Impact on Air Quality of Alternate Strategies for the Production, Distribution and Utilization of Energy in Texas 1975 - 2000

JANUARY 1975

PREPARED FOR

GOVERNOR'S ENERGY ADVISORY COUNCIL
BY THE STAFF OF
THE TEXAS AIR CONTROL BOARD

ACKNOWLEDGEMENTS

The author wishes to thank all the investigators who contributed so ably to the completion of this project. A special note of gratitude is expressed to Messrs. Steven N. Spaw, P.E. and Lawrence E. Pewitt, P.E. and Mrs. Betty Streetman for assisting with the compilation of this report.

Table of Contents

page

Introduction....................................1

Methodology.....................................2

Results...3

Conclusions and Recommendations.................6

Appendix A - Distribution of Contaminants by Source Category

Appendix B - Regional Distribution of Air Contaminant Emissions

Appendix C - Dispersion Modeling of Predicted Ground Level Modeling of Air Contaminants

Appendix D - Texas Power Plant Emission Projections

Appendix E - Texas Petrochemical Industry Emission Projections

Appendix F - Texas Petroleum Refining Industry Emission Projections

Appendix G - Texas Metallurgical Industries Emission Projections

Appendix H - Texas Non Metal Mining and Processing Industry Emission Projections

Appendix I - Texas Agricultural Production and Processing Industry Emission Projections

Appendix J - Texas Chemical Pulping Industry Emission Projections

Appendix K - Texas Transportation Emission Projections

Appendix L - Capital Costs for Emission Controls from Stationary Industrial Plants in Texas

INTRODUCTION

Early in 1974, the Texas Air Control Board was requested to provide assistance in the work of the Governor's Energy Advisory Council, specifically in projects E/S-2 and E/S-4 of the Environmental and Social Committee. Project E/S-2 is titled "Impact on Air Quality of Alternate Strategies for the Production, Distribution and Utilization of Energy in Texas from 1975 - 2000".

This study is significant since major shifts in fuels used in Texas are expected. The reduced availability and increased cost of natural gas is making the use of other energy sources such as solid and liquid fossil fuels more attractive. The use of these alternate fuels is expected to result in increased emissions to the Texas atmosphere of air pollutants such as sulfur dioxide and particulate matter. While air pollution control technology is readily available, the application of this technology is costly and should not be required unless necessary to protect the population from exposure to unacceptable levels of pollution. The purpose of this study is to examine possible energy growth patterns and translate this growth into resulting effects on the Texas air environment.

The following sources which contribute to air pollution were included in this study:

Electric Power Generation
Petrochemical Manufacture
Petroleum Refining
Metals Refining
Non Metal Mining and Processing
Agricultural Production and Processing
Chemical Pulping (Kraft)
Transportation

METHODOLOGY

Three growth patterns were chosen for the study as follows. Scenario I represents a continuation of late 1960 growth rates and assumes adequate availability of low cost natural gas. Obviously, this Scenario is not realistic in light of today's knowledge of energy costs. Scenario II represents growth in a "market forces" situation with increased reliance on coal and nuclear power. Case three, labeled "E/S-2 growth", represents projections made by the staff of the Texas Air Control Board based on OBERS growth projections and information obtained from permit applications for planned construction projects. Scenario I and II growth data were provided by the Governor's Office of Information Services. In most instances, the growth projected in case three was greater than that projected by Scenarios I or II.

Air pollutant emissions were predicted for all growth projections. These emission calculations were made assuming that all growth will comply with presently applicable Federal new source performance standards and with best available control technology as of 1974. No consideration was given to probable advances in air pollution control technology nor to breakthroughs in process technology which may drastically reduce air pollutant emissions.

Geographically the projected industrial growth was distributed across the State in proportion to existing installation of a similar type.

RESULTS

Predicted air pollutant emissions for all three growth projections were made and are summarized in Table A. The influence of expected increases in usage of higher sulfur bearing fuels is evident in sulfur dioxide emission projections for 1985 and 2000. Similarly the increases shown in particulate matter emissions reflect the increased use of solid and liquid fossil fuels. The projected decreases in hydrocarbon and carbon monoxide emissions reflect the influences of application of current air pollution control regulations on stationary sources and planned Federal controls on new mobil sources.

Dispersion modeling was accomplished for most major metropolitan areas in Texas using projected sulfur dioxide emissions for 1985. A discussion of parameters used in the dispersion model is found in Appendix C along with maps showing predicted sulfur dioxide levels. Modeling results indicate that even with significant increases in emissions to the atmosphere, Federal ambient air quality standard for sulfur dioxide will not be exceeded through 1985.

Distribution of pollutants by source category as projected by E/S-2 growth is shown in Appendix A. The significant increase in sulfur dioxide emissions is caused primarily by growth and fuels switches in the electric power and petrochemical industries. Similar changes are noted for particulate matter emissions. The significance of Federal new motor vehicle controls is evident in the reduction shown in hydrocarbon and carbon monoxide emissions.

The regional distribution of emissions for the E/S-2 growth case is shown in Appendix B. Major growth is predicted to continue in the coastal areas.

Capital costs estimates for air pollution control equipment were made for Scenario I and Scenario II projections by RADIAN CORPORATION and are shown in Table B. Similar cost projections for E/S-2 growth projections are not available.

Individual studies of each major source category are presented beginning in Appendix A.

TABLE A

Pollutants*	SCENARIO I			SCENARIO II			E/S-2 GROWTH		
	1970	1985	2000	1970	1985	2000	1970	1985	2000
Sulfur Dioxide (SO_2)	0.71	0.58	0.70	0.71	1.45	1.73	0.65	2.63	6.91
Nitrogen Oxides (NO_x)	1.68	1.90	2.61	1.63	1.63	2.04	1.38	2.01	4.78
Hydrocarbons (HC)	1.86	0.98	1.28	1.92	0.88	1.16	1.87	1.08	1.72
Carbon Monoxide (CO)	6.64	2.29	2.57	6.69	2.12	2.40	5.28	1.98	2.25
Particulate Matter (PA)	0.27	0.36	0.53	0.28	0.44	0.53	0.30	0.58	1.08

* All emissions in million tons per year.

CONCLUSIONS AND RECOMMENDATIONS

Major increases in sulfur dioxide and particulate matter emissions will occur during the next several years as a result of increased usage of solid and liquid fossil fuels which will replace natural gas. Through the application of Federal new source performance standards and best available control technology, it does not appear that any areas in Texas will exceed the Federal ambient air quality standards as a result of these increased emissions.

Significant reductions in emissions of hydrocarbons and carbon monoxide will occur primarily because of controls on stationary sources and new motor vehicles.

TABLE B

CAPITAL COSTS FOR EMISSION CONTROLS FROM STATIONARY INDUSTRIAL SOURCES IN TEXAS

Scenario I

	Million of 1974 Dollars		
	1970	1985	2000
Electrical Generation	0	0	0
Agricultural Products	11	25	40
Industrial, including Petrochemicals and Petroleum Refining	25	249	368
	36	274	408

Scenario II(a)

	Million of 1974 Dollars		
	1970	1985	2000
Electrical Generation	0	465	618
Agricultural Products	11	15	21
Industrial, including Petrochemicals and Petroleum Refining	25	251	366
	36	731	1005

Scenario II(b)*

	Million of 1974 Dollars		
	1970	1985	2000
Electrical Generation	0	547	726
Agricultural Products	11	15	21
Industrial, including Petrochemicals and Petroleum Refining	25	291	426
	36	853	1173

* Cost estimates to apply control technology more efficient than that available in 1974.

APPENDIX A

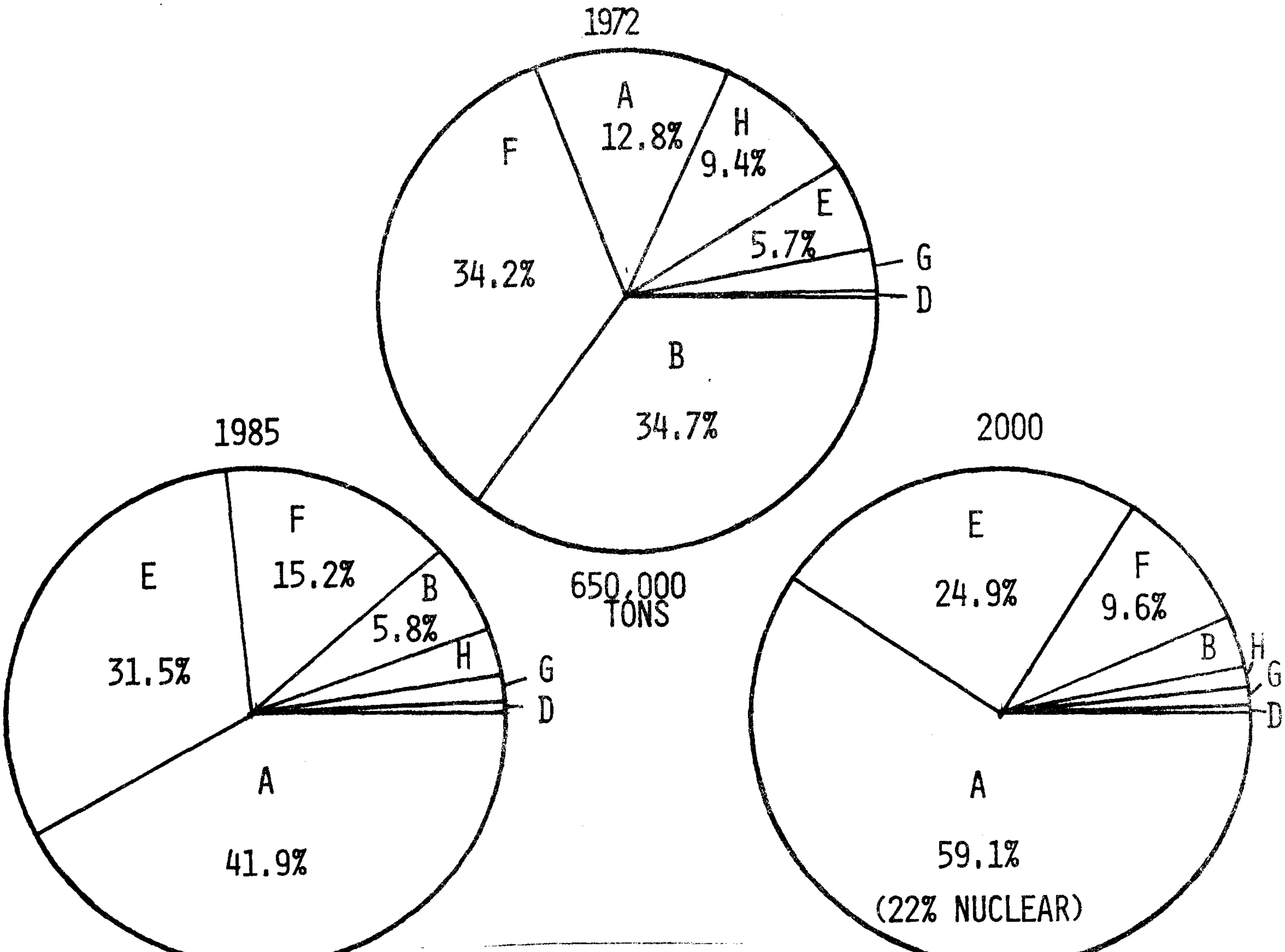
DISTRIBUTION OF AIR CONTAMINANTS

BY SOURCE CATEGORY

DISTRIBUTION OF AIR CONTAMINANTS

STATEWIDE

SULFUR DIOXIDE



2,631,000 TONS

6,910,700 TONS

A--ELECTRIC GENERATING

B--PRIMARY METALS

C--AGRICULTURE

D--CHEMICAL PULPING (KRAFT)

E--PETROCHEMICAL

F--REFINERY

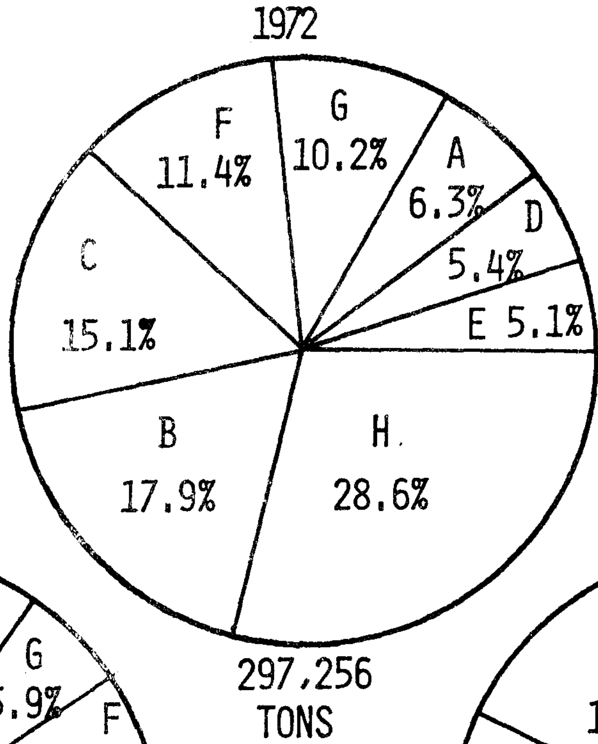
G--NON-METAL MINING

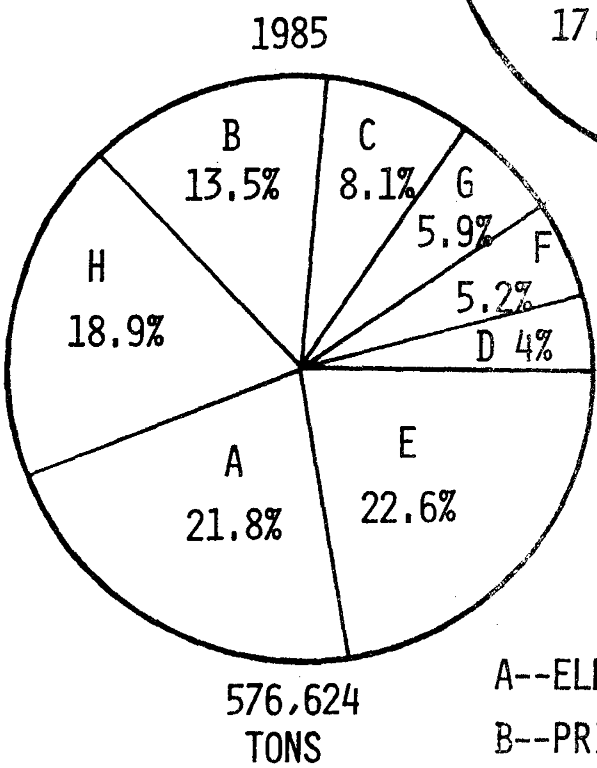
H--TRANSPORTATION

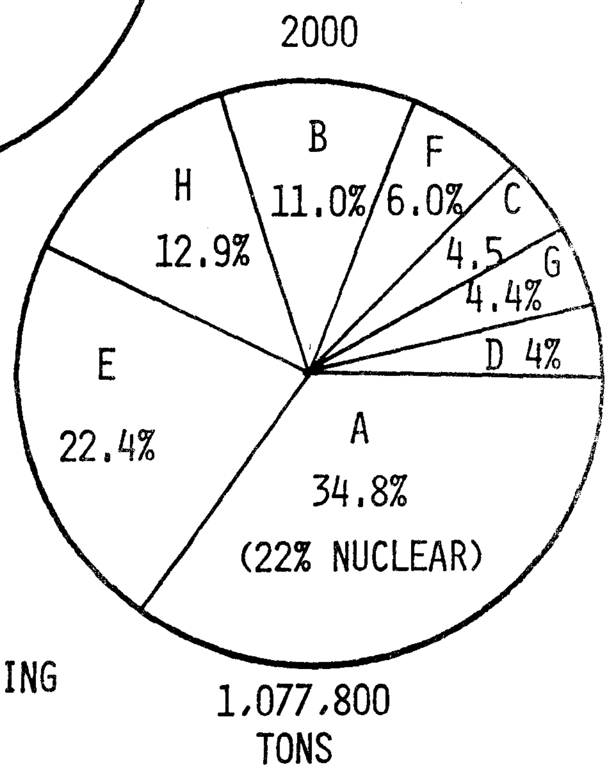
DISTRIBUTION OF AIR CONTAMINANTS

STATEWIDE

PARTICULATE







A--ELECTRIC GENERATING

B--PRIMARY METALS

C--AGRICULTURE

D--CHEMICAL PULPING (KRAFT)

E--PETROCHEMICAL

F--REFINERY

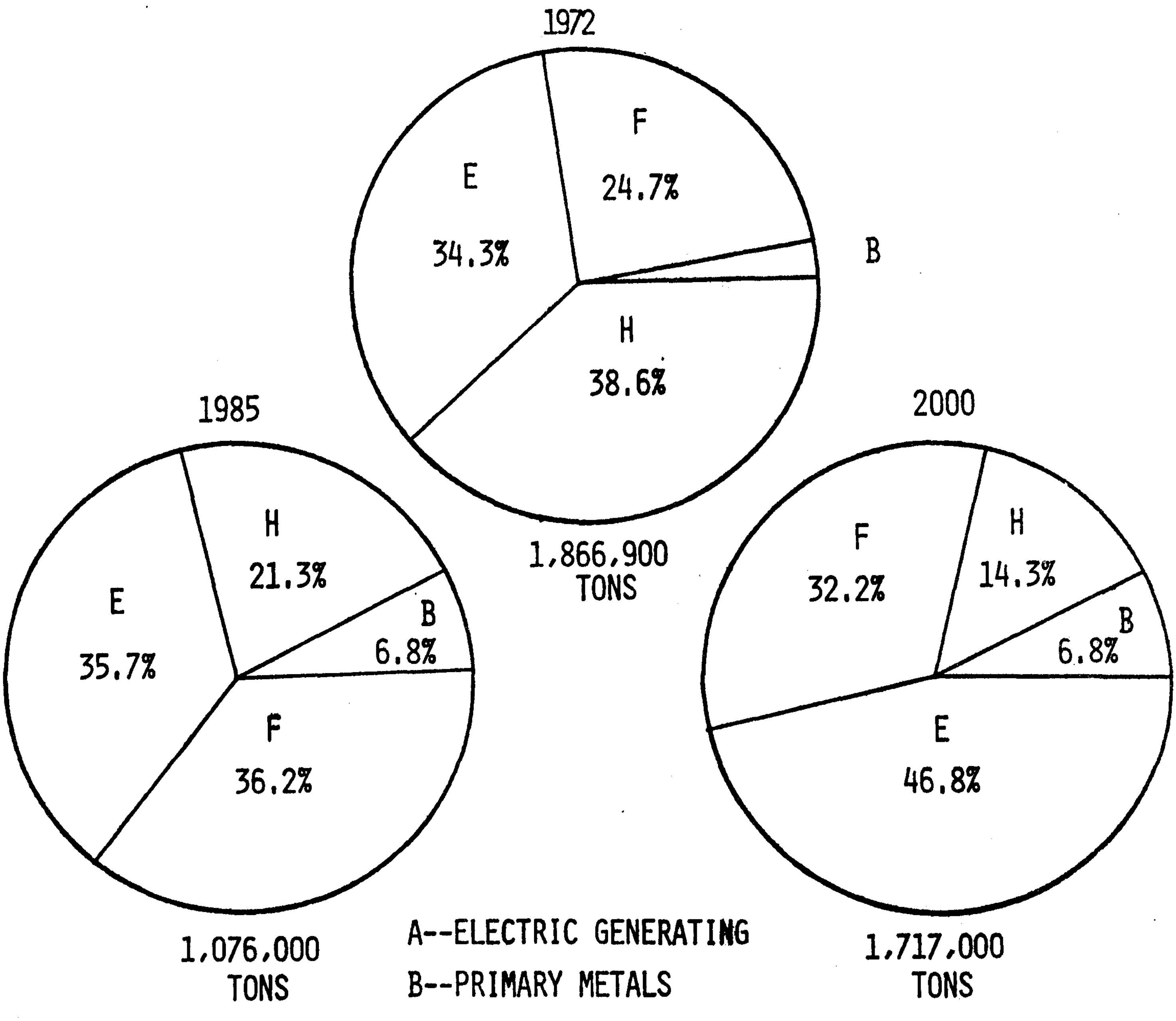
G--NON-METAL MINING

H--TRANSPORTATION

DISTRIBUTION OF AIR CONTAMINANTS

STATEWIDE

HYDROCARBON



A--ELECTRIC GENERATING

B--PRIMARY METALS

C--AGRICULTURE

D--CHEMICAL PULPING (KRAFT)

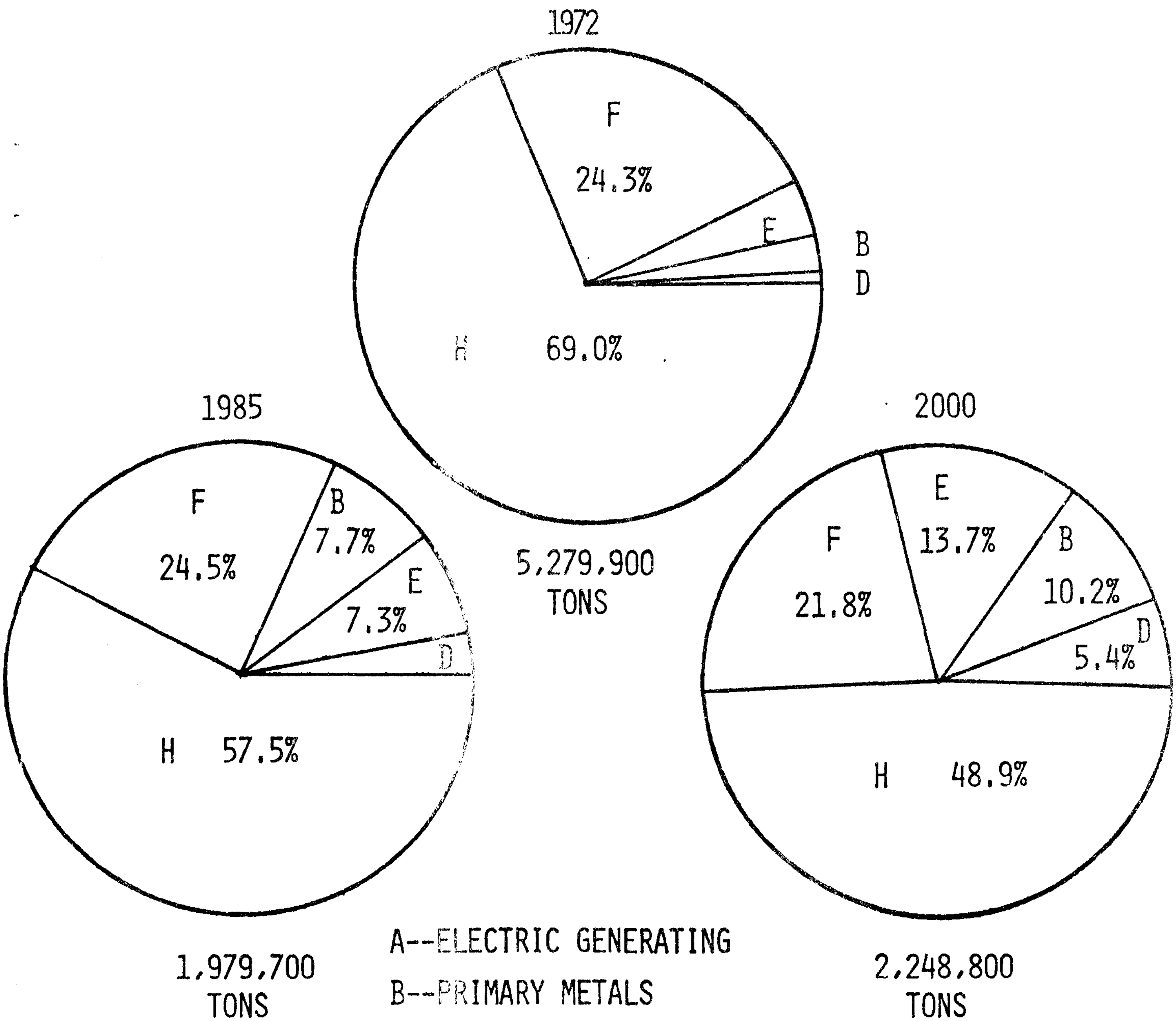
E--PETROCHEMICAL

F--REFINERY

G--NON-METAL MINING

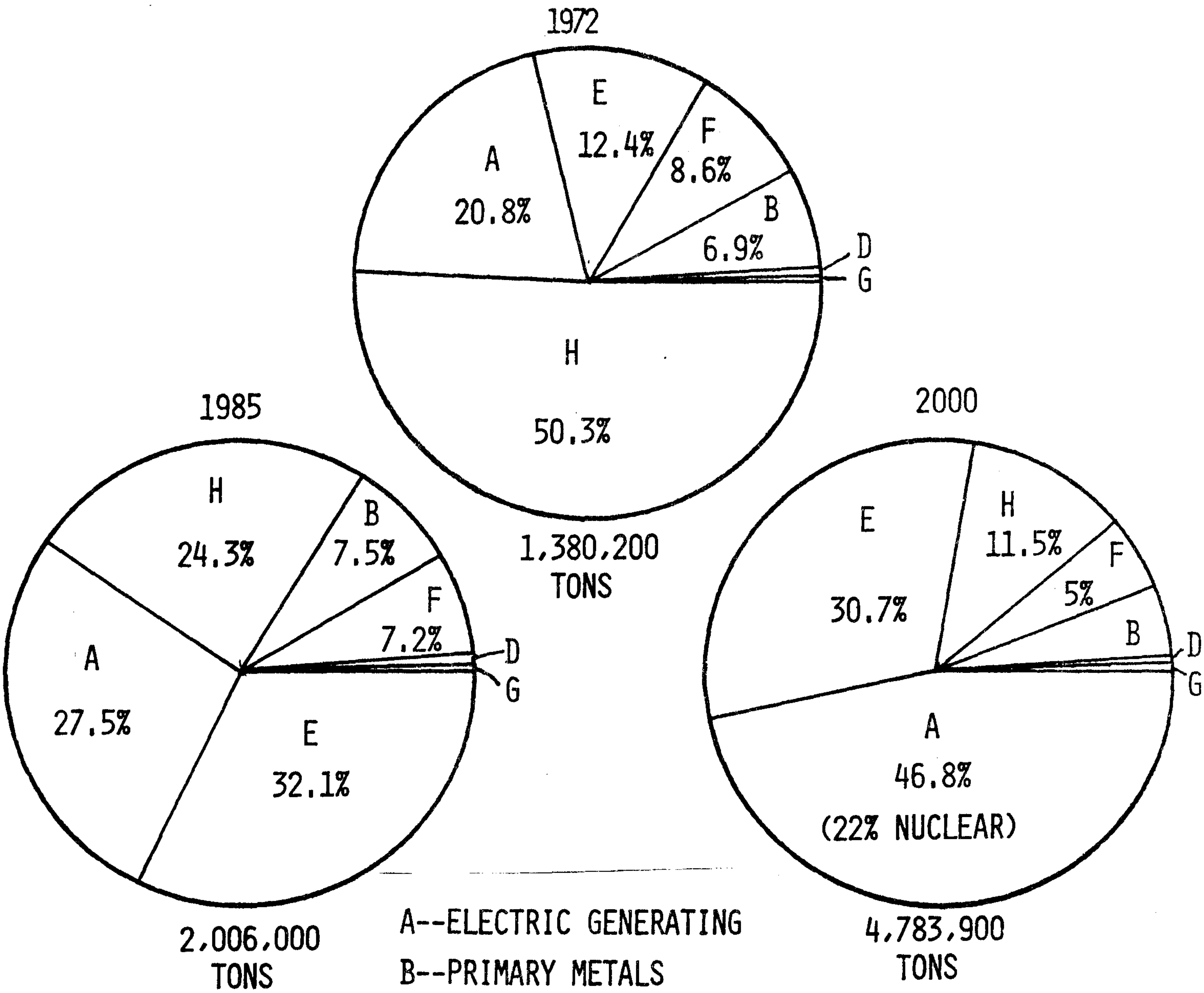
H--TRANSPORTATION

DISTRIBUTION OF AIR CONTAMINANTS
STATEWIDE
CARBON MONOXIDE



A--ELECTRIC GENERATING
B--PRIMARY METALS
C--AGRICULTURE
D--CHEMICAL PULPING (KRAFT)
E--PETROCHEMICAL
F--REFINERY
G--NON-METAL MINING
H--TRANSPORTATION

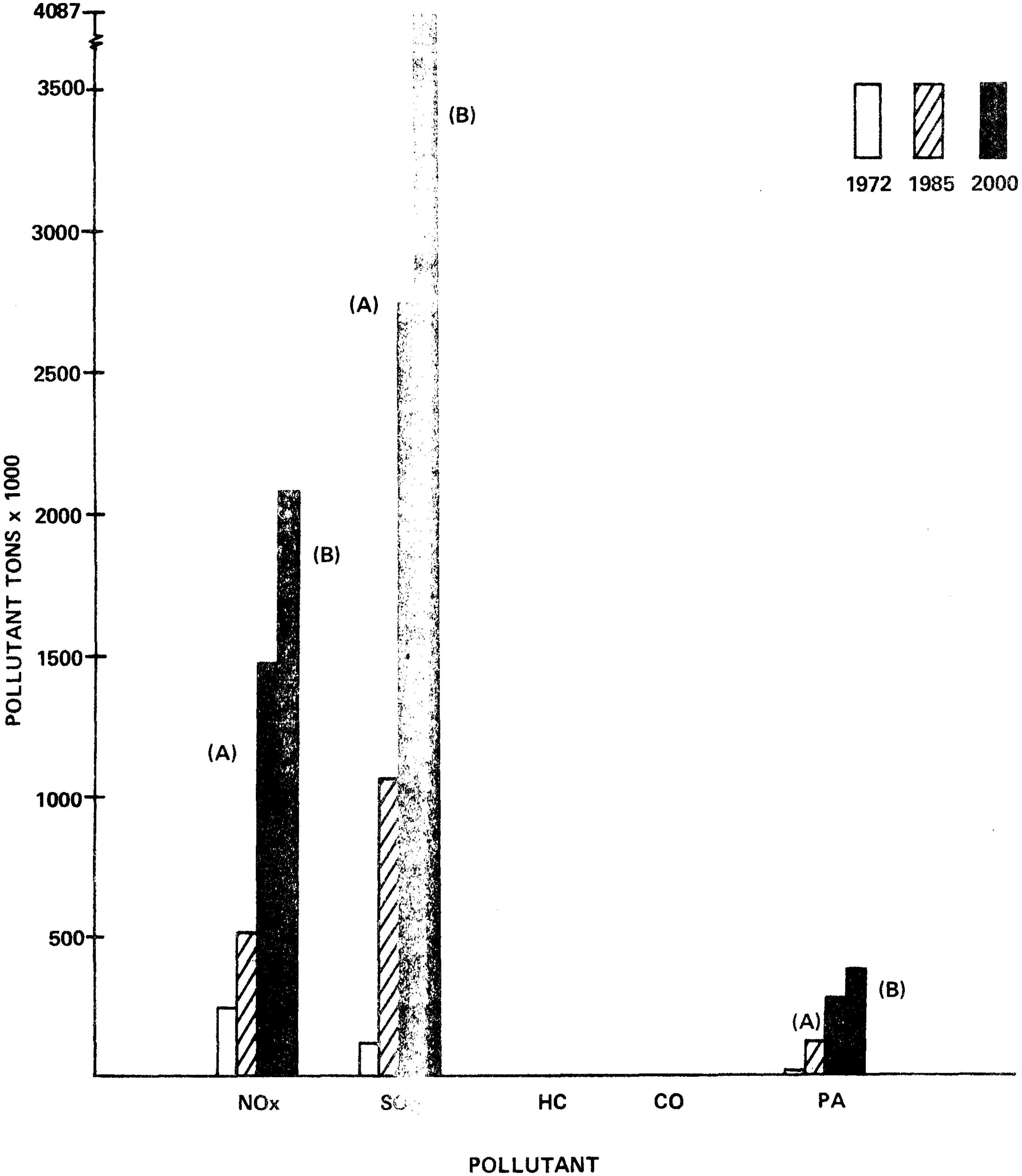
DISTRIBUTION OF AIR CONTAMINANTS
STATEWIDE
NITROGEN OXIDES



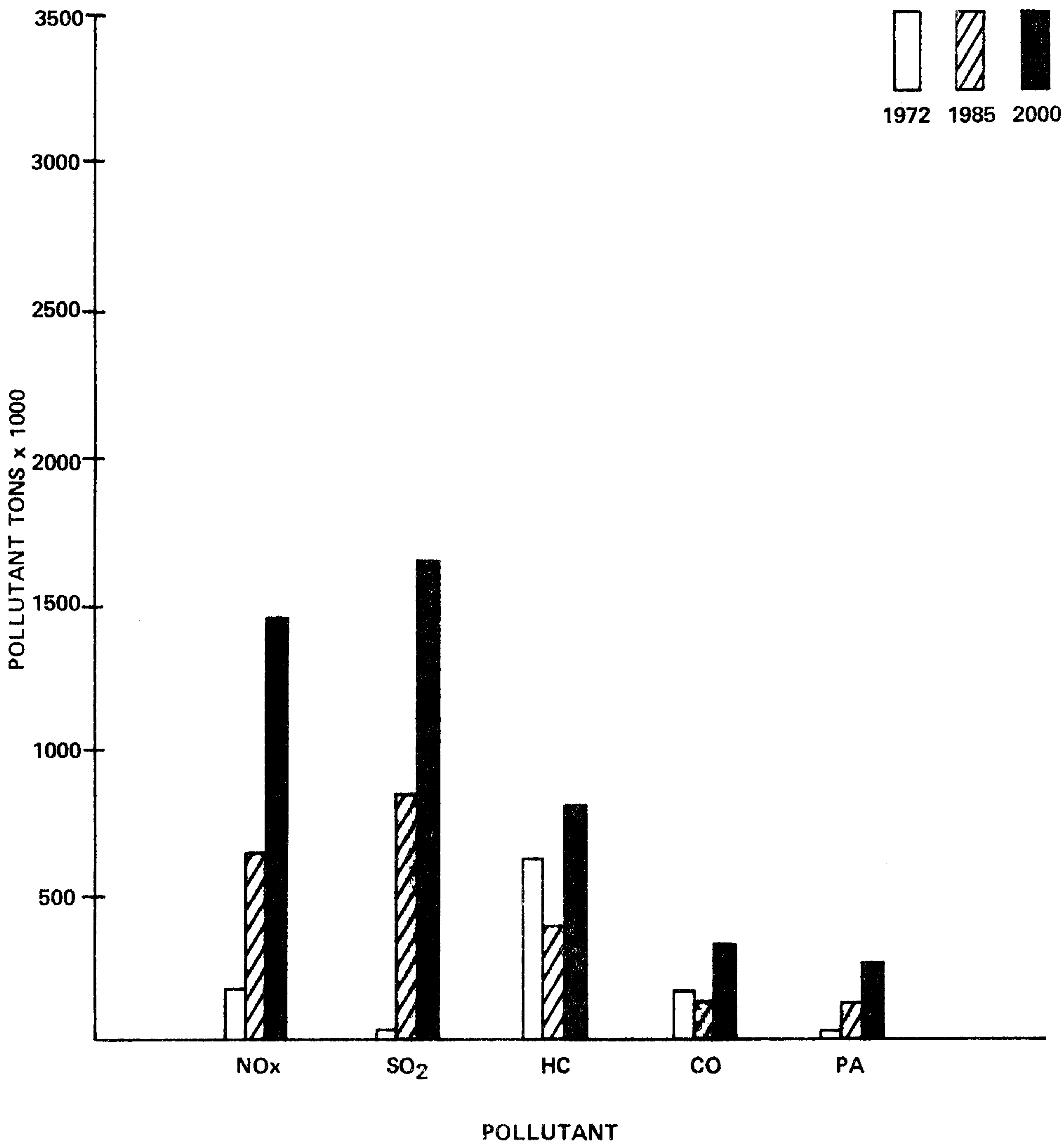
A--ELECTRIC GENERATING
B--PRIMARY METALS
C--AGRICULTURE
D--CHEMICAL PULPING (KRAFT)
E--PETROCHEMICAL
F--REFINERY
G--NON-METAL MINING
H--TRANSPORTATION

