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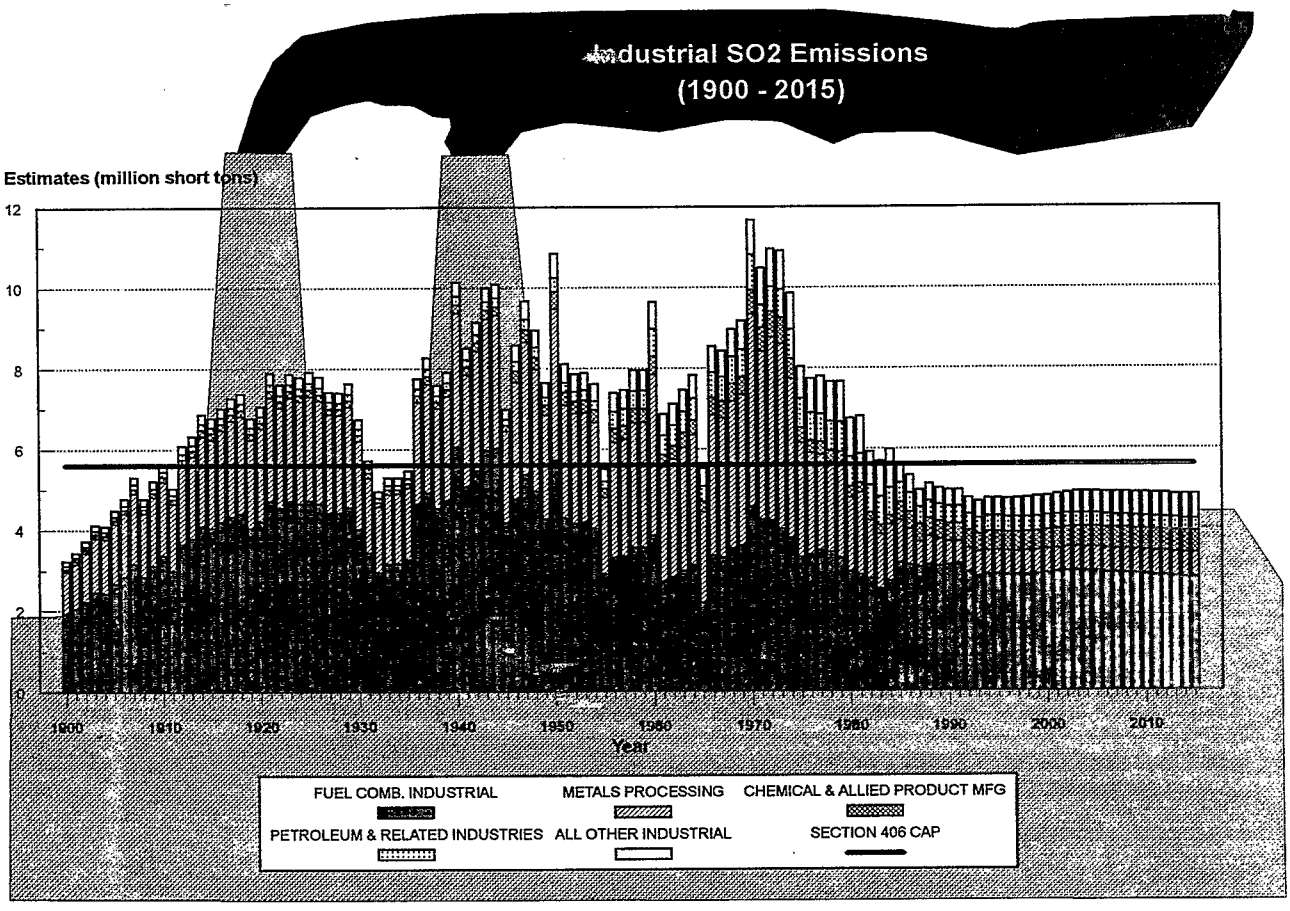
Report To Congress



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EXECUTIVE SUMMARY

This report provides an inventory of national annual sulfur dioxide (SO_2) emissions from industrial (i.e., nonutility) sources. It also contains estimates of actual emission reductions resulting from diesel fuel desulfurization regulations defined in section 211(i) of the Clean Air Act Amendments of 1990 (CAAA), which became effective in October 1993.

The major health effects associated with high exposures to SO_2 in the ambient air include problems in breathing, respiratory illness, alterations in the lung's defenses, and aggravation of existing respiratory and cardiovascular disease. Those most sensitive to SO_2 include asthmatics and individuals with chronic lung disease (such as bronchitis or emphysema) or cardiovascular disease. Children and the elderly may also be sensitive.

Sulfur dioxide also produces foliar damage on trees and agricultural crops. Sulfur dioxide and nitrogen oxides (NO_x) in the air cause acidic deposition, commonly known as acid rain. Acid rain is associated with a number of effects including acidification of lakes and streams, damage to high-elevation forests, and accelerated corrosion of buildings and monuments. Sulfur dioxide and NO_x emissions also form sulfates and nitrates in the atmosphere that can significantly impair visibility.

In 1990 the Congress amended the Clean Air Act (CAA) to address problems associated with acid rain. Title IV of the 1990 Amendments requires a 10 million ton reduction of SO_2 and significant reductions of NO_x to reduce the harmful effects of acid rain. Title IV also calls for the establishment of a market-based allowance trading program to minimize compliance costs and maximize economic efficiency. In January 1993 EPA issued final regulations implementing the SO_2 allowance trading program. The SO_2 reductions are to be achieved primarily from utilities, but also from industrial sources that opt into the allowance trading program and from the desulfurization of diesel fuel. Rulemaking on industrial sources, to be finalized in early 1995, allows SO_2 industrial combustion sources to receive permits and allowance allocations. The remaining process sources will fall under a second rulemaking, to be promulgated later in 1995.

A. CLEAN AIR ACT AMENDMENTS OF 1990 MANDATE

This report provides information required under section 406 of the CAAA. The CAAA of 1990 actually contains two section 406's in Title IV. All references to section 406 in this report refer to 42 USC 7651, (note also referred to as section 406, Appendix B), which deals with Industrial SO_2 Emissions. Section 406 states that:

> Not later than January 1, 1995 and every 5 years thereafter, the Administrator of the Environmental Protection Agency (EPA) shall transmit to the Congress a report containing an inventory of national annual SO_2 emissions from industrial sources (as defined in title IV of

> the Act), including units subject to section 405(g)(6) of the CAA, for all years for which data are available, as well as the likely trend in such emissions over the following 20-year period. The report shall also contain estimates of the actual emission reduction in each year resulting from promulgation of the diesel fuel desulfurization regulations under section 211(i).

Industrial sources are defined in section 402(24) of the 1990 CAAA. An industrial source is:

> a unit that does not serve a generator that produces electricity, a "nonutility unit" as defined in this section, or a process source as defined in section 410(e).

A nonutility unit is defined in section 402(25) as "a unit other than a utility unit." Although reference is made to a process source definition in section 410(e), section 410(d) actually deals with process sources, but no definition of a process source is given. For the purposes of this report, a process source is any source that emits SO_2 as the result of the production or manufacturing process and not as the result of any type of fuel combustion.

Section 406 also provides that whenever the inventory required by this section indicates that sulfur dioxide emissions from industrial sources, including units subject to section 405(g)(6) of the CAA, may reasonably be expected to reach levels greater than 5.60 million tons per year, the Administrator of the EPA shall take such actions under the CAA as may be appropriate to ensure that such emissions do not exceed 5.60 million tons per year. Such actions may include the promulgation of new and revised standards of performance for new sources, including units subject to section 405(g)(6) of the CAA, under section 111(b) of the CAA, as well as promulgation of standards of performance for existing sources, including units subject to section 405(g)(5) of the CAA, under authority of this section. Although the act refers to 405(g)(5), the actual reference should be 405(g)(6).

B. SELECTION OF A BASELINE EMISSIONS INVENTORY METHODOLOGY

The 5.60 million ton cap cited in section 406 was derived from emissions estimated for industrial sources as part of the 1985 National Acid Precipitation Assessment Program (NAPAP) inventory. As a consequence, 1985 emissions serve as the baseline from which all other emissions estimates are derived. The U.S. Environmental Protection Agency (EPA) also produces annual emissions estimates, including those for 1985, as part of their annual assessment of emission trends. A comparison made between the 1985 NAPAP emission inventory and the Trends data for 1985 (available in the October 1992 EPA Trends report) for industrial sources indicated that the two 1985 estimates (NAPAP and Trends) compare favorably at the national level (NAPAP estimated 5.6 million tons SO_2 and Trends estimated 6.0 million tons SO_2). There were, however, individual source category by source category discrepancies. The 1985 NAPAP inventory still represents the most comprehensive and accurate emission estimates for 1985 because of its rigorous quality assurance of emissions and bottom-up derivation. Therefore, the NAPAP estimate, which is the basis for the emission cap in the CAAA, should be used as the starting point for all future comparisons.

1. Emissions Levels from 1985-1990

Estimates of industrial SO_2 emissions over the period 1985 to 1990 show a moderate decline from 5.6 million tons to slightly less than 5 million tons. Over that time period, coal-related SO_2 emissions dominate emissions from industrial fuel sources. Emissions from oil combustion in the industrial sector have declined slightly from the 1985 NAPAP levels, while contributions from gas and other fuels have remained approximately the same.

Copper processing operations were the largest contributor to metals processing emissions according to the 1985 NAPAP emission inventory. Emissions from copper processing operations have decreased dramatically from approximately 0.65 million tons in 1985 to slightly over 0.2 million tons in 1990. A large part of this decrease in emissions is attributable to the demolition of the Phelps Dodge copper smelter (in Arizona) in January 1987, resulting in a decrease in emissions of 330,000 tons/year of SO_2. Emissions from other metals processing sources from 1985-1990 have stayed approximately the same.

SO_2 emissions from chemical manufacturing processes are dominated by emissions from inorganic sulfur compound production over the period 1985-1990. Emissions from the other chemical processes remain relatively flat for this time period.

Emissions from petroleum and related industries from 1985-1990 shows that natural gas production SO_2 emissions are approximately the same as those from fluid catalytic cracking units at petroleum refineries. Prior to 1985, natural gas production SO_2 emissions were approximately one-half those from fluid catalytic cracking units at petroleum refineries.

Cement manufacturing is the leading other industrial processes subcategory SO_2 emission producer. This source does show a slight, but steady decline in emission from 1985 to 1990. Emissions from wood, pulp and paper, and publishing operations remained virtually constant over the same time frame, as did waste disposal operations, and the all other industrial processes categories. Mineral products (excluding cement manufacturing) declined slightly over the period.

2. Selection of Base Year Emission Inventory

In order to produce the emission projections required under section 406, a base year emission inventory upon which to base these projections was required. EPA feels that the best inventory to use for developing the emission projections required under section 406 is the 1990 Emission Trends inventory. This decision was based on three criteria:

- It is based upon the 1985 NAPAP emission inventory, which is generally regarded as the most comprehensive inventory ever compiled,
- It is an outgrowth of the 1990 Interim Inventory which is currently being utilized in ROM modeling efforts and is generally regarded as the best national level inventory currently available, and

- The 1990 inventory coincides with the year of enactment for the CAAA.

C. PROJECTED EMISSIONS LEVELS

Industrial source SO_2 emissions for the base year (1990) are approximately 5 million tons. Starting with the base year emissions, emission projections were developed using growth factors. No new national controls for any industrial SO_2 sources were identified, nor were changes in current "rule effectiveness." (Rule effectiveness reflects the ability of a regulatory program to achieve all the emission reductions that could have been achieved by full compliance with the applicable regulations at all sources at all times.) Thus the emission projections developed represent growth with no new controls.

Table ES-1 shows the 1985, 1993, and 2015 emission levels for five broad categories of industrial SO_2 emissions. 2015 was chosen as the last projection year, since it represents a 20-year period from the January 1995 date required for this report. Table ES-1 shows that emissions were 5.6 million tons in 1985, decreased to 4.7 million tons in 1993 and are projected to increase slightly to 4.8 million tons in 2015.

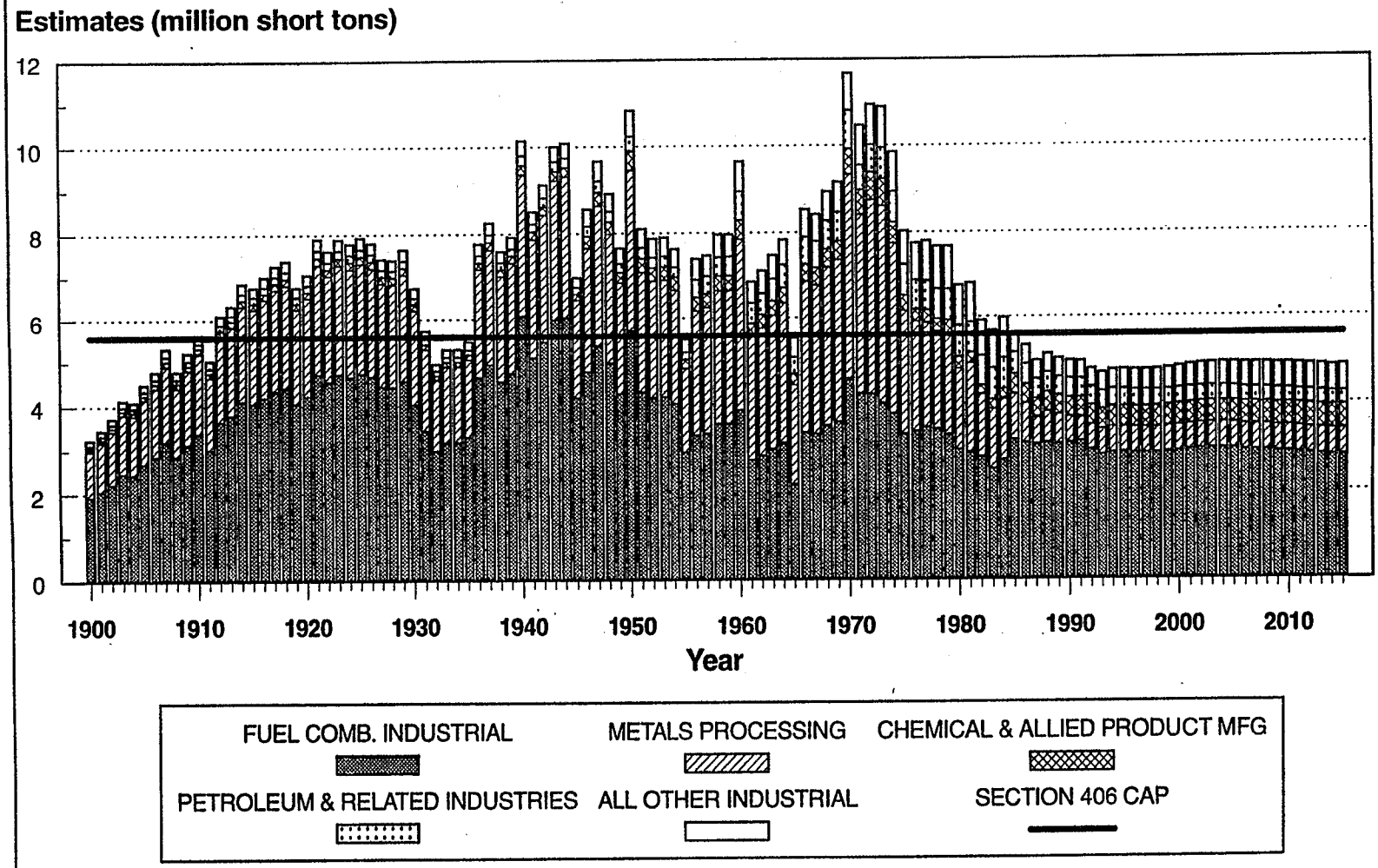
Figure ES-1 provides a long term look at emissions from industrial SO_2 sources. This figure shows historic, current and projected emissions levels for the five categories included in Table ES-1 as well as an indicator of the 5.6 million ton/year cap called for in section 406. This figure shows that prior to 1970, emission levels were almost double the 5.6 million ton/year cap, but declined significantly after that. This decline is coincident with the passage of the Clean Air Act of 1970. Figure ES-1 also shows that projected emissions show a slight increase from 1990 to 2000 and then are projected to level off in the foreseeable future.

Figure ES-2 provides a map showing the locations and relative emissions of the top 100 industrial point source emitters as derived from EPA's Aerometric Information System Facility Subsystem (AIRS/AFS). These emissions were not used in the baseline analysis.

Table ES-1
National Sulfur Dioxide Emissions from Industrial Sources for the Years 1985, 1993, and 2015 (thousand short tons)

Source Category	1985	1993	2015
Fuel Combustion	3,169	2,830	2,803
Metals Processing	1,042	580	584
Chemical & Allied Product Manufacturing	456	450	540
Petroleum & Related Industries	505	409	312
All Other Industrial	440	430	620
Total	**5,612**	**4,699**	**4,859**

Figure ES-1
Industrial SO2 Emissions
(1900 - 2015)



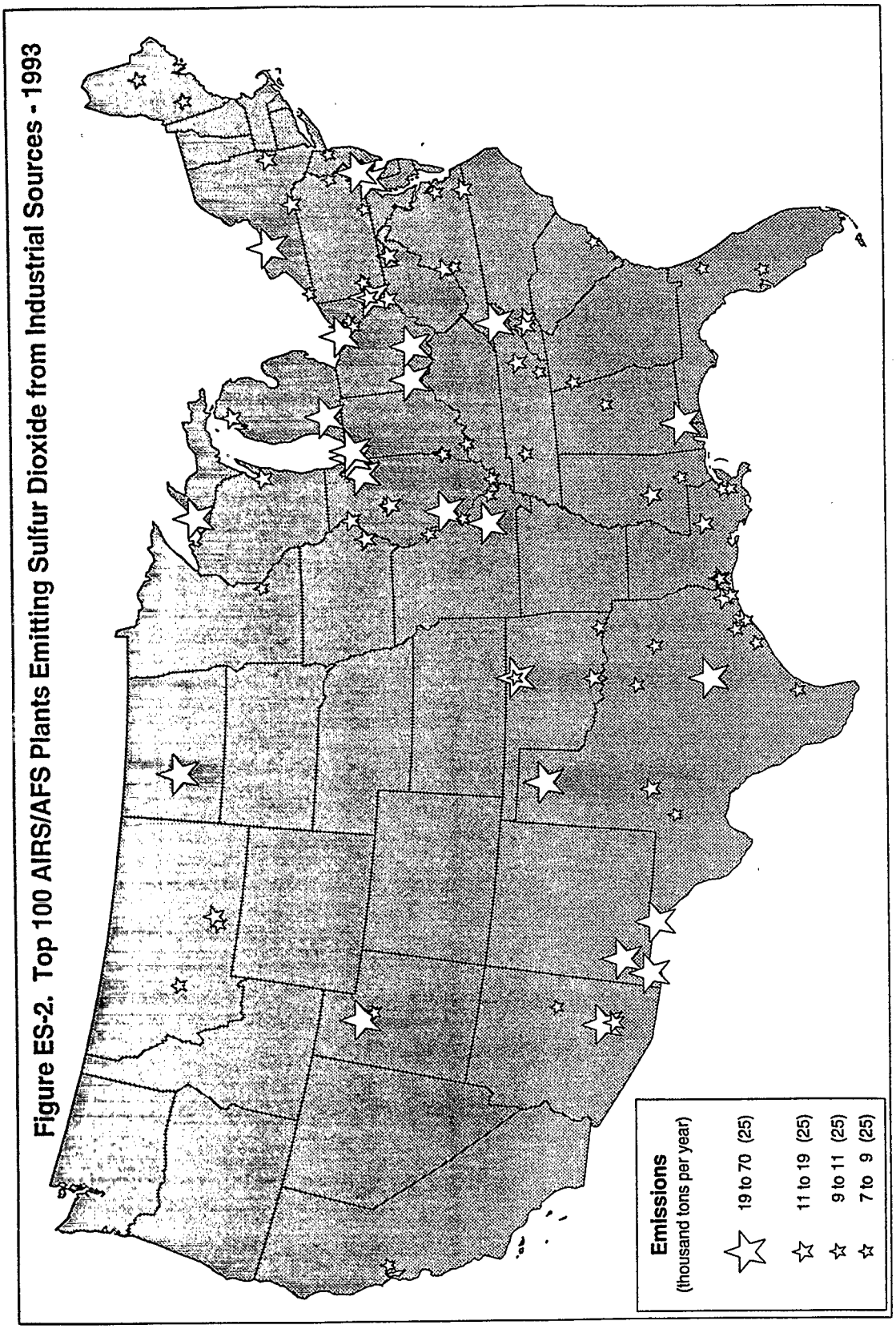


Figure ES-2. Top 100 AIRS/AFS Plants Emitting Sulfur Dioxide from Industrial Sources - 1993

CHAPTER I
INTRODUCTION

This report provides information required under section 406 of the Clean Air Act Amendments of 1990 (CAAA). The CAAA of 1990 actually contains two section 406's in Title IV. All references to section 406 in this report refer to 42 USC 7651, note (also referred to as section 406, Appendix B, which deals with Industrial SO_2 Emissions. Section 406 states that:

> Not later than January 1, 1995 and every 5 years thereafter, the Administrator of the Environmental Protection Agency (EPA) shall transmit to the Congress a report containing an inventory of national annual sulfur dioxide (SO_2) emissions from industrial sources (as defined in title IV of the Act), including units subject to section 405(g)(6) of the Clean Air Act (CAA), for all years for which data are available, as well as the likely trend in such emissions over the following 20-year period. The report shall also contain estimates of the actual emission reduction in each year resulting from promulgation of the diesel fuel desulfurization regulations under section 211(i) of the CAAA of 1990.

It should be noted that although section 406 references diesel fuel desulfurization regulations under section 214, the diesel fuel desulfurization regulations are actually specified in section 211(i) of the 1990 CAAA.

Industrial sources are defined in section 402(24) of the 1990 CAAA. An industrial source is:

> a unit that does not serve a generator that produces electricity, a "nonutility unit" as defined in this section, or a process source as defined in section 410(e).

A nonutility unit is defined in section 402(25) as "a unit other than a utility unit." Although reference is made to a process source definition in section 410(e), section 410(d) actually deals with process sources, but no definition of a process source is given. For the purposes of this report, a process source is any source that emits SO_2 as the result of the production or manufacturing process and not as the result of any type of fuel combustion.

Section 406 also provides that whenever the inventory required by this section indicates that sulfur dioxide emissions from industrial sources, including units subject to section 405(g)(5) of the CAA, may reasonably be expected to reach levels greater than 5.60 million tons per year, the Administrator of the EPA shall take such actions under the CAA as may be appropriate to ensure that such emissions do not exceed 5.60 million tons per year. Such actions may include the promulgation of new and revised standards of performance for new sources, including units subject to section 405(g)(5) of the CAA,

under section 111(b) of the CAA, as well as promulgation of standards of performance for existing sources, including units subject to section 405(g)(5) of the CAA, under authority of this section. Although the act refers to 405(g)(5), the actual reference should be 405(g)(6).

This report fulfills the requirements of section 406 by presenting information related to 1) historic emissions from industrial SO_2 sources, 2) current emissions from industrial SO_2 sources (i.e., a baseline emission inventory), 3) emission projections for a 20-year period from the baseline emission inventory, and 4) emission reductions related to changes in the diesel fuel desulfurization regulations. Chapter 2 of this report examines historic emissions from industrial SO_2 sources. For the purposes of this report, historic emissions are considered to be emissions prior to 1985. 1985 was chosen as the cutoff for historic emissions for several reasons. First, the 5.60 million tons per year level mentioned in section 406 is derived from data collected during the development of the 1985 National Acid Precipitation Assessment Program (NAPAP) emission inventory effort. Second, an evaluation of the differences between emission estimates developed as part of the 1985 NAPAP emission inventory and those developed by EPA for publication in the annual report commonly referred to as the Emission Trends report, indicates that, while the total national emissions estimates are similar, there are large differences between the two inventories at the individual source category level and the 1985 NAPAP inventory is thought to be a more comprehensive inventory. Finally, the method used to estimate emissions as part of EPA's current Emission Trends estimation procedure now incorporates a method that is more closely aligned with the 1985 NAPAP inventory effort than with the previous Emission Trends method, thus 1985 represents a more appropriate break between historic emissions and current emissions.

