source of the emissions and, in the case of combustion sources, the fuel type. The national activity of a process producing lead emissions was measured by the consumption of fuel, the throughput of raw materials, or an alternative production indicator. An emission factor was then applied to activity data to determine the amount of lead emitted from a specific process. For some categories, the lead content of the fuel was incorporated into the estimating procedure as part of the emission factor. The final element used to estimate emissions was the control efficiency, which quantifies the amount of lead not emitted due to the presence of control devices.

The lead emissions were presented in the 1997 *Trends* report by Tier categories, but in the lead emissions methodology, emissions were estimated by a different set of source categories. The source categories or subcategories contributing to lead emissions were regrouped into the Tier categories. The estimation procedures are presented in this section by Tier II category. The correspondence between the Tier II categories and the lead emissions methodology source categories is presented in Table 5.1-1. Within the description of the procedures for each Tier II category, the correlation between the categories is reiterated.

5.1.2 General Procedure

Lead emissions were calculated according to Equation 5.1-1.

$$Lead\ Emissions_{i,j} = A_{i,j} \times EF_{i,j} \times [1 - CE_{i,j}] \qquad \text{(Eq. 5.1-1)}$$

where:
A = activity
EF = emission factor
CE = control efficiency
I = year
j = source category

As an aid in the calculation of emissions by the lead methodology, two Excel spreadsheets were created for each year and are collectively referred to as the *Trends* spreadsheets. The spreadsheets were entitled TRENDSxx.XLS and MGTMPxx.XLS, where xx represents the year. The required data were entered into the TRENDSxx.XLS spreadsheet, after which the MGTMPxx.XLS spreadsheet was opened and the necessary calculations were made to estimate the national emissions. This procedure was designed to simplify the process of estimating emissions for a new year. By using the TRENDSxx.XLS spreadsheets from the previous year as templates, the spreadsheets for the new year were created by editing only the data requiring updating.

The calculations utilized within the TRENDSxx.XLS spreadsheets required specific units for the activity indicators and the emission factors. The required units are specified within the procedures for each Tier II category. In general, the units for activity indicators were short tons for solids, gallons for liquids, and cubic feet for gases. Emission factors were expressed in units of metric pounds of pollutant per unit consumption or throughput. Control efficiencies were expressed as a dimensionless decimal fraction. By using these units, the emissions calculated within the spreadsheets were expressed in metric tons. Raw data used as the basis for activity indicators or emission factors were often expressed in units which required conversion to the appropriate units. The following conversion factors were used in many cases.

1 ton (metric)	=	1.1023 tons (short)
1 ton (long)	=	1.1016 tons (short)
1 ton (short)	=	0.9072 tons (metric)
1 bbl	=	42 gal

The emission factors used to estimate lead emissions were based on the most recent information available. For many categories, the most recent emission factor was used to estimate the emissions for all years.

When the emissions were estimated for 1996, not all of the activity information was available. In order to make a preliminary emissions estimate, activity data from preceding years were used to estimate the activity data for 1996. This was done using several different methods. The first method used a quadratic equation and the past 20 years of activity data. Data for 1976-1995 were used, and the previous ten year's data (1986-1995) was repeated. The second method used a linear regression and the past 7 years of activity data. Data from 1989-1995 were used, 1993-1995 data were repeated, and the 1995 data were repeated a third time. The third method, used in cases where the first method resulted in a negative activity value, calculated the average of the activity data over the past 5 years. Table 5.1-2 presents by general source category the method used to estimate activity data for generating 1996 emissions. For general source categories not listed, activity data for the current year were available at the time the emissions were estimated.

5.1.3 Organization of Procedures

The methodology used to estimate lead emissions is described by Tier II category except for the On-road vehicles category which is described at the Tier I level. For each category, the procedure is divided into four sections, reflecting the data required to generate the estimates: (1) technical approach, (2) activity indicator, (3) emission factor, and (4) control efficiency. The procedures for obtaining activity indicators, emission factors or control efficiencies are arranged in a variety of ways, depending on the specific requirements of the category. The procedures could be arranged by process, fuel type, or other subcategory.

References are provided at the end of the description of the procedure for each Tier II category. Many of the references are published annually as part of a series. In some cases, several references are provided for the same information, reflecting a change or discontinuation of one source and its replacement by another. The specific source used would depend on the specific year for which information is needed. All tables and supporting data immediately follow the description of the procedure for each Tier II category.

Table 5.1-1. Correspondence Between Tier II Categories and Lead Emissions Methodology Categories

Tier I Category	Tier II Category	Tier I/Tier II Code	Lead Emissions Methodology Category	Lead Emissions Methodology Subcategory
Fuel Combustion - Electric Utility	Coal	01-01	Bituminous Coal and Lignite	Electric Utility
			Anthracite Coal	Electric Utility
	Oil	01-02	Residual Oil	Electric Utility
			Distillate Oil	Electric Utility
Fuel Combustion - Industrial	Coal	02-01	Bituminous Coal and Lignite	Industrial
			Anthracite Coal	Industrial
	Oil	02-02	Residual Oil	Industrial
			Distillate Oil	Industrial
Fuel Combustion - Other	Commercial and Institutional Coal	03-01	Bituminous Coal and Lignite	Commercial and Institutional
			Anthracite Coal	Commercial and Institutional
	Commercial and Institutional Oil	03-02	Residual Oil	Commercial and Institutional
			Distillate Oil	Commercial and Institutional
	Miscellaneous Fuel Combustion (except residential)	03-04	Residual Oil	Waste Oil
	Residential Other	03-06	Bituminous Coal and Lignite	Residential
			Anthracite Coal	Residential
			Residual Oil	Residential
			Distillate Oil	Residential

Table 5.1-1 (continued)

Tier I Category	Tier II Category	Tier I/Tier II Code	Lead Emissions Methodology Category	Lead Emissions Methodology Subcategory
Chemical and Allied Product Manufacture	Inorganic Chemical Manufacturing	04-02	Industrial Processes	Secondary Metals (lead oxide/pigment)
Metals Processing	Nonferrous	05-01	Industrial Processes	Nonferrous Metals (copper, zinc, and lead production) Secondary Metals (lead, copper, and battery production) Miscellaneous Process Sources [miscellaneous products (can soldering and cable covering)]
	Ferrous	05-02	Industrial Processes	Iron and Steel Industry Nonferrous Metals (ferroalloy production) Secondary Metals Industry (grey iron foundries)
	Not Elsewhere Classified	05-03	Industrial Processes	Mineral Products (ore crushing) Miscellaneous Process Sources [miscellaneous products (type metal production)]
Other Industrial Processes	Mineral Products	07-05	Industrial Processes	Mineral Products (cement manufacturing and glass production, lead-glass)
	Miscellaneous Industrial Processes	07-10	Industrial Processes	Miscellaneous Process Sources (lead alkyl production - electrolytic process, sodium lead alloy, and miscellaneous products (ammunition)]
Waste Disposal and Recycling	Incineration	10-01	Solid Waste Disposal	Incineration
On-road vehicles	All Categories (Light-Duty Gas Vehicles and Motorcycles, Light-Duty Gas Trucks, and Heavy-Duty Gas Vehicles)	11	On-road vehicles	Gasoline (leaded and unleaded)
Non-road engines and vehicles	Nonroad Gasoline	12-01	Other Non-road engines and vehicles	Gasoline
				Gasoline
	Aircraft	12-03	Vessels	Aviation Gasoline
			Aircraft	

Table 5.1-2. Method Used for Estimating 1996 Activity Data

General Source Category	Activity Data Estimation Method
Non-road engines and vehicles	Quadratic equation method
All Anthracite Coal Categories	Linear regression method
Fuel Combustion, excluding Electric Utility	
Bituminous Coal	Linear regression method
Residual Oil	Quadratic equation method
Distillate Oil	Linear regression method
Solid Waste	Quadratic equation method
Industrial Process Sources	Linear regression method

5.2 FUEL COMBUSTION ELECTRIC UTILITY - COAL: 01-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (See Table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Bituminous Coal and Lignite	Electric Utility
Anthracite Coal	Electric Utility

5.2.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million short tons for bituminous coal, and in thousand short tons for anthracite coal. Emission factors were expressed in metric pounds/thousand short tons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.2.2 Activity Indicator

The activity indicator for the combustion of coal at electric Utility was the anthracite coal receipts at electric Utility obtained from Reference 1a or 1b.

The activity indicator for the combustion of bituminous coal and lignite was calculated as the difference between the total national consumption of coal by electric Utility and the anthracite coal consumption at electric Utility as determined above. The total national consumption of coal was obtained from Reference 2a or Reference 3.

5.2.3 Emission Factor

The emission factors for the combustion of anthracite coal and of bituminous coal and lignite were obtained from Reference 4a.

5.2.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.2.5 References

1. *Cost and Quality of Fuels for Electric Utility Plants*. DOE/EIA-0191(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Appendix A
   b. Table entitled, "Receipts and Average Delivered Cost of Coal By Rank, Census Division, and state, 19xx."

2. *Electric Power Annual*. DOE/EOA-0348(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Volume I. Table entitled, "Consumption of Fossil Fuels and End-year Stocks of Coal and Petroleum at U.S. Utility."

3. *Quarterly Coal Report: January - March*. DOE/EIA-0121(xx/1Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Quarterly.

4. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.3 FUEL COMBUSTION ELECTRIC UTILITY - OIL: 01-02

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Residual Oil	Electric Utility
Distillate Oil	Electric Utility

5.3.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/million gallons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.3.2 Activity Indicators

The activity indicators for the combustion of residual and distillate oils were the consumption of these fuel types by electric Utility. The distillate oil consumption was assumed to be equal to the "adjusted" distillate fuel oil sales to electric Utility obtained from Reference 1a or Reference 2. The residual fuel oil consumption was obtained from "adjusted" residual fuel sales in Reference 1a. When this reference was unavailable, the residual oil consumption was calculated as the difference between the total oil consumption and the distillate oil consumption. The total annual oil consumption was obtained from Reference 3.

5.3.3 Emission Factors

The emission factors for the combustion of residual oil and of distillate oil by electric Utility were obtained from Reference 4a.

5.3.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.3.5 References

1. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Adjusted Sales of Distillate Fuel Oil By End Use in the U.S."
   b. Table entitled, "Adjusted Sales of Residual Fuel Oil By End Use in the U.S."

2. *Petroleum Marketing Annual*. DOE/EIA-0389(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

3. *Electric Power Annual*. DOE/EOA-0348(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

4. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.4 FUEL COMBUSTION INDUSTRIAL - COAL: 02-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Anthracite Coal	Industrial
Bituminous Coal and Lignite	Industrial

5.4.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicators were expressed in million short tons for bituminous coal, and in thousand short tons for anthracite coal. The emission factors were expressed in metric pounds/thousand short tons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.4.2 Activity Indicator

The activity indicator for the industrial combustion of anthracite coal was the distribution of anthracite coal from Pennsylvania (i.e. District 24) obtained from Reference 1a under the category "Industrial Plants (except coke)."

The activity indicator for the combustion of bituminous coal and lignite was based on total national coal consumption obtained from Reference 2a under the category "Industrial Plants (except coke)." The sum of coal consumption by cement plants and lime plants was subtracted from the total coal consumption. The coal consumption by cement plants was obtained from Reference 3 or Reference 4a. The coal consumption by lime plants was estimated by multiplying the lime production value obtained from Reference 5 by the conversion factor, 0.1 tons coal/ton lime produced. If Reference 4 was unavailable, the previous year's data was used.

5.4.3 Emission Factors

The emission factors for the industrial combustion of anthracite coal and of bituminous coal and lignite were obtained from Reference 6a.

5.4.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.4.5 References

1. *Coal Distribution January-December 19xx*. DOE/EIA-0125(xx/4Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Domestic Distribution of U.S. Coal by Origin, Destination, and Consumer: January-December 19xx."

2. *Quarterly Coal Report: January - March*. DOE/EIA-0121(xx/1Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Quarterly.
   a. Table entitled, "U.S. Coal Receipts By End-Use Sector"

3. *Minerals Industry Surveys*, Cement. Bureau of Mines, U.S. Geological Survey, Washington, DC. Monthly.

4. Minerals Yearbook, Cement. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual
   a. Table entitled, "Clinker Produced and Fuel Consumed by the Portland Cement Industry the U.S. by process."

5. *Chemical and Engineering News, Facts and Figures Issue*. American Chemical Society, Washington, DC. Annual.

6. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.5 FUEL COMBUSTION INDUSTRIAL - OIL: 02-02

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Residual Oil	Industrial
Distillate Oil	Industrial

5.5.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/million gallons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.5.2 Activity Indicator

The activity indicator for industrial combustion of residual oil was based on the adjusted quantity of residual oil sales for industrial and oil company use obtained from Reference 1 or 2a. The total of three statistics was subtracted from this value to obtain the activity indicator. The first statistic was two-thirds of the quantity of oil consumed by cement plants reported in Reference 3 or 4a. The second statistic was the quantity of residual oil consumed by petroleum refineries reported in Reference 5a. The third statistic was the quantity of residual oil consumed by steel mills; this value was calculated by multiplying the quantity of raw steel production obtained from Reference 6a or 7, by $0.00738 * 10^6$ gal/10^3 ton steel. The conversion factor between the gallons of oil and the tons of steel was updated in 1982 based on Reference 8.

The activity indicator for industrial combustion of distillate oil was based on the adjusted quantity of distillate oil sales to industrial and oil companies obtained from Reference 1 or 2a. The total of two statistics was subtracted from this value to obtain the activity indicator for distillate oil. The first statistic was one-third of the quantity of oil consumed by cement plants, expressed in gallons, reported in Reference 3 or 4a. The second statistic was the quantity of distillate oil consumed by petroleum refineries, expressed in gallons, reported in Reference 5a or 5b.

5.5.3 Emission Factor

The lead emission factor for the industrial combustion of residual oil and of distillate oil were obtained from Reference 9a.

5.5.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.5.5 References

1. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Adjusted Sales of Residual Fuel Oil by End-Use in the U.S."

3. *Minerals Industry Surveys*, Cement. Bureau of Mines, U.S. Department of the Interior, Washington, DC. Monthly.
   a. Table entitled, "Clinker Produced and Fuel Consumed by the Portland Cement Industry in the U.S. By Process."

4. Minerals Yearbook, Cement. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual
   a. Table entitled, "Clinker Produced and Fuel Consumed by the Portland Cement Industry in the U.S. By Process."

5. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Fuel Consumed at Refineries by PAD District."
   b. Table entitled, "Refinery Fuel Use and Losses by PAD District."

6. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.
   a. Table containing information on metals and manufactures.

7. Mineral Industry Surveys. Iron and Steel. US Geological Survey (formerly Bureau of Mines).
   a. Table entitled, "Salient Iron and Steel Statistics."

8. *Census of Manufactures (Fuels and Electric Energy Consumed)*. Bureau of the Census, U.S. Department of Commerce, Washington, DC. 1982.

9. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.6 FUEL COMBUSTION OTHER - COMMERCIAL/INSTITUTIONAL COAL: 03-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Anthracite Coal	Commercial / Institutional
Bituminous Coal and Lignite	Commercial / Institutional

5.6.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, the activity indicators were expressed in million short tons for bituminous coal, and in thousand short tons for anthracite coal. The emission factors were expressed in metric pounds/thousand short tons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.6.2 Activity Indicator

The activity indicators for the combustion of anthracite and bituminous coal and lignite were the consumption of each coal type by commercial and institutional users. Determination of these activity indicators required activity data for both anthracite and bituminous residential coal combustion.

The commercial/institutional consumption of anthracite coal was obtained by subtracting the residential anthracite consumption from residential and commercial/institutional anthracite consumption. Residential and commercial/institutional consumption of anthracite coal was obtained from Reference 1a for District 24 only. This calculation is shown in Equation 5.6-1.

$$Anthracite\ Coal_{C/I} = Anthracite\ Coal_{R\ and\ C/I} - Anthracite\ Coal_{R} \qquad \text{(Eq. 5.6-1)}$$

where: R = residential consumption
C / I = commercial/institutional consumption

Residential consumption of anthracite coal was determined by extrapolating the consumption of the previous year based on the change in the number of dwelling units in the Northeastern United States having coal as the main fuel for space heating. Data concerning the number of dwelling units were obtained from Reference 2. The calculation of the residential anthracite coal consumption is summarized in Equation 5.6-2.

$$Anthracite\ Coal_{R,\ i} = Anthracite\ Coal_{R,\ i-1} \times \frac{Dwelling\ Units_i}{Dwelling\ Units_{i-1}} \qquad \text{(Eq. 5.6-2)}$$

where: R = residential consumption
I = year under study

Commercial/institutional consumption of bituminous coal was obtained by subtracting the residential bituminous consumption from the residential and commercial/institutional bituminous consumption. Residential and commercial/institutional consumption of bituminous coal was calculated by subtracting residential and commercial/institutional consumption of anthracite coal from residential and commercial/institutional consumption of all types of coal. These two consumption values were obtained from Reference 1a and excluded coal from District 24 which represents anthracite coal consumption. This calculation is summarized in Equation 5.6-3.

$$Bituminous\ Coal_{C/I} = (All\ Coal_{R\ and\ C/I} - Anthracite\ Coal_{R\ and\ C/I}) - Bituminous\ Coal_R \qquad \text{(Eq. 5.6-3)}$$

where: R = residential consumption
C / I = commercial/institutional consumption

The residential consumption of bituminous coal was determined by estimating the quantity of all coal consumed by all dwelling units using coal as the main fuel and subtracting from this value the residential consumption of anthracite coal calculated above. The quantity of all coal consumed was calculated using the number of dwelling units using coal as the main fuel for space heating obtained from Reference 2 and a factor estimating the average annual consumption of coal per dwelling unit. This calculation is summarized in Equation 5.6-4.

$$Bituminous\ Coal_R = (Dwelling\ Units \times 6.73\ tons\ burned/dwelling/year) - Anthracite\ Coal_R \qquad \text{(Eq. 5.6-4)}$$

where: R = residential consumption

5.6.3 Emission Factors

The emission factors for the commercial/institutional combustion of anthracite coal and of bituminous coal and lignite were obtained from Reference 3a.

5.6.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.6.5 References

1. *Coal Distribution January-December 19xx*. DOE/EIA-0125(xx/4Q). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Domestic Distribution of U.S. Coal to the Residential and Commercial Sector by Origin."

2. *American Housing Survey, Current Housing Reports, Series H-150-83*. Bureau of the Census, U.S. Department of Commerce, Washington DC. Biennial.

3. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.7 FUEL COMBUSTION OTHER - COMMERCIAL/INSTITUTIONAL OIL: 03-02

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Residual Oil	Commercial / Institutional
Distillate Oil	Commercial / Institutional

5.7.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trends* spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/million gallons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.7.2 Activity Indicator

The activity indicator for the commercial/institutional combustion of residual oil was the "adjusted" total quantity of residual oil sales for commercial and military use obtained from Reference 1 or Reference 2a.

The activity indicator for the combustion of distillate oil was the "adjusted" total quantity of distillate oil sales for commercial and military use (not including military diesel fuel) obtained from Reference 1, or commercial and military use obtained from Reference 2b minus military diesel fuel use obtained from Reference 2c.

5.7.3 Emission Factor

The emission factors for the commercial/institutional combustion of residual oil and of distillate oil were obtained from Reference 3a.

5.7.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.7.5 References

1. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

2. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Adjusted Sales of Residual Fuel Oil by End Use in the US."
   b. Table entitled, "Adjusted Sales of Distillate Fuel Oil by End Use in the US."
   c. Table entitled, "Adjusted Sales for Military, Non-road engines and vehicles, and All Other Uses: Distillate Fuel Oil, Residual Fuel Oil and Kerosene."

3. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.8 FUEL COMBUSTION OTHER - MISCELLANEOUS FUEL COMBUSTION (EXCEPT RESIDENTIAL): 03-04

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Residual Oil	Waste Oil

5.8.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, the activity indicator was expressed in million gallons and the emission factor was expressed in metric pounds/million gallons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1996.

5.8.2 Activity Indicator

The activity indicator for the combustion of residual waste oil was assumed to be a constant annual consumption of 500 x 10^6 gallons of waste oil.

5.8.3 Emission Factor

The emission factor for the combustion of residual waste oil was calculated as 75 lb/1,000 gal multiplied by the average percentage of lead. It was assumed that the percentage of lead had a constant value of 0.5333 up to the year 1975; after which, it was assumed that the lead percentage steadily decreased. After 1984, the value has remained constant at 0.0213. The average lead percentage values are presented in Table 5.8-1.

5.8.4 Control Efficiency

No control efficiency was applied to activity data to estimate lead emissions from the combustion of waste oil.

5.8.5 References

None.

Table 5.8-1. Annual Percentage Lead Content

Year	Percent Lead
1975	0.5333
1976	0.4702
1977	0.407
1978	0.3439
1979	0.2807
1980	0.2176
1981	0.1545
1982	0.0913
1983	0.0282
1984	0.0213

5.9 FUEL COMBUSTION OTHER - RESIDENTIAL OTHER: 03-06

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Anthracite Coal	Residential
Bituminous Coal and Lignite	Residential
Residual Oil	Residential
Distillate Oil	Residential

5.9.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, the activity indicators were expressed in million tons for bituminous coal and in thousand tons for anthracite coal. The emission factors for these categories were expressed in metric pounds/thousand tons. Activity indicators for residual and distillate oils were expressed in million gallons and emission factors were expressed in metric pounds/million gallons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.9.2 Activity Indicator

The activity indicator for the residential combustion of anthracite coal was the residential consumption of anthracite coal. This value was determined by extrapolating the residential consumption of anthracite coal during the previous year based on the change in the number of dwelling units in the Northeastern United States having coal as the main fuel for space heating. Data concerning the number of dwelling units were obtained from Reference 1. The calculation of the residential anthracite coal consumption is summarized in Equation 5.9-1.

$$Anthracite\ Coal_{R,\ i} = Anthracite\ Coal_{R,\ i-1} \times \frac{Dwelling\ Units_{i}}{Dwelling\ Units_{i-1}} \qquad \text{(Eq. 5.9-1)}$$

where: R = residential consumption
I = year under study

The activity indicator for the combustion of bituminous coal and lignite was the residential consumption of bituminous coal and lignite. This value was determined by estimating the quantity of all coal consumed by all dwelling units using coal as the main fuel and subtracting from this value the residential consumption of anthracite coal calculated above. The quantity of all coal consumed was calculated using the number of dwelling units using coal as the main fuel for space heating obtained from Reference 1 and a factor estimating the average annual consumption of coal per dwelling unit. This calculation is summarized in Equation 5.9-2.

$$Bituminous\ Coal_R = (Dwelling\ Units \times 6.73\ tons\ burned/dwelling/year) - Anthracite\ Coal_R \quad \text{(Eq. 5.9-2)}$$

where: R = residential consumption

The activity indicator for the residential combustion of residual oil was assumed to be zero. The activity indicator for the combustion of distillate oil was the sum of the "adjusted" sales (or deliveries) for residential use of distillate oil and for farm use of other distillates as reported in Reference 2 or Reference 3a and 3b.

5.9.3 Emission Factors

The emission factor for the residential combustion of anthracite coal was obtained from Reference 4.

The emission factor for the combustion of bituminous coal and lignite and for distillate oil was obtained from Reference 5a.

No emission factor was required for the combustion of residual oil because the activity was assumed to be zero.

5.9.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from the sources included in this Tier II category.

5.9.5 References

1. *American Housing Survey, Current Housing Reports, Series H-150-83*. Bureau of the Census, U.S. Department of Commerce, Washington DC. Biennial.

2. *Petroleum Marketing Monthly*. DOE/EIA-0380(xx/01). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.

3. *Fuel Oil and Kerosene Sales 19xx*. DOE/EIA-0535(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Adjusted Sales of Distillate Fuel Oil by End Use in the U.S."
   b. Table entitled, "Adjusted Sales for Gram Use: Distillate Fuel Oil and Kerosene; Sales for Electric Utility and Oil Company Uses; Distillate Fuel Oil and Residual Fuel Oil."

4. *Development of HATREMS Data Base and Emission Inventory Evaluation*. EPA-450/3-77-011. U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1977.

5. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.10 CHEMICAL AND ALLIED PRODUCT MANUFACTURE - INORGANIC CHEMICAL MANUFACTURE: 04-02

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Secondary Metals (lead oxide/pigment)

5.10.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in thousand tons and emission factors were expressed in metric pounds/tons.

The following procedures for determining activity indicators and emission factors were used for the years 1970 through 1995.

5.10.2 Activity Indicator

Activity indicators for the of barton pot (litharge and leady oxide), red lead, and white lead were the respective quantities of each produced (using the lead content) as reported in Reference 1. If the litharge and red lead are reported together, the last known distribution was used to distribute the activity. If the value for white lead was withheld, the previous year's data was used.

5.10.3 Emission Factor

The lead emission factors for barton pot, red lead, and white lead were obtained from Reference 2a.

5.10.4 Control Efficiency

No control efficiencies were applied to activity data to estimate lead emissions from the sources included in this Tier II category.

5.10.5 References

1. *Minerals Yearbook*, Lead. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Production & Shipments of Lead Pigments and Oxides in the U.S."

2. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Table 7.16-1

5.11 METALS PROCESSING - NONFERROUS: 05-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Nonferrous Metals (copper, zinc, and lead production)
	Secondary Metals (lead, copper, and battery production)
	Miscellaneous Process Sources [miscellaneous products (can soldering and cable covering)]

5.11.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emissions factor, and control efficiency, where applicable. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in thousand tons and emission factors were expressed in metric pounds/tons. All control efficiencies were expressed as dimensionless fractions.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.11.2 Activity Indicator

5.11.2.1 Nonferrous Metals

The activity indicator for copper roasting was based on the primary copper smelter production from domestic and foreign ores from Reference 1a. Copper smelter production was expressed in units of blister copper produced. It was assumed that of the 4 tons of copper concentrate/ton of blister, only half was roasted. Therefore, the amount of blister copper produced multiplied by 2 resulted in the activity indicator for the roasting process.

Activity indicators for copper smelting and converting were assumed to be equivalent. Activity data were calculated in the same manner as for the roasting process, except it was assumed that all of the blister copper produced was smelted and converted. Therefore, units of blister copper produced multiplied by 4 resulted in the activity indicators for the smelting and converting process.

Activity data for zinc sintering was based on the redistilled slab zinc production obtained from Reference 2a. The activity indicator for the horizontal retort process was assumed to be zero. The activity indicator for the vertical retort process was assigned the same value as used for zinc sintering.

The activity indicators for lead sintering, blast furnaces, and reverberatory furnaces were assumed to be equal to the primary refined lead production from domestic and foreign ores as listed in Reference 3.

5.11.2.2 Secondary Metals

Activity data for three copper-producing processes were obtained from Reference 1b. The production level of high-leaded tin bronze was used as the basis for high Lead (58%) activity. The production level of yellow brass was used as the basis for red-yellow brass (15%) activity. Other alloys (7%) activity was based on the production level of leaded red brass and semi-red brass.

Activity indicators for three lead-producing furnace types and fugitive lead processes were obtained from Reference 3 or 4a. The pot furnace activity was estimated as 90 percent of the total consumption of lead scrap by all consumers obtained from Reference 4a. The activity indicator for reverberatory furnaces was estimated by multiplying the total consumption of lead scrap by the ratio between the quantity of lead recovered as soft lead (obtained from Reference 3b) and the total lead recovered from scrap. The activity indicator for blast furnaces was estimated by multiplying the total consumption of lead scrap by the ratio between lead recovered as antimonial lead and the total lead recovered from scrap. Fugitive lead activity was assumed to be equal to the total quantity of lead recovered.

Battery production consists of five processes: (1) grid casting, (2) paste mixing, (3) lead oxide mill, (4) three process operations, and (5) lead reclamation furnace. The number of batteries produced was used as the activity indicator for each process. The total weight of lead used to produce storage batteries was obtained from Reference 3c. This value was converted from metric tons to English units and was used to calculate the number of batteries produced, expressed in thousands of batteries, as shown in Equation 5.11-1.

$$Number\ of\ Batteries = \frac{Weight_{Pb} \times 1.10231 \times 2{,}000\ lb/ton}{1{,}000 \times 26\ lb/battery} \qquad \text{(Eq. 5.11-1)}$$

The activity indicator for lead reclamation furnaces was 1 percent of the number of batteries produced as calculated above.

5.11.2.3 Miscellaneous Process Sources

The activity indicator for can soldering was the can soldering consumption as listed in Reference 3c. If this activity indicator was not available, the previous year's value was used. The activity indicator for cable covering was based on the value for cable covering consumption, also obtained from Reference 3c, which was multiplied by 10 to account for recycling.