POWER PLANT

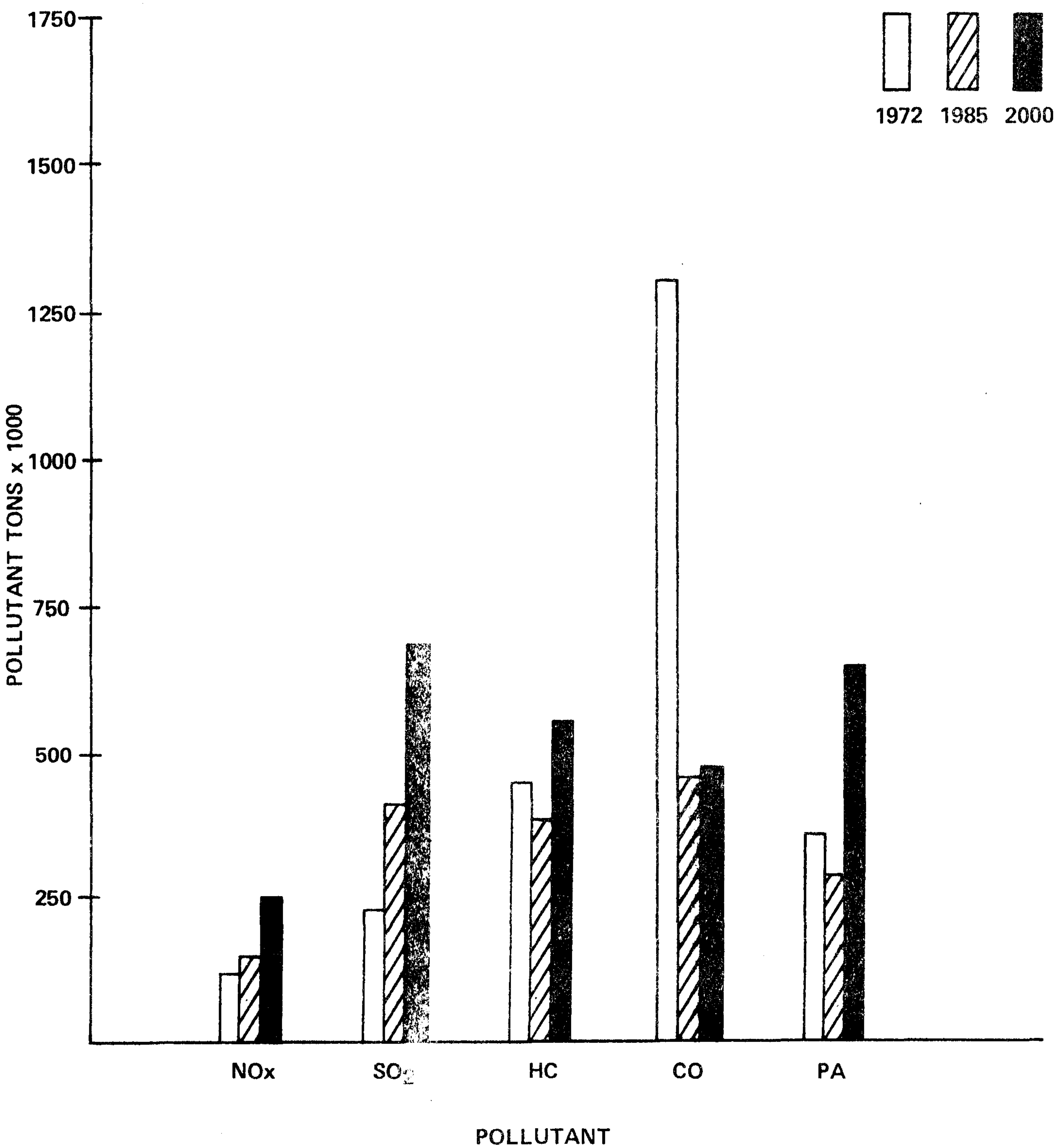
STATEWIDE POLLUTANT TOTALS



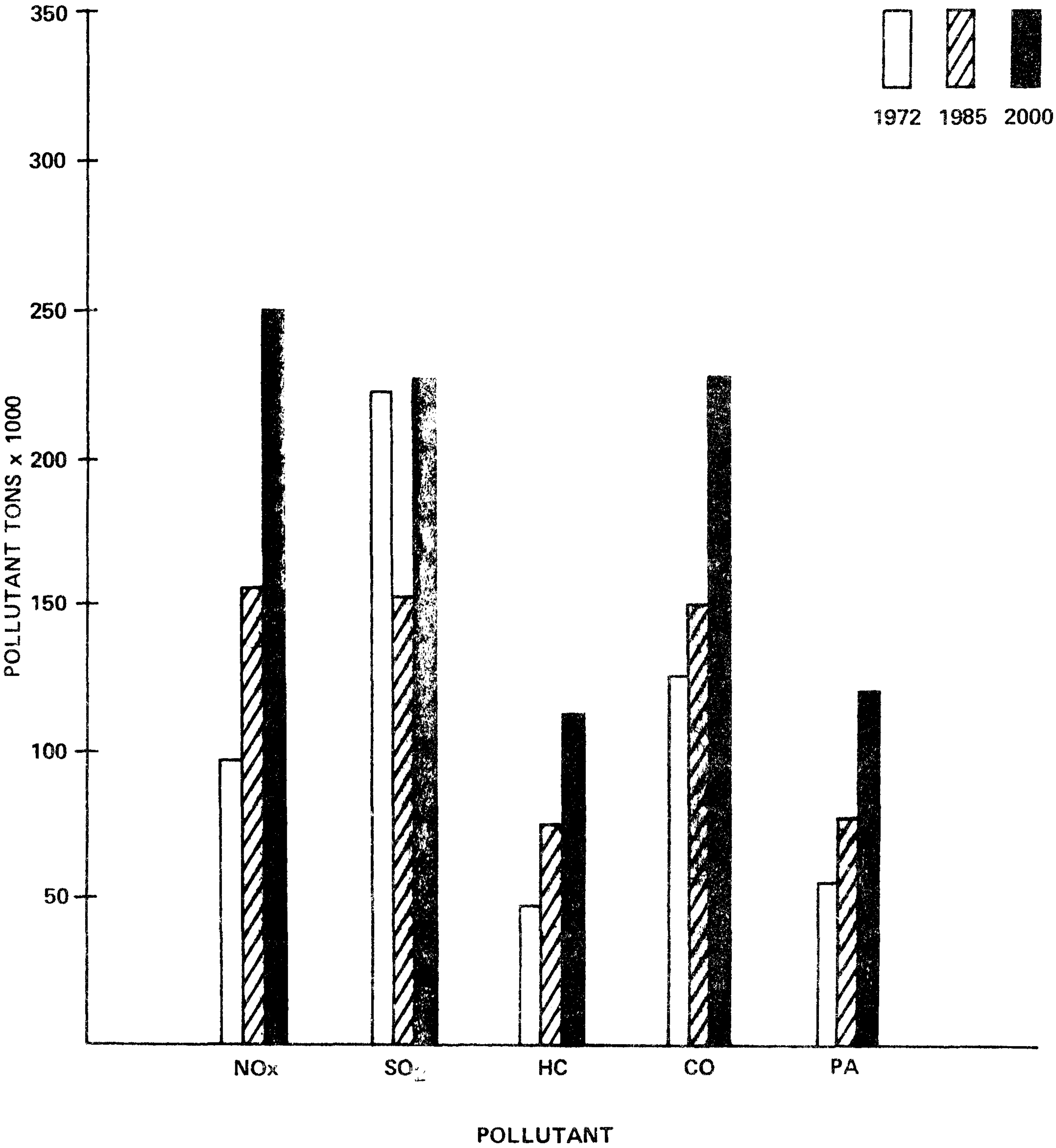
PETROCHEMICAL INDUSTRY
STATEWIDE POLLUTANT TOTALS



PETROLEUM REFINERIES
STATEWIDE POLLUTANT TOTALS

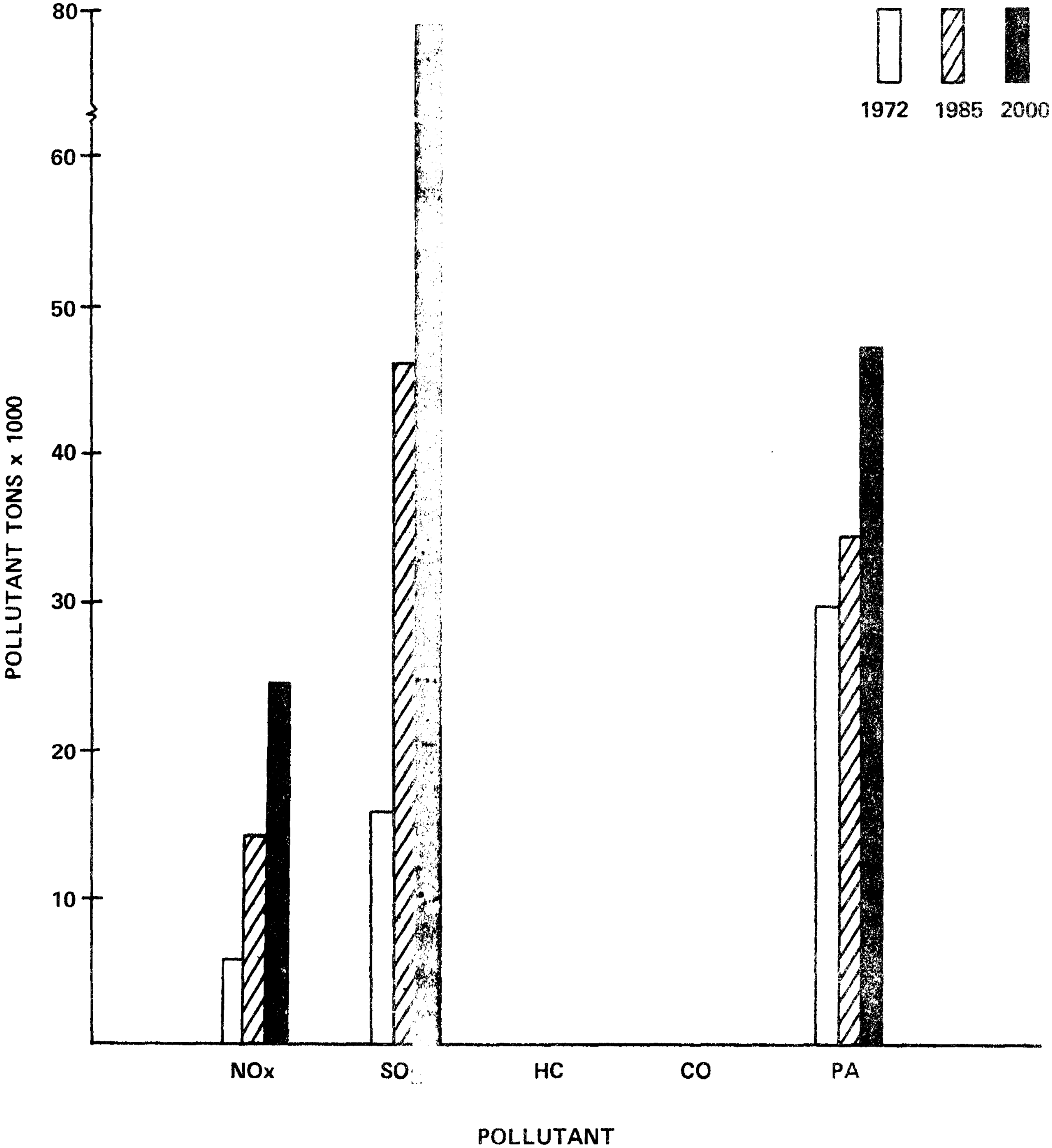


PRIMARY METALS INDUSTRY
STATEWIDE POLLUTANT TOTALS



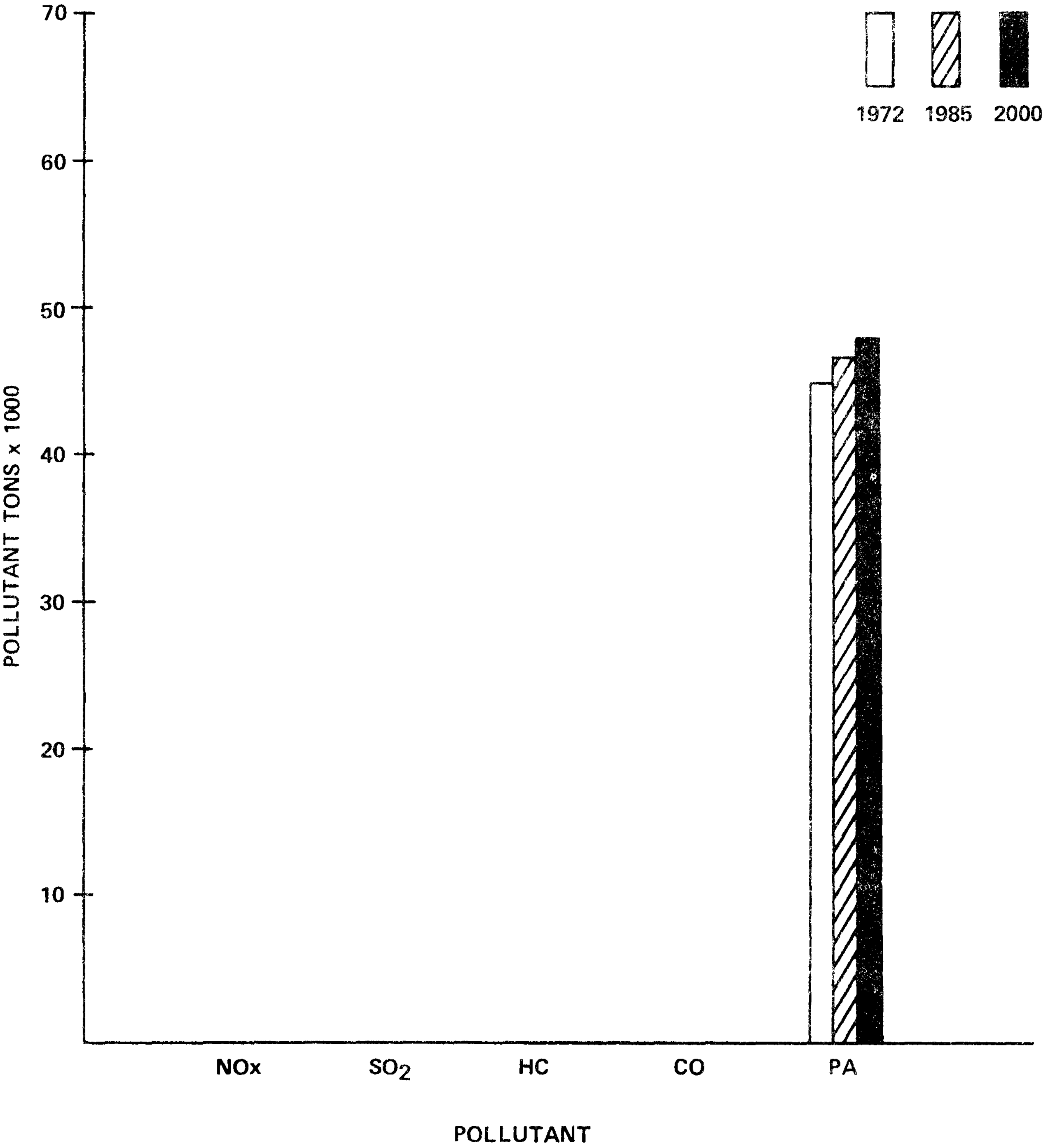
NON-METAL MINING INDUSTRY

STATEWIDE POLLUTANT TOTALS

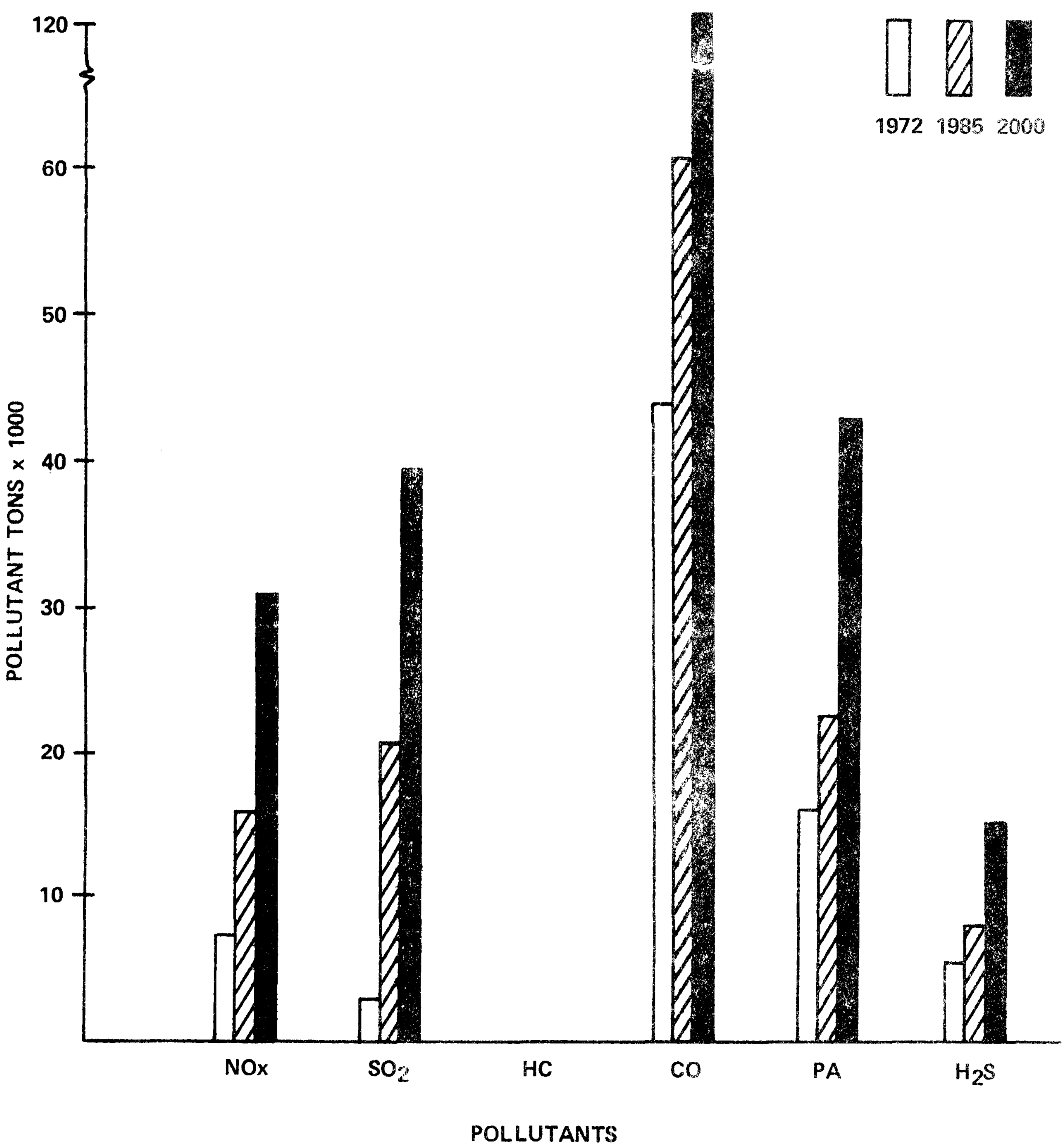


AGRICULTURAL PROCESSES

STATEWIDE POLLUTANT TOTALS

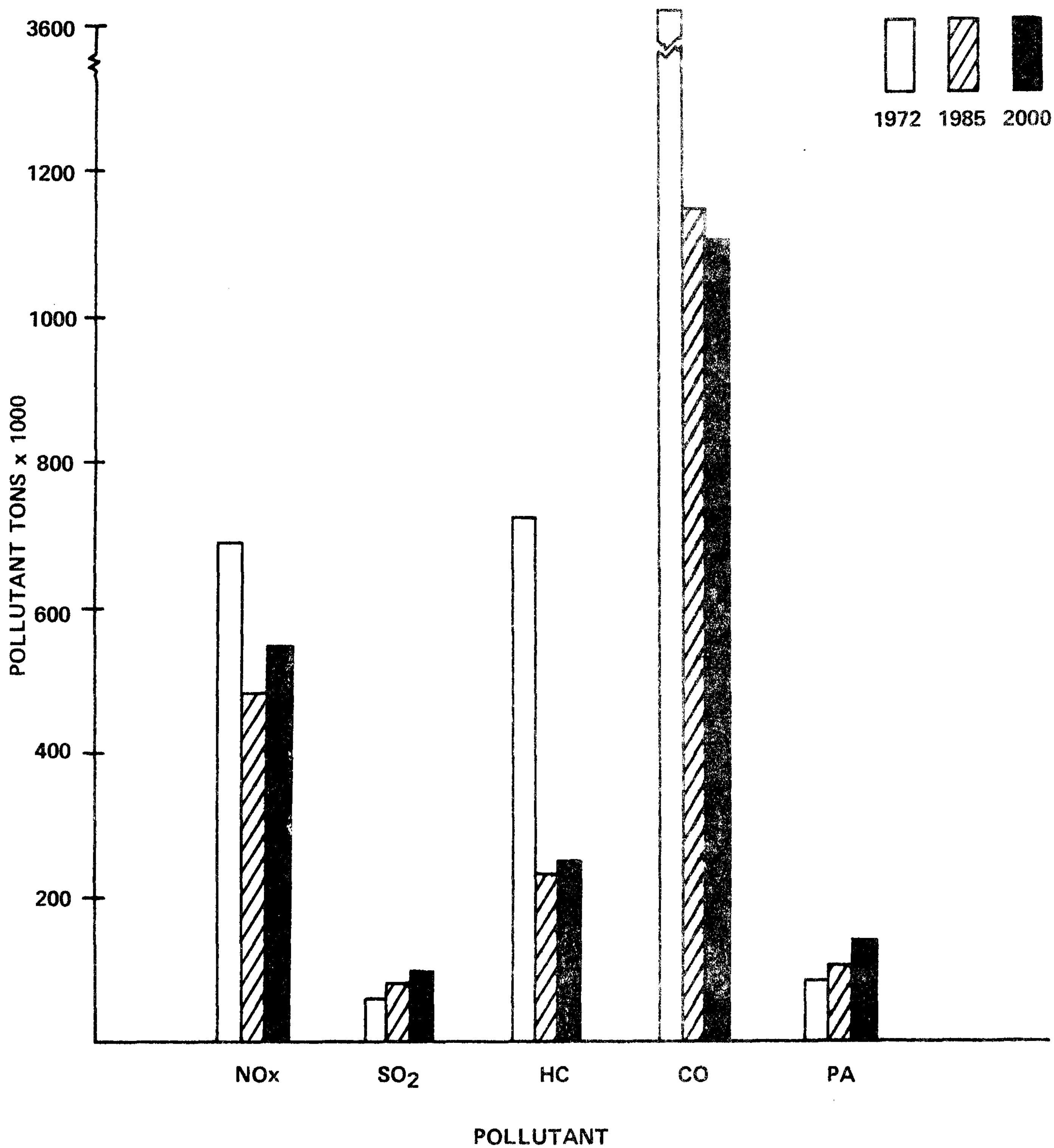


CHEMICAL PULPING (KRAFT)
STATEWIDE POLLUTANT TOTALS



TRANSPORTATION SOURCES

STATEWIDE POLLUTANT TOTALS

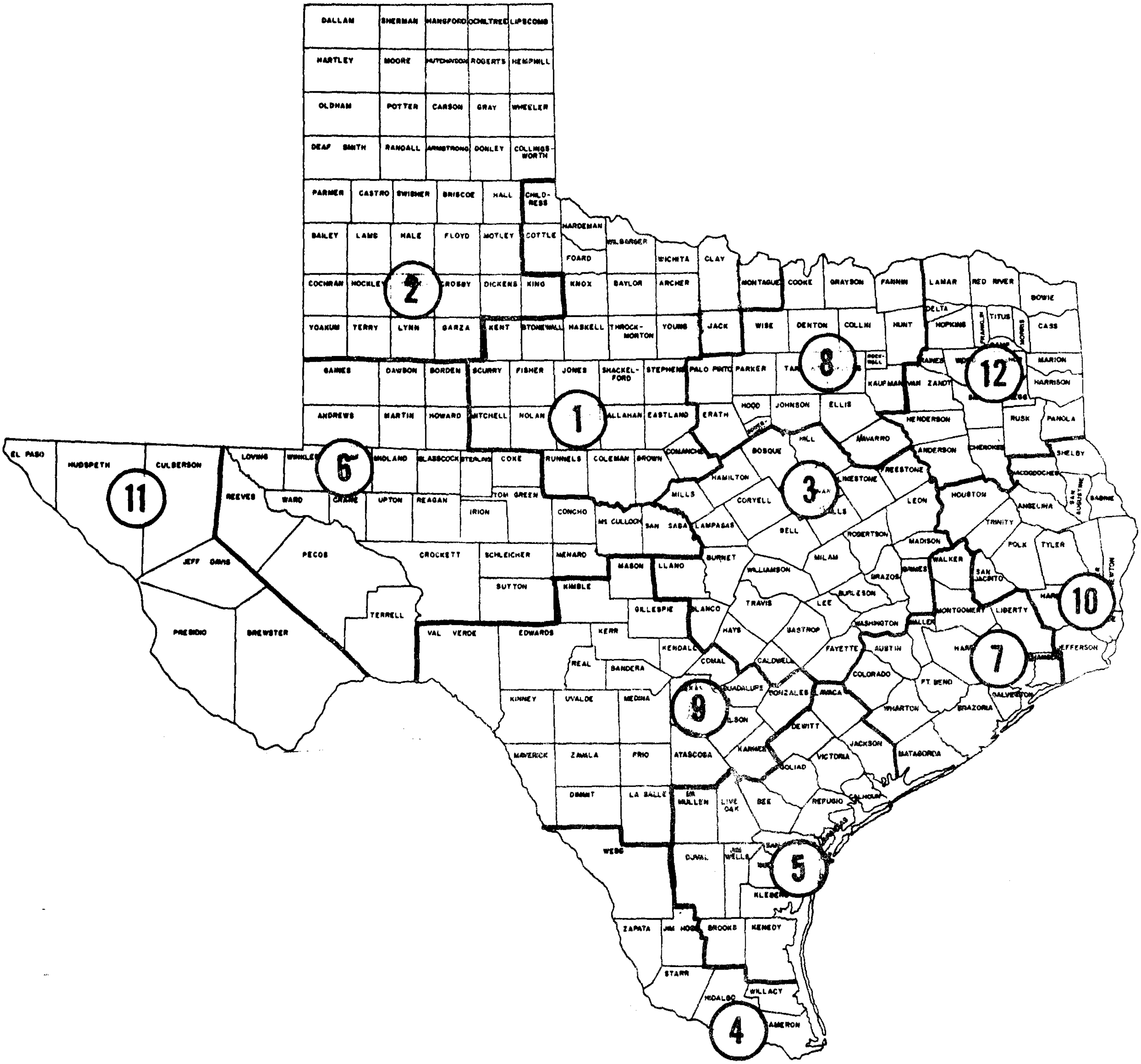


APPENDIX B

REGIONAL DISTRIBUTION OF AIR CONTAMINANT EMISSIONS

TEXAS AIR CONTROL BOARD

REGIONAL OFFICES



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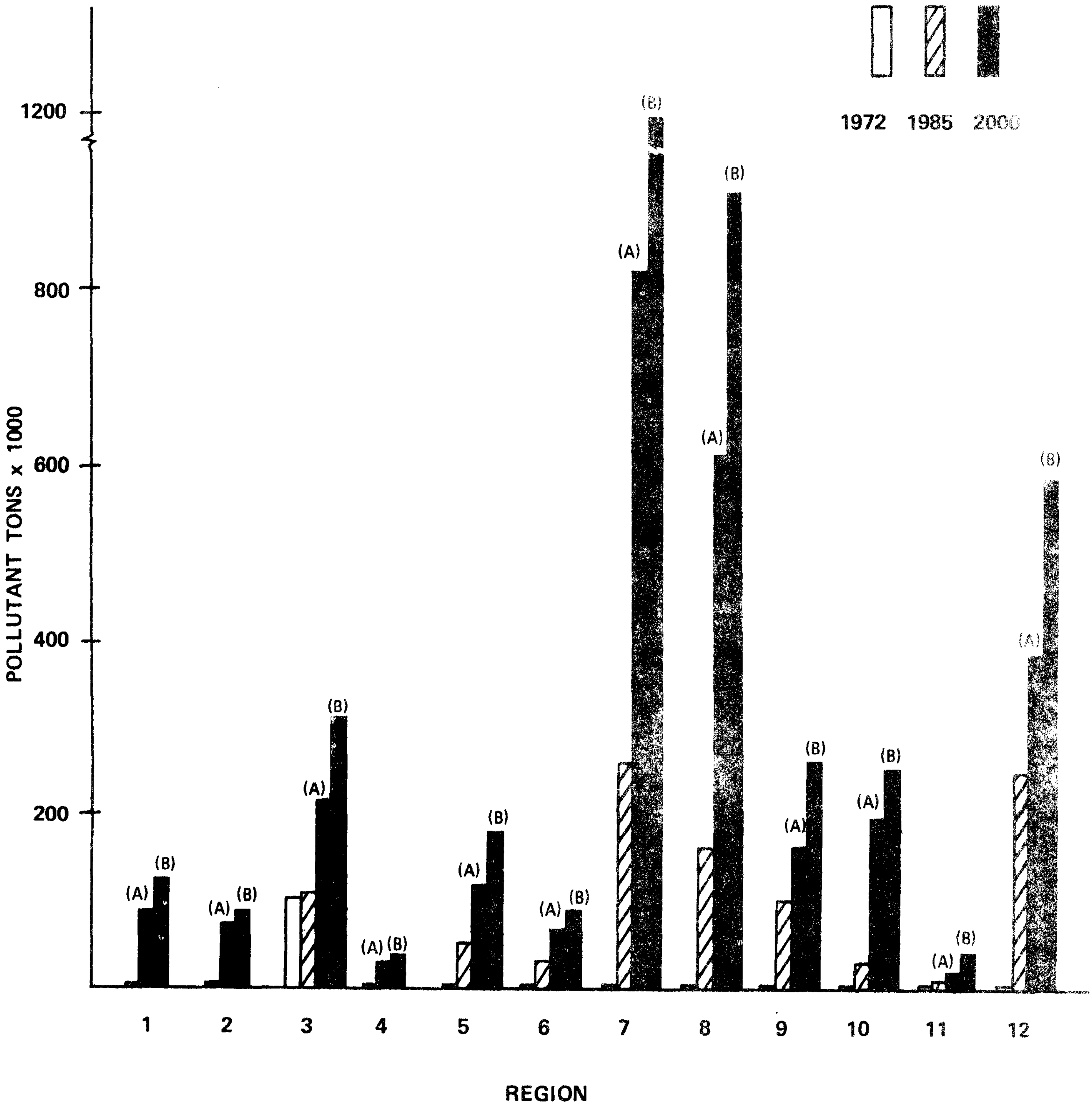
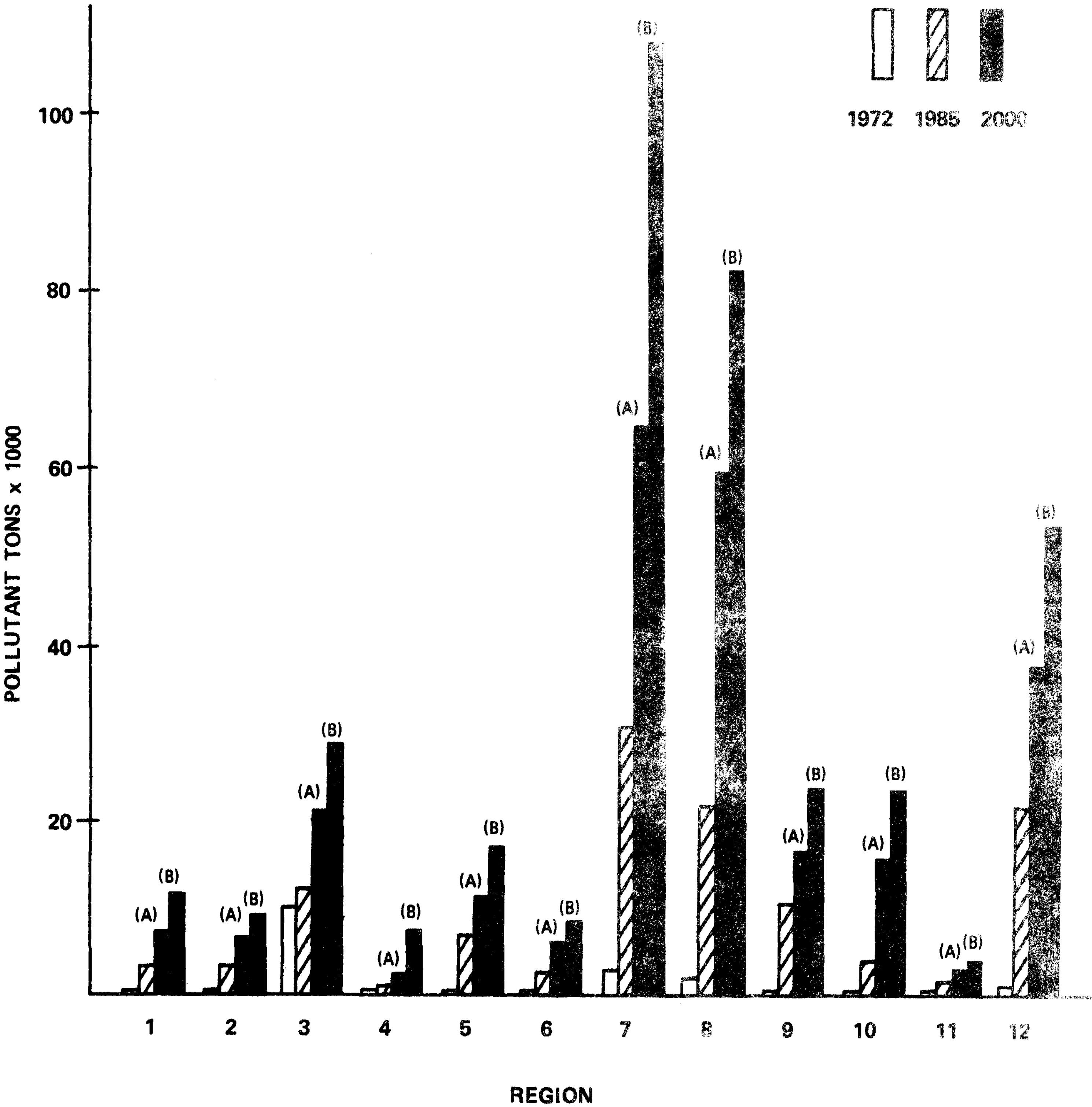
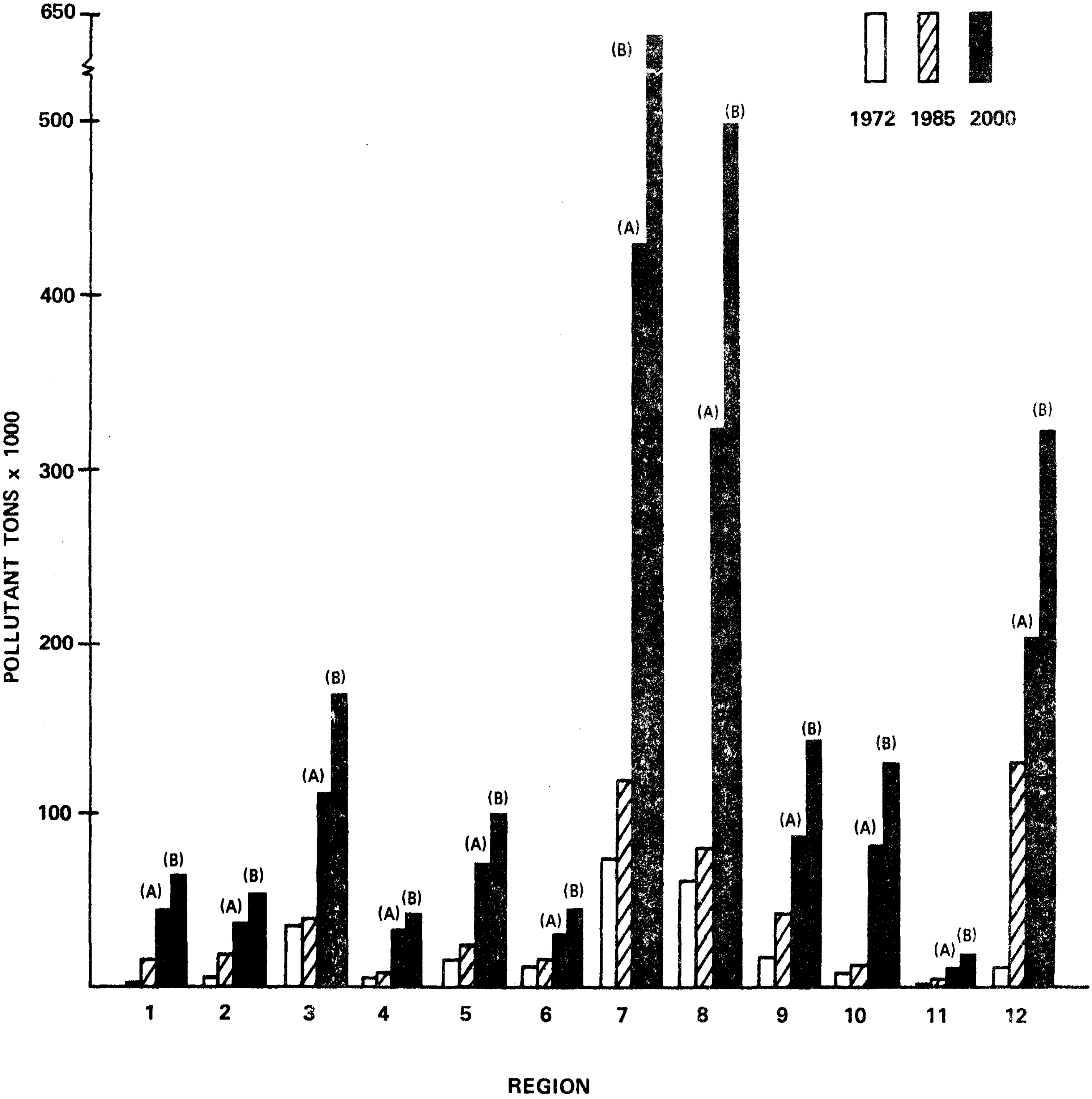
POWER PLANT
SO_2
REGIONAL POLLUTANT TOTALS



POWER PLANT
PARTICULATE
REGIONAL POLLUTANT TOTALS



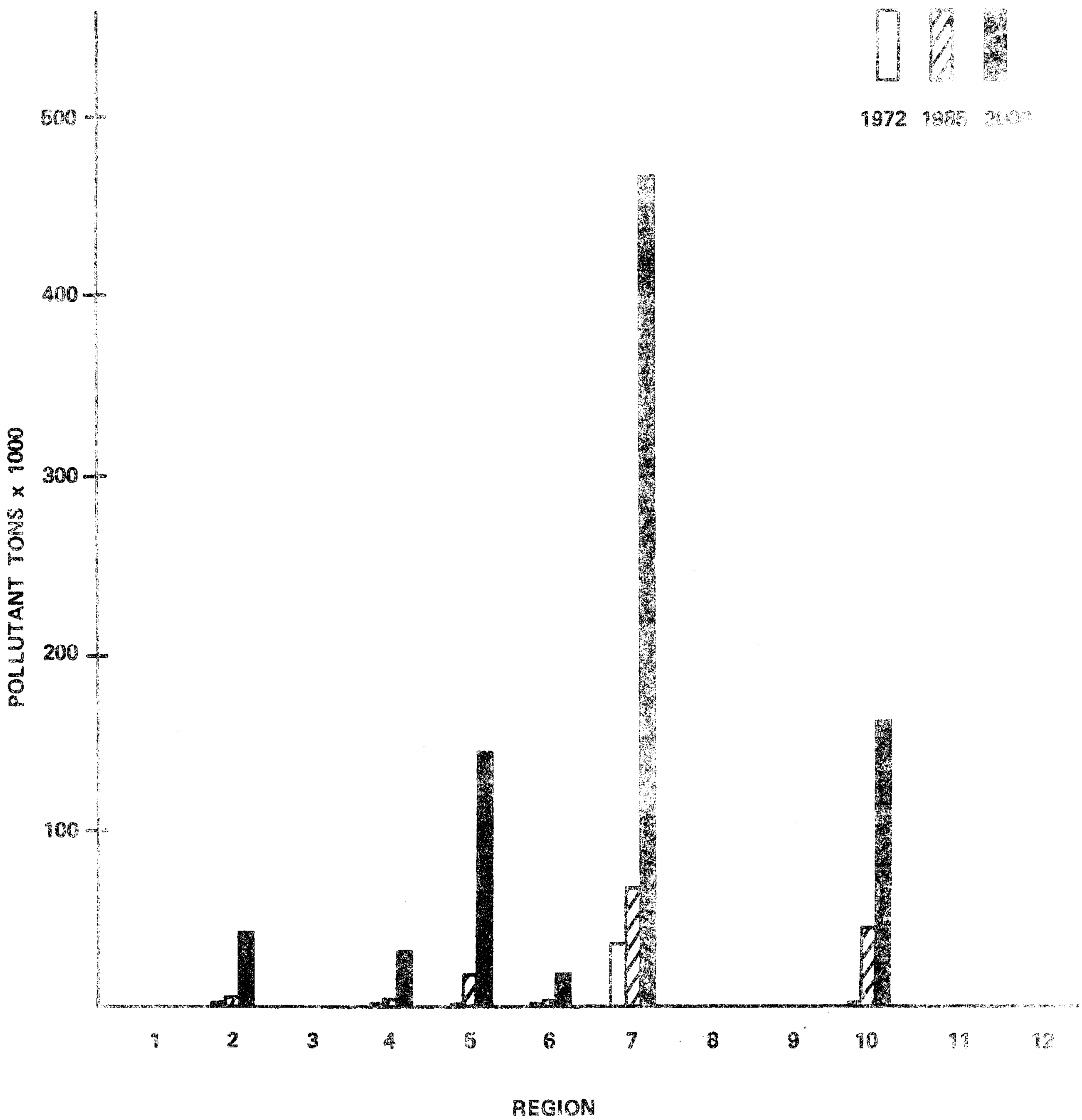
POWER PLANT
NOx
REGIONAL POLLUTANT TOTALS