Chapter 3 presents a broad overview of the differences between the emissions estimated as part of the 1985 NAPAP emission inventory effort and the corresponding emissions developed as part of EPA's Emission Trends effort. Chapter 4 presents the baseline emission inventory developed for this report. This baseline inventory represents the year 1990. 1990 was chosen to be consistent with the year of enactment of the CAAA. Data are also presented for the years 1991-1993 in this chapter. Chapter 5 presents the emission projections for the period 1994-2015 developed from the baseline 1990 emission inventory. Chapter 6 describes emission reductions resulting from institution of the diesel fuel desulfurization regulations.

CHAPTER II
HISTORIC INDUSTRIAL SO_2 EMISSIONS

A. INTRODUCTION

EPA has been preparing emissions estimates for industrial SO_2 sources for a number of years. These estimates have been prepared either as part of large-scale, bottom-up emission inventory development efforts (such as the 1980 and 1985 NAPAP emission inventories) or as part of EPA's on-going Emission Trends effort. As a consequence, national emissions estimates for industrial SO_2 sources are available from 1900 to the present. This chapter presents historic national industrial SO_2 emissions estimates for the period 1900-1984. As indicated in Chapter 1, historic emissions estimates are considered to be all emissions estimates developed prior to 1985, since the 1985 NAPAP emission inventory served as the basis for the section 406 requirements.

EPA has recently instituted a "tiered" source category assignment mechanism which can be used to summarize emissions on a consistent basis. This system is comprised of three tiers. Tiers 1 and 2 are identical for all pollutants. Tier 3 categories are pollutant specific. Additionally, a distinct naming convention has been instituted with the tier categorization. Tier 1 category names are given in all capital letters. Tier 2 names are given with the first letter of each word capitalized. Tier 3 categories are shown in all lower case letters. Information presented in this report is consistent with that naming convention. For example, a full tier category name for distillate oil emissions from industrial boiler operation would be:

Tier 1 Name	FUEL COMBUSTION - INDUSTRIAL
Tier 2 Name	Oil
Tier 3 Name	distillate

Information presented in this report is provided using the tier categorization scheme. In some cases several tiers are combined together for presentation purposes. However, when this combination is made, the naming convention is maintained. For example, in Figure II-1, ALL OTHER INDUSTRIAL is not a true Tier 1 category name, but represents the sum of all the other Tier 1 industrial source emissions not presented individually. Additional information concerning the tier categorization scheme can be found in Barnard et al., 1993.

In addition, historic SO_2 emissions for selected industrial source subcategories (i.e., Tier 2 or 3 levels) are presented at 10-year intervals for the period 1940-1980. Information presented in this chapter at the Tier 2 level or below is only provided from 1940-1980. Differences in the way emissions estimates were developed for years prior to 1940 prohibit Tier 2 or 3 reporting.

The original inventories, and large accompanying sets of now widely distributed emission factors and activity data have all been reported in English units; the estimated emissions in this report also are reported in English short tons.

B. NATIONAL LEVEL HISTORIC INDUSTRIAL SOURCE SO_2 EMISSIONS ESTIMATES

Figure II-1 presents national level historic industrial source SO_2 emissions estimates for the period 1900-1984. Industrial SO_2 emissions can result from industrial fuel combustion, chemical and allied product manufacturing, metals processing, petroleum and related industries, solvent utilization, storage and transport activities, industrial waste disposal and recycling activities, and other industrial processes. Figure II-1 clearly shows that two categories, industrial fuel combustion and metals processing, have historically been the largest contributors to industrial source SO_2 emissions. The 5.6 million ton cap specified in section 406 is included for reference purposes in Figure II-1.

Figure II-1 also clearly indicates the overall trend in emissions during the period 1900-1984. From 1900 to the late 1920s, industrial source emissions steadily increased to levels slightly below 8 million tons. However, the effects of the depression of 1929 can clearly be seen in Figure II-1. Emissions from industrial sources dropped from peak pre-depression levels of approximately 8 million tons to close to 5 million tons during the depression years.

Dramatic increases in industrial source SO_2 emissions resulted from the increased industrial activity resulting from the onset of World War II, with peak emissions levels of approximately 10 million tons in the mid-1940s. Emissions then declined to levels approximately the same as those of the 1920s during the post-war years (i.e., late 1940s-mid 1950s).

From the early 1960s, industrial SO_2 emissions begin increasing steadily, reaching the highest estimated levels of slightly less than 12 million tons in 1970. Since 1970, industrial SO_2 emissions have steadily declined to levels approximately the same as the early 1900s and the depression years. 1970 marked the passage of the Clean Air Act of 1970 (CAA).

C. HISTORIC EMISSIONS FOR SELECTED INDUSTRIAL SOURCE SUBCATEGORIES

As indicated above, industrial fuel combustion and metals processing are the two major industrial source Tier 1 category contributors to historic industrial SO_2 emissions estimates from 1900-1984. Figures II-1 through II-5 provide additional detail related to the Tier 2 and 3 subcategories that are the major contributors to the Tier 1 categories shown in Figure II-1.

1. Fuel Combustion

Figure II-1 clearly indicates that industrial fuel combustion is the largest contributor to industrial source SO_2 emission on an historic basis. Figure II-2 provides a breakdown

of emissions contributions from industrial combustion by fuel type at 10-year intervals for the period 1940-1980. Coal burning is the major contributor to industrial combustion SO_2 emissions over this period. However, coal burning emissions show a steady decline from slightly over 5 million tons in 1940 to approximately 1.5 million tons in 1980.

Emissions from the burning of oil at industrial facilities has increased during the same time period, from just over 0.5 million tons in 1940 to slightly over 1 million tons in 1980. Peak emissions occurred in 1970 during the time period examined.

Emissions of SO_2 from the combustion of gas and other fuels have been relatively small. Emissions accompanying gas burning have remained virtually constant over the 1940-1980 time period, while emissions from other fuels have steadily declined.

2. Metals Processing

Metals processing has historically been the second largest industrial SO_2 emissions source. In particular, copper smelting activities have historically produced large SO_2 emissions. Figure II-3 clearly shows the dominance of copper producing activities in production of SO_2 emissions. From 1940-1970, copper production contributed over twice as much SO_2 than any other metals processing operation. However, the collapse of the copper market in the 1970s has resulted in a dramatic decrease in copper smelting activities. This can be clearly seen in Figure II-3 where emissions levels dropped from approximately 3.5 million tons in 1970 to just over 1 million tons in 1980.

Emissions from other metals processing sources show different patterns than that exhibited by copper processing. Lead processing emissions have declined slightly over the same time period. However, aluminum processing emissions have increased during the same timeframe. Other nonferrous metal processing emissions have decreased steadily since the 1950s. Ferrous metals processing emissions have remained approximately the same from 1940 to 1980.

3. Chemical and Allied Product Manufacturing

Figure II-4 indicates that for the period 1940-1980, the only subcategory source of any importance with respect to SO_2 emissions from chemical and allied product manufacturing is the production of inorganic sulfur compounds. These emissions increased steadily from 1949 until 1970 producing peak emissions of approximately 0.6 million tons. By 1980, however, the emission levels from this source were less than half the 1970 levels. Other chemical manufacturing activities provided minor emissions in 1980.

4. Petroleum and Related Industries

SO_2 emissions from petroleum and related industries (Figure II-5) generally show steadily increasing emissions from the 1940s to the 1970s, with slight declines after 1970. None of the emissions from the subcategories detailed in Figure II-5 are above 0.5 million tons even at their peak emissions levels. Fluid catalytic cracking units at petroleum refineries are the single largest subcategory contributor to SO_2 emissions from petroleum and related industries.

5. Other Industrial Processes

Figure II-6 presents historic SO_2 emissions from other industrial processes. Cement manufacturing clearly is the largest contributor among these industrial source subcategories, with emissions increasing from slightly over 0.3 million tons in 1940 to over 0.6 million tons in 1980. Figure II-6 also indicates that SO_2 emissions from Wood, Pulp and Paper, and Publishing activities have steadily increased through the same time period, with 1980 emissions levels exceeding 0.2 million tons.

D. HISTORIC EMISSIONS SUMMARY

There are two principal routes by which industrial SO_2 emissions reach the atmosphere: fuel combustion and process releases. On a percentage basis, the industrial sector's contribution to total U.S. emissions of SO_2 has declined from about 50 percent in 1940 to approximately 25 percent in 1980.

The downward trend, since the 1970s, in collective SO_2 emissions from industrial fuel combustion and process emissions could be attributed, at best, to *cleaner* operations; at worst, to a *dwindling* industrial sector. Actually some of both, and more, unquestionably is occurring as the complex U.S. economy evolves. Figure II-7 compares trends in industrial SO_2 emissions with primary energy expended by the combustion of fossil fuels in the industrial sector since 1950, in British thermal units (Btus) (Energy Information Admin., 1993). This figure appears to show that in the 1950s and 1960s both SO_2 emissions and industrial activity were increasing along roughly parallel courses. Electricity, classified as a secondary energy form, is excluded in this analysis. Through the 1970s and 1980s, however, estimated industrial SO_2 emissions decreased markedly while primary energy expended in the industrial sector has fluctuated only gradually downward. Some of this reduction in primary industrial energy use can be credited to increased efficiencies as new equipment and processes have been phased in. Some can also be attributed to overseas transfers. Certainly a portion results from conversions to electrically powered equipment, which merely transfers SO_2 emissions out of the industrial category and into the already sizeable electric utility category (if this electricity was supplied by electric utility generators rather than industrial generators). Thus, the actual trend in industrial activity may be more positive than this primary energy indicator implies. Consequently, use of a primary energy indicator as a surrogate for evaluating emissions may provide a conservative assessment of the real and substantial reduction in SO_2 emissions, collectively, by the industrial sector of the U.S. economy. Interestingly, the decrease in industrial emissions occurs starting in 1970, coincident with the passage of the Clean Air Act of 1970.

Figure II-8 shows the subcategory of industrial SO_2 emissions from fuel combustion, partitioned by the principal fuel types: coal, oil, and natural gas. Emissions from industrial combustion sources burning coal evidence the most reduction. The bars in Figure II-8 depict the same index of industrial activity used in Figure II-7. The decreasing trend in the combustion component of industrial SO_2 emissions through the 1960s took place while industrial energy use was increasing; more recently, both industrial combustion-generated SO_2 emissions and primary energy use have leveled off.

Three industrial source categories contribute the majority of process-related SO_2 emissions: chemical manufacturing and related products, metals refining and processing, and petroleum refining and related products. The largest contributing category, metals, increased its process emissions in the initial post-war decades, overriding reductions in the combustion category. In the 1970s and 1980s, process emissions from these sources have substantially decreased. Figure II-9 shows both industrial process emissions as well as a surrogate indicator of emission, an economic index for the predominant source category (the metals industry) compiled by the Federal Reserve (Statistical Abstracts, 1993). Apart from its somewhat conspicuous rise in 1965, this economic index exhibits a pattern generally similar to that of primary energy use (as shown in Figure II-8). Through the 1960s, both the process SO_2 emissions and the economic index trended generally upward. Subsequently, the economic index has leveled off or declined slightly, while process emissions (most conspicuously from the metals category) have declined markedly.

In summary, this analysis indicates that the most significant reductions in combustion emissions of SO_2 by U.S. industries occurred early in the post-war period; concurrently, process emissions were rising, resulting in a net increase from the industrial sector. Through the 1950s and 1960s, the collective upward trend in estimated industrial SO_2 emissions occurred while the industrial sector of the U.S. economy, as gauged by two indicators: energy use and an economic index of the metals industry, was also growing. Since the 1970s, marked reductions in process emissions have been achieved, principally in metals refining and processing leading to declining industrial SO_2 emissions during a period when industrial activity levelled off or perhaps declined slightly. Again, this decrease is coincident with the passage of the CAA of 1970.

Figure II-1
Historic Industrial SO2 Emissions
(1900 - 1984)

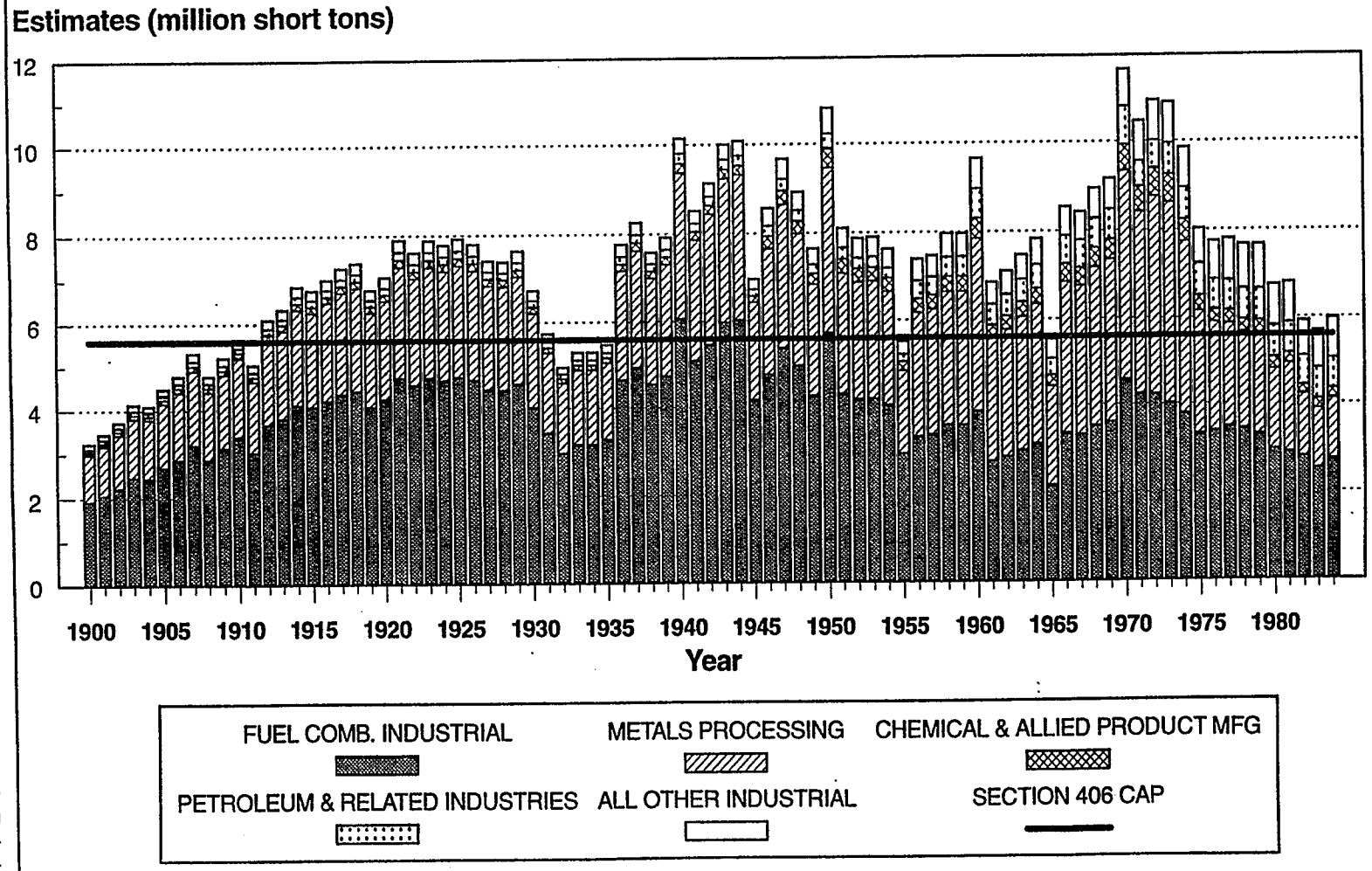


Figure II-2
Historic Industrial Combustion SO2 Emissions
(1940 - 1980)

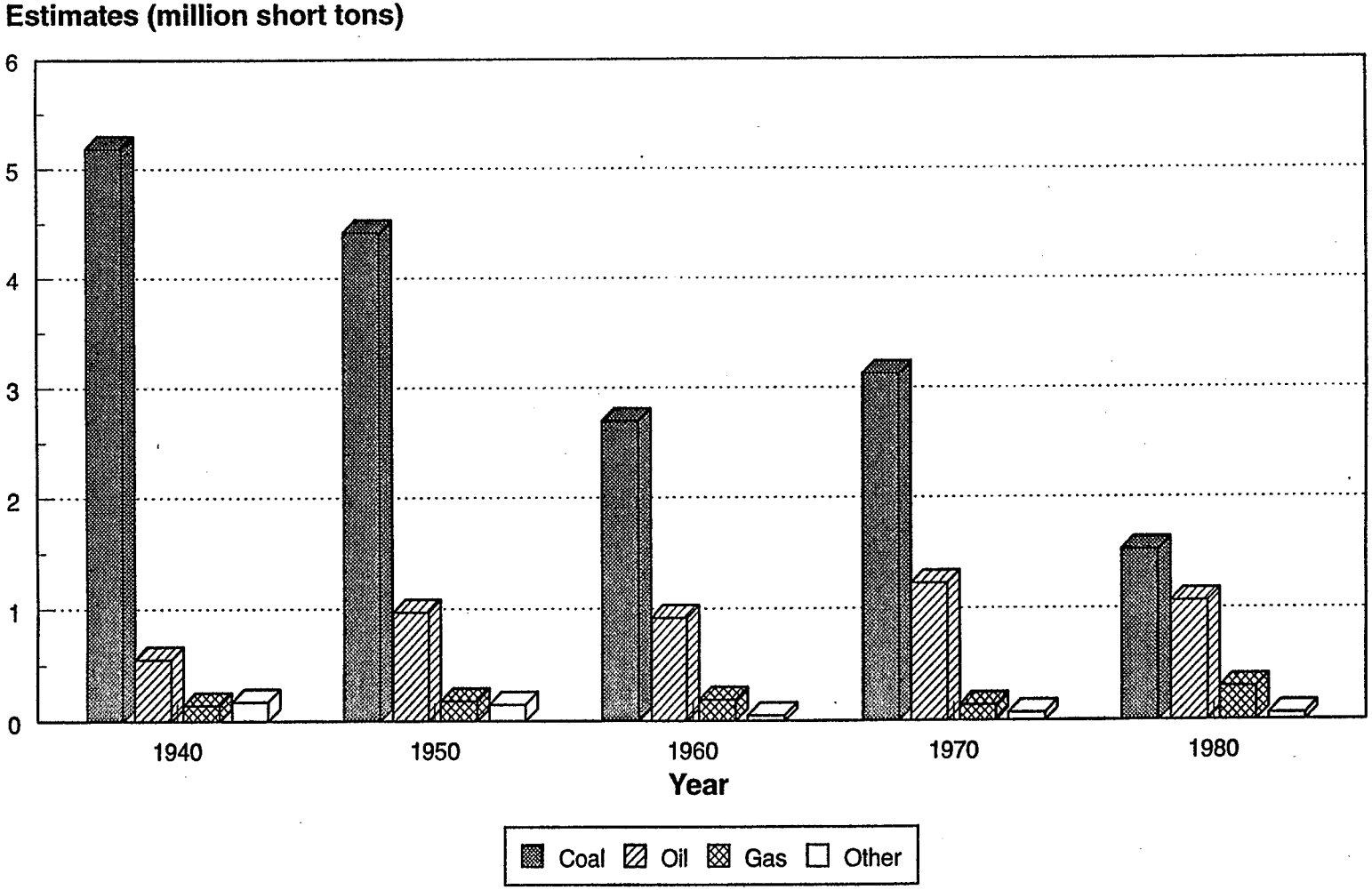


Figure II-3
Historic Industrial SO2 Emissions from Metals Processing
(1940 - 1980)

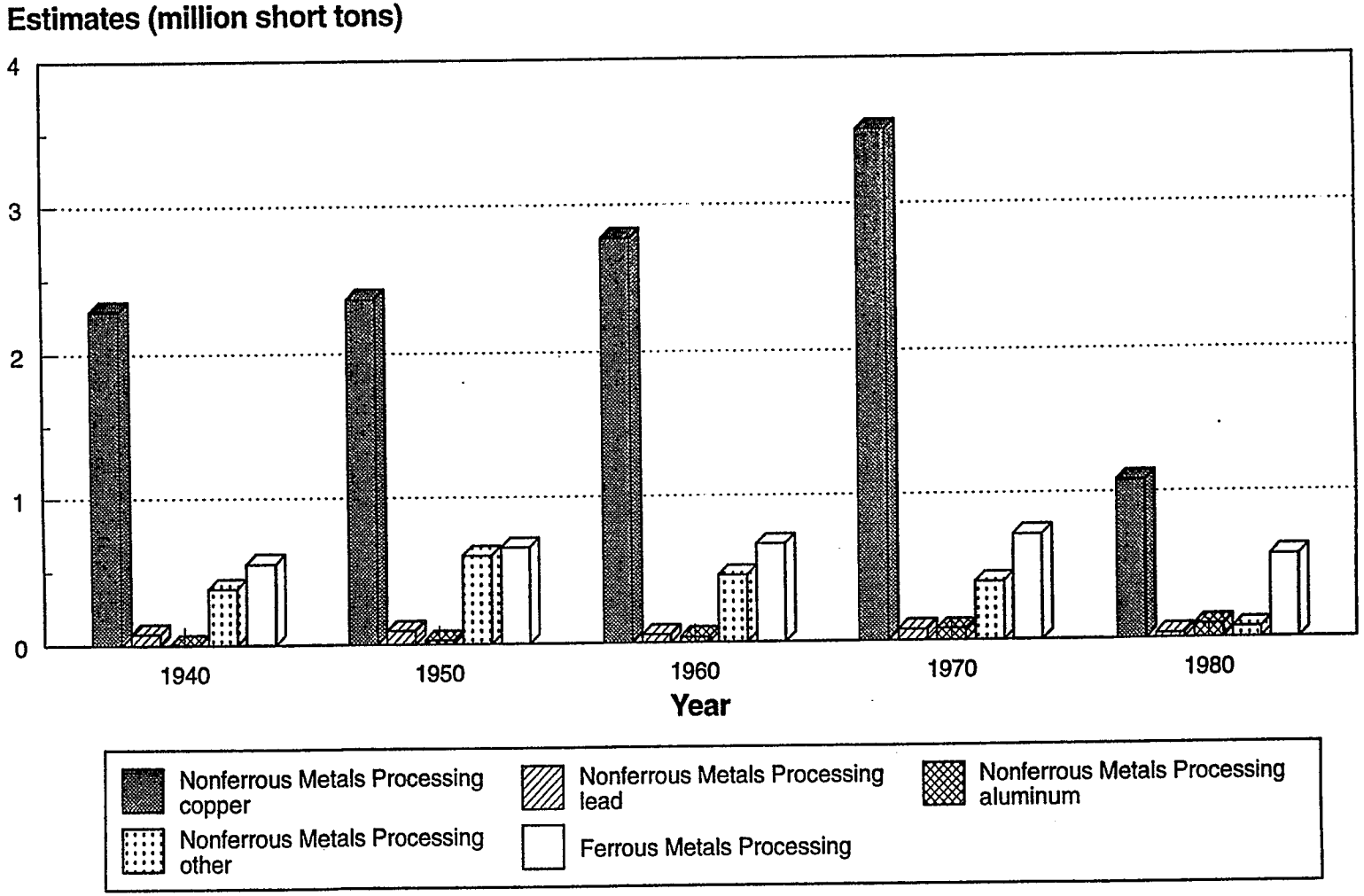


Figure II-4
Historic Industrial SO2 Emissions from Chemical & Allied Product Mfg (1940 - 1980)