5.11.3 Emission Factor

5.11.3.1 Nonferrous Metals

The emission factors for primary copper and lead smelting processes were obtained from References 5a and 5b, respectively. The emission factors for processes associated with primary zinc smelting were obtained from Reference 6a. Values for these emission factors were established as the midpoint of the emission factor ranges reported in the references cited.

5.11.3.2 Secondary Metals

The emission factors for secondary lead processing were obtained from Reference 6a. The emission factors for secondary copper processing were obtained from Reference 5c. Battery production emission factors were reported in Reference 5d.

5.11.3.3 Miscellaneous Process Sources

The emission factors for can soldering and can covering were obtained from Reference 5e.

5.11.4 Control Efficiency

5.11.4.1 Nonferrous Metals

The control efficiencies for all copper, zinc, and lead production processes for the years 1970 through 1984 were equivalent to the TSP control efficiencies for the same processes. The TSP control efficiencies were derived from Reference 7 or Reference 8 using Equation 5.11-2. Values for the control efficiency were assumed constant after the year 1984.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \qquad \text{(Eq. 5.11-2)}$$

where:
- CE = control efficiency
- UE = emissions before control
- AE = emissions after control

5.11.4.2 Secondary Metals

The control efficiencies for the secondary lead production processes were obtained from Reference 9.

5.11.4.3 Miscellaneous Process Sources

The control efficiencies for can soldering and cable covering were obtained from Reference 9.

5.11.5 References

1. *Minerals Yearbook*, Copper. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Copper: World Smelter Production, by Country."
   b. Table entitled, "Production of Secondary Copper & Copper Alloy Products in the U.S. by Item Produced From Scrap."

2. *Minerals Yearbook*, Zinc. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Salient Zinc Statistics" (production of slab zinc from scrap).

3. *Minerals Yearbook*, Lead. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Salient Lead Statistics."
   b. Table entitled, "Pb Recovered from Scrap Processed in the U.S., by Kind of Scrap and Form of Recovery."
   c. Table entitled, "U.S. Consumption of Lead, by Product."

4. *Minerals Yearbook*, Recycling of Nonferrous Materials. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Stocks and Consumption of New and Old Lead Scrap in the U.S. by Type of Scrap."

5. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Table 7.3-10
   b. Table 7.6-1
   c. Table 7.9-1
   d. Table 7.15-1
   e. Table 7.17-1

6. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

7. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

8. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

9. *Control Techniques for Lead Air Emissions, Volumes 1 and 2*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

5.12 METALS PROCESSING - FERROUS: 05-02

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Iron and Steel Industry (coke, blast furnace, sintering, open hearth, BOF (Basic Oxygen Furnace), and electric arc furnace)
	Nonferrous Metals (ferroalloy production)
	Secondary Metals Industry (grey iron foundries)

5.12.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emissions factor, and control efficiency, where applicable. In order to utilize these values in the *Trend*s spreadsheets, activity indicators for all source categories, except those in the iron and steel industry, were expressed in thousand tons. For the iron and steel industry source categories, activity indicators were expressed in million tons. All emission factors were expressed in metric pounds/tons. All control efficiencies were expressed as dimensionless fractions.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.12.2 Activity Indicator

5.12.2.1 Iron and Steel

The activity indicator for coke production was the oven production figure obtained from Reference 1a. The activity for coke production was assumed to be zero for all years including and following 1994. The activity indicator for blast furnaces was the total pig iron production as reported in Reference 1b, Reference 2a, or Reference 3. This value included exports. The activity indicator for the windbox sintering process was the total production of pig iron, divided by 3 (two other processes [discharge, sinter-fugitive] to not contribute to Pb emissions).

The activity indicators for open hearth, basic oxygen, and electric arc furnaces were based on the total scrap and pig iron consumption. Reference 4 contained the total scrap and pig iron consumed by each furnace type by manufacturers of pig iron and raw steel and castings. The fraction of the combined quantity of scrap and pig iron consumed by each of the three furnace types was calculated. Total raw steel production reported in Reference 1b or Reference 2a was multiplied by each fraction to obtain the raw steel production for each furnace type.

5.12.2.2 Nonferrous Metals

The activity indicator for ferrosilicon production was the net gross weight production obtained from Reference 5a or 6a. Silicon manganese activity was assumed to be 42.1 percent of the net production of ferrosilicon. Production of ferromanganese by electric furnaces was assumed to be 57.9 percent of the net production of ferrosilicon. Production of silicon metal was obtained from Reference 6a. For ferromanganese from blast furnaces and for Ferro-Mang (std), the activity indicators were assumed to be zero.

Ferrochrome-silicon activity was obtained from Reference 5a or 7, and activity data for High Carbon Ferro production was obtained from Reference 5a or 8. If these data were not available, values for the previous year were used.

5.12.2.3 Secondary Metals

The activity indicator for cupola furnaces in grey iron foundries was based on the combined quantity of scrap and pig iron consumed by cupola furnaces. This value was obtained from Reference 4a under the category of iron foundries and miscellaneous users. The final activity was determined by adjusting this production value to account for this category's respective emission factor, which was expressed in terms of the charged quantity, and not the fresh feed quantity. This adjustment required dividing the production value by 0.78.

The activity indicator for electric induction was based on the combined quantity of iron and steel scrap and pig iron consumed in electric furnaces. This value was obtained from Reference 4a under the category of iron foundries and miscellaneous users. The amount consumed was adjusted to account for recycling by dividing the consumption value by 0.78.

5.12.3 Emission Factor

5.12.3.1 Iron and Steel

The emission factors for all processes were obtained from Reference 9a. The emission factor used for by-product coke was the same as that established for metallurgical coke manufacturing.

5.12.3.2 Nonferrous Metals

The emission factors for all processes were set equal to the midpoint of the emission factor ranges reported in Reference 10a.

5.12.3.3 Secondary Metals - Grey Iron Foundries

The emission factors for all processes were reported in Reference 10b.

5.12.4 Control Efficiency

The control efficiencies for all processes included in this Tier II category for the years 1970 through 1984 were equivalent to the TSP control efficiencies for the same processes. The TSP control efficiencies were derived from Reference 11 or Reference 12 using Equation 5.12-1. Values after the year 1984 were assumed constant.

$$CE = \left[\frac{(UE - AE)}{UE}\right] \qquad \text{(Eq. 5.12-1)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

5.12.5 References

1. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.
   a. Table containing information on "Petroleum, Coal, and Products." SCC = 3-03-003
   b. Table containing information on "Metals and Manufactures."

2. Minerals Yearbook, Iron and Steel. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Salient Iron and Steel Statistics."
   b. Table entitled, "U.S. Consumption of Iron and Steel Scrap, Pig Iron, and Direct-Reduced Iron (DRI) in 19xx, by Type of Furnace and Other Use."

3. *Minerals Industry Surveys*, Iron Ores. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Monthly.

4. *Minerals Industry Surveys*, Iron and Steel Scrap. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Monthly.
   a. Table on consumption of iron and steel scrap and pig iron in the United States by type of furnace or other use.

5. *Minerals Yearbook*, Ferroalloys. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Table 2. Ferroalloys Produced and Shipped from Furnaces in the U.S."

6. *Minerals Yearbook*, Silicon. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. "Table 1. Production, Shipments, and Stocks of Silvery Pig Iron, Ferrosilicon, and Silicon Metal in the U.S. in 19xx"

7. *Minerals Yearbook*, Chromium. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.

8. *Minerals Yearbook*, Iron and Steel. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.

9. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

10. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
    a. Table 7.4-5
    b. Table 7.10-3

11. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

12. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

5.13 METALS PROCESSING - NOT ELSEWHERE CLASSIFIED: 05-03

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Mineral Products (ore crushing)
	Miscellaneous Process Sources [miscellaneous products (type metal production)]

5.13.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emissions factor, and control efficiency, where applicable. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in thousand tons and emission factors were expressed in metric pounds/tons. All control efficiencies were expressed as dimensionless fractions.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.13.2 Activity Indicator

The activity indicator for lead ore production was the gross weight of lead ore produced on a dry weight basis as reported in Reference 1a or 1b. If this value is not reported on a dry weight basis, the dry weight is estimated from the Pb ore production, in terms of recoverable Pb content, divided by 0.0799. The activity indicator for Zn, Cu, Cu-Zn ores was estimated as the sum of the "ore produced" listed in Reference 2a, and "all other sources" listed in Reference 1a. The activity data for Pb-Zn, Cu-Pb, Cu-Pb-Zn ores was assumed to be zero. If Reference 1a is not available, Zn, Cu, Cu-Zn ores are estimated using the following equation:

$$1.4291(x) - 49736.557 \qquad \text{(Eq. 5.13-1)}$$

where: x = value for copper ore produced, in short tons.

The activity indicator for type metal production was based on the consumption of lead for type metal production obtained from Reference 1. In accordance with procedures provided in Reference 3, this value was multiplied by 330 to account for recycling. If the value is withheld, use the most recent available year.

5.13.3 Emission Factor

The emission factors for ore crushing and grinding processes were obtained from Reference 4a. The emission factors for type metal production were obtained from Reference 4b.

5.13.4 Control Efficiency

The control efficiencies for ore crushing and grinding processes and type metal production were obtained from Reference 3. No control efficiencies were applied to the activity data to estimate emissions from type metal production.

5.13.5 References

1. *Minerals Yearbook*, Lead. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Production of Lead and Zinc in Terms of Recoverable Metals, in U.S. in 19xx, by State."
   b. Table Entitled, "Salient Lead Statistics."

2. *Minerals Yearbook*, Copper. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
   a. Table entitled, "Salient Copper Statistics."

3. *Control Techniques for Lead Air Emissions, Volumes 1 and 2*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

4. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Table 7.6-1
   b. Table 7.17-1

5.14 OTHER INDUSTRIAL PROCESSES - MINERAL PRODUCTS: 07-05

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Mineral Products [Cement Manufacturing (wet kiln/cooler, wet dryer/grinder, dry kiln/cooler and dry dryer/grinder) and Glass Production (lead-glass)]

5.14.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emissions factor, and control efficiency, where applicable. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in thousand tons and emission factors were expressed in metric pounds/tons. All control efficiencies were expressed as dimensionless fractions.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.14.2 Activity Indicator

The activity indicators for wet kiln/cooler and wet dryer/grinder used in cement manufacturing were assumed to be equal. The value used was the sum of two categories: “wet” clinker produced and “both” clinker produced, reported in Reference 1a or Reference 2a. The activity indicators for dry kiln/cooler and dry dryer/grinder were both estimated to be the sum of “dry” clinker produced and “both” clinker produced, as reported in Reference 1a. The activity indicator for lead-glass production was assumed to be zero.

5.14.3 Emission Factor

The emission factors for cement manufacturing processes were obtained from Reference 3a. The emission factor for glass production was obtained from Reference 3b.

5.14.4 Control Efficiency

The control efficiencies for the wet and dry kiln/cooler used in cement manufacturing for the years 1970 through 1984 were equivalent to the TSP control efficiencies for kilns. The control efficiencies for the wet and dry dryer/grinders for the years 1970 through 1984 were equivalent to the TSP control efficiencies for grinders. These TSP control efficiencies were derived from Reference 4 or Reference 5 using Equation 5.14-1. All control efficiencies for the years following 1984 were assumed constant.

$$CE = \left[\frac{(UE - AE)}{UE} \right] \quad \text{(Eq. 5.14-1)}$$

where: CE = control efficiency
UE = emissions before control
AE = emissions after control

No control efficiencies were applied to activity data to estimate emissions from lead-glass production.

5.14.5 References

1. *Minerals Industry Surveys*, Cement. US Geological Survey (formerly Bureau of Mines), Washington, DC. Monthly.
   a. Table entitled, "Clinker Produced and Fuel Consumed by the Portland Cement Industry."

2. Minerals Yearbook, Cement. US Geological Survey (formerly Bureau of Mines), Washington, DC. Annual
   a. Table entitled, "Clinker Produced and Fuel Consumed by the Portland Cement Industry in the U.S. by process."

3. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Table 8.6-1
   b. Table 8.13-1

4. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

5. *Standard Computer Retrievals, NE257 report, from the National Emissions Data System (NEDS)*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

5.15 OTHER INDUSTRIAL PROCESSES - MISCELLANEOUS INDUSTRIAL PRODUCTS: 07-10

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Industrial Processes - Lead Emissions	Miscellaneous Process Sources [Lead Alkyl Production (electrolytic process), Sodium Lead Alloy (recovery furnace, TEL process vents, TML process vents, and sludge pits), and Miscellaneous Products (ammunition)]

5.15.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator, emissions factor, and control efficiency, where applicable. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in thousand tons and emission factors were expressed in metric pounds/tons. All control efficiencies were expressed as dimensionless fractions.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.15.2 Activity Indicator

The activity indicator for lead alkyl production by the electrolytic process was based on the quantity of lead consumed in anti-knock manufacturing obtained from Reference 1a. This quantity of lead was converted to a quantity of additive by multiplying by 1.76. The activity indicator for this category was assumed to be 10 percent of the quantity of additive consumed based on Reference 2. As of 1992, it was assumed that there were no producers of lead alkyl products in the United States. All emissions after 1992 for this category are zero.

The activity indicator for sodium lead alloy production processes was based on the remaining 90 percent of the quantity of additive consumed as determined above for lead alkyl production. The activity for recovery furnaces and sludge pits was assumed to be equal to the remaining quantity of additive. The activity of TEL (TetraEthyl Lead) process vents and TML (TetraMethyl Lead) process vents was 63 percent and 37 percent, respectively, of the remaining quantity of additive. These apportionments were based on Reference 2. As of 1992, it was assumed that there were no producers of sodium lead alloy products in the US. All emissions after 1992 for this category are zero.

The activity indicator for ammunition production was the sum of lead consumption for the following uses: (1) caulking lead (building construction), (2) total pipes, traps, and other extruded products, (3) total sheet lead, and (4) other metal products. The consumption information was obtained from Reference 1.

5.15.3 Emission Factor

The emission factors for lead alkyl and sodium lead alloy production processes were obtained from Reference 3a. The emission factors for ammunition production were obtained from Reference 3b.

5.15.4 Control Efficiency

The control efficiencies for ammunition production were obtained from Reference 2. No control efficiencies were applied to estimate emissions from the other sources included in this Tier II category.

5.15.5 References

1. *Minerals Yearbook*, Lead. U.S. Geological Survey (formerly Bureau of Mines), Washington, DC. Annual.
    a. Table entitled, “U.S. Consumption of Lead, by Product.”

2. *Control Techniques for Lead Air Emissions, Volumes 1 and 2*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

3. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
    a. Table 5.22-1
    b. Table 7.17-1

5.16 WASTE DISPOSAL AND RECYCLING : 10-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Solid Waste Disposal	Incineration (Municipal, Residential, Commercial/Institutional, and Conical Woodwaste)

5.16.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in million tons and emission factors were expressed in metric pounds/thousand tons.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.16.2 Activity Indicator

The activity indicator for municipal incineration was the sum of the operating rates for the SCCs 5-01-001-01 and 5-01-001-02 obtained from Reference 1 or 2. The activity for 1995 was calculated by multiplying the 1990 activity by the ratio of 1995 combustion to 1990 combustion from Reference 3.

The activity indicator for residential incineration was the operating rate for residential on-site incineration obtained from Reference 4. The activity for 1995 and 1996 was calculated by multiplying the 1994 activity obtained from reference 4 by the ratio of 1994 activity to 1995 or 1996 activity obtained from Reference 5.

Commercial/industrial incineration was based on the sum of the operating rates provided in Reference 1 or 2 for the following SCCs: 5-02-001-01, 5-02-001-02, 5-03-001-01, and 5-03-001-02. The previous year's activity data reported in the *Trends* spreadsheet was scaled based on the ratio of the total operating rate for the current year to the total for the previous year. This calculation is shown in Equation 5.16-1.

$$A_i = A_{i-1} \times \left(\frac{\sum_{SCCs} OR_i}{\sum_{SCCs} OR_{i-1}} \right) \qquad \text{(Eq. 5.16-1)}$$

where: A = activity indicator
I = year
OR = operating rates for SCCs 5-02-001-01, 5-02-001-02, 5-03-001-01, and 5-03-001-02

The activity for commercial/industrial incineration for the years 1995 and 1996 was calculated by multiplying the 1994 activity obtained from Reference 1 by the ratio of 1994 emissions to 1995 or 1996 emissions obtained from Reference 5.

The activity indicator for conical woodwaste incineration was the sum of the operating rates for the SCCs 5-02-001-05 and 5-03-001-05 obtained from Reference 1 or 2.

5.16.3 Emission Factor

The emission factors for municipal, residential, and commercial/institutional incineration were obtained from Reference 6a or Reference 7a.

The emission factor for conical woodwaste incineration (SCC 5-02-001-05) was assumed to be zero.

5.16.4 Control Efficiency

The control efficiency associated with municipal incineration was obtained from Reference 1 or 2 for SCC 5-01-001.

No control efficiencies were applied to the activity data to estimate emissions from the remaining types of incineration (i.e., residential, commercial/institutional, and conical woodwaste).

5.16.5 References

1. *Standard Computer Retrievals, AFP650 report, from the AIRS Facility Subsystem*. Unpublished computer reports. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Annual.

2. *Computer Retrieval, NE257 report, by Source Classification Code (SCC) from the National Emission Data System (NEDS)*. Unpublished computer report. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. February 9, 1980.

3. *Characterization of Municipal Solid Waste in the United States. (1996 Update)* Municipal and Industrial Solid Waste Division, U.S. Environmental Protection Agency, Washington, DC. June 1997.

4. *Computer Retrieval, NE260 report, by Source Classification Code (SCC) from the National Emission Data System (NEDS)*. Unpublished computer report. National Air Data Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. February 9, 1980.

5. *National Emission Trends Report.* Draft Report. Prepared by E.H. Pechan and Associates, Inc. under contract No. 68-D3-0035, work assignment III-102 for Emission Factor and Inventory Group, U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1997.

6. *Compilation of Air Pollutant Emission Factors, Fourth Edition, Supplements A through D, AP-42*. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1991.
   a. Table 2.1-1.

7. *Compilation of Air Pollutant Emission Factors, Third Edition, Supplements 1 through 14, AP-42*. NTIS PB-275525. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1977.
   a. Appendix E

5.17 ON-ROAD VEHICLES: 11

The emissions for all Tier II categories under this Tier I category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
On-road vehicles	Gasoline (leaded, unleaded)

5.17.1 Technical Approach

The lead emissions included in these Tier II categories were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/gallons. The total lead emissions for the Tier I category were allocated to the Tier II categories by the relative fraction of vehicle miles traveled (VMT) for the appropriate vehicle types.

The following procedures for determining activity indicators, emission factors, and allocation to the Tier II categories were used for the years 1970 through 1996.

5.17.2 Activity Indicator

The activity indicator for On-road vehicles was the gasoline consumption by all On-road vehicles as reported in Reference 1a. If this consumption value was not available, the previous year's consumption was adjusted based on the vehicle miles traveled (VMT) obtained from Reference 2a using Equation 5.17-1:

$$GC_i = GC_{i-1} \times \frac{VMT_i}{VMT_{i-1}} \qquad \text{(Eq. 5.17-1)}$$

where:

where:	GC	=	total gasoline consumption by all On-road vehicles
	I	=	year of interest
	VMT	=	vehicle miles traveled

The percentage of total unleaded gasoline was obtained from Reference 3a, and this value was applied to the total consumption of gasoline, resulting in unleaded gasoline use. This procedure was repeated to obtain leaded gasoline activity.

5.17.3 Emission Factor

The lead emission factors for On-road vehicles were reported in Reference 4 to be 1.5(Y) lb/ton, where Y is the number of grams of lead/gasoline. Y values are shown in Table 5.17-1. The values for Y were obtained from Reference 5.

5.17.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from On-road vehicles.

5.17.5 Allocation of Emissions to the Tier II Categories

The total lead emissions were the sum of the emissions from leaded gasoline and from unleaded gasoline. Lead emissions from these two types of gasolines were calculated by multiplying the activity indicator by the emission factor. In order to allocate the total lead emissions to the Tier II categories, the relative fraction of the VMT for each of the three vehicle classifications was determined. The VMT data for this purpose were obtained from a variety of sources. Relative VMT fractions used for the years 1940 through 1993 for each of the vehicle classifications are given in Table 5.17-2.

5.17.6 References

1. *On-road vehicles Statistics*. Federal On-road vehicles Administration, U.S. Department of Transportation, Washington, DC. Annual.
    a. Table MF-21, "Motor Fuel Use"

2. Welty, K. On-road vehicles Information Management, Federal On-road vehicles Administration, US Department of Transportation, personal communications with E.H. Pechan and Associates, Inc., Durham, NC, 1997. (Information received on floppy diskette.)

3. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
    a. Table entitled, "Finished Motor Gasoline Supply and Disposition."

4. *Control Techniques for Lead Air Emissions, Volumes 1 and 2*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

5. *Motor Gasolines*. National Institute for Petroleum and Energy Research, IIT Research Institute, Barltesville, OK. Summer 1987 and Summer 1990.

Table 5.17-1. Number of Grams of Lead/Gasoline (Y)

Year	Leaded Gasoline	Unleaded Gasoline
1970	2.43	NA
1971	2.59	NA
1972	2.63	NA
1973	2.2	0.014
1974	2.07	0.014
1975	1.82	0.014
1976	2.02	0.014
1977	2.03	0.014
1978	1.76	0.01
1979	1.76	0.016
1980	1.33	0.028
1981	1.01	0.009
1982	1.02	0.005
1983	0.83	0.003
1984	0.84	0.006
1985	0.59	0.002
1986	0.37	0.002
1987	0.15	0.001
1988	0.15	0.001
1989	0.08	0.002
1990	0.08	0.0004
1991	0.0002	0.0002
1992	0.0002	0.0002
1993	0.0002	0.0002
1994	0.0002	0.0002
1995	0.0002	0.0002
1996	0.0002	0.0002

Table 5.17-2. Relative VMT Fractions for Each Tier II Category

Year	Light-Duty Gas Vehicles and Motorcycles	Light-Duty Gas Trucks	Heavy-Duty Gas Trucks
1970	0.83	0.13	0.04
1971	0.83	0.13	0.03
1972	0.82	0.14	0.03
1973	0.82	0.14	0.03
1974	0.82	0.15	0.03
1975	0.82	0.15	0.03
1976	0.81	0.16	0.03
1977	0.80	0.17	0.03
1978	0.80	0.17	0.03
1979	0.79	0.18	0.03
1980	0.78	0.19	0.03
1981	0.76	0.21	0.03
1982	0.79	0.19	0.02
1983	0.78	0.20	0.02
1984	0.77	0.21	0.02
1985	0.76	0.22	0.02
1986	0.75	0.23	0.02
1987	0.74	0.24	0.02
1988	0.75	0.24	0.02
1989	0.75	0.24	0.02
1990	0.75	0.24	0.02
1991	0.75	0.24	0.01
1992	0.75	0.24	0.01
1993	0.75	0.24	0.01
1994	0.75	0.24	0.01
1995	0.75	0.24	0.01
1996	0.75	0.24	0.01

5.18 NON-ROAD ENGINES AND VEHICLES - NONROAD GASOLINE: 12-01

The emissions for this Tier II category were determined by the Lead Emissions Methodology for the following source categories (see table 5.1-1 for Tier correspondence):

Category:	**Subcategory:**
Other Non-road engines and vehicles	Gasoline (Farm Tractors, Other Farm Equipment, construction, Snowmobiles, Small Utility Engines, Heavy Duty General Utility Engines, Motorcycles)
Vessels	Gasoline
Aircraft	Aviation Gasoline

5.18.1 Technical Approach

The lead emissions included in this Tier category were the sum of the emissions from the source categories listed above. Emissions were estimated from an activity indicator and an emissions factor. In order to utilize these values in the *Trend*s spreadsheets, activity indicators were expressed in million gallons and emission factors were expressed in metric pounds/thousand gallons.

The following procedures for determining activity indicators, emission factors, and applicable control efficiencies were used for the years 1970 through 1995.

5.18.2 Activity Indicator

The activity indicator for gasoline-powered farm tractors was based on the 1973 gasoline consumption by farm tractors reported in Reference 1. The adjustment factor applied to the 1973 data was the ratio of the quantity of gasoline consumed by all agricultural equipment in 1973 and in the year under study as reported in Reference 2a. It is assumed that this procedure was used for the years both before 1973 and after 1973. Equation 5.18-1 summarizes this procedure.

$$GC_{Tractor,\ i} = GC_{Tractor,\ 1973} \times \frac{GC_{Agriculture,\ i}}{GC_{Agriculture,\ 1973}} \qquad \text{(Eq. 5.18-1)}$$

where: GC = gasoline consumption
I = year under study

The activity indicator for other gasoline-powered farm equipment was also based on gasoline consumption. It was assumed that the gasoline consumption by other farm equipment was equivalent to 8.52 percent of the quantity of gasoline consumed by farm tractors as determined by the preceding procedure. Activity for other farm equipment is considered zero for the year 1991 and all subsequent years.

The activity indicator for gasoline-powered construction equipment was the total gasoline consumption by construction equipment as reported in Reference 2.

Activity data for snowmobiles were based on the 1973 gasoline consumption by snowmobiles, as reported in Reference 1. An adjustment factor was applied to the 1973 value to account for the ratio of the number of snowmobile registrations in 1973 and in the year under study as reported in Reference 3. It is assumed that this procedure was used for the years both before 1973 and after 1973. Equation 5.18-2 summarizes this procedure.

$$GC_{Snowmobiles,\ i} = GC_{Snowmobiles,\ 1973} \times \frac{N_{Snowmobiles,\ i}}{N_{Snowmobiles,\ 1973}} \qquad \text{(Eq. 5.18-2)}$$

where: GC = gasoline consumption
I = year under study
N = number of registered vehicles

Activity data for small utility gasoline engines was based on the 1980 value for gasoline consumption by small engines (533 x 10^6 gallons). An adjustment factor was applied to the 1980 data to account for the ratio of the number of single unit dwellings in 1980 and in the year under study. The number of single unit dwellings in 1980 was obtained from Reference 4. For the year under study, the number of single unit dwellings was estimated by adding or subtracting the number of new one-family structures started each year between 1980 and the year under study to the number of single unit dwellings in 1980. The number of new one-family structures started was obtained from Reference 5 for each year. It is assumed that this procedure was used for the years both before 1973 and after 1973. Equation 5.18-3 summarizes this procedure.

$$GC_{SmallEngines,\ i} = (533 \times 10^6\ gal) \times \frac{Single\ Unit\ Dwellings_i}{Single\ Unit\ Dwellings_{1980}} \qquad \text{(Eq. 5.18-3)}$$

where: GC = gasoline consumption
I = year under study

The activity indicator for heavy duty general gasoline utility engines was the total gasoline consumed by the industrial/commercial category obtained from Reference 2.

The activity indicator for motorcycles was calculated from the number of motorcycles, the average annual Non-road engines and vehicles mileage traveled, and the median estimated average miles per gallon. The motorcycle population and the Non-road engines and vehicles mileage were obtained from Reference 6. The average miles per gallon (MPG) was assumed to be 44.0 miles/gallon. Activity for motorcycles was considered zero for the year 1995 and all subsequent years because no leaded gasoline was consumed by motorcycles after this year. Equation 5.18-4 summarizes this calculation.

$$GC_{Motorcycles} = N_{Motorcycles} \times \frac{M_{Motorcyles,\ Off-highway}}{MPG} \qquad \text{(Eq. 5.18-4)}$$

where: GC = gasoline consumption
N = number of motorcycles
M = mileage
MPG = miles/gallon

The activity indicator for aircraft was the total national quantity of aviation gasoline supplied as reported in Reference 7a, Reference 8a, or Reference 9a. Reference 7a was used for the years 1970 through 1978. Reference 8a was used for the years 1979 and 1980. Reference 9a was used for the years 1981 through 1995.

5.18.3 Emission Factor

The lead emission factor for the combustion of gasoline in Non-road engines and vehicles was reported in Reference 10 to be 1.5(Y) lb/ton, where Y is the number of grams of lead/gasoline. It was assumed that all gasoline used for these engines was leaded. The value of Y was obtained from Reference 11 for the years 1970 to 1988 and Reference 12 for the years 1989 to 1996.

The lead emission factor for aircraft was reported in Reference 13 to be the lead content of aviation gasoline multiplied by the percent of lead emitted. Therefore, the emission factor is 2g/gal times 0.75.

5.18.4 Control Efficiency

No control efficiencies were applied to activity data to estimate emissions from Non-road engines and vehicles.