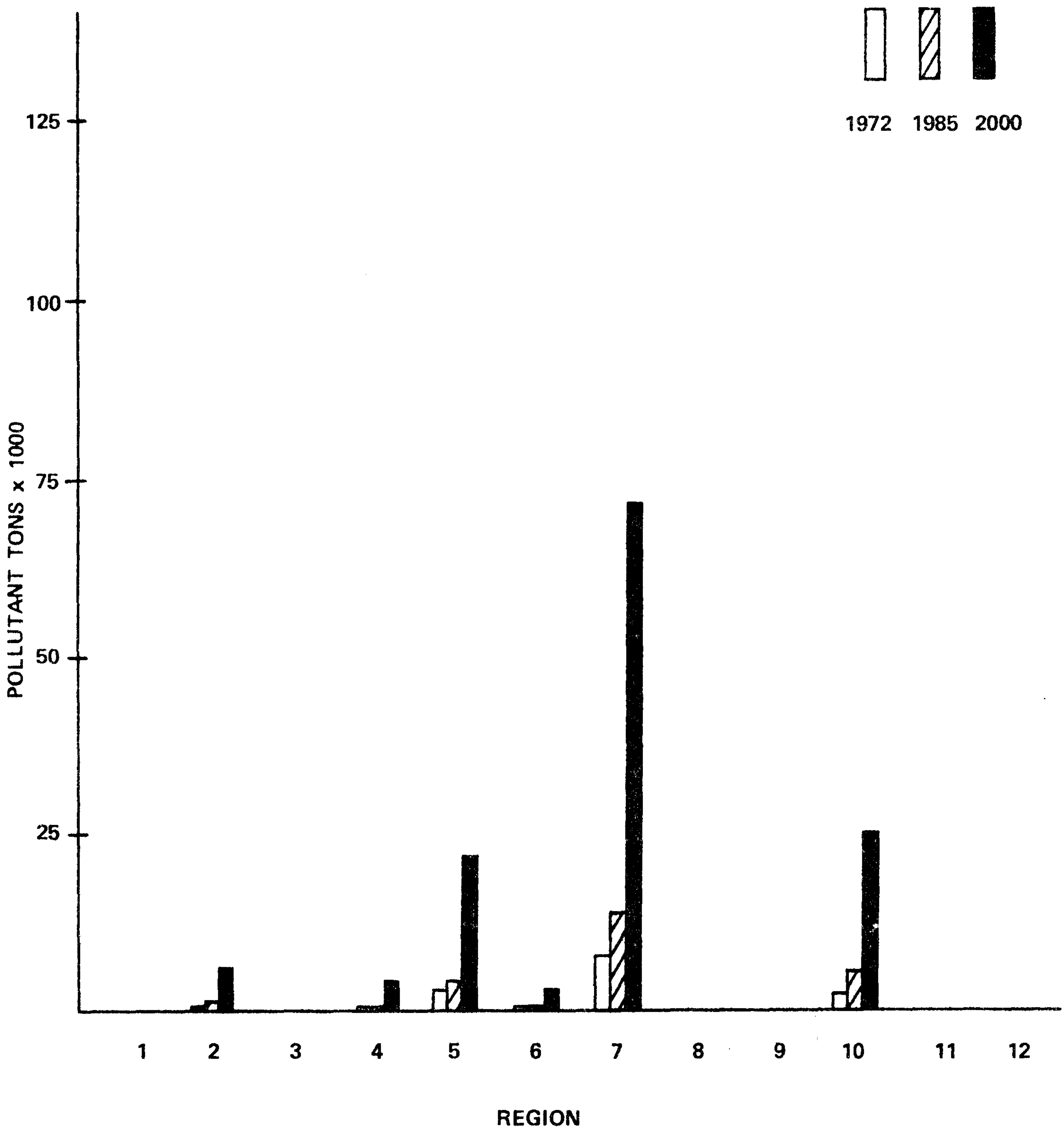
PETROCHEMICAL INDUSTRY

SO_2

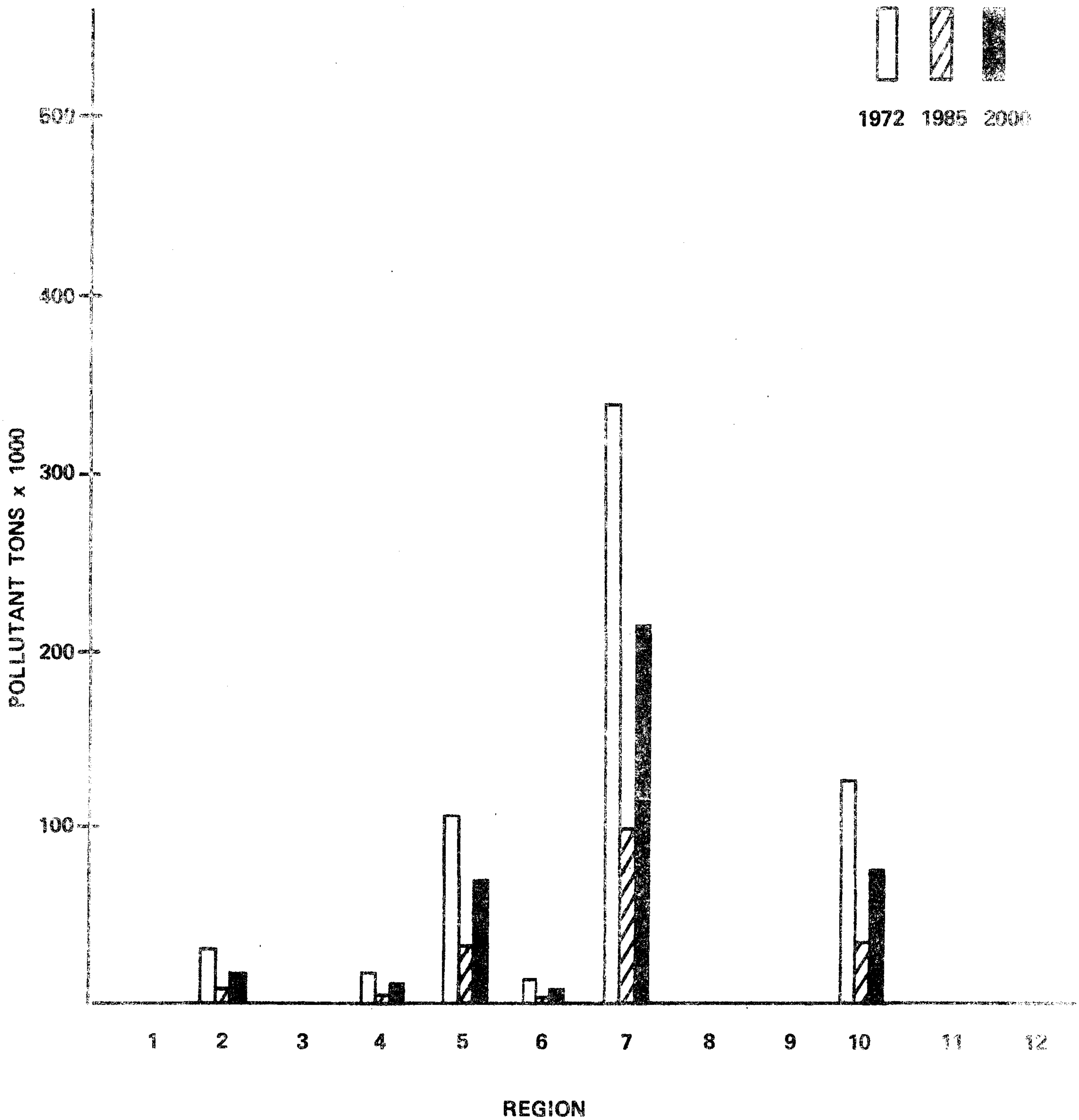
REGIONAL POLLUTANT TOTALS



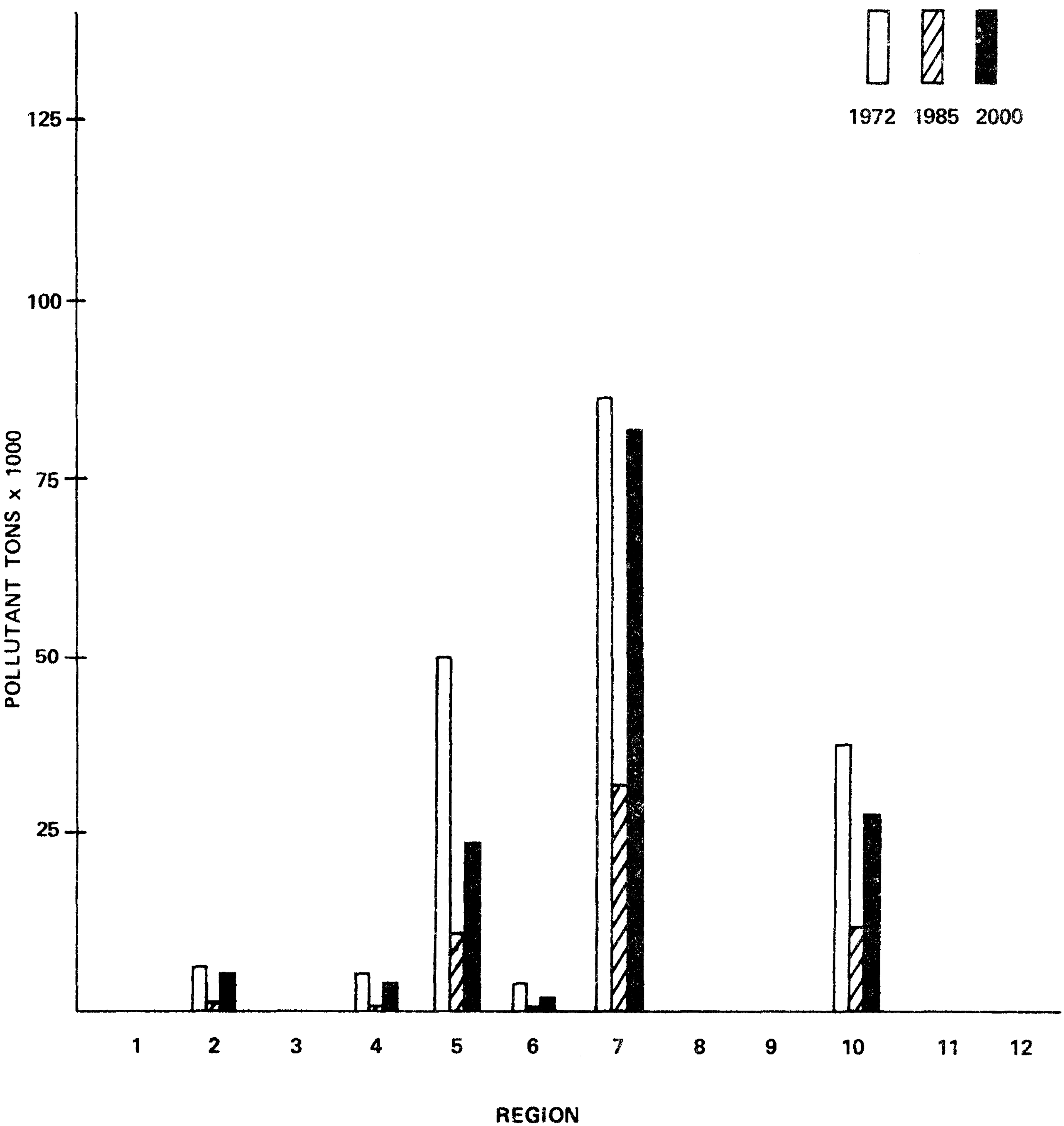
PETROCHEMICAL INDUSTRY
PARTICULATE
REGIONAL POLLUTANT TOTALS



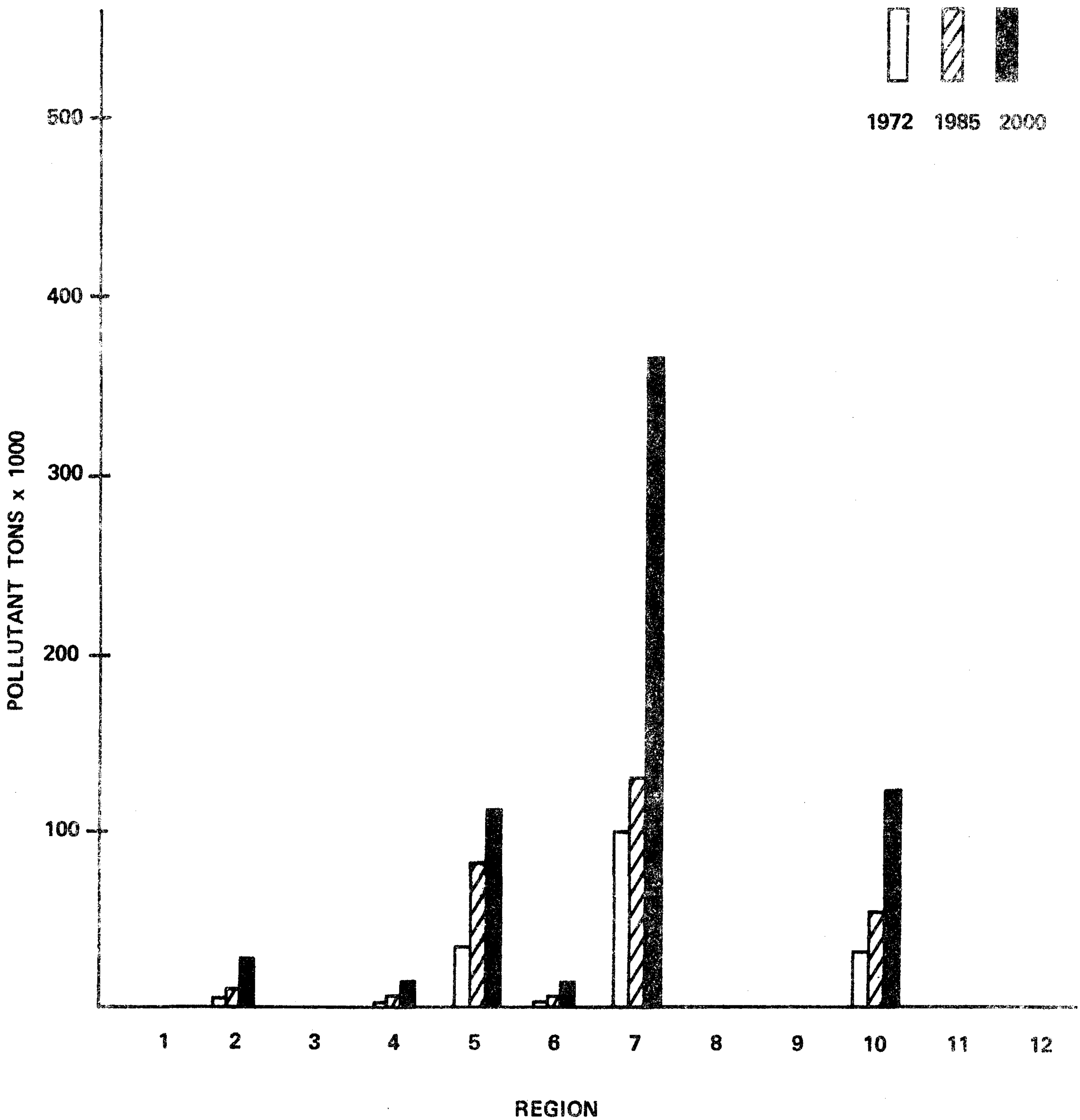
PETROCHEMICAL INDUSTRY
HC
REGIONAL POLLUTANT TOTALS



PETROCHEMICAL INDUSTRY
CO
REGIONAL POLLUTANT TOTALS



PETROCHEMICAL INDUSTRY
NOx
REGIONAL POLLUTANT TOTALS



PETROLEUM REFINERIES
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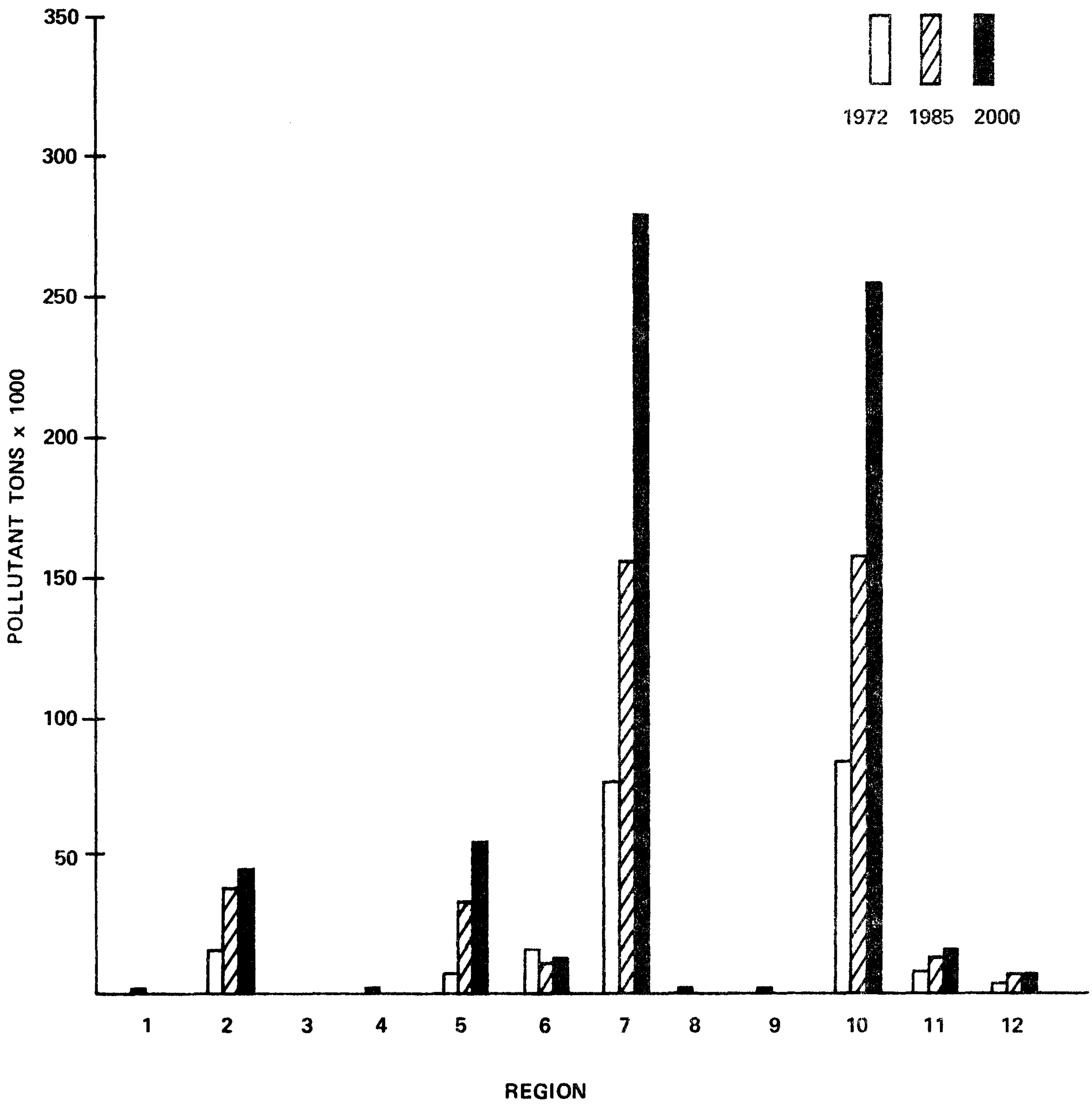
REGIONAL POLLUTANT TOTALS



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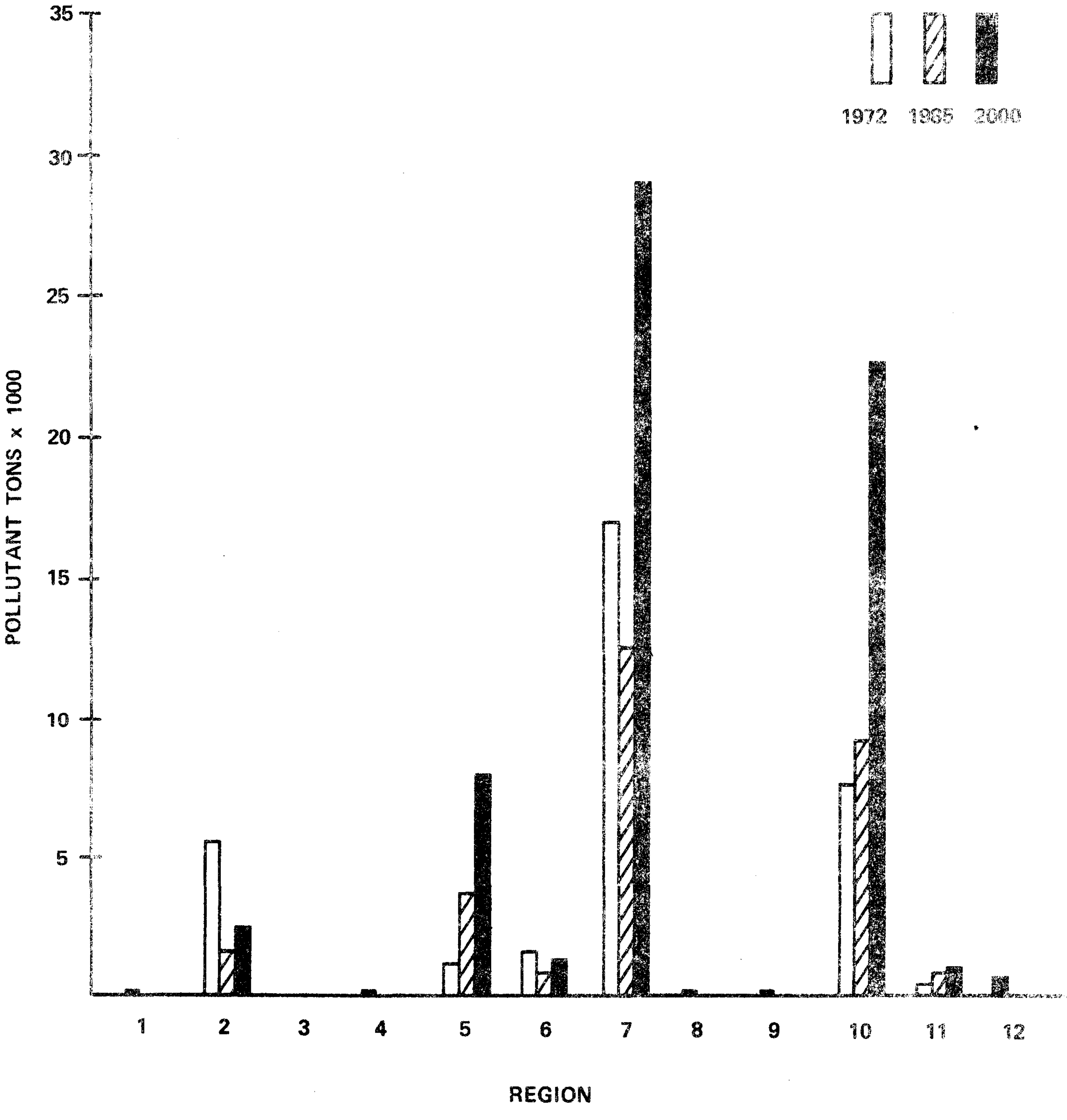
REGIONAL POLLUTANT TOTALS



PETROLEUM REFINERIES
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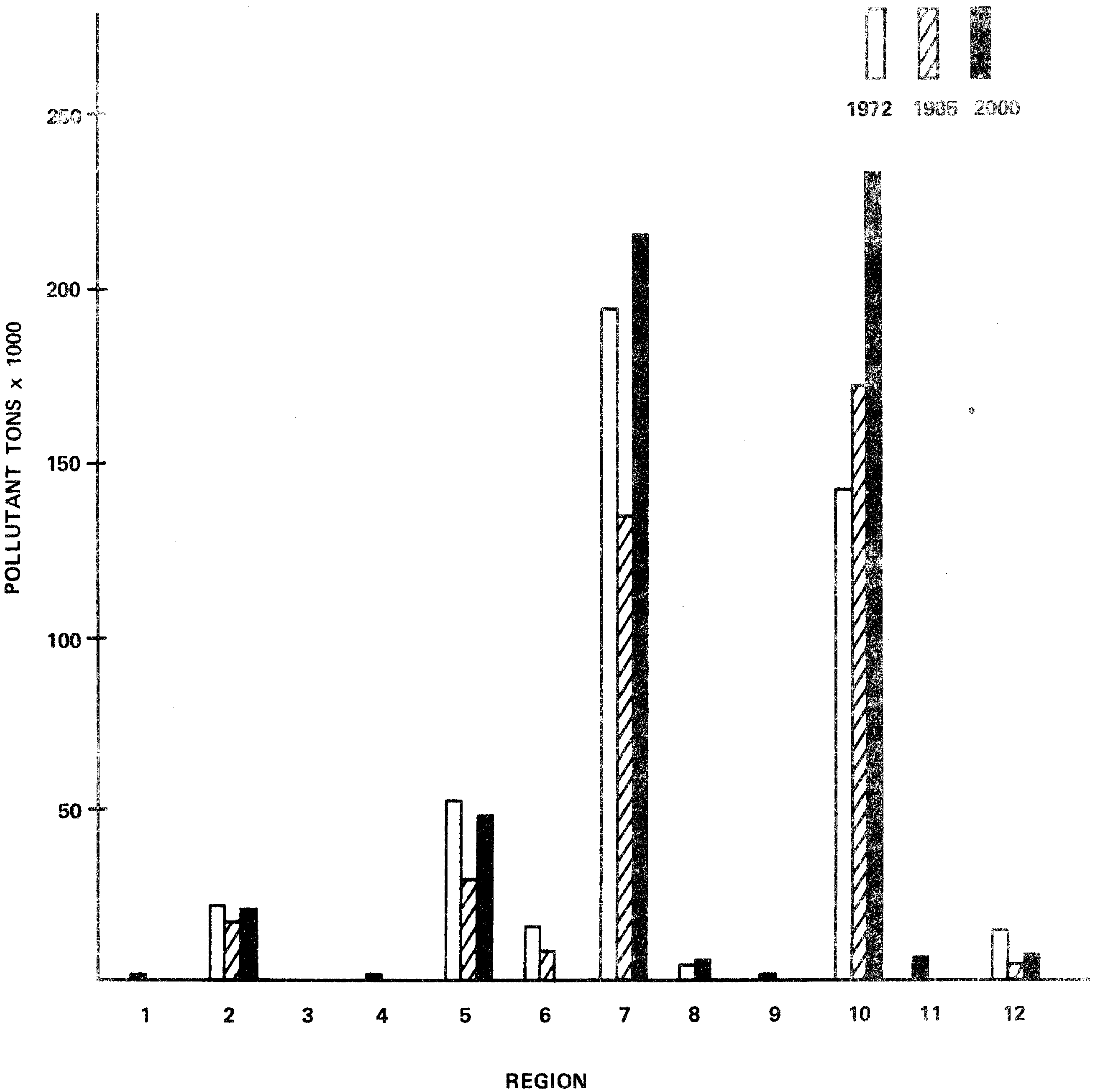
REGIONAL POLLUTANT TOTALS



PETROLEUM REFINERIES
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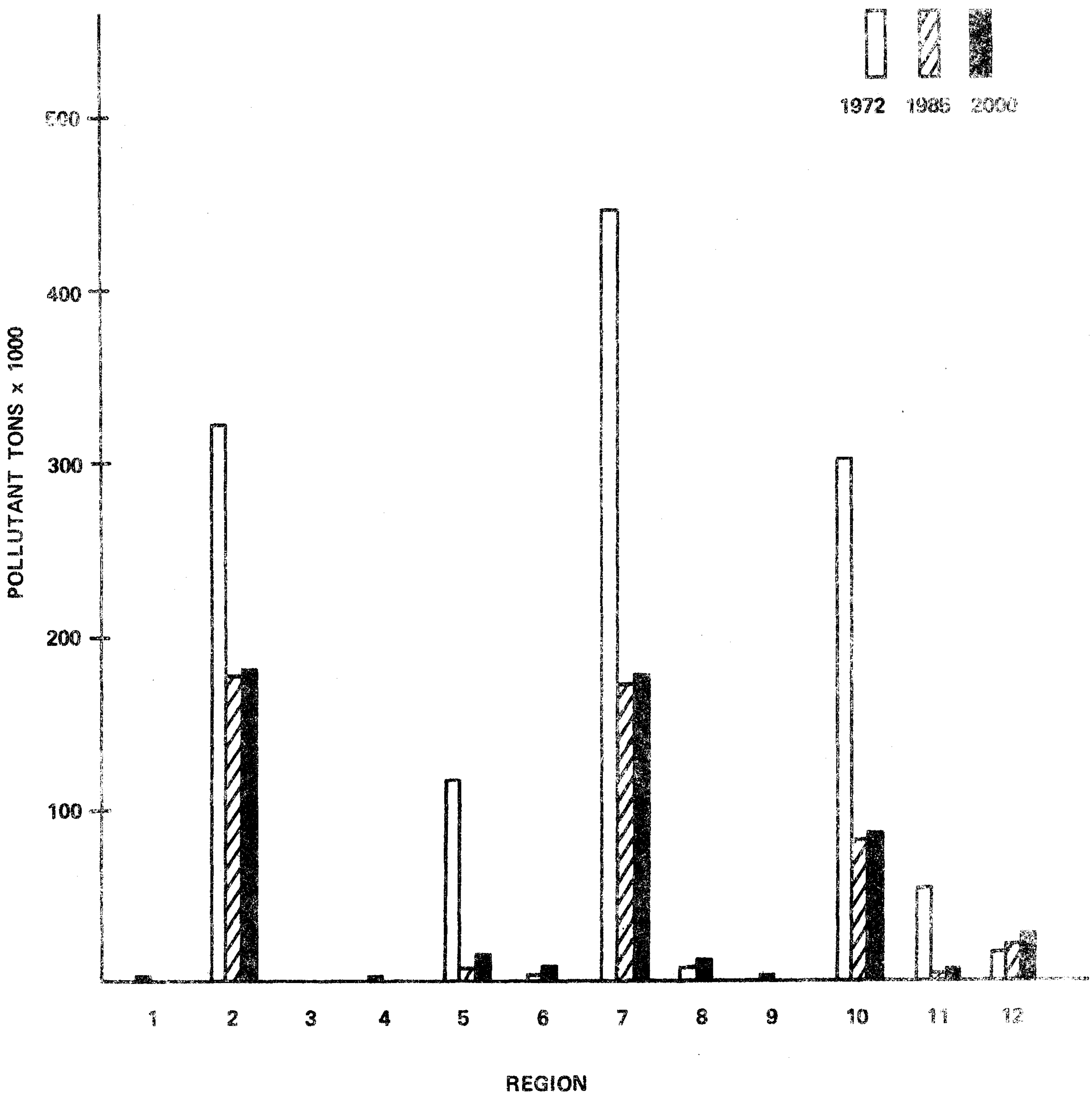
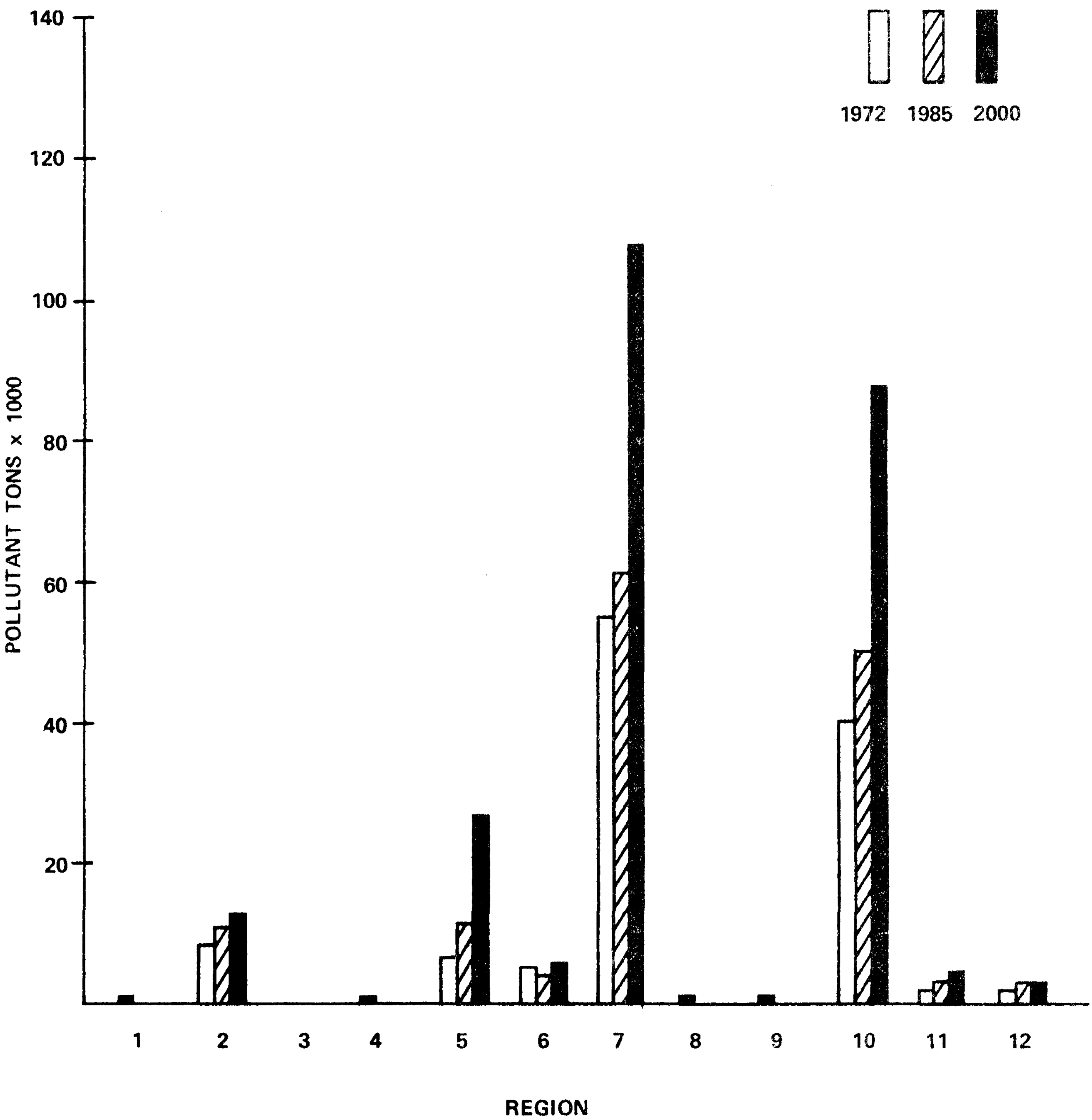
REGIONAL POLLUTANT TOTALS



PETROLEUM REFINERIES
NOx
REGIONAL POLLUTANT TOTALS



PRIMARY METALS INDUSTRY
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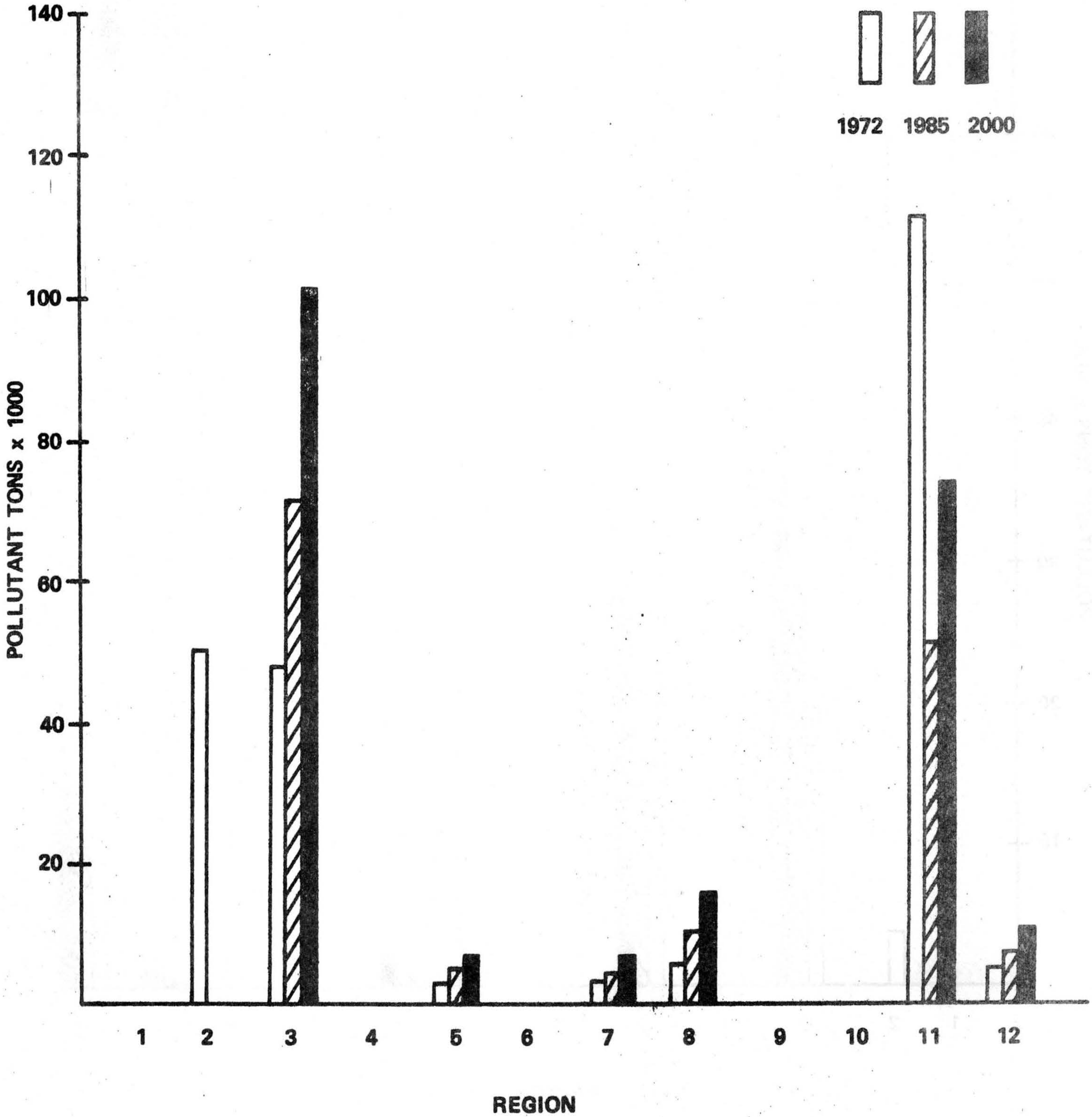

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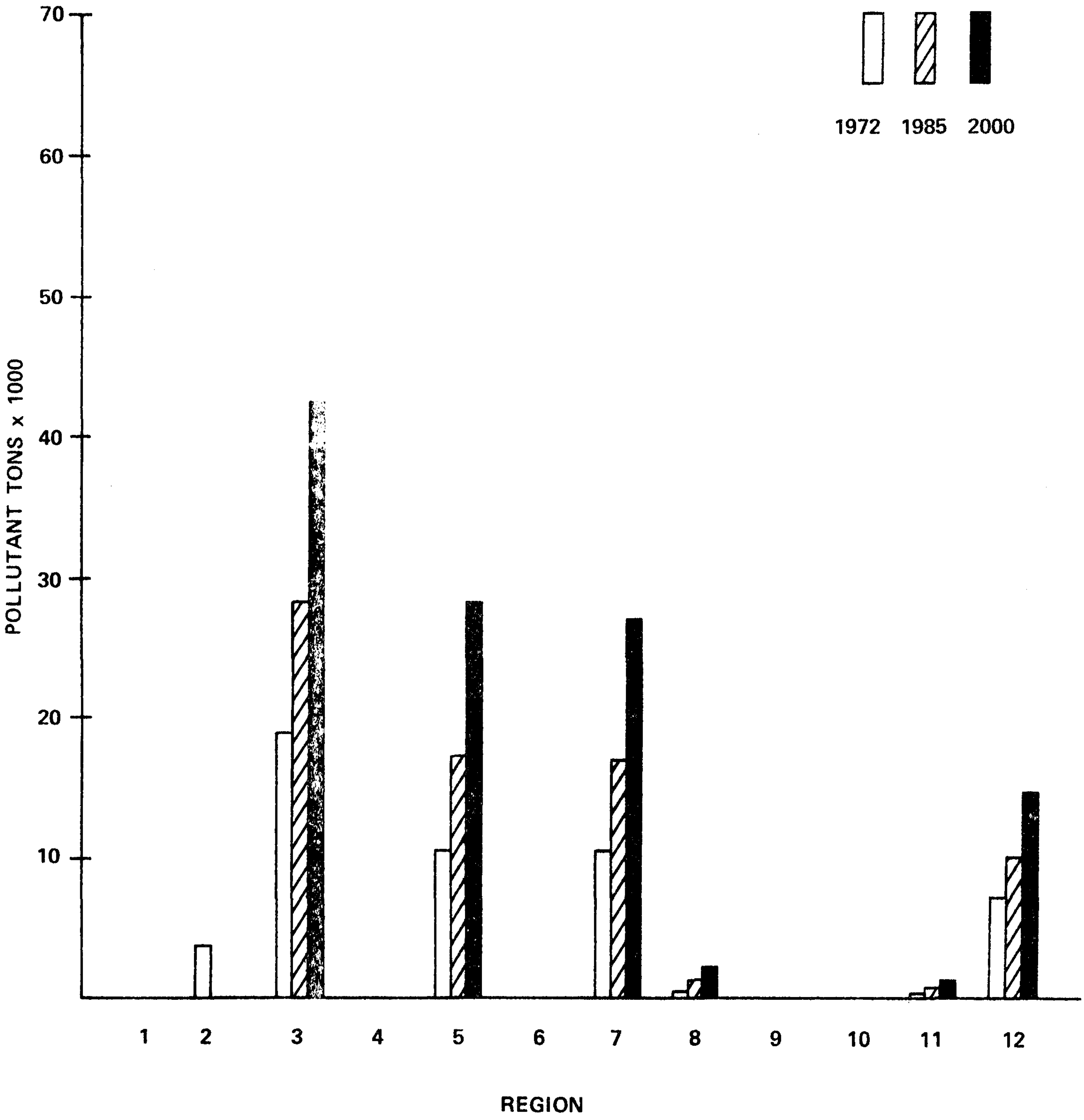
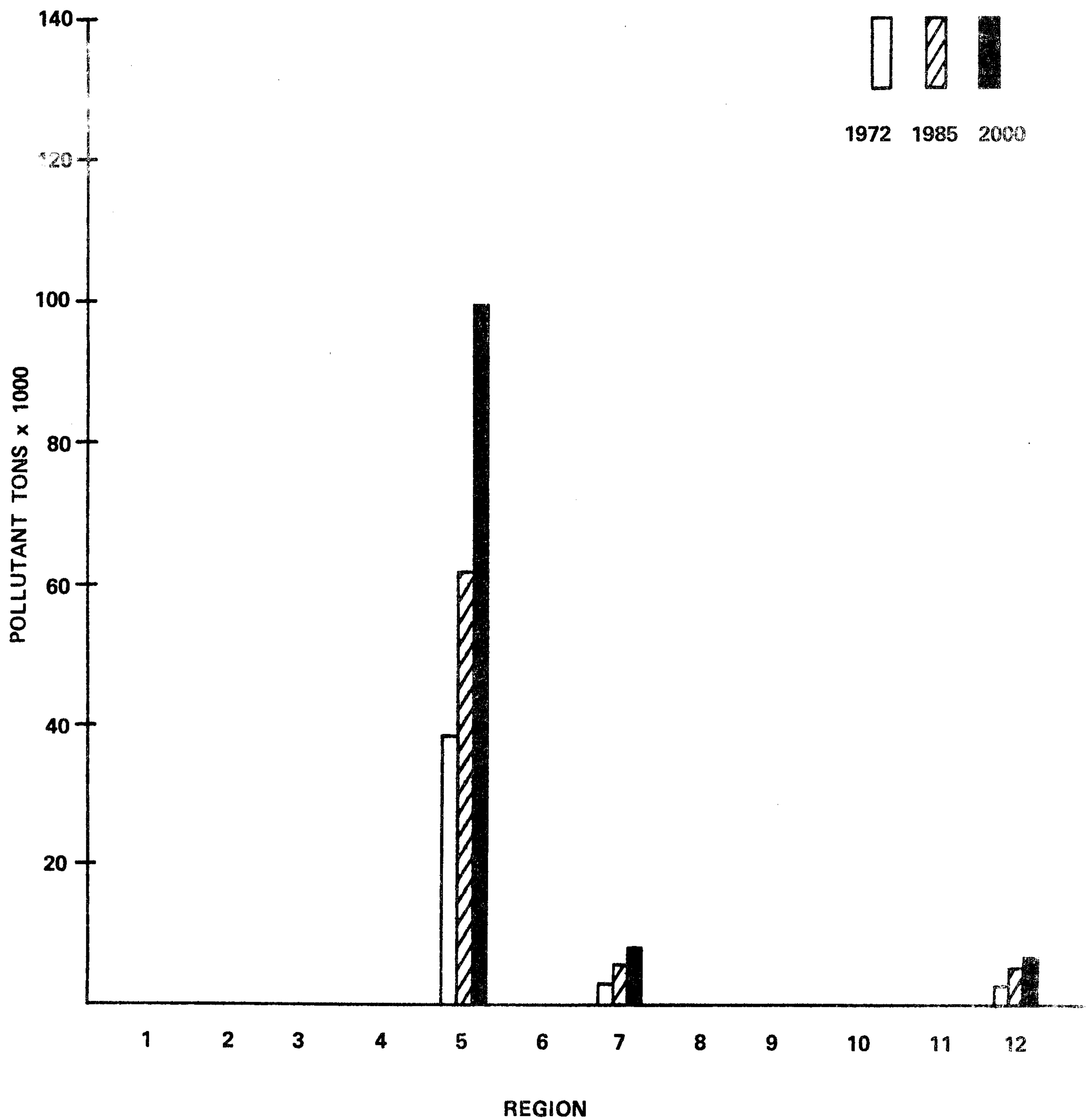
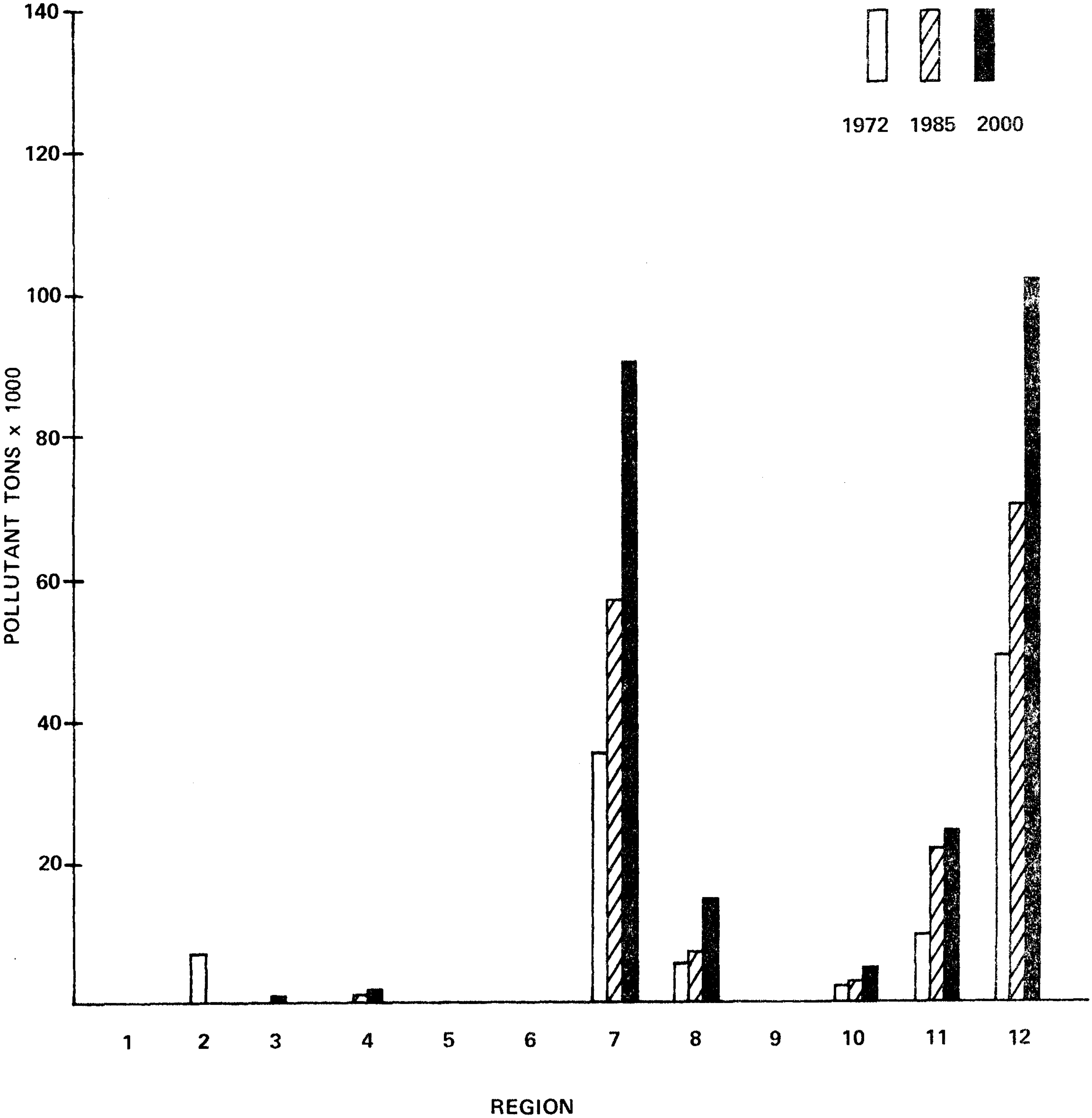
REGIONAL POLLUTANT TOTALS