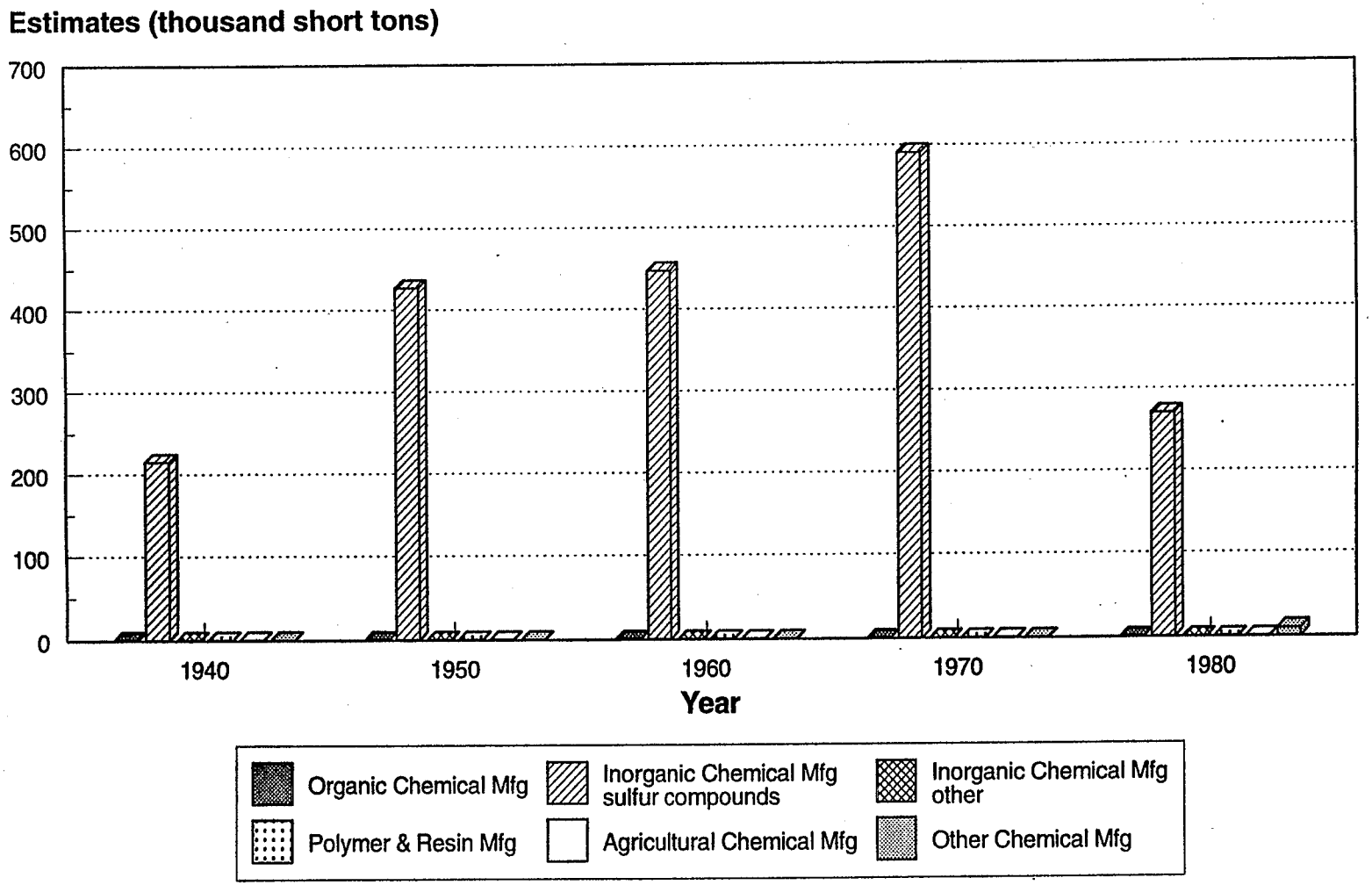


Figure II-5
Historic Industrial SO2 Emissions from Petroleum & Related Industries (1940 - 1980)

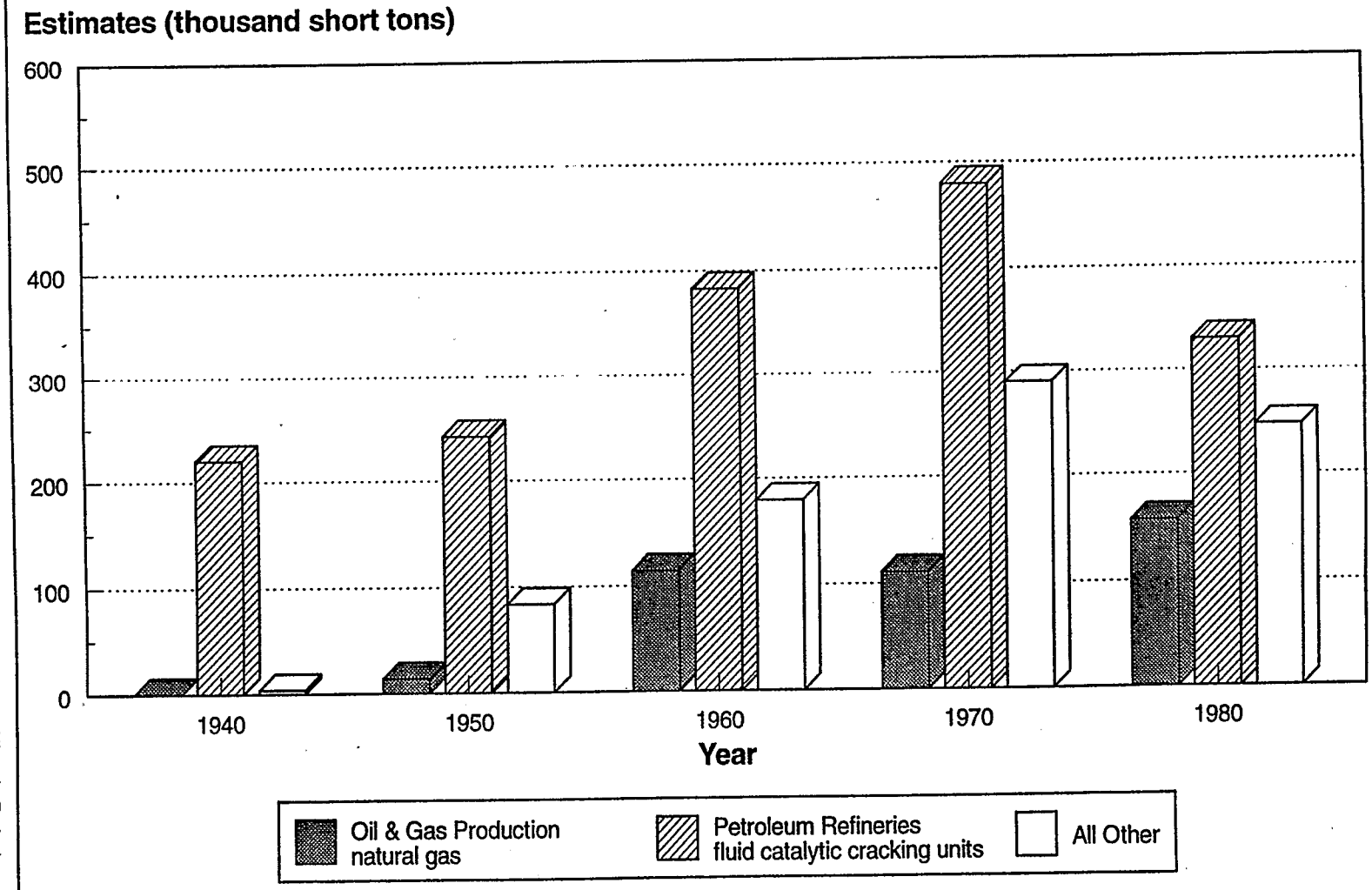


Figure II-6
Historic Industrial SO2 Emissions from Other Industrial Processes (1940 - 1980)

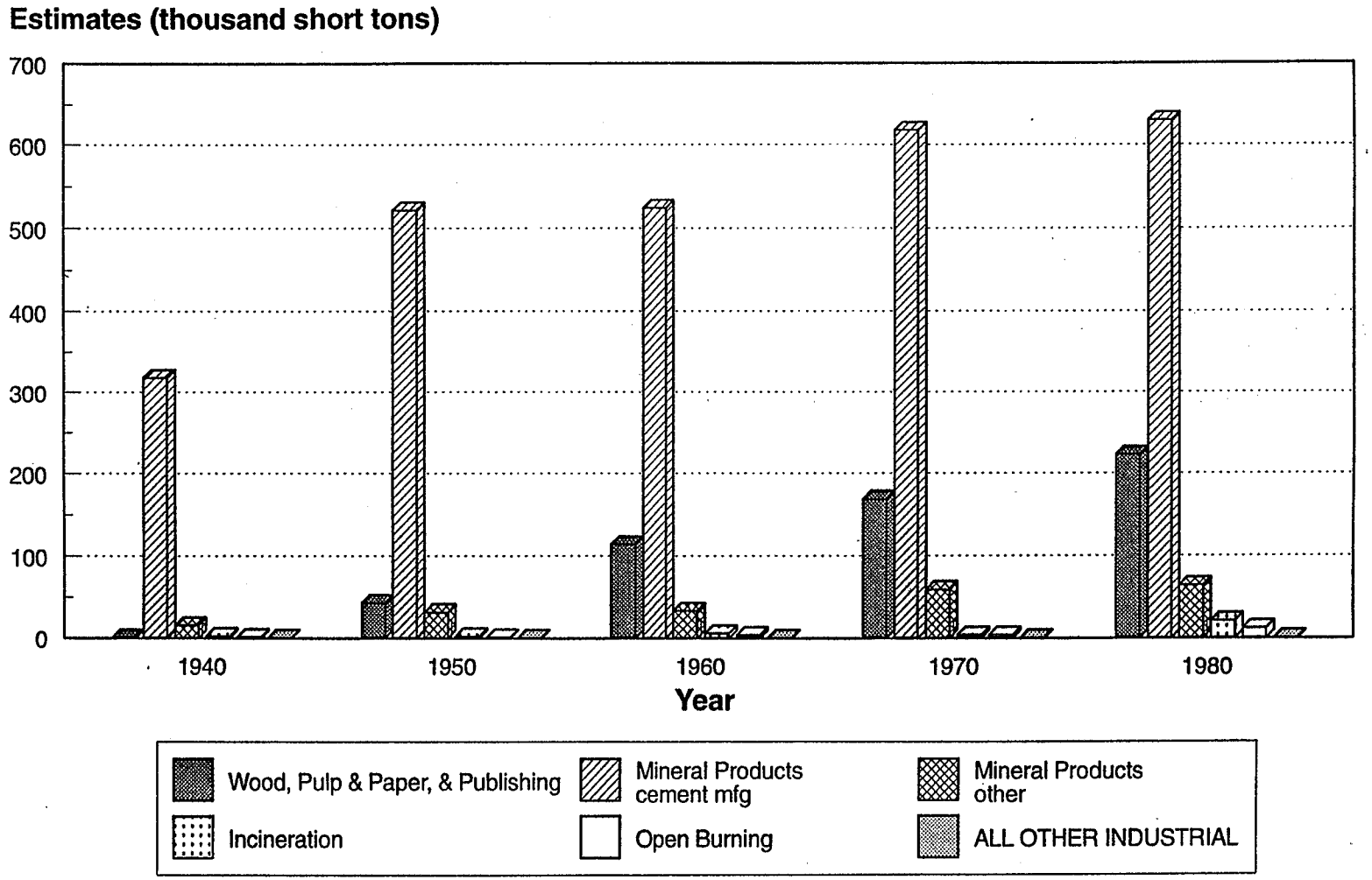


Figure II-7
Trends in Industrial SO2 Emissions and Energy Use
(1940 - 1985)

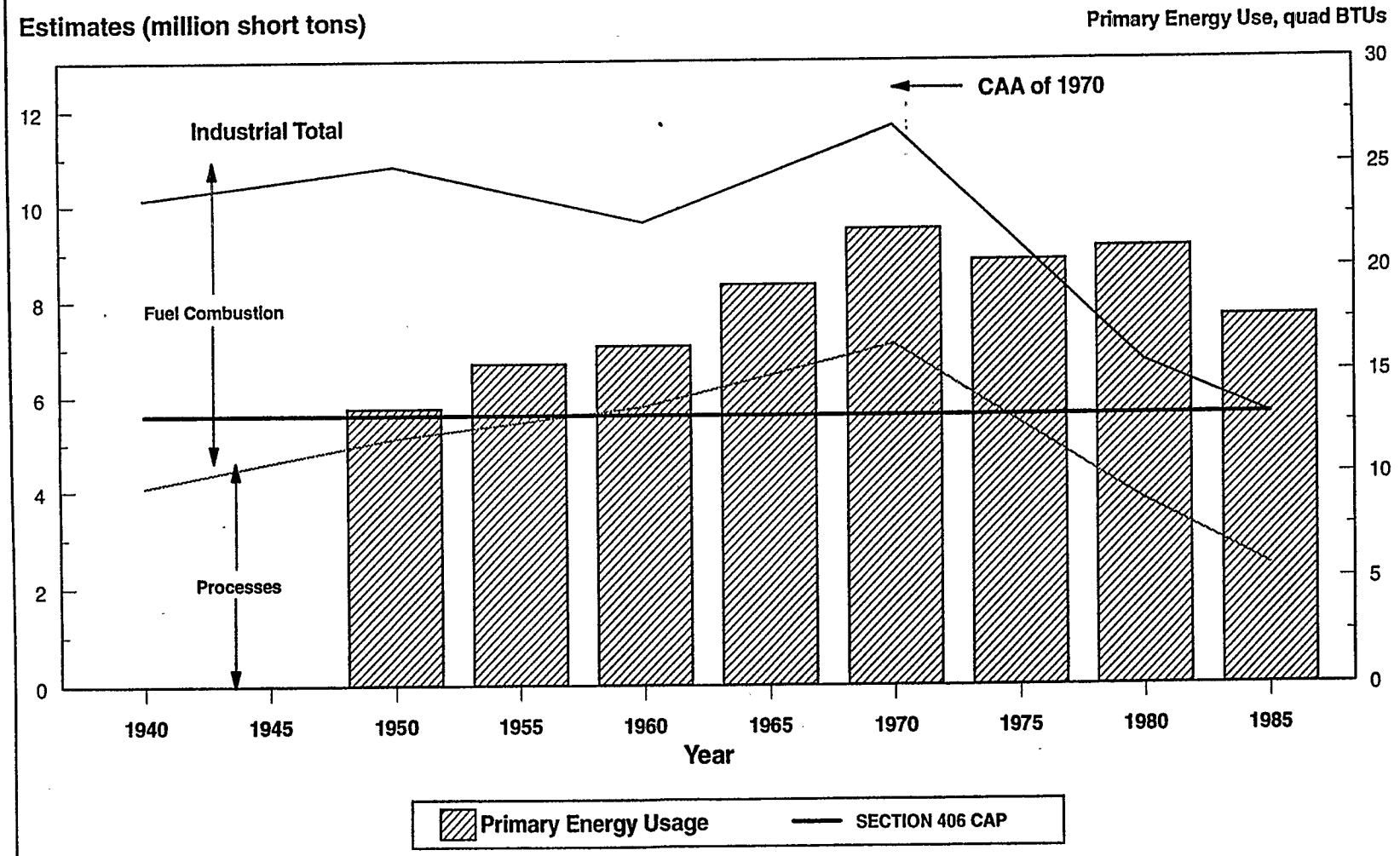


Figure II-8
Industrial Combustion SO2 Emissions and Energy Use
(1940 - 1980)

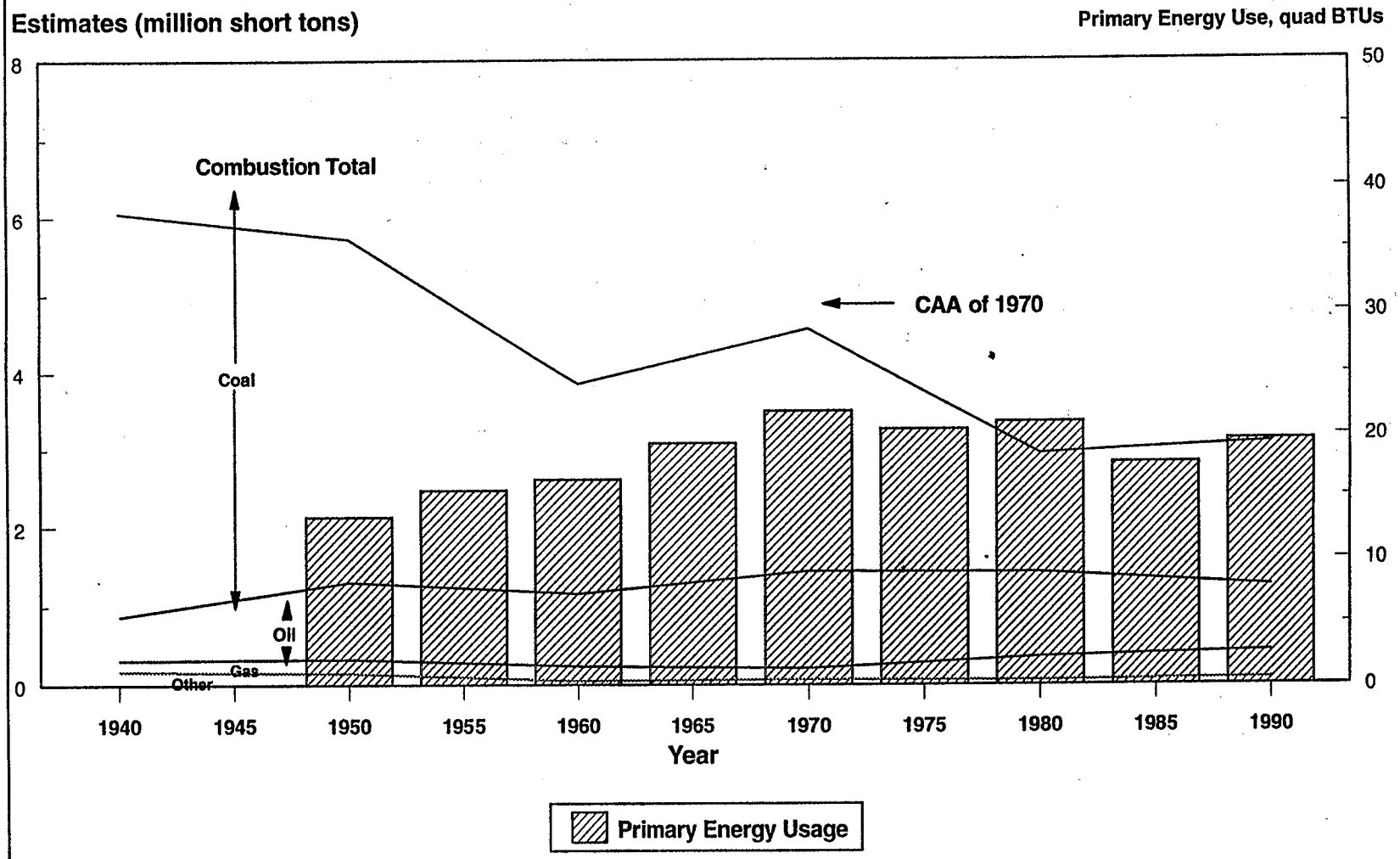
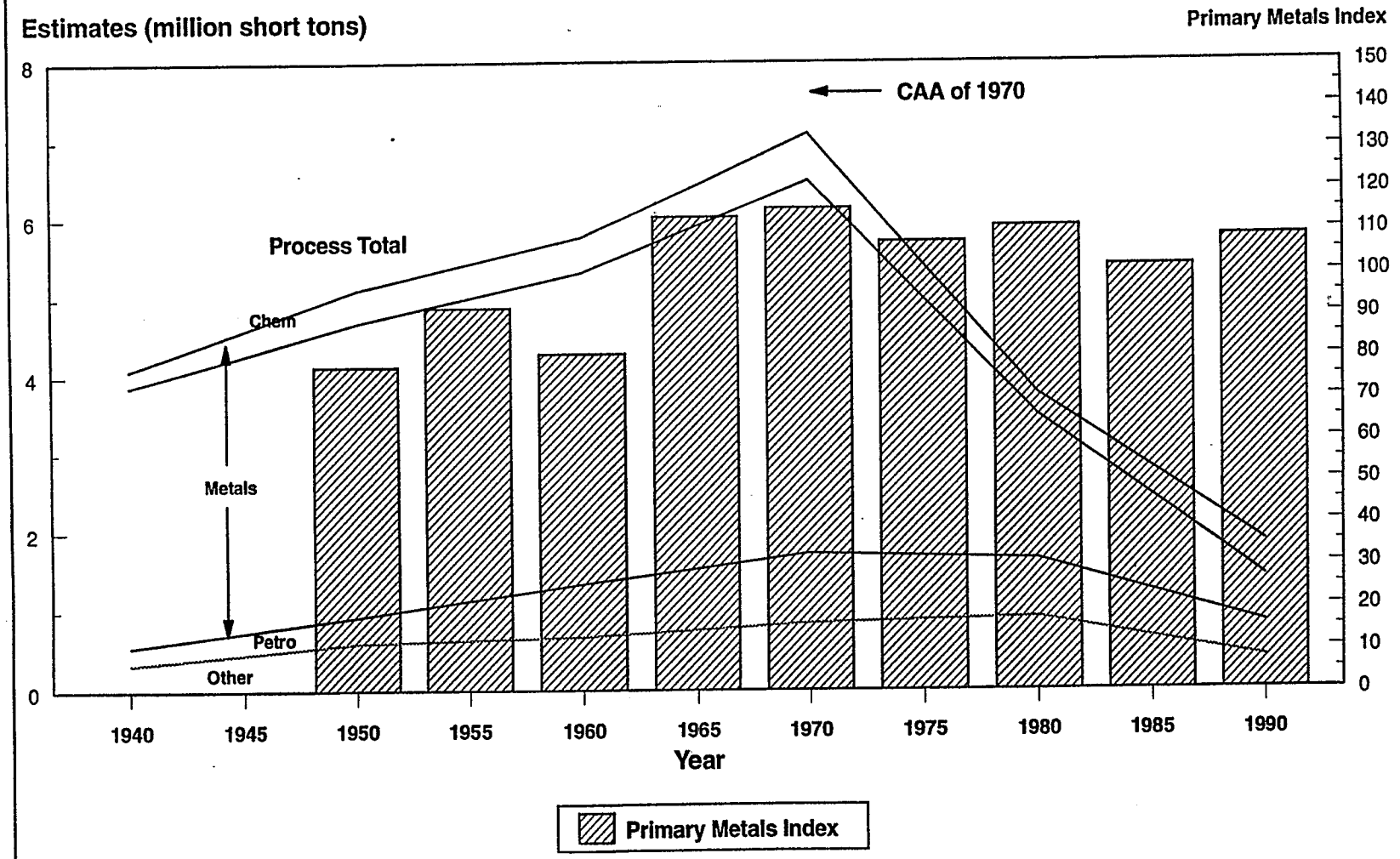


Figure II-9
Industrial Process SO2 Emissions and Primary Metals Index
(1940 - 1990)



CHAPTER III
SUMMARY CHAPTER COMPARING EMISSIONS FROM BASELINE ANALYSIS REPORT

Section 406 of the 1990 CAAA requires that the Administrator of the Environmental Protection Agency transmit to Congress a report containing a national inventory of annual sulfur dioxide (SO_2) emissions from industrial sources not later than January 1, 1995 for all years for which data are available, as well as the likely trend in SO_2 emissions over the following 20-year period (1995-2015). Under the Act as amended, 1985 served as the baseline for the 5.6 million tons industrial SO_2 emission limit referred to in section 406. To provide the 1995 analysis mandated by Congress, the 1985 baseline data must first be examined to identify strengths and weaknesses in the available emissions and supporting data. This chapter presents a summary of the analysis presented in the "Comparison of the 1985 NAPAP Emissions Inventory with the 1985 EPA Trends Estimates for Industrial SO_2 Sources" (EPA, 1994) (hereinafter referred to as the *Comparison*). The two major sources of 1985 industrial emission data available at the time: the 1985 National Acid Precipitation Assessment Program (NAPAP) Emissions Inventory (EPA, 1989) and the 1985 National Air Pollutant Emission Estimates (EPA, 1992), referred to as the "Old Trends" emission estimates, are compared in the report.