5.18.5 References

1. *Exhaust Emissions from Uncontrolled Vehicles and Related Equipment Using Internal Combustion Engines*. U.S. Environmental Protection Agency. Prepared by Southwest Research Institute, San Antonio, TX, under Contract No. EHS-70-108. October 1973.

2. *On-road vehicles Statistics*. Federal On-road vehicles Administration, U.S. Department of Transportation, Washington, DC. Annual.
   a. Table MF-24

3. International Snowmobile Industry Association, 7535 Little River Turnpike, Suite 330, Annandale, VA.

4. *American Housing Survey, Current Housing Reports, Series H-150-83*. Bureau of the Census, U.S. Department of Commerce, Washington DC. Biennial.

5. *Survey of Current Business*. Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.

6. *19xx Motorcycle Statistical Annual*. Motorcycle Industry Council, Inc., Costa Mesa, CA. Annual.

7. *Annual Energy Review.* DOE/EIA-0384(xx). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table Entitled, "Petroleum Products Supplied to the Transportation Sector, Electric Utilities, and Total, 1949-19xx."

8. *Energy Data Report*. DOE/EIA-0109(80/12). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table entitled, "Comparative Supply of Disposition Statistics."

9. *Petroleum Supply Annual*. DOE/EIA-0340(xx/07). Energy Information Administration, U.S. Department of Energy, Washington, DC. Annual.
   a. Table Entitled, "U.S. Supply, Disposition, and Ending Stocks of Crude Oil and Petroleum Products, 19xx."

10. *Control Techniques for Lead Air Emissions, Volumes 1 and 2*. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1977.

11. Gray, C.L. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. "Transmittal of Revised Lead Mobile Source Emission Factors." Internal Memorandum to D. Tyler.

12. *Motor Gasolines*. National Institute for Petroleum and Energy Research, IIT Research Institute, Barltesville, OK. Summer 1987 and Summer 1990.

13. *Locating and Estimating Air Emissions from Sources of Lead and Lead Compounds.* Draft Report. U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1996.

SECTION 6.0
NATIONAL CRITERIA POLLUTANT ESTIMATES PROJECTIONS METHODOLOGY

6.1 INTRODUCTION

The general approach for developing the projections estimates involved using the 1995 emissions estimates as the base year and applying growth factors and control efficiencies, as appropriate. The following sections describe the specific procedures used for each section of the inventory: nonutility point sources; utilities; area sources; highway mobile sources; and non-road mobile sources.

6.2 NONUTILITY POINT SOURCE PROJECTIONS

6.2.1 Growth Factors

U.S. Environmental Protection Agency (EPA) guidance for projecting emissions lists the following economic variables (in order of preference) for projecting emissions:[1]

- product output
- value added
- earnings
- employment

In the absence of product output projections, EPA guidance recommends value added projections. *Value added* is the difference between the value of industry outputs and inputs. U.S. Department of Commerce Bureau of Economic Analysis (BEA) gross state product (GSP) projections represent a measure of value added and are a fuller measure of growth than BEA's earnings projections because earnings represent only one component of GSP. GSP measures reflect the value added to revenue from selling a product minus the amounts paid for inputs from other firms. By incorporating inputs to production, GSP reflects future changes in production processes, efficiency, and technological changes. BEA's GSP projections are available by state at the 2-digit Standard Industrial Classification (SIC) code level.[2]

Growth factors were developed for each projection year and each 2-digit SIC from BEA GSP data for the base year (1995) and the projection years, using the following equation:

$$GF_y = (GSP_y)/(GSP_{95})$$

where:

where:	GF_y	=	growth factor for year *y*
	GSP_y	=	gross state product for year *y*
	GSP_{95}	=	gross state product for base year 1995

A file containing the growth factors used to develop Trends emission projections can be found on the following EPA Web page: http://www.epa.gov/ttn/chief/ei_data.html.

6.2.2 Control Assumptions/Factors

Controls applied to the projected emissions are those mandated under the Clean Air Act Amendments of 1990 (CAAA). CAAA provisions affecting nonutility industrial point sources include:

- National volatile organic compound (VOC) rules
- Benzene national emission standards for hazardous air pollutants (NESHAPs)
- Title III 2-year and 4-year maximum achievable control technology (MACT) standards
- VOC and oxides of nitrogen (NO_x) reasonably available control technology (RACT) requirements in ozone nonattainment areas
- New Control Techniques Guidelines (CTGs)
- Ozone rate-of-progress requirements

Controls assumed for each pollutant to project emissions are described in the following sections.

6.2.2.1 VOC Controls

Control measures for VOC include RACT, new CTGs, and Title III MACT controls. The stringency of the Title III MACT standard is based on draft or final standards where available. The promulgation and compliance dates for the 2-year and 4-year MACT standards are listed in table 6.2-1. For other sources, emission standards (expressed as percentage reductions in emissions) are based on technology transfer from other categories and engineering judgement. Title III MACT controls are generally as stringent, or more stringent, than RACT controls and are thus the dominant control option for many source categories. VOC control efficiencies are summarized in table 6.2-2. A 100 percent rule effectiveness (RE) is assumed for all control measures.

The Trends projections estimates **do not** include the following provisions which could further reduce VOC emissions in ozone nonattainment areas:

- Ozone nonattainment areas and the northeast ozone transport region (OTR) are subject to offset requirements for major new source growth and major modifications.

- Areas must attain the ozone standard by deadlines set according to their nonattainment classification. The mix of VOC and NO_x reductions chosen as the attainment strategy is determined through Urban Airshed Modeling. These reduction requirements are area-specific and are unknown for many areas at this time.

6.2.2.2 NO_x Controls

Industrial point source NO_x controls include NO_x RACT. Major stationary source NO_x emitters in marginal and above nonattainment areas and in the northeast OTR are required to install RACT-level controls under the ozone nonattainment related provisions of Title I. RACT control levels are specified by each state. Representative RACT levels were chosen for each source type (see table 6.2-3) in order to model the reductions associated with this requirement. These control levels were based on EPA Alternative Control Techniques documents (ACTs) and an assumed RE of 100 percent. Note that NO_x

RACT was already implemented by 1996 for all nonattainment areas except Louisville, Kentucky. NO_x RACT controls in Louisville were modeled in 1996 and beyond.

6.2.2.3 CO, SO_2, and PM Controls

No CO controls were applied to the projected emissions, although some CO nonattainment areas may have adopted controls for specific point sources within the nonattainment areas. Sulfur dioxide (SO_2) nonattainment provisions of the CAA do not specify any mandatory controls for SO_2 emitters, although individual states or nonattainment areas may require further controls. No SO_2 controls were applied to the Trends projected emissions. Possible control initiatives for particulates under the CAAA would result from the Title I provisions related to particulate matter less than 10 microns in diameter (PM-10) nonattainment. Because review of the draft SIPs available indicate that the controls are mainly targeting area source emitters, no PM controls were applied to the projected emissions.

6.2.3 Other Issues

An emission cap of 5.6 million tons of SO_2 per year was set by the CAAA for industrial sources. If this cap is exceeded, the Administrator may promulgate new regulations. To reflect improved fuel efficiency for combustion sources, adjustments were made to the projected industrial, commercial/ institutional and residential combustion emissions. The adjustments to industrial emissions projections are described below. Similar adjustments were made to the commercial/institutional and residential emissions projections and are described in section 6.2.3.2.

6.2.3.1 Industrial Emissions Adjustments

Adjustments were made to the projected emissions for combustion sources in the industrial sector by assuming increases in fuel efficiencies for future years. Efficiency adjustment factors (EAFs) were developed from data on energy consumption per unit output from the U.S. Department of Energy (DOE) publication *Annual Energy Outlook 1997*.[4] Using 1995 as the base year, the EAFs were calculated for each fuel (e.g., natural gas, steam coal, residual fuel, etc.) as the ratio between the base year consumption per unit output and the projection year consumption per unit output, as shown below:

$$EAF_y = C_y / C_{95}$$

where: EAF_y = efficiency adjustment factor for projection year y
C_y = consumption per unit output for projection year y
C_{95} = consumption per unit output for base year 1995

Table 6.2-4 shows the industrial sector EAFs calculated for each fuel for each projection year.

Source classification codes (SCCs) for the industrial sector were identified from the Tier categories and each SCC was assigned to one of the fuel categories. These assignments were performed electronically for most SCCs, however, some assignment had to be performed manually for certain SCCs.

Appropriate EAFs were applied to growth-factor based emissions projections for all pollutants for each SCC to develop the revised emissions projections. Note that no adjustments were made to the electricity fuel sector.

6.2.3.2 Commercial/Institutional and Residential Emission Adjustments

Adjustments were made to the projected emissions for combustion sources in the commercial/ institutional and residential sectors by assuming increases in fuel efficiencies for future years. Efficiency adjustment factors (EAFs) were developed from data on energy consumption by fuel type and square footage obtained from the DOE publication *Annual Energy Outlook 1997*.[1] It was assumed that fuel efficiency increases if square footage increases and fuel consumption decreases. Consumption factors (CFs) were developed for each fuel for each year by multiplying the square footage (total floor space for commercial/institutional and average house square footage for residential) by the delivered energy consumption by fuel.

Using 1995 as the base year, the EAFs were calculated for each fuel (e.g., natural gas, coal, etc.) as the ratio between the base year CF and the projection year CF, as shown below:

$$EAF_y = CF_y / CF_{95}$$

where: EAF_y = efficiency adjustment factor for projection year *y*
CF_y = consumption factor for projection year *y*
CF_{95} = consumption factor for base year 1995

Table 6.2-5 shows the commercial/institutional and residential sector EAFs calculated for each fuel for each projection year.

SCCs for the commercial/institutional and residential sectors were identified from the Tier categories and each SCC was assigned to one of the fuel categories. These assignments were performed electronically for most SCCs, however, some assignments had to be performed manually for certain SCCs. Appropriate EAFs were applied to the growth factor based emissions projections for all pollutants for each SCC to develop the revised emissions projections. Note that no adjustments were made to the electricity fuel sector.

6.2.4 References

1. *Procedures for Preparing Emissions Projections*, EPA-450/4-91-019, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1991.

2. *Regional State Projections of Economic Activity and Population to 2045*, U.S. Department of Commerce, Bureau of Economic Analysis, Washington, DC, July 1995.

3. *National Air Quality and Emissions Trends Report, 1995*, EPA-454/R-96-005, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, July 1996.

4. *Annual Energy Outlook 1997 with Projections to 2015*, DOE/EIA-0383(97), U.S. Department of Energy, Energy Information Administration, Washington, DC, December 1996.

Table 6.2-1. Compliance Dates for Promulgated 2-Year and 4-Year MACT Standards[3]

Source Category	Promulgation Date	Compliance Date
2-Year Standards:		
Hazardous Organic National Emission Standards for Hazardous Air Pollutants (NESHAP) (HON)	February 1994	October 1994
Commercial (point/area) and Industrial Dry-cleaning	September 1993	December 1993
4-Year Standards:		
Aerospace Industries	July 1995	September 1998
Chromic Acid Anodizing (point/area)	November 1994	January 1996
Coke Ovens: Charging, Top Side, & Door Leaks	October 1993	November 1993
Commercial Sterilization Facilities (point/area)	November 1994	December 1997
Decorative and Hard Chromium Electroplating (point/area)	November 1994	January 1996
Gasoline Distribution-Stage I	November 1994	December 1997
Halogenated Solvent Cleaners (point/area)	November 1994	December 1997
Industrial Process Cooling Towers	July 1994	March 1996
Magnetic Tapes (Surface Coating)	November 1994	December 1996
Marine Vessel Loading	July 1995	September 1999
Off-site Waste Operations	May 1996	July 1999
Petroleum Refineries - other sources not distinctly listed	July 1995	August 1998
Polymers/Resins Group I	July 1996	July 1999
Polymers/Resins Group II	February 1995	March 1998
Polymers/Resins Group IV	May 1996	September 1999
Printing/Publishing (Surface Coating)	May 1996	May 1999
Secondary Lead Smelting (point)	May 1995	June 1997
Shipbuilding and Ship Repair (Surface Coatings)	November 1995	December 1997
Wood Furniture	November 1995	November 1997

Table 6.2-2. Point Source VOC Controls

Source Category	VOC Control Efficiency (%)
National Rules	
Marine vessel loading: petroleum liquids	80
TSDFs	96
Benzene NESHAP (national)	
By-product coke mfg	85
By-product coke - flushing-liquor circulation tank	95
By-product coke - excess-ammonia liquor tank	98
By-product coke mfg. - tar storage	98
By-product coke mfg. - light oil sump	98
By-product coke mfg. - light oil dec/cond vents	98
By-product coke mfg. - tar bottom final cooler	81
By-product coke mfg. - naphthalene processing	100
By-product coke mfg. - equipment leaks	83
By-product coke manufacture - other	94
By-product coke manufacture - oven charging	94
Coke ovens - door and topside leaks	94
Coke oven by-product plants	94
2-Year MACT (national)	
Synthetic Organic Chemical Manufacturing Industry (SOCMI) HON	
– SOCMI processes	79
– VOL storage	95
– SOCMI fugitives (equipment leak detection and repair)	60
– SOCMI wastewater	0
– Ethylene oxide manufacture	98
– Phenol manufacture	98
– Acrylonitrile manufacture	98
– Polypropylene manufacture	98
– Polyethylene manufacture	98
– Ethylene manufacture	98
Dry Cleaning	
– Perchloroethylene	95
– Other	70
4-Year MACT (national)*	
TSDFs (offsite waste operations)	96
Shipbuilding and repair	24
Polymers and resins II	78
Polymers and resins IV	70
Styrene-butadiene rubber manufacture (polymers & resins group I)	70
Wood furniture surface coating	30
Aircraft surface coating (aerospace)	60

Table 6.2-2 (continued)

Source Category	VOC Control Efficiency (%)
Petroleum Refineries: other sources	
– Fixed roof petroleum product tanks	98
– Fixed roof gasoline tanks	96
– External floating roof petroleum product tanks	90
– External floating roof gasoline tanks	95
– Petroleum refinery wastewater treatment	72
– Petroleum refinery fugitives	72
– Petroleum refineries - Blowdown w/o control	78
– Vacuum distillation	72
Halogenated Solvent Cleaners	
– Open top degreasing - halogenated	63
– In-line (conveyorized) degreasing - halogenated	39
Printing	
– Flexographic	32
– Gravure	27
Gasoline Marketing	
– Storage	5
– Splash loading	99
– Balanced loading	87
– Submerged loading	99
– Transit	5
– Leaks	39
7/10-Year MACT (national)	
Paint and varnish manufacture	35
Rubber tire manufacture	70
Green tire spray	90
Automobile surface coating	79
Beverage can surface coating	57
Paper surface coating	78
Flatwood surface coating	90
Fabric printing	80
Metal surface coating	90
Plastic parts surface coating	45
Pulp and paper production	70
Agricultural chemical production	79
Pharmaceutical production	79
Polyesters	70
Fabric coating	70
Petroleum refineries - fluid catalytic cracking	70
Oil and natural gas production	90
Explosives	70

Table 6.2-2 (continued)

Source Category	VOC Control Efficiency (%)
Plywood/particle board	70
Reinforced plastics	70
7/10-Year MACT (national) (continued)	
Publicly-owned treatment works (POTWs)	70
Phthalate plasticizers	70
Polymers and resins III	78
Rayon production	70
Polyvinyl chloride	70
Spandex production	70
Nylon 6 production	70
Alkyd resins	70
Polyester resins	70
Chelating agents	70
New CTGs (moderate and above)	
SOCMI reactor	85
SOCMI distillation	85
Printing - lithographic	44
Non-CTG and Group III CTG RACT (moderate and above)**	
Carbon black manufacture	90
Whiskey fermentation - aging	85
Charcoal manufacturing	80
Cold cleaning	63
Bakeries	95
Urea resins - general	90
Organic acids manufacture	90
Leather products	90
CTG RACT (marginal and above)**	
Terephthalic acid manufacture	98
Cellulose acetate manufacture	54
Vegetable oil manufacture	42
Dry cleaning - stoddard	70
Stage I - splash unloading	95
Stage I - submerged unloading	95
Open top degreasing	42
In-line (conveyorized) degreasing	42
Petroleum refineries - blowdown	98

NOTE(S): *Compliance dates for 2- and 4-year MACT standards are listed by source category in 6.2-2.
**RACT controls are effective in 1995 or 1996, depending on the geographic area.

Table 6.2-3. NO_x Nonutility Point Source RACT Controls*

Source Category	Control Strategy	NO_x Percentage Reduction
ICI Boilers - Coal	LNB	50
ICI Boilers - Residual Oil	LNB	50
ICI Boilers - Distillate Oil	LNB	50
ICI Boilers - Natural Gas	LNB	50
ICI Boilers - Wood/Bark	None	0
ICI Boilers - Cyclone	NGR	53
ICI Boilers - Stoker	SNCR	55
Internal Combustion Engines - Oil	IR	25
Internal Combustion Engines - Gas	AF + IR	30
Gas Turbines - Oil	Water Injection	68
Gas Turbines - Natural Gas	LNB	84
Process Heaters - Distillate Oil	ULNB	74
Process Heaters - Residual Oil	ULNB	73
Process Heaters - Natural Gas	ULNB	75
Adipic Acid Manufacturing	Thermal Reduction	81
Nitric Acid Manufacturing	Extended Absorption	95
Glass Manufacturing - Container	LNB	40
Glass Manufacturing - Flat	LNB	40
Glass Manufacturing - Pressed/Blown	LNB	40
Cement Manufacturing - Dry	Mid-Kiln Firing	25
Cement Manufacturing - Wet	Mid-Kiln Firing	25
Iron & Steel Mills - Reheating	LNB	66
Iron & Steel Mills - Annealing	LNB	50
Iron & Steel Mills - Galvanizing	LNB	50
Municipal Waste Combustors	SNCR	45
Medical Waste Incinerators	SNCR	45
Open Burning	None	0

LNB = Low NO_x burners
LNC2 = Low NO_x burners plus overfire air
NGR = Natural gas reburning
SNCR = Selective noncatalytic reduction
IR = Ignition timing retardation
AF = Air/Fuel adjustment
ULNB = Ultra-low NO_x burners

NOTE: *RACT controls are effective in 1995 or 1996, depending on the geographic area.

Table 6.2-4. EAFs for Industrial Sector

RATIO CODE	NAME	1999	2000	2002	2005	2007	2008	2010
SC	Steam Coal - Industrial	0.977	0.977	0.953	0.907	0.884	0.884	0.860
RO	Residual Oil - Industrial	0.667	0.778	0.778	0.778	0.778	0.667	0.667
DO	Distillate Oil - Industrial	1.000	1.000	1.000	0.968	0.935	0.935	0.935
NG	Natural Gas - Industrial	0.976	0.970	0.943	0.902	0.879	0.868	0.845
RE	Renewables (hydroelectric, wood, wood waste, solid waste) - Industrial	0.979	0.979	0.979	0.979	0.957	0.957	0.957
MCC	Metallurgical Coal and Coke - Industrial	0.880	0.840	0.760	0.680	0.640	0.640	0.600
OP	Other Petroleum (pet. Coke, asphalt, road oil, lubricants, gasoline) - Industrial	0.991	0.973	0.945	0.900	0.873	0.864	0.836
LP	LPG - Industrial	0.927	0.909	0.909	0.873	0.836	0.836	0.818

Table 6.2-5. EAFs for Commercial and Residential Sector

RATIO CODE	NAME	1999	2000	2002	2005	2007	2008	2010
RDO	Distillate Oil - Residential	0.937	0.913	0.857	0.803	0.773	0.763	0.727
RNG	Natural Gas - Residential	1.005	0.995	0.973	0.949	0.933	0.930	0.916
RRE	Renewables (Wood) - Residential	0.949	0.935	0.895	0.860	0.823	0.813	0.795
ROF	Other Fuels (kerosene and coal) - Residential	0.876	0.863	0.841	0.741	0.722	0.713	0.697
RLP	LPG - Residential	0.996	1.005	0.979	0.963	0.939	0.948	0.927
CDO	Distillate Oil - Commercial	0.866	0.859	0.821	0.801	0.766	0.760	0.748
CNG	Natural Gas - Commercial	1.017	1.012	1.003	0.993	0.988	0.983	0.981
CRE	Renewables (Wood) - Commercial	1.000	1.000	1.000	1.000	1.000	1.000	1.000
COF	Other Fuels (kerosene, coal, lpg, residual fuel oil) - Commercial	0.850	0.870	0.855	0.834	0.846	0.840	0.826

6.3 UTILITY PROJECTIONS

6.3.1 Existing Unit Projections

Electric utility generation projections were based on the 1995 Trends utility database. This file was summed to the boiler level and compared to generation data found on DOE, Energy Information Administration (EIA) Forms 759[1] and 767[2] to find one-to-one boiler to generator matches. Where these matches were found, generation data were taken from Form 767 and where a one-to-one correspondence was not available, a heat input (MMBtu) boiler to plant, fuel type ratio was established for use in allocating Form 759 plant level/fuel type generation to the boilers.

Heat input of the base file was totaled to the fuel/plant level and a boiler to plant level ratio was calculated for each point. The base file was then mapped by plant to the Form 759 plant level generation file and the boiler/plant ratio was multiplied by the Form 759 generation data to estimate boiler generation allocation.

Additionally, boilers were mapped into the Form 767 file and when a one-to-one boiler to generator correspondence was determined, the Form 767 generation value was used. Only in cases where plant level generation was positive and where boiler level generation was zero *or* where a one-to-one boiler to generator correspondence was not established was the Form 759 generation allocation used. The noted exception occurred at Warrick (ORIS 6705). The baseline file for this plant showed it had several boilers in the inventory base year. However, only Boiler 4 was determined to have operated during this period. The additional boilers were therefore eliminated from the file.

Once base year generation was established for each of the inventory's boilers, an operating profile type was associated based on the calculated capacity utilization factor. This factor was calculated at the boiler level using the following equation:

Capacity Factor Utilization = Generation (GW-hr)/[Boiler Capacity (MW) x 8.76]

where: 8.76 is the product of the 8,760 operating hours per year and the 10^{-3} factor converting MW to GW.

Previously, historical capacity utilization factors were used to estimate utility profiles, however, because generation data were available for the operating years 1990 and 1995, only the actual operating data for that year (1995) were used. Within each profile, a maximum change in capacity factor was established (as part of the Ozone Transport Assessment Group [OTAG] process and used in ERCAM-NO_x) to estimate future year fuel use, emissions, and generation for each unit. Table 6.3-1 presents the profile types and their associated maximum change in capacity factors.

Total projected generation from these existing units was compared to NERC region-fuel generation demands and new units were brought on-line or capacity utilization at existing units was decreased in order to meet total generation.

6.3.2 Planned Units

Listings of electric utility units expected to begin operation over the next 10 years are published annually by the DOE.[3] Available unit-specific data for these planned units include the unit's location, capacity, primary fuel type, and expected year of startup. These data were downloaded from the DOE's web site and converted to dBase format.

In most cases, the planned unit data include the county that the unit is expected to be sited in. For these units, latitude and longitude coordinates were assigned to planned units corresponding to the centroid of the county listed for the unit. Planned units without a county designation were sited as described below for siting generic units. The following additional unit parameters were assigned to planned units.

	Coal-Fired Units	Oil-Fired Units	Gas-Fired Units
Heat Rate (Btu/kWh)	10,070	9,680	9,680
Capacity Utilization Factor	0.90	0.20	0.90

6.3.3 Generic Units

Additional generation capacity, above that which is expected to be provided by existing and planned utility units, will be needed in projection years to meet electricity demand. This generation demand is assumed to be filled by units termed "generic units." Generic units were created in the utility data base to meet the generation demands in the projection years that will not be met by existing and planned units. Generic units are essentially place-holders used to account for emissions caused by the generation of electricity expected to be needed in each state beyond the generation that will be provided by existing and planned units.

Total generation demand is projected by DOE by region and fuel type. These generation forecasts are also broken down by utility generation and nonutility generation. Table 6.3-2 presents these generation forecasts by NERC region and fuel type. The procedure used to estimate the unmet generation in the projection years is described below.

- Generation from the electric utility units existing in the 1995 Trends inventory and the known planned units was estimated for the projection years by multiplying the 1995 generation at these units by the ratio of the future capacity factor (calculated as discussed above) to the 1995 capacity factor. Units projected to retire in the future have a future year capacity factor of 0.

- The 1995 generation from the fossil-fuel fired utility units included in the Trends inventory were totaled by state and fuel type and by federal DOE region and fuel type.

- The DOE regional/fuel type generation projections for 1990, 2000, and 2010 were interpolated to give generation estimates by region and fuel type for 1996, 1999, 2005, 2007, and 2008.
- The projected generation from the existing and planned units at the regional/fuel level was subtracted from the corresponding generation demand projection to give the generation requirement that would need to be filled by generic units.

- Generation from generic units at the regional/fuel level was allocated at the state/fuel level based on the fraction of each state's generation for a specific fuel type in the specific projection year out of the total generation for that fuel in that region for the specific projection year.

- The total generic generation needed for a state was divided into individual generic combined cycle (CC) and combustion turbine (CT) units with assumed capacities of 200 MW for oil, 450 MW for gas, and 500 MW for coal units. Other characteristics of generic units were assumed to be the same as those listed above for planned units.

Combined cycle and combustion turbine plants have proven to be superior in terms of low emissions, improved heat rates, low cost, load flexibility, and are showing increasing use in the electric generating sector. As a result of these trends, it was assumed that generic units would shift to CCs (oil) and CTs (natural gas), rather than coal-fired boilers.

The generic units were sited at existing fossil-fuel fired plant sites. When possible, generic units were not sited in nonattainment areas. Because of the large number of generic units in some states and the limited number of existing plant sites to choose from, a hierarchy was developed for siting the generic units. First, in attainment areas only, generic units were sited to replace units scheduled to retire by the projection year. Second, generic units were sited at plant sites that were constructed in 1970 or later. New utility units generally tend to be added to sites with other relatively new units, rather than with older units. Third, if necessary, generic units were sited at plant sites older than 1970. If additional generic units remained to be sited after all available existing sites in attainment areas were filled, the above hierarchy was repeated using sites in nonattainment areas.

6.3.4 Control Assumptions

Both NO_x and SO_2 controls were applied to the utility projections.

6.3.4.1 NO_x Controls

Controlled NO_x emissions at electric utility units were estimated by applying ERCAM-NO_x control strategies to meet emission rate limits. Emission rates for certain coal-fired boiler types are specified in the CAAA's Title IV. Additional rates for units required to apply RACT controls under Title I are specified in the NO_x Supplement to the Title I General Preamble. These include emission rate limits for oil- and gas-fired boilers. New units sited in nonattainment areas or the OTR are subject to NSR and, therefore, more stringent emission limits. The control limits applied encompass controls specified by Title I, Title IV, the Ozone Transport Commission's memorandum of understanding (MOU) Phase II limits, and New Source Performance Standard (NSPS) NO_x regulations.

Existing units located in ozone nonattainment areas or located within the OTR may be subject to Title I requirements which include RACT for electric generating units.

Under Title IV, coal-fired boilers are subject to certain NO_x emission rate limits based on their bottom and firing types. No limits have been established for Group II boilers, however, actual emission rate data from EPA's Acid Rain Division were used. Table 6.3-3 presents NO_x emission rate limits for Group I and II boilers as modeled. Some oil and gas plants were also subject to emission rate limit requirements and the limits modeled in this study are included in this table. Title IV limits are applied to boilers in ozone nonattainment areas, boilers in the OTR if unit level emissions exceed 100 tons NO_x per year, and to any Phase I unit.

In 1994, the OTR's 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 lbs/MMBtu or achieve a 65 percent reduction from 1990 baseline levels, as specified in the Phase II round of control. 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 projection year emission estimates.

6.3.4.2 SO_2 Controls

The electric utility SO_2 reductions were developed using B2-SO2, a system built on the AIRCOST system, which was used extensively to analyze proposed utility SO_2 controls leading up to Title IV of the CAAA. B2-SO2 develops least cost control measures at the unit/boiler level to meet a target emissions reduction tonnage input by the user.

National reductions were developed from pre-control estimates of plant emissions and Title IV Phase I and II emissions targets as shown below.

Year	SO_2 Emission Target (kilotons/year)	SO_2 National Reduction Requirement
1999	11,060	2,730
2000	10,216	3,610
2002	10,329	3,512
2005	10,442	3,311
2007	10,295	3,551
2008	10,148	3,367
2010	10,002	3,453

Candidate SO_2 controls were developed for each of the coal burning units in the data file which showed high enough SO_2 emissions to make controls cost-effective. Three types of controls were possible: (1) coal fuel switching; (2) wet flue gas desulfurization (FGD); and (3) 100 percent natural gas conversion by coal plants.