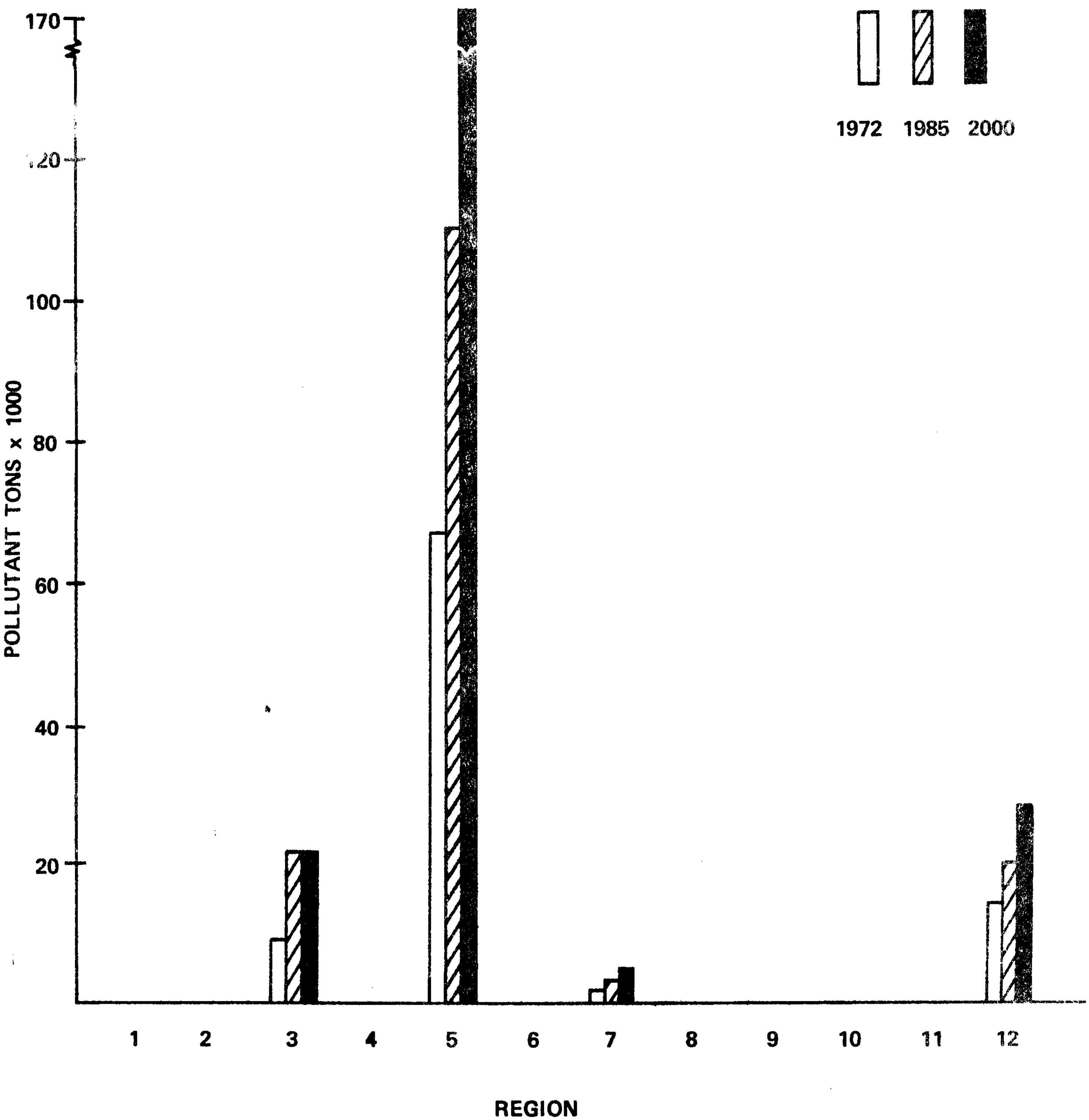
PRIMARY METALS INDUSTRY
HC
REGIONAL POLLUTANT TOTALS



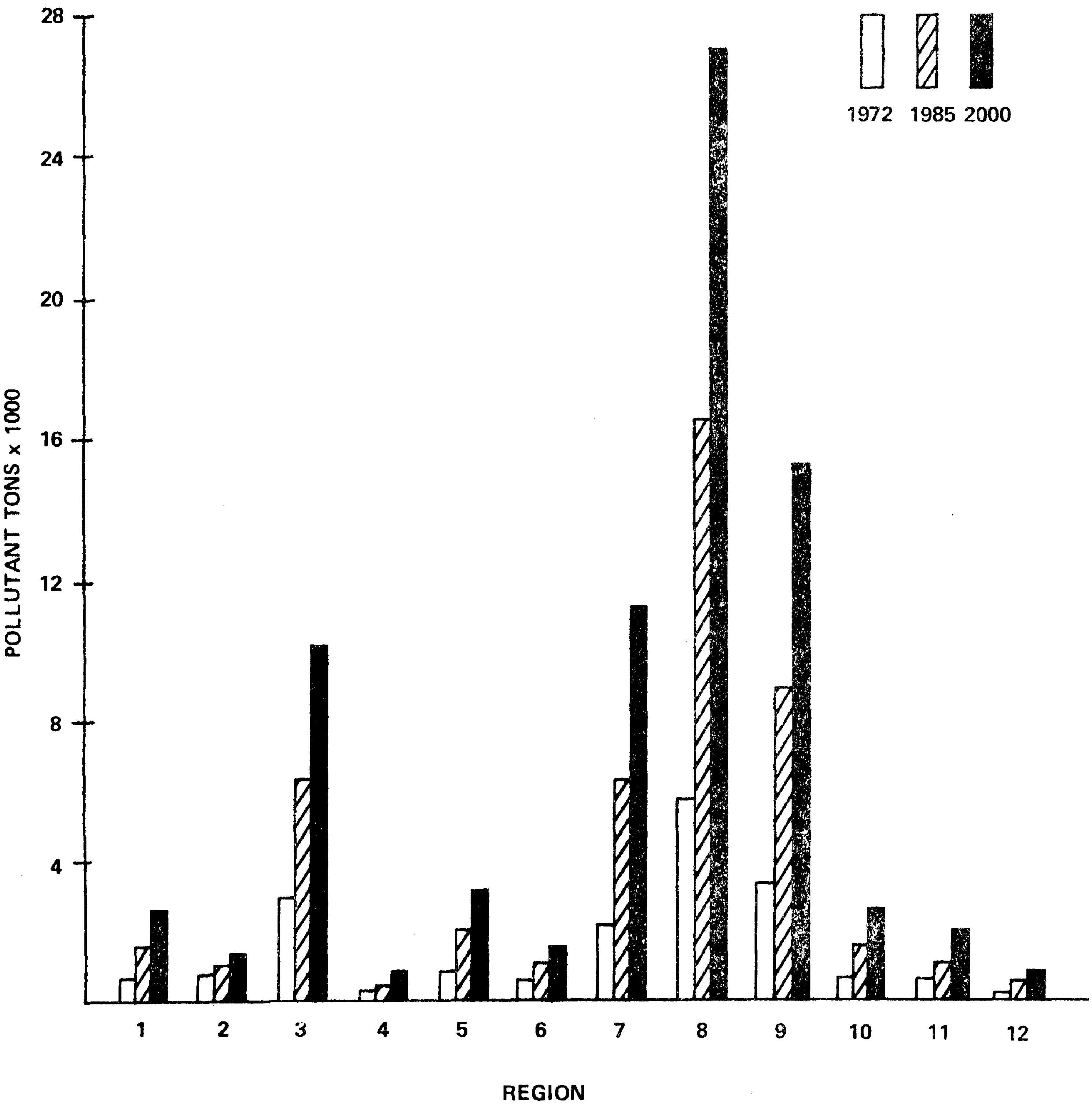
PRIMARY METALS INDUSTRY
CO
REGIONAL POLLUTANT TOTALS



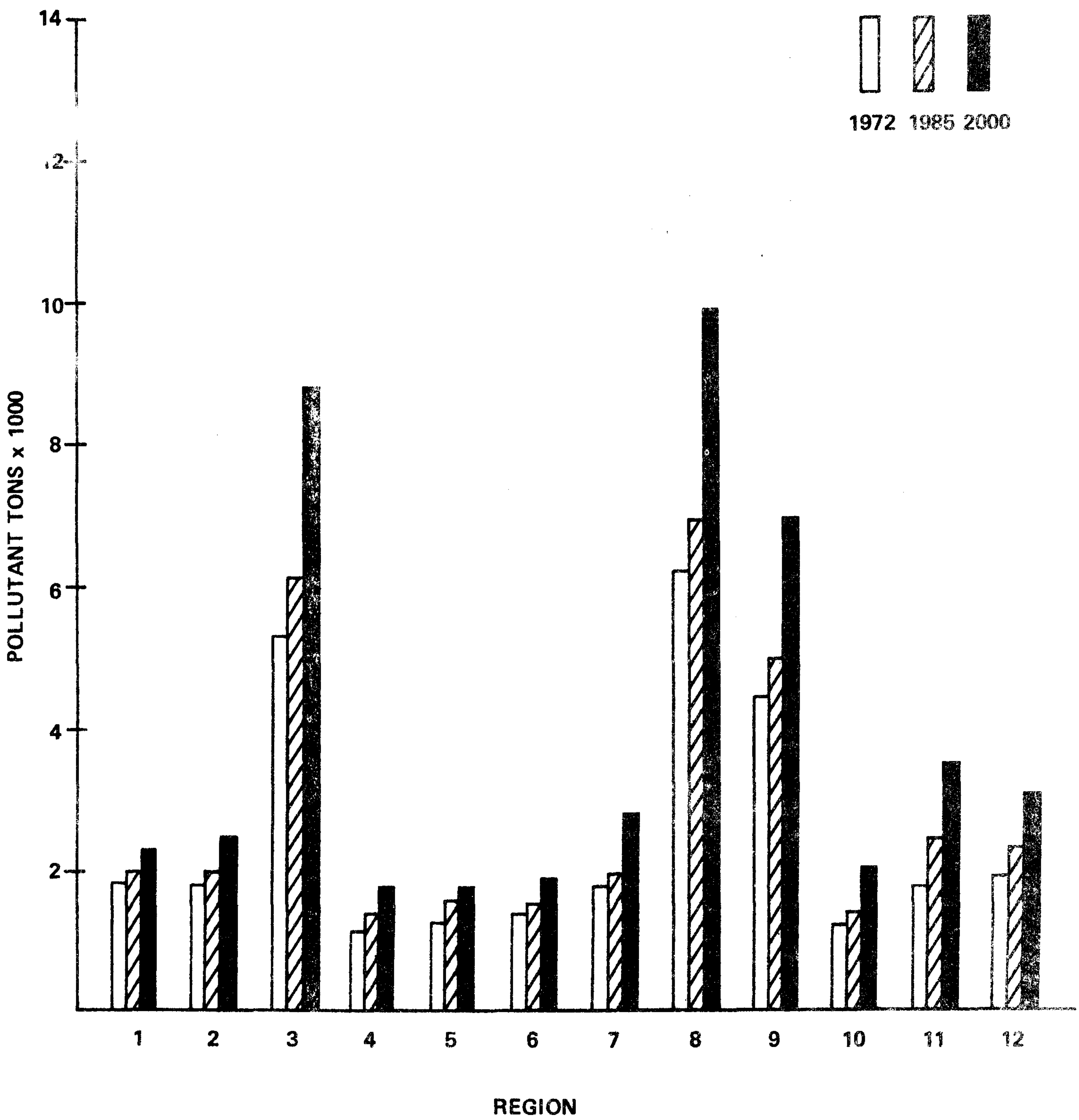
PRIMARY METALS INDUSTRY
NOx
REGIONAL POLLUTANT TOTALS



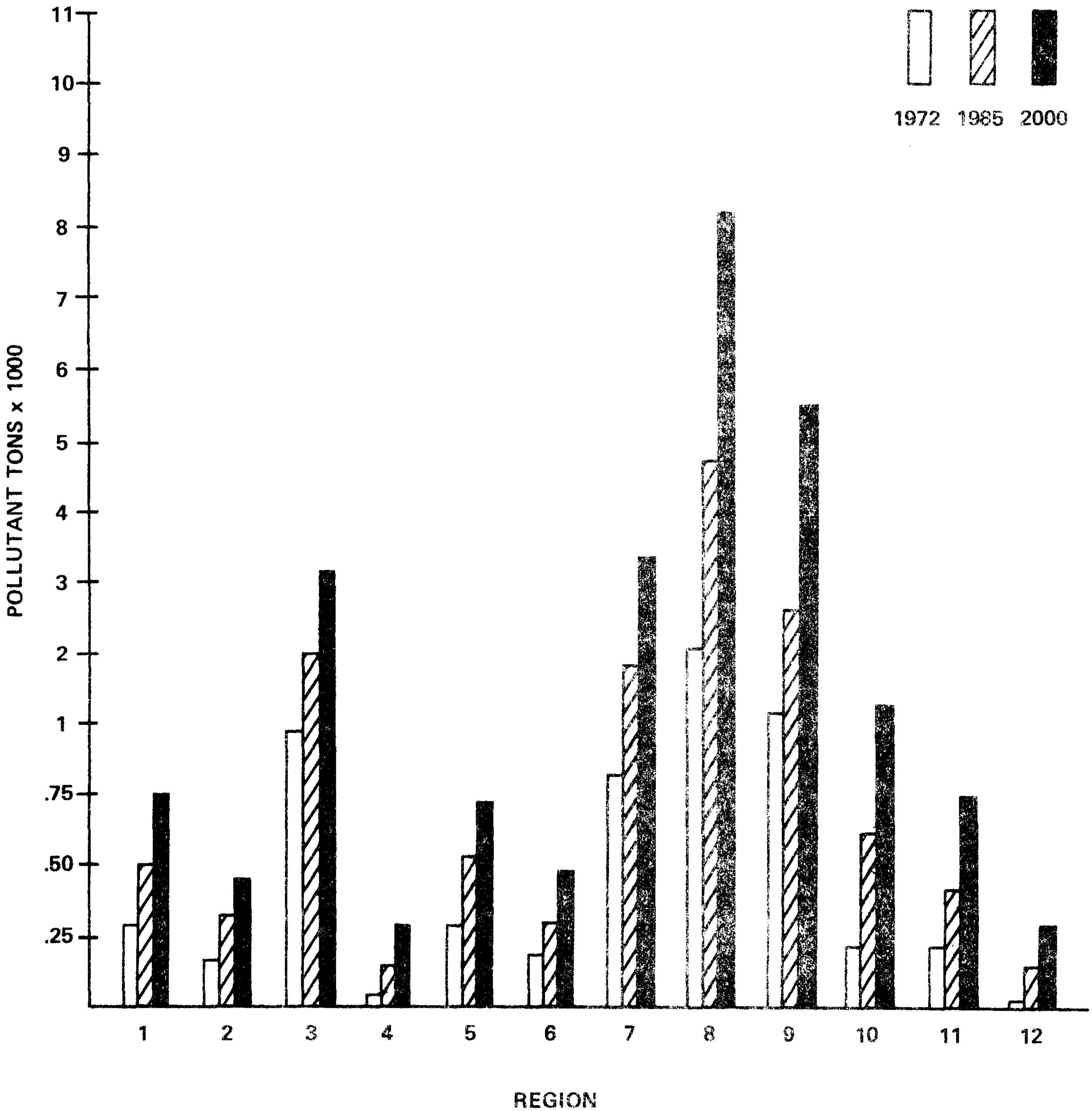
NON-METAL MINING INDUSTRY
SO_2
REGIONAL POLLUTANT TOTALS



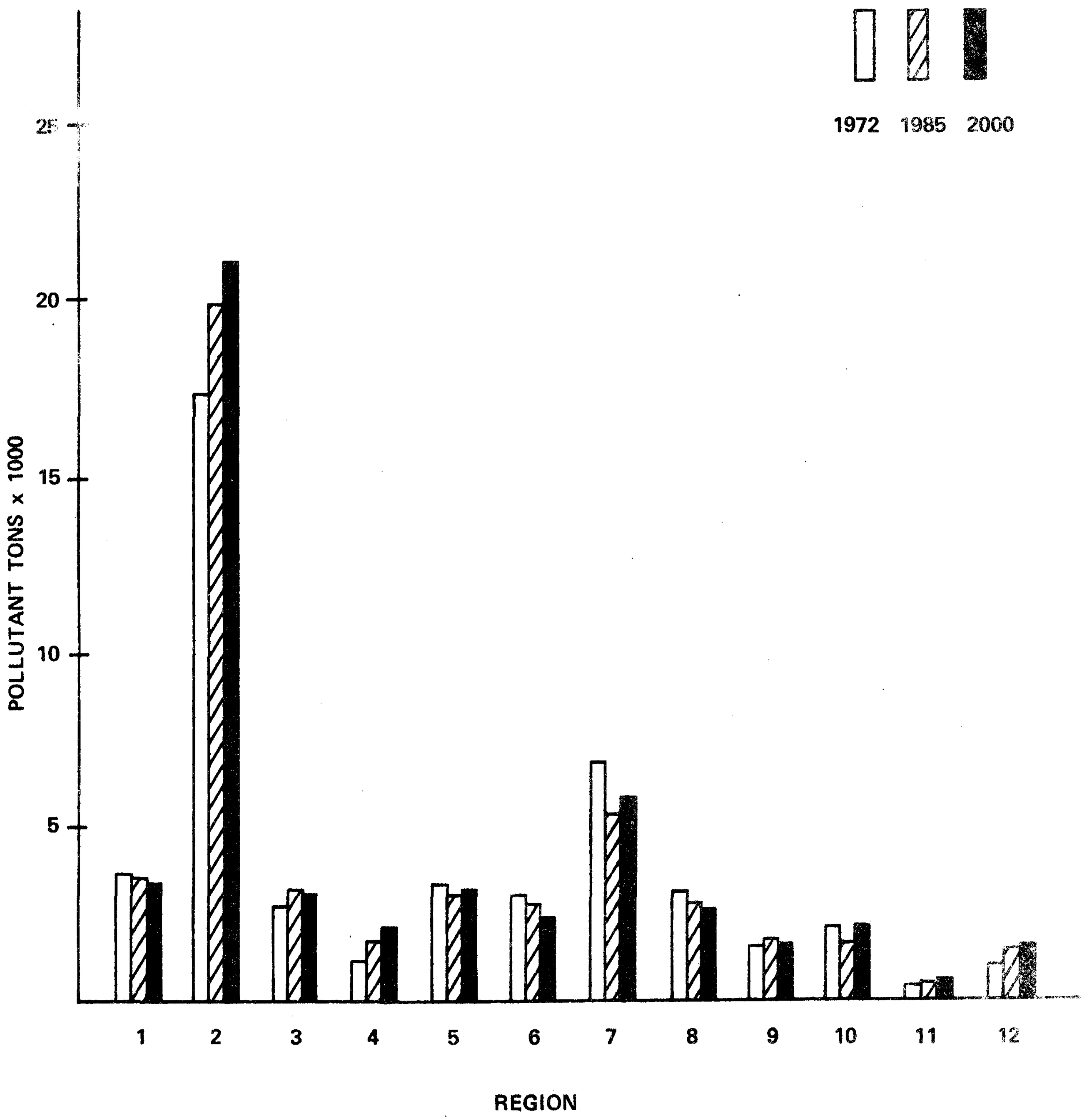
NON-METAL MINING INDUSTRY
PARTICULATE
REGIONAL POLLUTANT TOTALS



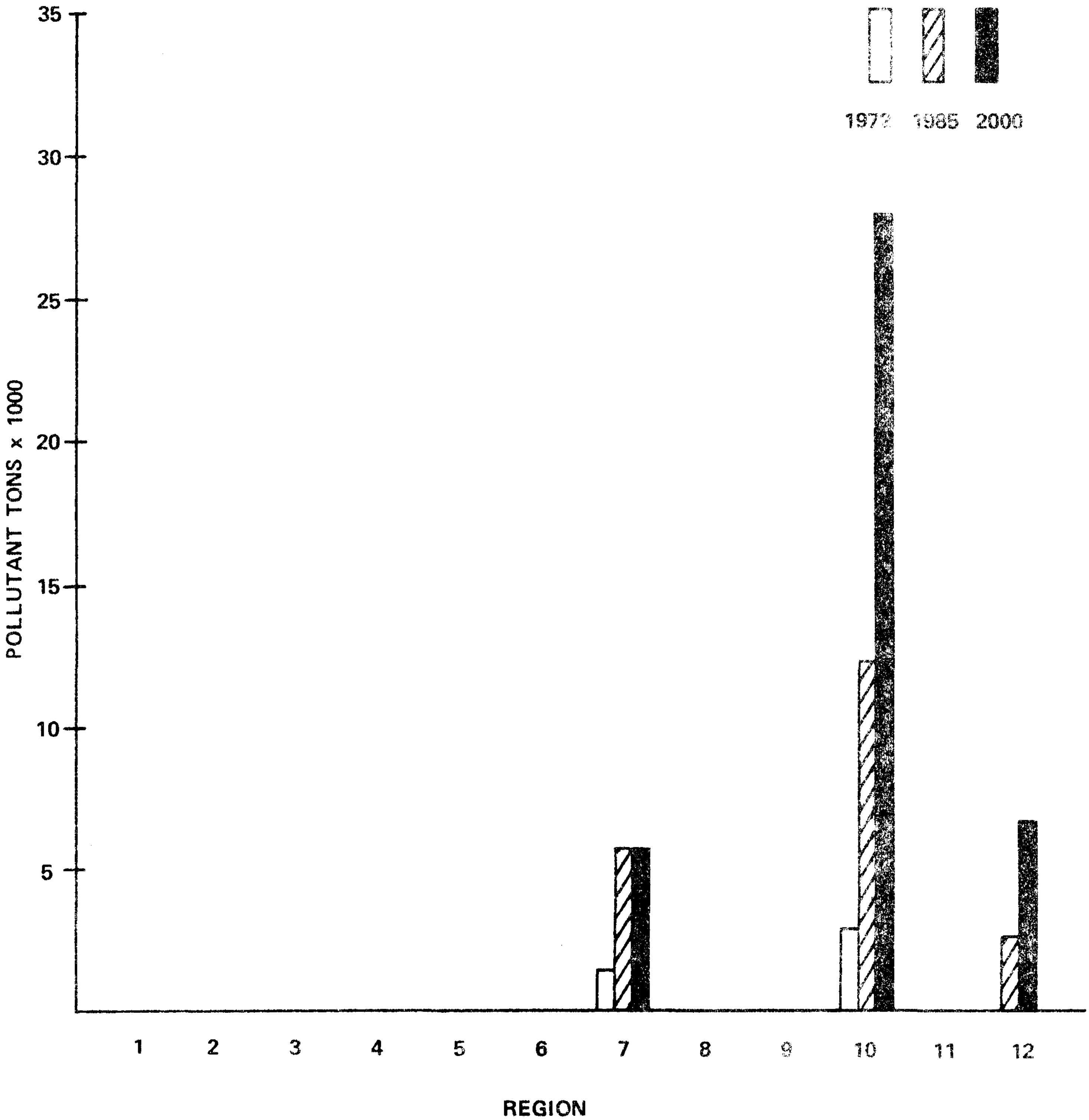
NON-METAL MINING INDUSTRY
NOx
REGIONAL POLLUTANT TOTALS



AGRICULTURAL PROCESSES
PARTICULATE
REGIONAL POLLUTANT TOTALS



CHEMICAL PULPING (KRAFT)
SO_2
REGIONAL POLLUTANT TOTALS



CHEMICAL PULPING (KRAFT)
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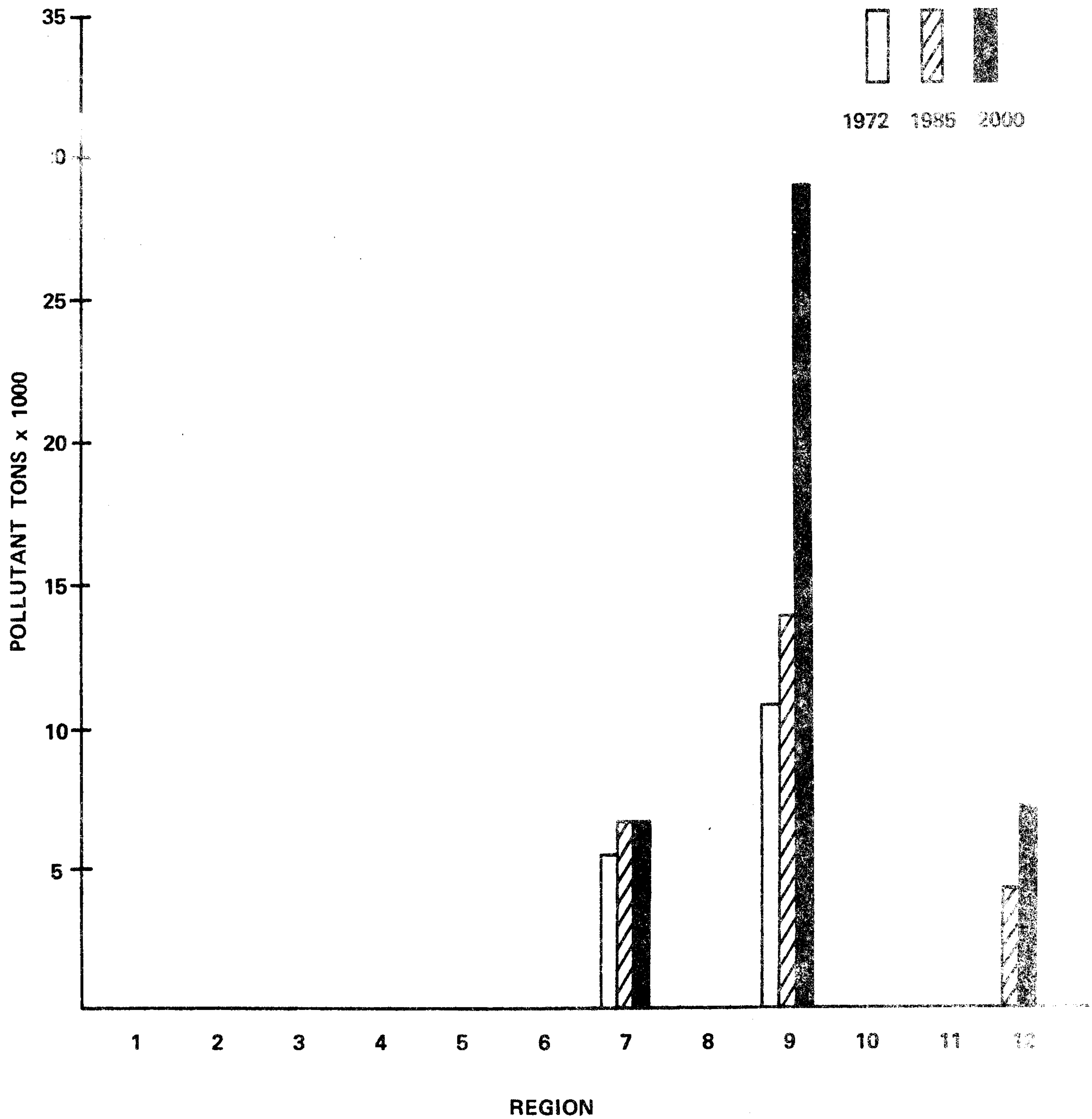
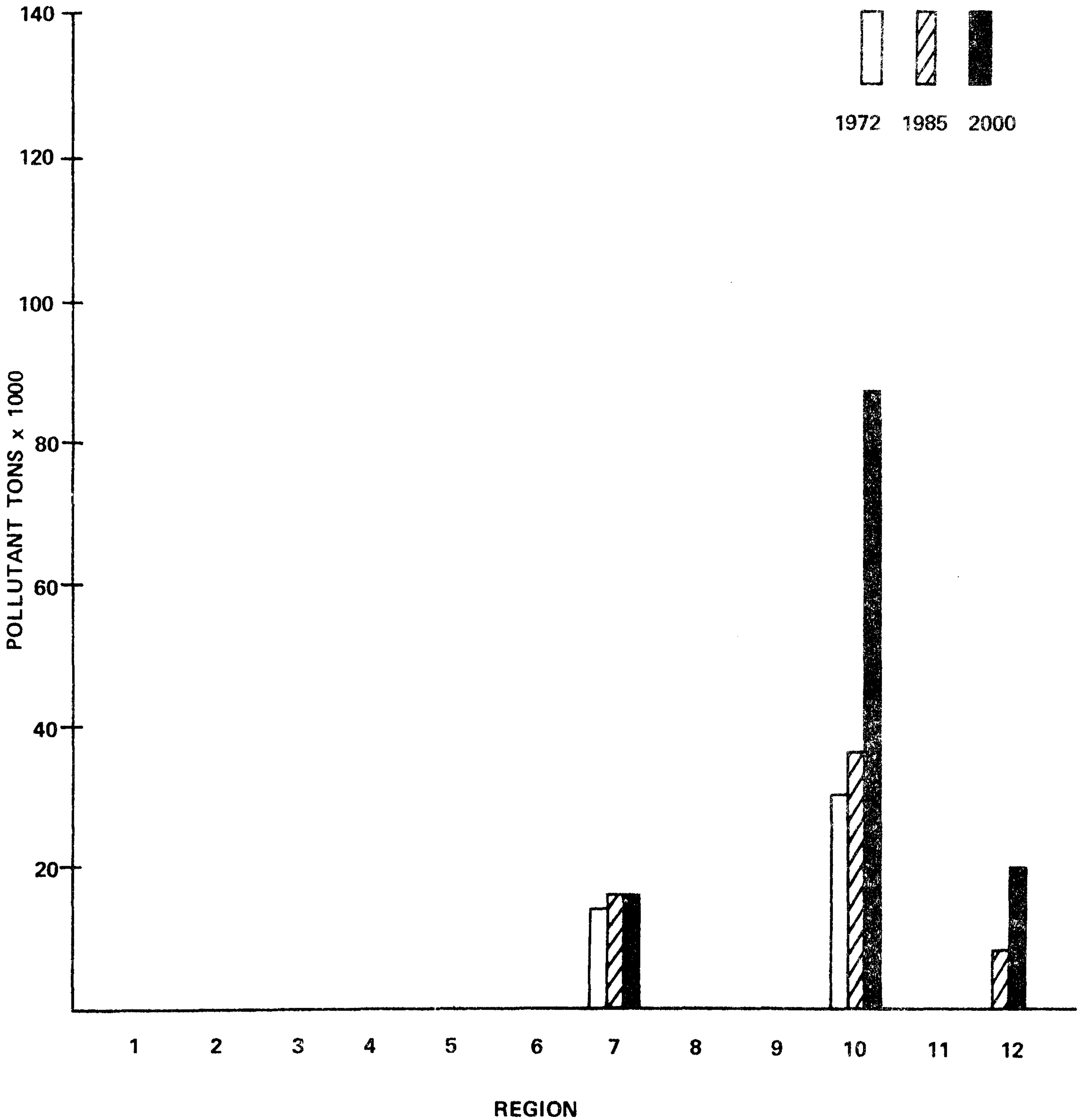
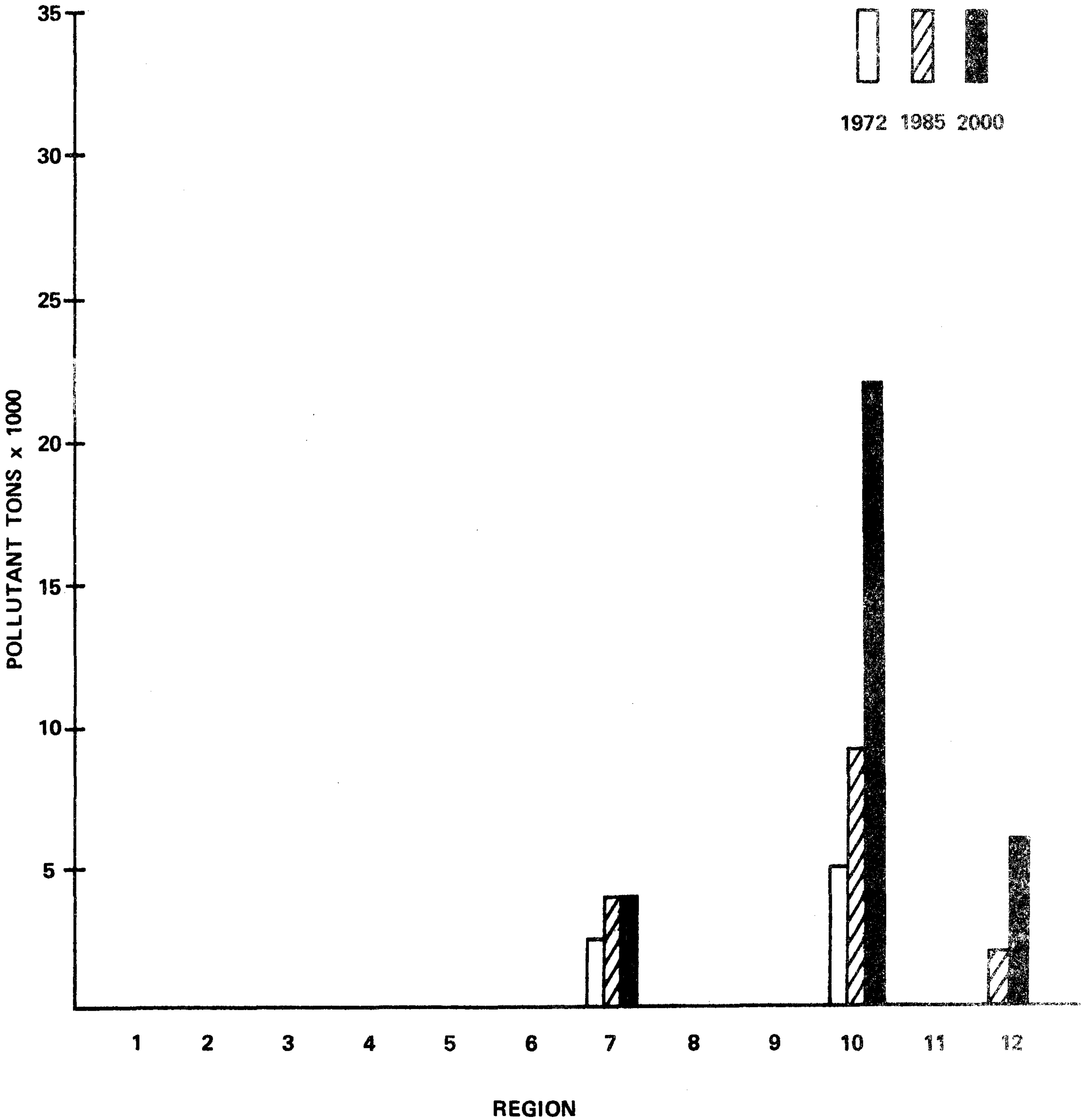
REGIONAL POLLUTANT TOTALS