A. 1985 NAPAP EMISSION INVENTORY VERSION 2

The 1985 NAPAP emission inventory effort supported joint acid precipitation deposition research with Canada, including atmospheric modeling, through comprehensive, detailed source emission estimates provided by local and state agencies. An inventory of emissions and facility data representing point and area source classification code (SCC)-level operating characteristics for 1985 was developed to provide information for assessing acid deposition problems. The U.S. portion of the 1985 NAPAP Emissions Inventory covers the 48 contiguous states and the District of Columbia. It is a "bottom-up" inventory and should be considered a snapshot of the 1985 emissions. The SO_2 emission data for significant [> 100 tons per year (TPY)] sources were systematically quality assured, with greater effort expended on larger sources. The inventory included a unique confirmation step, allowing individual plants emitting at least 2,500 TPY to review their emission estimates prior to finalization. The resulting inventory is widely regarded as the most comprehensive and accurate national inventory compiled to date.

1. Methodology

The U.S. anthropogenic emissions data were collected through the EPA emissions inventory data system known as the National Emissions Data System (NEDS) (EPA 1986). The annual anthropogenic emissions are divided into two major categories, point and area sources. Point sources have precise location data and emit at least 100 TPY of

any of the criteria[a] pollutants: sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOC), total suspended particulate (TSP)[b], or carbon monoxide (CO). The U.S. point source emissions and facility data were collected by state agencies using the NEDS methodology. In that methodology, process-level emissions were estimated directly for each source. The emission estimates were based on source tests, emission factors, or material balance. In some cases, when no other information was available, engineering judgement was used to estimate the emissions.

The U.S. point source facilities and emissions data were prepared by the state air agencies and delivered to NAPAP through the EPA Regional Offices. NAPAP worked closely with the Office of Air Quality Planning and Standards (OAQPS) to process the point source data through NEDS.

Emissions and facility data were requested for point source facilities that emitted at least 100 TPY of SO_2, NO_x, VOC, TSP, or CO during 1985. An extensive quality assurance and quality control (QA/QC) program was conducted during the inventory development process to correct erroneous, questionable, or missing data elements for a list of high priority point source data items. The QA/QC effort focused on points that emitted at least 25 TPY that were located at plants that emitted at least 1,000 TPY of any of the three priority pollutants SO_2, NO_x, and VOC.

Some states were able to provide emissions data for facilities that had emissions of criteria pollutants below the target reporting levels. Those emissions records were removed from the point source inventory and included as county-level area source categories for minor point sources.

An inventory of area source emissions was developed to account for emissions from sources that were not included in the point source inventory. The area source inventory was developed through a process quite different from the point source inventory. Area source emission estimates were calculated by multiplying the activity rate for each area source category by an emission factor. The activity rate data from the United States were developed through statistical procedures based on distributions of national activity rate. Generally, emission factors developed by EPA were applied to the allocated activity levels to produce annual emissions estimates for each area source category.

The majority of industrial SO_2 emissions as reported in the 1985 NAPAP emission inventory are reported as point sources. Over 4,000 industrial facilities were listed as emitting SO_2, one third of these facilities emitted a small amount of SO_2 (< 100 tons of SO_2). About 130 facilities account for approximately 50 percent of the industrial SO_2

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[a]The CAA requires that the EPA Administrator publish a list of pollutants that have adverse effects on public health or welfare, and which are emitted from numerous and diverse stationary or mobile sources. For each pollutant, a "criteria" document must be compiled and published by the Administrator. The criteria are scientific compendia of the studies documenting adverse effects of specific pollutants at various concentrations in the ambient air. For each pollutant, National Ambient Air Quality Standards (NAAQS) are set at levels which, based on the criteria, protect the public health and the public welfare from any known or anticipated adverse effects. Regulated pollutants are therefore referred to as "criteria pollutants."

[b]The current regulated size of particulate is ≤ to 10 microns.

emissions. Based on data from the 1985 NAPAP inventory only 500 facilities account for 80 percent of the industrial SO_2 emissions.

2. Quality Assurance and Quality Control (QA/QC)

The QA/QC activities were major efforts for the 1985 NAPAP Emissions inventory. The inventory data was collected through a cooperative effort involving EPA and the states. Early in the inventory planning, a decision was made to involve the state agencies to the maximum extent possible. The 1985 NAPAP Emissions Inventory Version 2 is the first inventory to be developed with significant and repeated input from state agencies. Thus, the inventory is considered the most complete and accurate national inventory of air pollutants ever assembled.

The state inventories were submitted to EPA and subjected to various automated and manual quality control checks. As problems or questions were identified, procedures were implemented to refer these problems back to the state agencies for comment and/or correction. Each state was given two opportunities to review its entire point source inventory. The state-level area source inventories developed by EPA were also submitted to each state for review.

Specific QA/QC procedures applied to the state annual inventories included checks for completeness, range checks, a separate analysis of utility records, an emissions confirmation by the facilities for the largest emitters and identification of emission values for a list of priority data items. All questions were referred back to the participating state agencies for resolution. Although most problems were resolved through the state agencies, EPA corrected remaining problems involving emission and erroneous data. Many of the additional corrections were addressed by the substitution of default parameters.

B. 1985 EPA NATIONAL AIR POLLUTANT EMISSION ESTIMATES

The Trends emission estimates represent both current and historic emissions (1900 to present) and are compiled annually by OAQPS. The annual Emissions Trends document presents the most recent estimates of national emissions of the criteria air pollutants.

The emissions of each pollutant are estimated for many different source categories, which collectively account for nearly all anthropogenic emissions. The document presents the total emissions from all 48 contiguous states, Alaska, Hawaii, and the District of Columbia. The emission trends are the net effect of many factors, including changes in the nation's economy and in industrial activity, technology, consumption of fuels, traffic, and other activities which cause air pollution. The trends also reflect changes in emissions as a result of air pollution regulations and emission controls. The emission trends presented in the "Old Trends" document are based on consistent methods applied to all years. The "Old Trends" emission estimates were developed for comparative purposes and the use of "Old Trends" emission estimates as an absolute value for any given year is inappropriate.

National emissions are estimated annually by the U.S. EPA based on statistical information about each source category, emission factors, and control efficiency. The estimates are made for over 450 individual source categories that include nearly all major sources of anthropogenic emissions. The emission estimates for individual source categories are aggregated to show the emission trends at the national levels by major source category.

Since it is impossible to annually measure the emission of every source individually, a "top down" estimating procedure must be 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, raw material processed, etc. When indicators are used, emission factors which relate the quantity of emissions to the activity indicator must also be used. This approach provides a consistently derived national emission estimate at the emission category level (e.g., industrial oil combustion) rather than the source (e.g., boiler) level.

The basic "top down" calculation procedure may be represented by the following equation:

$$E_{p,s} = A_s * EF_{p,s} * (1 - \frac{C_{p,s}}{100}) \quad (1)$$

where:

E	=	emissions
p	=	pollutant
s	=	source category
A	=	activity level
EF	=	emission factor
C	=	percent control efficiency

National activity indicators for individual source categories are obtained from many different publications. Emission factors are generally obtained from the U.S. EPA's Compilation of Air Pollutant Emission Factors, AP-42 (EPA 1991). The overall control efficiency of a source category was derived from NEDS.

An exception to this approach is copper smelters. SO_2 emissions for this source were obtained from the plants directly through the respective state air pollution agencies.

C. ANALYSIS[c]

This section summarizes the analysis of the derivation of the individual industrial category 1985 emission estimates from NAPAP and "Old Trends" as presented in the *Comparison*. Such an analysis is complicated by several factors:

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[c]The source categories in this chapter are the same as those presented in the *Comparison* and do not match with those in the rest of the report.

- 1985 NAPAP is comprehensive and includes all reported industrial emission categories. "Old Trends" is limited to categories thought to emit at least 10 thousand metric tons (11 thousand short tons) of a criteria pollutant per year.

- 1985 NAPAP is source and plant specific. "Old Trends" is national and category-specific. There is no opportunity to match individual data values between the inventories; in fact, category definitions differ between the two inventories.

- The 1985 NAPAP inventory is a single year inventory published in November of 1989 and is not updated. The "Old Trends" methodology was first applied to 1985 in the annual report published in January of 1987; subsequent annual reports include adjustments to prior years based on the most current emission factors (dependent on time and resources).

The *Comparison* presents a highly detailed view of the two inventories on a category by category basis, principally relying on emission activity (throughput data). Methodologies, data sources, emissions, and assumptions are documented and analyzed in as much detail as possible so that this information need not be recompiled for future examination. The analysis proved complex, especially when disaggregating data to create comparable categories between NAPAP and "Old Trends" data sets, and raised a number of questions. (In particular, categories with significant in-process fuel emissions such as cement proved difficult to assess because the process and fuel emissions were treated differently in each data set.)

The 1985 EPA "Old Trends" and 1985 NAPAP emission estimates and their differences are presented in Table III-1 and Figure III-1. Overall, the two 1985 estimates (NAPAP and "Old Trends") compare favorably: NAPAP estimates 5.6 million tons SO_2 (as reflected in the CAAA) and "Old Trends" estimated 6.0 million short tons. When broken down, however, the two estimates show greater divergence for individual source categories. The "Old Trends" estimate was larger than the 1985 NAPAP estimate and did not include as many source categories. The "Old Trends" estimate systematically overestimated emissions, relative to the NAPAP inventory, and therefore on aggregate the estimates are very similar. The primary reason for the overestimation in the "Old Trends" method was the exclusion of SO_2 control technology for some categories. Several categories exceeding 100,000 tons of SO_2 differ by more than 50 percent between the two data sets: primary lead and zinc, iron and steel, oil and natural gas production, pulp and paper, and cement.

1. Combustion Sources

The combustion estimates in "Old Trends" (2.5 million tons) and NAPAP (2.6 million tons) are very similar. This is due in part to the method utilized by NAPAP to estimate area source emissions. In the NAPAP inventory, the industrial point source fuel usage is subtracted from national fuel use estimates provided by the Department of Energy, and emission from the unaccounted for fuel are allocated to the area source inventory. This method of determining area source emissions or alternatively of accounting for emissions

from unaccounted for fuel use has several drawbacks. First, many sources do not report fuel use. Second, the state of Texas does not report any individual fuel use. Instead, all industrial fuel use reported in Texas is at the county level to ensure confidentiality. As a result, the initial fuel use estimate from point sources in Texas, reported through NAPAP, is believed to be an underestimate. Consequently, the NAPAP inventory may allocate too much fuel to the area sources and, therefore, too many fuel-related emissions to the area source inventory.

In the coal category for both the NAPAP (1.7 million tons) and the "Old Trends" (1.8 million tons) emission estimates, the majority of the emissions are from the combustion of bituminous coal. The average sulfur content that is used in the computation of the emission factor is extremely important. The "Old Trends" method has a complicated procedure to determine an average fuel sulfur content based on statistics for the coal-producing regions. The NAPAP estimate was reported by the source or State and may or may not have been estimated using emission factors. Therefore, it is not possible to compare the average sulfur content used in the "Old Trends" methodology to the sulfur content reported in NAPAP. Additional research into average sulfur contents for all of the fuels (bituminous coal, anthracite, lignite, residual oil, distillate oil, crude oil, and process gas) would be needed to complete the comparison.

2. Nonferrous Smelting Sources

Nonferrous smelting emissions are an important component of industrial SO_2 emissions because sulfur is present in the ores. Consequently, sulfur recovery is an important component of the emission estimate. The "Old Trends" method determines sulfur recovery through statistics reported through the Department of Interior's *Minerals Yearbook*. The "Old Trends" method includes emission estimates for primary copper, primary lead, primary zinc, primary aluminum, and secondary lead smelting.

The primary copper estimates were obtained on a point by point basis from domestic primary copper smelters obtained through the EPA State or Regional offices. As a result the "Old Trends" (645 thousand tons) and NAPAP (655 thousand tons) estimates are consistent for primary copper smelters.

The "Old Trends" method appears to overestimate the emissions from primary lead, primary zinc, primary aluminum, and secondary lead smelting. The primary lead and primary zinc estimates are combined and reported as 242 thousand tons in the "Old Trends" document. The emissions in NAPAP are reported as only 106 thousand tons. "Old Trends" assumes that all roasting is done in a multiple hearth roaster which has an emission factor of 1,100 lbs/ton of concentrated ore processed. NAPAP did not report the majority of emissions through the multiple hearth roaster. Two other roasting processes, flash roaster and fluid bed roaster were reported in NAPAP with smaller emission factors of 404.4 and 223.5 lbs/ton of concentrated ore processed, respectively. Thus differences in the emission factors and the type of roaster account for the majority of the differences between the two estimates for these sources.

The "Old Trends" emission estimate of 71 thousand tons of SO_2 from primary aluminum smelters differs from the NAPAP emission estimate of 58 thousand tons of SO_2. This difference is attributed to a higher emission factor and no controls for the "Old

Trends" emission estimates. The secondary lead emission estimate of 26 thousand tons of SO_2 reported in "Old Trends" is slightly higher than the 21 thousand tons of SO_2 reported in NAPAP due to the absence of control efficiency information for this source in the "Old Trends" methodology.

3. Other Industrial Process Sources

Significant differences exist in the 1985 "Old Trends" (2.5 million tons) and NAPAP (2.1 million tons) SO_2 emissions estimates for other industrial process emissions. In general, the "Old Trends" estimates depend on national production figures developed by the Department of Energy and the Department of Commerce and an emissions factor. The emission factor chosen often represented the largest source(s) of emissions within the category. To compare the NAPAP and "Old Trends" estimates, the entire NAPAP estimate for the category is used. This would include in-process fuel, fugitive emissions, and processes that are not specifically cited in the "Old Trends" method.

The NAPAP inventory includes many additional source categories that are not included in the "Old Trends" industrial SO_2 emission estimation method. The "Old Trends" method includes only three categories in the chemical manufacturing group: sulfur, sulfuric acid, and carbon black. The NAPAP inventory includes ten additional chemical manufacturing source categories with combined additional emissions of 127 thousand tons of SO_2. The "Old Trends" method includes three categories in the mineral products manufacturing group; cement, glass, and lime. The NAPAP inventory includes nine additional mineral products manufacturing source categories with combined additional emissions of 51 thousand tons of SO_2.

The "Old Trends" method, with very few exceptions, does not include the effects of air pollution control devices unless the effects are inherent in either the process (e.g., sulfur recovery) or in the emission factor. The "Old Trends" estimates for most categories are significantly higher than the corresponding NAPAP estimates. A major exception to this is oil and natural gas production.

As a result, the net difference between NAPAP and "Old Trends" for other industrial process sources is 380 thousand tons. This is a result of overestimating the "Old Trends" source categories by not applying controls (616 thousand tons) and excluding the source categories listed above (236 thousand tons).

D. CONCLUSIONS

The following conclusions were drawn as a result of the in-depth analysis reported in the *Comparison* of the 1985 NAPAP data and the October 1992 EPA "Old Trends" report for industrial sources.

The "Old Trends" methodology uses broad assumptions for emission factors and controls across a source category. Adjustments for individual plant controls and operating characteristics are impossible. Some industrial emission categories, notably processes within oil and natural gas production, are missing from the "Old Trends" method. The "Old Trends" method contains outdated activity and emission factor data that have been

revised after the initial estimations were made. The "Old Trends" method relies on average fuel consumption values for some industrial processes and does not account for any control measures in the majority of the industrial SO_2 emission estimates.

Activity data in the 1985 NAPAP inventory were not subject to the same standard of QA or completeness checking as emissions data. Some data were unreported due to confidentiality restrictions, and activity data from small sources (i.e., < 100 TPY) passed only the grossest QA checks. The accuracy and representativeness of activity data in the NAPAP inventory are best evaluated source by source; category-level summaries are unreliable without adjustments. The NAPAP activity data are not complete enough to provide a reliable estimate of industrial production; therefore, the NAPAP activity data do not support the generation of source category level emission factors or control efficiencies for future use in the "Old Trends" methodology.

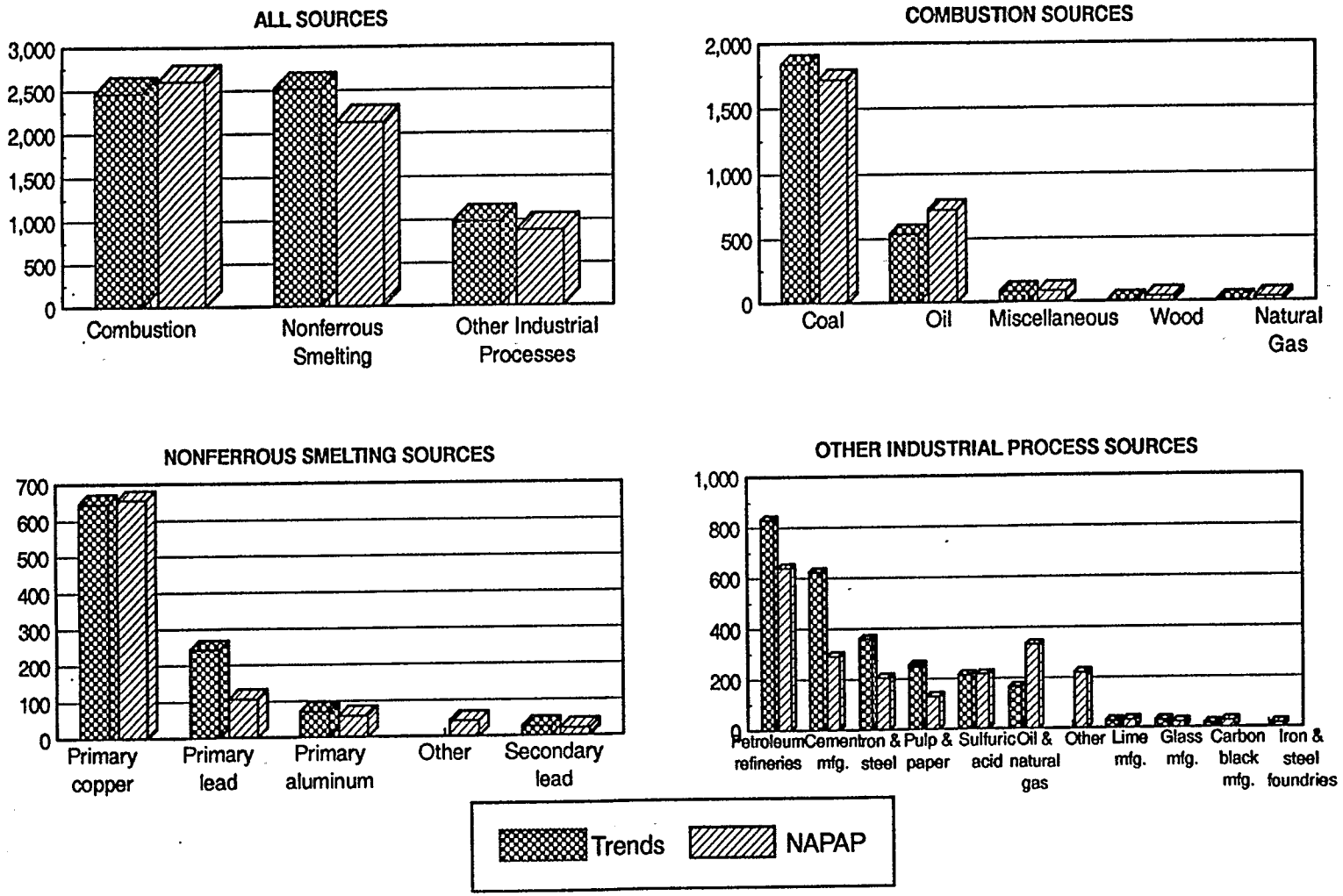
Overall, the two 1985 estimates (NAPAP and "Old Trends") compare favorably at the national level: NAPAP estimates 5.6 million tons SO_2 and "Old Trends" estimates 6.0 million tons SO_2. There are , however, individual source category by source category discrepancies. The 1985 NAPAP inventory still represents the most comprehensive and accurate emission estimates for 1985 because of its rigorous QA of emissions and bottom-up derivation. Therefore, the NAPAP estimate, which is the basis for the emission cap in the CAAA, should be used as the starting point for all future comparisons.

Table III-1
Differences between 1985 Trends and NAPAP SO_2 Emission Estimates
(thousand short tons)

Source Category	Emissions		Delta	
	"Old Trends"	NAPAP	10^3 tons	percent
COMBUSTION	2,467	2,595	-128	-5%
Coal	1,841	1,721	120	7%
anthracite	9	11	-2	-18%
bituminous	1,832	1,710	122	7%
Oil	537	712	-175	-25%
residual	467	605	-138	-23%
distillate	70	107	-37	-35%
Natural gas	2	33	-31	-94%
Wood	6	42	-36	-86%
Miscellaneous fuels	81	87	-6	-7%
coke	35	11	24	218%
coke oven gas	43	3	40	1333%
kerosene	3	<1	3	-100%
LPG	<1	<1		
other*		73	-73	-100%
NONFERROUS SMELTING	984	882	102	12%
Primary copper	645	655	-10	-2%
Primary lead and zinc	242	106	136	128%
Primary aluminum	71	58	13	22%
Secondary lead	26	21	5	24%
Other*		42	-42	-100%
OTHER INDUSTRIAL PROCESSES	2,513	2,133	380	18%
Iron and steel	359	204	155	76%
Iron and steel foundries		16	-16	-100%
Oil and natural gas production	164	332	-168	-51%
Pulp and paper	253	130	123	95%
Cement	623	291	332	114%
Glass	29	23	6	26%
Lime	27	32	-5	-16%
Sulfuric acid	213	217	-4	-2%
Carbon black	15	28	-13	-46%
Petroleum Refineries	830	640	190	30%
Other*		220	-220	-100%
TOTAL	5,964	5,610	354	6%

NOTE: * A list of sources can be found in "Comparison of the 1985 NAPAP Emissions Inventory with the 1985 EPA Trends Estimate for Industrial SO_2 Sources."

Figure III-1
Comparison of 1985 Trends and NAPAP by Source Category
(thousand short tons)



CHAPTER IV
BASELINE INDUSTRIAL SO_2 EMISSION INVENTORY

A. INTRODUCTION

As indicated earlier, the baseline for the 5.6 million ton "cap" on industrial SO_2 emissions is the 1985 NAPAP emissions inventory. This chapter presents information related to current emissions levels (1985-1990), selection of the appropriate emission inventory to use as the starting point for developing emission projections, the top 100 industrial SO_2 point source emitters (as derived from EPA's Aerometric Information Retrieval System [AIRS]), and information related to sources subject to section 405(g)(6).

B. CURRENT EMISSIONS LEVELS (1985-1990)

Industrial SO_2 emissions as reported in the 1985 NAPAP emission inventory were 5.6 million tons. Figure IV-1 provides emissions levels for industrial fuel combustion, metals processing, chemical and allied products manufacturing, petroleum and related industries, and all other industrial sources for the period 1985-1990. At the time of passage of the 1990 CAAA, industrial SO_2 emissions were just under 5 million tons.

The emissions estimates presented in Figure IV-1 are derived from EPA's Emission Trends document. Effective with the October 1993 edition of that report ("National Air Pollutant Emission Trends, 1900-1992," EPA-454/R-93-032), EPA instituted a new method of developing emission estimates for most sources. The new methodology utilizes an approach that is more representative of a "bottom-up" inventory approach than the old method, which was a "top-down" approach. The Trends emissions compared in the *Comparison* report described in the previous chapter were prepared using the old "top-down" approach. For many source categories, the new Trends method is analogous to the NAPAP method. As a consequence, for many sources, values presented in the EPA Emission Trends report for 1985 are identical to the 1985 NAPAP emissions. This is the case for industrial SO_2 sources.