Costs of the fuel switching control options were estimated using the most recent DOE data on cost and quality of fuel at electricity utility plants (FERC Form 423 for 1993, 1994, and 1995).[4] The FGD options were estimated using engineering cost parameters in a format similar to the Electric Power Research Technology (EPRI) Technology Assessment Guide approach, with cost parameters updated to reflect the most recent information on costs. Capital costs for FGD were developed from the results of IAPCS model for standardized units. Operating and maintenance (O&M) cost parameters were based on experience with six retrofit scrubbers as outlined in a recent paper by DOE.[5] Finally, state-level cost adjustment factors were applied, varying from 85 to 118 percent, representing regional differences in construction costs.

While the actual cost factors for wet scrubbing are rather complex, the algorithm results in the following costs for a 90 percent removal scrubber on a 500 megawatt unit:

Capital recovery factor	0.11 (11 percent per year)
Capital	154.26 $/kW (1995 dollars)
O&M (total fixed + variable)	1.93 mils/kWh

The percentage reduction for the FGD options is a user-stipulated variable. However, it was found that the maximum, 97 percent, was the least cost removal level, and was selected for all of the FGD units the model built.

The cost fuel switching module applied different costs and modeling approaches for bituminous as opposed to sub-bituminous coals. Fuel switching "down-rank," from bituminous to sub-bituminous, was modeled separately.

All candidate unit control options are input to a data file and sorted by increasing incremental cost per ton of SO_2 removed. The model then selects options for each unit up to the level at which total reductions just exceed the desired target reduction tonnage. The most expensive option selected for the each boiler (if any) by this procedure is the control reported for the unit.

The B2-SO2 system is applied to all units, excluding those known to be retiring prior to the scenario date. The files include known planned start-ups, and "generic" units required to meet generation forecasts by fuel type. However, the planned and generic units will not normally be controlled, since they must meet the Phase II standards, and any further reductions are typically found to be uneconomic.

6.3.5 Other Issues

6.3.5.1 Particulate Matter Emissions

When fuel switching control options are applied to utility boilers 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 with reported percent ash content in the Trends baseline file, new percent ash content values were directly ratioed to calculate new PM emission levels. This was done for both PM-10 and for every boiler where fuel switching occurred.

6.3.6 References

1. *Form 759*, U.S. Department of Energy, Energy Information Administration, Washington, DC.

2. *Form 767*, U.S. Department of Energy, Energy Information Administration, Washington, DC.

3. *Supplement to the Annual Energy Outlook 1997*, U.S. Department of Energy, Energy Information Administration, Washington, DC, electronic download, 1997.

4. *Form 423*, U.S. Department of Energy, Washington, DC, electronic download, 1997.

5. *The Effects of Title IV of the Clean Air Act Amendments of 1990 on Electric Utilities: An Update*, DOE/EIA-0582(97), U.S. Department of Energy, Washington, DC, March 1997.

Table 6.3-1. Profile Types and Maximum Change in Capacity Factors

Historical Average Capacity Factor	Profile Type	Maximum Change in Capacity Factor
>90%	Base	No change
78 - 90%	Base with moderate turndown	Increase capacity factor to 90%
66 - 77%	Base with significant turndown	Increase capacity factor to 77%
47 - 65%	Intermediate	Increase capacity factor to 65%
20 - 46%	Peaking with long runtime	Increase capacity factor to 46%
<20%	Peaking with short runtime	No change

Table 6.3-2. Utility Projections by NERC Region and Fuel Type[3]
(Generation in Billions of kWh)

Region	Fuel Type	1995	1996	1999	2002	2005	2007	2010
ECAR	Coal	450.36	451.71	477.00	477.26	494.36	514.49	515.09
	Oil	1.56	2.44	1.46	1.44	1.86	2.49	2.47
	Natural Gas	3.62	8.88	8.26	12.85	20.09	25.00	46.47
ERCOT	Coal	93.86	98.23	99.06	104.95	105.04	115.66	117.07
	Oil	2.24	0.59	0.48	0.40	0.43	0.38	0.32
	Natural Gas	80.34	95.70	105.58	111.71	125.07	123.24	133.63
MAAC	Coal	104.45	98.70	103.58	104.34	101.99	106.41	106.35
	Oil	6.40	7.33	4.79	2.38	2.65	2.21	2.19
	Natural Gas	11.29	15.16	32.27	54.60	79.26	76.31	83.43
MAIN	Coal	127.70	131.75	142.19	136.55	121.81	126.31	124.81
	Oil	1.07	1.58	0.78	0.73	0.67	0.84	0.74
	Natural Gas	4.12	10.09	17.04	20.97	54.21	63.30	73.93
MAPP	Coal	108.65	99.98	112.64	117.32	121.84	124.30	124.81
	Oil	0.70	0.89	0.90	1.00	0.88	1.01	1.13
	Natural Gas	1.35	3.63	4.45	5.59	14.05	17.27	24.60
NPCC/NY	Coal	25.84	23.25	24.70	24.37	24.39	26.64	26.95
	Oil	7.86	4.70	6.65	2.18	1.75	2.02	2.39
	Natural Gas	23.43	17.18	18.98	18.85	27.98	31.23	39.34
NPCC/NE	Coal	16.22	16.11	15.49	15.50	15.70	15.70	15.70
	Oil	11.20	9.00	13.37	20.40	20.88	20.84	17.88
	Natural Gas	13.76	15.05	14.95	18.54	23.65	28.65	39.99
SERC/FL	Coal	58.84	60.32	61.61	63.87	67.23	67.61	70.10
	Oil	21.58	22.71	17.47	13.30	14.66	15.11	14.20
	Natural Gas	35.39	28.19	34.90	42.44	52.03	55.85	63.33
SERC	Coal	340.16	342.22	363.05	378.50	396.01	398.45	397.28
	Oil	2.16	5.30	4.33	2.52	3.97	4.36	4.39
	Natural Gas	9.58	13.52	32.68	73.42	83.84	98.63	133.58
SPP	Coal	154.55	159.73	172.28	176.71	177.87	178.03	180.88
	Oil	0.90	0.92	0.45	0.56	0.53	0.54	0.51
	Natural Gas	83.54	74.38	70.24	86.15	103.21	116.09	127.09
WSCC/NWP	Coal	74.07	72.33	82.44	83.92	85.93	85.93	86.37
	Oil	0.11	0.08	0.58	0.69	0.45	1.24	1.35
	Natural Gas	5.73	2.46	26.26	35.12	43.03	51.24	55.12
WSCC/RA	Coal	83.33	89.18	88.94	91.27	93.18	93.08	95.29
	Oil	0.12	0.18	0.18	0.16	0.13	0.13	0.13
	Natural Gas	5.27	11.81	19.90	24.15	32.99	37.02	40.87
WSCC/CNV	Coal	32.51	36.37	35.80	35.52	47.80	62.67	81.07
	Oil	1.37	0.85	1.22	0.96	0.96	0.95	0.89
	Natural Gas	41.38	26.97	53.24	47.72	41.79	36.35	26.49

Table 6.3-3. Title IV or RACT NO_x Emission Rate Limits

	Source Category	NO_x Emission Rate Limit (lbs/MMBtu)*
	Coal-Fired Boilers	
	Dry bottom, wall-fired	0.45
**	Dry bottom, wall-fired (Phase I)	0.50
	Dry bottom, tangentially-fired	0.38
**	Dry bottom, tangentially-fired (Phase I)	0.45
	Wet bottom	0.86
	Cyclone	0.94
	Vertically-fired	0.80
	Fluidized bed combustor	0.29
	Cell burner	0.68
	Other	1.00
	Oil/Gas-Fired Boilers	
	Wall-fired	0.30
	Tangentially-fired	0.20

* These rates are based on the draft Title IV NO_x rulemaking.

** Group I boilers; all others are Group II.

6.4 AREA SOURCE PROJECTIONS

Area source projections include small stationary sources not included in the point source data base (e.g., dry cleaners, graphic arts, industrial fuel combustion, gasoline marketing, etc.) and solvent use (e.g., consumer solvents, architectural coatings). Highway mobile and non-road mobile are described in sections 6.5 and 6.6, respectively.

6.4.1 Growth Factors

As with the nonutility point sources, area source growth factors were developed for each year and each 2-digit SIC from BEA GSP data for the base year (1995) and projection years. A file containing the growth factors used to develop Trends emission projections can be found on the following EPA Web page: http://www.epa.gov/ttn/chief/ei_data.html.

6.4.2 Control Assumptions/Factors

Controls applied to the projected area source emissions are those mandated under the CAAA and address VOC, NO_x, and PM emissions as described below.

6.4.2.1 VOC Controls

Control measures for VOC include RACT, new CTGs, Stage II vapor recovery, federal consumer solvent controls, and Title III MACT standards. VOC percent reduction and rule effectiveness are summarized in table 6.4-1.

6.4.2.2 NO_x Controls

As with point sources, NO_x RACT had already been implemented in the 1995 emission estimates for every nonattainment area except for the Louisville nonattainment area. NO_x RACT controls were added for Louisville for the projections. Table 6.4-2 shows the area source industrial fuel combustion NO_x RACT penetration rates.

6.4.2.3 PM Controls

For the area source projections, PM controls were implemented in PM nonattainment areas. The controls modeled depend on the severity of PM nonattainment and the level of emissions from source categories for which controls are available. Table 6.4-3 shows the area source PM-10 control measures.

6.4.3 Other Issues

Efficiency adjustment factors were applied to area source fuel combustion sources within the industrial, commercial/institutional, and residential sectors. These factors were calculated using the same procedure used for efficiency adjustment factors for nonutility point sources described in sections 6.2.3.1 and 6.2.3.2.

Table 6.4-1. Area Source VOC Control Measures

Control Measure	VOC Percentage Reduction	VOC Rule Effectiveness
Federal Control Measures (National)		
Consumer Solvents	25	100
Architectural and Industrial Maintenance (AIM) Coatings	25	100
Onboard Refueling Vapor Recovery Systems	*	
Treatment, Storage, and Disposal Facilities	94	100
Municipal Solid Waste Landfills	82	100
Title III MACT (National)		
Wood Furniture Surface Coating	30	100
Aerospace Surface Coating	60	100
Marine Vessel Surface Coating	24	100
Halogenated Solvent Cleaners	63	80
Autobody Refinishing	37	100
Perchloroethylene Dry Cleaning	44	100
Petroleum Refinery Fugitives	78	100
SOCMI Fugitives	60	100
Title I RACT (Ozone NAAs)		
Synthetic Fiber Manufacture	54	80
Pharmaceutical Manufacture	37	80
Petroleum Dry Cleaning	44	80
Bulk Terminals	51	80
Paper Surface Coating	78	80
Oil and Natural Gas Production Fields	37	80
Service Stations - Stage I	95	80
Cutback Asphalt	100	80
New CTGs (Moderate and Above)		
SOCMI Batch Reactor	78	80
Web Offset Lithography	80	80
Stage II Vapor Recovery (Serious and Above, OTR)	*	

*The effects of onboard vapor recovery and Stage II are modeled using MOBILE5a. Because MOBILE5a does not model the phase-in schedule for onboard, a series of runs were performed with different start dates and a weighted gram per gallon emission factor was calculated.

Table 6.4-2. Area Source Industrial Fuel Combustion NO_x RACT Penetration Rates

	NO_x Penetration Rate (%)			
RACT Size Cutoff	Coal	Oil		Gas
Moderate	23		8	11
Serious and Above	45		16	22
LNB Control Efficiencies	21	Residual:	42	31
		Distillate:	36	

Table 6.4-3. Area Source PM-10 Control Measures

Category	Serious	Moderate
Paved Roads	Vacuum sweeping - urban and rural roads - 2 times per month to achieve 79% control level. Penetration factor varies by road type.	Vacuum sweeping - urban roads - 2 times per month to achieve 79% control level. Penetration factor varies by road type.
Unpaved Roads	Pave urban unpaved roads (96% control and 50% penetration). Water rural roads (96% control and 25% penetration)	Pave urban paved roads (96% control and 50% penetration)
Construction	Dust control plan (50% control, 75% penetration)	Dust control plan (50% control, 75% penetration)
Cattle Feedlots	Watering (50% control)	Watering (50% control)
Residential Wood Combustion	Switch to natural gas (44% reduction in 2000, 74% reduction in 2010)	EPA Phase II stoves (41% reduction in 2000, 63% reduction in 2010)
Agricultural Burning	Propane and bale/stack burning (control level varies from 50% to 63 % by state according to the types of crop)	Propane and bale/stack burning (control level varies from 50% to 63% by state according to the types of crop)

6.5 HIGHWAY MOBILE SOURCE PROJECTIONS

This section describes how highway mobile source emissions were projected to future years. Note that this section does not provide guidance for using the MOBILE5b model. MOBILE5b guidance is available in Reference 1.

6.5.1 VMT Projection Methodologies

The 1995 vehicle miles traveled (VMT) data were used as the starting point for calculating the projection year VMT estimates. Growth factors used in the projection year VMT calculations were developed at the Metropolitan Statistical Area (MSA) level by vehicle class. These VMT growth factors were calculated by multiplying national vehicle class growth factors, calculated from national VMT projection data by vehicle type output by EPA's MOBILE4.1 Fuel Consumption Model (FCM),[2] by the ratio of MSA-specific population growth to national population growth. The equation below illustrates how the projection year VMT growth factors were calculated.

$$VMTGF_{PY,VT,M} = \frac{VMT_{PY,VT,US}}{VMT_{95,VT,US}} x \frac{POP_{PY,M}}{POP_{95,M}} x \frac{POP_{95,US}}{POP_{PY,US}}$$

where:	$VMTGF_{PY, VT, M}$	=	1995 to projection year PY growth factor for vehicle type VT and MSA M
	$VMT_{PY, VT, US}$	=	U.S. total projection year VMT for vehicle type VT obtained from the MOBILE4.1 Fuel Consumption Model
	$VMT_{95, VT, US}$	=	U.S. total 1995 VMT for vehicle type VT obtained from the MOBILE4.1 Fuel Consumption Model
	$POP_{PY, M}$	=	Projection year population for MSA M obtained from the BEA population projections
	$POP_{95, M}$	=	1995 population for MSA M obtained from BEA data
	$POP_{95, US}$	=	U.S. total population for 1995 from BEA data
	$POP_{PY, US}$	=	U.S. total population for projection year PY from BEA population projections

An electronic file was developed, containing the resultant VMT growth factors for each projection year by MSA and vehicle type. Due to the vehicle classes used in the FCM, the light-duty gasoline truck (LDGT) 1 and LDGT2 growth factors are identical, and motorcycles are assigned the same growth factors as light-duty gasoline vehicles (LDGVs). Also, in determining these growth factors, heavy-duty diesel vehicles (HDDVs) are treated as a single vehicle class.

A county correspondence file was developed that indicated which counties are included in each MSA and rest-of-state area. Each data point in the 1995 VMT file at the county/vehicle type/road type level was then multiplied by the corresponding VMT growth factor projected at the MSA/vehicle type level for each projection year. These resulting projected annual VMT at the county/roadway type/vehicle type level of detail were then temporally allocated by month. The temporal allocation procedure used the same temporal allocation factors used for the 1995 VMT allocation. Table 6.5-1 summarizes the VMT data for the projection years by vehicle type. State-level VMT totals for the same years are shown in table 6.5-2.

6.5.2 Registration Distribution for Projection Years Used as MOBILE5b Inputs

Due to the uncertainties and shifts in the automobile and truck sales markets, creating projection year registration distributions result in a high degree of uncertainty. Several methodologies were considered for projecting the registration distributions. In consultation with EPA's Office of Mobile Sources (OMS), it was determined that the default MOBILE5b and PART5 registration distributions would provide sufficiently reasonable values to use as the registration distributions for the projection years. However, because the State-provided distributions include valuable information on local trends in fleet turnover, any county modeled with a State-supplied registration distribution 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.

6.5.3 Additional MOBILE5b Inputs

Additional MOBILE5b inputs include Reid vapor pressure (RVP), temperature, speed data, operating mode, altitude, MONTH flag, and control program data. These inputs for the projection years inventories are described in this section.

6.5.3.1 RVP Values

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 psi in 9.0 psi areas to account for the allowable margin of safety in meeting the RVP limits. Table 6.5-3 lists the RVP modeled by month for all areas in the projection years.

6.5.3.2 Temperature Data

Actual temperature data are not available 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, 30-year average temperature data are used in the projection year estimates. The average minimum and maximum daily temperature for each month and state were obtained from the Statistical Abstracts.[3] A single site within each state was 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. Table 6.5-4 shows the temperatures modeled by state and month in the projection years.

6.5.3.3 Speed Data

The 1990 speeds used for 1995 and 1996 (obtained from the HPMS impact analysis output[4]) were also used for the projection years. Table 6.5-5 presents the average speed used for each road type/vehicle type combination.

6.5.3.4 Operating Mode

The operating mode assumptions of the Federal Test Procedure (FTP) were used for 1995 and 1996 were also used in the projection years MOBILE5b input files.

6.5.3.5 Altitude

The entire states of Colorado, Nevada, New Mexico, and Utah were modeled as high altitude areas for the projection years. All other states were modeled as low altitude areas.

6.5.3.6 MONTH Flag

When modeling months from January through June for the projection years, the MONTH flag within the MOBILE5b input files was set to "1" to simulate January registration distributions. For months from July through December, the flag was set for "2" to model July registration distributions.

6.5.3.7 Additional Inputs from OTAG

In addition to the inputs described above, several additional MOBILE5b inputs (trip length distributions, alcohol fuel market shares, and diesel sales shares) were supplied by the states for the OTAG modeling and were incorporated into the Trends MOBILE5b input files. Specifically, State-supplied trip length distribution data were applied in the 1995, 1996, and in the projection years. Table 6.5-6 summarizes the state-supplied trip length distribution data.

6.5.3.8 Control Program Inputs

6.5.3.8.1 Inspection and Maintenance Programs — The primary sources of data describing inspection and maintenance (I/M) program inputs for the 1999, 2000, and 2002 projection years was the latest OMS I/M program summary sheet.[5] In consultation with OMS, it was agreed that the stringency rate inputs, waiver rate inputs, and compliance rate inputs should be standardized for all areas. Stringency rate were set to 20 percent, waiver rates were set to 3 percent, and compliance rates were set to 96 percent. These rates are consistent with the corresponding rates included in EPA's enhanced I/M performance standard and are by far the most common rates claimed in the modeling demonstrations submitted to EPA by the states. There is very little variance from these rates in state I/M program plans. States may change these rates at some time in the future, but for now they should be considered accurate. The specific inputs modeled for each area's I/M program in 1999, 2000, and 2002 are shown in table 6.5-7. This table also indicates which year or years the inputs were modeled in. Table 6.5-8 shows which counties each set of I/M program inputs were applied to.

For the 2005, 2007, 2008, and 2010 projection years, the area-specific inputs were replaced with the corresponding EPA I/M program performance standards (i.e., it was assumed that any area that is supposed to have enhanced I/M receives full credit for it). EPA's rationale behind this approach is that in that time frame, by whatever means, EPA is assuming I/M programs would improve to the point where higher credits are appropriate. The split between 2002 and 2005 was a semi-arbitrary split between current/near term years and later years. The specific inputs modeled for each of the I/M program performance standards are shown in table 6.5-9. Table 6.5-10 shows which counties each set of I/M program inputs were applied to.

I/M program coverage for the projection years was based on data collected by EPA for OTAG and Section 812 emission projections.[6, 7] During this data collection process, each state was contacted to confirm which counties in that state would be implementing an I/M program. Each state was also asked to indicate which of the EPA I/M program types the program would most closely resemble–high enhanced, low enhanced, basic, or OTR low enhanced. Responses were collected from each state with a planned CAAA I/M program. These data were used in the Trends emission projection calculations by assigned the I/M programs defined in the OMS I/M program summary for a given state to the counties within that state listed as having a projected I/M program.

6.5.3.8.2 Reformulated Gasoline **—** Table 6.5-11 lists the areas that participated in the federal reformulated gasoline program. The only change in coverage between 1995 and 1996 and the projection years is the addition of the Phoenix, Arizona nonattainment area. This area opted in to the program in 1997 and therefore was modeled with reformulated gasoline in the projection years, but not in 1995 or 1996.

6.5.3.8.3 Oxygenated Fuel **—** The areas modeled with oxygenated fuel for the projection years were the same as those modeled with oxygenated fuel for 1995 and 1996.

6.5.3.8.4 National Low Emission Vehicle Program **—** A National Low Emission Vehicle (NLEV) program was modeled in the projection years using EPA's most current (at the time the modeling was performed) assumptions about the characteristics of the proposed NLEV program. This program was modeled as starting in the Northeast Ozone Transport Commission (OTC) states in 1999 and in the remaining (non-California) states in 2001. The implementation schedule of the NLEV program is shown below.

Model Year	Federal Tier I Standards	Transitional LEV Standards	LEV Standards
1999	30%	40%	30%
2000		40%	60%
2001 and later			100%

States in the OTC that had already adopted a LEV program on their own at this time were modeled with the characteristics of the OTC-LEV program until the start date of the NLEV program. These states included Massachusetts, New York, and Connecticut. The programs in Massachusetts and New York began with the 1996 model year. The Connecticut program began with the 1998 model year. The implementation schedule followed by these states prior to 1999 (the start year of the NLEV program) was based on the implementation schedule of the OTC-LEV program, and is shown below. Only the 1998 model year is applicable in Connecticut.

Model Year	Federal Tier I Standards	TLEV Standards	Intermediate LEV Standards	LEV Standards	Intermediate ULEV Standards	ULEV Standards
1996	80%	20%				
1997	73%		25%		2%	
1998	47%			51%		2%

These implementation schedules differ from the MOBILE5b default LEV implementation schedule, which was designed to model the California LEV program. For the model to access the implementation schedule of the NLEV program, the PROMPT flag in the applicable MOBILE5b input files was set to "5" and the name of the file containing the NLEV implementation schedule was entered when prompted by MOBILE5b. In addition to setting the PROMPT flag, the REGION flag was set to "4" to properly model the NLEV program in the MOBILE5b input files. The setting of "4" for the REGION flag indicates that an additional line is being added to the input file to model a LEV program. The necessary inputs for this additional program line include the start year of the LEV program and whether an "appropriate" I/M program will be implemented in conjunction with the LEV program. The start year of the LEV program was set to "96" for input files modeling Massachusetts and New York, "98" for input files modeling Connecticut, "99" for input files modeling all other states within the OTC (including the Washington, DC nonattainment area portion of Virginia), and "01" for all remaining States (including the remainder of Virginia), except California.

With an "appropriate" I/M program, maximum benefits of the LEV program are modeled by MOBILE5b, implementing a lower set of deterioration rates (DRs). For the modeling projection years 1999, 2000, and 2002, areas implementing an IM240 program were assumed to meet this requirement and were modeled with the maximum LEV program benefits (flag setting of "2"). These I/M programs are identified in table 6.5-8 with an asterisk following the I/M program name. In addition, for the 2005 and later emission projections, all areas modeled with the enhanced I/M program performance standard were modeled with this same setting. All other areas in all projection years were modeled to receive the minimum LEV program benefits (i.e., a flag setting of "1").

The following table shows the emission standards of the Federal Tier 1 program, the transitional LEV (TLEV) standards, the LEV standards, and the Ultra-Low Emission Vehicle (ULEV) standards. These standards apply to the LDGV and LDGT1a classes of vehicles, according to the implementation schedules shown above. The LDGT1b category is also included in the NLEV program, but the emission standards for these vehicles are slightly less stringent than those listed below for the lighter vehicles.

Emission Standard	Nonmethane Organic Gas (NMOG)	CO	NO_x
Federal Tier 1	0.250 grams/mile nonmethane hydrocarbon (NMHC)	3.4 grams/mile	0.40 grams/mile
Transitional LEV (TLEV)	0.125 grams/mile	3.4 grams/mile	0.40 grams/mile
LEV	0.075 grams/mile	3.4 grams/mile	0.20 grams/mile
ULEV	0.040 grams/mile	1.7 grams/mile	0.20 grams/mile

The REGION flag, used to indicate that a LEV program is being modeled in a MOBILE5b input file, is the same flag that is used to indicate that an area is a high altitude area. An area cannot be modeled as being both a high altitude area and having a LEV program simultaneously. Thus, when the NLEV program was modeled for the four high altitude states, the standards modeled for LDGT2s, HDGVs, and all diesel vehicles are those for low altitude areas. To correct this, two sets of input files were created for the high altitude areas for projection years 2002 and beyond. In the first set, the REGION flag was set to "4" and the additional line was added for each scenario to model the NLEV program. In the second set, the REGION flag was set to "2" to model the high altitude standards. The LDGV and LDGT1 emission factors from the first set of files, including the effects of the NLEV program, were then combined with the LDGTs, HDGV, light duty diesel vehicle (LDDV), light duty diesel truck (LDDT), HDDV, and motorcycle (MC) emission factors from the second set of files, which included the effects of the high altitude standards. This was done by replacing the LDGV and LDGT1 emission factors created by the second, or high altitude, set of files with the LDGV and LDGT1 emission factors created by the first, or NLEV, set of files.

6.5.3.8.5 Heavy Duty Diesel Engine Corrections and Controls —

Basic Emission Rate Corrections. The same input corrections for the basic emission rates (BERs) for HDDVs and HDGVs used in the 1995 and 1996 input files were used for the projection year input files. The zero mile level (ZML) and DR inputs are given below.

		NO_x		VOC	
Vehicle Category	Model Year	ZML (g/bhp-hr)	DR (g/bhp-hr/10k mi)	ZML (g/bhp-hr)	DR (g/bhp-hr/10k mi)
HDGV	1998 +	3.19	0.045		
HDGV	1994 +			0.364	0.023
HDDV	1994 - 2003			0.283	0.000

HDDV Controls. EPA has determined that additional reductions in NO_x and NMHC emissions are needed at the national level from heavy duty vehicles. In response, EPA has issued more stringent emission standards for HDDVs starting with the 2004 model year. These standards are found in 40 CFR, 62, No. 203, 54694-54730, October 21, 1997. This new standard, referred to as the HDDV 2.0 g/bhp-hr NO_x standard, is not incorporated in MOBILE5b. To simulate the effects of the new HDDV standard, BERs for heavy-duty diesel vehicles were input to MOBILE5b, as shown below. This input line was included in the projection year files for 2005 and beyond, for both low and high altitude areas. These input files also included the heavy-duty vehicle (HDV) BER corrections as documented above. As with the files that only included the BER corrections, NEWFLG was set to "2."

Vehicle Category	Model Year	NO_x ZML (g/bhp-hr)	NO_x DR (g/bhp-hr/10k mi)	VOC ZML (g/bhp-hr)	VOC DR (g/bhp-hr/10k mi)
HDDV	2004 +	1.84	0.000	0.257	0.000

6.5.3.8.6 California-specific Inputs — Because California's highway vehicle fleet has been subject to different emission standards than the rest of the county, an EPA-modified version of MOBILE5a, referred to as CALI5, was used for California. Input files used with this model are essentially identical to MOBILE5a input files, and the model internally handles the different emission standards.

Phase II of California's reformulated gasoline program began on June 1, 1996. This was modeled by setting the reformulated gasoline flag to "5" starting with the June 1996 scenarios in the CALI5 input files and in all of the projection year files. The RVP value modeled for California in all projection years was 7.0 psi, following EPA guidance.

California's low emission vehicle program began in 1994. This was modeled in the CALI5 input files indicating a start year of 1994 for this program and minimum LEV credits. Because MOBILE5a did not include LDGT2s in the LEV modeling, this was carried forward to CALI5. However, California's LEV program does include LDGT2s. To model the LDGT2s in the LEV program, additional BER input lines were added to model the ZML and DR of the California LEV program standard for LDGT2s. Two sets of BERs were developed–one modeling the maximum LEV benefits for LDGT2s and the other modeling the minimum benefits. The maximum LEV benefits were applied in areas modeled with the high enhanced I/M program beginning in 2005. Table 6.5-12 shows the ZMLs and DRs modeled for both areas.

6.5.4 Additional PART5 Model Inputs

The HDDV VMT splits used in 1995 and 1996 were also used for the projection years. In addition, the values developed for the average number of wheels per vehicle per vehicle class were used for all years, including the projection years.

6.5.5 Calculation of Highway Vehicle Emission Inventories

Emissions from highway vehicles were calculated the same way (multiplying the appropriate emission factors by the corresponding VMT values) for all years, including the projection years.

6.5.6 References

1. *MOBILE5b Users Manual*, U.S. Environmental Protection Agency, Office of Mobile Sources, Ann Arbor, MI.

2. *MOBILE4.1 Fuel Consumption Model (Draft)*, U.S. Environmental Protection Agency, Office of Mobile Sources, Ann Arbor, MI, August 1991.