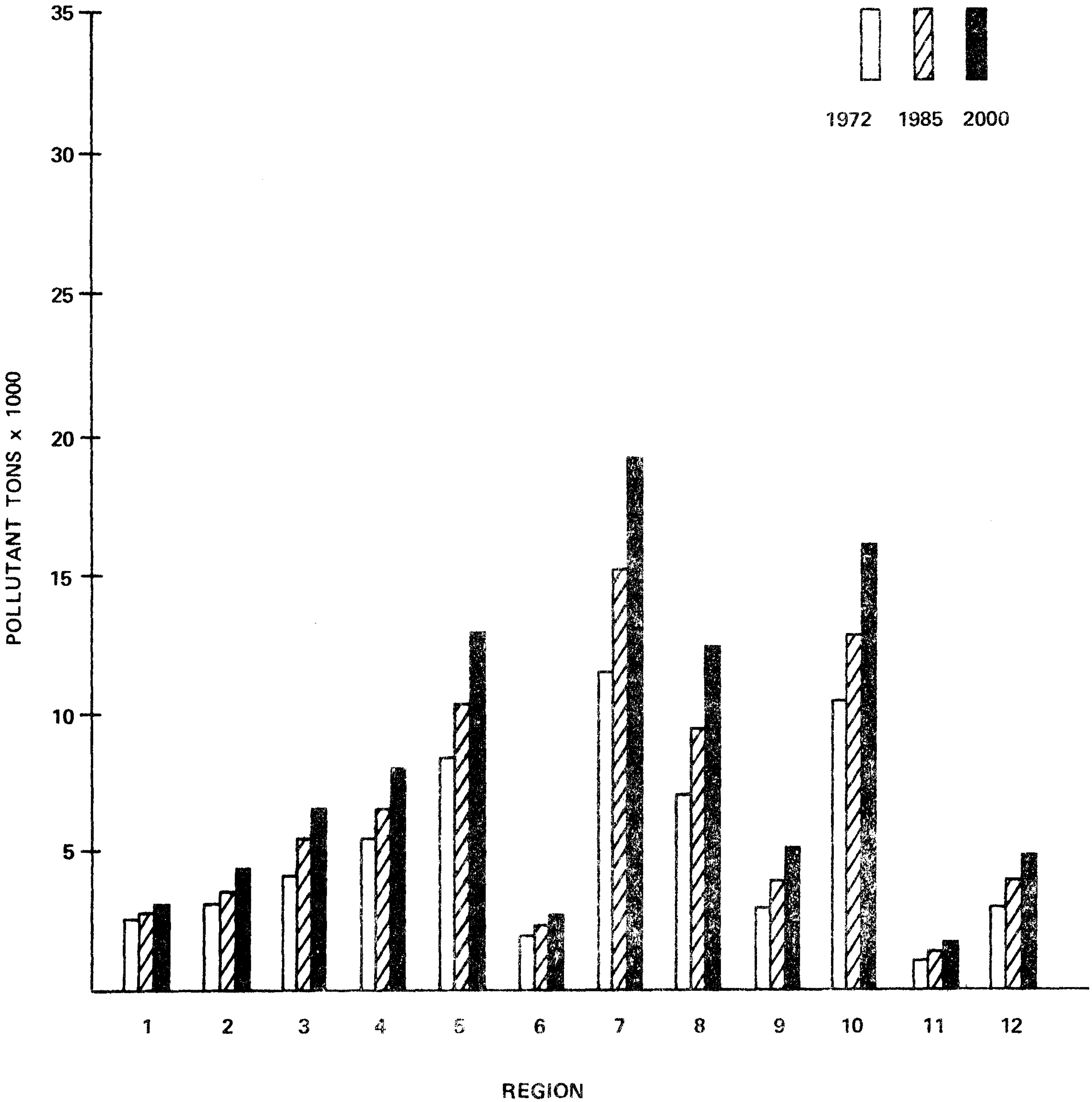
CHEMICAL PULPING (KRAFT)
CO
REGIONAL POLLUTANT TOTALS



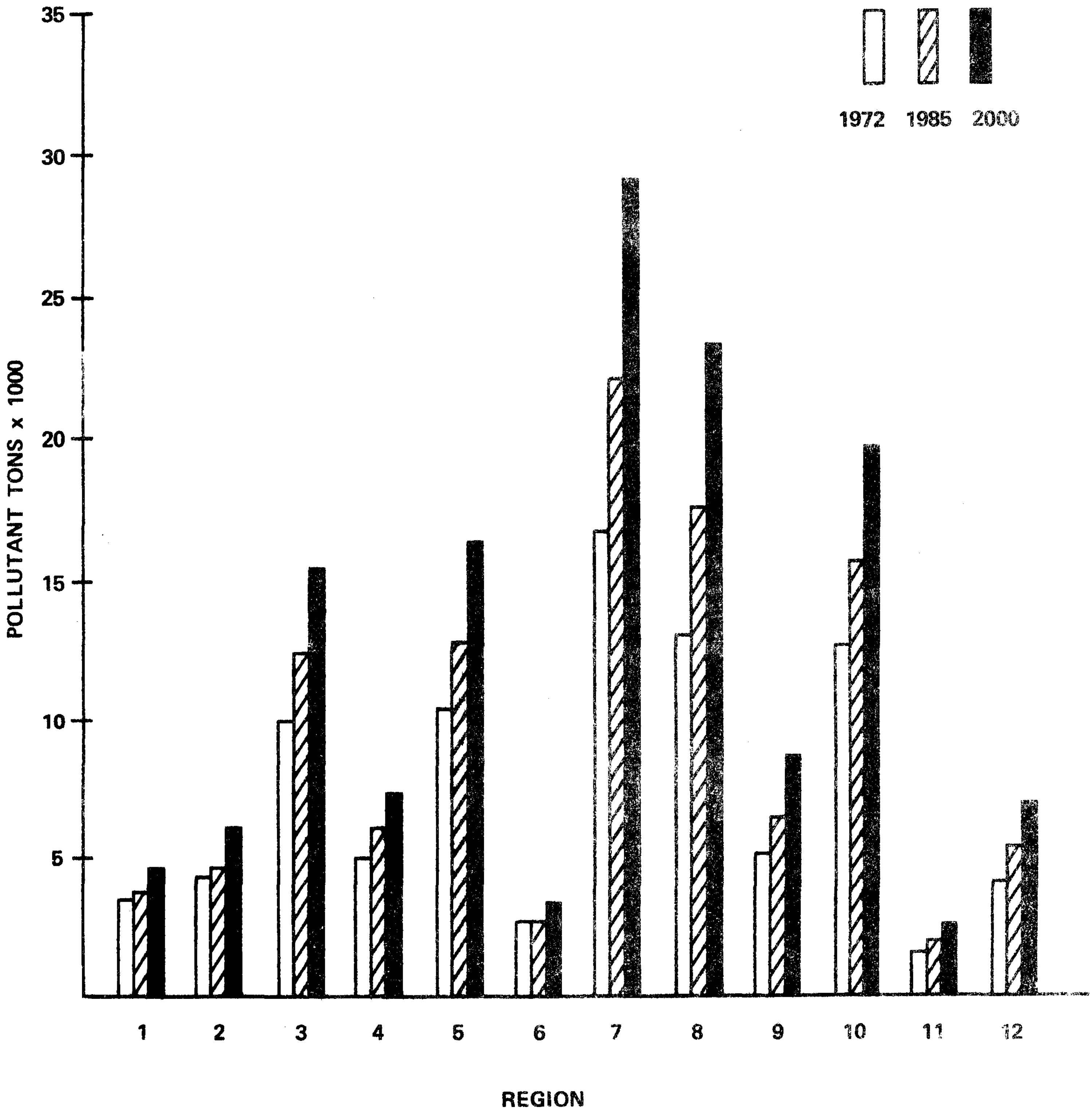
CHEMICAL PULPING (KRAFT)
NOx
REGIONAL POLLUTANT TOTALS



TRANSPORTATION SOURCES
SO_2
REGIONAL POLLUTANT TOTALS



TRANSPORTATION SOURCES
PARTICULATE
REGIONAL POLLUTANT TOTALS



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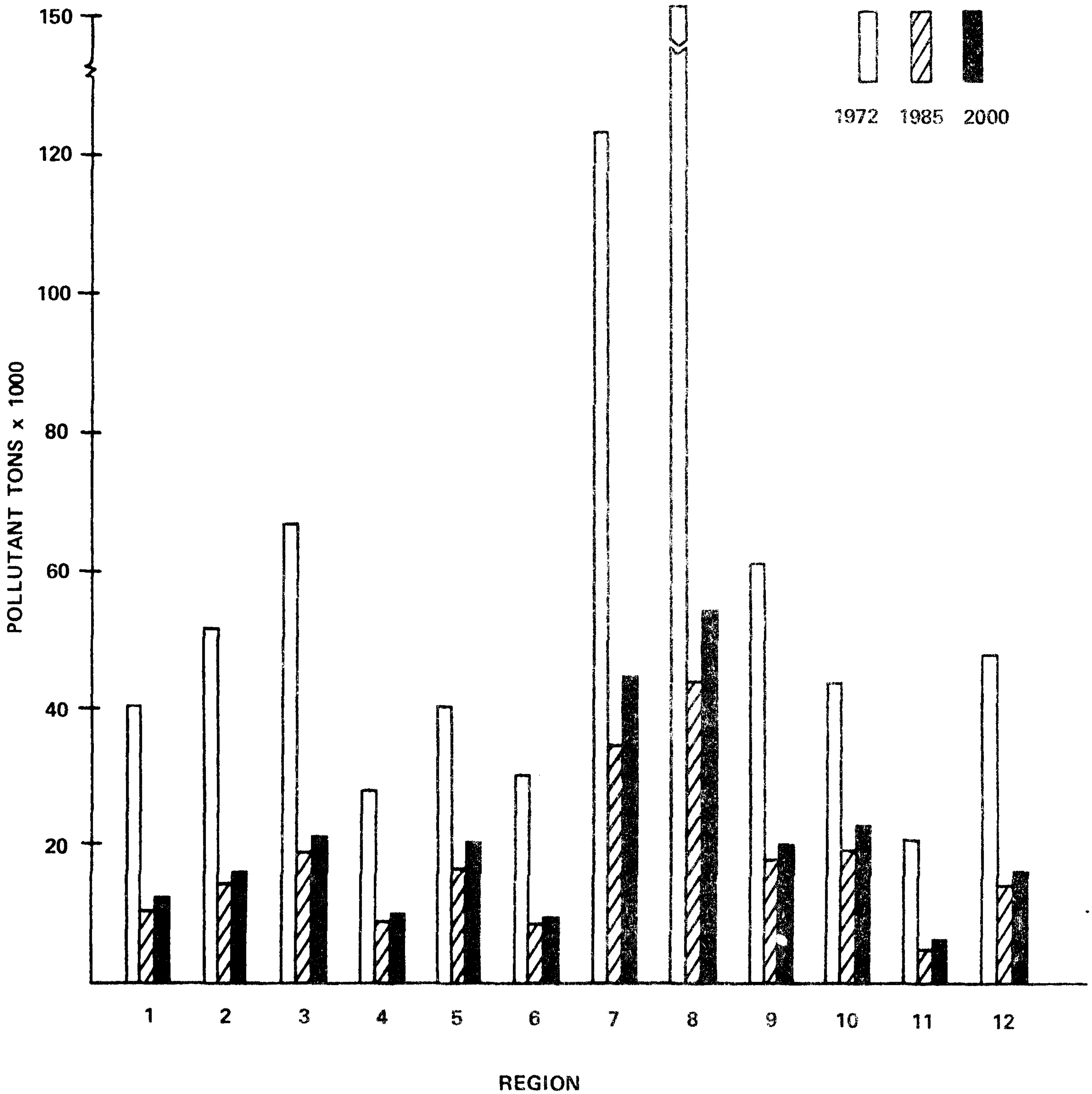
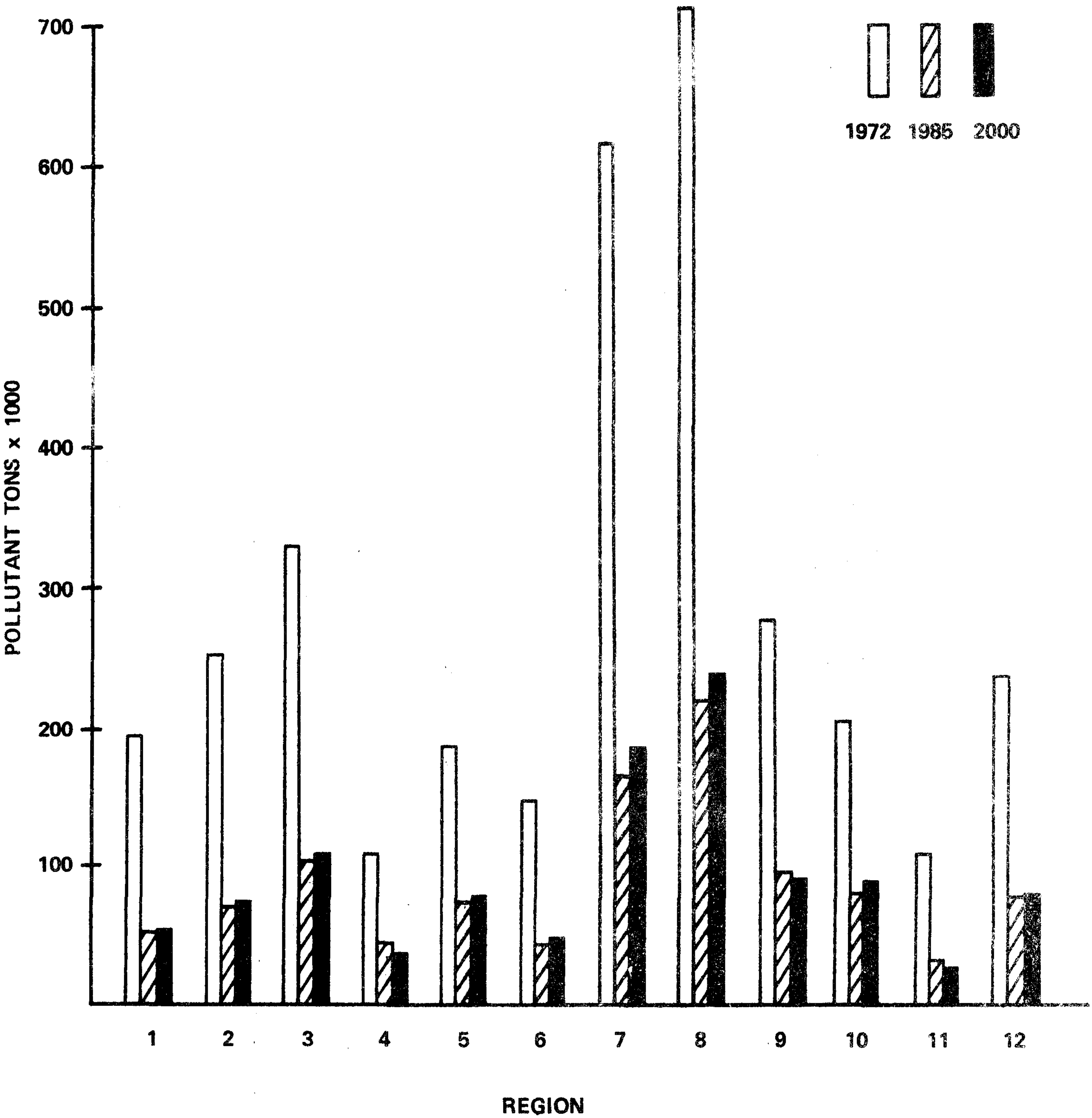
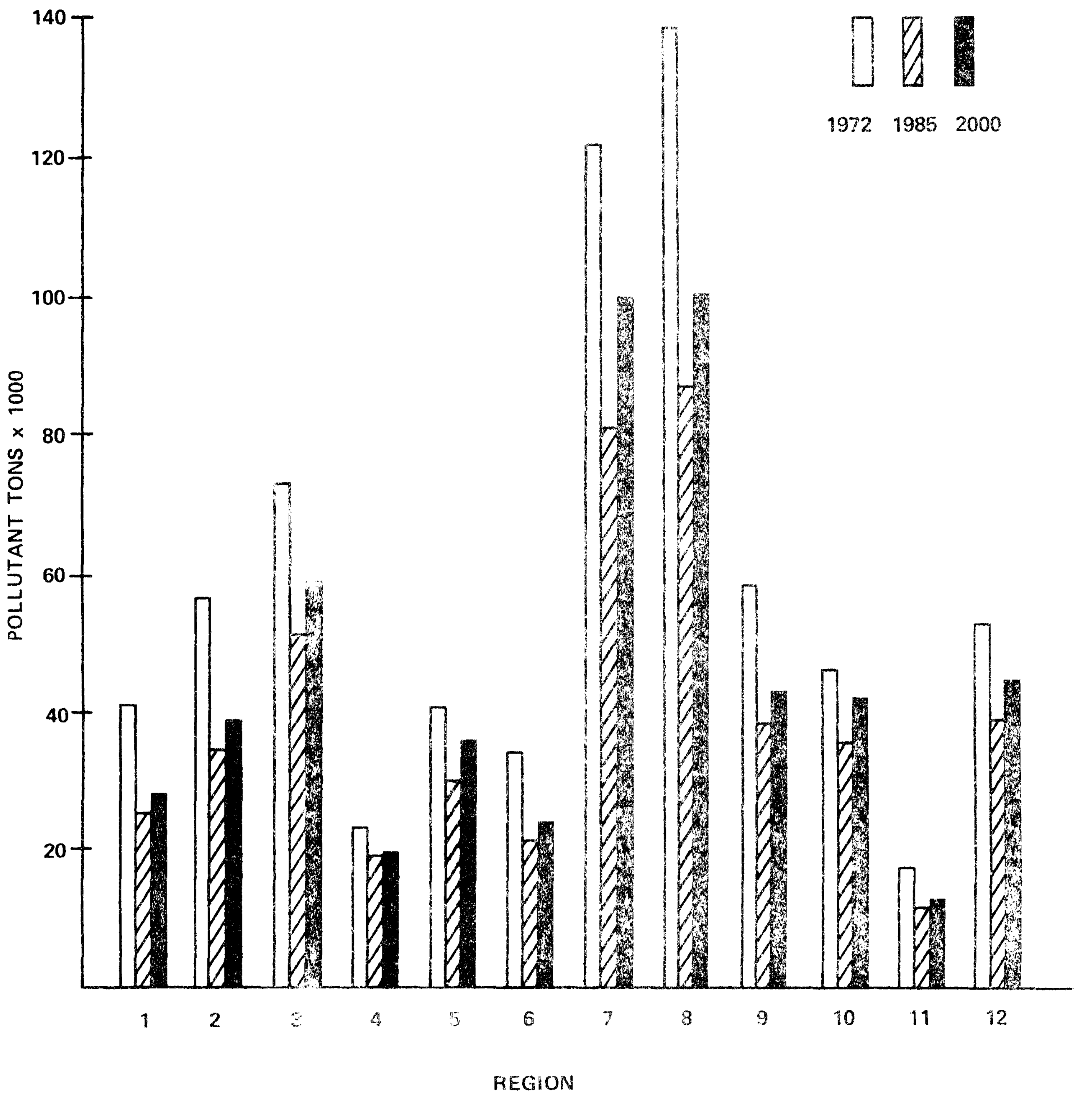
REGIONAL POLLUTANT TOTALS



TRANSPORTATION SOURCES
CO
REGIONAL POLLUTANT TOTALS



TRANSPORTATION SOURCES
NOx
REGIONAL POLLUTANT TOTALS



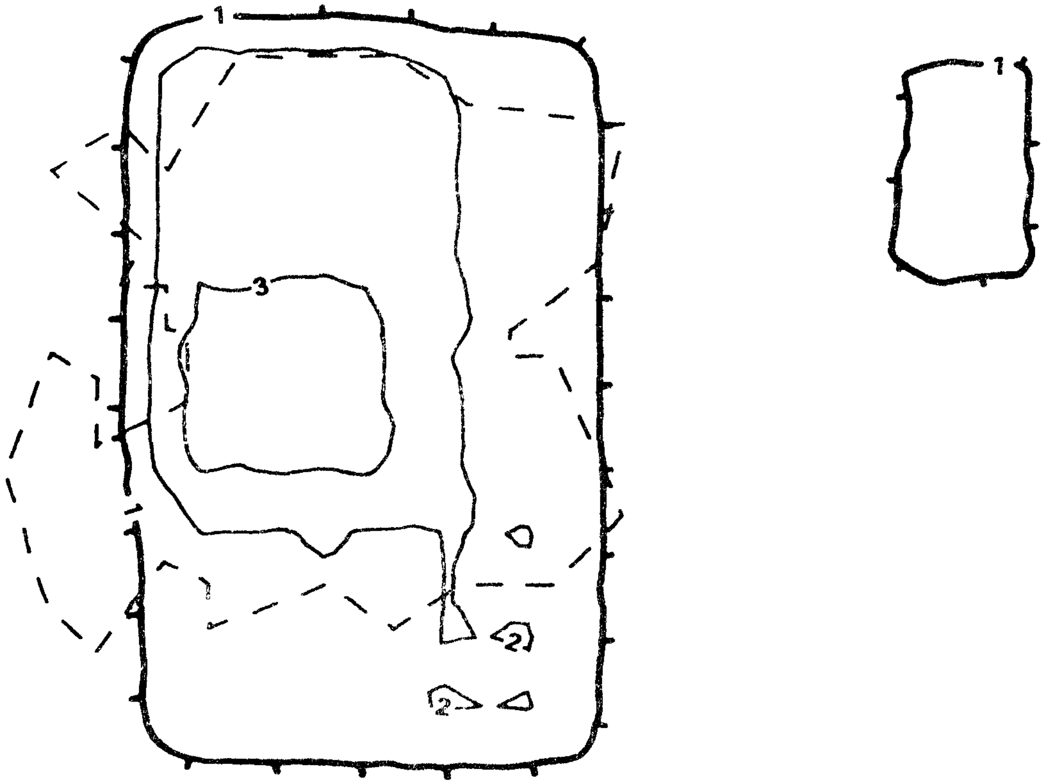
APPENDIX C

DISPERSION MODELING OF PREDICTED GROUND LEVEL CONCENTATIONS OF AIR CONTAMINANTS

BACKGROUND

The mathematical model used to generate the following isopleth maps of annual average sulfur dioxide concentrations is the Fast Air Quality Model developed by the Texas Air Control Board staff. The model employs the widely accepted Gaussian diffusion equation to calculate concentrations due to large elevated point sources of pollution. Sulfur emissions from low level area sources (e.g. mobile transportation sources) are calculated by a simple equation stating that the concentration is proportional to a constant times the emission rate per unit area divided by the wind speed. The resultant concentration calculated by the model is the sum of the concentrations calculated by the Gaussian equation and the simple equation for a specific point. The results of the model are calibrated to local conditions as indicated by sulfur dioxide measurements made by national, state, and local air pollution control agencies.

The isopleth maps are useful tools for area-wide planning because they show the relative density of pollution concentrations from point to point within an area or from year to year under the guidelines of the various scenarios. For instance, the relative impact of the use of high sulfur content fuels in 1985 (Scenario II and E/S-2 growth) vs. the use of low sulfur content fuels in 1985 (Scenario I) is well illustrated by the isopleth maps of these scenarios. However, the predicted maximum concentrations should not be taken as absolute values because the numbers are conservative in that the model usually over-calculates expected concentrations. Additionally, no adjustments in stack height were made for existing sources, presently burning natural gas, which were projected to convert to solid or liquid fossil fuels with higher sulfur content. In actual practice stack height increases may be required which will further reduce ground level concentrations of sulfur dioxide. There are many statistically uncertain values used in most models which affect their accuracy. The model can be no more accurate than the emissions inventory data, the average meteorological data, and the measured ground level data that are used in the calculation of concentrations. Actual values of concentration may vary from those shown on the isopleths by as much as a factor of two. Therefore, the relative not the absolute values should be considered when assessing the impact of the various scenarios within the metropolitan areas and from year to year.



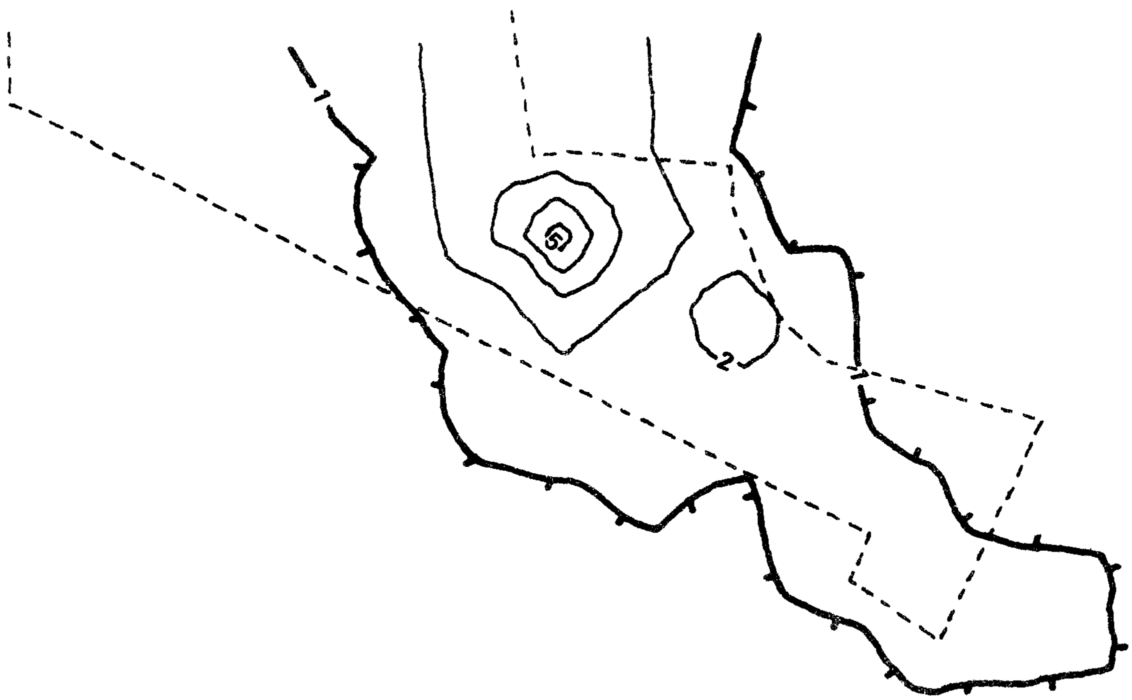
SAN ANTONIO: 1972 ANNUAL SO_2 ($\mu g/M^3$)

SAN ANTONIO: ES/2 1985 ANNUAL SO_2 ($\mu g/M^3$)

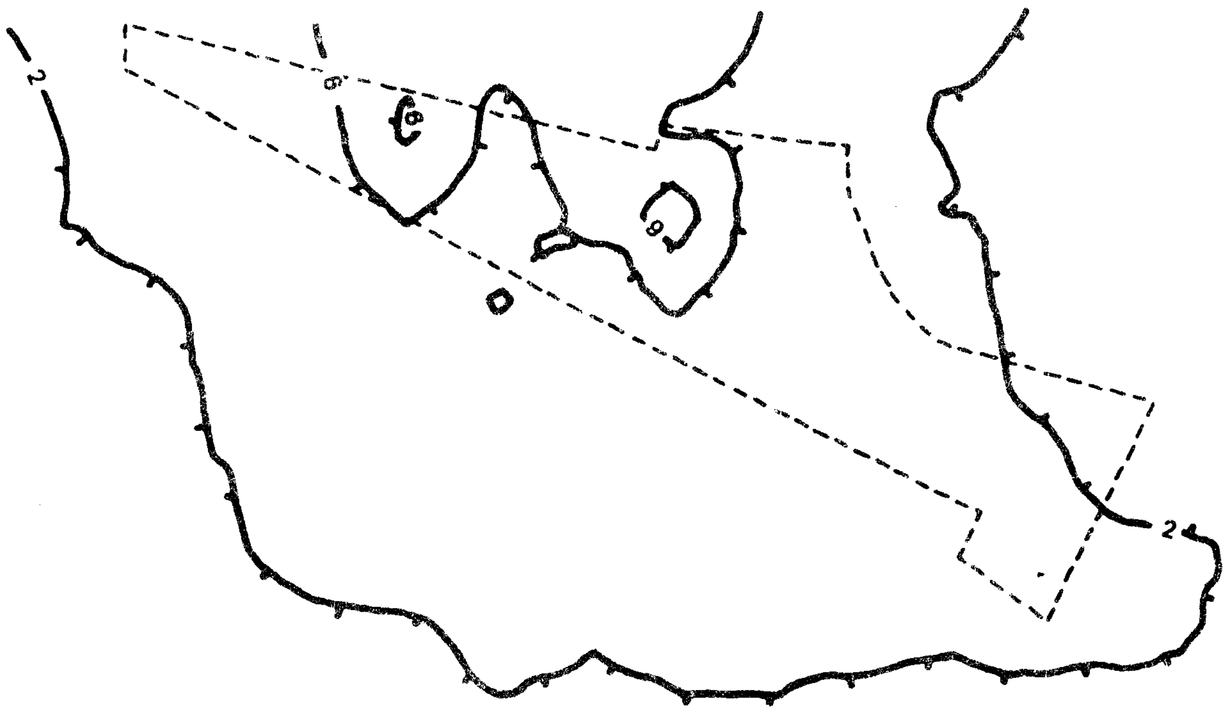
AUSTIN: ES/2 1972 ANNUAL SO_2 ($\mu g/M^3$)

AUSTIN: ES/2 1985 ANNUAL SO_2 ($\mu g/m^3$)

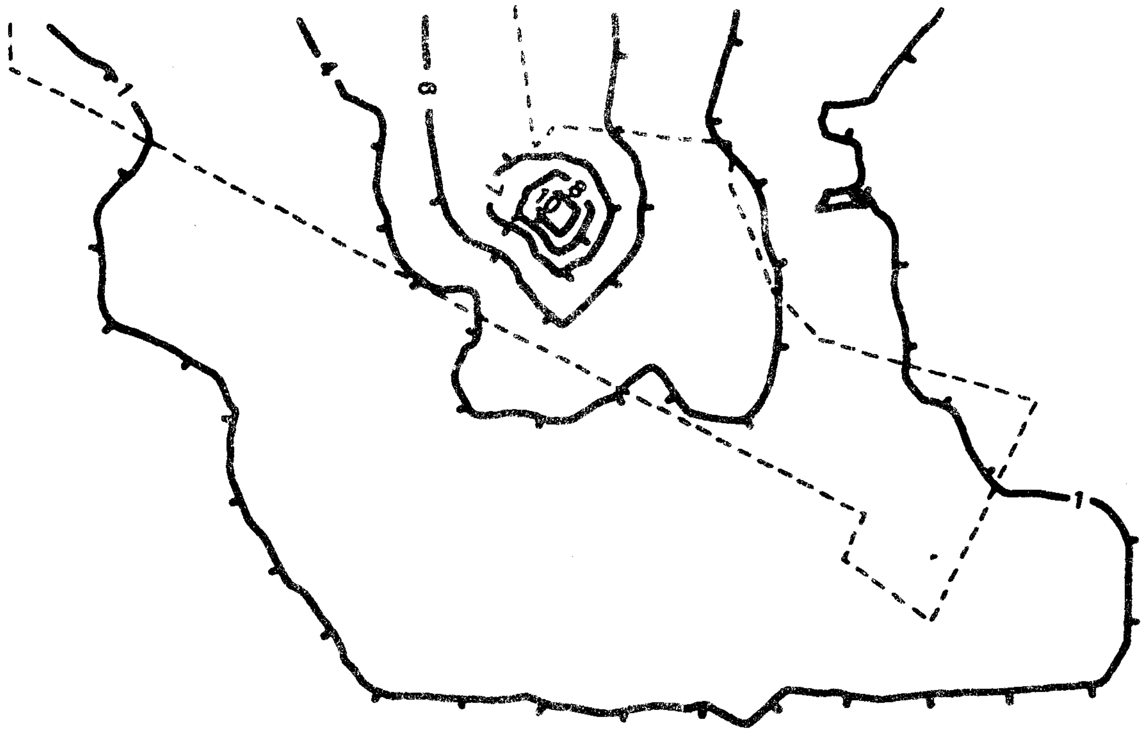
AUSTIN: SCENARIO 2 1985 ANNUAL SO_2 ($\mu g/m^3$)



CORPUS CHRISTI: 1972 ANNUAL SO_2 ($\mu g/m^3$)

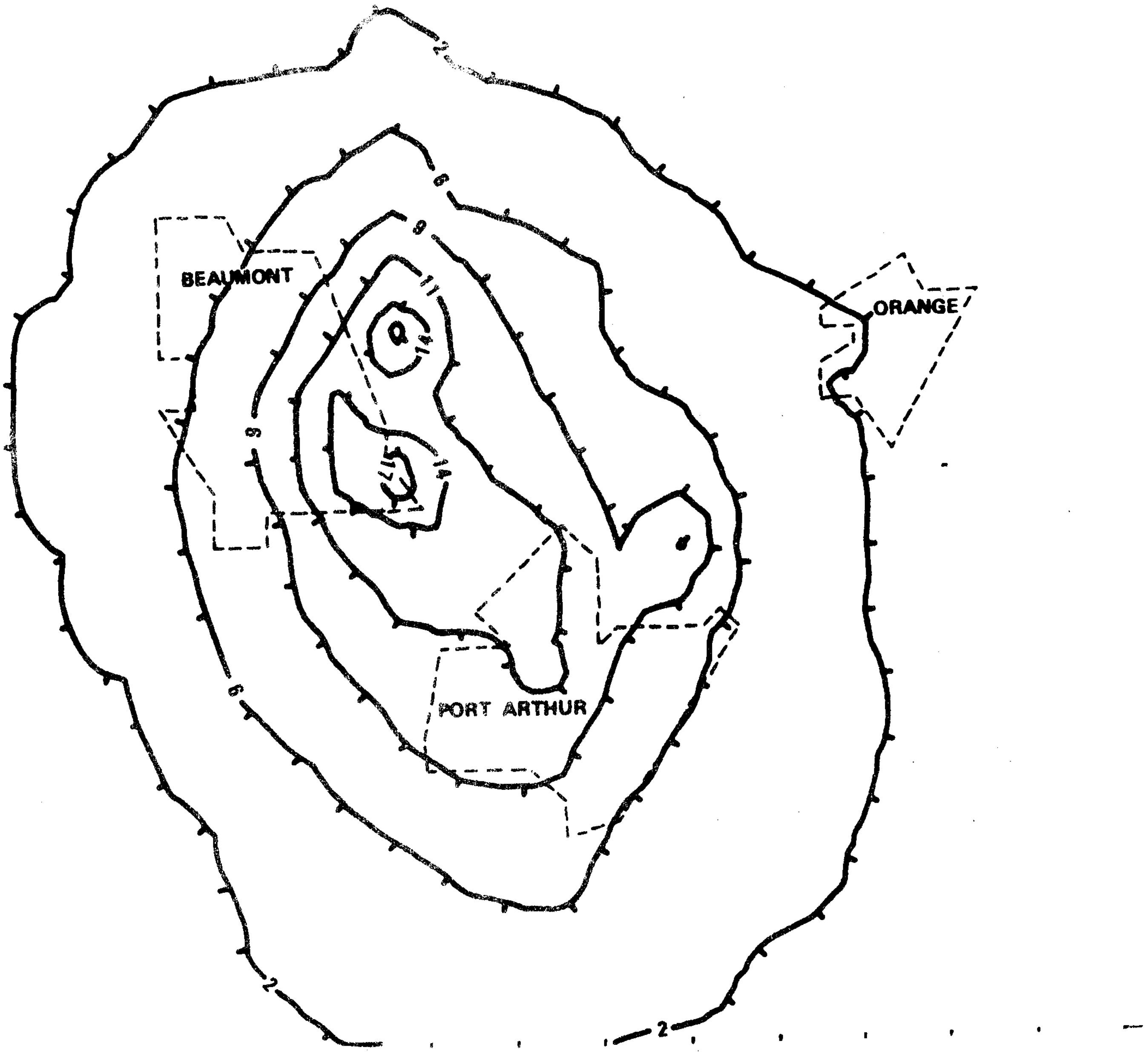


CORPUS CHRISTI: ES/2 1985 ANNUAL SO_2 ($\mu g/m^3$)



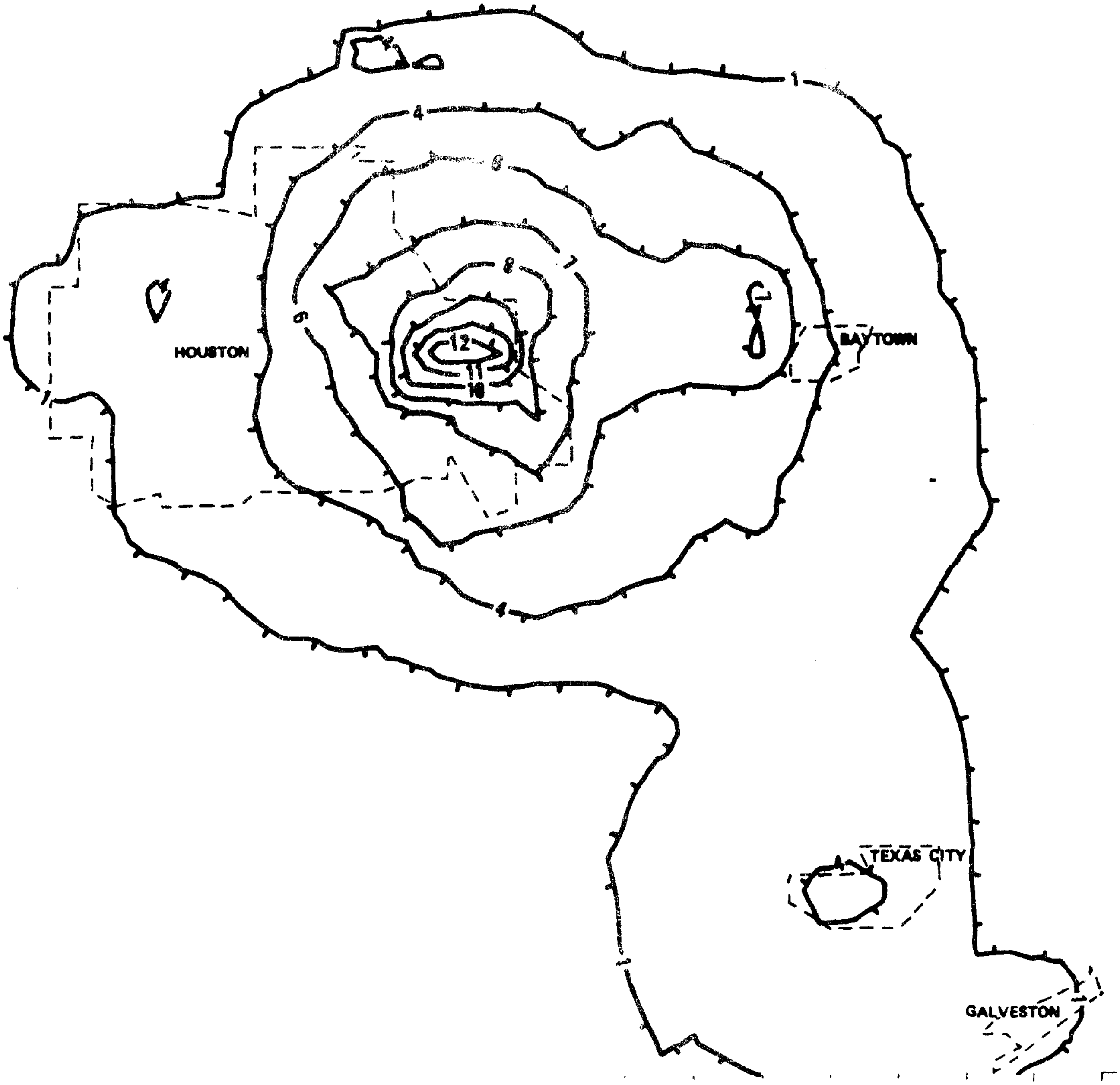
CORPUS CHRISTI: SCENARIO 2 1985 ANNUAL SO_2 (µg/M³)

BEAUMONT – PORT ARTHUR – ORANGE: 1972 ANNUAL SO_2 ($\mu g/m^3$)

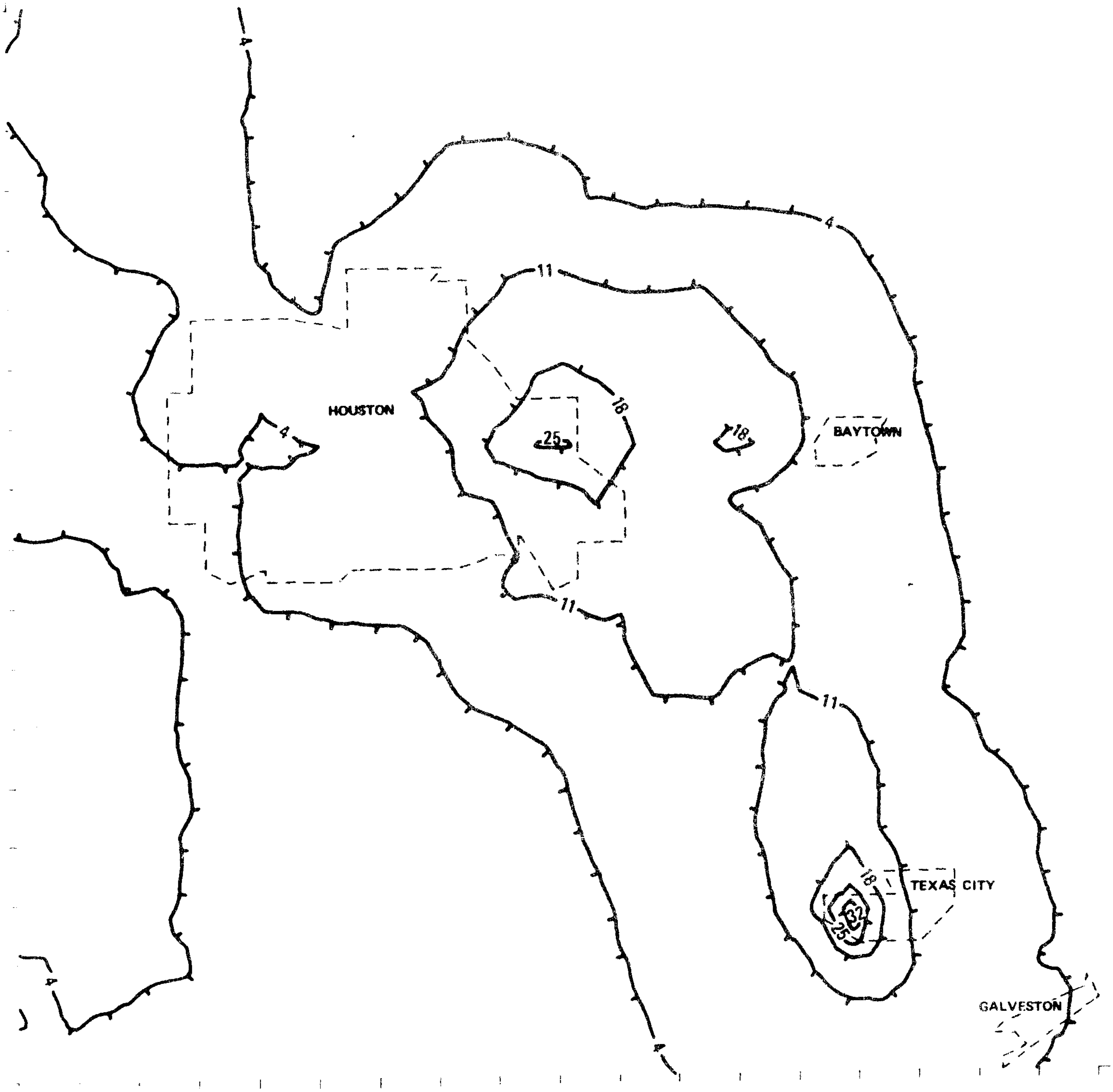


BEAUMONT – PORT ARTHUR – ORANGE: ES/2 1985 ANNUAL SO_2 (µg/M³)

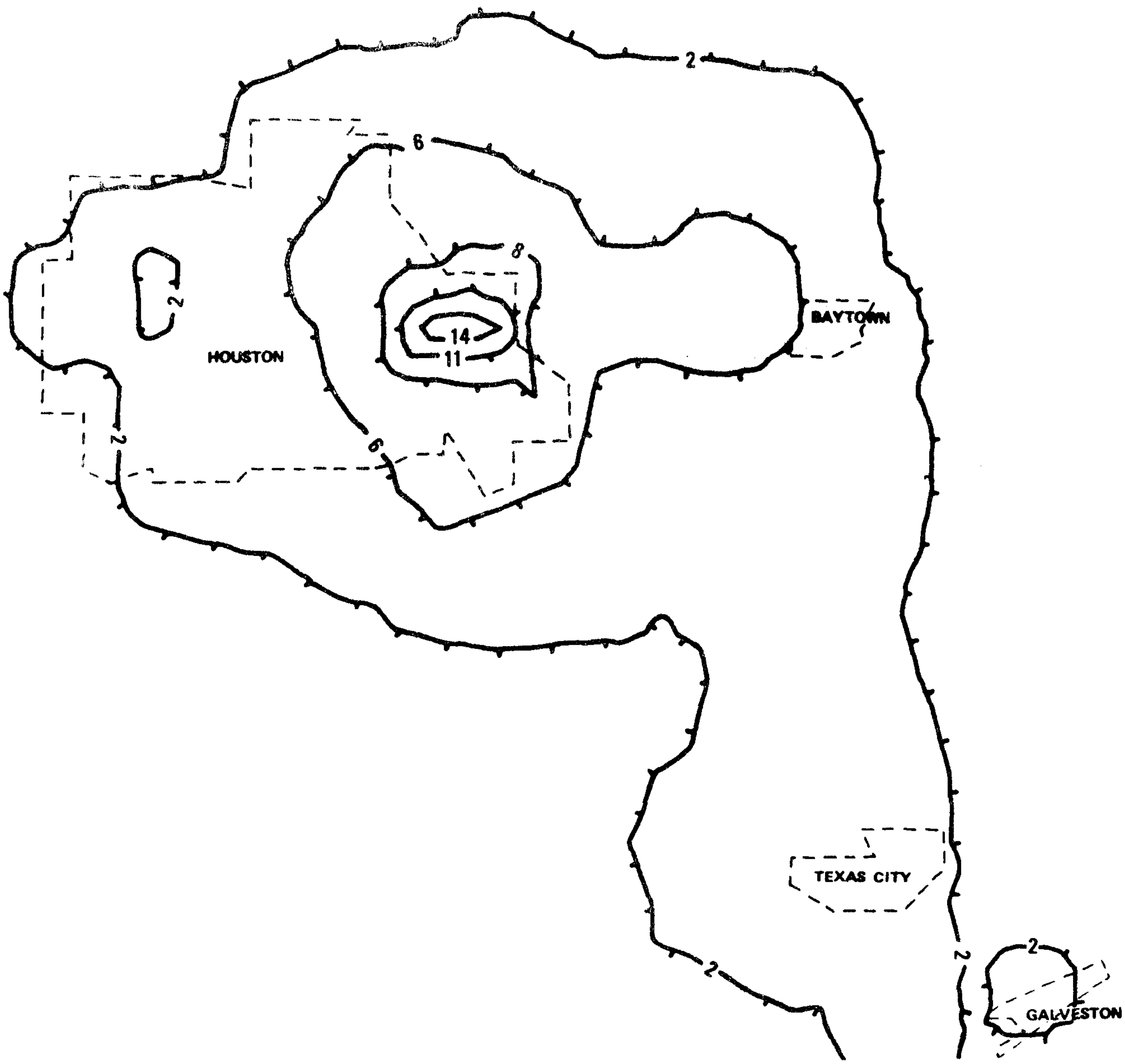
BEAUMONT – PORT ARTHUR – ORANGE: SCENARIO 2 1985 ANNUAL SO_2 ($\mu g/M^3$)



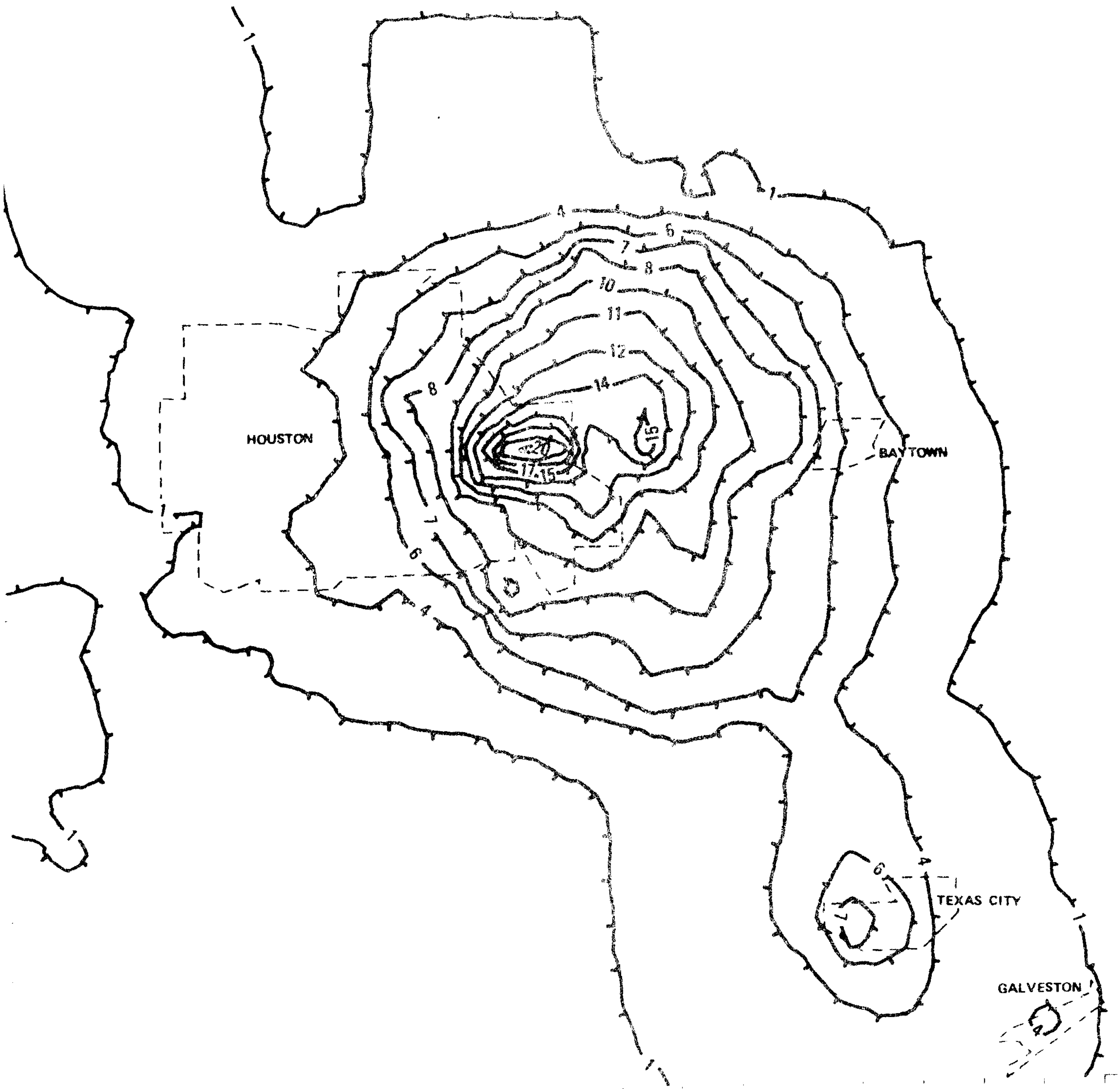
HOUSTON AREA: 1972 ANNUAL SO_2 ($\mu g/M^3$)



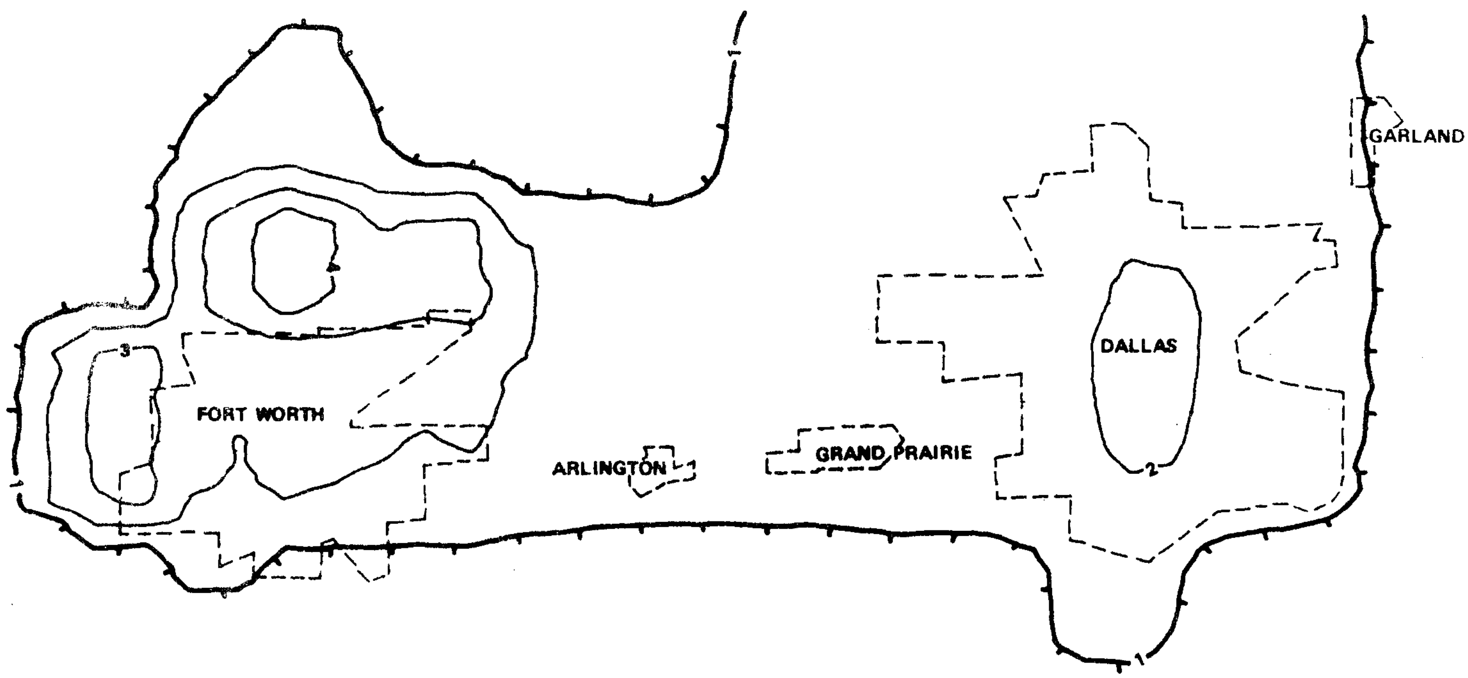
HOUSTON AREA: ES/2 1985 ANNUAL SO_2 ($\mu g/m^3$)