The new approach to developing emission trends has been instituted for all years from 1985 forward (EPA, 1993a). The new emissions estimates are prepared using an approach that is similar to that used to develop the 1990 Interim Inventory (EPA, 1993b). The 1990 Interim Inventory utilized the 1985 NAPAP emissions inventory as the basis for developing 1990 emissions estimates for some categories. The 1990 Interim Inventory provides a point level emission inventory suitable for use in Regional Oxidant Modeling (ROM). For industrial sources, 1990 Interim Inventory emissions estimates were developed using Bureau of Economic Analysis (BEA) growth factors to grow 1985 NAPAP emissions. In a review of the SO_2 emissions baseline used to develop SO_2 emission reductions under the CAAA of 1990, NAPAP's Office of the Director concluded that for nonutility sources, a method of estimating emission trends developed by Argonne National

Laboratory (ANL) for the Department of Energy (DOE) that extrapolated the 1985 NAPAP inventory using growth rates (which were based upon EPA's "Old Trends" values) was preferred to the "top-down" approach in use by EPA at the time of the review for developing emission trends (Mahoney, 1990). EPA's new methodology for developing emission trends now uses economic indices to develop emission trends, with the 1985 NAPAP emission inventory serving as the basis for many source categories. This approach is consistent with the preferred approach of the NAPAP Office of the Director and that used by ANL/DOE. However, the new Trends methodology allows EPA to update the data with reviewed and approved State emission inventory data when available, thus it can account for plant-level operating changes and pollution control initiatives that the ANL/DOE methodology cannot currently account for.

C. CURRENT EMISSIONS FOR SELECTED INDUSTRIAL SOURCE SUBCATEGORIES

As Figure IV-1 indicates, emissions levels over the 1985-1990 time frame show a moderate decline from 5.6 million tons to slightly less than 5 million tons. This section looks at contributions from selected industrial source subcategories during that time period.

1. Fuel Combustion

As described in Chapter II, coal-related SO_2 emissions dominate emissions from industrial fuels. Emissions from oil combustion have declined slightly from the 1985 NAPAP levels, while contributions from gas and other fuels have remained approximately the same (see Figure IV-2). Total industrial fuel combustion SO_2 emissions for 1990 were 3,106 thousand tons.

2. Metals Processing

Copper processing operations were the largest contributor to metals processing emissions according to the 1985 NAPAP emission inventory. Figure IV-3 shows that emissions from copper processing operations have decreased dramatically from approximately 0.65 million tons in 1985 to slightly over 0.2 million tons in 1990. A large part of this decrease in emissions is attributable to the demolition of the Phelps Dodge copper smelter (in Arizona) in January 1987, resulting in a decrease in emissions of 330,000 tons/year of SO_2. Emissions from other metals processing sources from 1985-1990 have stayed approximately the same. Total 1990 SO_2 emissions for metals processing operations were 578 thousand tons.

3. Chemical and Allied Product Manufacturing

Figure IV-4 provides a noticeable contrast to the historic emissions picture given in Chapter II, Figure II-4. The major reason for the appearance of several of these categories is the change in emissions estimation methodology between the years 1984 and 1985, for EPA's Emission Trends reporting. Emissions prior to 1985 were developed using the "top-down" methodology, while post-1984 were developed using the "bottom-up" method, which is capable of being summarized at the Tier 2 (or Tier 3) level. Tier 2 level

emissions for this category could not be derived for the "Old Trends" method. Thus the abrupt inclusion of emissions from some chemical and allied manufacturing sources (e.g., Organic Chemical Manufacturing) is an artifact, not the sudden appearance of new emissions sources.

Figure IV-4 does show that for the period 1985-1990, inorganic sulfur compound production continues to dominate emissions from this category. Emissions from the other chemical processes remain relatively flat for this time period. Total emissions in 1990 from this category were 440 thousand tons.

4. Petroleum and Related Industries

Figure IV-5 shows emissions from petroleum and related industries from 1985-1990. This figure shows that natural gas production SO_2 emissions are approximately the same as those from fluid catalytic cracking units at petroleum refineries. This is in distinct contrast to the information presented in Figure II-5 which showed that natural gas production SO_2 emissions, even as late as 1980, were approximately one-half those from fluid catalytic cracking units at petroleum refineries. Figure IV-5 shows that the two petroleum refinery sources have decreased slightly from 1985 to 1990. Natural gas production showed decreasing emissions until 1990, where a slight increase was observed. Total SO_2 emissions from petroleum and related industries for 1990 were 440 thousand tons.

5. Other Industrial Processes

As with the historic emissions information presented in Chapter II, cement manufacturing is the leading other industrial processes subcategory SO_2 emission producer. This source does show a slight, but steady decline in emission from 1985 to 1990 (Figure IV-6). Emissions from wood, pulp and paper, and publishing operations remained virtually constant over the same time frame, as did waste disposal operations, and the all other industrial processes categories. Mineral products (excluding cement manufacturing) declined slightly over the period. Total national SO_2 emissions for 1990 from other industrial processes were 417 thousand tons.

D. SELECTION OF THE EMISSION PROJECTIONS BASE YEAR INVENTORY

Based upon the information presented above, EPA feels that the best inventory to use for developing the emission projections required under section 406 is the 1990 Emission Trends inventory. This decision was based on three criteria:

- It is based upon the 1985 NAPAP emission inventory, which is generally regarded as the most comprehensive inventory ever compiled,
- It is an outgrowth of the 1990 Interim Inventory which is currently being utilized in ROM modeling efforts and is generally regarded as the best national level inventory currently available, and
- The 1990 inventory coincides with the year of enactment for the CAAA.

E. TOP 100 INDUSTRIAL SO_2 POINT SOURCES

Table IV-1 presents the current top 100 industrial point source SO_2 emitters based on information extracted from the AIRS Facility Subsystem (AFS) and reviews and updates by State air pollution control agencies. The data presented in this table are not the same as that found in the base year inventory used for projections. The data in Table IV-1 are presented for informational purposes only. In addition to presenting information relative to the emissions from these sources, information concerning the 4-digit Standard Industrial Classification (SIC) code and SIC grouping, the latest year-of-record for emissions, and the State, county and EPA region are also presented.

Table IV-2 groups these top 100 industrial point sources by general industry groupings, including SIC codes. Figure IV-7 maps the locations of the sources listed in Table IV-1 and classifies the emitters by the magnitude of their emissions.

F. SECTION 405(g)(6) SOURCES

Section 406(a) of Appendix B specifically states that the Administrator of the EPA shall transmit to Congress no later than January 1, 1995 and every five years thereafter a report containing an inventory of national sulfur dioxide emissions from industrial sources, *including units subject to section 405(g)(6) of the CAA*. Section 406(b) then states that whenever the inventory required by section 406 indicates that sulfur dioxide emissions from industrial sources, *including units subject to section 405(g)(6)* may reasonably be expected to reach levels greater than 5.60 million tons per year, then the Administrator of the EPA shall take such actions to ensure that such emissions do not exceed 5.60 million tons per year.

Section 405(g)(6) indicates that the provisions of Title IV shall not apply to either qualifying small power production facilities or qualifying cogeneration facilities or to a new independent power production facility as defined by section 416 unless certain conditions apply at the date of enactment of the CAAA of 1990.

EPA's Acid Rain Division estimates that there are approximately 125 independent power producers, and several hundred qualifying facilities exempt from Title IV under section 405(g)(6). It is not currently possible to estimate the emissions from these facilities since no inventory currently includes these sources. The emissions from these sources should be in the baseline inventory. Many of these factilities have gas turbines and EPA's EIB is in the process of adding these facilities to the 1990 base year emission inventory.

Table IV-1
Top 100 AIRS/AFS Industrial Plants Emitting Sulfur Dioxide

Rank	Plant Name	EPA Region	State	County	NEDS ID	SIC	SIC Grouping	Year	Emissions (short tons)
1	ALCOA (Aluminum Company of America)	6	TX	331	1	3334	Al	92	67,988
2	Copper Range Company	5	MI	131	2	1021	other	90	65,156
3	ASARCO Incorporated	6	TX	141	1	3331	CS	90	47,341
4	ASARCO Incorporated	7	MO	93	8	3332	Lead	90	44,136
5	Shell Oil Co., Wood River Mfg. Complex	5	IL	119	104	2911	PR	93	40,063
6	Dakota Gasification Company	8	ND	57	13	1311	O&NG	93	37,394
7	Phelps Dodge Mining/Hidalgo Smelter	6	NM	23	3	3331	CS	91	34,592
8	USS/Kobe Steel Co. - Lorain Works	5	OH	93	5004	3312	I&S	90	34,467
9	Mead Corporation	5	OH	141	5001	2621	P&P	90	33,921
10	Star Enterprise, Delaware City	3	DE	3	16	2911	PR	92	33,574
11	ASARCO Incorporated	9	AZ	7	4	3331	CS	90	32,959
12	Kodak Park Div.	2	NY	55	258	3861	other	90	32,718
13	James River Corporation	5	MI	77	39	2621	P&P	90	32,714
14	Phillips 66 Company, Division of Phillips	6	TX	233	15	2911	PR	92	30,661
15	Kennecott	8	UT	35	30	3331	CS	90	30,047
16	ARMCO Steel Company L.P.	5	OH	17	5002	3312	I&S	90	29,132
17	Phelps Dodge/Chino Mines	6	NM	17	1	3331	CS	91	28,058
18	Mobil Oil Corp.	2	NJ	15	6	2911	PR	87	26,240
19	Bethlehem Steel Corporation	5	IN	127	1	3312	I&S	90	26,029
20	Exxon Co. USA	4	AL	53	7	1311	O&NG	92	25,876
21	Mobil Joliet Refining Corp.	5	IL	197	89	2911	PR	93	24,824
22	Wheeling Pittsburgh Steel Steubenville	5	OH	81	5006	3312	I&S	90	22,714
23	Conoco Inc.	6	OK	71	10	2911	PR	87	22,494
24	Inland Steel Flat Products, Part 2	5	IN	89	317	3312	I&S	90	21,242
25	Tenn Eastman Co.	4	TN	163	3	4961	other	93	19,236
26	Westvaco	3	MD	1	11	2621	P&P	91	18,901
27	Champion Int., Corp.	4	NC	87	159	2621	P&P	89	18,613
28	Fort Howard Corporation	5	WI	9	328	2621	P&P	90	18,071
29	Uno-ven Company	5	IL	197	77	2911	PR	93	18,021
30	Florida Power	4	FL	101	17	4953	other	87	17,742
31	Union Camp Corp./Fine Paper Div.	3	VA	93	6	2621	P&P	92	17,398
32	Shell Western E & P	4	MS	121	36	2819	H_2SO_4	86	17,116
33	Reynolds Metals Co.	6	LA	33	21	2999	PR	90	16,628
34	Grain Processing Corp.	7	IA	139	25	2869	other	92	15,885
35	ADM Corn Processing - Clinton	7	IA	45	30	2046	other	92	15,654
36	Carolina Power and Light Skyland	4	NC	21	628	4411	other	85	15,349
37	Clark Oil & Refining Corporation	5	IL	31	2448	2911	PR	93	14,791
38	Mobil Oil Corporation	6	TX	245	18	2911	PR	90	14,628
39	PPG Industries	3	WV	51	2	2819	H_2SO_4	85	14,422
40	Goudey Station - Johnson	2	NY	7	292	3573	other	90	13,933
41	Westvaco Corp.	3	VA	5	3	2631	P&P	92	13,513
42	Pekin Energy Company	5	IL	179	44	2869	other	93	13,355
43	U.S. Doe Y-12 Plant	4	TN	1	1020	3499	other	90	12,800
44	Magma Metals Company - San Manuel Smelter	9	AZ	21	32	3331	CS	90	12,553

Table IV-1 (continued)

Rank	Plant Name	EPA Region	State	County	NEDS ID	SIC	SIC Grouping	Year	Emissions (short tons)
45	Medusa Cement Company	5	MI	29	7	3241	CP	90	12,476
46	Total Petroleum, Inc.	6	OK	19	209	2911	PR	88	12,361
47	Wheeling Pitts. Steel, Steubenville North	5	OH	81	5008	3312	I&S	90	11,815
48	Atlantic Cement Co.	2	NY	1	40	3241	CP	90	11,759
49	Exxon Co., USA	8	MT	111	13	2911	PR	93	11,626
50	Fina Oil and Chemical Company	6	TX	227	1	2911	PR	90	11,531
51	Citgo Petroleum Corp.	6	LA	19	16	2911	PR	90	11,466
52	LaFarge Corporation	6	TX	439	24	3273	other	85	11,308
53	BP Oil Company	6	LA	75	15	2911	PR	90	11,220
54	Indian Refining Limited Partnership	5	IL	101	15	2911	PR	93	11,144
55	LTV Steel Company - Pittsburgh Works	3	PA	3	22	3312	I&S	90	11,004
56	Chesapeake Paper Products Co.	3	VA	101	1	2621	P&P	92	10,908
57	E. I. Du Pont De Nemours and Company	4	TN	85	7	2816	other	90	10,674
58	Weyerhaeuser Valliant	6	OK	89	700	2631	P&P	92	10,673
59	Phibro Energy USA, Inc.	6	TX	201	65	2911	PR	92	10,602
60	LTV Steel Co. (Rep)	5	OH	35	5050	3312	I&S	88	10,597
61	Western Gas Resources, Inc.	6	TX	467	1	1321	O&NG	90	10,484
62	Conoco, Inc.	6	OK	71	202	2911	PR	90	10,323
63	ASARCO Incorporated	8	MT	49	1	3332	Lead	93	10,315
64	Packaging Corp of America	5	OH	169	5008	2631	P&P	90	10,125
65	ALCOA (Aluminum Co. of America)	5	IN	173	7	3334	Al	92	10,065
66	Holnam Inc.	7	MO	163	1	3241	CP	90	10,028
67	International Paper Company - Androscoggin	1	ME	7	21	2611	P&P	90	9,940
68	LaFarge Corporation	5	IL	127	12	3241	CP	93	9,773
69	Bowater, Great Northern	1	ME	19	56	2611	P&P	90	9,473
70	Great Lakes Carbon Corporation	6	TX	245	23	2999	other	92	9,412
71	Coastal Refining & Marketing, Inc.	6	TX	355	18	2911	PR	92	9,201
72	Coastal Eagle Point Oil Co.	2	NJ	15	4	2911	PR	87	9,082
73	Cenex	8	MT	111	12	2911	PR	93	8,966
74	Inland - Rome Inc.	4	GA	115	21	2631	P&P	90	8,877
75	Inland Steel Flat Products	5	IN	89	316	3312	I&S	90	8,871
76	Rhone Poulenc	6	TX	201	37	2819	H_2SO_4	92	8,716
77	Lone Star Industries, Inc.	3	PA	95	31	3241	CP	85	8,712
78	General Electric Co.	3	PA	49	9	3743	other	90	8,580
79	Phillips Petroleum Company	6	TX	39	10	2911	PR	92	8,447
80	Westvaco - Kraft Div.	4	SC	19	8	2631	P&P	91	8,437
81	Bowater Southern Paper Co.	4	TN	107	12	2611	P&P	93	8,391
82	Archer Daniels Midland Corn Sweeteners	5	IL	143	41	2869	other	93	8,384
83	Amoco Oil Company	6	TX	167	1	2911	PR	92	8,325
84	GPM Gas Corporation	6	TX	103	6	1311	O&NG	88	8,134
85	Geneva Steel	8	UT	49	27	3312	I&S	92	8,120
86	River Cement Co.	7	MO	99	2	3241	CP	90	8,085
87	Stone Container Corporation	9	AZ	17	7	2611	P&P	90	8,081
88	Koch Refining	5	MN	37	11	2911	PR	90	8,045
89	Glatfelter, P. H. Co.	3	PA	133	16	2621	P&P	90	8,031
90	Calciner Industries, Inc.	6	LA	87	6	3334	Al	90	8,009

Table IV-1 (continued)

Rank	Plant Name	EPA Region	State	County	NEDS ID	SIC	SIC Grouping	Year	Emissions (short tons)
91	AMAX, Inc.	2	NJ	23	2	3341	other	86	7,932
92	Lake Charles Calc. Plant	6	LA	19	69	2999	other	90	7,919
93	Amerada Hess Corp.	4	MS	73	1	2911	PR	86	7,847
94	Chevron USA	9	HI	3	52	2911	PR	83	7,845
95	Goodyear Tire & Rubber Co.	5	OH	153	5041	3011	other	90	7,841
96	GA Pacific	4	FL	107	5	2621	P&P	90	7,834
97	Kimberly-Clark Corp.	4	AL	121	6	2621	P&P	92	7,744
98	Lone Star Industries	7	MO	31	21	3241	CP	87	7,705
99	Roanoke Cement Co. (formerly Tarmac)	3	VA	23	3	3241	CP	92	7,667
100	Tosco Corp., Avon Refinery	9	CA	13	13	2911	PR	90	7,660

NOTES: These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. Although some sources listed in this table may appear to be associated with electric utilities, their SIC codes are indicative of an industrial source.

Table IV-2
Analysis of Top 100 Industrial SO_2 Point Sources by Industry

Industry	SIC Grouping	SIC CODE(s)	Number of Facilities	Facility Ranks
Petroleum Refinery	PR	29xx	29	5, 10, 14, 18, 21, 23, 29, 33, 37, 38, 46, 49, 50, 51, 53, 54, 59, 62, 71, 72, 73, 79, 83, 88, 93, 94, 96, 97, 100
Pulp & Paper	P&P	26xx	17	9, 13, 26, 27, 28, 31, 41, 56, 58, 64, 67, 69, 74, 80, 81, 87, 89
Iron & Steel	I&S	331x, 332x	10	8, 16, 19, 22, 24, 47, 55, 60, 75, 85
Cement Production	CP	324x	8	45, 48, 66, 68, 77, 86, 98, 99
Primary Copper Smelters	CS	3331	6	3, 7, 11, 15, 17, 44
Oil & Natural Gas	O&NG	13xx	4	6, 20, 61, 84
Primary Aluminum	Al	3334	3	1, 65, 90
Sulfuric acid Production	H2SO4	2819	3	32, 39, 76
Primary Lead	Lead	3332*	2	4, 63
Carbon Black	CB		0	
Glass	glass		0	
Lime	lime		0	
Other	other	various	18	
copper ore mining		1021	1	2
wet corn milling		2046	1	35
inorganic pigments		2816	1	57
inorganic chemicals nec		2869	3	34, 42, 82
products of petroleum and coal nec		2999	2	70, 92
tires & inner tubes		3011	1	95
ready mix concrete		3273	1	52
secondary smelting & refining of nonferrous metals		3341	1	91
fabricated metals products nec		3499	1	43
electronic computer equipment		3573*	1	40
railroad equipment		3743	1	78
photographic equipment & supplies		3861	1	12
deep sea foreign transportation freight		4411	1	36
refuse systems		4953	1	30
steam & air conditioning supply		4961	1	25

NOTE: * SIC is from a 1977 SIC listing and is not listed in the 1987 manual.

Figure IV-1
Industrial SO2 Emissions
(1985 - 1990)

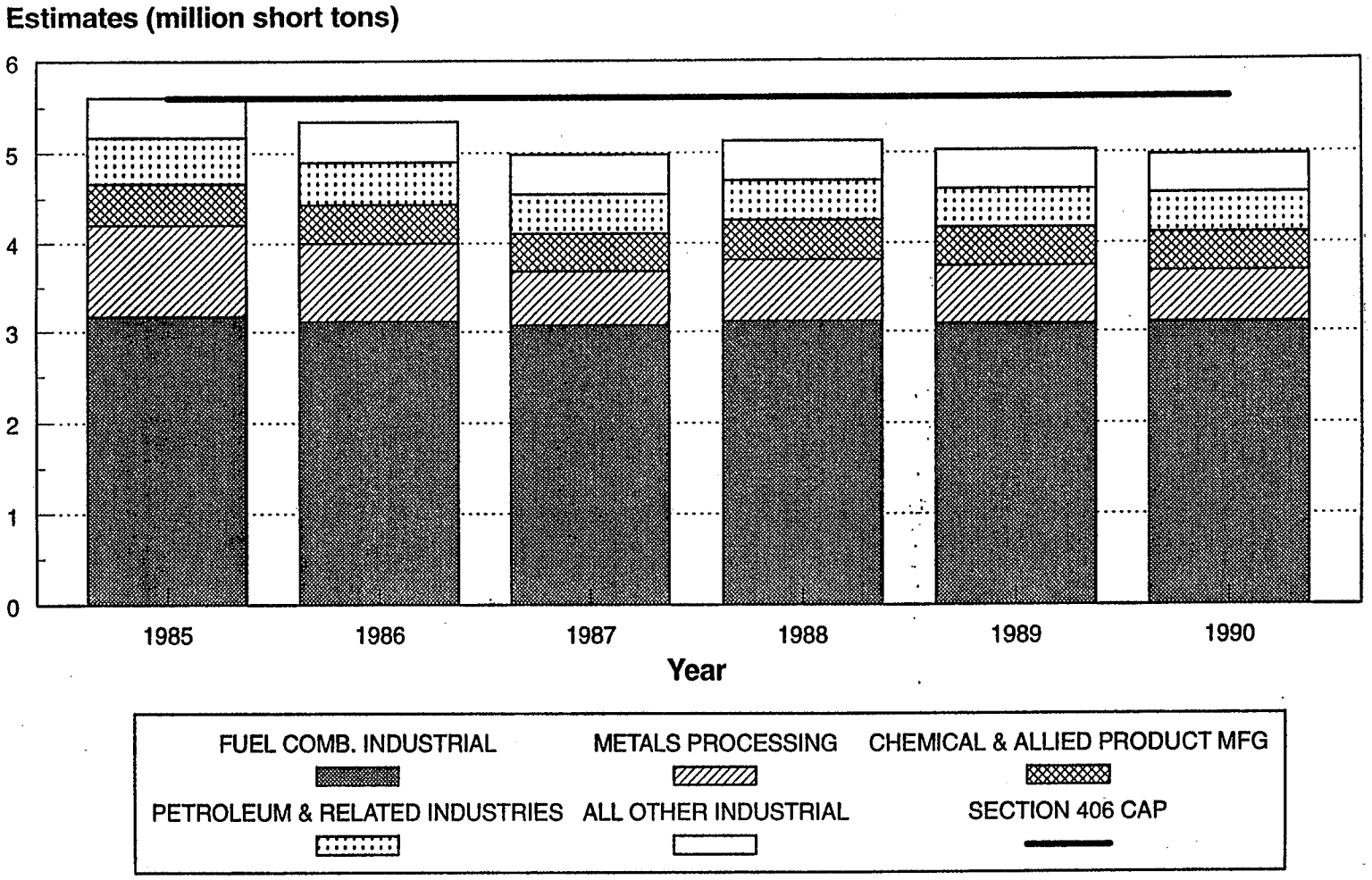


Figure IV-2
Industrial Combustion SO2 Emissions
(1985 - 1990)