3. *Statistical Abstract of the United States - 1993*, U.S. Department of Commerce, Bureau of the Census, Washington, DC, 1994.

4. *Highway Performance Monitoring System Field Manual*, U.S. Department of Transportation, Federal Highway Administration, Washington, DC, December 1987.

5. *Major Modeling Elements for Operating I/M Programs*, table provided by Joseph Somers, U.S. Environmental Protection Agency, Office of Mobile Sources, to E.H. Pechan & Associates, Inc., February 25, 1997.

6. *Ozone Transport Assessment Group (OTAG) Emission Inventory Development Report–Volume III: Projections and Controls*, Draft report prepared by E.H. Pechan & Associates, Inc., for the U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1997.

7. *Emission Projections for the Clean Air Act Section 812 Prospective Analysis*, External draft report prepared by E.H. Pechan & Associates, Inc., for Industrial Economics, Inc., Cambridge, MA, February 1997.

Table 6.5-1. National Annual Highway Vehicle VMT Projections by Vehicle Type

Vehicle Type	National Annual Highway Vehicle VMT Projections (million miles/year)						
	1999	2000	2002	2005	2007	2008	2010
LDGV	1,720,746	1,750,598	1,809,586	1,901,018	1,963,516	1,995,184	2,059,873
LDGT1	451,510	465,153	491,886	531,881	558,639	572,088	599,170
LDGT2	230,022	236,973	250,592	270,967	284,599	291,450	305,248
HDGV	57,188	58,881	62,357	67,627	71,539	73,547	77,537
LDDV	7,970	5,983	3,529	2,107	678	463	65
LDDT	2,931	2,569	2,028	1,753	1,427	1,327	1,264
HDDV	154,067	159,931	171,272	188,361	199,580	205,211	216,487
2B HDDV	*191*	*198*	*213*	*233*	*248*	*256*	*270*
Light HDDV	*4,049*	*4,203*	*4,502*	*4,951*	*5,246*	*5,395*	*5,692*
Medium HDDV	*15,646*	*16,241*	*17,393*	*19,128*	*20,267*	*20,840*	*21,985*
Heavy HDDV	*126,374*	*131,184*	*140,484*	*154,504*	*163,704*	*168,320*	*177,569*
Buses	*7,808*	*8,105*	*8,680*	*9,546*	*10,114*	*10,400*	*10,972*
MC	11,281	11,476	11,862	12,460	12,868	13,076	13,499
TOTAL	***2,422,820***	***2,691,564***	***2,803,112***	***2,976,174***	***3,092,846***	***3,152,346***	***3,273,141***

Table 6.5-2. Annual State VMT Totals by Year (million miles/year)

State	1995	1999	2000	2002	2005	2007	2008	2010
Alabama	50,628	54,366	55,342	57,342	60,408	62,557	63,663	65,874
Alaska	4,121	4,531	4,638	4,845	5,169	5,376	5,480	5,695
Arizona	39,653	44,759	46,100	48,637	52,591	55,188	56,522	59,235
Arkansas	26,653	28,946	29,541	30,725	32,550	33,786	34,427	35,704
California	276,372	304,433	311,847	326,719	349,935	365,126	372,854	388,693
Colorado	35,059	39,045	40,086	42,116	45,288	48,401	48,474	50,672
Connecticut	28,043	29,969	30,483	31,620	33,372	34,592	35,210	36,454
Delaware	7,517	8,201	8,383	8,731	9,274	9,641	9,829	10,212
DC	3,467	3,805	3,896	4,077	4,356	4,546	4,642	4,838
Florida	127,809	142,451	147,558	155,709	168,402	176,919	181,271	190,143
Georgia	85,384	94,812	97,288	102,031	109,442	114,430	116,957	122,143
Hawaii	7,945	8,636	8,816	9,178	9,742	10,122	10,315	10,711
Idaho	12,297	13,696	14,063	14,718	15,735	16,406	16,743	17,436
Illinois	94,189	101,036	102,847	106,583	112,439	116,339	118,353	122,367
Indiana	64,551	69,136	70,334	72,786	76,570	79,206	80,544	83,254
Iowa	25,986	27,673	28,107	29,041	30,481	31,465	31,969	32,985
Kansas	25,152	27,252	27,801	28,877	30,530	31,645	32,209	33,362
Kentucky	41,095	44,047	44,816	46,420	48,884	50,600	51,468	53,218
Louisiana	38,647	41,494	42,246	43,779	46,156	47,751	48,570	50,212
Maine	12,590	13,554	13,804	14,358	15,208	15,790	16,089	16,693
Maryland	44,881	48,812	49,837	51,907	55,101	57,268	58,363	60,606
Massachusetts	48,054	51,484	52,403	54,334	57,306	59,376	60,407	62,536
Michigan	85,702	90,695	91,988	94,707	98,878	101,810	103,298	106,314
Minnesota	44,072	47,907	48,906	50,888	53,936	55,966	57,000	59,083
Mississippi	29,558	31,803	32,383	33,540	35,317	36,546	37,166	38,421
Missouri	59,347	64,007	65,222	67,713	71,568	74,175	75,512	78,211
Montana	9,440	10,392	10,639	11,114	11,853	12,339	12,590	13,094
Nebraska	15,808	17,086	17,412	18,072	19,088	19,772	20,121	20,822
Nevada	13,974	16,239	16,832	17,954	19,702	20,858	21,451	22,657
New Hampshire	10,643	11,509	11,738	12,207	12,928	13,424	13,673	14,185
New Jersey	61,013	65,465	66,633	68,986	72,629	75,103	76,370	78,932
New Mexico	21,149	23,615	24,265	25,514	27,466	28,754	29,412	30,752
New York	115,091	121,278	122,919	126,199	131,250	134,739	136,501	140,085
North Carolina	76,054	83,957	86,034	89,991	96,136	100,321	102,464	106,815
North Dakota	6,545	6,991	7,108	7,342	7,701	7,949	8,074	8,328
Ohio	100,788	107,151	108,831	112,240	17,499	121,143	123,024	126,769
Oklahoma	38,490	41,622	42,446	44,055	46,550	48,249	49,111	50,865
Oregon	30,034	33,144	33,955	35,562	38,055	39,710	40,548	42,256
Pennsylvania	94,518	100,641	102,206	1055,545	110,671	114,280	116,115	119,828
Rhode Island	6,894	7,332	7,443	7,698	8,098	8,371	8,516	8,803
South Carolina	38,722	42,371	43,329	45,266	48,273	50,297	51,340	53,440
South Dakota	7,668	8,388	8,576	8,948	9,530	9,913	10,112	10,506
Tennessee	56,213	61,530	62,920	65,559	69,667	72,454	73,870	76,742
Texas	181,096	199,555	204,410	213,615	227,923	237,359	242,198	252,007
Utah	18,781	21,249	21,903	23,179	25,180	26,474	27,144	28,493
Vermont	6,206	6,788	6,939	7,245	7,716	8,035	8,199	8,528
Virginia	69,811	75,784	77,357	80,599	85,615	89,082	90,839	94,403
Washington	49,248	54,652	56,073	59,005	63,582	66,614	68,151	71,312
West Virginia	17,422	18,493	18,772	19,341	20,210	20,836	21,162	21,813
Wisconsin	51,396	55,304	56,307	58,420	61,678	63,902	65,030	67,326
Wyoming	7,045	7,628	7,784	8,080	8,538	8,843	8,996	9,309
Total	***2,422,820***	***2,635,715***	***2,691,564***	***2,803,112***	***2,976,174***	***3,092,846***	***3,152,346***	***3,273,141***

Table 6.5-3. Monthly RVP Values Modeled in Projection Years (in psi)

State	Nonattainment Area or Other Applicable Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AL	Birmingham	12.4	12.4	9.5	9.5	7.8	7.8	7.8	7.8	7.8	9.5	9.5	12.4
AL	Rest of State	12.4	12.4	9.5	9.5	8.7	8.7	8.7	8.7	8.7	9.5	9.5	12.4
AK	Entire State	14.1	14.1	14.1	14.1	9.5	9.5	9.5	9.5	9.5	14.1	14.1	14.1
AZ	Phoenix	8.7	7.9	7.2	7.2	7.8	7.8	7.8	7.8	7.8	6.8	7.2	7.9
AZ	Rest of State	8.7	7.9	7.2	7.2	8.7	8.7	8.7	8.7	8.7	6.8	7.2	7.9
AR	Entire State	13.7	13.7	9.8	9.8	8.7	8.7	8.7	8.7	8.7	9.8	13.7	13.7
CA	Entire State	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
CO	Entire State	13.2	12.1	10.7	10.7	8.7	8.7	8.7	8.7	8.7	9.6	10.7	12.1
CT	Entire State	13.0	13.0	10.8	10.8	8.7	8.7	8.7	8.7	8.7	10.8	10.8	13.0
DE	Entire State	13.5	13.5	11.1	11.1	8.7	8.7	8.7	8.7	8.7	7.9	11.1	13.5
DC	Entire State	12.8	10.3	10.3	7.0	7.8	7.8	7.8	7.8	7.8	7.0	10.3	12.8
FL	Miami-Ft Laud-W Plm Bea	11.8	11.8	7.4	7.4	7.8	7.8	7.8	7.8	7.8	7.4	7.4	11.8
FL	Tampa-St Petersbg-Clrwtr	11.8	11.8	7.4	7.4	7.8	7.8	7.8	7.8	7.8	7.4	7.4	11.8
FL	Rest of State	11.8	11.8	7.4	7.4	8.7	8.7	8.7	8.7	8.7	7.4	7.4	11.8
GA	Atlanta	12.4	12.4	9.4	9.4	7.8	7.8	7.8	7.8	7.8	9.4	9.4	12.4
GA	Rest of State	12.4	12.4	9.4	9.4	8.7	8.7	8.7	8.7	8.7	9.4	9.4	12.4
HI	Entire State	10.0	10.0	10.0	10.0	9.5	9.5	9.5	9.5	9.5	10.0	10.0	10.0
ID	Entire State	13.9	12.3	12.3	10.2	8.7	8.7	8.7	8.7	8.7	8.6	10.2	12.3
IL	Entire State	14.1	14.1	11.4	11.4	8.7	8.7	8.7	8.7	8.7	7.8	11.4	14.1
IN	Entire State	14.5	14.5	12.0	12.0	8.7	8.7	8.7	8.7	8.7	8.7	12.0	14.5
IA	Entire State	14.9	14.9	13.3	11.2	8.7	8.7	8.7	8.7	8.7	11.2	13.3	14.9
KS	Entire State	14.0	12.1	9.5	9.5	8.7	8.7	8.7	8.7	8.7	7.6	9.5	12.1
KY	Entire State	14.2	11.7	11.7	8.4	8.7	8.7	8.7	8.7	8.7	8.4	11.7	14.2
LA	Baton Rouge	12.4	12.4	9.6	9.6	7.8	7.8	7.8	7.8	7.8	9.6	9.6	12.4
LA	Lake Charles	12.4	12.4	9.6	9.6	7.8	7.8	7.8	7.8	7.8	9.6	9.6	12.4
LA	Rest of State	12.4	12.4	9.6	9.6	8.7	8.7	8.7	8.7	8.7	9.6	9.6	12.4
ME	Entire State	13.2	13.2	11.0	11.0	8.7	8.7	87.7	8.7	8.7	11.0	1.0	13.2
MD	Baltimore	13.2	13.2	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.5	10.8	13.2
MD	Phila-Wilmington-Trenton	13.2	13.2	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.5	10.8	13.2
MD	Washington DC	13.2	13.2	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.5	10.8	13.2
MD	Kent & Queen Anne Cos	13.2	13.2	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.5	10.8	13.2
MD	Rest of State	13.2	13.2	10.8	10.8	8.7	8.7	8.7	8.7	8.7	7.5	10.8	13.2
MA	Entire State	12.9	12.9	10.7	10.7	8.7	8.7	8.7	8.7	8.7	10.7	10.7	12.9
MI	Entire State	14.1	14.1	11.2	11.2	8.7	8.7	8.7	8.7	8.7	11.2	11.2	14.1
MN	Entire State	14.9	14.9	12.6	12.6	8.7	8.7	8.7	8.7	8.7	9.6	12.6	14.9
MS	Entire State	13.7	13.7	9.8	9.8	8.7	8.7	8.7	8.7	8.7	9.8	9.8	13.7
MO	St. Louis	13.9	11.9	11.9	9.2	7.8	7.8	7.8	7.8	7.8	9.2	11.9	11.9
MO	Rest of State	13.9	11.9	11.9	9.2	8.7	8.7	8.7	8.7	8.7	9.2	11.9	11.9
MT	Entire State	13.8	13.8	12.3	10.2	8.7	8.7	8.7	8.7	8.7	10.2	12.3	13.8
NE	Entire State	14.5	14.5	12.7	10.4	8.7	8.7	8.7	8.7	8.7	8.6	10.4	12.7
NV	Reno	10.5	9.2	8.2	8.2	7.8	7.8	7.8	7.8	7.8	7.6	8.2	9.2
NV	Rest of State	10.5	9.2	8.2	8.2	8.7	8.7	8.7	8.7	8.7	7.6	8.2	9.2
NH	Entire State	12.9	12.9	10.7	10.7	8.7	8.7	8.7	8.7	8.7	10.7	10.7	12.9
NJ	Entire State	13.7	13.7	11.3	11.3	8.7	8.7	8.7	8.7	8.7	11.3	11.3	13.7
NM	Entire State	11.7	11.7	10.2	9.1	8.7	8.7	8.7	8.7	8.7	9.1	10.2	11.7
NY	Entire State	14.3	14.3	11.9	11.9	8.7	8.7	8.7	8.7	8.7	11.9	11.9	14.3
NC	Charlotte-Gastonia	12.4	12.4	12.4	9.4	7.8	7.8	7.8	7.8	7.8	9.4	12.4	12.4
NC	Greensboro	12.4	12.4	12.4	9.4	7.8	7.8	7.8	7.8	7.8	9.4	12.4	12.4
NC	Raleigh-Durham	12.4	12.4	12.4	9.4	7.8	7.8	7.8	7.8	7.8	9.4	12.4	12.4
NC	Rest of State	12.4	12.4	12.4	9.4	8.7	8.7	8.7	8.7	8.7	9.4	12.4	12.4
ND	Entire State	14.9	14.9	13.3	13.3	8.7	8.7	8.7	8.7	8.7	11.2	13.3	14.9
OH	Entire State	14.6	14.6	12.1	12.1	8.7	8.7	8.7	8.7	8.7	8.7	12.1	14.6
OK	Entire State	13.9	13.9	10.1	10.1	8.7	8.7	8.7	8.7	8.7	7.2	10.1	13.9
OR	Portland-Vancouver	13.1	10.8	10.8	10.8	7.8	7.8	7.8	7.8	7.8	7.7	10.8	13.1
OR	Rest of State	13.1	10.8	10.8	10.8	8.7	8.7	8.7	8.7	8.7	7.7	10.8	13.1

Table 6.5-3 (continued)

State	Nonattainment Area or Other Applicable Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PA	Entire State	14.4	14.4	12.0	12.0	8.7	8.7	8.7	8.7	8.7	12.0	12.0	14.4
RI	Entire State	12.9	12.9	10.7	10.7	8.7	8.7	8.7	8.7	8.7	10.7	10.7	12.9
SC	Cherokee Co SC	12.4	12.4	12.4	9.4	7.8	7.8	7.8	7.8	7.8	9.4	12.4	12.4
SC	Rest of State	12.4	12.4	12.4	9.4	8.7	8.7	8.7	8.7	8.7	9.4	12.4	12.4
SD	Entire State	14.9	14.9	13.3	11.2	8.7	8.7	8.7	8.7	8.7	9.6	11.2	13.3
TN	Knoxville	12.7	12.7	12.7	9.5	7.8	7.8	7.8	7.8	7.8	9.5	12.7	12.7
TN	Memphis	12.7	12.7	12.7	9.5	7.8	7.8	7.8	7.8	7.8	9.5	12.7	12.7
TN	Nashville	12.7	12.7	12.7	9.5	7.8	7.8	7.8	7.8	7.8	9.5	12.7	12.7
TN	Rest of State	12.7	12.7	12.7	9.5	8.7	8.7	8.7	8.7	8.7	9.5	12.7	12.7
TX	Beaumont-Port Arthur	12.2	12.2	10.0	10.0	7.8	7.8	7.8	7.8	7.8	8.3	10.0	12.2
TX	Dallas-Fort Worth	12.2	12.2	10.0	10.0	7.8	7.8	7.8	7.8	7.8	8.3	10.0	12.2
TX	El Paso	12.2	12.2	10.0	10.0	7.8	7.8	7.8	7.8	7.8	8.3	10.0	12.2
TX	Houstn-Galvestn-Brazonia	12.2	12.2	10.0	10.0	7.8	7.8	7.8	7.8	7.8	8.3	10.0	12.2
TX	Rest of State	12.2	12.2	10.0	10.0	8.7	8.7	8.7	8.7	8.7	8.3	10.0	12.2
UT	Salt Lake City	13.2	12.1	12.1	10.7	7.8	7.8	7.8	7.8	7.8	9.6	10.7	12.1
UT	Rest of State	13.2	12.1	12.1	10.7	8.7	8.7	8.7	8.7	8.7	9.6	10.7	12.1
VT	Entire State	14.9	14.9	12.6	12.6	8.7	8.7	8.7	8.7	8.7	12.6	12.6	14.9
VA	Norfolk-Virginia	12.6	10.2	10.2	7.1	7.8	7.8	7.8	7.8	7.8	7.1	10.2	12.6
VA	Richmond-Petersburg	12.6	10.2	10.2	7.1	7.8	7.8	7.8	7.8	7.8	7.1	10.2	12.6
VA	Washington DC	12.6	10.2	10.2	7.1	7.8	7.8	7.8	7.8	7.8	7.1	10.2	12.6
VA	Smyth Co VA	12.6	10.2	10.2	7.1	7.8	7.8	7.8	7.8	7.8	7.1	10.2	12.6
VA	Rest of State	12.6	10.2	10.2	7.1	8.7	8.7	8.7	8.7	8.7	7.1	10.2	12.6
WA	Entire State	14.0	14.0	11.6	11.6	8.7	8.7	8.7	8.7	8.7	8.5	11.6	14.0
WV	Entire State	14.6	14.6	12.1	12.1	8.7	8.7	8.7	8.7	8.7	8.8	12.1	14.6
WI	Entire State	14.6	14.6	12.2	12.2	8.7	8.7	8.7	8.7	8.7	9.0	12.2	14.6
WY	Entire State	13.5	13.5	12.1	10.2	8.7	8.7	8.7	8.7	8.7	8.8	10.2	12.1

Table 6.5-4. Projection Year Monthly Temperature Inputs (°F)

	January			February			March			April			May			June		
State	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient
Alabama	60	40	49.9	64	43	53.2	71	50	60.5	78	57	67.8	85	64	74.5	90	71	80.4
Alaska	29	19	24.2	34	23	28.4	39	27	32.7	47	32	39.7	55	39	47.0	61	45	53.0
Arizona	66	41	53.6	71	45	57.7	76	49	62.2	84	55	69.9	94	64	78.8	104	73	88.2
Arkansas	49	29	39.1	54	33	43.6	64	42	53.1	73	51	62.1	81	59	70.2	89	67	78.4
California (LA)	66	48	56.8	66	49	57.6	66	50	58.0	67	53	60.1	69	56	62.7	72	60	65.7
California (SF)	56	42	48.7	59	45	52.2	61	46	53.3	64	47	55.6	66	50	58.1	70	53	61.5
Colorado	43	16	29.7	47	20	33.4	52	26	39.0	62	34	48.2	71	44	57.2	81	52	66.9
Connecticut	33	16	24.5	36	19	27.5	47	28	37.5	60	38	48.7	72	48	59.6	80	57	68.5
Delaware	39	22	30.6	42	25	33.4	52	33	42.6	63	42	52.2	73	52	62.6	81	62	71.5
DC	42	27	34.6	46	29	37.5	56	38	47.1	67	46	56.6	76	57	66.4	85	66	75.6
Florida	75	59	67.2	76	60	68.5	79	64	71.7	82	68	75.1	85	72	78.7	88	75	81.4
Georgia	50	32	41.0	55	34	44.8	64	42	53.4	73	50	61.5	80	59	69.2	86	66	76.0
Hawaii	80	66	72.9	80	65	73.0	82	67	74.4	83	69	75.8	85	70	77.5	86	72	79.4
Idaho	36	22	29.0	44	28	35.9	53	32	42.4	61	37	49.1	71	44	57.5	81	52	66.5
Illinois	29	13	21.0	34	17	25.4	46	28	37.2	59	39	48.6	70	48	58.9	80	58	68.6
Indiana	34	17	25.5	38	21	29.6	51	32	41.4	63	42	52.4	74	52	62.8	83	61	71.9
Iowa	28	11	19.4	34	16	24.7	47	28	37.3	62	40	50.9	73	52	62.3	82	61	71.7
Kansas	40	19	29.5	46	24	34.8	57	34	45.4	68	44	56.4	77	54	65.6	87	65	75.7
Kentucky	40	23	31.8	45	26	35.7	56	36	46.3	67	45	56.4	76	55	65.4	84	63	73.2
Louisiana	61	42	51.3	64	44	54.3	72	52	61.6	78	58	68.5	84	65	74.8	89	71	80.0
Maine	30	11	20.9	33	14	23.3	41	24	33.0	52	34	43.2	63	43	53.3	73	52	62.4
Maryland	40	23	31.8	44	26	34.8	54	34	44.1	64	42	53.4	74	53	63.4	83	62	72.5
Massachusetts	36	22	28.7	38	23	30.3	46	31	38.6	56	40	48.1	67	50	58.2	76	59	67.7
Michigan	30	16	23.0	33	18	25.5	44	27	35.7	58	37	47.3	70	47	58.4	79	56	67.6
Minnesota	21	3	11.8	27	9	17.9	39	23	31.0	56	36	46.4	69	48	58.5	79	58	68.2
Mississippi	56	33	44.2	60	36	47.9	69	44	56.7	77	52	64.7	84	60	72.0	91	67	78.9
Missouri	35	17	25.7	41	22	31.2	53	33	42.7	65	44	54.5	74	54	64.1	83	63	73.2
Montana	31	12	21.1	38	17	27.4	44	23	33.3	55	32	43.6	65	41	53.1	75	49	61.6
Nebraska	31	11	21.1	37	17	26.9	49	28	38.6	64	40	51.9	74	51	62.5	84	60	72.1
Nevada	45	21	32.9	52	24	38.0	56	29	42.8	64	33	48.5	73	40	56.5	83	47	65.0
New Hampshire	30	7	18.6	33	10	21.7	43	22	32.5	56	32	43.9	69	41	55.2	77	51	64.3
New Jersey	40	21	30.9	42	24	33.0	52	31	41.5	61	39	50.0	71	50	60.4	80	59	69.4
New Mexico	47	22	34.3	54	26	40.0	61	32	46.8	71	40	55.2	80	49	64.2	90	58	74.2
New York	38	25	31.5	40	27	33.6	50	35	42.4	61	44	52.5	72	54	62.7	80	63	71.6
North Carolina	49	29	38.9	53	31	42.0	62	39	50.4	72	46	59.0	79	55	67.0	85	64	74.3
North Dakota	20	0	9.3	26	5	15.8	38	18	28.2	55	31	43.0	68	42	55.0	77	52	64.4

Table 6.5-4 (continued)

	January			February			March			April			May			June		
State	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient
Ohio	34	18	26.3	38	21	29.6	50	31	40.9	62	40	51.0	72	50	61.2	80	58	69.2
Oklahoma	47	25	36.0	52	30	40.9	62	38	50.3	72	49	60.4	79	58	68.4	87	66	76.7
Oregon	45	11	28.4	51	14	32.3	56	24	40.3	61	34	47.4	67	43	55.3	74	52	63.1
Pennsylvania	38	23	30.4	41	25	32.9	52	33	42.4	63	42	52.4	73	53	62.9	82	62	71.8
Rhode Island	37	19	27.9	38	21	29.6	46	29	37.5	57	38	47.4	67	47	57.3	77	57	66.9
South Carolina	55	32	43.7	59	34	46.8	68	42	55.2	76	49	63.0	84	58	70.9	89	66	77.4
South Dakota	24	3	13.8	30	10	19.7	42	23	32.5	59	35	46.9	71	46	58.3	80	56	68.3
Tennessee	46	26	36.2	51	30	40.4	61	39	50.2	71	48	59.2	79	57	67.7	86	65	75.6
Texas	54	33	43.4	59	37	47.9	68	46	56.7	76	55	65.5	83	63	72.8	92	70	81.0
Utah	36	19	27.9	44	25	34.1	52	31	41.8	61	38	49.6	72	46	58.8	83	55	69.1
Vermont	25	8	16.3	28	9	18.2	39	22	30.7	54	34	43.9	67	45	56.3	76	55	65.2
Virginia	46	26	35.7	49	28	38.7	60	36	47.9	70	45	57.3	78	54	66.0	85	63	73.9
Washington	45	35	40.1	50	37	43.5	53	38	45.6	57	41	49.2	64	46	55.1	70	52	60.9
West Virginia	41	23	32.1	45	26	35.5	57	35	45.9	67	43	54.8	76	52	63.5	83	60	71.5
Wisconsin	26	12	18.9	30	16	23.0	40	26	33.3	53	36	44.4	64	45	54.6	75	55	65.0
Wyoming	38	15	26.5	40	18	29.3	45	22	33.5	55	30	42.4	65	39	52.0	74	48	61.4

Table 6.5-4 (continued)

	July			August			September			October			November			December		
State	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient
Alabama	91	73	82.3	90	73	81.7	87	69	77.8	80	57	68.4	70	49	59.7	63	43	53.0
Alaska	64	48	56.0	63	47	55.0	56	43	49.4	47	37	42.2	37	27	32.0	32	23	27.1
Arizona	106	81	93.5	104	79	91.5	98	73	85.6	88	61	74.5	75	49	61.9	66	42	54.0
Arkansas	92	72	82.0	91	70	80.6	85	64	74.1	75	51	63.0	63	42	52.1	52	33	42.8
California (LA)	75	63	69.1	77	64	70.4	77	63	69.9	74	59	66.8	70	53	61.6	66	48	56.9
California (SF)	72	54	62.8	72	55	63.7	74	55	64.4	70	52	61.0	62	47	54.8	56	43	49.4
Colorado	88	59	73.4	86	57	71.4	77	48	62.3	66	36	51.4	52	25	39.0	44	17	31.0
Connecticut	85	62	73.6	83	60	71.6	75	52	63.3	64	41	52.2	51	33	41.9	38	21	29.4
Delaware	86	67	76.4	84	66	75.0	78	58	68.0	67	46	56.2	56	37	46.3	44	28	35.8
DC	88	71	80.0	87	70	78.5	80	62	71.3	69	50	59.7	58	41	49.7	47	32	39.4
Florida	89	76	82.6	89	77	82.9	88	76	81.9	84	72	78.3	80	67	73.6	77	62	69.1
Georgia	88	70	78.8	87	69	78.1	82	64	72.7	73	52	62.3	63	43	53.1	54	35	44.5
Hawaii	88	74	80.5	89	74	81.5	88	74	81.0	87	72	79.6	84	70	77.2	81	67	74.1
Idaho	90	58	74.0	88	57	72.5	77	48	62.6	65	39	51.8	49	31	39.9	38	22	30.1
Illinois	84	63	73.2	82	62	71.7	75	54	64.4	63	42	52.8	48	32	40.0	34	19	26.6
Indiana	86	65	75.4	84	63	73.2	78	56	66.6	66	44	54.7	52	34	43.0	38	23	30.9
Iowa	87	66	76.6	84	64	73.9	76	54	65.1	64	43	53.5	48	30	39.0	33	16	24.4
Kansas	93	70	81.4	91	68	79.3	81	59	70.3	71	47	58.6	55	34	44.6	43	23	33.0
Kentucky	87	67	77.2	86	66	75.8	80	59	69.5	69	46	57.5	57	37	47.1	45	29	36.9
Louisiana	91	73	81.9	90	73	81.5	87	70	78.1	79	59	69.1	71	51	61.1	64	45	54.6
Maine	79	58	68.6	77	57	67.3	69	49	59.1	59	38	48.5	47	30	38.7	35	18	26.5
Maryland	87	67	77.0	85	66	75.6	78	58	68.5	67	46	56.6	56	37	46.8	45	28	36.7
Massachusetts	82	65	73.5	80	64	71.9	73	57	64.8	63	47	54.8	52	38	45.3	40	27	33.6
Michigan	83	61	72.3	81	60	70.5	74	52	63.2	62	41	51.2	48	32	40.2	35	21	28.3
Minnesota	84	63	73.6	81	60	70.5	71	50	60.5	59	39	48.8	41	25	33.1	26	10	17.9
Mississippi	92	70	81.5	92	70	80.9	88	64	75.9	79	50	64.7	69	42	55.8	60	36	47.8
Missouri	89	68	78.5	86	66	76.1	78	57	67.5	68	46	56.6	53	34	43.1	39	22	30.4
Montana	83	53	68.3	82	52	66.9	70	44	56.6	59	36	47.6	44	24	33.9	33	15	23.9
Nebraska	88	66	76.9	85	63	74.1	76	54	65.1	66	41	53.4	49	29	39.0	35	16	25.1
Nevada	92	51	71.6	90	50	69.6	80	41	60.4	69	33	50.8	54	27	40.3	46	20	32.7
New Hampshire	82	56	69.5	80	55	67.3	72	46	58.8	61	35	47.8	47	27	37.1	34	14	24.3
New Jersey	84	65	74.7	83	64	73.4	77	56	66.1	66	44	54.9	56	36	45.8	45	26	35.8
New Mexico	92	64	78.5	89	63	75.8	82	55	68.6	71	43	57.0	57	31	44.3	48	23	35.3
New York	85	68	76.8	84	67	75.5	76	60	68.2	65	50	57.5	54	41	47.6	42	31	36.6
North Carolina	88	68	78.1	87	68	77.2	81	61	71.1	72	48	60.0	63	40	51.2	53	32	42.6
North Dakota	84	56	70.4	83	54	68.3	71	43	57.0	59	32	45.6	39	18	28.6	24	3	13.9