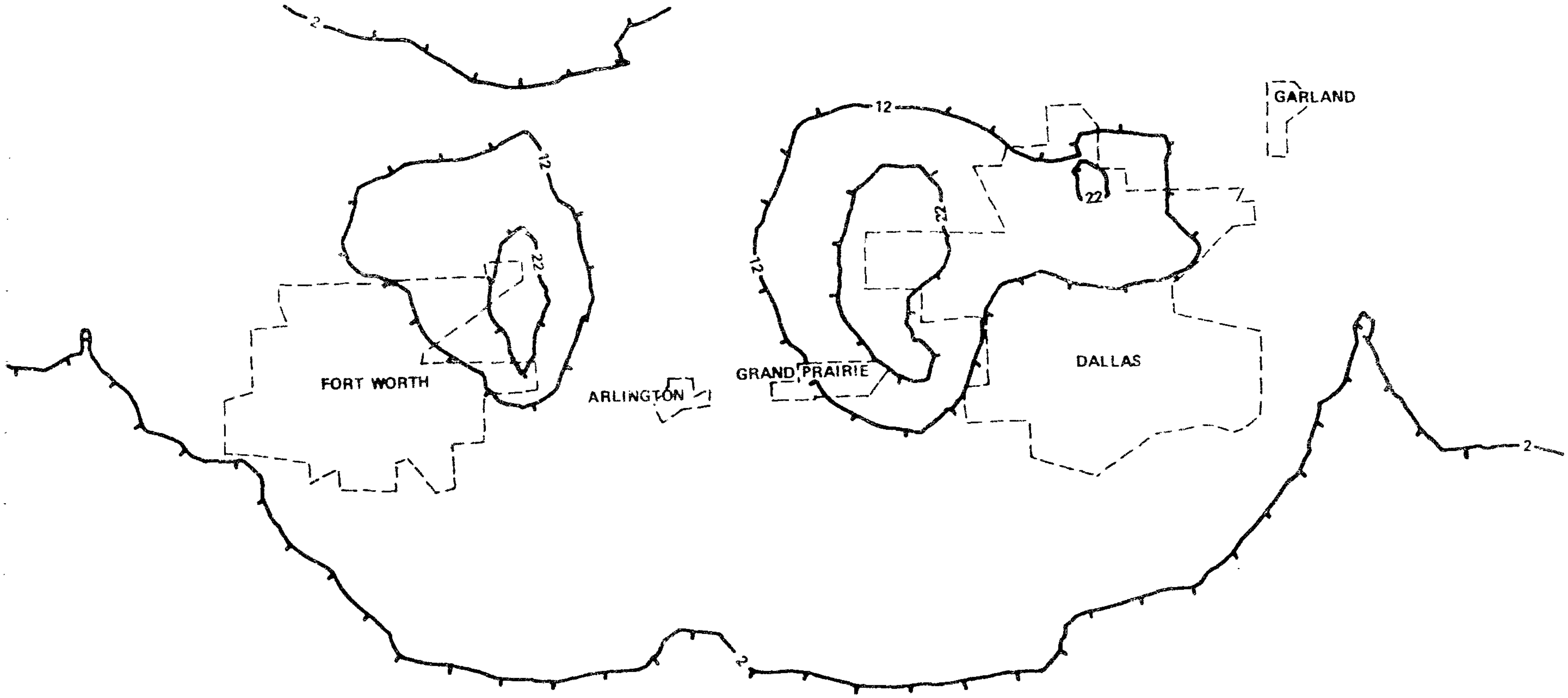
HOUSTON AREA: SCENARIO 1 1985 ANNUAL SO_2 ($\mu g/M^3$)



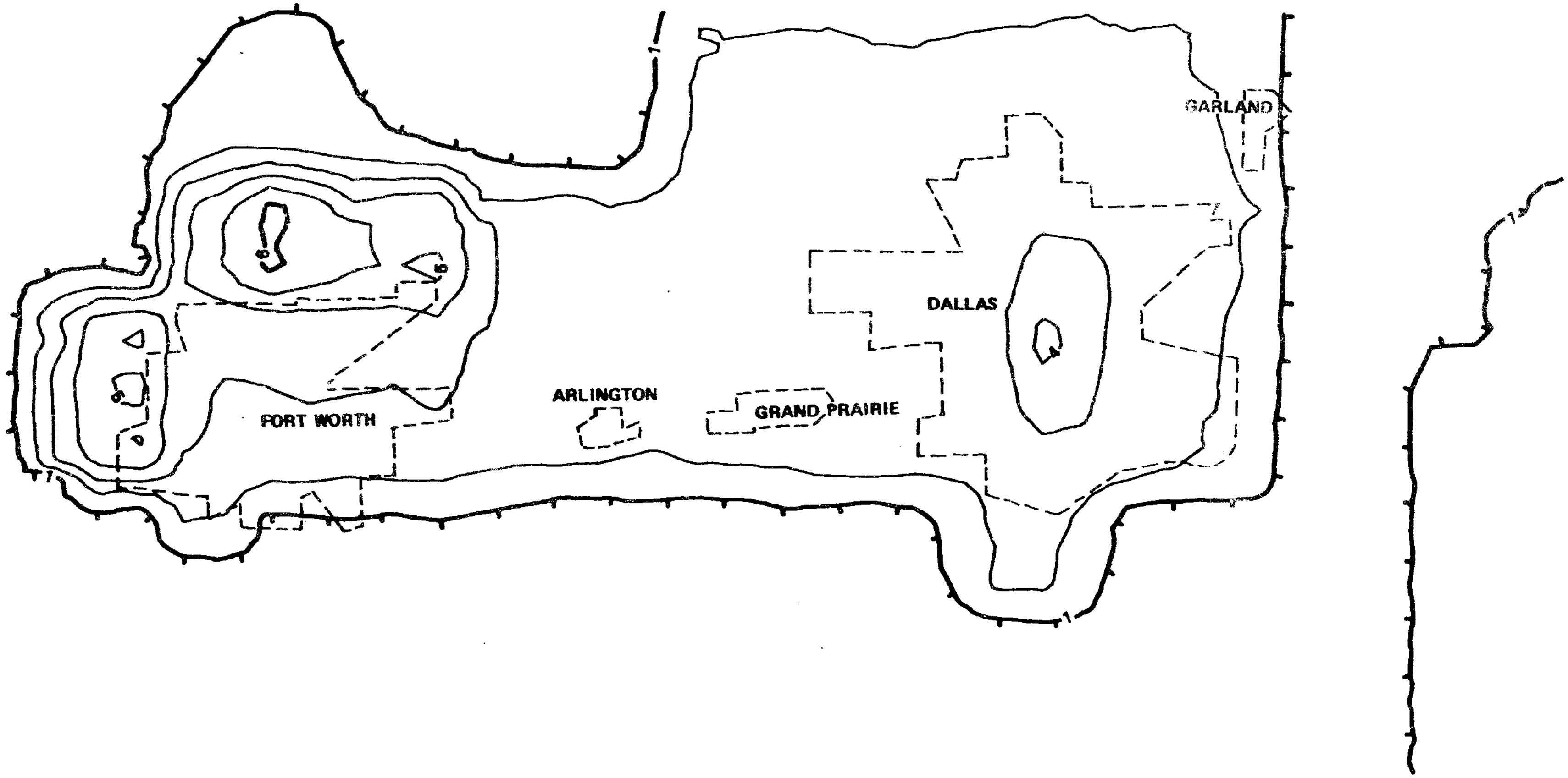
HOUSTON AREA: SCENARIO 2 1985 ANNUAL SO_2 ($\mu g/M^3$)



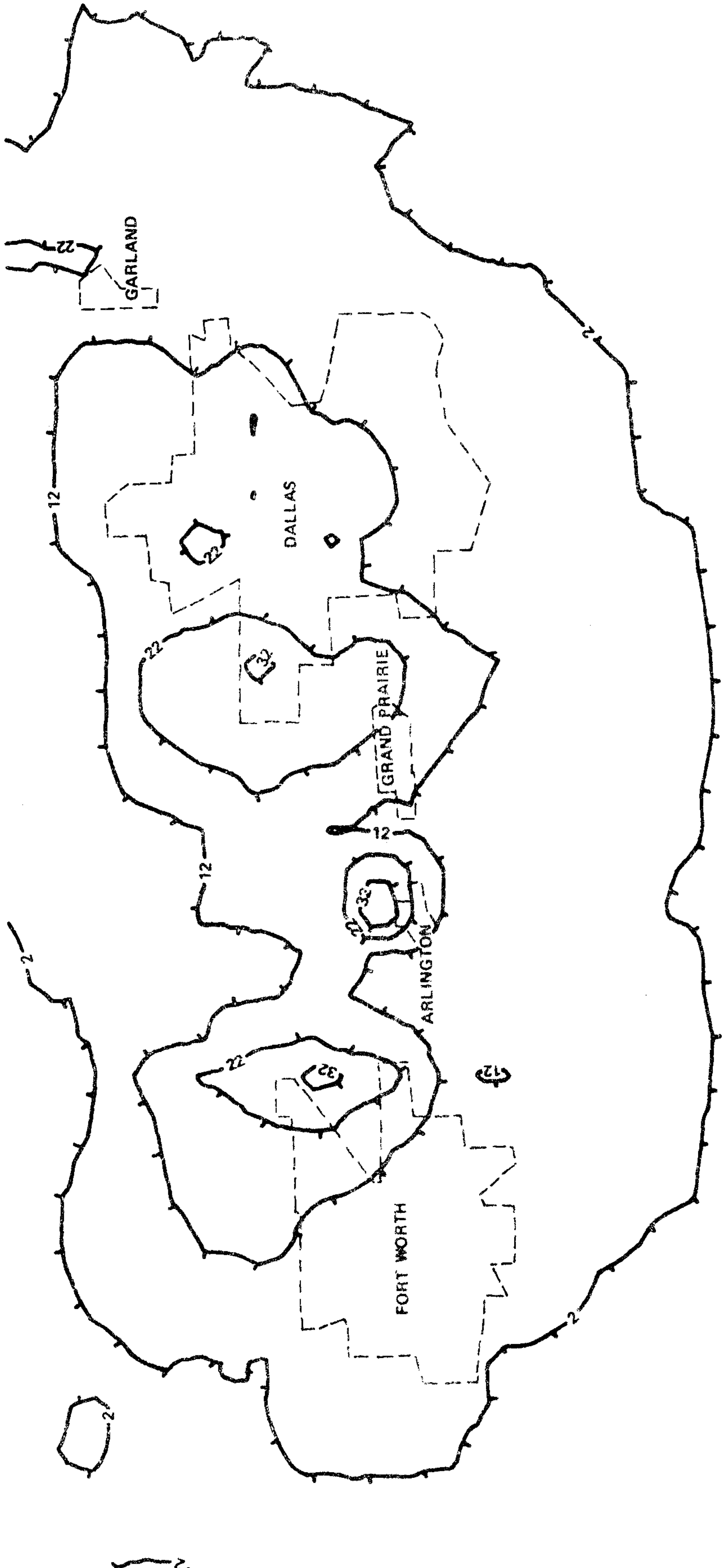
DALLAS – FORT WORTH: 1972 ANNUAL SO_2 (μg/m³)



DALLAS -- FORT WORTH: ES/2 1985 ANNUAL SO_2 (µg/M³)



DALLAS – FORT WORTH: SCENARIO 1 1985 ANNUAL SO_2 (μg/m³)



DALLAS -- FORT WORTH: SCENARIO 2 1985 ANNUAL SO_2 ($\mu g/m^3$)

APPENDIX D

TEXAS POWER PLANT EMISSION PROJECTIONS

TEXAS POWER PLANT EMISSION PROJECTIONS

1972 - 2000

Project E/S-2

Dennis Haverlah, P.E.

Appendix D

POWER PLANT EMISSIONS
1972 - 2000

To establish a date base for commercial electrical utilities in 1972, data from the Electrical Reliability Council of Texas (ERCOT), the Federal Power Commissions data on steam electric generating plants in Texas and data from the Radian Corporation has been compiled by region into Table I. This table shows the generating capacity and primary fuel in each region for the State of Texas in 1972.

In 1972 natural gas was used almost exclusively in Texas and no appreciable amount of oil was burned. In this study, coal and lignite are combined as one fuel source because emissions from these sources are assumed to be regulated to the same degree. The gas turbine, the internal combustion engine and hydro-electric power amount to approximately 3 percent of the total electricity generated in Texas and very little expansion of these facilities is predicted through the year 2000. These facilities are not a significant source of air pollution and are not considered as a part of this study.

Because of the severe natural gas shortage and curtailments of natural gas supplied to utilies in 1973 and 1974, it was assumed that of the liquid and gaseous fossil fuel burned in Texas in 1975, 70% will be natural gas and 30% will be oil.

By 1985, it was assumed that of the oil and natural gas burned, ninety percent will be oil and ten percent will be natural gas. By the year 2000, it was assumed that no electrical utility will be allowed to burn natural gas in its boilers. This assumption is based on the dewindling supply of natural gas and the assumption that home heating and chemical plant feedstock requirements will be allotted all available natural gas. Currently, there is talk of allocating natural gas with utilities at the bottom of the priority list. In addition, coal gasification to manufacture synthetic natural gas is not expected to provide large utilities with gas before the year 2000. This technology is still being developed and it has been shown that burning the coal directly in the boilers is much more efficient than gasifying the coal and transporting the synthetic natural gas to the generating site.

Data provided by the EPA gives total generating capacity for the year 1969 and total power generated in 1969. From this data, a load factor can be calculated. In 1969, this load factor was .51. This load factor was used for 1972 and 1975. Because almost all new units added in the future will be large base-load units and better control equipment will become available, a load factor of .55 is used for the years 1985 and 2000.

Actual planned plant expansion data supplied to this agency by ERCOT, the FPC, and the Radian Corporation.were used to determine generating capacities in Texas for each region for the years 1975 and 1985. This data is presented in Table II. For the period 1985-2000 no projections from the utilities were available. The University of Texas at Austin Lyndon B. Johnson School of Public Affairs has written a preliminary draft report entitled "State Planning for Nuclear Power. This report projects electrical energy requirements for the State of Texas for 1970 through the year 1990. This data is presented in Figure 1. Projection A assumes high population growth and constant 1970 dollar cost for electricity. Projection D assumes low population growth and constant price also. Projections B and E assume Federal Power Commission estimates of price of electricity with B using high population growth and E low population growth. Projection C and F assume the price of electricity doubles by the year 2000 using 1970 dollars with Projection C assuming high population growth and F assuming low population growth. This Figure illustrates that these projections are influenced highly by electrical price changes. In 1974, Central Texas customers have experienced a price increase from 50 to 80 percent. The Lower Colorado River Aughority which services these customers reported a <u>temporary</u> reduction of about 3 percent in electrical demand but new equipment installations continued as in the past with no decrease indicated. Because of this, it is our opinion that demand for electricity is not highly dependent on price but consumers are willing to rearrange priorities to pay more for electricity. Historically, the electrical demand in Texas has been doubling every 8.5 to 9 years for about 30 years. For this study, the electrical demand is assumed to slow its growth to double every 10 years. Plotted on Figure I is Curve G which plots demand of electricity if the demand continued to double every ten years. The equation for the curve is: Demand in year x = (Demand in 1972) $\cdot$ (2) exp $\left(\frac{x-1972}{10}\right)$ where x is the year for which the demand is being determined. Using a 51% utilization factor and total generating capacity as shown on Table I the demand in 1972 is calculated to be 139.6 Gkwh.* Using the above formula, the demand in the year 1985 will be 343.7 Gkwh. Comparing this with the LBJ School of Public Affairs projections in the year 1985, the Curve G is one and a half times the projected growth of C & F curves but only 75 percent of the B and E curves and only 45 percent of the high projections of that study. Also shown is the data point for 1985 - 322.7 Gkwh which is based on known actual expansion plans of the utilities. This data point fits in well with the doubling of capability every ten years. Projecting 1972 demand on out to the year 2000 will yield a demand of approximately 972.6 Gkwh. With a load factor of .55, the total generating capacity required in the year 2000 to meet this demand is 202,000 MWs** of generating capacity.

To determine the emission rates for air pollutants, EPA emission factors for existing sources were used for sources existing in 1972 and 1975 and for the gas-fired boilers in 1985. For the new sources added in 1985 and the year 2000, the EPA New Source Performance Standards as promulgated in the Federal Register, Volume 36, Number 247 dated December 23, 1971, were used. Table 3 summarizes the EPA emission standards for new sources and the State of Texas regulations for solid fossil fuel fired steam generators. The NOx emission rate for lignite fueled boilers was assumed to be the same as coal-fired boilers because the EPA has indicated the lignite exemption for NOx will soon be eliminated and the utilities have indicated that this emission rate is being met by new lignite-fired boilers.

* Gkwh -- Trillions of kwh

** MWs -- Million watts/hr

For the years 1972, 1975 and 1985, the locations of existing and proposed facilities is known. In the year 2000, it is assumed that the demand will increase in proportion to the percentage of the total generating capacity of the state that will exist in each region in 1985.

Based on data supplied by ERCOT and the Occupational Health and Radiation Control Section of the Texas State Health Department, it is assumed that in the year 2000 twenty percent of the generating capacity will be oil, thirty-five percent will be coal or lignite and forty-five percent will be nuclear capacity. Table 4 shows the calculated emissions of particulates, nitric oxides and sulfuric dioxide for the years 1972, 1975, 1985, and 2000 and this data is broken into regions of the State. Because of the conservative growth rate

and large percentage of nuclear power used in the projections, the results are considered to yield low emissions projections for the year 2000.

Data supplied by Radian Corporation indicates that only approximately 35 nuclear reactors will be built in Texas by the year 2000. This corresponds to 42,000 MW of generating capacity or about 22% of the total power requirements of Texas for the year 2000. The Radian Corporation projects this low nuclear capacity based on the limited availability of nuclear fuel for fission type reactors and limited nuclear power plant production capability of the United States. Any gap in Texas generating capability requirements would have to be filled by increasing the coal and lignite generating capability. Table 5 shows the generating capacity for each region as well as the total power plant emissions with the generating capacity provided as follows:

Oil	- 20%
Nuclear	- 22%
Coal and Lignite	- 58%

Particulate, SO_2 and NOx emission rates associated with this distribution of generating capacity are also shown in Table 4. The projections based on the 22% nuclear generating capacity yield emission projections that are the highest that should be expected for the year 2000. Figure 2 plots both the high and low projected emission rates of NOx, SO_2 and particulates for the entire state for the years 1972, 1975, 1985, and 2000.

This report predicts that in the next 25 years Texas will experience very large increases in the emissions of particulates, NOx, and SO_2 from electrical energy production. This increase is due to the requirement to switch from natural gas to alternate fuels and is also caused by the projected increase in electrical demand.

TABLE 1

Generating Capacity - 1972

REGION	GENERATING CAPACITY MWs			
	GAS	OIL	COAL OR LIGNITE	NUCLEAR
1	1790			
2	861			
3	2855		1150	
4	492			
5	1936			
6	987			
7	8220			
8	6997			
9	2314			
10	1404			
11	265			
12	1990			
TOTAL	30,111	-0-	1150	-0-

Note: Many utility boilers are capable of utilizing both gas and oil for fuel. The breakdown of generating capacity by fuel type is used throughout the report to indicate the type of fuel utilized during the year in question.

FIGURE 1

FORECAST OF TOTAL ELECTRICITY DEMAND FOR TEXAS

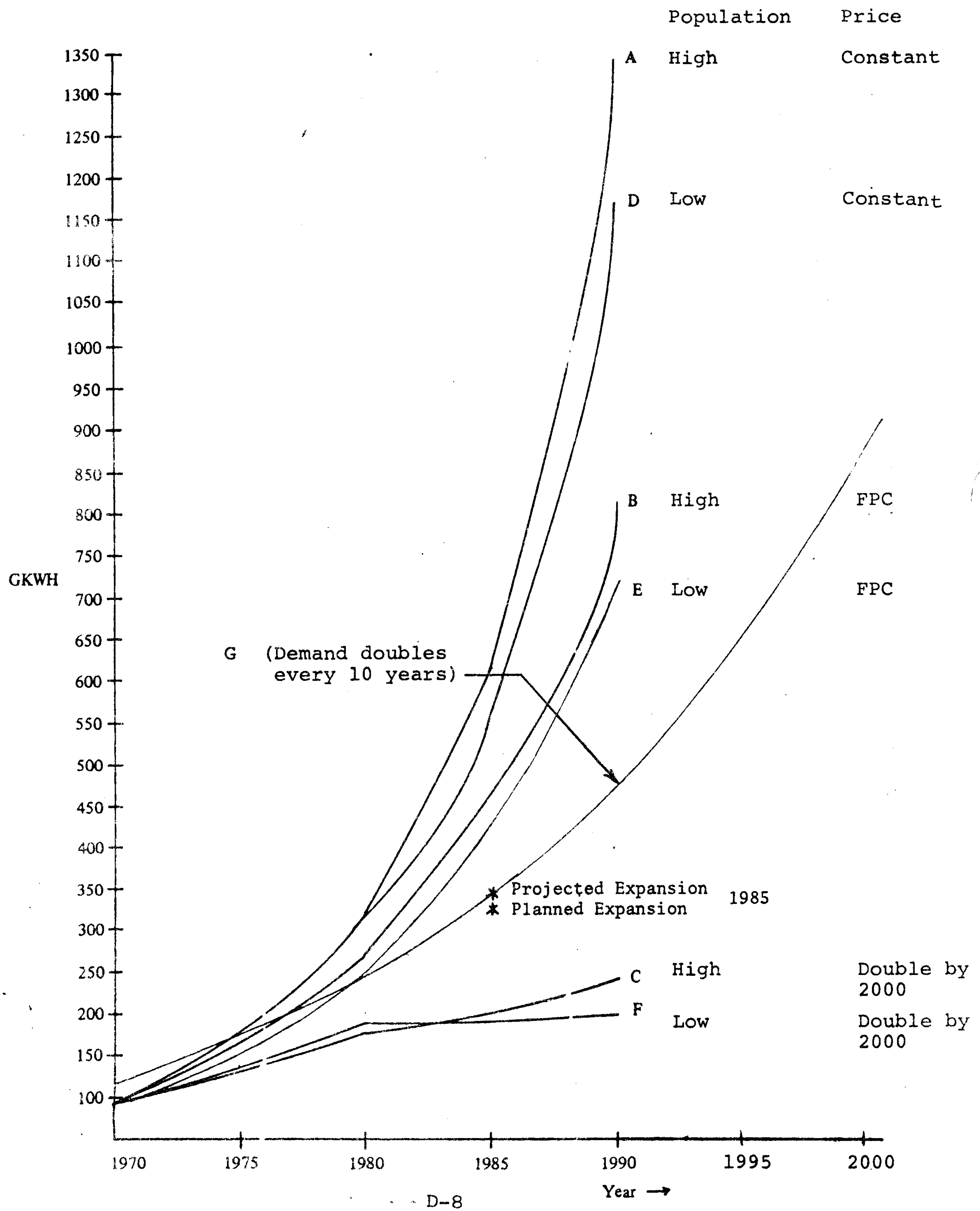


TABLE 2

GENERATING CAPACITY 1975, 1985, 2000

Region	1975 GAS	1975 OIL	1975 C-L	1975 NUC	1985 GAS	1985 OIL	1985 C-L	1985 NUC	2000 GAS	2000 OIL	2000 C-L	2000 NUC
1	1352	580			213	1923				1208	2145	2718
2	780	334			116	1043	700			1052	1839	2365
3	2418	1036	1150		399	3596	1580			3152	5519	7096
4	434	186			73	654				410	719	928
5	1589	681			259	2336	550			1779	3112	4003
6	1064	456			152	1370				861	1507	1937
7	7862	3370			1246	11230	1800	4600		11873	20880	26416
8	6457	2767			976	8724		4630		8700	15755	20454
9	1928	826			276	2478	1760			2554	4467	5745
10	1354	580			241	2173		1800		2382	4172	5363
11	539	231			77	694				436	762	980
12	1356	581	1186		234	2116	6961			5767	9816	12850
TOTAL	27133	11627	2336		4262	48437	13351	11030		40200	70700	90900

TABLE 3

Environmental Protection Agency New Source Performance Standards and Texas Regulations for Solid Fossil-Fueled Steam Generators

I. Fossil-Fuel Fired* Steam Generators - EPA

Standard for particulate matter**	Standard for sulfur dioxide**	Standard for nitrogen oxides (expressed as NO_2)**
(a) 0.10 lb. per million B.T.U. heat input	(a) 0.8 lb. per million B.T.U. heat input when liquid fossil fuel is burned	(a) 0.20 lb. per million B.T.U. heat input when gaseous fossil fuel is burned
(b) 20 percent opacity except that 40 percent opacity shall be permissible for not more than 2 minutes in any hour	(b) 1.2 lbs. per million B.T.U. heat input when solid fossil fuel is burned	(b) 0.30 lb. per million B.T.U. heat input when liquid fossil fuel is burned
		(c) 0.70 lb. per million B.T.U. heat input when solid fossil fuel (except lignite) is burned

II. Solid Fossil Fuel Fired Steam Generators - Texas

Reg. 105.31 No person may cause, suffer, allow, or permit emissions of particulate matter from any solid fossil fuel fired steam generator to exceed 0.3 lbs. per million BTU heat input maximum 2-hour average.

Reg. 201.05 No person may cause, suffer, allow or permit emissions of sulfur dioxide from any solid fossil fuel fired steam generator to exceed 3.0 lb. per million B.T.U. heat input. New proven technology must be applied in removing sulfur dioxide from the emission from solid fossil fuel fired steam generators when it becomes available.

* Fossil fuel means natural gas, petroleum, coal, and any form of solid, liquid, of gaseous fuel derived from such materials.

** All standards are for a maximum 2-hour average.

TABLE 4
Pollution Emission Rates Tons/Year 1972, 1975, 1985, and 2000
Using 45% Nuclear Capacity

	1972			1975			1985			2000		
gion	Part	NO_x	SO_2	Part	NO_x	SO_2	Part	NO_x	SO_2	Part	NO_x	SO_2
1	600	15,900	25	1,850	16,200	11,200	4,700	15,800	37,000	8,100	44,900	84,700
2	300	7,700	15	1,070	9,400	6,400	4,200	20,350	20,000	6,900	38,600	72,900
3	9,257	44,700	82,800	11,600	48,300	102,700	12,600	56,100	114,300	20,900	115,800	218,800
4	170	4,380	6	600	5,200	3,580	1,600	5,500	12,570	2,700	15,100	28,500
5	660	17,240	27	2,200	19,100	13,100	7,050	28,450	60,600	11,800	75,400	23,400
6	340	8,790	14	1,470	12,800	8,800	3,400	11,300	26,300	5,700	31,600	59,800
7	2,800	73,180	112	10,710	94,350	64,900	31,800	122,500	267,400	80,900	437,900	826,800
8	2,400	62,300	95	8,900	77,400	53,280	21,300	83,800	167,000	59,000	328,600	618,800
9	800	20,600	32	2,650	23,100	15,900	10,300	48,950	97,950	17,100	93,800	177,200
10	480	12,500	20	1,860	16,200	11,200	5,300	18,000	41,800	15,900	87,600	165,400
11	90	2,360	4	740	6,500	1,500	1,700	5,700	13,300	2,900	16,000	30,300
12	680	17,720	26	10,150	35,600	94,000	21,900	134,400	245,500	37,500	207,500	392,300
otal	18,580	287,370	83,176	53,800	364,150	386,560	125,800	550,800	1,103,700	270,400	1,492,800	2,798,900

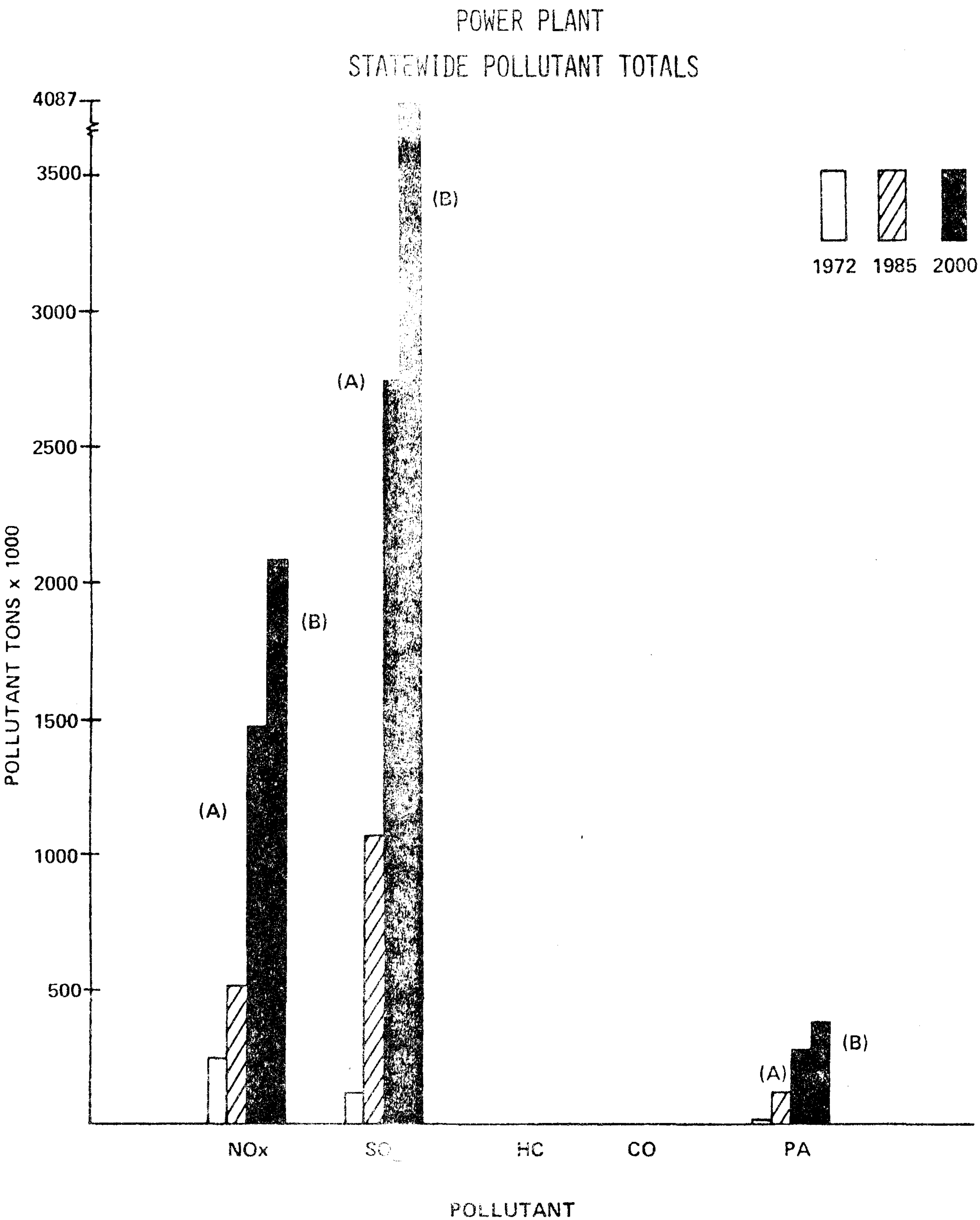
TABLE 5

Generating Capacity and Pollutant Emission Rates - Year 2000

Assuming 22% Nuclear Capacity

Region	Generating Capacity MWs			Pollution Emissions - Tons/Year		
	Oil	Coal or Lignite	Nuclear	Particulates	NO_x	SO_2
1	1,208	3,521	1,336	11,350	64,900	123,800
2	1,052	3,049	1,156	9,800	58,800	107,300
3	3,152	9,145	3,468	29,600	175,400	321,800
4	410	1,193	452	3,900	23,000	41,000
5	1,779	5,159	1,957	16,700	99,600	181,500
6	861	2,497	947	8,100	48,200	87,900
7	11,873	33,144	12,951	108,100	642,600	1,174,800
8	8,700	26,117	9,906	83,700	501,700	913,100
9	2,554	7,404	2,808	24,100	142,900	260,600
10	2,382	6,912	2,622	22,400	133,300	243,200
11	436	1,263	480	4,000	24,300	44,500
12	5,767	16,688	6,330	54,000	322,400	587,500
TOTAL	40,200	116,200	44,400	375,750	2,237,100	4,087,000

FIGURE 2


POWER PLANT
STATEWIDE POLLUTANT TOTALS
4087
3500
3000
2500
2000
1500
1000
500
POLLUTANT TONS x 1000
(A)
(B)
(A)
(B)
(A)
(B)
1972
1985
2000
NOx
HC
CO
PA
POLLUTANT

APPENDIX E

TEXAS PETROCHEMICAL INDUSTRY

EMISSION PROJECTIONS

TEXAS PETROCHEMICAL INDUSTRY EMISSIONS PROJECTIONS

1972 - 2000

Project E/S-2

Sam Crowther, P.E.

Appendix E

TABLE OF CONTENTS

	Page
Objective	1
Summary	1
Approach	1
Data Sources	1
Figure 1 - Location of Texas Petrochemical Industry	3
Table 1 - Texas Petrochemical Plant 1972 Emissions by County	5
Table 2 - Texas Point Source 1972 Emissions by County	7
Table 3 - Texas Petrochemical Plant 1972 Emissions by Region	9
Table 4 - Survey of 32 Texas Petrochemical Plant Sites	11
Table 5 - Assumptions Made for Table 6 Projections	13
Table 6 - Texas Petrochemical Industry Energy and Emissions Projections	15
Table 7 - 1975 and 1985 Projected Petrochemical Industry Emissions by Region	17

Projection of Texas Petrochemical Industry Emissions

Objective

The objective of this report is to define Texas petrochemical industry emissions for a base year (1972) and to project future emissions through the year 2000.

Summary

Petrochemical industry emissions are projected on the basis of an industry growth rate of 9.6 percent compounded annually through 1980 and a 5 percent rate from 1980 through 2000. This growth rate may be optimistic but is considered appropriate for the purpose of examining "pessimistic but possible" emission projections.

Given current State and Federal air pollution regulations and projected industry growth rates, substantial increases in NO_x, SO_2 and particulates will occur by 1985 from petrochemical sources. The bulk of the increase is produced by the switch to fuel oil and coal burning.

Existing restrictions imposed by TACB Regulation V governing carbon compound emissions may be adequate to maintain hydrocarbon and carbon monoxide emissions from petrochemical sources below 1972 levels at least until 1985.

Approach

Total 1972 products, energy use, and emissions are defined for 32 Texas petrochemical plant sites. These 32 sites accounted for about 90 percent of statewide petrochemical related emissions in 1972. Statewide growth of emissions for 90 petrochemical sites is projected based on an assumed 32-site growth rate and the anticipated effect of present pollution regulations, performance standards and control technology. Projected emissions are redistributed on a Regional basis in proportion to 1972 Regional hydrocarbon emission levels.

Data Sources

Data was obtained from the Texas Air Control Board 1972 Emission Inventories for 90 petrochemical plant sites and from a telephone survey of 32 petrochemical sites.

The year 1972 was selected as the base year because (1) corrected emissions inventories and computer summaries for 1973 were not available and (2) 1972 may represent best the emissions picture preceding the influence of most of the Texas Air Control Board Regulations.

Discussion of Figure 1

The location of the Texas Petrochemical Industry in 1972 (90 sites) is shown in Figure 1 in terms of hydrocarbon emissions. The location of existing petrochemical facilities in the coastal counties has been determined by the usual factors of favorable availability of feed stocks, large markets, labor supply, deep water transportation, and fresh water supply. One company official accurately described the Houston Ship Channel as the "best spot in the world" for petrochemical production. Most of the existing petrochemical sites have adequate land on which to expand. Those without adequate additional land are expected to tear down and rebuild as needed rather than expand to areas not endowed with the location factors described.

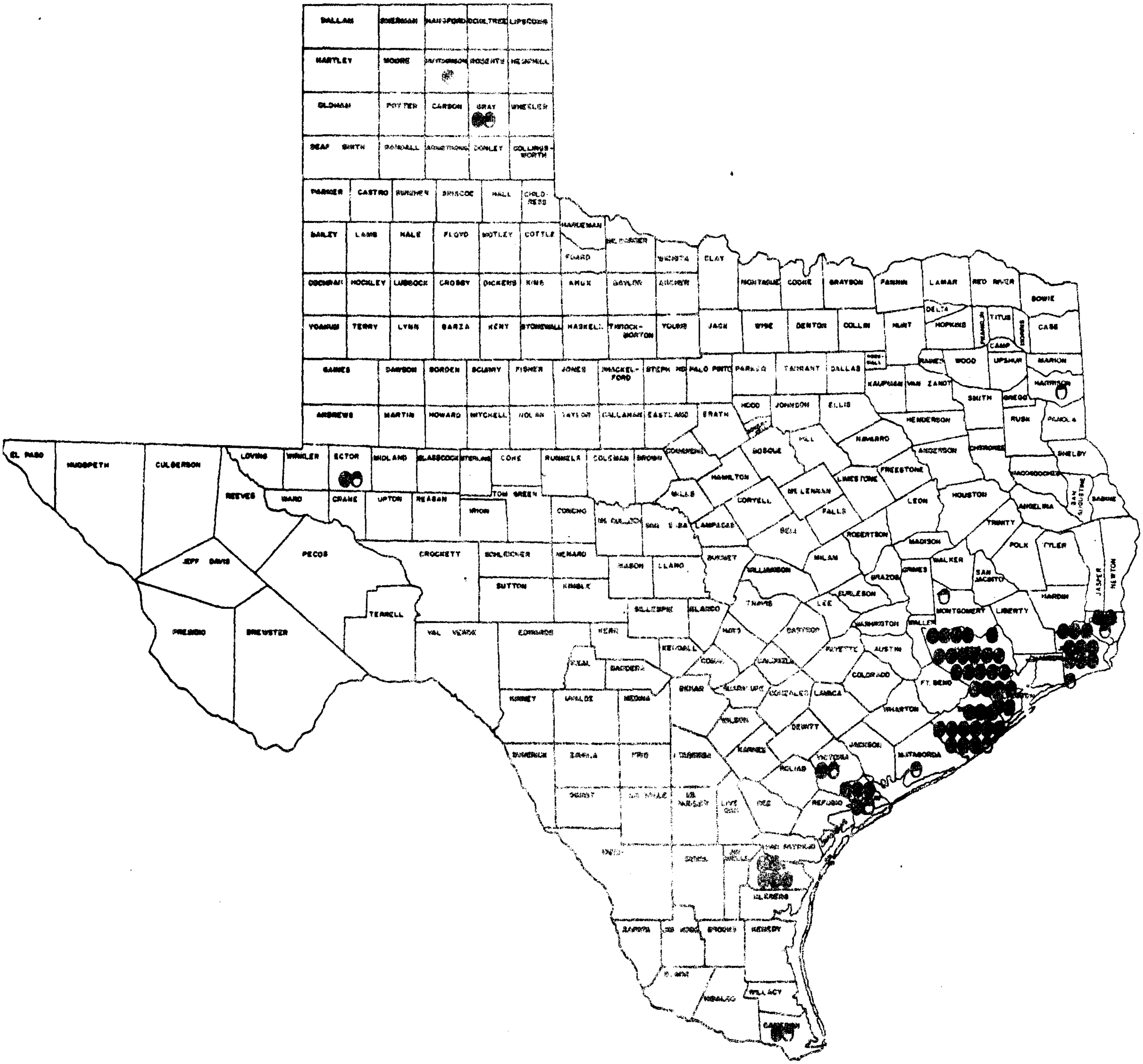
The location factors are expected to play an even greater role in determining petrochemical locations in the future, particularly with increased importation of foreign crude stocks, increased development of foreign markets and the continuing cost advantage of water transportation. As a result growth in the Texas Petrochemical Industry is expected to occur in the present coastal county locations in an even greater proportion to inland locations than is depicted in Figure 1.

In many cases, existing plant sites, already crowded for space, cannot grow at the rates projected. It is assumed that the growth rates will prevail and that companies will expand into other coastal sites if not at existing sites.

The coastal location of industry in Texas suggests at least two possible impacts in air pollution in Texas. First, the meteorology along the coast is more favorable for dispersion of emissions than would be most inland locations. Second, little comfort is taken in the favorable coastal meteorology because prevailing southeasterly winds carry the pollutants inland to populated areas. A beneficial land use planning concept from an air pollution viewpoint might be to arrange for industry locations southwest of and spaced in-between coastal cities.

FIGURE 1
Location of
Texas Petrochemical Industry
1972 (90 Sites) Hydrocarbon Emissions

● = 10,000 tons non-CH_4



Discussion of Table 1

Table 1 lists 1972 emissions from 90 Petrochemical plant sites by county. The 90 sites include all petrochemical facilities in Texas which represented hydrocarbon emissions in the 1972 emission inventory. The present study is limited to an evaluation of the major pollutants. Methane-type hydrocarbon emissions and ammonia emissions are not evaluated. Accordingly, carbon black plants and ammonia plants were not included in this first-pass emission projection. All other principal facilities manufacturing organic products from liquid and gaseous hydrocarbon feedstocks are included.

The 90 petrochemical sites are located in only 18 counties and about 90 percent of all the petrochemical emissions are located in 10 coastal counties. Harris and Brazoria counties alone account for about one-half the statewide petrochemical emissions.

In terms of all Texas point sources, the petrochemical related industry accounts for about 40 percent of all 1972 hydrocarbon emissions and about 20 percent of the 1972 NO_x emissions. In 1972, the petrochemical sources emitted only a small proportion of statewide SO_2, CO and particulate emissions.

TABLE 1

Texas Petrochemical[1] Plant Emissions By County
Adjusted 1972 Emissions Inventory Data[2]

Region	County	Number of Sites	1972 Emissions in Tons NO_x	SO_2	HC	CO^3	PA
1	----	0					
2	Gray	1	1,903	18	17,695	1,548	128
	Hutchinson	3	2,905	1,268	7,671	4,642	204
3	Travis	2	26	-------	5	-------	2
4	Cameron	1	967	16	14,558	5,174	67
5	Calhoun	1	9,047	13	42,293	266	842
	Nueces	2	11,230	13	49,013	35,120	1,694
	Victoria	1	11,569	5	15,483	14,661	366
6	Ector	7	2,790	6	12,420	1,903	279
7	Brazoria	7	47,455	2,471	143,555	41,405	2,882
	Chambers	1	174	5	35	---	86
	Galveston	6	14,033	1,265	45,774	1,601	1,275
	Harris	38	31,336	30,257	160,314	40,060	4,034
	Matagorda	1	4,722	-------	5,847	2,064	269
	Montgomery	1	189	-------	449	-------	81
8	----	0					
9	----	0					
10	Angelina	1	86	-------	70	-------	7
	Jefferson	10	15,169	1,760	96,255	27,679	1,820
	Orange	6	14,052	185	26,336	9,855	559
11	----	0					
12	Harrison	1	3,562	-------	1,318	21	245
STATE PETCHEM	18 Counties	90	171,215	37,282	639,091	185,999	14,840
(% of State Point Sources)			(21.5)	(3.9)	(40.0)	(6.7)	(2.8)
COASTAL PETCHEM	10 Counties	73	148,185	35,985	583,980	163,224	13,528
(% of State Petrochemical)			(86.5)	(96.5)	(91.4)	(87.8)	(91.1)
HARRIS & BRAZ PETCHEM	2 Counties	45	78,791	32,728	303,869	81,465	6,916
(% of State Petrochemical)			(46.0)	(87.7)	(47.5)	(43.7)	(46.6)
STATE POINT SOURCE -- All Counties			794,907	952,743	1,593,109	2,772,838	537,448

[1] Includes some general chemical plant emissions where emissions were significant and not covered in a separate study. Carbon black and ammonia plants not included in petrochemical totals, but would be included in State point source totals.