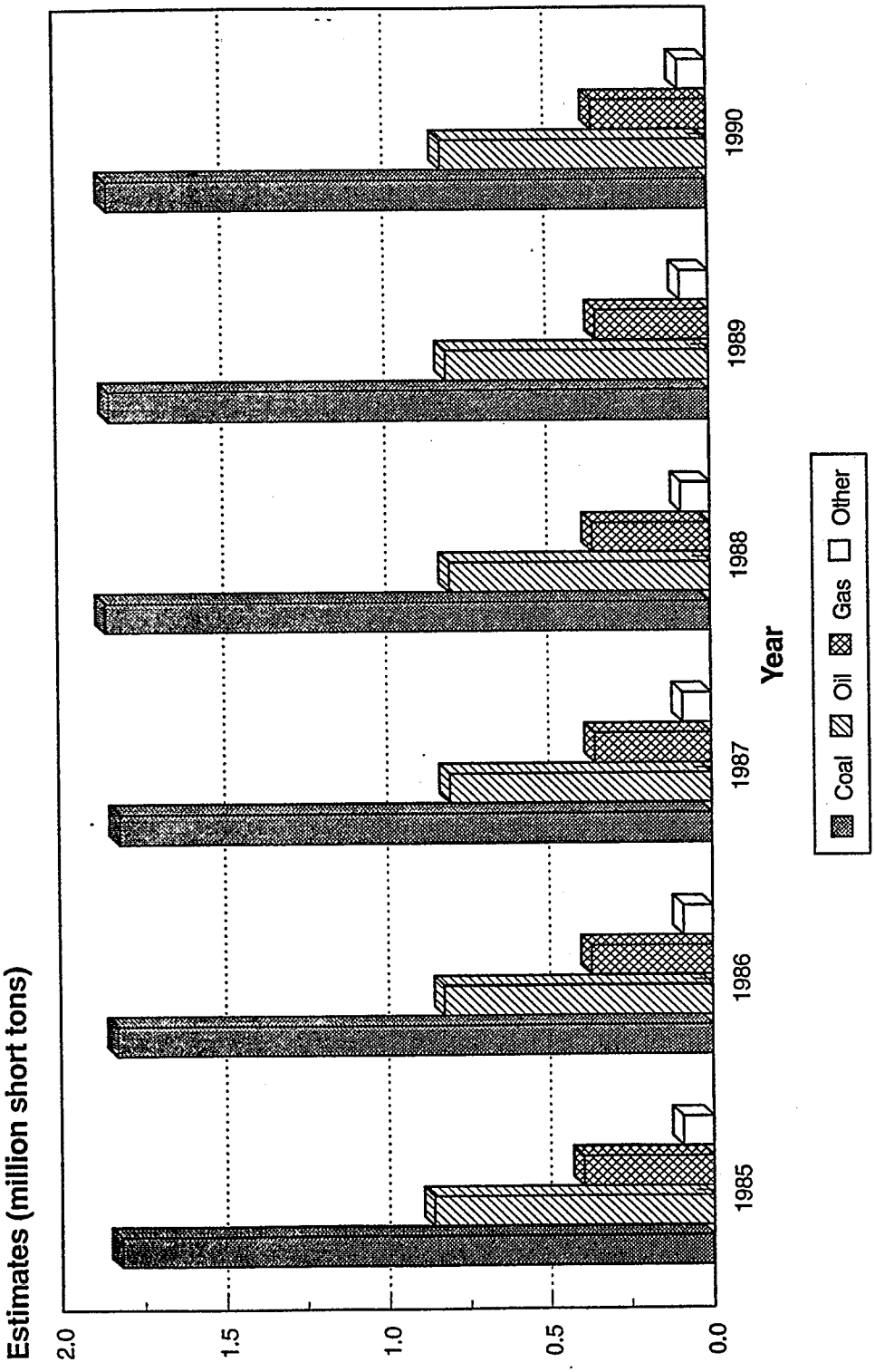


Figure IV-3
Industrial SO2 Emissions from Metals Processing
(1985 - 1990)

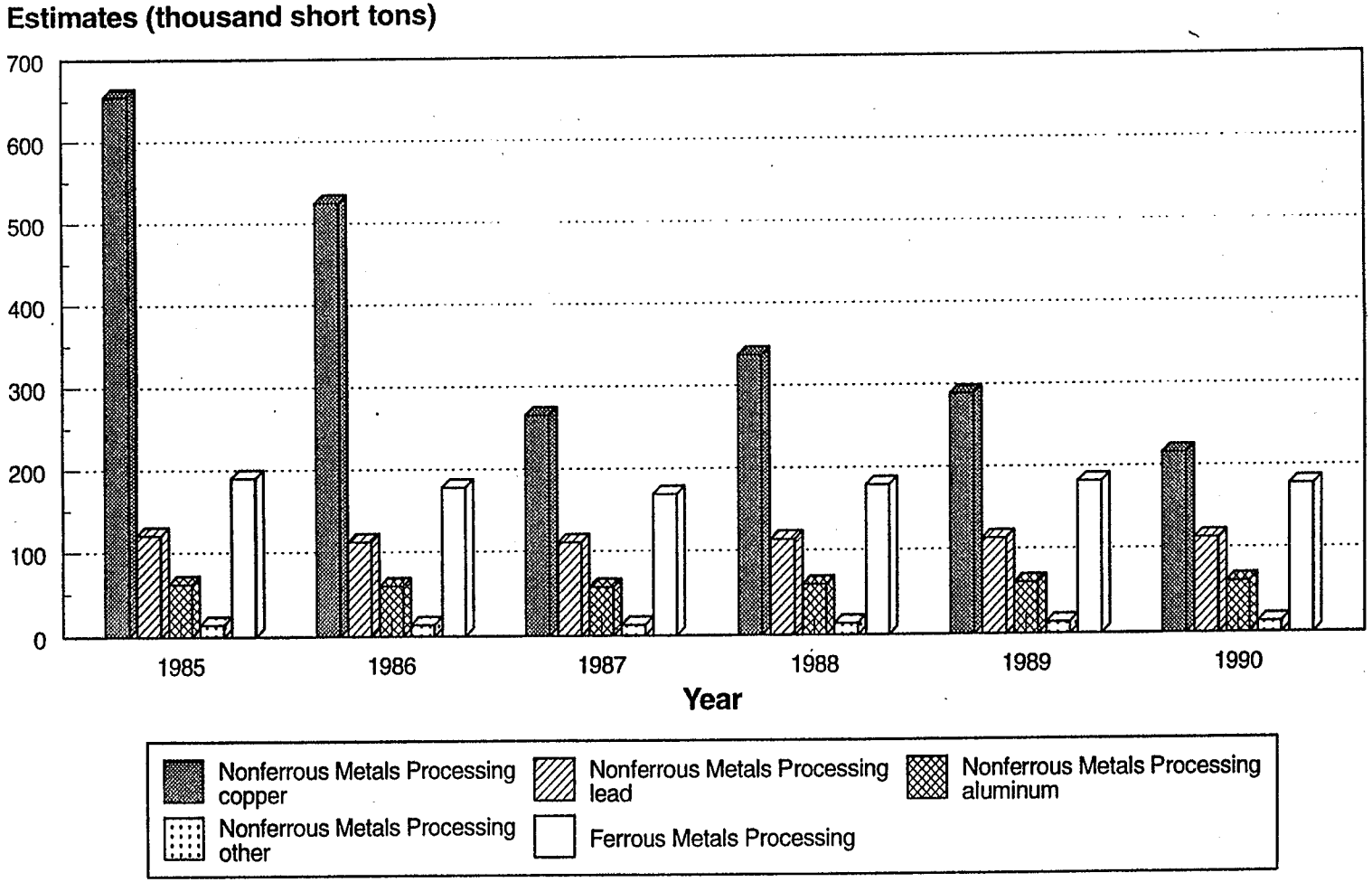


Figure IV-4
Industrial SO2 Emissions from Chemical & Allied Product Mfg
(1985 - 1990)

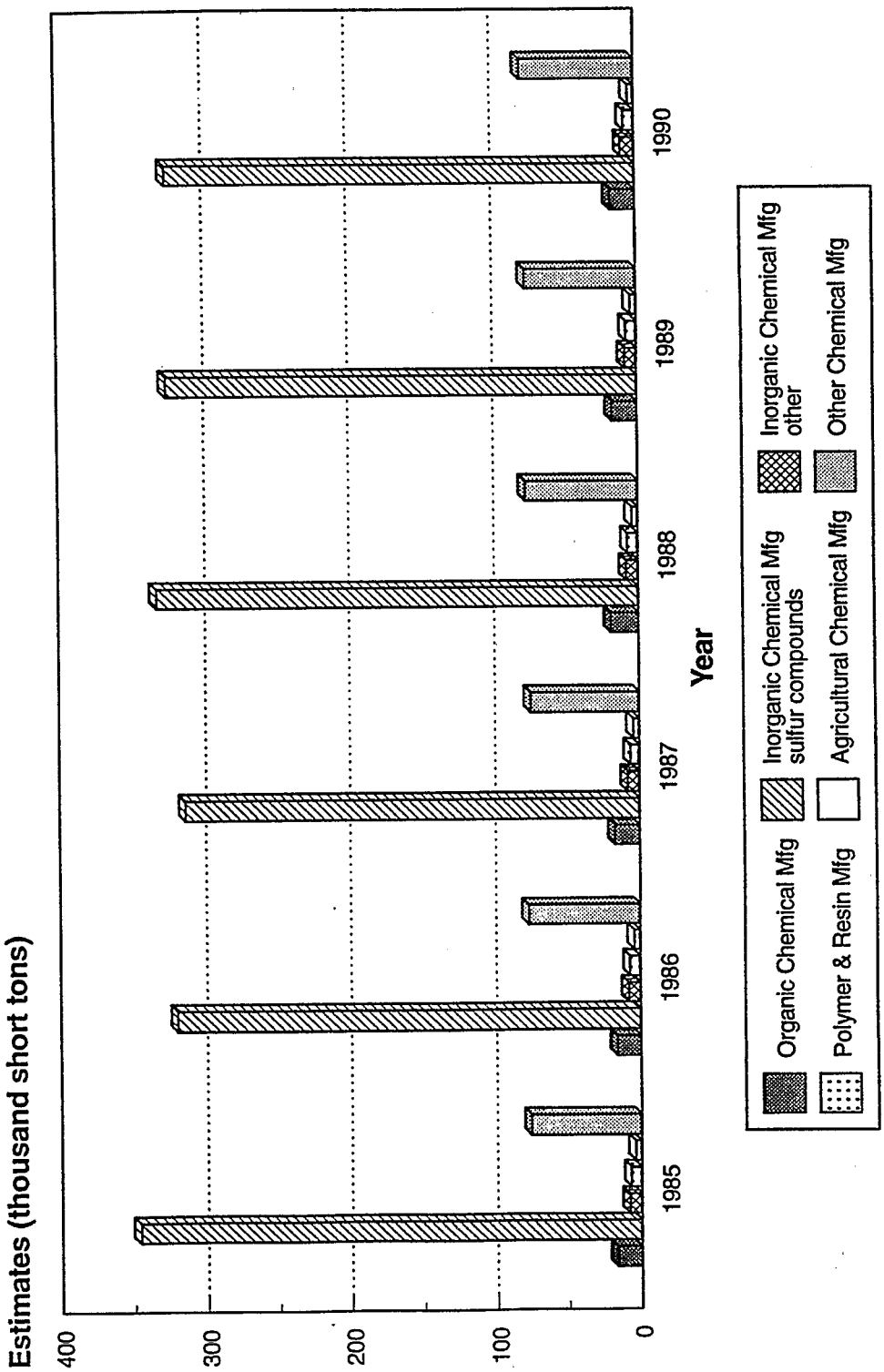


Figure IV-5
Industrial SO2 Emissions from Petroleum & Related Industries
(1985 - 1990)

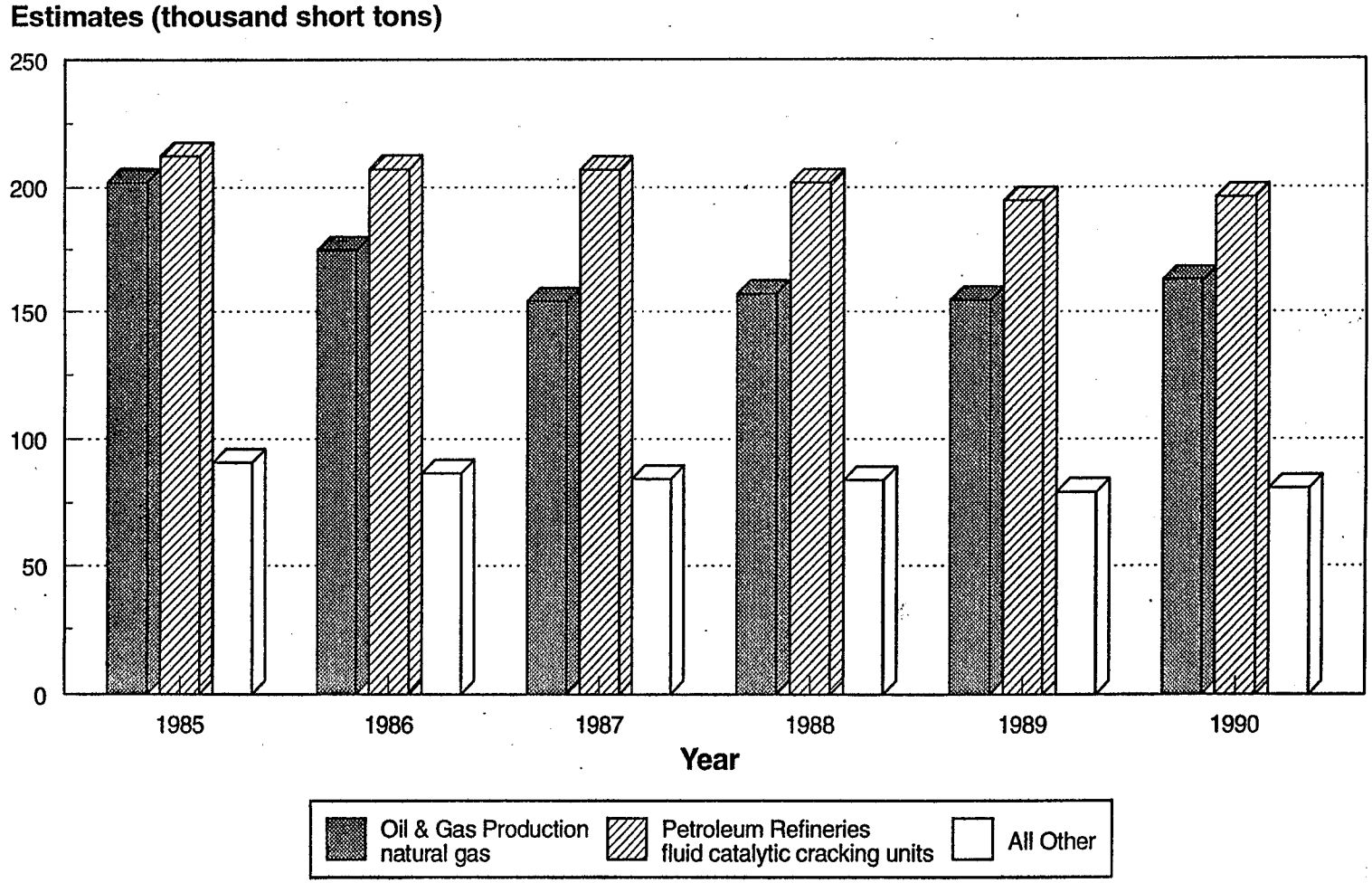
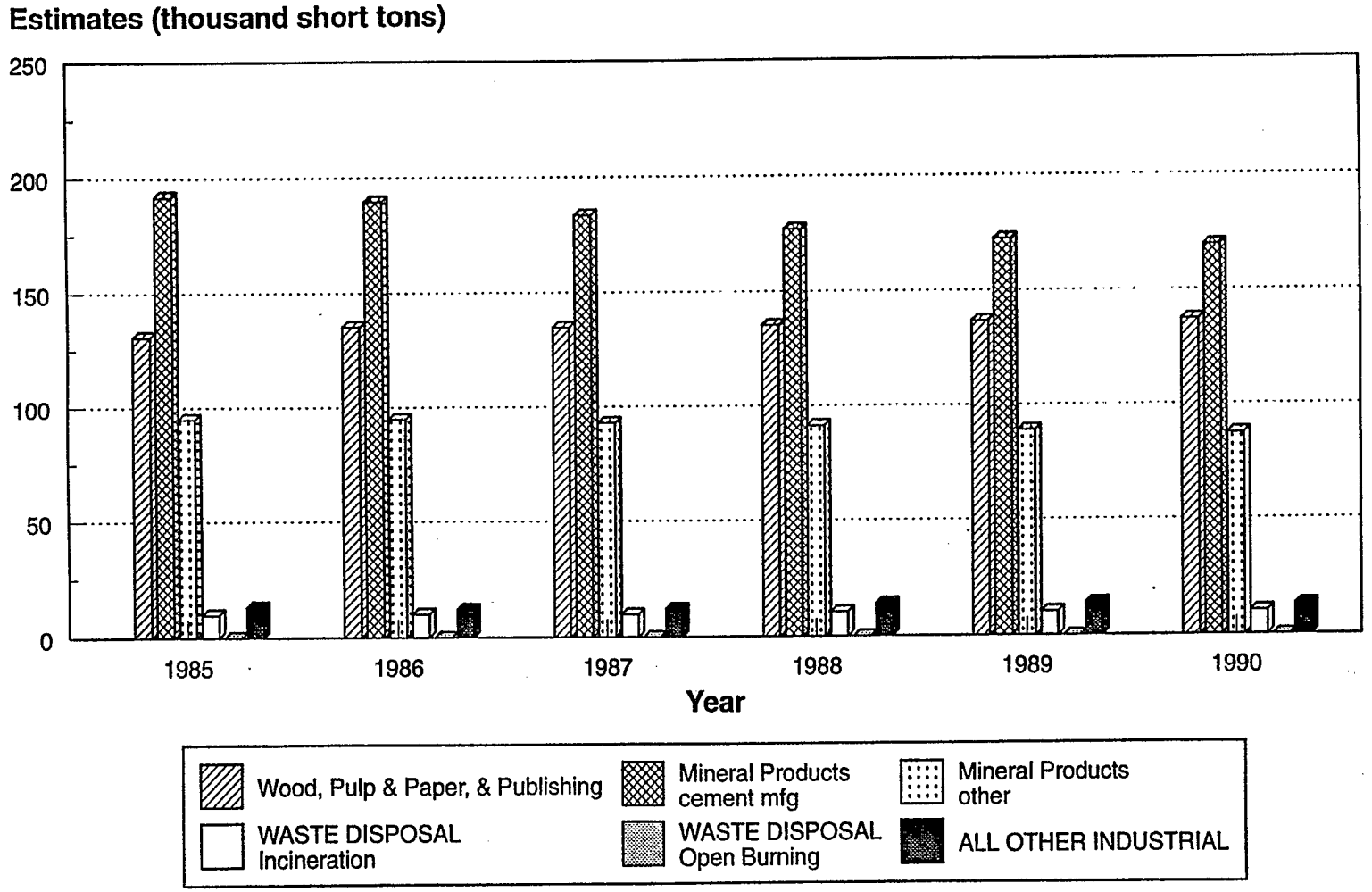


Figure IV-6
Industrial SO2 Emissions from Other Industrial Processes
(1985 - 1990)



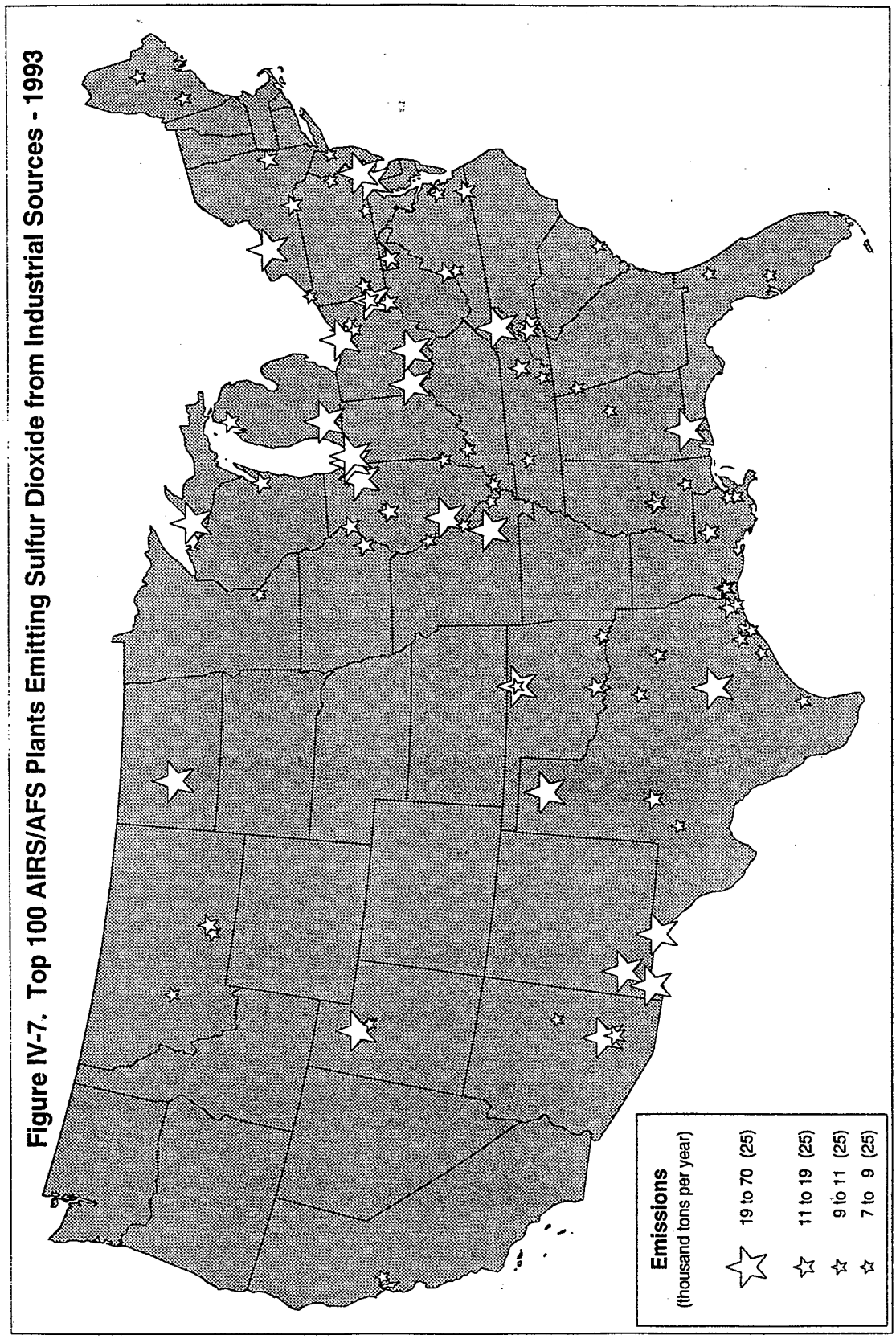


Figure IV-7. Top 100 AIRS/AFS Plants Emitting Sulfur Dioxide from Industrial Sources - 1993
Emissions
(thousand tons per year)
19 to 70 (25)
11 to 19 (25)
9 to 11 (25)
7 to 9 (25)

CHAPTER V
INDUSTRIAL SO_2 EMISSION PROJECTIONS

A. INTRODUCTION

In addition to a national inventory of SO_2 emissions, section 406 of the CAAA of 1990 also calls for presentation of the likely trend in such emissions over the following 20-year period. Thus, emission projections for industrial SO_2 emissions are required under section 406. This chapter discusses the methods used to develop these emission projections, the emission projected for the period 1990-2015, and selected information on the emission projections of certain industrial sources subcategories.

Although section 406 calls for development of the likely trend in emissions for a 20 year period, emission projections were developed from 1990 (the base year) to 2015, since 2015 represents 20 years from the due date of the required report to Congress (January 1, 1995).

It is important to remember that the projections presented in this chapter represent the best estimate of what emissions from industrial SO_2 sources will be in the future. As with any type of projection, values presented for periods of time more than 3-4 years away from the base year will become increasingly speculative and should be treated with some degree of skepticism. It is also important to realize that the factors used to develop the projections typically only reflect changes in activity levels and may not capture changes in technology or emission factors over time.

B. PROJECTION METHODOLOGY

Industrial source SO_2 emissions were projected using the Industrial SO_2 and NO_x Tracking System (ISNTS). This "system" is actually a composite of several different computer systems. The ISNTS is not a computer system designed to be distributed to State or local air pollution personnel, nor is it designed to be used by personnel who do not have a knowledge of the various system components, or a familiarity with data base management systems. ISNTS is not an integrated computer system, but rather is comprised of various component pieces developed either specifically for the purpose of projecting SO_2 emissions or for use in other EPA related projection purposes. ISNTS is comprised of the following components:

- Multiple Projections System (MPS). The version utilized is an in-house version specifically modified to project yearly SO_2 emissions.
- Economic Growth Analysis System (E-GAS).

- A British thermal unit (Btu) efficiency neural network (BENNET) specifically designed to provide growth factors for industrial combustion sources that account for fuel switching and the consequent variability in fuel quality (i.e., fuel sulfur content).
- An industrial fuel price neural network (FUNET) specifically designed to provide projected fuel price information for use in BENNET.

Two of the components of this "system" (E-GAS and MPS) are distributed stand-alone computer systems that have been provided by EPA for State and local air pollution control agencies. Each of these systems has a user's manual and/or reference manual that describes how to develop economic growth factors (E-GAS) or emission projections (MPS). The reader is referred to the following EPA publications for additional information concerning these programs:

"Economic Growth Analysis System: Reference Manual," EPA-600/R-94-139a, April 1993.

"Economic Growth Analysis System: User's Guide," EPA-600/R-94-139b, April 1993.

"Multiple Projections System (MPS): User's Manual Version 1.0," EPA-600/R-94-085, May 1994.