Table 6.5-4 (continued)

State	July			August			September			October			November			December		
	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient	Max	Min	Ambient
Ohio	84	63	73.2	82	61	71.5	76	55	65.5	64	43	53.7	51	34	42.9	39	25	31.9
Oklahoma	93	71	82.0	92	70	81.1	84	62	73.0	74	50	62.0	60	39	49.5	50	29	39.3
Oregon	80	58	69.1	80	57	68.7	75	49	61.8	64	38	51.2	53	30	41.5	46	18	31.7
Pennsylvania	86	67	76.7	85	66	75.5	78	59	68.2	66	46	56.4	55	38	46.4	43	28	35.8
Rhode Island	82	63	72.7	81	62	71.3	74	54	64.1	64	43	53.6	53	35	44.0	41	24	32.8
South Carolina	92	70	80.8	90	69	79.7	85	63	74.2	76	50	63.2	68	42	54.7	59	35	46.9
South Dakota	86	62	74.3	83	59	71.4	73	49	60.9	61	36	48.6	43	23	33.0	28	9	18.3
Tennessee	90	69	79.2	88	68	78.1	82	61	71.8	72	48	60.4	60	40	50.0	50	31	40.6
Texas	96	74	85.3	96	74	84.9	88	67	77.4	78	56	67.2	67	45	56.1	58	36	46.9
Utah	92	64	78.0	89	62	75.6	79	51	65.1	66	40	53.2	51	31	40.9	38	22	29.7
Vermont	81	60	70.5	78	58	67.9	69	49	58.9	57	39	47.8	44	30	36.8	30	16	23.0
Virginia	88	68	78.0	87	66	76.8	81	59	70.0	71	46	58.6	61	38	49.6	50	30	40.1
Washington	75	55	65.2	75	56	65.5	69	52	60.6	60	46	52.8	50	40	45.3	45	36	40.5
West Virginia	86	64	75.1	84	63	73.9	79	56	67.7	68	44	56.2	57	36	46.8	46	28	37.0
Wisconsin	80	62	71.0	78	61	69.3	71	53	61.7	59	42	50.3	45	31	37.7	31	18	24.4
Wyoming	82	55	68.4	80	53	66.4	71	44	57.4	60	34	47.0	47	24	35.3	39	17	27.8

Table 6.5-5. Average Speeds by Road Type and Vehicle Type (MPH)

Rural						
	Interstate	Principa l Arterial	Minor Arterial	Major Collector	Minor Collector	Loca l
LDV	60	45	40	35	30	30
LDT	55	45	40	35	30	30
HDV	40	35	30	25	25	25

Urban						
	Interstate	Other Freeways & Expressways	Principa l Arterial	Minor Arterial	Collector	Loca l
LDV	45	45	20	20	20	20
LDT	45	45	20	20	20	20
HDV	35	35	15	15	15	15

Table 6.5-6. State-Supplied Trip Length Distribution Inputs

	Percentage of Total VMT Accumulated in Trips of:					
Nonattainment Area	**< 10 Minutes**	**11 to 20 Minutes**	**21 to 30 Minutes**	**31 to 40 Minutes**	**41 to 50 Minutes**	**> 50 Minutes**
Washington, DC/MD/VA	16.6	33.9	23.4	13.3	6.1	6.7
Baltimore	15.1	31.7	26	13.3	6.5	7.4
Houston	14.8	27.9	22.4	14.3	8.5	12.1
Dallas	9.8	19	23.8	19.4	13.6	14.4

Table 6.5-7. State-Specific I/M Program Inputs - Projection Years

I/M Program Name	AKIM991	AKIM992	AZIM991	AZIM992
I/M Program Control Flag Record				
Technical Training and Certification Program				
Remote Sensing Device Inspections Program				
I/M Program Parameters				
Program Start Year	1986	1986	1978	1978
Model Years Covered	1968-2020	1975-2020	1967-1980	1967-2020
Program Type	TRC	TRC	TO	TO
Inspection Frequency	Biennial	Biennial	Annual	Biennial
Vehicle Types Inspected				
LDGV	YES	YES	YES	YES
LDGT1	YES	YES	YES	YES
LDGT2	YES	YES	YES	YES
HDGV	NO	NO	YES	YES
Test Type	2500/Idle Test	2500/Idle Test	Idle Test	Idle Test
I/M Cutpoints	220/1.2/999	220/1.2/999	220/1.2/999	220/1.2/999
Effectiveness Rates (% HC/CO/NO_x)	0.85/0.85/0.85	0.85/0.85/0.85	1.00/1.00/1.00	1.00/1.00/1.00
I/M Program Parameters				
Program Start Year			1978	
Model Years Covered			1981-2020	
Program Type			TO	
Inspection Frequency			Biennial	
Vehicle Types Inspected				
LDGV			YES	
LDGT1			YES	
LDGT2			YES	
HDGV			YES	
Test Type			Transient Test	
I/M Cutpoints			1.20/20.0/3.00	
Effectiveness Rates (% HC/CO/NO_x)	0.85/0.85/0.85	0.85/0.85/0.85	1.00/1.00/1.00	1.00/1.00/1.00
Anti-Tampering Program Parameters				
Program Start Year	1986	1986	1977	1977
Model Years Covered	1968-2020	1975-2020	1975-2020	1975-2020
Program Type	TRC	TRC	TO	TO
Effectiveness Rate	0.85	0.85	1.00	1.00
Vehicle Types Inspected				
LDGV	YES	YES	YES	YES
LDGT1	YES	YES	YES	YES
LDGT2	YES	YES	YES	YES
HDGV	NO	NO	YES	YES
Inspection Frequency	Biennial	Biennial	Biennial	Biennial
Inspections Performed				
Air Pump System	YES	YES	YES	YES
Catalyst	YES	YES	YES	YES
Fuel Inlet Restrictor	NO	NO	NO	NO
Tailpipe Lead Deposit Test	NO	NO	NO	NO

Table 6.5-8. Counties Included in State-Specific I/M Projection Year Programs

I/M Program Name	Included Counties
AKIM991	Anchorage Ed
AKIM992	Fairbanks Ed
AZIM991	Maricopa Co
AZIM992	Pima Co
CAIM991	Alameda Co, Butte Co, Contra Costa Co, El Dorado Co, Merced Co, Orange Co, Placer Co, Riverside Co, San Bernardino Co, Solano Co, Stanislaus Co, Sutter Co, Yolo Co, Marin Co, Monterey Co, San Mateo Co, Sonoma Co, Fresno Co, Kern Co, Los Angeles Co, Napa Co, Sacramento Co, San Diego Co, San Francisco Co
CAIM992	Colusa Co, Glenn Co, Kings Co, Madera Co, Nevada Co, San Benito Co, San Joaquin Co, Santa Clara Co, Shasta Co, Tehama Co, Tulare Co, Ventura Co, Yuba Co, San Luis Obispo Co, Santa Barbara Co, Santa Cruz Co
COIM991*	Adams Co, Arapahoe Co, Boulder Co, Douglas Co, Jefferson Co, Denver Co
COIM992	Pitkin Co, El Paso Co, Larimer Co, Weld Co
CTIM99	Fairfield Co, Hartford Co, Litchfield Co, Middlesex Co, New Haven Co, New London Co, Tolland Co, Windham Co
DCIM99*	Washington
DEIM991	Kent Co, Sussex Co
DEIM992	New Castle Co
FLIM99	Broward Co, Dade Co, Duval Co, Hillsborough Co, Palm Beach Co, Pinellas Co
GAIM001	Cobb Co, De Kalb Co, Fulton Co, Gwinnett Co
GAIM002	Cherokee Co, Clayton Co, Coweta Co, Douglas Co, Fayette Co, Forsyth Co, Henry Co, Paulding Co, Rockdale Co
GAIM021	Cobb Co, De Kalb Co, Fulton Co, Gwinnett Co
GAIM022	Cherokee Co, Clayton Co, Coweta Co, Douglas Co, Fayette Co, Forsyth Co, Henry Co, Paulding Co, Rockdale Co
GAIM991	Cobb Co, De Kalb Co, Fulton Co, Gwinnett Co
GAIM992	Cherokee Co, Clayton Co, Coweta Co, Douglas Co, Fayette Co, Forsyth Co, Henry Co, Paulding Co, Rockdale Co
IDIM99	Ada Co
ILIM991*	Cook Co, Du Page Co, Lake Co, Madison Co, St. Clair Co
ILIM992*	Kane Co, Kendall Co, McHenry Co, Will Co, Monroe Co
INIM99*	Clark Co, Floyd Co, Lake Co, Porter Co
KYIM991	Boone Co, Campbell Co, Kenton Co
KYIM992	Jefferson Co
KYIM993	Boyd Co, Greenup Co
LAIM99	Ascension Par, East Baton Rouge Par, Iberville Par, Livingston Par, Pointe Coupee Par, West Baton Rouge Par
MAIM99	Barnstable Co, Berkshire Co, Bristol Co, Dukes Co, Essex Co, Franklin Co, Hampden Co, Hampshire Co, Middlesex Co, Nantucket Co, Norfolk Co, Plymouth Co, Suffolk Co, Worcester Co
MDIM001*	Anne Arundel Co, Baltimore Co, Carroll Co, Harford Co, Howard Co, Baltimore, Montgomery Co, Prince Georges Co
MDIM002*	Calvert Co, Cecil Co, Queen Annes Co, Charles Co, Frederick Co, Washington Co

Table 6.5-8 (continued)

I/M Program Name	Included Counties
MDIM021*	Anne Arundel Co, Baltimore Co, Carroll Co, Harford Co, Howard Co, Baltimore, Montgomery Co, Prince Georges Co
MDIM022*	Calvert Co, Cecil Co, Queen Annes Co, Charles Co, Frederick Co, Washington Co
MDIM991*	Anne Arundel Co, Baltimore Co, Carroll Co, Harford Co, Howard Co, Baltimore, Montgomery Co, Prince Georges Co
MDIM992*	Calvert Co, Cecil Co, Queen Annes Co, Charles Co, Frederick Co, Washington Co
MEIM99	Cumberland Co
MNIM00	Anoka Co, Carver Co, Dakota Co, Hennepin Co, Ramsey Co, Scott Co, Washington Co
MNIN02	Anoka Co, Carver Co, Dakota Co, Hennepin Co, Ramsey Co, Scott Co, Washington Co
MNIN99	Anoka Co, Carver Co, Dakota Co, Hennepin Co, Ramsey Co, Scott Co, Washington Co
MOIM02	Jefferson Co, St. Charles Co, St. Louis Co, St. Louis
MOIM99	Jefferson Co, St. Charles Co, St. Louis Co, St. Louis
NCIM991	Mecklenburg Co
NCIM992	Durham Co, Wake Co
NCIM993	Forsyth Co, Guilford Co, Gaston Co
NCIM994	Cabarrus Co, Union Co, Orange Co
NHIM99	Hillsborough Co, Rockingham Co
NJIM99	Atlantic Co, Cape May Co, Warren Co, Burlington Co, Camden Co, Cumberland Co, Gloucester Co, Salem Co, Bergen Co, Essex Co, Hudson Co, Hunterdon Co, Middlesex Co, Monmouth Co, Morris Co, Ocean Co, Passaic Co, Somerset Co, Sussex Co, Union Co, Mercer Co
NMIM99	Bernalillo Co
NVIM99	Clark Co, Washoe Co
NYIM001	Bronx Co, Kings Co, Nassau Co, New York Co, Queens Co, Richmond Co, Rockland Co, Suffolk Co, Westchester Co
NYIM002	Orange Co
NYIM021	Bronx Co, Kings Co, Nassau Co, New York Co, Queens Co, Richmond Co, Rockland Co, Suffolk Co, Westchester Co
NYIM022	Orange Co
NYIM993	Albany Co, Allegany Co, Broome Co, Cattaraugus Co, Cayuga Co, Chautauqua Co, Chemung Co, Chenango Co, Clinton Co, Columbia Co, Cortland Co, Delaware Co, Erie Co, Essex Co, Franklin Co, Fulton Co, Genessee Co, Greene Co, Hamilton Co, Herkimer Co, Jefferson Co, Lewis Co, Livingston Co, Madison Co, Monroe Co, Montgomery Co, Niagara Co, Oneida Co, Onondaga Co, Ontario Co, Orleans Co, Oswego Co, Otsego Co, Rensselaer Co, St. Lawrence Co, Saratoga Co, Schenectady Co, Schoharie Co, Schuyler Co, Seneca Co, Steuben Co, Sullivan Co, Tioga Co, Tompkins Co, Ulster Co, Warren Co, Washington Co, Wayne Co, Wyoming Co, Yates Co, Duchess Co, Putnam Co
OHIM001*	Clermont Co, Geauga Co, Medina Co, Portage Co, Summit Co, Warren Co, Butler Co, Hamilton Co, Lake Co, Lorain Co, Cuyahoga Co
OHIM002*	Clark Co, Greene Co, Montgomery Co
OHIM021*	Clermont Co, Geauga Co, Medina Co, Portage Co, Summit Co, Warren Co, Butler Co, Hamilton Co, Lake Co, Lorain Co, Cuyahoga Co
OHIM022*	Clark Co, Greene Co, Montgomery Co
OHIM991*	Clermont Co, Geauga Co, Medina Co, Portage Co, Summit Co, Warren Co, Butler Co, Hamilton Co, Lake Co, Lorain Co, Cuyahoga Co
OHIM992*	Clark Co, Greene Co, Montgomery Co
ORIM991*	Jackson Co, Josephine Co

Table 6.5-8 (continued)

I/M Program Name	Included Counties
ORIM992*	Clackamas Co, Multnomah Co, Washington Co
PAIM991	Lehigh Co, Northampton Co
PAIM992	Berks Co, Clair Co, Cambria Co, Centre Co, Cumberland Co, Dauphin Co, Lackawanna Co, Lancaster Co, Lebanon Co, Luzerne Co, Lycoming Co, York Co, Erie Co, Mercer Co
PAIM993	Bucks Co, Chester Co, Delaware Co, Montgomery Co, Philadelphia Co
PAIM994	Allegheny Co, Beaver Co, Washington Co, Westmoreland Co
RIIM99	Bristol Co, Kent Co, Newport Co, Providence Co, Washington Co
TNIM991	Davidson Co
TNIM992	Shelby Co
TNIM993	Rutherford Co, Sumner Co, Williamson Co, Wilson Co
TXIM001	Harris Co
TXIM002	Dallas Co, Tarrant Co
TXIM003	El Paso Co
TXIM021	Harris Co
TXIM022	Dallas Co, Tarrant Co
TXIM023	El Paso Co
TXIM991	Harris Co
TXIM992	Dallas Co, Tarrant Co
TXIM993	El Paso Co
UTIM991	Utah Co
UTIM992	Weber Co
UTIM993	Davis Co, Salt Lake Co
VAIM991	Arlington Co, Fairfax Co, Prince William Co, Alexandria, Manassas, Manassas Park, Fairfax, Falls Church
VAIM992	Loudoun Co, Stafford Co
VTIM99	Addison Co, Bennington Co, Caledonia Co, Chittenden Co, Essex Co, Franklin Co, Grand Isle Co, Lamoille Co, Orange Co, Orleans Co, Rutland Co, Washington Co, Windham Co, Windsor Co
WAIM001	King Co, Snohomish Co
WAIM002	Pierce Co, Clark Co
WAIM003	Spokane Co
WAIM021	King Co, Snohomish Co
WAIM022	Pierce Co, Clark Co
WAIM023	Spokane Co
WAIM991	King Co, Snohomish Co
WAIM992	Pierce Co, Clark Co
WAIM993	Spokane
WIIM991*	Kenosha Co, Milwaukee Co, Ozaukee Co, Racine Co, Washington Co, Waukesha Co
WIIM992*	Sheboygan Co

*Indicates that the maximum LEV benefits were applied.

Table 6.5-9. I/M Performance Standard Program Inputs

I/M Program Name	Basic I/M Performance Standard	Low Enhanced I/M Performance Standard	High Enhanced I/M Performance Standard
I/M Program Parameters			
Program Start Year	1983	1983	1983
Stringency Level (Percent)	20	20	20
Model Years Covered	1968-2020	1968-2020	1968-1985
Waiver Rate for Pre-1981 Model Years (%)	0	3	3
Waiver Rate for 1981 and Later Models (%)	0	3	3
Compliance Rate (%)	100	96	96
Program Type	TO	TO	TO
Inspection Frequency	Annual	Annual	Annual
Vehicle Types Inspected			
LDGV	YES	YES	YES
LDGT1	NO	YES	YES
LDGT2	NO	YES	YES
HDGV	NO	NO	NO
Test Type	Idle Test	Idle Test	2500/Idle Test
I/M Cutpoints	220/1.2/999	220/1.2/999	220/1.2/999
Effectiveness Rates (% HC/CO/NO_x)	1.00/1.00/1.00	1.00/1.00/1.00	1.00/1.00/1.00
I/M Program Parameters			
Program Start Year			1983
Stringency Level (Percent)			20
Model Years Covered			1986-2020
Waiver Rate for Pre-1981 Model Years (%)			3
Waiver Rate for 1981 and Later Models (%)			3
Compliance Rate (%)			96
Program Type			TO
Inspection Frequency			Annual
Vehicle Types Inspected			
LDGV			YES
LDGT1			YES
LDGT2			YES
HDGV			NO
Test Type			Transient Test
I/M Cutpoints (g/mi HC/CO/NO_x)			0.80/20.0/2.00
			1.00/1.00/1.00
Anti-Tampering Program Parameters			
Program Start Year		1995	1995
Model Years Covered		1972-2020	1984-2020
Vehicle Types Inspected			
LDGV		YES	YES
LDGT1		YES	YES
LDGT2		YES	YES
HDGV		NO	NO
Program Type		TO	TO
Effectiveness Rate		1.00	1.00
Inspection Frequency		Annual	Annual
Compliance Rate (%)		96	96
Inspections Performed			
Air Pump System		NO	NO
Catalyst		NO	YES
Fuel Inlet Restrictor		NO	YES
Tailpipe Lead Deposit Test		NO	NO
EGR System		YES	NO
Evaporative Emission Control System		NO	NO
PCV System		NO	NO
Gas Cap		NO	NO

Table 6.5-9 (continued)

I/M Program Name	Basic I/M Performance Standard	Low Enhanced I/M Performance Standard	High Enhanced I/M Performance Standard
Functional Pressure Test Program			
Parameters			1995
Program Start Year			1983-2020
Model Years Covered			1.00
Effectiveness Rate			
Vehicle Types Tested			YES
LDGV			YES
LDGT1			YES
LDGT2			NO
HDGV			TO
Program Type			Annual
Inspection Frequency			96
Compliance Rate (%)			
Purge Test Program Parameters			1995
Program Start Year			1986-2020
Model Years Covered			1.00
Effectiveness Rate			
Vehicle Types Tested			YES
LDGV			YES
LDGT1			YES
LDGT2			NO
HDGV			TO
Program Type			Annual
Inspection Frequency			96
Compliance Rate (%)			
	05, 07, 08, 10	05, 07, 08, 10	05, 07, 08, 10
Years of Program Usage			

Notes: TO = Test Only
TRC = Test and Repair (Computerized)

Table 6.5-10. States Modeled with I/M Performance Standard Inputs in 2005, 2007, 2008, and 2010

I/M Performance Standard Modeled	State	County
Basic	Alaska	Fairbanks Ed
	Arizona	Pima Co
	Colorado	Pitkin Co, El Paso Co, Larimer Co, Weld Co
	Florida	Broward Co, Dade Co, Duval Co, Hillsborough Co, Palm Beach Co, Pinellas Co
	Idaho	Ada Co
	Kentucky	Boyd Co, Greenup Co, Boone Co, Campbell Co, Kenton Co, Jefferson Co
	Minnesota	Anoka Co, Carver Co, Dakota Co, Hennepin Co, Ramsey Co, Scott Co, Washington Co
	New Mexico	Bernalillo Co
	North Carolina	Cabarrus Co, Union Co, Orange Co, Forsyth Co, Guilford Co, Durham Co, Gaston Co, Mecklenburg Co, Wake Co
	Tennessee	Rutherford Co, Sumner Co, Williamson Co, Wilson Co, Davidson Co, Shelby Co
Low Enhanced	Delaware	Kent Co, New Castle Co, Sussex Co
	Louisiana	Ascension Par, East Baton Rouge Par, Iberville Par, Livingston Par, Pointe Coupee Par, West Baton Rouge Par
	Nevada	Clark Co, Washoe Co
	Pennsylvania	Berks Co, Blair Co, Cambria Co, Centre Co, Cumberland Co, Dauphin Co, Lackawanna Co, Lancaster Co, Lebanon Co, Luzerne Co, Lycoming Co, York Co, Allegheny Co, Beaver Co, Washington Co, Westmoreland Co, Erie Co, Mercer Co, Lehigh Co, Northampton Co
	Texas	El Paso Co
	Utah	Davis Co, Salt Lake Co, Utah Co, Weber Co
	Washington	Pierce Co, Clark Co, King Co, Snohomish Co, Spokane Co
High Enhanced	Alaska	Anchorage Ed
	Arizona	Maricopa Co
	California	Alameda Co, Butte Co, Colusa Co, Contra Costa Co, El Dorado Co, Glenn Co, Kings Co, Madera Co, Merced Co, Nevada Co, Orange Co, Placer Co, Riverside Co, San Benito Co, San Bernardino Co, San Joaquin Co, Santa Clara Co, Shasta Co, Solano Co, Stanislaus Co, Sutter Co, Tehama Co, Tulare Co, Ventura Co, Yolo Co, Yuba Co, Marin Co, Monterey Co, San Luis Obispo Co, San Mateo Co, Santa Barbara Co, Santa Cruz Co, Sonoma Co, Fresno Co, Kern Co, Los Angeles Co, Napa Co, Sacramento Co, San Diego Co, San Francisco CO
	Colorado	Adams Co, Arapahoe Co, Boulder Co, Douglas Co, Jefferson Co, Denver CO
	Connecticut	Fairfield Co, Hartford Co, Litchfield Co, Middlesex Co, New Haven Co, New London Co, Tolland Co, Windham Co
	DC	Washington

Table 6.5-10 (continued)

I/M Performance Standard Modeled	State	County
High Enhanced (continued)	Georgia	Cherokee Co, Clayton Co, Coweta Co, Douglas Co, Fayette Co, Forsyth Co, Henry Co, Paulding Co, Rockdale Co, Cobb Co, De Kalb Co, Fulton Co, Gwinnett Co
	Illinois	Cook Co, Du Page Co, Lake Co, Kane Co, Kendall Co, McHenry Co, Will Co, Madison Co, St. Clair Co, Monroe Co
	Indiana	Clark Co, Floyd Co, Lake Co, Porter Co
	Maryland	Anne Arundel Co, Baltimore Co, Carroll Co, Harford Co, Howard CO, Baltimore, Calvert Co, Cecil Co, Queen Annes Co, Charles Co, Frederick Co, Montgomery Co, Prince Georges CO, Washington Co
	Massachusetts	Barnstable Co, Berkshire Co, Bristol Co, Dukes Co, Essex Co, Franklin Co, Hampden Co, Hampshire Co, Middlesex Co, Nantucket Co, Norfolk Co, Plymouth Co, Suffolk Co, Worcester Co
	Missouri	Jefferson Co, St. Charles Co, St. Louis Co, St. Louis
	New Hampshire	Hillsborough Co, Rockingham Co, Strafford Co
	New Jersey	Atlantic Co, Cape May Co, Warren Co, Burlington Co, Camden Co, Cumberland Co, Gloucester Co, Salem Co, Bergen Co, Essex Co, Hudson Co, Hunterdon Co, Middlesex Co, Monmouth Co, Morris Co, Ocean Co, Passaic Co, Somerset Co, Sussex Co, Union Co, Mercer Co
	New York	Bronx Co, Kings Co, Nassau Co, New York Co, Queens Co, Richmond Co, Rockland Co, Suffolk Co, Westchester Co, Orange Co
	Ohio	Clark Co, Clermont Co, Geauga Co, Greene Co, Medina Co, Montgomery Co, Portage Co, Summit Co, Warren Co, Butler Co, Hamilton Co, Lake Co, Lorain Co, Cuyahoga Co
	Oregon	Clackamas Co, Jackson Co, Multnomah Co, Washington Co, Josephine Co
	Pennsylvania	Bucks Co, Chester Co, Delaware Co, Montgomery Co, Philadelphia Co
	Rhode Island	Bristol Co, Kent Co, Newport Co, Providence Co, Washington Co
	Texas	Dallas Co, Tarrant Co, Harris Co
	Virginia	Arlington Co, Fairfax Co, Loudoun Co, Prince William Co, Stafford Co, Alexandria, Manassas, Manassas Park, Fairfax, Falls Church
	Wisconsin	Kenosha Co, Milwaukee Co, Ozaukee Co, Racine Co, Washington Co, Waukesha Co, Sheboygan

Table 6.5-11. Counties Modeled with Federal Reformulated Gasoline

State (ASTM Class*)/ Nonattainment Area	County
Arizona (B)	
Phoenix**	
	Maricopa Co
Connecticut (C)	
Greater Connecticut	
	Hartford Co
	Litchfield Co
	Middlesex Co
	New Haven Co
	New London Co
	Tolland Co
	Windham Co
New York-Northern New Jersey-Long Island	
	Fairfield Co
District of Columbia (B)	
Washington DC	
	Washington
Delaware (C)	
Philadelphia-Wilmington-Trenton	
	Kent Co
	New Castle Co
Sussex County	
	Sussex Co
Illinois (C)	
Chicago-Gary-Lake County	
	Cook Co
	Du Page Co
	Grundy Co
	Kane Co
	Kendall Co
	Lake Co
	McHenry Co
	Will Co
Indiana (C)	
Chicago-Gary-Lake County	
	Lake Co
	Porter Co
Kentucky (C)	
Cincinnati-Hamilton	
	Boone Co
	Campbell Co
	Kenton Co
Maine (C)	
Knox & Lincoln Counties	
	Knox Co
	Lincoln Co
Lewiston-Auburn	
	Androscoggin Co
	Kennebec Co
Portland	
	Cumberland Co
	Sagadahoc Co
	York Co
Maryland (B)	
Baltimore	
	Anne Arundel Co
	Baltimore
	Baltimore Co
	Carroll Co
	Harford Co
	Howard Co
Kent & Queen Annes Counties	
	Kent Co
	Queen Annes Co
Philadelphia-Wilmington-Trenton	
	Cecil Co
Washington DC	
	Calvert Co
	Charles Co
	Frederick Co
	Montgomery Co
	Prince Georges Co
Massachusetts (C)	
Boston-Lawrence-Worcester-Eastern MA	
	Barnstable Co
	Bristol Co
	Dukes Co
	Essex Co
	Middlesex Co
	Nantucket Co
	Norfolk Co
	Plymouth Co
	Suffolk Co
	Worcester Co

Table 6.5-11 (continued)

State (ASTM Class*)/ Nonattainment Area	County	State (ASTM Class*)/ Nonattainment Area	County
Louisville		Springfield/Pittsfield-Western MA	
	Bullitt Co		Berkshire Co
	Jefferson Co		Franklin Co
	Oldham Co		Hampden Co
			Hampshire Co
New Hampshire (C)		New York (C)	
Manchester		Poughkeepsie	
	Hillsborough Co		Dutchess Co
	Merrimack Co		Putnam Co
Portsmouth-Dover-Rochester		Pennsylvania (C)	
	Rockingham Co	Philadelphia-Wilmington-Trenton	
	Strafford Co		Bucks Co
New Jersey (C)			Chester Co
Allentown-Bethlehem-Easton			Delaware Co
	Warren Co		Montgomery Co
Atlantic City			Philadelphia Co
	Atlantic Co	Rhode Island (C)	
	Cape May Co	Providence	
New York-Northern New Jersey-Long Island			Bristol Co
	Bergen Co		Kent Co
	Essex Co		Newport Co
	Hudson Co		Providence Co
	Hunterdon Co		Washington Co
	Middlesex Co	Texas (B)	
	Monmouth Co	Dallas-Fort Worth	
	Morris Co		Collin Co
	Ocean Co		Dallas Co
	Passaic Co		Denton Co
	Somerset Co		Tarrant Co
	Sussex Co	Houston-Galveston-Brazoria	
	Union Co		Brazoria Co
Philadelphia-Wilmington-Trenton			Chambers Co
	Burlington Co		Fort Bend Co
	Camden Co		Galveston Co
	Cumberland Co		Harris Co
	Gloucester Co		Liberty Co
	Mercer Co		Montgomery Co
	Salem Co		Waller Co
New York (C)		Virginia (B)	
New York-Northern New Jersey-Long Island		Norfolk-Virginia Beach-Newport News	
	Bronx Co		Chesapeake
	Kings Co		Hampton
	Nassau Co		James City Co
	New York Co		Newport News

Table 6.5-11 (continued)

State (ASTM Class*)/ Nonattainment Area	County	State (ASTM Class*)/ Nonattainment Area	County
	Orange Co		Norfolk
	Queens Co		Poquoson
	Richmond Co		Portsmouth
	Rockland Co		Suffolk
	Suffolk Co		Virginia Beach
	Westchester Co		Williamsburg
			York Co
Virginia (B)		Wisconsin (C)	
Richmond-Petersburg		Milwaukee-Racine	
	Charles City Co		Kenosha Co
	Chesterfield Co		Milwaukee Co
	Colonial Heights		Ozaukee Co
	Hanover Co		Racine Co
	Henrico Co		Washington Co
	Hopewell		Waukesha Co
	Richmond		
Washington DC			
	Alexandria		
	Arlington Co		
	Fairfax		
	Fairfax Co		
	Falls Church		
	Loudoun Co		
	Manassas		
	Manassas Park		
	Prince William Co		
	Stafford Co		

Notes: * ASTM Class B areas are subject to the Southern reformulated gasoline region requirements while ASTM Class C areas are subject to the Northern reformulated gasoline region requirements.