[2] 1972 Inventory data adjusted to include calculated combustion emissions and evaporative hydrocarbon emissions if these values were not submitted by the company.

3 Approximately 1 million tons of 1972 CO emissions from carbon black and charcoal plants are not included in this table as Petrochemical emissions but are included in the State point source total. Almost 60% of the carbon black plant emissions are in Region 2.

Discussion of Table 2

Table 2 presents 1972 emissions data for all point sources (not just chemical plants) in the counties which have petrochemical facilities. County petrochemical values of Table 1 may be compared to all point source data of Table 2.

TABLE 2

All Texas Point Source Emissions for
Counties Having Petrochemical Facilities

Adjusted 1972 Emissions Inventory Data[1]

Region	County	1972 Emissions In Tons				
		NO_x	SO_2	HC	CO	PA
2	Gray	3,873	430	21,796	59,643	560
	Hutchinson	13,290	16,774	63,056	513,692	6,422
3	Travis	4,662	265	3,255	6	1,942
4	Cameron	4,690	27	15,023	5,177	818
5	Calhoun	50,487	392	68,662	320	9,922
	Nueces	29,482	7,261	109,007	157,177	6,024
	Victoria	16,201	23	15,851	14,692	748
6	Ector	11,900	36,619	34,839	3,572	1,096
7	Brazoria	52,255	8,618	153,958	170,616	6,485
	Chambers	16,065	34	4,128	3,438	2,453
	Galveston	56,382	42,600	107,745	114,454	9,071
	Harris	97,681	131,089	329,095	449,445	62,209
	Matagorda	5,847	3	8,908	2,071	989
	Montgomery	8,591	412	9,248	90,193	4,684
10	Angelina	2,981	3,637	2,313	8,574	23,928
	Jefferson	64,982	91,064	266,373	331,838	15,806
	Orange	20,181	4,506	31,324	79,820	7,589
12	Harrison	4,075	1,385	2,312	4,168	7,866

[1] 1972 Inventory data adjusted to include calculated combustion emissions and evaporative hydrocarbon emissions if these values were not submitted by the company.

Discussion of Table 3

Table 3 regroups the 1972 emissions data of Tables 1 and 2 into Region totals. Petrochemical industry emissions account for an appreciable portion of total emissions only in Regions 5, 7 and 10.

TABLE 3

Texas Petrochemical[1] Plant Emissions By Region
Adjusted 1972 Emissions Inventory Data[2]

Region	Number of Counties	Number of Sites	1972 Emissions in Tons NO_x	SO_2	HC	CO	PA
			(All region point sources in parentheses)				
1	0	0	------- (32,019)	------- (1,228)	------- (19,105)	------- (304)	------- (24,445)
2	2	4	4,808 (47,783)	1,286 (102,623)	25,366 (174,215)	6,190 (938,122)	332 (41,403)
3	1	2	26 (42,557)	------- (85,255)	5 (12,819)	------- (5,159)	2 (74,181)
4	1	1	967 (10,532)	16 (208)	14,558 (21,778)	5,174 (5,838)	67 (2,715)
5	3	4	31,846 (140,989)	31 (12,787)	106,789 (245,725)	50,047 (293,031)	2,902 (24,053)
6	1	7	2,790 (46,530)	6 (174,455)	12,420 (102,413)	1,903 (76,854)	279 (8,923)
7	6	54	97,909 (261,214)	33,998 (182,879)	335,974 (624,831)	85,130 (831,092)	8,627 (102,135)
8	0	0	------- (53,050)	------- (10,366)	------- (32,051)	------- (15,520)	------- (81,269)
9	0	0	------- (14,058)	------- (14,962)	------- (9,338)	------- (111)	------- (37,442)
10	3	17	29,307 (92,226)	1,945 (101,031)	122,661 (302,720)	37,534 (444,734)	2,386 (92,013)
11	0	0	------- (5,485)	------- (194,044)	------- (6,509)	------- (79,876)	------- (6,971)
12	1	1	3,562 (48,464)	------- (72,905)	1,318 (41,599)	21 (82,197)	245 (41,898)
TOTAL	18	90	171,215 (794,907)	37,282 (952,743)	639,091 (1593,109)	185,999 (2772,838)	14,840 (537,448)

1 Includes some general chemical plant emissions where emissions were significant and not covered in a separate study. Carbon black and ammonia plants not included in petrochemical totals, but would be included in State point source totals.

2 1972 Inventory data adjusted to include calculated combustion emissions and evaporative hydrocarbon emissions if these values were not submitted by the company.

Discussion of Table 4

To get a feel for Texas petrochemical industry growth in products and energy, a telephone survey of 32 of the 90 sites was conducted. A larger survey would be useful when time permits. The 32 facilities account for 90 percent of the hydrocarbon emissions from the 90 sites. Table 4 presents a summary of the information obtained in the survey. Individual plants are not described because the data is considered proprietary by the companies.

The 32 sites are expected to grow rapidly through 1980 at a rate which the TACB staff projects as 9.6 percent compounded annually on the basis of the survey. After 1980, the projection is taken as 5 percent compounded annually to the year 2000. Most of the 1972-1980 growth appears to be a "run" on converting more of the barrel of crude oil to other than fuel products. After 1980, the growth projection reflects a probable decrease in the growth rate of processing crude oil to petrochemical feedstocks. A gradual shift to a petrochemical growth based on more expensive coal derivative feedstocks and an increase in recycle of products made from carbon compounds may support a 5 percent or less annual growth after 1980. These growth values are aggressive considering the unclear availability of sufficient feedstocks and energy to support such growth. However, this high level of growth is foreseen at least through 1980 by the industries contacted. Perhaps the growth rates selected will permit a "pessimistic but possible" emissions projection for the purpose of this report. It did not seem useful to examine a least growth-least emissions projection.

TABLE 4

Survey of 32[1] Texas Petrochemical Plant Sites

Year	Total Products 10^6 Tons	Fossil Fuel 10^{12} BTU	Purchased Elec.[2] 10^{12} BTU	Total Energy 10^{12} BTU	NO_x Tons	SO_2 Tons	HC Tons	CO Tons	PA Tons
1972	29.7	681[4]	33[5]	714	142012	27343	570115	170535	10809
		lbs emission/100 lbs product →			0.478	0.0920	1.92	0.574	0.0364
	9.6 compound growth	lbs emission/10^6 BTU →			0.417	0.0803	1.67	0.501	0.0318
1980[3]	61.7	1133	60	1193	------	------	------	------	------

1 32 Largest petrochemical sources of hydrocarbon emissions, 1972

2 Reported Kwhr converted to BTU (3413 BTU/Kwhr) with no efficiency corrections

3 Projected by TACB staff based on the survey

4 386 x 10^{12} BTU fossil fuel used in process boilers

5 32 x 10^{12} BTU (9376 x 10^6 Kwhr) was generated on-plant using an unknown portion of the fossil fuel

Discussion of Table 5

Table 5 lists the principal assumptions made which underlie the Table 6 emission projections. Other projections may be constructed by applying new assumptions to the 1972 values of Table 5.

TABLE 5

Texas Petrochemical Industry Study

Assumptions Made for Table 6 Projections

1. Continued petrochemical growth in present (Table 1) petrochemical counties. No petrochemical addition in other counties.
2. Petrochemical product growth projected at 9.6% compounded annually through 1980, 5% compounded annually from 1980 to 2000.
3. Rollback of 1972 emissions via Regulation.
   - A. NO_x - none.
   - B. SO_2 - 80% reduction of 1972 sources by January, 1977. (Little effect as petrochemical SO_2 in 1972 was almost negligible).
   - C. HC and CO - 80% reduction of 1972 sources by June, 1975.
   - D. Particulate - 50% rollback of particulate sources by January, 1974.
4. Fuel Distributions

Fuel	wt % S	% of Total Energy 1975	1980	1985	2000
Natural gas	0	60	20	10	10
Waste gas	0	20	20	20	20
#6 Fuel oil	0.8	20	50	50	20
Coal	2.0	0	10	20	40
Nuclear or other	0	0	0	0	10

5. Growth in emissions with no new regulation development.
   - A. Combustion sources
     1. NO_x, SO_2 and Particulate - growth projected using Table 4 energy values, product growth percentages in No. 2 above, and emission limits per Federal New Source Performance Standards, Federal Register, Thursday, December 23, 1971, Vol. 36, No. 247, Part II.
     2. HC and CO - growth using same approach as for NO_x except emissions determined with emission factors contained in AP-42, Compilation of Air Pollutant Emission Factors, Second Edition, USEPA, April, 1973. One exception CO from Natural gas combustion is assumed to be 4 lbs per 10^6 ft^3 instead of the AP-42 value of 17 lbs per 10^6 ft^3.
   - B. Process sources
     1. NO_x and SO_2 growth with products growth.
     2. HC - growth based on permit experience at 6.127 lbs HC per Ton products.
     3. CO - growth at 0.1 lb CO/10^6 BTU or 20% of Table 4 value for 1972.
     4. Particulate - growth at 0.016 lb/ton products or 50% of Table 4 value for 1972.

Discussion of Table 6

Table 6 is an estimate of future emission values obtained by extrapolating the 90-site emission data of Table 1 with the use of all the assumptions listed in Table 5. The projections suggest the areas where future emissions controls most will be needed.

1975

The effect of growth and a partial conversion from gas to fuel oil is expected to triple SO_2 from petrochemical sources by 1975. For the first time the petrochemical industry will become a major SO_2 source in Texas.

Emissions of NO_x and particulate increase appreciably by 1975 from the combined effect of greater energy consumption and partial conversion to fuel oil burning. Most of the increase is from combustion and not from process waste gas streams. The increased particulate level probably is not significant compared to statewide particulates.

The increased NO_x is substantial and may take on greater significance when viewed with the expected decrease in hydrocarbon and carbon monoxide emissions brought about by compliance with TACB Regulation V. The ratio of petrochemical emissions of hydrocarbons to NO_x changes from 3.7 in 1971 to 0.76 in 1975. With changes from other fixed point sources in the same direction of decreased HC/NO_x ratios, the atmospheric mix of pollutants after 1975 may not resemble the 1972 mix. An accurate appraisal of the effect of this change in HC/NO_x ratio probably cannot be made with present knowledge. However, the expected magnitude of the change should add incentive to expedite studies of atmospheric chemistry--particularly in Harris County.

1985

The projection of 1985 reflects major increases in all pollutants. The NO_x, SO_2 and particulate increases are primarily from oil and coal burning. Increases in carbon compounds are primarily from growth of process sources. Even with the increases, the carbon compounds are not expected to regain the 1972 levels by 1985. The projected NO_x and SO_2 levels for 1985 from petrochemical sources are not far below the 1972 values for all Texas point sources (see Table 1). By 1985, the particulate emissions from petrochemical fuel burning operations are expected to be a significant portion of statewide particulate emissions.

TABLE 6

Texas Petrochemical Industry Energy & Emission Projections
(Based on 90 Petrochemical Sites)

Year	Total[1] Products 10^6 Tons	Total[1] Energy 10^{12} BTU	Emissions NO_x Tons	SO_2 Tons	HC Tons	CO Tons	PA Tons
1972[2]	48	950	171,000	37,000	640,000	186,000	15,000
1975	63	1250	233,000	110,000	177,000	57,000	25,000
1980	100	1978	455,000	400,000	298,000	107,000	103,000
1985	127	2524	644,000	828,000	384,000	144,000	130,000
2000	264	5247	1,470,000	1,720,000	803,000	309,000	241,000

1 1972 product and energy levels were estimated by interpolation of the 33 site data (Table 4) and the September 24, 1974 interim values generated by a study of over 200 chemical plant sites by Dr. H. W. Prengle, Jr. and associates (Project S/D-10, University of Houston). Projections hold energy use constant at 20 x 10^6 BTU per ton of products.

2 1972 Emissions data for 90 sites from Table 1.

Discussion of Table 7

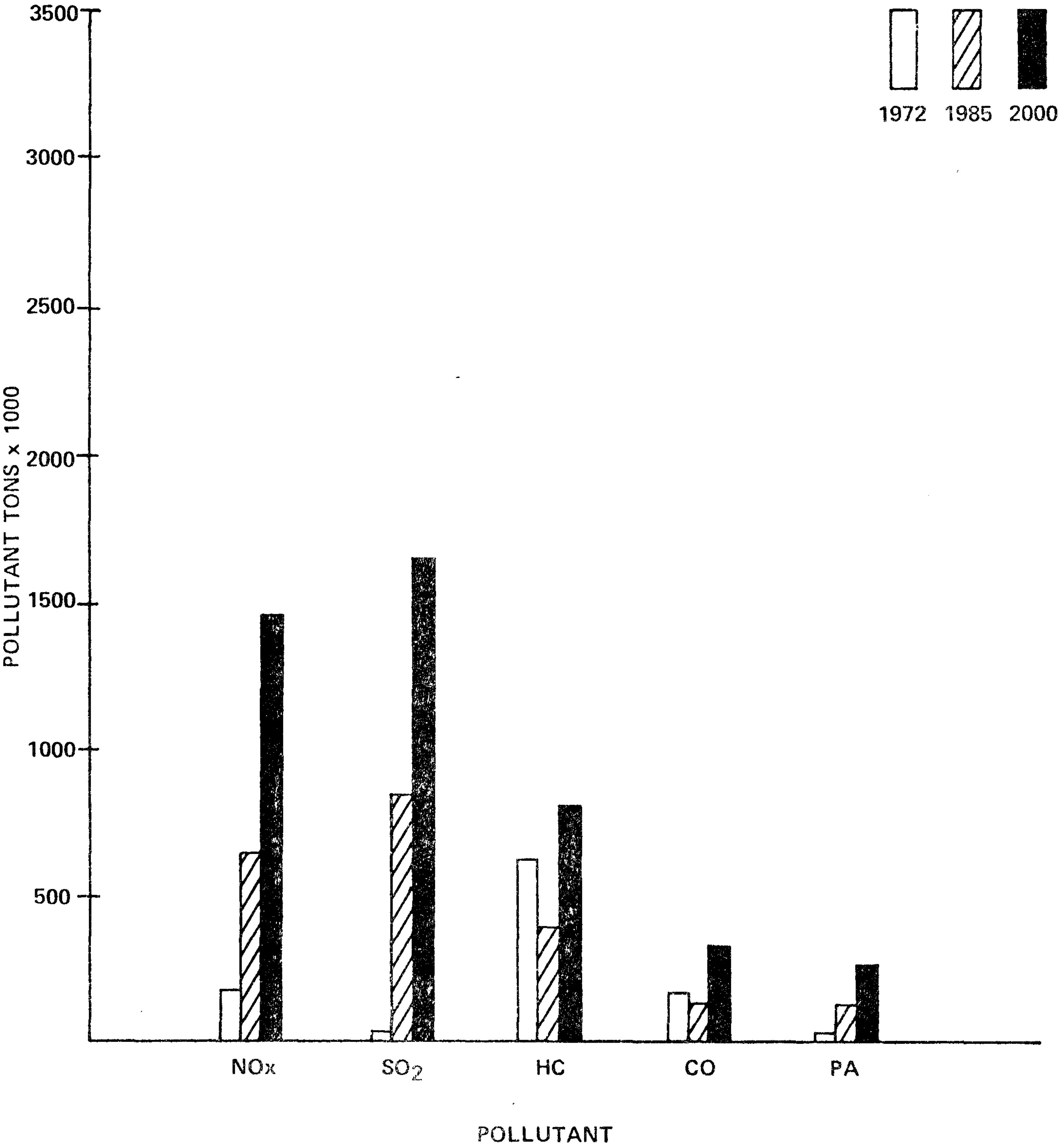
The projections of Table 6 are redistributed to the Regions in Table 7. Distribution is made in proportion to the Regional hydrocarbon values of Table 3. Any Region projected to have less than 1000 tons of any one pollutant are omitted from Table 7.

TABLE 7

1975 and 1985 Projected Petrochemical
Industry Emissions by Region

Year	Region	NO_x Tons	SO_2 Tons	HC Tons	CO Tons	PA Tons
1975	2	9,000	4,500	7,000	2,300	1,000
	4	5,000	2,500	4,000	1,300	600
	5	39,000	18,400	29,600	9,500	4,200
	6	4,500	2,100	3,400	1,100	500
	7	130,000	61,300	98,500	31,800	13,800
	10	45,000	21,000	34,000	10,900	4,800
	12	500	200	500	100	100
	TOTAL	233,000	110,000	177,000	57,000	25,000
1985	2	25,600	32,900	15,200	5,700	5,100
	4	14,700	18,900	8,800	3,300	3,000
	5	107,600	138,400	64,200	24,100	22,000
	6	12,500	16,100	7,500	2,800	2,500
	7	358,700	461,100	214,000	80,200	72,200
	10	123,600	158,900	73,500	27,600	24,900
	12	1,300	1,700	800	300	300
	TOTAL	644,000	828,000	384,000	144,000	130,000

PETROCHEMICAL INDUSTRY
STATEWIDE POLLUTANT TOTALS



APPENDIX F

TEXAS PETROLEUM REFINING INDUSTRY

EMISSION PROJECTIONS

TEXAS PETROLEUM REFINING INDUSTRY EMISSION PROJECTIONS

1972 - 2000

Project E/S-2

Frank Spuhler, P.E.

Appendix F

TABLE OF CONTENTS

	Page
Objective	1
Capacity	1
Verification of List	1
Mid-Continent Questionnaire	2
Pollution Emission in 1972	2
Refinery Fuel Usage	3
Base Case Year is 1972 followed by Growth	4
Projected Growth	5
Growth within Regions	5
Change in Fuel Usage in Refineries	6
Pollution Emission(s) by Regions, 1972-2000	7
Conclusions	7
Bibliography	9
Tables	
1 Outline of Work Plan	10
2 Capacity of Texas Refineries, 1972	11
3 Refinery Emissions, 1972	13
4 Refinery Portion of Statewide Emissions, 1972	15
5 Refinery Capacity and Fuel Usage	16
6 Fuel Usage by Refinery Size	17
7 Emissions by Region, 1972	18
8 Emissions by Region, 1975	19
9 Emissions by Region, 1985	20
10 Emissions by Region, 2000	21
11 Emissions Statewide, 1970-2000	22
Figures	
1 Statewide Pollution Totals, 1970-2000	23
2 NO_x Emissions by Regions, 1970-2000	24
3 SO_2 Emissions by Regions, 1970-2000	25
4 HC Emissions by Regions, 1970-2000	26
5 CO Emissions by Regions, 1970-2000	27
6 Pa Emissions by Regions, 1970-2000	28

Objective

The objective of Project E/S-2 is to examine the impact on air quality of alternate strategies for production, distribution and utilization of energy in Texas in the period 1975-2000. This portion of the input data concerns existing and future petroleum refining capacity, fuel usage, fuel conversions, and the resultant pollutant emissions from refining operations. The key years are 1972, 1975, 1985 and 2000. 1972 is the latest year for which capacity, fuel usage, emissions, etc. is documented and thus, serves as the Base Year. 1975 and 1985 are the key years in determining compliance with the requirements of the State and Federal Clean Air Acts. The Federal Standards for named pollutants are to be achieved in all Regions by 1975 (or 1977)* and maintenance of these standards is required thereafter. The following 10-year period (1975-1985) is to be examined for maintenance using an area basis (SMSA's).

An outline of the Work Plan for Refineries (Table 1) breaks the effort down into nine steps.

Capacity of Texas Fuel Products Refineries

The capacities of the Texas fuel products Refineries operating in 1972 are listed in Table 2 in both barrels per calendar day (B/CD) and barrels per stream day (B/SD). The Bureau of Mines format of Inland/Gulf Coast split is used. The 15 Inland Refineries operating in 1972 had a capacity of 417,850 B/CD whereas the 22 Gulf Coast Refineries had a capacity of 3,093,305 B/CD. Natural Gas Liquids (NGL) as well as crude is "Runs to Stills" in these refineries; in some cases the fraction of feeds other than crude is significant in its contribution to the fuel product mix. The extra NGL in 1972 is estimated to 175,000 B/CD. The total capacity in B/CD for the 37 fuel products refineries including the NGL is listed as 3,686,155 out of a B/SD capability of 3,844,870.

Verification of the List of Refineries

Source data for operating capacity for fuel products is API, Bureau of Mines, Oil and Gas Journal, Texas Railroad Commission, and the TACB Emission Inventory Files. In some cases where values were not reported, estimates were made. A number of refineries were idle, produced specialty products, reclaimed

* 1977 applies if a 2-year extension is granted.

motor oil, recovered tank bottoms, or was a petrochemical operation, hence these non-fuel products facilities were not counted in this study as operating refineries in the Base Year, 1972. Refer to Appendix Item 7 for supplemental information.

The above numbers contrast with the Railroad Commission compilation (Runs to Stills) of 3,643,841 B/CD in calendar year 1972, the Mid-Continent Survey value of 3,360,586 B/CD for 24 reporting Refineries and the API listing of 3,774,000 B/CD.

Our conclusion is that the 37 Refineries considered actually charged 3,643,841 B/CD as Runs to Stills. The differences result primarily from treatment of Natural Gas Liquids and the classification of Refineries and Natural Gas or GAsoline Plants. As an additional check on the refineries in Texas, the Refinery Section of the R. W. Byram and Company Survey for 1974 was examined.

Mid-Continent Questionnaire Capacity Listing

Only 24 Refineries reported in this Survey (Appendix Item 1) and not all of them reported on all questions. The other data sources are believed to be more accurate than Section 1-Identification, and Section 2-Refinery Capacity of this Survey when the total Texas fuel-products refining capacity is the desired basis.

Pollution Emission in 1972

The quantity of named pollutants emitted by these fuel-products refineries is listed in Table 3. The list is in descending order, within State, for sulfur dioxide (SO_2) emission. 497 accounts are included in the list of SO_2 emitters. The 37 refineries release 221,981 T/Yr of SO_2 out of the total 952,743 T/Yr listed for the State—this is 23.3%. The rank of the refineries within the 497 accounts list varies from 4th to 491st. Three refineries are in the top ten highest emitters of SO_2. It should be noted that in 1972 many refineries burned clean natural gas and in a number of refineries the in-plant produced fuel gas is also clean—yet the SO_2 emitted by the industry is substantial. As conversions to other fuels result from supply restrictions or or cost of natural gas, SO_2 emission is expected to increase since the fuel alternates contain significantly higher sulfur.

For other pollutants, as listed in Table 4, these refineries emitted 16.4% of the total nitrogen oxides (NO_x), 33.5% of the hydrocarbon* (HC) and 46.9% of the carbon monoxide. The compliance schedules of Regulations V and VI are causing reductions in HC and CO emission in named counties while all expansions (new facilities) must startup and continue to operate with reduced emissions anywhere within the State. It should be noted that NO_x emission is only partially regulated and will continue to increase.

Refinery Fuel Usage in 1972

Texas refineries vary widely in size, degree of integration, product-mix and the portion of feed run to other than fuel products. Some facilities charge a high ratio of natural gas liquids in addition to crude, many produce benzene, toluene, xylene (BTX) which has alternate use as chemical intermediates or raw material; a few produce ammonia, ethylene or other non-fuel products. For this study, the 37 Refineries named were considered. They are for the most part fuel products refineries, the capacity used is crude plus other or "Runs to Stills" and the fuel usage is total for the facility. So this study is on a total and actual basis.

Four size ranges for capacity were used as listed in Table 5. In MB/CD, these ranges are 225 to 445, 100 to 225, 50 to 100 and up to 50. It is noted that the larger the refinery the more fuel (energy) it takes to process a barrel of throughput; it is concluded that efficiency of fuel utilization in a given unit is not as controlling as is the number of units or the intensity of processing. Overall the requirement may vary five fold from 200 to 1,000 MBTU/Bbl, but the average is 637 MBTU/Bbl. Thus, about 1/10 of a barrel of energy equivalent is required to process a barrel of charge run to stills. Expressed in natural gas equivalent, this is 617 SCF/Bbl—1031 BTU/SCF (gross) is used as the basis. In many cases, calculator read-out is recorded rather than rounded values—the reader should judge the accuracy of the values in drawing conclusions or in making further calculations.

It is noted from Table 6 that the fuel energy requirement varies from 539 to 690 MBTU/Bbl dependent on the refinery size. However, the requirement may vary from ±15 to $\pm40\%$ of the average value depending on the size. This is

* Hydrocarbons at times means carbon-hydrogen compounds and at other times in regulations it includes other organic compounds.

further evidence of the effect of diversity and intensity of processing. These fuel energy requirements do not include purchased electricity. Some of the refineries generate essentially all of their electric requirement while others generate none.

Section 3—Utilities of the Mid-Continent Survey indicates that on a fuel usage basis 786 MBTU/Bbl is required on the average. Counting the purchased electricity as equivalent heat energy (1KWH = 3413 BTU) increases the value to 797 MBTU/Bbl and if the total fuel requirement including that for generating the purchased electricity in off-facilities is the basis, then the value is 818 MBTU/Bbl.

As a cross check with the preliminary value from study S/D 10—The Potential for Energy Conservation in Industries in Texas—226 x 10E6 T/Yr of crude requires 8.84 x 10E14 BTU/Yr of energy consumption. Our results indicate the fuel energy requirement to be 8.47 x 10E14 BTU/yr. On a unit basis, our average requirement is 637 MBTU/Bbl, and the S/D 10 Study value is 675 MBTU/Bbl. The S/D 10 Study includes purchased electricity; using the Mid-Continent data to convert our value (the Emissions Inventories do not record KWH usage) to the same basis as S/D 10 gives a requirement of 647 MBTU/Bbl on a fuel plus purchased KWH basis and when the fuel equivalent of the purchased electricity is included the value becomes 669 MBTU/Bbl.

Base Case Year is 1972 followed by Growth

This documentation gives the capacity of the Texas fuel products Refineries, the actual runs to stills, the fuel usage and the resultant pollution emissions from refining operations for 1972 as the Base Year. Estimates of the situation in 1975 and 1985 is the next step. Known expansions (Permits Program) and growth estimates for capacity and for emissions will be used. The effect of fuel conversions in existing refineries and fuel usage in new refineries will increase the SO_2 emissions as is indicated by Permit Activity to date. Request for operations under the Temporary Fuel Shortage Control Plan of Regulation II have been limited to date. A cross check with the results of the Radian Refining Siting Report[a] has been made to compare estimates of energy usage requirements.

[a] Final Report to EPA, A Program to Investigate Various Factors in Refinery Siting, February 15, 1974.

Further, the Emission Factors stated by Radian will be used to estimate the emissions from the refinery expansions; Radian's approach is application of best available practical technology. More specific emission information is contained in another report; Radian Technical Memorandum[b]. (Refer to Item 14 of the Appendix.)

Projected Growth

The indexes in Volume 5 of the 1972 OBERS Projections of Economic Activity in the U.S. dated September, 1972 are used to forecast the Petroleum Refining capacity growth for Texas as a whole. A copy of page 181—OBERS Table 2 is Appendix item 12 A worksheet (included) shows capacity indexes as follows:

1972 - 100
1975 - 108 (110 used)
1985 - 139
2000 - 216

The capacity which will be operated in 1975 is now existing or in construction and it is higher than OBERS projections. An index value of 110 is used; if planned expansions are approved, this accelerated rate will continue in the immediate future.

Growth Within Regions

Region 1. The counties within this Region have lost population over the last 20 years and the loss rate is higher within the last 10 years. There was some gain between 1950/1960 (+0.12% annual). Over the last 20 years loss is -.37% annual, and during the last 10 years loss is -.86% annual. Say no growth after the present expansion which is completed in 1974.

Region 2. Although some loss in population during the last 10 years, there has been growth over the last 20 years of about +1% annual. The Region has three modern refineries—slow growth will continue to serve its tributary markets. Say one-half of the Texas rate.

Region 6. } Situation is similar to that of Region 2.
Region 11. } Project the same growth rate.

Region 3. No Refineries. None proposed.

b Technical Memorandum, Some Environmental Considerations in the Petroleum Refining Industry, March 13, 1974.

Region 4. No growth.

Region 8. No growth.

Region 9. No growth.

Although some capacity exists in these-mid-State Regions they are too close to the large efficient Gulf Coast Refineries to permit growth. All are served by product pipelines.

Region 5. Region 7. Region 10. These Regions will share most of the future growth. They are at tidewater and have most of the present capacity. Although 5 and 7 will most likely have the earliest and possibly a larger portion of the growth, growth is each has been projected from present capacity for this study.

Region 12. Somewhat like Region 2. This Region has lost population during the last 20 years, but there was some growth during the last 10 years. Say, one-fourth of the Texas rate.

Change in Fuel Usage in Refineries

Natural Gas has been the primary fuel in the past because of availability and price. Cost has been about 20 cents per million ($\bar{M}$) BTU. Future cost will be at least 3 to 5 times higher and perhaps as high as 150-175 cents per $\bar{M}$ BTU as projected shortages have their full impact. Priority usage may further restrict availability. These factors will back natural gas out of the refineries. Use of plant fuel gas will continue for critical furnaces, others will shift to liquid fuels and boilers may shift to solid fuels. Much of the plant produced fuel gas is now sweetened (sulfur reduced) but the liquid and solid fuels will contain some sulfur. Regulations will limit the permissible sulfur content of the liquid and solid fuels.

The net change as a result of fuel conversion and fuel switches will be an increase in sulfur dioxide (SO_2) emission. The Radian Report selected 0.3%(w) sulfur as the content of the fuel oil used—for many crudes technology (and cost) make this feasible. However, present Regulations (both Federal and State) allow sulfur content to be in the 0.8 to 0.9%(w) range. A value of 0.8%(w) is used in this study.

As noted in Tables 5 and 6 actual average fuel usage in Texas Refineries is 637 M BTU/Bbl. The Radian Report (which had a different purpose) estimates

345 M BTU/Bbl in a typical 200,000 B/CD fuel products Gulf Coast Refinery—certain offsite supporting facilities were not included. Certainly cost factors will force more attention to fuel use efficiency. For this study, a rounded value of 550 M BTU/Bbl—approximately a 15% reduction—was selected as the most likely number. Higher efficiencies can be achieved, but shortages of resources (manpower and material) will not permit the maximum achievement.

For detail calculations, refer to worksheet Appendix item 13.

Although refineries are fuel products manufacturers, some smaller operators may take advantage of the grace period up to December 31, 1976 allowed by revised Regulation II, which allows use of higher sulfur content fuel under certain conditions. Long range compliance with all Rules is required.

Pollution Emission(s) by Regions 1972-2000

Tables 7 through 10 list actual emissions for 1972 and 1975, an estimate of 1985 emissions and values for 2000 based on trend year 1972 values are reported actual year 1975 values are estimated by the refineries with adjustments as stated in the study basis. Year 1985 values are estimates based on the emission factors of the Radian Report but with the fuel sulfur content as 0.8%(w). Year 2000 values are those which may result if all the factors continue as projected. The emission values for year 1985 are more realistic than the trend values of year 2000 because cost and availability will force technology changes as well as changes in the Regulatory restrictions.

As the Texas Refining Capacity increases from the present 3.6 $\overline{M}$ B/CD through the 4.0 $\overline{M}$ B/CD now committed for year 1975 and the possible 5.0 $\overline{M}$ B/CD of year 1985, the order of magnitude of the emission increase associated with growth is indicated. The values for year 2000 should be considered as a what-if case.

Conclusions

- In the period up to 1985 much of the U.S. energy supply will be based on fossil fuel, i.e., oil (and gas), and even though domestic production (and reserves) including Texas, are declining, a large portion of the refining industry will continue to be located on the Texas Gulf Coast. Most of the Refinery Fuel Products will be exported from Texas to tributary markets following present trends.

- Present Rules and Regulations have caused a rollback in pollutant emission(s) or have continued to protect against exceeding the Standards.

- Although Refineries are only one of the industry source categories, their energy usage is relatively large. Trends for industry as a whole are parallel.

  This industry is concentrated at tidewater and inland growth in Texas will be slower and may actually decline. The Regional impact varies from none to large.

- Since the cost of energy will (and has) jumped by a factor of 3 to 5 times and may level at about 7 times fuel conversions and shifts will be made. Fuel use efficiency will increase. SO_2 production from fuel burning can only increase and the associated NO_x production will likely increase as higher thermal efficiency is demanded and realized.

- The NO_x problem is complex, its production is inverse to that of other pollutants and attack on the problem is generally lagging relative to other named pollutants.

- Rollback of carbon compound emission (HC) has been substantial. Its' actual calculated Regional rollback is the subject of another study. Control Strategy for an adequate rollback is being refined. Long range emission associated with growth will continue to have a large impact. Interaction with NO_x and with oxidant level requirements is complex.

- Carbon monoxide (CO) emission reductions have been dramatic in most Regions and abatement technology is available at reasonable cost.

- Particulate (Pa) emission reductions have been substantial and, like CO, abatement technology is available at reasonable cost.

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TABLE 1

Impact of Refinery Emissions on Air Quality in Texas 1974-2000

Outline of Work Plan

1. Compile a list of all refineries: crude capacity, fuel usage, emissions, etc. This item defines the 1972 Base Case.
2. Verify completeness of list of refineries from Emission Inventory Group 06 Summaries and other sources.
3. Analyze Texas Mid-Continent Oil and Gas Association Questionnaire on present and future refining operations.
4. Clarify items in (3) with John Wagner of Texas Mid-Continent O. & G. Assn.
5. Compile and analyze Refinery Expansions (Permit VI applications) and compare result with that of items (3) and (4) Permit Engineers will assist with this task.
6. Estimate probable fuel conversions in remaining refineries.
7. Apply other appropriate growth factors and growth in emissions to 1975, 1985 and 2000.
8. Forecast Temporary Fuel Shortage Control Plan effects in Refineries.
9. Estimate pollutant emission levels by years and determine impact Analysis will require input from all other Emission Inventory Groups.

TABLE 2

Capacity of Texas Refineries Operating in 1972[a]

Company and Location Inland, 15 Refineries	Capacity[b] B/SD	B/CD
Adobe Refining Co., La Blanca	5,000	4,250
American Petrofina, Mt. Pleasant	26,500	26,000
Chevron Oil Co., El Paso	70,000	65,000
Cosden Oil & Chemical Co., Big Spring	60,000	58,000
Diamond Shamrock, Sunray	47,500	45,000
Howell Hydrocarbons, San Antonio	3,230[c]	3,100
La Gloria Oil & Gas Co., Tyler	25,000	24,000
Longview Refining Co., Longview	5,300	5,000
Phillips Petroleum Co., Borger	100,000[c]	95,000
Pride Refining, Inc., Abilene	9,000	8,500[c]
Shell Oil Co., Odessa	30,000	29,000
Tesoro Petroleum Corp., Carrizo Springs	6,500	6,000
Texaco, Inc., Amarillo	20,780[c]	20,000
Texaco, Inc., El Paso	17,760[c]	17,000
Winston Refining Co., Ft. Worth (Old Ft. Worth Refining Co.)	12,500	12,000
Sub-Total, Inland	439,070	417,850

TABLE 2 (cont'd)

Company and Location Gulf, 22 Refineries	Capacity[b] B/SD	Capacity[b] B/CD
American Petrofina Co., Port Arthur (Old B. P.)	85,000	76,600
Amoco Oil Co., Texas City	332,500[c]	320,000
Atlantic Richfield Co., Houston	220,000	210,000
Champlin Petroleum Co., Corpus Christi	63,000	62,000
Charter International Oil Co., Houston	63,000	62,055
Coastal States Petroleum Co., Corpus Christi	135,000[c]	130,000
Crown Central Petroleum Co., Pasadena	96,000	93,000
Eddy Refining Co., Houston	2,100[c]	2,000
Exxon Co., Baytown	365,000	350,000
Gulf Oil Corp., Port Arthur	319,000	312,100
Marathon Oil Co., Texas City	58,000	55,000
Mobil Oil Corp., Beaumont	350,000	335,000
Phillips Petroleum Co., Sweeney	89,500[c]	85,000
Shell Oil Co., Deer Park	280,000	268,000
South Hampton Co., Silsbee	2,775[c]	2,550[c]
Southwestern Oil & Refining Co., Corpus Christi	52,000	50,000
Suntide Refining Co., Corpus Christi	54,000	51,000
Texaco, Inc., Port Arthur	415,650[c]	400,000
Texaco, Inc., Port Neches	55,075[c]	53,000
Texas City Refining, Texas City	63,000	60,000
Union Oil Co., Nederland	111,200[c]	107,000
Union Texas Petroleum, Winnie	9,500	9,000
Sub-Total, Gulf	3,221,130	3,093,305
	439,070	417,850
	3,660,370	3,511,155
Natural Gas Liquids not included in above capacities	184,500	175,000
TOTAL CHARGE	3,844,870	3,686,155[d]

a Compiles from Oil & Gas Journal, Spring, 1972, 1973, Bureau of Mines, 1972.

b Crude capacity includes some other feed stocks for some refineries.

c Estimate.

d Compares with 3,643,841 Refinery Runs to Stills in 1972 from Railroad Commission Annual Report

TABLE 3

1972 Emission Inventory Descending Order (SO_2) State
Report N 12060 Print Date Feb. 15, 1974

ID No.	Company[d]	Region	County	City	NO_x T/Yr	SO_2 Emission[a] T/Yr[c]	SO_2 Emission[a] Rank as Ref.	SO_2 Emission[a] Rank in State	HC T/Yr	CO T/Yr	Pa T/Yr	H_2S T/Yr	Org T/Yr	H_2SO_4 T/Yr	Fl T/Yr
1132792	Texaco, Inc.[b]	10	Jefferson	Port Arthur	14511	39882	1	4	74833	211502	1743	365	291	---	---
1006908	Amoco	7	Galveston	Texas City	10217	35309	2	5	38039	99847	5823	---	247	5	---
1060023	Gulf	10	Jefferson	Port Arthur	11101	17869	3	8	29783	19	3649	---	335	7	---
1012291	American Petrofina	10	Jefferson	Port Arthur	744	13524	4	14	7674	92267	394	---	17	---	---
1103920	Phillips	2	Hutchinson	Borger	6141	12334	5	15	13558	213176	4863	1	---	---	---
1047035	Exxon	7	Harris	Baytown	17337	11960	6	16	48811	57477	4940	50	240	---	---
1034316	Cosden	6	Howard	Big Spring	2462	11727	7	17	7342	1903	1131	---	27	---	---
1035649	Crown Central	7	Harris	Pasadena	1980	10448	8	20	17943	3	868	---	59	---	163
1010531	Atlantic Richfield	7	Harris	Houston	5575	9373	9	23	14933	1827	810	---	142	---	---
1091450	Mobil	10	Jefferson	Beaumont	9761	7812	10	26	14114	17	746	---	290	---	---
1104250	Phillips	7	Brazoria	Sweeny	6614	6112	11	34	4521	129210	2146	---	106	---	---
1141473	Union	10	Jefferson	Nederland	2831	5744	12	37	13179	---	1110	---	14	---	---
1120620	Shell	7	Harris	Deer Park	9449	5551	13	39	26691	15	957	---	259	---	---
1132831	Texaco	11	El Paso	El Paso	514	4693	14	44	2011	21468	117	---	14	---	---
1027166	Chevron	11	El Paso	El Paso	1053	4604	15	45	3354	33665	261	---	---	---	---
1129830	Suntide	5	Nueces	Corpus Christi	2536	4268	16	49	10576	---	265	---	70	---	---
1026836	Charter	7	Harris	Houston	2300	3799	17	57	22080	146004	679	---	64	---	
1133489	Texas City Refining	7	Galveston	Texas City	1073	3344	18	63	13235	20507	375	---	29	---	40
1120646	Shell	6	Ector	Odessa	1241	3073	19	67	8742	1	280	---	20	---	---
1132849	Texaco	2	Potter	Amarillo	551	2396	20	75	5751	40375	499	---	15	---	---
1002983	American Petrofina	12	Titus	Mt. Pleasant	610	1902	21	82	2270	17452	150	165	12	---	---
1085492	Marathon	7	Galveston	Texas City	1382	1754	22	88	8243	1225	341	73	31	---	---
1039989	Diamond Shamrock	2	Moore	Sunray	2568	1131	23	108	3084	72334	397	399	63	38	---
1077511	La Gloria Oil & Gas	12	Smith	Tyler	328	1065	24	112	9392	29	125	149	7	---	---
1030311	Coastal States	5	Nueces	Corpus Christi	1729	962	25	119	7983	39542	502	---	85	---	---
1125575	Southwestern Oil & Ref. Co.	5	Nueces	Corpus Christi	1458	435	26	153	12532	34946	281	---	41	---	---
1051610	Winston Refining	8	Tarrant	Fort Worth	104	305	27	170	4375	7829	43	---	3	---	---
1026577	Champlin	5	Nueces	Corpus Christi	1360	295	28	172	22255	47530	260	---	36	---	---
1132806	Texaco	10	Jefferson	Port Neches	548	230	29	182	3699	---	53	---	16	---	---
1123351	South Hampton	10	Hardin	Silsbee	82	79	30	225	163	---	7	---	---	---	---
1141431	Union Texas	7	Chambers	Winnie	816	1	31	491	1395	285	51	---	---	---	---
1082663	Longview Refining	12	Gregg	Longview	51	---	32	---	3973	---	4	---	1	---	---
1132369	Tesoro	9	Dimmit	Carrizo Springs	20	---	33	---	1395	---	2	---	---	---	---
1108018	Pride Refining Co.	1	Jones	Abilene	91	---	34	---	1068	---	14	---	1	---	---
1002791	Adobe Refining Co.	4	Hidalgo	La Blanca	18	---	35	---	577	---	1	---	---	---	---
1067893	Howell Hydrocarbons	9	Bexar	San Antonio	38	---	36	---	414	---	3	---	---	---	---
1043871	Eddy Refining Co.	7	Harris	Houston	10	---	37	---	778	---	25	---	---	---	---
					119204	221981			460765	1280455	53915	1202	2535	50	203

a Rank is in descending order SO_2 Emission as refineries within State.

b Texaco Terminal include with refinery.

c Total listed SO_2 Emission is 964,470 T/Yr for 498 companies. The 37 refineries emit 221,981 T/Yr or 23 percent of the total SO_2 Emission listed.

d A number of refineries listed elsewhere are not included in this list. Some were not operating in 1972: Cosden-Colorado City, J & W Refining (old Anderson)-Tucker, Quintana Howell-Corpus Christi, and Three Rivers Refining-Three Rivers. Others are specialty operations like Asphalt, Ink Oils, Micro crystalline waxes, or recover tank bottoms and reclaim motor oil; Viz. Flint Chemical-San Antonio, Industrial Lubricants-San Antonio, Petrolite Corp-Kilgore, S&R Oil-Houston, Texas Asphalt and Refining-Fort Worth, Western Petrochemical-Kilgore and Wood County Refining-Quitman. Petroleum Refining Co. at Lueders is shut down and dismantled.

TABLE 4

Refinery Portion of Total Pollutants Emitted in 1972

Pollutant	Total in T/Yr In State	Total in T/Yr By Refineries	Refineries % of Total In State
NO_x	728,259	119,204	16.4
SO_2	952,743	221,981	23.3
HC	1,375,797	460,765	33.5
CO	2,729,954	1,280,455	46.9
Pa	263,394	33,915	12.9
H_2S	33,161	1,202	3.6
Organics[(a)]	---	2,535	----
H_2SO_4	3,843	50	1.3
Fl	4,335	203	4.7

(a) Organic compounds other than hydrocarbons.