E-GAS is an economic and activity forecasting model that projects growth factors by source classification code (SCC) for nonattainment areas and attainment portions of States for the 48 contiguous States. The system is composed of a national economic tier, a regional economic tier, and a growth factor tier which includes energy consumption models for the residential, commercial, and industrial sectors, modules which forecast industrial physical output and vehicle miles travelled, and a crosswalk which matches the appropriate growth factor with each point, area, and mobile source SCC. The growth factor tier from E-GAS is used in ISNTS to provide growth factors for projecting emissions from noncombustion industrial sources.

MPS is a projection model that uses a base year inventory, source-specific growth factors, and projected changes in (source-specific) control efficiency and rule effectiveness to develop inventories for future years. MPS is used to store the appropriate SO_2 base year emissions data, and generate forecasts of industrial process emissions using activity growth factors from E-GAS (for noncombustion sources and industrial combustion area sources) and BENNET (for industrial combustion point sources). In addition, MPS can be used to generate summary tables and graphs.

The *Fuel Price Neural Network* (FUNET) estimates/forecasts prices paid by industrial consumers in each of the 4 census regions for any of 5 fuels (coal, natural gas, distillate, residual, LPG), and electricity. As options, sulfur content may be specified for residual oil and coal and heat content may be specified for coal. Because coal ranks (anthracite, bituminous, sub-bituminous, and lignite) can be distinguished by heat content, the ability to specify heat content effectively gives FUNET the ability to estimate/forecast coal price by rank.

BENNET forecasts gross SO_2 emissions (GSE) resulting from combustion of coal, residual, and distillate by the manufacturing industries, Standard Industrial Codes (SIC) 20 - 39. GSE are defined for purposes of this report as emissions resulting from conversion of sulfur contained in the fuel to SO_2 by combustion. Since BENNET does not account for removal of SO_2 from combustion gas by ash removal, scrubbers, precipitators, or any other physical or chemical process designed to reduce the release of air pollutants into the atmosphere, the GSE are used as relative growth factors applied to net base year emissions, that is, with existing control systems in operation.

GSE were calculated by forecasting the amount, in Btu, of each of 6 fuels used by each of 20 manufacturing SICs in each state during each future year and then calculating the SO_2 which would result from combustion. Btu consumption includes the effects of fuel switching due to price differences among fuels plus the effects of capital investment, which include both fuel switching and changes in efficiency. Six fuels were considered when forecasting Btu consumption: coal, distillate, electricity, natural gas, LPG, and residual. Although electricity is, strictly speaking, not a fuel, it is an alternative to the other 5 in many industrial applications and is therefore included. Only 3 of the fuels are considered to produce SO_2: coal, residual, and distillate. Both natural gas and LPG contain small amounts of sulfur but these amounts are considered negligible and were therefore ignored.

As indicated above, GSE forecast by BENNET are expressed as growth rates relative to the base year. In other words, for the base year, GSE for any state and SIC equals 100.0. GSE for any other state/year/SIC would be a number like 98.5 or 102.3, which indicates that GSE for the state/year/SIC would be 98.5 or 102.3 percent of its base year value.

Details of the theory and development of the neural networks and additional details concerning how the industrial SO_2 emissions projections were prepared are given in Pechan, 1994.

C. INDUSTRIAL SO_2 EMISSION PROJECTIONS

As indicated in the previous chapter, industrial source SO_2 emissions for the base year, 1990, are approximately 5 million tons. Starting with the base year emissions, emission projections were developed using either E-GAS growth factors (for noncombustion sources and combustion area sources) or BENNET growth factors for industrial combustion sources. E-GAS growth factors were utilized for the combustion area sources since these sources are felt to be too small and too disperse to be able to effectively switch fuels.

No new national controls for any industrial SO_2 sources were identified, nor were changes in current rule effectiveness. Thus the emission projections presented in this chapter represent growth with no new controls.

Figure V-1 shows the results from the emission projections developed using ISNTS. Values presented for 1990-1993 represent emission estimates developed as part of EPA's Emission Trends effort. 1994-2015 values represent projected emissions using the 1990 base year inventory discussed in the previous chapter.

Figure V-1 shows that emissions decreased slightly from 1990-1993, and then show a slightly increasing trend to the year 2005. From 2005 to 2015 projected emissions are basically flat. In all cases, the emissions projections show that total national industrial SO_2 emissions remain below 5 million tons, well below the 5.60 million ton per year cap established by section 406. As with historic emissions and the base year, industrial combustion emissions continue to be the largest contributor to future industrial SO_2 emissions.

D. PROJECTED EMISSIONS FOR SELECTED INDUSTRIAL SOURCE SUBCATEGORIES

1. Industrial Combustion

Figure V-2 shows the projected emissions from the industrial SO_2 combustion sector by fuel type at five year intervals from 1990-2015. This figure indicates that for coal, emissions decrease slightly from 1990-1995, then rise from 1995-2005 followed by another decline after 2005. Oil-related emissions, on the other hand, decrease steadily from their base year levels, while the contribution from gas remains virtually constant for the period. Emissions from other fuels decline slightly.

2. Metals Processing

Industrial SO_2 emission projections for various subcategories in the metals processing sector are shown in Figure V-3. Projected emissions for all subcategories examined basically show virtually no growth in emissions from this sector.

3. Chemical and Allied Products Manufacturing

Inorganic chemical manufacturing (sulfur compounds) shows increasing emissions over the period 1990-2015, rising from slightly over 300 thousand tons in 1990 to over 400 thousand tons in 2015 (Figure V-4). Figure V-4 also shows that the remaining chemical and allied products manufacturing subcategories show only slight growth in emissions (if any) over the same time period.

4. Petroleum and Related Industries

Figure V-5 indicates that emissions from all petroleum and related industry subcategories decline steadily from 1990-2015 with the exception of oil and natural gas production which shows declining emissions until 2005 and then increasing emissions until 2015.

5. Other Industrial Processes

Other industrial process emissions increase steadily over the period 1990-2015 (Figure V-6). Wood, pulp and paper, and publishing emissions increase from slightly below 150 thousand tons to over 200 thousand tons by 2015. Cement manufacturing shows an even greater increase, rising from just over 150 thousand tons in 1990 to well

over 250 thousand tons in 2015. Other subcategories in the other industrial processes sector show slight increases as well.

E. EMISSION PROJECTIONS SUMMARY

Industrial SO_2 emission projections show a slight decrease from the base year to approximately 1994-1995. From 1995, emission levels increase slightly to a peak about 2005. From 2005 to 2015, collective emission levels for all categories decrease very slightly. Two subcategories, chemical and allied products manufacturing and other industrial processes, are forecast to produce small increases in emissions over the period 1990-2015.

Table V-1 summarizes the Tier 1 level emission projections from 1990-2015. Values for 1990-1993 are derived from EPA's Emission Trends effort. Only values from 1994-2015 represent projected emissions values.

Table V-1
National Tier 1 Emissions Projections, 1990 to 2015

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fuel Combustion - Industrial	3,106	3,139	2,947	2,830	2,878	2,884	2,866	2,863	2,867	2,887	2,908
Chemical and Allied Prod. Mfg.	440	442	447	450	462	462	467	471	475	479	483
Metals Processing	578	544	557	580	579	579	579	579	579	579	580
Petroleum & Related Industries	440	444	417	409	405	397	390	383	377	371	364
Other Industrial Processes	401	391	401	413	430	435	445	456	467	477	488
Solvent Utilization	1	1	1	1	1	1	1	1	1	1	1
Storage and Transport	5	5	5	5	5	5	5	5	5	5	5
Waste Disposal & Recycling	11	11	11	11	11	11	11	11	11	11	11
TOTAL	4,981	4,977	4,786	4,699	4,769	4,773	4,763	4,768	4,781	4,811	4,840

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fuel Combustion - Industrial	2,937	2,958	2,968	2,966	2,962	2,930	2,919	2,912	2,890	2,882	2,857	2,842	2,820	2,800	2,803
Chemical and Allied Prod. Mfg.	487	491	494	498	501	507	511	516	520	524	528	532	535	537	540
Metals Processing	580	580	580	581	581	581	582	582	582	583	583	583	584	584	584
Petroleum & Related Industries	358	352	347	341	335	333	331	328	326	323	321	319	316	314	312
Other Industrial Processes	499	510	521	533	545	553	559	566	572	578	584	590	594	599	603
Solvent Utilization	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Storage and Transport	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Waste Disposal & Recycling	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
TOTAL	4,878	4,908	4,927	4,935	4,941	4,921	4,919	4,920	4,907	4,907	4,891	4,883	4,866	4,851	4,858

Figure V-1
Projected Industrial SO2 Emissions
(1990 - 2015)

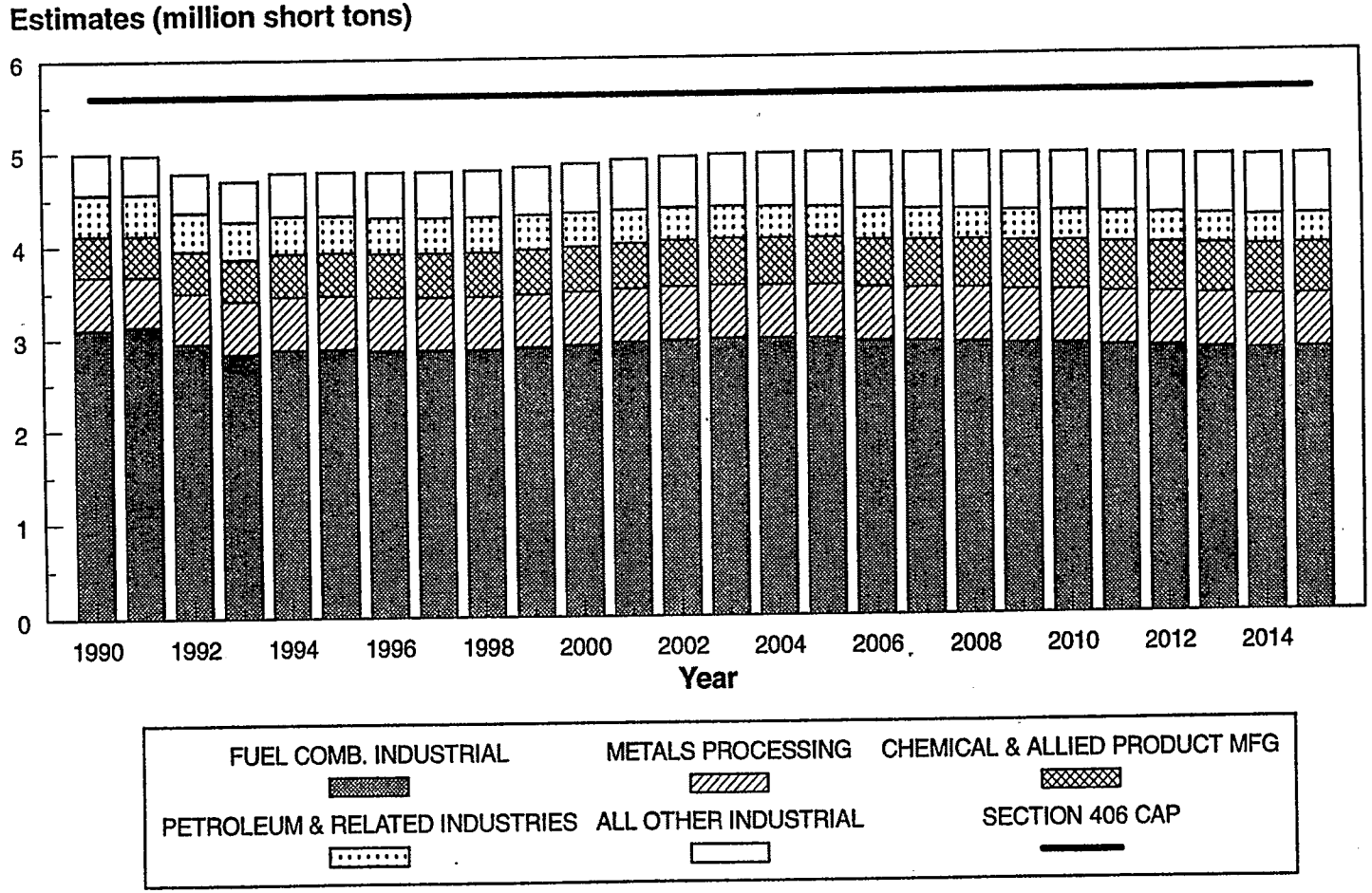


Figure V-2
Projected Industrial Combustion SO2 Emissions
(1990 - 2015)

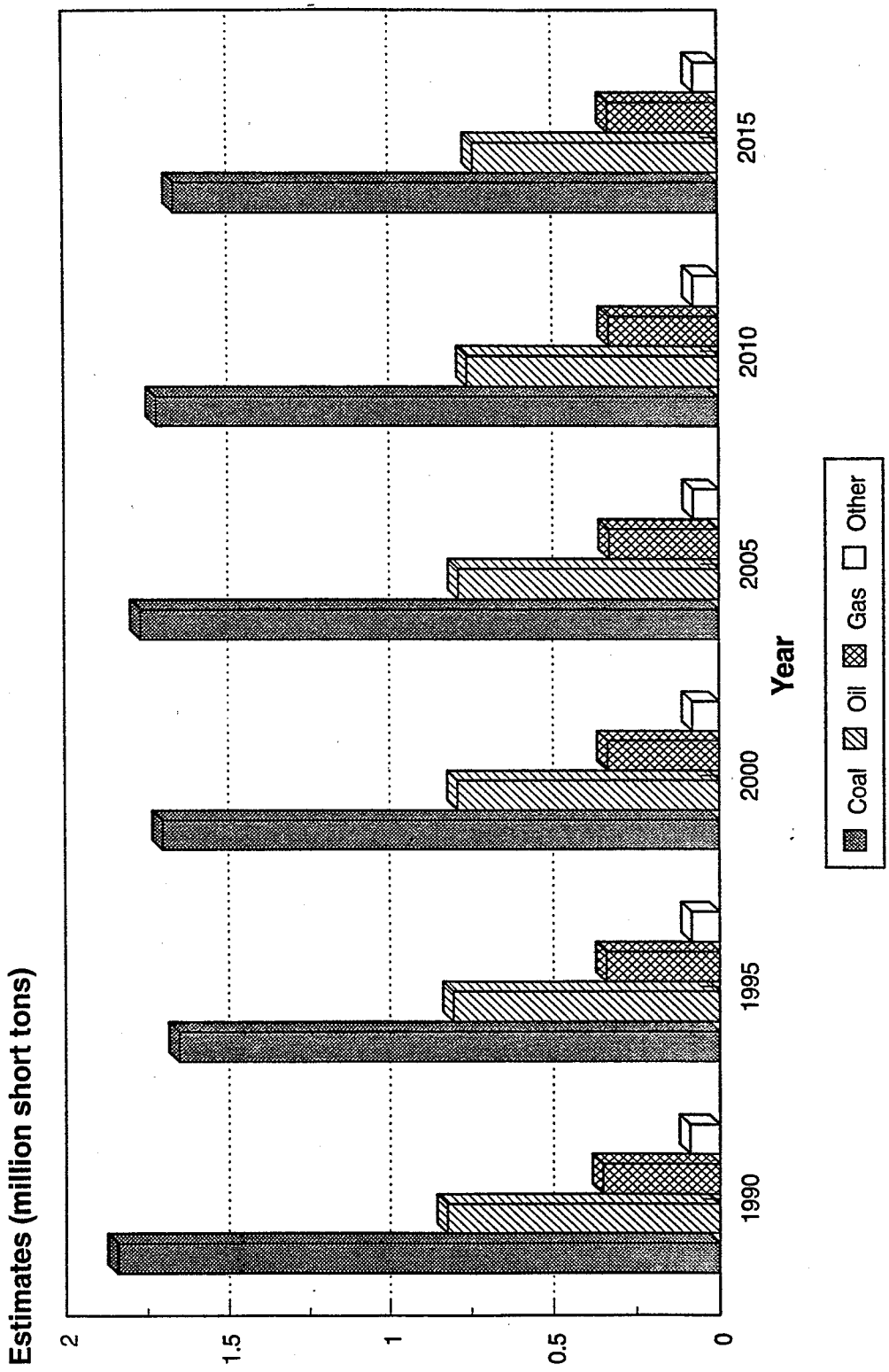


Figure V-3
Projected Industrial SO2 Emissions from Metals Processing
(1990 - 2015)

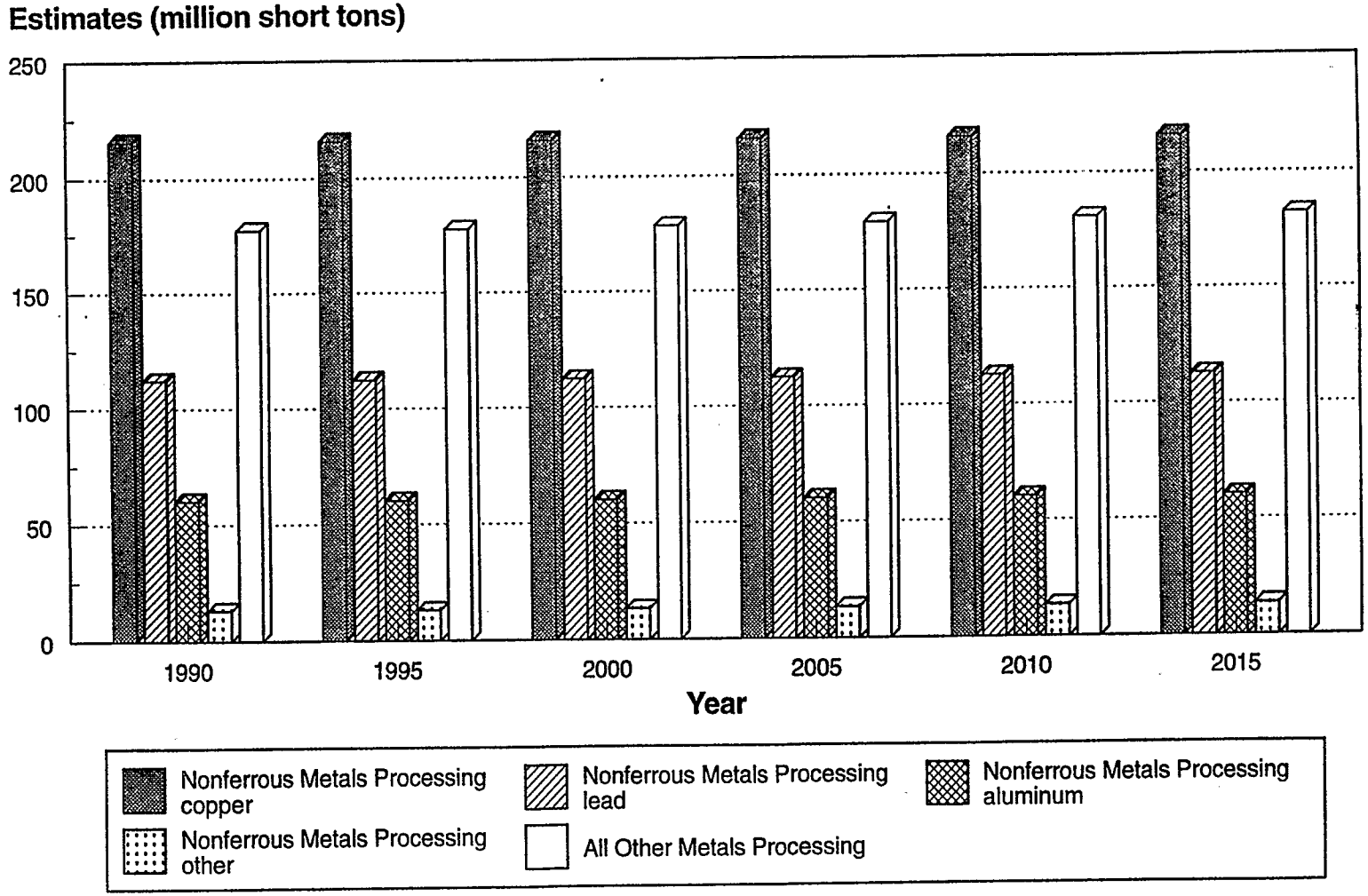


Figure V-4
Projected Industrial SO2 Emissions from Chemical & Allied Product Mfg (1990 - 2015)

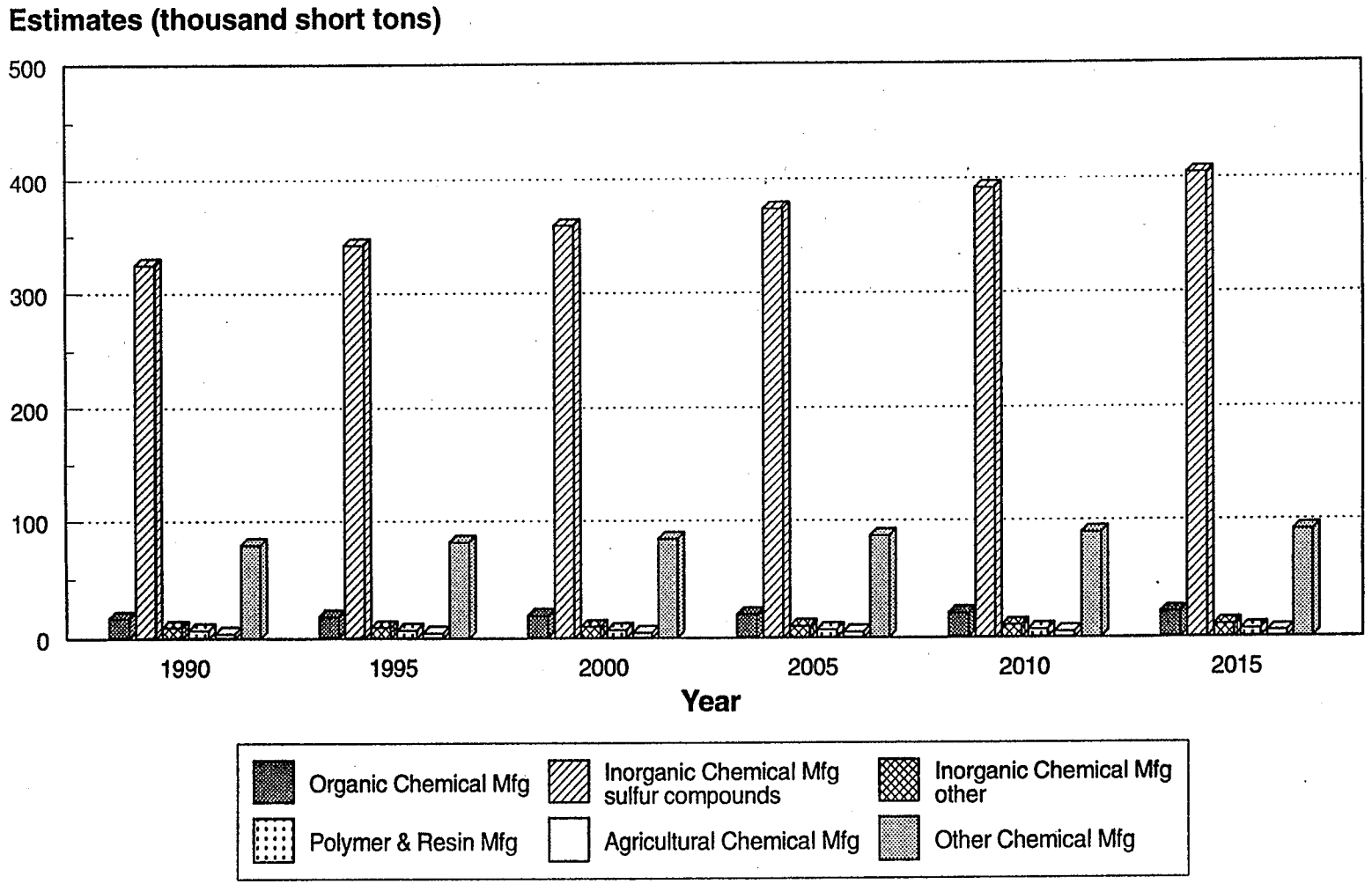


Figure V-5
Projected Industrial SO2 Emissions from Petroleum & Related Industries (1990 - 2015)