** Reformulated gasoline was only modeled in Phoenix beginning with the projection years, as the opt-in date for Phoenix was 1997. California reformulated gasoline was modeled statewide in California.

Table 6.5-12. California Basic Emission Rate Limits

Vehicle Type	Pollutant	LEV Credits	Model Years Covered	Zero Mile Level (HDVs: g/bhp-hr) (LDVs: g/mi)	Deterioration Rate <50,000 mi (HDVs: G/bhp-hr/10 kmi) (LDVs: g/mi/10 kmi)	Deterioration Rate >50,000 mi (HDVs: g/bhp-hr/10 kmi) (LDVs: g/mi/10 kmi)
HDGV	NO_x	N/A	1998 - 2003	3.1900	0.0450	0.0450
	NO_x	N/A	2004 +	1.6600	0.0210	0.0210
	NO_x	N/A	1991 - 1997	4.6000	0.0000	0.0000
	NO_x	N/A	1998 - 2003	3.6800	0.0000	0.0000
	NO_x	N/A	2004 +	1.8400	0.0000	0.0000
	VOC	N/A	1994 - 2003	0.3640	0.0230	0.0230
	VOC	N/A	2004 +	0.2770	0.0180	0.0180
	VOC	N/A	1994 - 2003	0.2830	0.0000	0.0000
	VOC	N/A	2004 +	0.2570	0.0000	0.0000
LDGT2	VOC	Minimum	1995 - 1997	0.2413	0.0720	0.2730
	VOC	Minimum	1998	0.2345	0.0720	0.2730
	VOC	Minimum	1999	0.2297	0.0720	0.2730
	VOC	Minimum	2000	0.1780	0.0720	0.2730
	VOC	Minimum	2001	0.1547	0.0720	0.2730
	VOC	Minimum	2002	0.1522	0.0720	0.2730
	VOC	Minimum	2003 +	0.1403	0.0720	0.2730
	CO	Minimum	1995 - 1997	2.9111	1.4480	3.4340
	CO	Minimum	1998	2.9823	1.4480	3.4340
	CO	Minimum	1999	3.0957	1.4480	3.4340
	CO	Minimum	2000	3.2091	1.4480	3.4340
	CO	Minimum	2001	2.8523	1.4480	3.4340
	CO	Minimum	2002	2.5961	1.4480	3.4340
	CO	Minimum	2003 +	2.3399	1.4480	3.4340
	NO_x	Minimum	1995 - 1997	0.3744	0.0830	0.1860
	NO_x	Minimum	1998	0.3594	0.0830	0.1860
	NO_x	Minimum	1999	0.3454	0.0830	0.1860
	NO_x	Minimum	2000	0.3315	0.0830	0.1860
	NO_x	Minimum	2001 +	0.2125	0.0830	0.1860
LDGT2	VOC	Maximum	1995 - 1997	0.2413	0.0272	0.0272
	VOC	Maximum	1998	0.2345	0.0263	0.0263
	VOC	Maximum	1999	0.2297	0.0257	0.0257
	VOC	Maximum	2000	0.1780	0.0190	0.0190
	VOC	Maximum	2001	0.1547	0.0159	0.0159
	VOC	Maximum	2002	0.1522	0.0156	0.0156
	VOC	Maximum	2003 +	0.1403	0.0140	0.0140
	CO	Maximum	1995 - 1997	2.9111	0.3398	0.3398
	CO	Maximum	1998	2.9823	0.3585	0.3585
	CO	Maximum	1999	3.0957	0.3718	0.3718
	CO	Maximum	2000	3.2091	0.3850	0.3850
	CO	Maximum	2001	2.8523	0.4373	0.4373
	CO	Maximum	2002	2.5961	0.4596	0.4596
	CO	Maximum	2003 +	2.3399	0.4819	0.4819
	NO_x	Maximum	1995 - 1997	0.3744	0.0931	0.0931
	NO_x	Maximum	1998	0.3594	0.0894	0.0894
	NO_x	Maximum	1999	0.3454	0.0859	0.0859
	NO_x	Maximum	2000	0.3315	0.0825	0.0825
	NO_x	Maximum	2001 +	0.2125	0.0528	0.0528

6.6 NON-ROAD MOBILE SOURCES

Non-road emissions were projected to 1999, 2000, 2002, 2005, 2007, 2008, and 2010. The Trends 1995 emission estimates were used as the base year for the emission projections.

6.6.1 Growth Factors

1995 emissions were projected to each projection year using BEA GSP projections by state and industry[1] as a surrogate for growth. These growth factors were applied in much the same manner as the growth factors were applied to the 1990 data to estimate 1995 and 1996 emissions. There were several minor differences in the procedures used to project future year emissions. First, since the BEA GSP projection data were already in constant dollars, no adjustments to account for inflation were needed. Second, the BEA GSP projection data did not contain data points for all years of interest. The BEA data project 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.

The crosswalk between SCC and growth factors is the same as the one used for the 1995 and 1996 estimates, and is shown in table 6.6-1. Zero growth was assumed for all railroad SCCs. This assumption is based on information that shows railroad use and earning increasing, but fuel use remaining constant due to efficiency gains in locomotive design.[2] For the 1995 and 1996 estimates, Federal Aviation Administration (FAA) landing-takeoff (LTO) data were used as the growth surrogates for commercial aircraft. The FAA LTO data included all years of interest except 2010. 2010 LTO estimates were developed assuming straight line growth in air carrier LTOs from 1996 through 2010. Table 6.6-2 lists the 1999 through 2010 growth factors by state and SIC.

6.6.2 Control Factors

The impact of the following four non-road control programs are included in the emission projections: 1) Phase I of the compression ignition standards for diesel engines, 2) Phase I of the spark ignition standards for gasoline engines, 3) recreational marine vessel controls, and 4) reformulated gasoline. The impact of the compression ignition standards and the recreational marine controls were incorporated in the adjustments to emissions from non-road diesel engines and recreational marine engines based on the OMS national emission estimates. The procedure for adjusting emissions based on the OMS national emission estimates is described below.

Emission reductions resulting from Phase I of the spark ignition standard were modeled using overall percentage reductions estimated by OMS.[3]

6.6.3 Use of OMS National Emissions Estimates

OMS supplied national emission estimates from its rulemaking analyses that were used to develop emissions for each projection year. The OMS emission estimates (for 1992) were developed by taking per capita emissions values from one of 27 areas and then applying these estimates to the remainder of the country (applied at the county level). This method provides total non-road emissions for each county. The emissions from OMS were provided in 27 7-digit SCCs. The percent of the total emissions represented by each of these 27 SCCs was calculated for each of the 27 areas for which OMS provided detailed emission inventories. These percentages were then applied to the total emissions for each county based on the per capita emissions scaling described above in order to apportion the total emissions to the 27 SCCs. New national totals for each year (including the projection years) were obtained by using the growth factors described above.

OMS also used the EPCD non-road model to calculate new national non-road diesel values for all years. These diesel emissions did not reflect the proposed Phase II standards. For the non-road diesel estimates, a factor reflecting the "final/initial" ratio for all years was developed for the eight diesel 7-digit SCCs. These eight ratios were then applied to the initial county estimates to develop final county emission estimates. The only difference in the way these data were applied was for the emissions from railroads. Railroad emissions for all pollutants were held constant after 1996 for all projection years.

Some of the emissions data used as the basis for the projections was obtained directly from States. As part of the OTAG effort, 24 States provided actual data for these sources (17 States provided complete State data, 7 provided partial State data). The data provided as part of the OTAG effort were generally daily emissions data. The daily data were converted to annual data.

Finally, the national diesel non-road agriculture emissions were allocated to the county using information on the acreage of crops harvested, rather than population.

6.6.4 References

1. *Regional Projections to 2045*, data files, U.S. Department of Commerce, Bureau of Economic Analysis, Washington, DC, August 1995.

2. Notice of Proposed Rulemaking (40 CFR, 62, No. 28, 6366-6405), February 11, 1995.

3. *Fleet Average Annual Emission Reduction Percentages Small Gasoline Engines Phase I*, E-mail sent to Sharon Nizich, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, from U.S. Environmental Protection Agency, Office of Mobile Sources, July 23, 1997.

Table 6.6-1. SCC-SIC Crosswalk

SCCs	Non-road Segment	SIC	SIC Name
2260001, 2265001, 2270001	Recreational Vehicles	999*	Population
2260002, 2265002, 2270002	Construction	15	Construction
2260003, 2265003, 2270003	Industrial	998*	Total Manufacturing
2260004, 2265004, 2270004	Lawn and Garden	999*	Population
2260005, 2265005, 2270005	Farm	01	Farm
2260006, 2265006, 2270006	Light Commercial	998*	Total Manufacturing
2260007, 2265007, 2270007	Logging	07	Agricultural Services, Forestry, Fisheries, and Other
2260008, 2265008, 2270008	Airport Service	45	Transportation by Air
2275 (except 2275001 and 2275002)	Aircraft (except Military and Commercial)	45	Transportation by Air
2275001	Military Aircraft	992*	Federal, military
2275002	Commercial Aircraft	LTO*	Landing-Takeoff Operations
2280	Commercial Marine Vessels	44	Water Transportation
2282	Recreational Marine Vessels	999*	Population
2283	Military Marine Vessels	992*	Federal, military
2285**	Railroads	40	Railroad Transportation

NOTES: *Growth factor does not correspond to an SIC.
**E-GAS growth factors used for 1995 and 1996 NO_x emissions. Zero growth assumed after 1996 for all pollutants.

Table 6.6-2. 1999 - 2010 Growth Factors

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
01	01	Farm	1.092	1.123	1.166	1.231	1.268	1.286	1.324
01	07	Agricultural services, forestry, fisheries, and other	1.214	1.259	1.365	1.523	1.627	1.679	1.783
01	15	Construction	1.044	1.046	1.064	1.092	1.111	1.121	1.140
01	40	Railroad Transportation	1.136	1.170	1.243	1.353	1.419	1.452	1.518
01	44	Water Transportation	1.007	1.008	1.011	1.014	1.020	1.022	1.028
01	44	Water Transportation	1.237	1.296	1.396	1.547	1.649	1.701	1.803
01	992*	Federal, military	0.949	0.939	0.947	0.960	0.971	0.976	0.988
01	998*	Total Manufacturing	1.114	1.136	1.183	1.254	1.300	1.323	1.369
01	999*	Population	1.030	1.036	1.048	1.067	1.082	1.089	1.103
01	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
02	01	Farm	1.131	1.166	1.217	1.297	1.343	1.366	1.411
02	07	Agricultural services, forestry, fisheries, and other	1.172	1.212	1.294	1.417	1.495	1.533	1.611
02	15	Construction	1.087	1.083	1.110	1.151	1.177	1.190	1.216
02	40	Railroad Transportation	1.000	1.000	1.000	1.000	1.000	1.000	1.000
02	44	Water Transportation	1.058	1.072	1.078	1.086	1.093	1.096	1.103
02	45	Transportation by air	1.156	1.195	1.261	1.360	1.424	1.457	1.521
02	992*	Federal, military	0.946	0.942	0.948	0.957	0.966	0.971	0.980
02	998*	Total Manufacturing	1.045	1.070	1.106	1.160	1.196	1.213	1.248
02	999*	Population	1.057	1.071	1.095	1.131	1.153	1.163	1.185
02	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
04	01	Farm	1.154	1.202	1.251	1.324	1.365	1.386	1.427
04	07	Agricultural services, forestry, fisheries, and other	1.229	1.280	1.393	1.564	1.677	1.734	1.848
04	15	Construction	1.140	1.154	1.199	1.267	1.309	1.331	1.373
04	40	Railroad Transportation	1.213	1.266	1.360	1.500	1.589	1.633	1.722
04	44	Water Transportation	1.140	1.158	1.175	1.211	1.228	1.246	1.263
04	45	Transportation by air	1.196	1.245	1.328	1.454	1.536	1.577	1.659
04	992*	Federal, military	0.988	0.993	0.999	1.008	1.017	1.021	1.030
04	998*	Total Manufacturing	1.145	1.172	1.229	1.314	1.366	1.392	1.445
04	999*	Population	1.084	1.104	1.139	1.190	1.223	1.240	1.272
04	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
05	01	Farm	1.029	1.045	1.080	1.132	1.162	1.177	1.206
05	07	Agricultural services, forestry, fisheries, and other	1.210	1.259	1.366	1.526	1.632	1.685	1.791
05	15	Construction	1.064	1.070	1.090	1.119	1.138	1.148	1.167
05	40	Railroad Transportation	1.168	1.210	1.286	1.399	1.467	1.502	1.570
05	44	Water Transportation	1.162	1.198	1.216	1.243	1.261	1.270	1.288
05	45	Transportation by air	1.262	1.327	1.413	1.540	1.624	1.667	1.751
05	992*	Federal, military	0.877	0.870	0.870	0.871	0.876	0.877	0.882
05	998*	Total Manufacturing	1.125	1.145	1.194	1.267	1.315	1.339	1.386
05	999*	Population	1.035	1.042	1.056	1.078	1.093	1.101	1.116
05	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
06	01	Farm	1.076	1.105	1.145	1.204	1.237	1.253	1.286
06	07	Agricultural services, forestry, fisheries, and other	1.176	1.219	1.313	1.453	1.544	1.590	1.680
06	15	Construction	1.046	1.066	1.109	1.173	1.212	1.231	1.271
06	40	Railroad Transportation	1.162	1.203	1.272	1.376	1.438	1.469	1.532
06	44	Water Transportation	0.984	0.980	0.978	0.975	0.976	0.977	0.978
06	45	Transportation by air	1.164	1.205	1.289	1.415	1.497	1.538	1.620
06	992*	Federal, military	0.905	0.894	0.900	0.908	0.916	0.920	0.929
06	998*	Total Manufacturing	1.084	1.113	1.154	1.215	1.254	1.274	1.313
06	999*	Population	1.055	1.072	1.099	1.140	1.166	1.178	1.204
06	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
08	01	Farm	1.123	1.157	1.203	1.274	1.316	1.337	1.379
08	07	Agricultural services, forestry, fisheries, and other	1.242	1.292	1.408	1.581	1.696	1.754	1.870
08	15	Construction	1.116	1.121	1.149	1.189	1.217	1.230	1.257
08	40	Railroad Transportation	1.242	1.303	1.410	1.570	1.672	1.722	1.824
08	44	Water Transportation	1.114	1.143	1.200	1.257	1.286	1.314	1.343
08	45	Transportation by air	1.226	1.283	1.386	1.541	1.645	1.697	1.801
08	992*	Federal, military	0.962	0.955	0.963	0.974	0.985	0.990	1.000

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
08	998*	Total Manufacturing	1.120	1.145	1.193	1.265	1.312	1.335	1.381
08	999*	Population	1.073	1.089	1.119	1.164	1.193	1.207	1.236
08	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
09	01	Farm	1.114	1.147	1.194	1.263	1.303	1.323	1.362
09	07	Agricultural services, forestry, fisheries, and other	1.211	1.257	1.356	1.504	1.600	1.649	1.745
09	15	Construction	1.039	1.050	1.071	1.102	1.123	1.134	1.155
09	40	Railroad Transportation	1.000	1.000	1.000	1.000	1.000	1.000	1.000
09	44	Water Transportation	1.005	1.005	1.012	1.022	1.031	1.037	1.046
09	45	Transportation by air	1.165	1.206	1.288	1.412	1.494	1.535	1.617
09	992*	Federal, military	0.924	0.917	0.924	0.935	0.945	0.950	0.960
09	998*	Total Manufacturing	1.053	1.065	1.087	1.120	1.140	1.151	1.171
09	999*	Population	1.023	1.032	1.047	1.071	1.087	1.096	1.112
09	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
10	01	Farm	0.978	0.995	1.014	1.044	1.059	1.066	1.082
10	07	Agricultural services, forestry, fisheries, and other	1.208	1.250	1.351	1.502	1.599	1.649	1.747
10	15	Construction	1.049	1.076	1.097	1.127	1.148	1.158	1.178
10	40	Railroad Transportation	1.263	1.328	1.439	1.605	1.711	1.765	1.871
10	44	Water Transportation	0.982	0.977	0.982	0.991	1.000	1.000	1.009
10	45	Transportation by air	1.145	1.182	1.271	1.402	1.492	1.534	1.623
10	992*	Federal, military	1.002	1.011	1.018	1.029	1.040	1.045	1.055
10	998*	Total Manufacturing	1.036	1.045	1.073	1.114	1.142	1.155	1.183
10	999*	Population	1.047	1.059	1.080	1.110	1.131	1.141	1.162
10	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
11	01	Farm	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	07	Agricultural services, forestry, fisheries, and other	1.282	1.350	1.476	1.670	1.796	1.854	1.981
11	15	Construction	0.937	0.926	0.926	0.925	0.926	0.927	0.928
11	40	Railroad Transportation	1.311	1.388	1.502	1.675	1.781	1.834	1.940
11	44	Water Transportation	1.283	1.348	1.337	1.315	1.315	1.304	1.304
11	45	Transportation by air	1.135	1.167	1.228	1.321	1.381	1.409	1.470
11	992*	Federal, military	0.959	0.951	0.951	0.952	0.956	0.957	0.961
11	998*	Total Manufacturing	1.007	1.010	1.019	1.033	1.042	1.047	1.056
11	999*	Population	0.976	0.974	0.970	0.965	0.966	0.966	0.967
11	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
12	01	Farm	1.149	1.188	1.241	1.320	1.364	1.386	1.429
12	07	Agricultural services, forestry, fisheries, and other	1.203	1.252	1.356	1.512	1.615	1.667	1.769
12	15	Construction	1.105	1.127	1.163	1.218	1.252	1.269	1.304
12	40	Railroad Transportation	1.189	1.236	1.332	1.475	1.563	1.607	1.695
12	44	Water Transportation	1.068	1.085	1.117	1.166	1.196	1.211	1.241
12	45	Transportation by air	1.225	1.282	1.359	1.474	1.547	1.584	1.657
12	992*	Federal, military	0.911	0.902	0.908	0.918	0.927	0.931	0.941
12	998*	Total Manufacturing	1.117	1.143	1.191	1.263	1.307	1.330	1.374
12	999*	Population	1.075	1.095	1.131	1.184	1.218	1.235	1.270
12	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
13	01	Farm	1.043	1.062	1.095	1.144	1.171	1.185	1.212
13	07	Agricultural services, forestry, fisheries, and other	1.227	1.273	1.382	1.546	1.653	1.707	1.814
13	15	Construction	1.090	1.093	1.123	1.168	1.198	1.213	1.244
13	40	Railroad Transportation	1.130	1.162	1.232	1.337	1.401	1.432	1.496
13	44	Water Transportation	1.032	1.040	1.047	1.058	1.068	1.072	1.082
13	45	Transportation by air	1.152	1.190	1.255	1.353	1.416	1.448	1.512
13	992*	Federal, military	0.989	0.990	0.998	1.011	1.022	1.028	1.039
13	998*	Total Manufacturing	1.118	1.140	1.187	1.257	1.302	1.325	1.370
13	999*	Population	1.059	1.072	1.097	1.133	1.158	1.170	1.194
13	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
15	01	Farm	1.157	1.212	1.291	1.410	1.481	1.517	1.588
15	07	Agricultural services, forestry, fisheries, and other	1.197	1.251	1.355	1.510	1.612	1.663	1.765
15	15	Construction	1.049	1.070	1.089	1.118	1.137	1.147	1.166
15	40	Railroad Transportation	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors						
			1999	2000	2002	2005	2007	2008	2010
15	44	Water Transportation	1.041	1.051	1.066	1.088	1.104	1.112	1.128
15	45	Transportation by air	1.130	1.163	1.232	1.336	1.403	1.437	1.505
15	992*	Federal, military	0.965	0.965	0.971	0.980	0.990	0.994	1.004
15	998*	Total Manufacturing	1.007	1.012	1.027	1.051	1.068	1.077	1.094
15	999*	Population	1.053	1.068	1.093	1.129	1.154	1.166	1.190
15	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
16	01	Farm	1.116	1.147	1.195	1.268	1.310	1.331	1.373
16	07	Agricultural services, forestry, fisheries, and other	1.226	1.278	1.392	1.564	1.678	1.735	1.850
16	15	Construction	1.087	1.090	1.105	1.128	1.144	1.152	1.169
16	40	Railroad Transportation	1.142	1.178	1.249	1.355	1.419	1.452	1.516
16	44	Water Transportation	1.056	1.056	1.093	1.148	1.185	1.204	1.241
16	45	Transportation by air	1.248	1.310	1.415	1.572	1.678	1.732	1.838
16	992*	Federal, military	0.965	0.953	0.960	0.972	0.982	0.987	0.998
16	998*	Total Manufacturing	1.182	1.216	1.288	1.394	1.463	1.497	1.566
16	999*	Population	1.067	1.080	1.102	1.134	1.155	1.165	1.186
16	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
17	01	Farm	0.970	0.994	1.021	1.062	1.085	1.096	1.119
17	07	Agricultural services, forestry, fisheries, and other	1.195	1.239	1.345	1.504	1.609	1.662	1.767
17	15	Construction	1.038	1.045	1.062	1.088	1.105	1.113	1.130
17	40	Railroad Transportation	1.158	1.198	1.258	1.347	1.400	1.427	1.479
17	44	Water Transportation	1.118	1.148	1.156	1.168	1.179	1.183	1.194
17	45	Transportation by air	1.199	1.249	1.327	1.444	1.521	1.559	1.636
17	992*	Federal, military	0.912	0.901	0.905	0.911	0.918	0.922	0.929
17	998*	Total Manufacturing	1.102	1.119	1.151	1.201	1.231	1.247	1.278
17	999*	Population	1.027	1.035	1.049	1.070	1.084	1.091	1.105
17	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
18	01	Farm	1.038	1.068	1.118	1.193	1.236	1.257	1.301
18	07	Agricultural services, forestry, fisheries, and other	1.218	1.266	1.380	1.549	1.662	1.718	1.830
18	15	Construction	1.055	1.059	1.077	1.105	1.124	1.133	1.152
18	40	Railroad Transportation	1.166	1.207	1.283	1.397	1.467	1.502	1.571
18	44	Water Transportation	1.064	1.080	1.106	1.145	1.172	1.185	1.212
18	45	Transportation by air	1.292	1.364	1.474	1.638	1.748	1.803	1.913
18	992*	Federal, military	0.944	0.930	0.939	0.952	0.964	0.970	0.981
18	998*	Total Manufacturing	1.121	1.140	1.179	1.238	1.275	1.294	1.331
18	999*	Population	1.027	1.033	1.045	1.063	1.076	1.083	1.096
18	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
19	01	Farm	0.955	1.006	1.050	1.116	1.153	1.172	1.210
19	07	Agricultural services, forestry, fisheries, and other	1.191	1.234	1.331	1.477	1.572	1.620	1.715
19	15	Construction	1.057	1.060	1.077	1.103	1.119	1.127	1.144
19	40	Railroad Transportation	1.166	1.208	1.278	1.384	1.447	1.479	1.543
19	44	Water Transportation	1.132	1.160	1.188	1.236	1.264	1.271	1.299
19	45	Transportation by air	1.207	1.258	1.338	1.459	1.536	1.574	1.651
19	992*	Federal, military	0.967	0.952	0.961	0.974	0.986	0.992	1.003
19	998*	Total Manufacturing	1.115	1.132	1.171	1.230	1.267	1.285	1.322
19	999*	Population	1.015	1.019	1.027	1.039	1.048	1.053	1.062
19	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
20	01	Farm	1.013	1.032	1.067	1.119	1.148	1.163	1.192
20	07	Agricultural services, forestry, fisheries, and other	1.225	1.276	1.391	1.563	1.677	1.734	1.848
20	15	Construction	1.048	1.048	1.066	1.092	1.109	1.118	1.135
20	40	Railroad Transportation	1.145	1.182	1.256	1.366	1.433	1.467	1.534
20	44	Water Transportation	1.150	1.150	1.150	1.200	1.200	1.250	1.250
20	45	Transportation by air	1.198	1.248	1.337	1.473	1.561	1.606	1.694
20	992*	Federal, military	0.976	0.973	0.979	0.988	0.997	1.002	1.011
20	998*	Total Manufacturing	1.107	1.128	1.171	1.236	1.277	1.297	1.338
20	999*	Population	1.032	1.041	1.055	1.075	1.089	1.096	1.110
20	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
21	01	Farm	1.066	1.100	1.153	1.233	1.280	1.304	1.351

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
21	07	Agricultural services, forestry, fisheries, and other	1.201	1.248	1.356	1.518	1.626	1.679	1.786
21	15	Construction	1.062	1.068	1.086	1.112	1.130	1.139	1.157
21	40	Railroad Transportation	1.077	1.097	1.148	1.224	1.267	1.289	1.332
21	44	Water Transportation	0.964	0.955	0.961	0.970	0.979	0.983	0.992
21	45	Transportation by air	1.222	1.277	1.370	1.509	1.603	1.650	1.744
21	992*	Federal, military	0.970	0.967	0.974	0.985	0.995	0.999	1.009
21	998*	Total Manufacturing	1.114	1.132	1.170	1.226	1.263	1.281	1.318
21	999*	Population	1.028	1.034	1.047	1.065	1.079	1.086	1.100
21	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
22	01	Farm	1.042	1.071	1.112	1.173	1.208	1.226	1.261
22	07	Agricultural services, forestry, fisheries, and other	1.192	1.235	1.332	1.478	1.572	1.620	1.714
22	15	Construction	1.035	1.041	1.062	1.093	1.113	1.124	1.144
22	40	Railroad Transportation	1.176	1.220	1.294	1.406	1.474	1.508	1.576
22	44	Water Transportation	0.992	0.990	0.989	0.988	0.990	0.991	0.993
22	45	Transportation by air	1.122	1.153	1.210	1.296	1.351	1.378	1.433
22	992*	Federal, military	0.916	0.913	0.922	0.935	0.947	0.952	0.964
22	998*	Total Manufacturing	1.075	1.090	1.125	1.178	1.212	1.229	1.263
22	999*	Population	1.024	1.030	1.042	1.061	1.073	1.080	1.092
22	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
23	01	Farm	1.102	1.142	1.198	1.282	1.332	1.356	1.406
23	07	Agricultural services, forestry, fisheries, and other	1.143	1.175	1.250	1.363	1.433	1.469	1.539
23	15	Construction	1.042	1.053	1.073	1.104	1.124	1.134	1.154
23	40	Railroad Transportation	1.076	1.093	1.147	1.228	1.277	1.300	1.349
23	44	Water Transportation	1.043	1.051	1.060	1.077	1.085	1.094	1.102
23	45	Transportation by air	1.388	1.484	1.595	1.760	1.871	1.928	2.039
23	992*	Federal, military	0.863	0.848	0.854	0.863	0.872	0.876	0.885
23	998*	Total Manufacturing	1.080	1.098	1.131	1.180	1.212	1.228	1.260
23	999*	Population	1.026	1.035	1.050	1.074	1.091	1.100	1.116
23	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
24	01	Farm	1.010	1.035	1.074	1.132	1.164	1.180	1.212
24	07	Agricultural services, forestry, fisheries, and other	1.197	1.240	1.341	1.493	1.591	1.639	1.737
24	15	Construction	1.024	1.028	1.042	1.062	1.076	1.083	1.097
24	40	Railroad Transportation	0.998	0.998	1.027	1.070	1.091	1.101	1.122
24	44	Water Transportation	0.949	0.936	0.928	0.916	0.913	0.910	0.906
24	45	Transportation by air	1.193	1.241	1.346	1.503	1.608	1.662	1.768
24	992*	Federal, military	0.954	0.946	0.950	0.956	0.963	0.967	0.974
24	998*	Total Manufacturing	1.044	1.052	1.073	1.103	1.123	1.133	1.153
24	999*	Population	1.043	1.054	1.074	1.104	1.124	1.133	1.153
24	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
25	01	Farm	1.110	1.142	1.189	1.260	1.301	1.321	1.362
25	07	Agricultural services, forestry, fisheries, and other	1.141	1.177	1.253	1.367	1.439	1.475	1.547
25	15	Construction	1.088	1.097	1.118	1.149	1.169	1.179	1.200
25	40	Railroad Transportation	1.232	1.290	1.384	1.526	1.613	1.656	1.744
25	44	Water Transportation	1.023	1.028	1.035	1.044	1.052	1.057	1.065
25	45	Transportation by air	1.172	1.215	1.294	1.413	1.491	1.530	1.609
25	992*	Federal, military	0.881	0.857	0.864	0.876	0.886	0.891	0.901
25	998*	Total Manufacturing	1.059	1.072	1.091	1.119	1.137	1.146	1.164
25	999*	Population	1.025	1.031	1.046	1.068	1.083	1.091	1.107
25	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
26	01	Farm	1.055	1.082	1.125	1.188	1.224	1.242	1.278
26	07	Agricultural services, forestry, fisheries, and other	1.206	1.249	1.355	1.516	1.621	1.674	1.779
26	15	Construction	1.048	1.048	1.064	1.088	1.104	1.112	1.128
26	40	Railroad Transportation	1.119	1.149	1.200	1.277	1.323	1.346	1.392
26	44	Water Transportation	1.078	1.097	1.113	1.135	1.151	1.160	1.176
26	45	Transportation by air	1.152	1.190	1.254	1.350	1.413	1.444	1.507
26	992*	Federal, military	0.869	0.847	0.851	0.859	0.866	0.870	0.878
26	998*	Total Manufacturing	1.082	1.090	1.115	1.152	1.177	1.190	1.215

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
26	999*	Population	1.017	1.021	1.029	1.041	1.050	1.055	1.064
26	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
27	01	Farm	0.976	1.035	1.103	1.205	1.262	1.291	1.349
27	07	Agricultural services, forestry, fisheries, and other	1.191	1.234	1.334	1.483	1.580	1.629	1.725
27	15	Construction	1.051	1.061	1.080	1.109	1.127	1.136	1.154
27	40	Railroad Transportation	1.154	1.193	1.254	1.345	1.399	1.426	1.479
27	44	Water Transportation	0.947	0.934	0.927	0.918	0.915	0.915	0.913
27	45	Transportation by air	1.110	1.138	1.211	1.321	1.393	1.429	1.502
27	992*	Federal, military	0.950	0.946	0.953	0.965	0.975	0.981	0.991
27	998*	Total Manufacturing	1.125	1.148	1.194	1.262	1.306	1.327	1.370
27	999*	Population	1.037	1.046	1.062	1.086	1.101	1.109	1.125
27	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
28	01	Farm	0.980	0.991	1.029	1.087	1.121	1.138	1.172
28	07	Agricultural services, forestry, fisheries, and other	1.200	1.244	1.346	1.498	1.599	1.648	1.749
28	15	Construction	1.115	1.118	1.143	1.179	1.203	1.215	1.239
28	40	Railroad Transportation	1.157	1.196	1.261	1.359	1.418	1.447	1.505
28	44	Water Transportation	1.000	0.999	1.000	1.001	1.006	1.009	1.013
28	45	Transportation by air	1.259	1.324	1.431	1.592	1.700	1.754	1.863
28	992*	Federal, military	1.027	1.027	1.035	1.047	1.058	1.064	1.075
28	998*	Total Manufacturing	1.119	1.142	1.191	1.264	1.310	1.334	1.381
28	999*	Population	1.026	1.031	1.041	1.057	1.069	1.075	1.086
28	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
29	01	Farm	1.021	1.061	1.105	1.171	1.209	1.228	1.266
29	07	Agricultural services, forestry, fisheries, and other	1.201	1.246	1.346	1.497	1.595	1.644	1.742
29	15	Construction	1.056	1.051	1.069	1.095	1.113	1.121	1.139
29	40	Railroad Transportation	1.161	1.201	1.275	1.387	1.455	1.489	1.556
29	44	Water Transportation	0.835	0.794	0.776	0.748	0.735	0.729	0.715
29	45	Transportation by air	1.032	1.040	1.084	1.150	1.191	1.212	1.253
29	992*	Federal, military	0.929	0.918	0.925	0.935	0.945	0.950	0.959
29	998*	Total Manufacturing	1.083	1.097	1.130	1.179	1.211	1.227	1.258
29	999*	Population	1.032	1.040	1.055	1.077	1.092	1.100	1.116
29	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
30	01	Farm	1.155	1.173	1.237	1.334	1.392	1.421	1.479
30	07	Agricultural services, forestry, fisheries, and other	1.225	1.278	1.388	1.555	1.666	1.721	1.832
30	15	Construction	1.095	1.109	1.139	1.185	1.213	1.227	1.255
30	40	Railroad Transportation	1.199	1.249	1.322	1.433	1.500	1.533	1.600
30	44	Water Transportation	1.000	1.000	1.000	1.200	1.200	1.400	1.400
30	45	Transportation by air	1.207	1.259	1.351	1.487	1.578	1.622	1.713
30	992*	Federal, military	1.001	0.994	1.001	1.011	1.021	1.026	1.036
30	998*	Total Manufacturing	1.060	1.077	1.107	1.152	1.181	1.196	1.226
30	999*	Population	1.056	1.069	1.091	1.125	1.146	1.157	1.178
30	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
31	01	Farm	1.022	1.045	1.079	1.130	1.158	1.172	1.200
31	07	Agricultural services, forestry, fisheries, and other	1.200	1.246	1.349	1.503	1.604	1.654	1.755
31	15	Construction	1.097	1.105	1.132	1.172	1.196	1.208	1.233
31	40	Railroad Transportation	1.177	1.222	1.304	1.428	1.504	1.542	1.618
31	44	Water Transportation	1.000	1.000	1.000	1.043	1.043	1.043	1.043
31	45	Transportation by air	1.191	1.238	1.320	1.443	1.522	1.562	1.642
31	992*	Federal, military	0.893	0.887	0.894	0.904	0.914	0.919	0.929
31	998*	Total Manufacturing	1.117	1.133	1.174	1.235	1.274	1.294	1.333
31	999*	Population	1.028	1.036	1.048	1.067	1.080	1.086	1.099
31	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
32	01	Farm	1.183	1.237	1.292	1.375	1.424	1.448	1.497
32	07	Agricultural services, forestry, fisheries, and other	1.240	1.283	1.404	1.585	1.706	1.767	1.888
32	15	Construction	1.194	1.212	1.257	1.323	1.366	1.387	1.429
32	40	Railroad Transportation	1.178	1.222	1.293	1.400	1.465	1.496	1.561
32	44	Water Transportation	1.197	1.246	1.279	1.344	1.377	1.410	1.443

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
32	45	Transportation by air	1.217	1.271	1.367	1.511	1.611	1.661	1.761
32	992*	Federal, military	0.970	0.972	0.977	0.984	0.992	0.995	1.003
32	998*	Total Manufacturing	1.198	1.225	1.295	1.398	1.466	1.500	1.568
32	999*	Population	1.114	1.137	1.185	1.257	1.302	1.325	1.370
32	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
33	01	Farm	1.084	1.104	1.150	1.218	1.258	1.277	1.317
33	07	Agricultural services, forestry, fisheries, and other	1.210	1.257	1.367	1.533	1.642	1.697	1.806
33	15	Construction	1.069	1.079	1.104	1.140	1.164	1.177	1.201
33	40	Railroad Transportation	1.090	1.101	1.157	1.236	1.281	1.315	1.360
33	44	Water Transportation	1.069	1.086	1.103	1.121	1.138	1.138	1.155
33	45	Transportation by air	1.433	1.542	1.705	1.950	2.115	2.198	2.363
33	992*	Federal, military	0.963	0.949	0.959	0.973	0.986	0.990	1.002
33	998*	Total Manufacturing	1.110	1.130	1.169	1.227	1.262	1.280	1.315
33	999*	Population	1.045	1.057	1.077	1.107	1.128	1.138	1.158
33	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
34	01	Farm	1.085	1.115	1.160	1.227	1.266	1.285	1.324
34	07	Agricultural services, forestry, fisheries, and other	1.180	1.215	1.297	1.421	1.499	1.538	1.616
34	15	Construction	1.055	1.066	1.087	1.119	1.139	1.149	1.169
34	40	Railroad Transportation	1.177	1.220	1.289	1.392	1.453	1.484	1.545
34	44	Water Transportation	0.962	0.952	0.941	0.925	0.918	0.915	0.909
34	45	Transportation by air	1.236	1.295	1.387	1.523	1.614	1.659	1.749
34	992*	Federal, military	0.934	0.930	0.937	0.949	0.959	0.964	0.975
34	998*	Total Manufacturing	1.028	1.035	1.049	1.071	1.085	1.092	1.106
34	999*	Population	1.033	1.042	1.057	1.080	1.096	1.103	1.119
34	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
35	01	Farm	1.114	1.142	1.196	1.277	1.325	1.349	1.397
35	07	Agricultural services, forestry, fisheries, and other	1.240	1.300	1.426	1.615	1.736	1.797	1.918
35	15	Construction	1.152	1.167	1.208	1.270	1.310	1.330	1.370
35	40	Railroad Transportation	1.161	1.201	1.273	1.382	1.448	1.481	1.547
35	44	Water Transportation	1.250	1.250	1.375	1.500	1.500	1.625	1.625
35	45	Transportation by air	1.322	1.402	1.523	1.705	1.828	1.890	2.013
35	992*	Federal, military	0.985	0.981	0.987	0.996	1.005	1.010	1.019
35	998*	Total Manufacturing	1.207	1.241	1.312	1.418	1.485	1.518	1.585
35	999*	Population	1.062	1.076	1.102	1.141	1.165	1.178	1.203
35	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
36	01	Farm	1.063	1.097	1.142	1.210	1.248	1.268	1.307
36	07	Agricultural services, forestry, fisheries, and other	1.162	1.199	1.276	1.391	1.460	1.495	1.565
36	15	Construction	0.996	0.999	1.004	1.011	1.017	1.020	1.025
36	40	Railroad Transportation	1.130	1.162	1.220	1.306	1.356	1.381	1.431
36	44	Water Transportation	0.912	0.890	0.857	0.809	0.784	0.771	0.747
36	45	Transportation by air	1.084	1.105	1.146	1.206	1.243	1.262	1.299
36	992*	Federal, military	0.959	0.949	0.960	0.976	0.989	0.996	1.009
36	998*	Total Manufacturing	1.014	1.019	1.027	1.039	1.047	1.051	1.059
36	999*	Population	1.010	1.013	1.017	1.023	1.029	1.031	1.037
36	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
37	01	Farm	1.020	1.043	1.067	1.103	1.123	1.132	1.152
37	07	Agricultural services, forestry, fisheries, and other	1.219	1.265	1.373	1.536	1.643	1.696	1.804
37	15	Construction	1.103	1.118	1.149	1.195	1.226	1.242	1.273
37	40	Railroad Transportation	1.102	1.127	1.183	1.268	1.318	1.343	1.393
37	44	Water Transportation	0.988	0.984	1.004	1.033	1.053	1.064	1.084
37	45	Transportation by air	1.192	1.240	1.326	1.455	1.542	1.585	1.672
37	992*	Federal, military	1.008	1.010	1.018	1.031	1.043	1.048	1.060
37	998*	Total Manufacturing	1.107	1.127	1.168	1.229	1.269	1.288	1.328
37	999*	Population	1.054	1.067	1.090	1.123	1.146	1.157	1.180
37	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
38	01	Farm	0.918	0.932	0.969	1.025	1.057	1.074	1.106
38	07	Agricultural services, forestry, fisheries, and other	1.207	1.252	1.354	1.509	1.610	1.661	1.763

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
38	15	Construction	1.097	1.109	1.135	1.173	1.197	1.208	1.232
38	40	Railroad Transportation	1.256	1.320	1.418	1.566	1.655	1.700	1.790
38	44	Water Transportation	1.000	1.000	1.000	1.000	1.000	1.000	1.000
38	45	Transportation by air	1.227	1.284	1.382	1.527	1.615	1.662	1.751
38	992*	Federal, military	0.963	0.952	0.957	0.966	0.974	0.979	0.987
38	998*	Total Manufacturing	1.182	1.211	1.271	1.360	1.416	1.444	1.500
38	999*	Population	1.012	1.016	1.023	1.032	1.040	1.044	1.052
38	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
39	01	Farm	1.028	1.056	1.098	1.162	1.199	1.217	1.253
39	07	Agricultural services, forestry, fisheries, and other	1.192	1.236	1.339	1.492	1.593	1.644	1.745
39	15	Construction	1.073	1.079	1.098	1.126	1.144	1.154	1.172
39	40	Railroad Transportation	1.112	1.141	1.185	1.253	1.290	1.309	1.346
39	44	Water Transportation	1.006	1.008	1.014	1.025	1.034	1.039	1.048
39	45	Transportation by air	1.170	1.213	1.287	1.399	1.473	1.510	1.583
39	992*	Federal, military	0.933	0.923	0.930	0.942	0.953	0.958	0.968
39	998*	Total Manufacturing	1.091	1.105	1.137	1.186	1.217	1.233	1.264
39	999*	Population	1.019	1.023	1.031	1.045	1.055	1.060	1.070
39	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
40	01	Farm	1.105	1.142	1.195	1.276	1.323	1.347	1.395
40	07	Agricultural services, forestry, fisheries, and other	1.237	1.293	1.418	1.606	1.732	1.795	1.921
40	15	Construction	1.085	1.098	1.121	1.157	1.180	1.192	1.215
40	40	Railroad Transportation	1.114	1.143	1.201	1.288	1.339	1.364	1.416
40	44	Water Transportation	1.151	1.189	1.208	1.245	1.283	1.283	1.321
40	45	Transportation by air	1.173	1.216	1.294	1.409	1.485	1.523	1.599
40	992*	Federal, military	0.981	0.983	0.990	1.001	1.012	1.017	1.027
40	998*	Total Manufacturing	1.129	1.153	1.199	1.268	1.311	1.332	1.375
40	999*	Population	1.030	1.038	1.052	1.072	1.086	1.093	1.108
40	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
41	01	Farm	1.031	1.049	1.096	1.167	1.208	1.229	1.271
41	07	Agricultural services, forestry, fisheries, and other	1.189	1.228	1.324	1.468	1.561	1.607	1.701
41	15	Construction	1.092	1.103	1.133	1.178	1.207	1.222	1.250
41	40	Railroad Transportation	1.183	1.229	1.301	1.408	1.473	1.505	1.570
41	44	Water Transportation	1.004	1.004	1.000	0.993	0.993	0.992	0.992
41	45	Transportation by air	1.233	1.291	1.399	1.562	1.670	1.725	1.833
41	992*	Federal, military	0.966	0.958	0.966	0.979	0.990	0.996	1.007
41	998*	Total Manufacturing	1.097	1.117	1.158	1.219	1.258	1.278	1.318
41	999*	Population	1.055	1.067	1.091	1.125	1.147	1.158	1.181
41	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
42	01	Farm	1.041	1.070	1.114	1.180	1.218	1.237	1.275
42	07	Agricultural services, forestry, fisheries, and other	1.183	1.226	1.318	1.457	1.546	1.590	1.679
42	15	Construction	1.020	1.023	1.032	1.047	1.057	1.062	1.072
42	40	Railroad Transportation	1.188	1.235	1.297	1.391	1.445	1.473	1.527
42	44	Water Transportation	0.973	0.966	0.963	0.958	0.959	0.959	0.959
42	45	Transportation by air	1.210	1.262	1.341	1.460	1.539	1.578	1.657
42	992*	Federal, military	0.931	0.922	0.929	0.939	0.948	0.953	0.962
42	998*	Total Manufacturing	1.061	1.070	1.090	1.120	1.139	1.149	1.168
42	999*	Population	1.017	1.023	1.032	1.045	1.056	1.061	1.072
42	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
44	01	Farm	1.105	1.129	1.167	1.225	1.258	1.274	1.307
44	07	Agricultural services, forestry, fisheries, and other	1.133	1.166	1.242	1.356	1.428	1.464	1.536
44	15	Construction	1.049	1.059	1.078	1.107	1.127	1.136	1.156
44	40	Railroad Transportation	1.134	1.165	1.216	1.299	1.351	1.371	1.423
44	44	Water Transportation	0.954	0.939	0.939	0.934	0.934	0.934	0.934
44	45	Transportation by air	1.215	1.269	1.358	1.493	1.582	1.627	1.716
44	992*	Federal, military	0.917	0.910	0.916	0.927	0.936	0.941	0.951
44	998*	Total Manufacturing	1.068	1.083	1.108	1.146	1.171	1.183	1.208
44	999*	Population	1.017	1.025	1.038	1.058	1.072	1.079	1.093

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
44	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
45	01	Farm	1.060	1.085	1.120	1.173	1.202	1.216	1.245
45	07	Agricultural services, forestry, fisheries, and other	1.201	1.248	1.349	1.499	1.597	1.647	1.745
45	15	Construction	1.081	1.100	1.133	1.183	1.215	1.231	1.264
45	40	Railroad Transportation	1.096	1.119	1.184	1.280	1.338	1.367	1.425
45	44	Water Transportation	1.023	1.029	1.043	1.065	1.079	1.086	1.101
45	45	Transportation by air	1.215	1.268	1.382	1.551	1.664	1.720	1.832
45	992*	Federal, military	0.906	0.907	0.914	0.924	0.934	0.939	0.949
45	998*	Total Manufacturing	1.139	1.172	1.231	1.319	1.375	1.402	1.458
45	999*	Population	1.044	1.056	1.077	1.109	1.130	1.141	1.162
45	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
46	01	Farm	1.018	1.041	1.076	1.130	1.162	1.177	1.209
46	07	Agricultural services, forestry, fisheries, and other	1.195	1.232	1.325	1.463	1.553	1.597	1.687
46	15	Construction	1.083	1.092	1.116	1.150	1.172	1.183	1.205
46	40	Railroad Transportation	1.213	1.267	1.342	1.455	1.524	1.557	1.626
46	44	Water Transportation	1.000	1.000	1.000	1.000	1.000	1.000	1.000
46	45	Transportation by air	1.220	1.273	1.360	1.493	1.583	1.627	1.717
46	992*	Federal, military	0.960	0.948	0.959	0.974	0.987	0.993	1.006
46	998*	Total Manufacturing	1.225	1.265	1.353	1.485	1.570	1.612	1.697
46	999*	Population	1.037	1.047	1.064	1.089	1.106	1.114	1.130
46	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
47	01	Farm	1.045	1.076	1.124	1.196	1.238	1.260	1.302
47	07	Agricultural services, forestry, fisheries, and other	1.218	1.264	1.375	1.541	1.650	1.705	1.815
47	15	Construction	1.091	1.103	1.128	1.166	1.191	1.204	1.229
47	40	Railroad Transportation	1.122	1.152	1.217	1.315	1.373	1.402	1.460
47	44	Water Transportation	1.063	1.078	1.100	1.134	1.156	1.166	1.188
47	45	Transportation by air	1.212	1.265	1.366	1.519	1.618	1.668	1.768
47	992*	Federal, military	0.949	0.944	0.952	0.964	0.975	0.981	0.992
47	998*	Total Manufacturing	1.123	1.146	1.191	1.257	1.299	1.320	1.363
47	999*	Population	1.048	1.060	1.079	1.108	1.127	1.137	1.157
47	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
48	01	Farm	1.108	1.133	1.187	1.269	1.317	1.341	1.388
48	07	Agricultural services, forestry, fisheries, and other	1.207	1.253	1.362	1.526	1.634	1.688	1.796
48	15	Construction	1.073	1.087	1.115	1.156	1.183	1.196	1.222
48	40	Railroad Transportation	1.201	1.252	1.335	1.461	1.538	1.577	1.654
48	44	Water Transportation	1.025	1.032	1.037	1.044	1.052	1.056	1.064
48	45	Transportation by air	1.209	1.261	1.352	1.489	1.581	1.627	1.718
48	992*	Federal, military	0.998	0.998	1.002	1.009	1.018	1.022	1.030
48	998*	Total Manufacturing	1.112	1.134	1.180	1.248	1.292	1.314	1.358
48	999*	Population	1.056	1.068	1.090	1.123	1.144	1.154	1.175
48	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
49	01	Farm	1.094	1.128	1.174	1.243	1.282	1.302	1.342
49	07	Agricultural services, forestry, fisheries, and other	1.264	1.319	1.450	1.646	1.779	1.846	1.979
49	15	Construction	1.150	1.167	1.219	1.297	1.347	1.372	1.421
49	40	Railroad Transportation	1.179	1.224	1.304	1.423	1.497	1.534	1.608
49	44	Water Transportation	1.150	1.150	1.150	1.200	1.200	1.250	1.250
49	45	Transportation by air	1.246	1.308	1.412	1.567	1.672	1.725	1.830
49	992*	Federal, military	0.953	0.951	0.957	0.967	0.976	0.980	0.989
49	998*	Total Manufacturing	1.186	1.225	1.302	1.418	1.490	1.527	1.599
49	999*	Population	1.087	1.108	1.147	1.206	1.242	1.260	1.295
49	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
50	01	Farm	1.064	1.097	1.144	1.215	1.256	1.276	1.317
50	07	Agricultural services, forestry, fisheries, and other	1.202	1.253	1.358	1.516	1.619	1.670	1.774
50	15	Construction	1.072	1.087	1.110	1.143	1.165	1.176	1.198
50	40	Railroad Transportation	1.127	1.155	1.211	1.289	1.331	1.359	1.401
50	44	Water Transportation	1.000	1.000	1.000	1.019	1.038	1.038	1.058
50	45	Transportation by air	1.283	1.350	1.448	1.601	1.704	1.753	1.857

Table 6.6-2 (continued)

State Code	SIC	SIC Name	Growth Factors 1999	2000	2002	2005	2007	2008	2010
50	992*	Federal, military	1.007	1.005	1.018	1.037	1.050	1.059	1.073
50	998*	Total Manufacturing	1.085	1.110	1.146	1.200	1.234	1.251	1.285
50	999*	Population	1.041	1.053	1.072	1.100	1.120	1.130	1.150
50	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
51	01	Farm	0.948	0.967	0.991	1.028	1.048	1.058	1.078
51	07	Agricultural services, forestry, fisheries, and other	1.213	1.256	1.363	1.524	1.631	1.684	1.790
51	15	Construction	1.067	1.074	1.100	1.138	1.164	1.177	1.203
51	40	Railroad Transportation	1.164	1.205	1.286	1.406	1.481	1.518	1.592
51	44	Water Transportation	0.996	0.994	1.003	1.017	1.028	1.033	1.045
51	45	Transportation by air	1.174	1.218	1.292	1.404	1.478	1.515	1.589
51	992*	Federal, military	0.963	0.963	0.971	0.982	0.993	0.998	1.008
51	998*	Total Manufacturing	1.062	1.075	1.108	1.158	1.190	1.207	1.240
51	999*	Population	1.043	1.054	1.074	1.104	1.125	1.135	1.156
51	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
53	01	Farm	1.013	1.020	1.065	1.132	1.172	1.193	1.233
53	07	Agricultural services, forestry, fisheries, and other	1.146	1.186	1.272	1.400	1.481	1.522	1.604
53	15	Construction	1.053	1.068	1.096	1.137	1.164	1.177	1.203
53	40	Railroad Transportation	1.201	1.251	1.331	1.449	1.523	1.559	1.632
53	44	Water Transportation	0.996	0.995	1.002	1.012	1.022	1.027	1.036
53	45	Transportation by air	1.137	1.171	1.249	1.366	1.442	1.481	1.557
53	992*	Federal, military	0.981	0.979	0.986	0.997	1.008	1.013	1.023
53	998*	Total Manufacturing	1.062	1.079	1.125	1.193	1.238	1.261	1.306
53	999*	Population	1.064	1.079	1.109	1.154	1.183	1.197	1.226
53	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
54	01	Farm	1.144	1.192	1.278	1.407	1.485	1.525	1.603
54	07	Agricultural services, forestry, fisheries, and other	1.233	1.286	1.408	1.591	1.714	1.774	1.897
54	15	Construction	1.069	1.073	1.082	1.097	1.108	1.114	1.126
54	40	Railroad Transportation	1.109	1.136	1.199	1.293	1.349	1.377	1.433
54	44	Water Transportation	1.011	1.014	1.017	1.022	1.028	1.034	1.039
54	45	Transportation by air	1.164	1.205	1.276	1.380	1.451	1.486	1.557
54	992*	Federal, military	0.979	0.995	1.005	1.022	1.034	1.042	1.054
54	998*	Total Manufacturing	1.035	1.040	1.060	1.090	1.109	1.119	1.139
54	999*	Population	1.014	1.018	1.024	1.032	1.041	1.046	1.055
54	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
55	01	Farm	1.014	1.060	1.130	1.233	1.288	1.316	1.371
55	07	Agricultural services, forestry, fisheries, and other	1.214	1.265	1.373	1.535	1.642	1.695	1.802
55	15	Construction	1.064	1.075	1.096	1.128	1.150	1.160	1.181
55	40	Railroad Transportation	1.206	1.258	1.325	1.426	1.486	1.516	1.576
55	44	Water Transportation	1.000	1.000	0.996	0.991	0.991	0.991	0.991
55	45	Transportation by air	1.188	1.235	1.322	1.452	1.539	1.583	1.670
55	992*	Federal, military	0.971	0.957	0.967	0.983	0.996	1.003	1.016
55	998*	Total Manufacturing	1.120	1.140	1.183	1.247	1.287	1.308	1.348
55	999*	Population	1.032	1.041	1.055	1.078	1.093	1.101	1.117
55	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387
56	01	Farm	1.138	1.162	1.218	1.301	1.350	1.374	1.423
56	07	Agricultural services, forestry, fisheries, and other	1.228	1.279	1.395	1.568	1.684	1.741	1.857
56	15	Construction	1.075	1.083	1.108	1.146	1.171	1.183	1.208
56	40	Railroad Transportation	1.162	1.203	1.282	1.402	1.476	1.513	1.587
56	44	Water Transportation	1.071	1.071	1.071	1.143	1.143	1.143	1.143
56	45	Transportation by air	1.209	1.257	1.340	1.461	1.545	1.581	1.665
56	992*	Federal, military	1.047	1.071	1.079	1.090	1.100	1.106	1.116
56	998*	Total Manufacturing	1.116	1.139	1.184	1.253	1.297	1.319	1.363
56	999*	Population	1.039	1.048	1.064	1.088	1.103	1.110	1.126
56	LTO*	Landing-Takeoff Operations	1.095	1.124	1.182	1.263	1.328	1.358	1.387