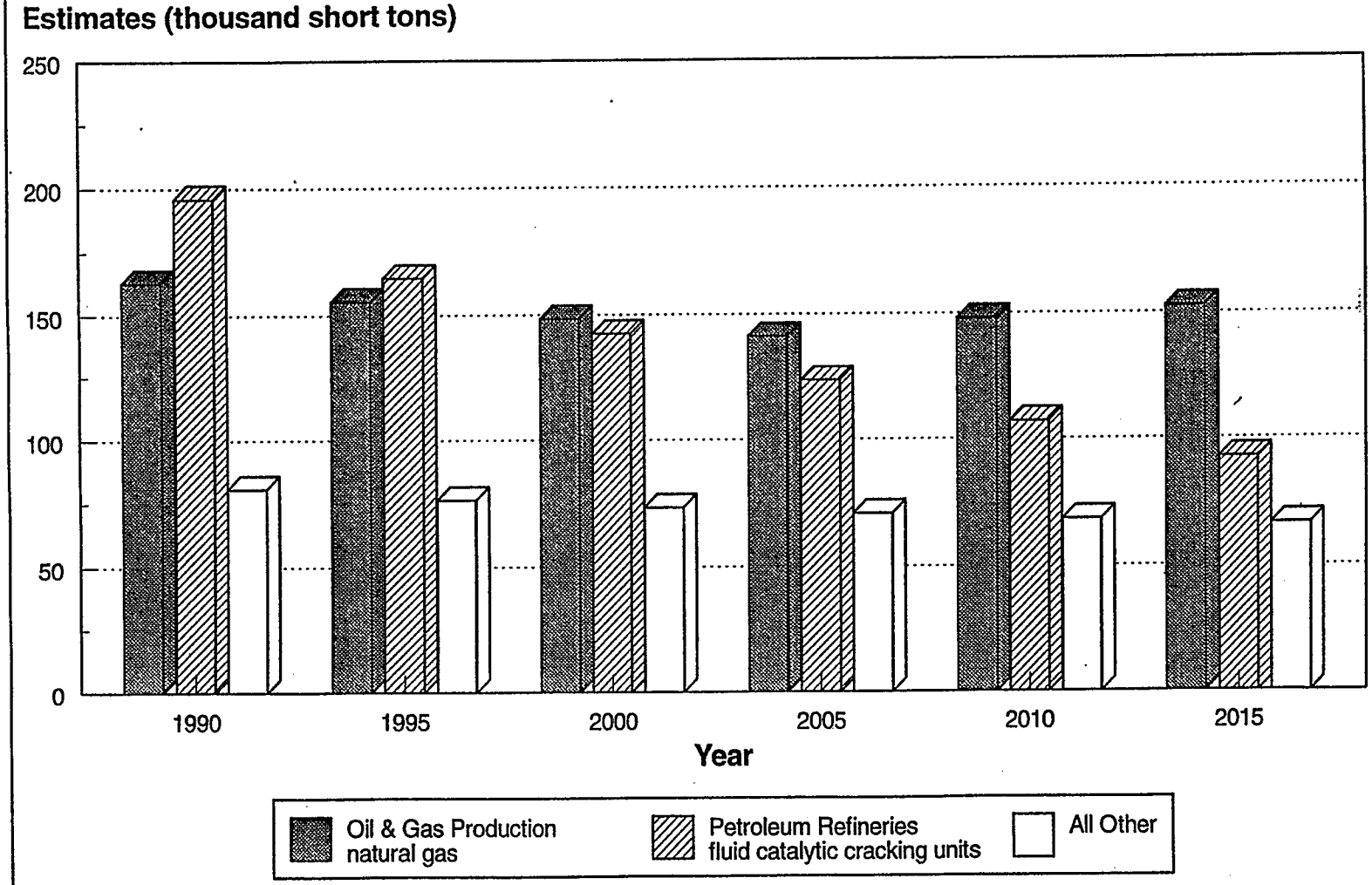
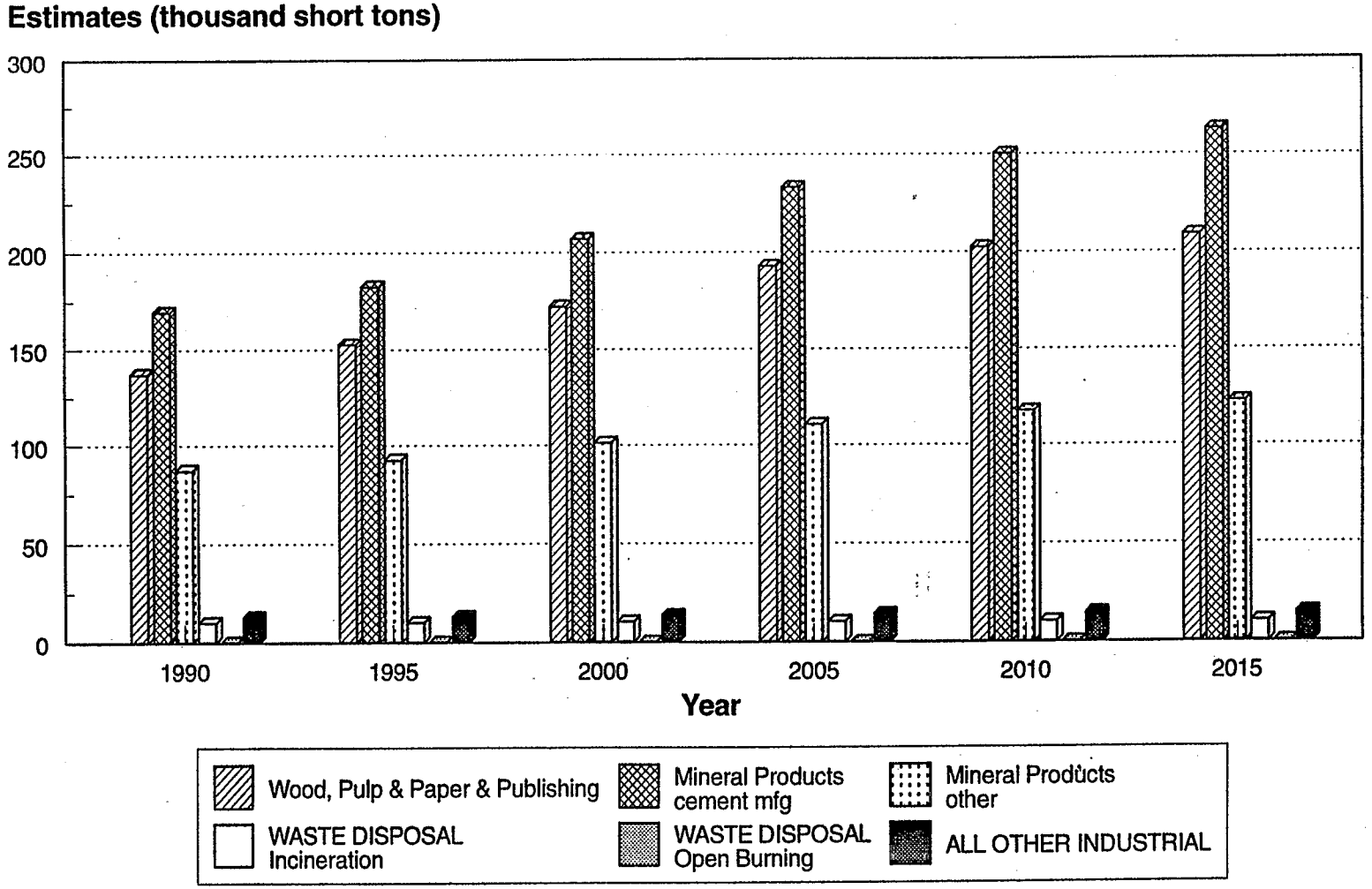


Figure V-6
Projected Industrial SO2 Emissions from Other Industrial Processes (1990 - 2015)



CHAPTER VI
EMISSION REDUCTIONS RESULTING FROM DIESEL DESULFURIZATION REGULATIONS

A. INTRODUCTION

Section 406 of the 1990 CAAA requires that EPA's industrial SO_2 emissions report to Congress include estimates of the emission reductions resulting from the diesel fuel desulfurization regulations mandated by Section 211(i) of the CAAA. The first two sections of this chapter of the report describe the desulfurization regulations and the methods used to estimate the SO_2 emission reductions from these regulations. The final section of this chapter presents estimates of SO_2 emission reductions in 1993, the first year they were implemented.

B. DIESEL DESULFURIZATION REGULATIONS

Section 211(i) of the CAAA outlines the sulfur content requirements for diesel fuel. Congress mandated that all motor vehicle diesel fuel that contains a concentration of sulfur in excess of 0.05 percent by weight or which fails to meet a minimum cetane index of 40, be banned from commerce beginning on October 1, 1993. The EPA published regulations on August 21, 1990 (54 FR 35276) which govern the desulfurization of diesel motor fuel.

C. METHOD OF ESTIMATING EMISSION REDUCTIONS

The first step in estimating the SO_2 emission reductions resulting from the diesel desulfurization regulations is to assemble data characterizing the sulfur content of motor fuel. To estimate 1993 emission reductions, government agencies and private organizations were contacted to assess the availability of sulfur content data for motor fuel produced or consumed during 1993. Because specific fuel composition data were not available, SO_2 emission reductions were estimated based on assumed sulfur content levels of pre- and post-desulfurization motor fuel. For pre-desulfurization months in 1993 (i.e., January-September), the average sulfur content of motor fuel as reported in U.S. EPA's AP-42 publication was used. For post-desulfurization months (October-December), it was assumed that all motor diesel fuel contained 0.05 percent sulfur content, the maximum permitted by law.

The general procedure followed in estimating SO_2 emission reductions was to subtract the estimated SO_2 emissions in 1993 (based on the assumed sulfur content of motor fuel in each month) from the estimated SO_2 emissions in 1993 assuming no desulfurization took place (i.e., assuming the pre-desulfurization diesel fuel sulfur content for the entire year). Emissions were estimated by first calculating pre- and post-desulfurization emission factors by each of the eight vehicle types (e.g., light-duty diesel vehicle). Next,

the percentage sulfur content data were then combined with fuel density data from AP-42 and fuel economy data from the MOBILE4.1 fuel consumption model to estimate pre- and post-desulfurization emission factors for each vehicle type. The appropriate emission factors were then multiplied by State-level vehicle miles traveled data by vehicle type, which are available from the Highway Performance Monitoring System. The final step involved subtracting the estimated 1993 SO_2 emissions (with implementation of the regulation) from the estimated 1993 emissions if no desulfurization regulations were in place (i.e., assuming that pre-regulation motor fuel sulfur content continues for the entire year).

D. ESTIMATED SO_2 EMISSION REDUCTIONS

Figure VI-1 displays a month-by-month comparison of 1993 diesel motor vehicle SO_2 emissions with and without the desulfurization program. This figure shows a large decline in SO_2 emissions from diesel motor vehicles for October-December, the first three months of desulfurization. Table VI-1 presents the estimated national SO_2 emission reductions for all of 1993 from the diesel desulfurization regulations. This table indicates that the amount of SO_2 emitted from all motor vehicles was reduced by approximately 10 percent in 1993 due to diesel desulfurization. A 19 percent decline in SO_2 emissions was registered for diesel vehicles. It is important to remember that this reduction was realized even with the regulations only in place for the last three months of 1993. If only the three months that the desulfurization regulations were in effect are analyzed, total SO_2 emissions from all motor vehicles (including non-diesel fueled vehicles) declined an estimated 42 percent, and SO_2 emissions from diesel vehicles for the same period declined an estimated 75 percent.

Table VI-2 displays State-level 1993 SO_2 emissions estimates, both with and without the desulfurization program. South Dakota and Montana had the biggest overall percentage reduction in motor vehicle SO_2 emissions from the desulfurization program at 11.9 percent; the smallest reduction occurred in the District of Columbia (8.2 percent). The slight differences seen between the various States is the result of differences in the vehicle fleet in each state. The percentage reduction column in Table VI-2 is based on reductions from all vehicles (i.e., diesel-fueled as well as non-diesel fueled). Thus, although diesel vehicles are the largest emitters of sulfur from mobile sources, emissions from non-diesel fueled vehicles account for a significant (but variable) fraction of the emissions and create the slight differences among the overall percentage reductions among the various States.

Table VI-1
Estimated National SO_2 Emission Reductions from Diesel Desulfurization (Oct.-Dec., 1993) (short tons)

Vehicle Type	SO_2 Emissions without Desulfurization	SO_2 Emissions with Desulfurization	SO_2 Emission Reductions	Percentage Reduction
DIESEL VEHICLE	268,304	217,336	50,968	19
Light-Duty Diesel Vehicle	12,033	9,813	2,220	18
Light-Duty Diesel Truck	2,235	1,823	412	18
Heavy-Duty Diesel Vehicle	254,036	205,701	48,335	19
NONDIESEL VEHICLE	220,085	220,085	0	0
TOTAL, diesel and nondiesel	488,389	437,421	50,968	10

Note: Numbers may not sum due to rounding.

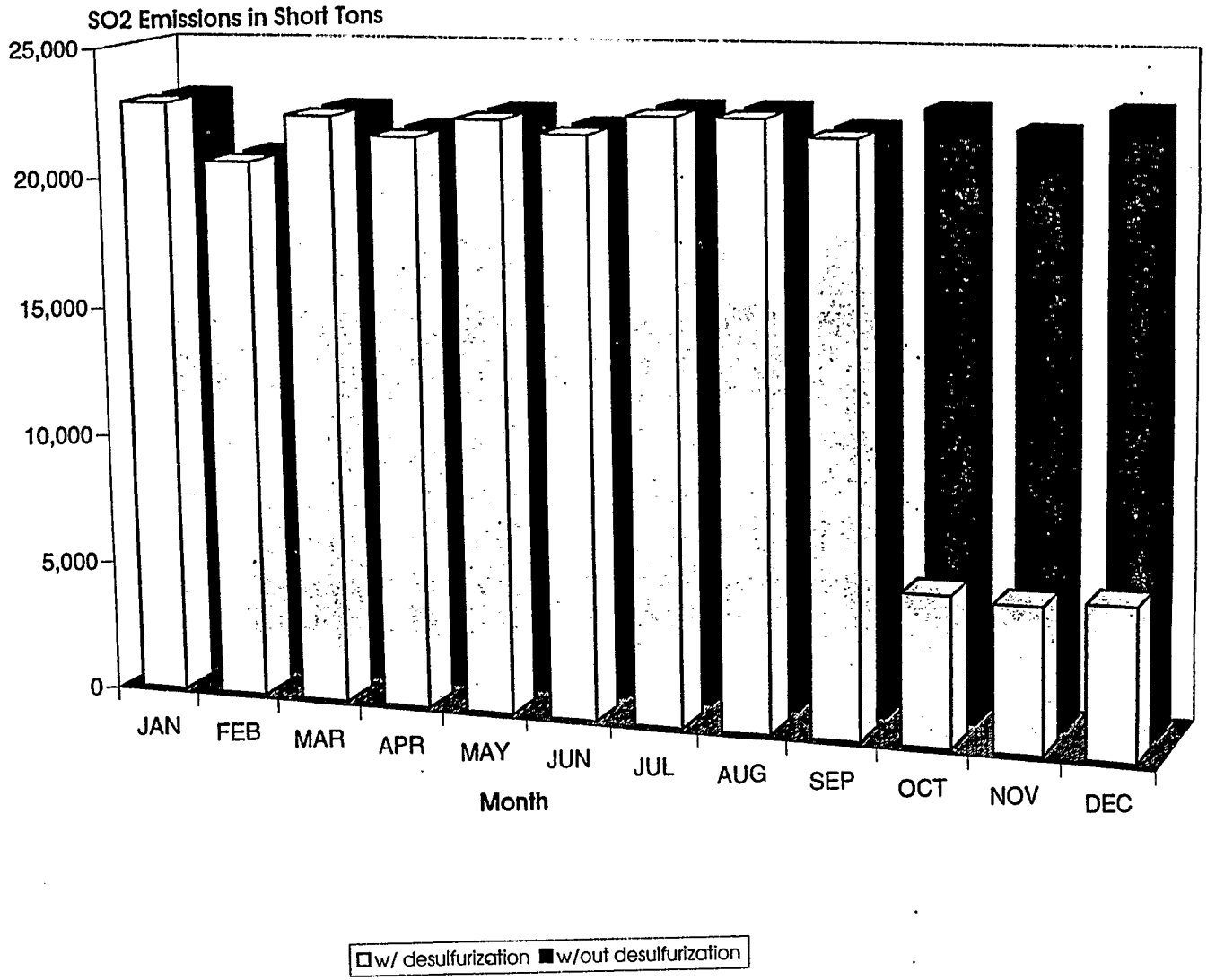
Table VI-2
Estimated State-Level SO_2 Emissions with and without Diesel Desulfurization (Oct.-Dec., 1993)
(short tons)

State	LDDV		LDDT		HDDV		All Vehicle Types*		
	without	with	without	with	without	with	without	with	percentage reduction
Alabama	245	199	47	38	5,803	4,699	10,612	9,454	10.9
Alaska	21	17	4	3	496	402	900	801	11.0
Arizona	190	155	35	29	4,010	3,247	7,708	6,904	10.4
Arkansas	121	99	24	19	3,317	2,686	5,729	5,072	11.5
California	1,418	1,156	252	206	23,566	19,082	50,715	45,923	9.4
Colorado	159	129	29	24	3,277	2,654	6,360	5,702	10.3
Connecticut	145	119	26	21	2,508	2,031	5,300	4,791	9.6
Delaware	37	30	7	6	775	628	1,494	1,338	10.4
Dist. of Columbia	20	16	3	3	243	197	618	567	8.2
Florida	625	510	114	93	11,702	9,476	23,770	21,407	9.9
Georgia	421	343	79	64	9,114	7,380	17,334	15,507	10.5
Hawaii	44	36	8	6	793	642	1,637	1,477	9.8
Idaho	56	46	11	9	1,543	1,250	2,657	2,351	11.5
Illinois	475	387	87	71	9,265	7,502	18,463	16,597	10.1
Indiana	304	248	58	47	7,269	5,886	13,257	11,807	10.9
Iowa	126	102	25	20	3,406	2,758	5,905	5,230	11.4
Kansas	126	103	24	20	3,086	2,499	5,574	4,959	11.0
Kentucky	201	164	39	32	5,032	4,075	9,004	8,002	11.1
Louisiana	182	148	35	28	4,420	3,579	8,002	7,121	11.0
Maine	62	51	12	10	1,836	1,487	3,084	2,720	11.8
Maryland	226	184	41	34	4,294	3,477	8,656	7,790	10.0
Massachusetts	256	209	46	37	4,174	3,380	9,079	8,229	9.4
Michigan	458	373	85	69	9,406	7,616	18,301	16,412	10.3
Minnesota	221	180	42	34	5,140	4,162	9,472	8,445	10.8
Mississippi	141	115	28	23	3,925	3,178	6,746	5,968	11.5
Missouri	286	233	54	44	6,546	5,300	12,147	10,838	10.8
Montana	44	36	9	7	1,343	1,088	2,236	1,970	11.9
Nebraska	76	62	15	12	2,011	1,629	3,527	3,127	11.3
Nevada	59	48	11	9	1,258	1,019	2,404	2,151	10.5
New Hampshire	52	43	10	8	1,402	1,135	2,442	2,164	11.4
New Jersey	324	264	58	47	5,375	4,352	11,571	10,478	9.4
New Mexico	96	78	19	15	2,575	2,085	4,476	3,965	11.4
New York	589	480	107	87	10,788	8,735	22,134	19,953	9.9
North Carolina	352	287	67	54	8,265	6,692	15,178	13,528	10.9
North Dakota	30	25	6	5	907	734	1,520	1,341	11.8
Ohio	514	419	95	78	10,812	8,754	20,821	18,651	10.4
Oklahoma	189	154	36	29	4,449	3,603	8,163	7,275	10.9
Oregon	146	119	28	23	3,627	2,937	6,502	5,779	11.1
Pennsylvania	476	388	89	73	10,338	8,371	19,631	17,560	10.6
Rhode Island	43	35	8	6	672	544	1,501	1,364	9.1
South Carolina	183	150	36	29	4,786	3,875	8,424	7,473	11.3
South Dakota	38	31	8	6	1,177	953	1,945	1,713	11.9
Tennessee	272	222	51	42	6,117	4,953	11,436	10,213	10.7
Texas	895	730	165	134	18,014	14,587	35,387	31,763	10.2
Utah	90	73	17	13	1,831	1,482	3,570	3,202	10.3
Vermont	31	25	6	5	892	722	1,510	1,333	11.7
Virginia	332	270	62	51	7,532	6,099	14,027	12,521	10.7
Washington	265	216	49	40	5,268	4,266	10,407	9,347	10.2
West Virginia	86	70	17	14	2,496	2,021	4,219	3,725	11.7
Wisconsin	256	209	49	40	6,208	5,027	11,252	10,014	11.0
Wyoming	32	26	6	5	944	764	1,583	1,397	11.8

LDDV: Light-Duty Diesel Vehicle LDDT: Light-Duty Diesel Truck HDDV: Heavy-Duty Diesel Vehicle

* Includes nondiesel vehicles.

Figure VI-1. Graphical Comparison of 1993 Diesel Motor Vehicle SO2 Emissions with and without Fuel Desulfurization



REFERENCES

Barnard, W., E. Laich, S. Bromberg, et al. "Development of Tier Categories for the Collection, Management, and Reporting of Emissions Inventory Data." In Proceedings of the 1993 U.S. EPA/A&WMA Emission Inventory Specialty Conference, Air and Waste Management Association, Pasadena, CA 1993.

EPA, 1994: U.S. Environmental Protection Agency, Joint Emissions Inventory Oversight Group, "Comparison of the 1985 NAPAP Emissions Inventory with the 1985 EPA Trends Estimates for Industrial SO_2 Sources," EPA-600/R-94-012, Research Triangle Park, NC, January 1994.

EPA, 1993a: U.S. Environmental Protection Agency, "National Air Pollutant Emission Trends 1900-1992," EPA-454/R-93-032, Research Triangle Park, NC, October 1993.

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

EPA, 1991: U.S. Environmental Protection Agency, "Compilation of Air Pollutant Emission Factors, Fourth Edition, and Supplements through D, AP-42," Research Triangle Park, NC, September 1991.

EPA, 1992: U.S. Environmental Protection Agency, "National Air Pollutant Emission Estimates, 1900-1991," EPA-454/R-92-013, Research Triangle Park, NC, October 1992.

EPA, 1989: U.S. Environmental Protection Agency, "The 1985 NAPAP Emission Inventory (Version 2): Development of the Annual Data and Modeler's Tapes," EPA-600/7-89-012a, Cincinnati, OH, November 1989.

EPA, 1986: U.S. Environmental Protection Agency, National Air Data Branch, Office of Air Quality Planning and Standards, "Standard Computer Retrievals from the National Emissions Data System (NEDS)," unpublished computer report available from NADB, Research Triangle Park, NC. (This system is no longer operational.)

Mahoney, James R., 1990: Letter to Representative John D. Dingell, concerning review of NAPAP's evaluation of SO_2 emission baseline for use in calculating emission reduction credits under H.R. 3030, February 5, 1990.

Pechan, 1994: "Industrial SO_2 and NO_x Tracking System," Final Report prepared for U.S. EPA by E.H. Pechan and Associates, Inc., for Contract # 68D10146, Work Assignment # 2/033, Pechan Report # 94.09.003/1010.033, September 1994.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report fulfills a requirement of the Clean Air Act Amendments of 1990 that EPA submit to Congress once every five years information on national annual sulfur dioxide (SO2) emissions from industrial sources, such as coal burning plants, pulp and paper mills, and petroleum refineries. The report contains emissions data for each year from 1985 to the present, as well as the likely trend in emissions over the next twenty years.

SO2 can cause adverse human health and environmental effects. Exposure to emissions of SO2 can aggravate asthma and other respiratory diseases. In addition, SO2 is the major contributor to acid rain.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Sulfur Dioxide Air Pollution Emission Trends Industrial Emissions Emission Reductions	Air Pollution Control Air Pollution Trends	

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