TABLE 5

Refinery Capacity and Fuel Usage in 1972[b]

Size MB/CD	Capacity B/SD B/CD	Runs to Stills B/CD 1972	Fuel Usage[c] M̄BTU/yr M̄BTU/CD M̄BTU/B	Fuel Requirement MCF/yr Natural Gas Equivalent[a]
225 to 425	2,282,150 2,195,100	2,152,823	542,108,413 1,485,229 0.689,898	525,808,354
100 to 225	768,200 735,000	708,664	146,598,077 401,639 0.566,755	142,190,181
50 to 100	516,000 489,655	497,876	101,951,694 279,320 0.561,023	98,886,221
Up to 50	278,520 266,400	284,478	55,976,158 153,359 0.539,089	54,293,070
TOTAL	3,844,870 3,686,155	3,643,841	846,634,342 2,319,546 0.636,566	821,177,828 2,249,802 M/CD 617,426 CF/B

a 1031 BTU/SCF

b Values are calculator readouts—such high accuracy is not implied for all values.

c M̄ is millions.

TABLE 6

Fuel Usage Dependent on Refinery Size[a]

1972

Size MB/CD	Fuel Usage MBTU/B	Variation in Requirement + or - %	Rounded Value BTU/B
225 to 445	0.689,898	25	690,000
100 to 225	.566,755	15	567,000
50 to 100	.561,023	35	561,000
Up to 50	.539,089	40	539,000
Overall Average	.636,566	--	637,000 or 617 CF/B

a See note b, Table 5.

TABLE 7

Pollutant Emissions by Regions in 1972

Region	B/CD	NO_x	SO_2	HC	CO	Pa
1	5,728	91	---	1,068	--	1
2	273,983	9,260	15,861	22,471	325,885	5,759
3	NONE					
4	4,250	19	---	574	--	1
5	270,040	7,083	6,374	53,537	122,018	1,308
6	94,487	3,703	14,326	16,131	1,904	1,411
7	1,514,362	55,937	78,277	196,433	446,115	16,964
8	9,720	104	305	4,378	7,829	3
9	8,014	58	---	1,809	--	5
10	1,280,499	40,394	85,141	145,803	304,090	7,753
11	85,512	1,567	9,297	5,379	55,133	378
12	55,014	989	3,332	15,643	17,493	279
TOTAL	3,643,841	119,204	221,981	460,765	1,280,455	33,915

TABLE 8

Pollutant Emissions by Regions in 1975

Region	B/CD	NO_x	SO_2	HC	CO	Pa
1	35,390	333	174	3,911	--	4
2	287,421	9,024	34,960	16,266	183,625	1,155
3	NONE					
4	4,250	23	44	721	--	1
5	418,444	7,003	21,316	23,336	502	2,270
6	106,078	3,444	10,291	7,456	3,000	1,002
7	1,660,451	45,448	110,424	108,586	176,750	6,301
8	12,000	111	340	4,652	8,857	46
9	10,875	45	19	1,591	--	92
10	1,323,339	37,727	121,068	148,373	87,414	4,337
11	91,206	1,701	9,489	4,285	3,002	383
12	58,399	1,042	3,998	6,353	18,158	260
TOTAL	4,007,853	105,901	312,123	325,530	481,308	15,851
% of 1972	110	89	141	71	38	47

TABLE 9

Pollutant Emissions Estimate by Regions in 1985

Region	B/CD	NO_x	SO_2	HC	CO	Pa
1	35,390	333	174	3,911	--	4
2	323,604	10,265	38,423	18,390	183,714	1,616
3	NONE					
4	4,250	23	44	721	--	1
5	541,949	11,239	33,135	30,586	805	3,845
6	111,599	3,633	10,819	7,780	3,014	1,072
7	2,150,539	61,751	157,325	137,354	177,951	12,550
8	12,000	111	340	4,652	8,857	46
9	10,875	45	19	1,591	--	92
10	1,713,929	51,124	158,447	171,301	88,371	9,317
11	100,999	2,037	10,426	4,880	3,026	508
12	59,805	1,090	4,133	6,436	18,161	278
TOTAL	5,064,939	141,651	413,285	387,602	483,899	29,329
% of 1972	139	119	186	84	38	86

TABLE 10

Trend in Pollutant Emissions by Region in 2000

Region	B/CD	NO_x	SO_2	HC	CO	PA
1	35,390	333	174	3,911	-	4
2	387,606	12,460	44,548	22,147	183,870	2,432
3	NONE					
4	4,250	23	44	721	-	1
5	872,135	26,801	64,734	49,968	1,614	8,055
6	133,672	4,390	12,932	9,076	3,068	1,354
7	3,460,765	107,199	282,714	214,264	181,161	29,255
8	12,000	111	340	4,652	8,857	46
9	10,875	45	19	1,591	-	92
10	2,758,147	86,941	258,379	232,596	90,929	22,631
11	129,030	2,998	13,109	6,505	3,095	865
12	66,827	1,331	4,805	6,848	18,179	367
TOTAL	7,870,697	242,632	681,798	552,279	490,773	65,101
% of 1972	216	204	307	120	38	192

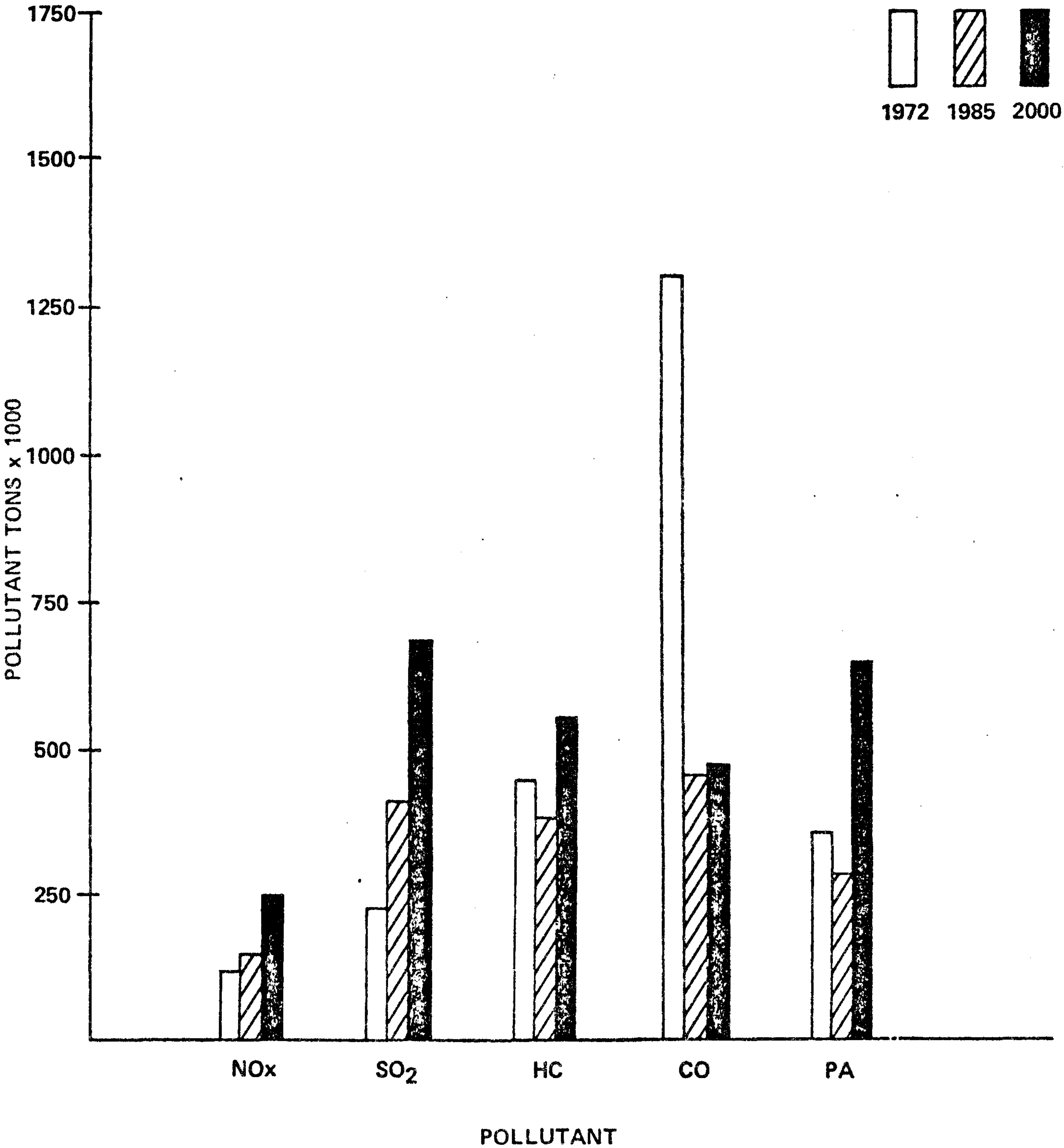
PETROLEUM REFINERY EMISSIONS

ES-2 Study Projections for Bar Charts Statewide

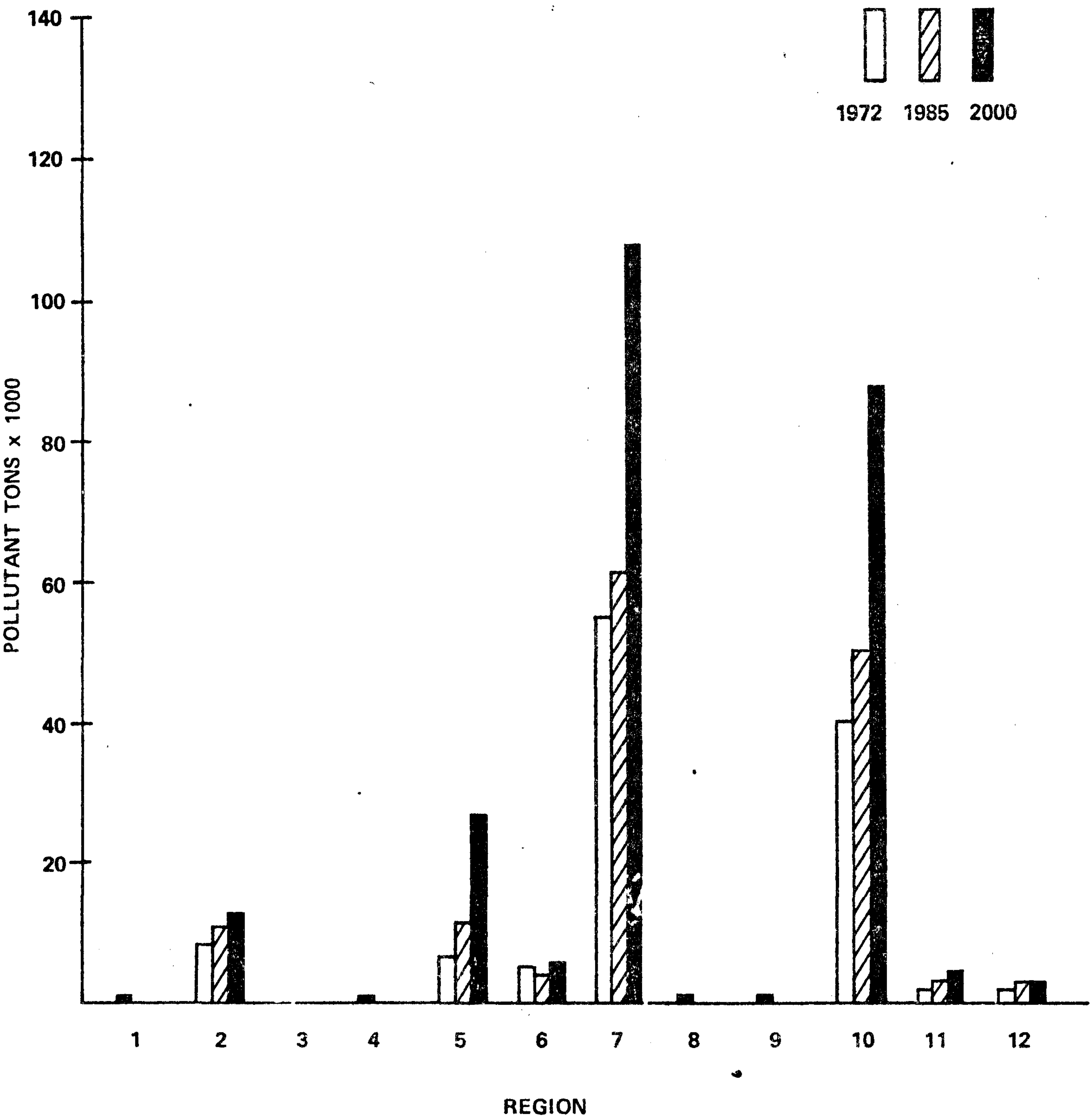
	NO_x	SO_2	HC	CO	Pa	Refining Capacity B/CD	B/CD Source
1970	114,356	286,789	442,024	1,566,686	36,227	3,495,634	RRC
1972	119,204	221,981	460,765	1,280,455	33,915	3,643,841	RRC
1975	105,901	312,123	325,530	481,308	15,851	4,007,853	Industry Actual
(1975)	105,901	312,123	325,530	481,308	15,851	4,007,853	Actual
growth	+ 37,508	+ 87,986	+ 64,190	+ 2,679	+13,942	+1,093,524	OBERS GROWTH
1985	143,409	400,109	389,720	483,987	29,793	5,101,377	Projected 1985
(1975)	105,901	312,123	325,530	481,308	15,851	4,007,853	Actual
growth	+132,496	+353,010	+226,749	+ 9,464	+49,251	+3,862,844	OBERS GROWTH
2000	238,397	665,133	552,279	490,772	65,102	7,870,697	Projected 2000

PETROLEUM REFINERIES

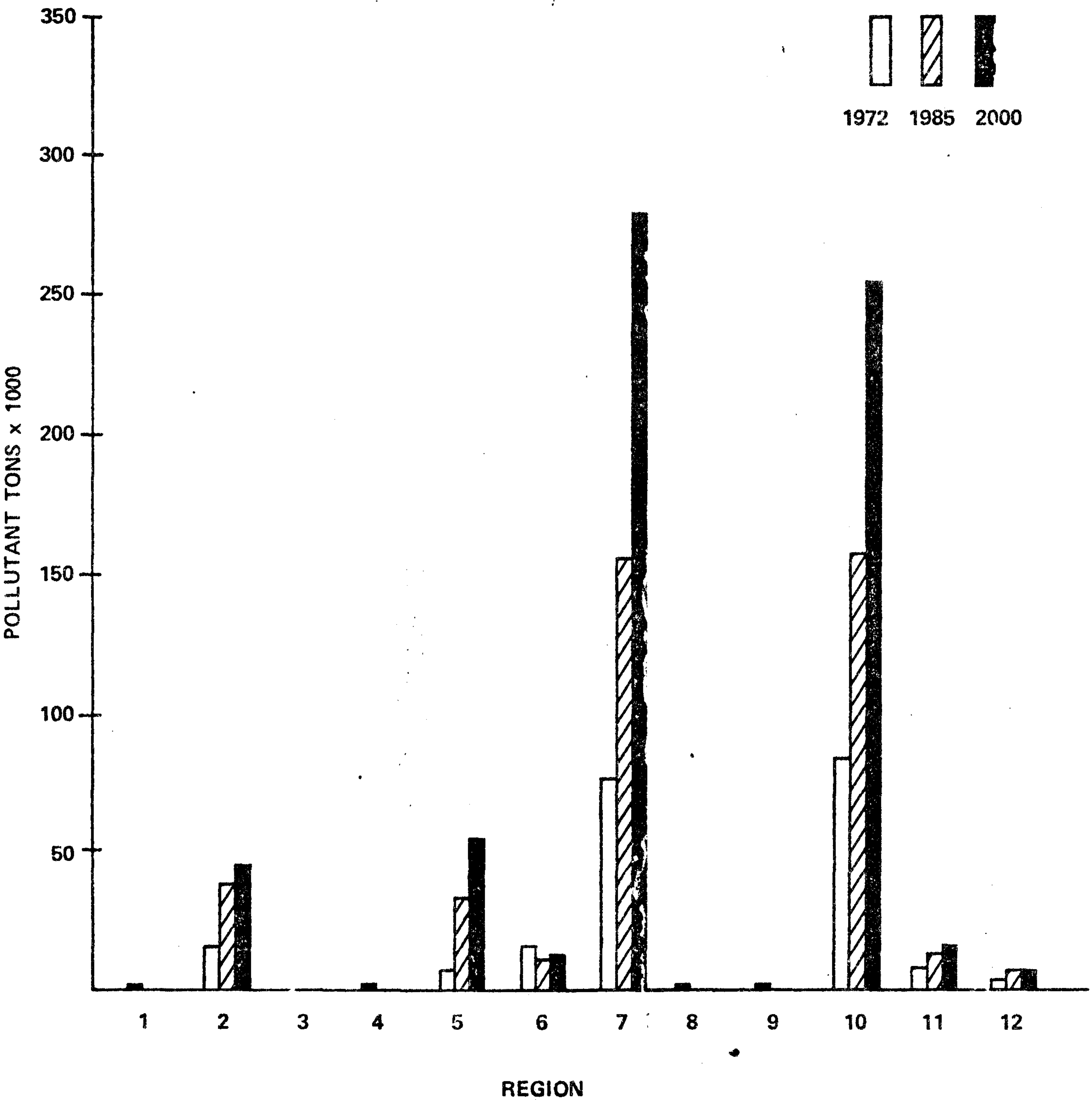
STATEWIDE POLLUTANT TOTALS



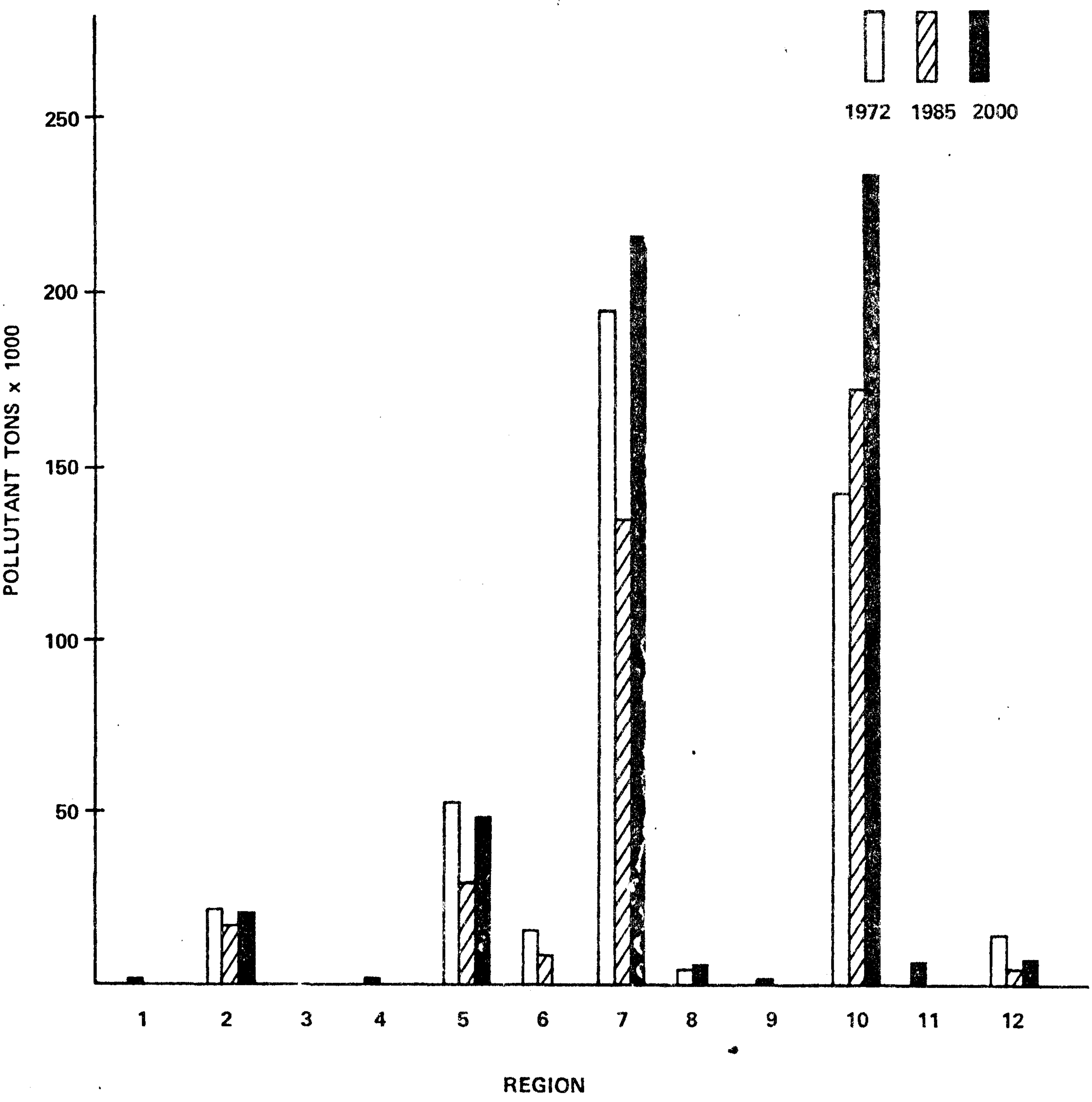
PETROLEUM REFINERIES
NOx
REGIONAL POLLUTANT TOTALS



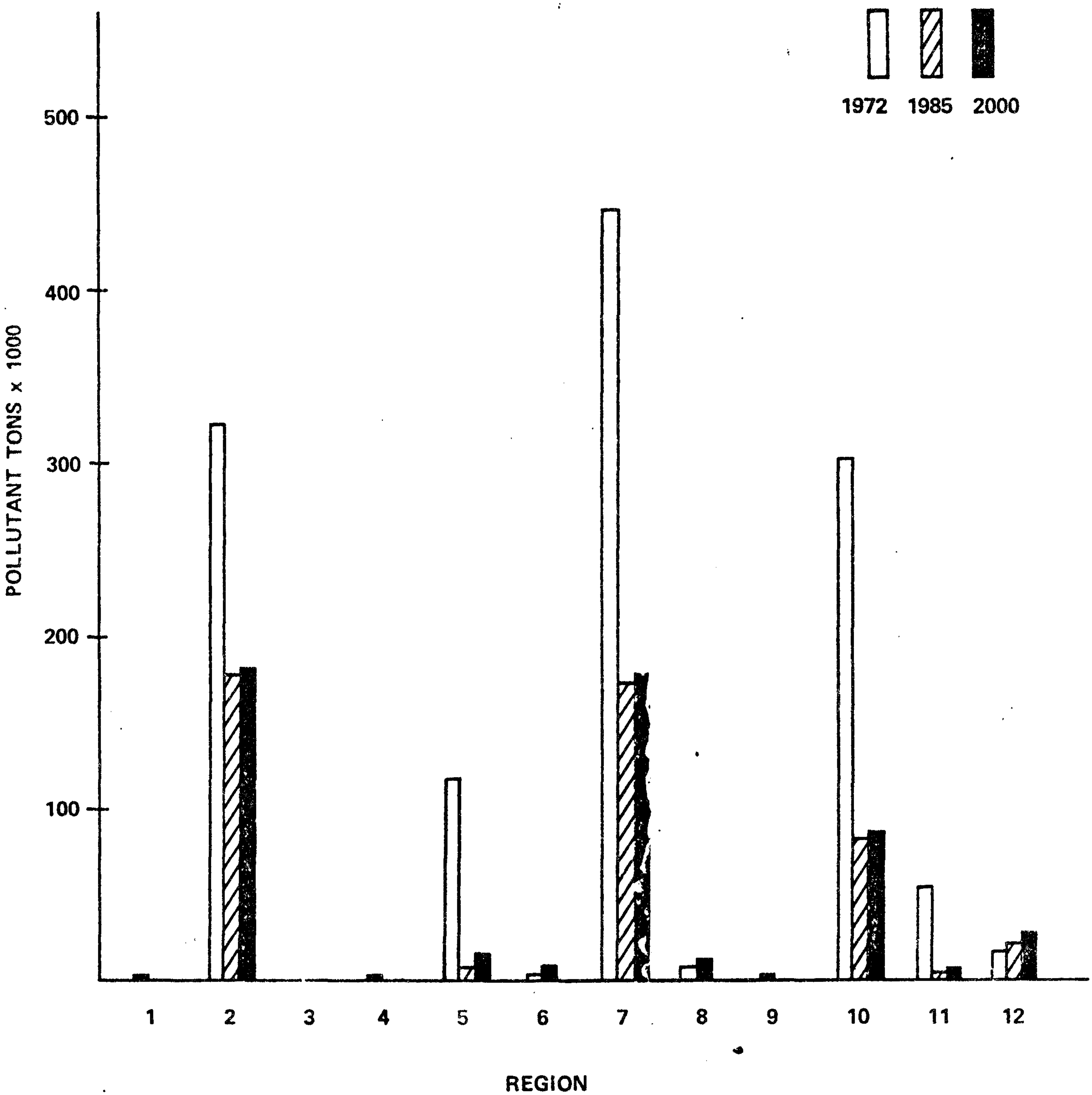
PETROLEUM REFINERIES
SO_2
REGIONAL POLLUTANT TOTALS



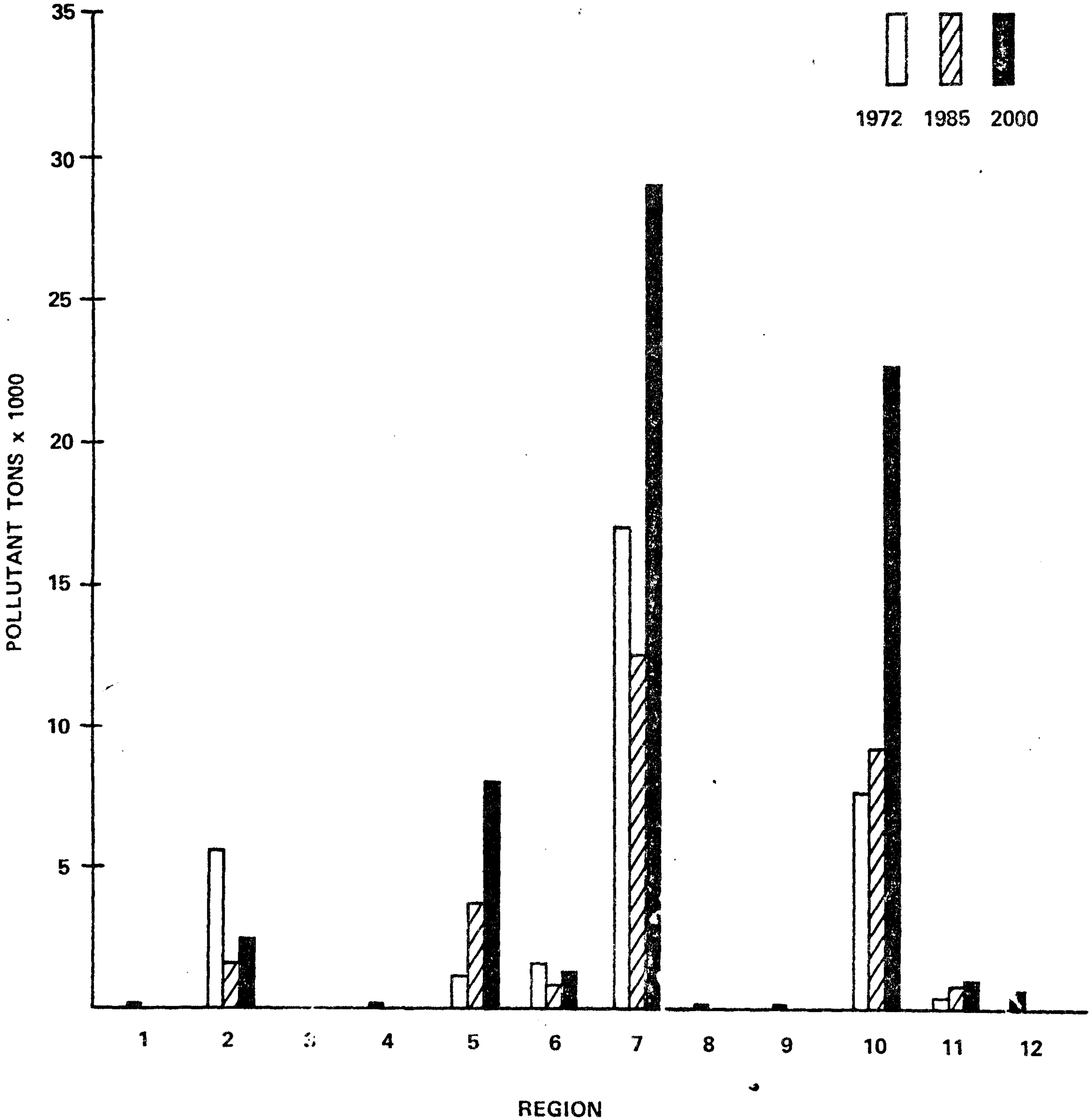
PETROLEUM REFINERIES
HC
REGIONAL POLLUTANT TOTALS



PETROLEUM REFINERIES
CO
REGIONAL POLLUTANT TOTALS



PETROLEUM REFINERIES
PARTICULATE
REGIONAL POLLUTANT TOTALS



APPENDIX G

TEXAS METALLURGICAL INDUSTRIES

EMISSION PROJECTIONS

TEXAS METALLURGICAL INDUSTRIES EMISSION PROJECTIONS

1972 - 2000

Project E/S-2

Lawrence E. Pewitt, P.E.

Appendix G

TABLE OF CONTENTS

Abstract	1
Use of U.S. Department of The Interior Projections	3
Figure I - Forecast Demand for Iron and Steel	4
Figure II - Forecast Demand for Aluminum	5
Figure III - Forecast Demand for Primary Copper	6
Figure IV - Forecast Demand for Lead	7
Figure V - Forecast Demand for Primary Zinc	8
Table IV - Primary Metals - 1972 Emissions by Region	11
Table VA - Primary Metals - 1985 Emissions by Region Based on Bureau of Mines Projections	12
Table VB - Primary Metals - 2000 Emissions by Region Based on Bureau of Mines Projections	13
Use of OBERS Projections	14
Table VIIA - Primary Metals - 1985 Emissions by Region Based on OBERS Projections	16
Table VIIB - Primary Metals - 2000 Emissions by Region Based on OBERS Projections	17
Figure VI - Primary Metals Industry - Statewide Industry Totals	18
Projections of Energy Consumption by Use of U.S. Bureau of Mines Projections	20
Projections of Energy Requirements by Use of OBERS Projections	24
Table XI - Fuels and Electric Energy Used for Heat and Power by Industry Group - 1971	26
Table XII - Consumption of Selected Types of Energy in the Iron and Steel Industry	27
Table XIII - Quantity of Purchased Fuels Used for Heat and Power by Industry Group - United States	28
Summary	29
Bibliography	30

ABSTRACT

The study of the impact on air quality in Texas in the year 2000 by the growth of basic metallurgical industries requires several limitations such that projections may be made and used to determine the emissions and energy requirements. Some of the limitations are:

1. No technological change will occur that will significantly change the basic energy requirements or air contaminant emission rates.

2. The growth of production in the metallurgical industry in Texas will occur at about the same rate as the total United States.

3. Production of the selected metals will occur at about the same rate as projected demand.

4. Industries to be considered consist of steel mills, primary smelters, secondary smelters and foundries.

The projections used to determine emissions from metallurgical industries and energy requirements of these industries are:

1. Projections of demand of selected metals in the year 2000 by the Bureau of Mines, Department of the Interior.

2. Projections of growth of primary metals industries by OBERS Projections, U.S. Water Resources Council.

The lower values of projections of demand will be used based on information from Texas industries. Projections of production and demand for iron, aluminum, copper, lead and zinc were selected for consideration as there is expected to be no shortage of supply of the basic materials to produce these metals and production levels can substantially equal demand levels.

Although there are facilities for production of other metals in Texas, the production rates of some of the facilities are confidential; consequently no projections have been made using estimates of production from these facilities or any individual facility using confidential production rates.

The emission of air contaminants from over 95 percent of all basic metallurgical industries have been considered and projection of emissions from all have been made and included in the total impact.

All emission projections have been made from 1972; the emission rates from this year have been modified in projection to allow for known industrial plans to either increase or decrease emission rates. All facilities are then assumed to be in compliance with Texas Air Control Board Regulations.

I <u>Projections by use of the Projections of Demand by The U. S. Department of the Interior.</u>

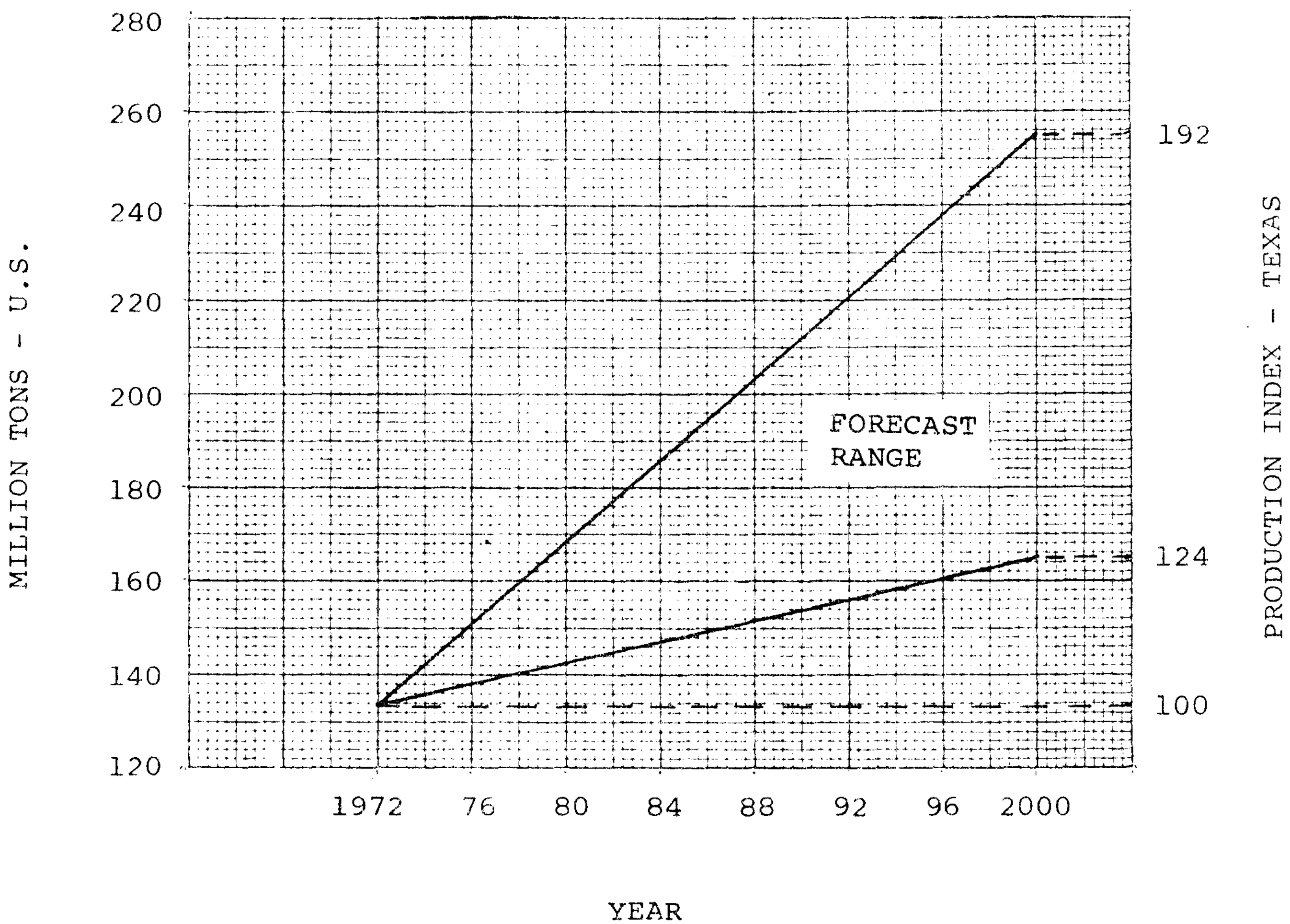
Projections of demand for the selected metals in the United States to the year 2000 have been graphed from production rates in 1972. (Table III) These projections of demand are shown in Figures I, II, III, IV and V.

Production indexes for each metal for the State of Texas based on the demand projections are shown on these Figures. These production indexes have been used to determine expected emissions in the years 1985 and 2000. The basis for projection of total air contaminants was selected as the year 1972. The lower production indexes have been used for emission level consideration and projection due to the base of demand of the indexes and due to industrial estimates of projected production.

Table IV shows the emission level of various air contaminants during 1972. These emissions have been projected to 1985 in Table V-A and 2000 in Table V-B.

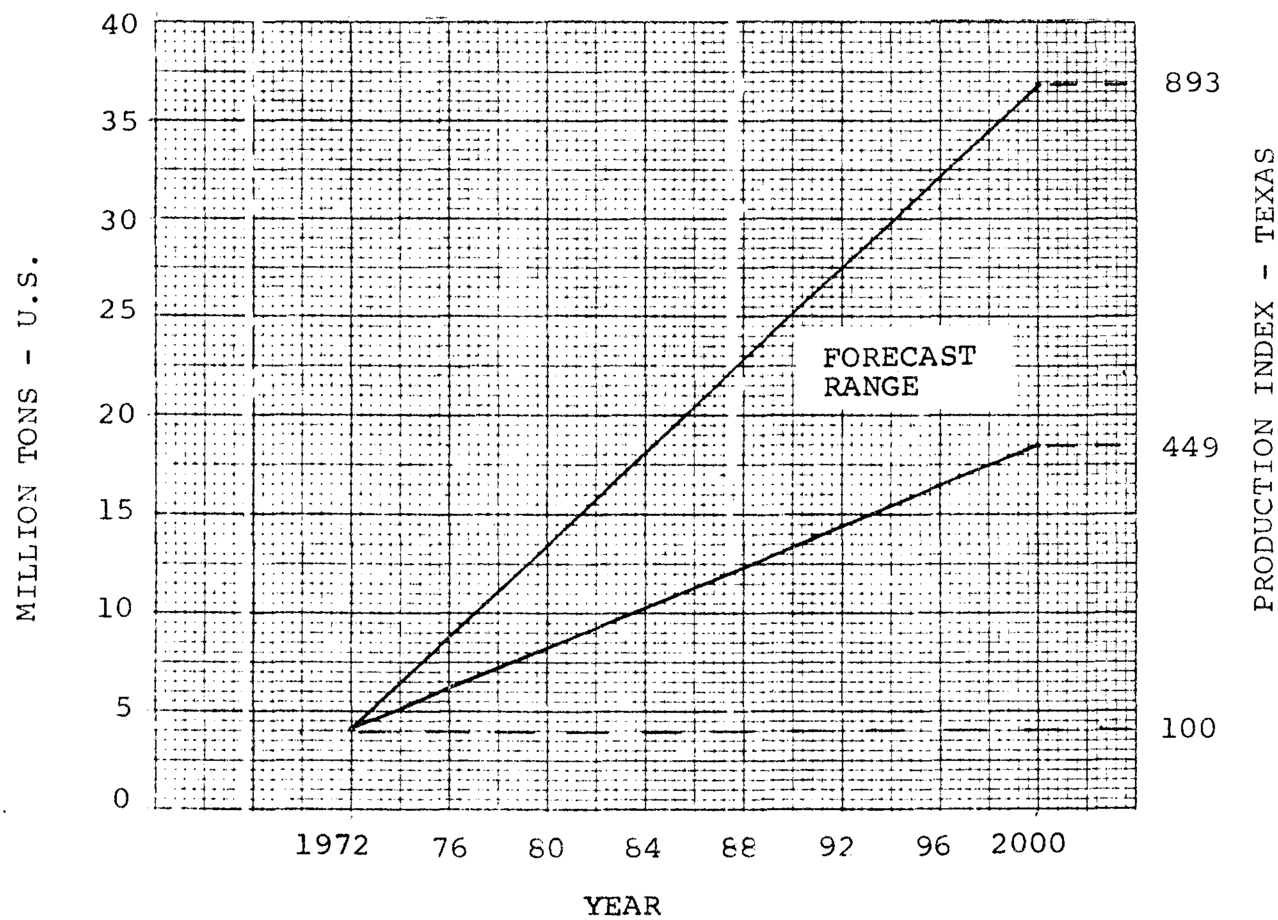
The large reduction in emissions from 1972 to 1985 in Region 2 is due to the planned closing of one facility. The large reduction in emissions in Region 11 from 1972 to 1985 is due to the planned installation of additional air pollution control devices.

FIGURE I



FORECAST DEMAND FOR
IRON AND STEEL[1]

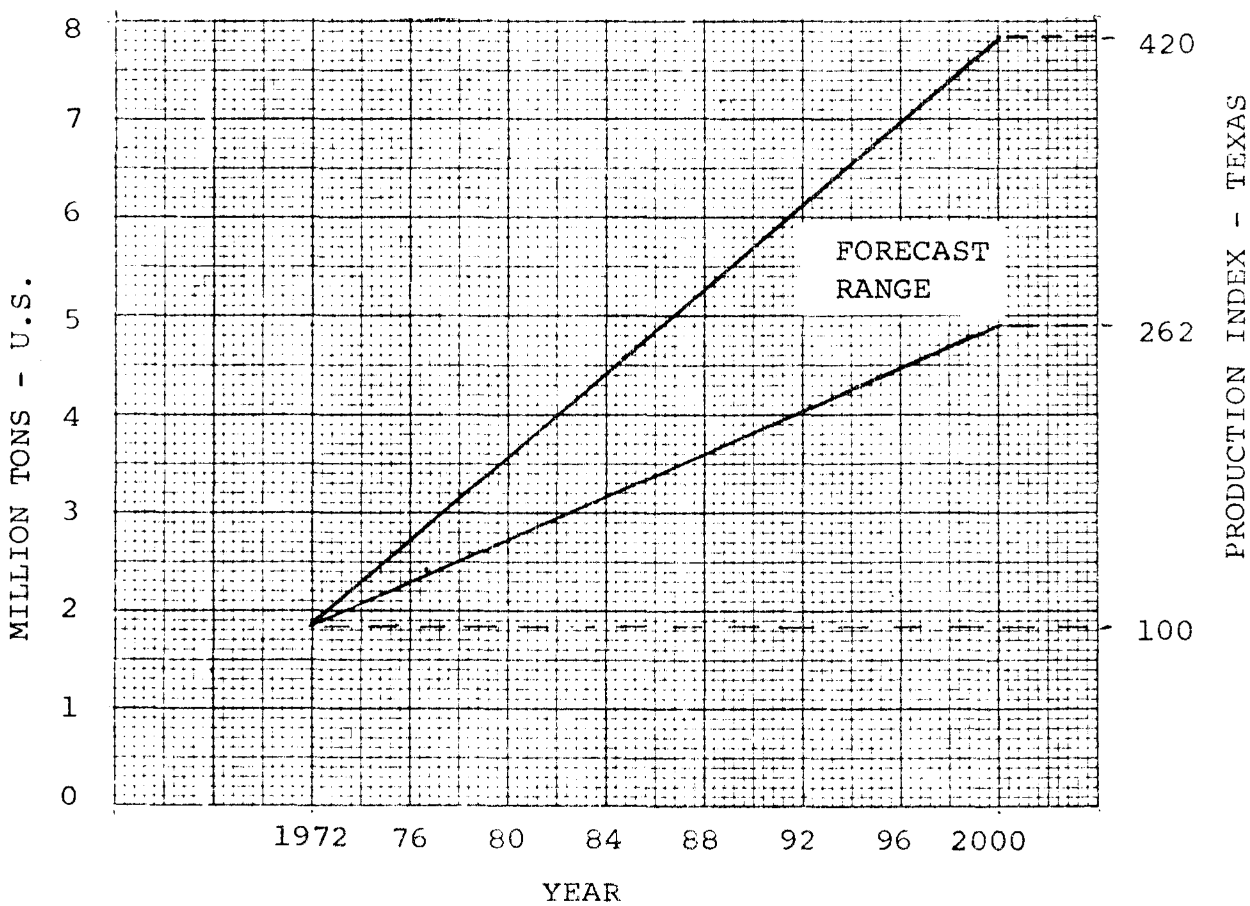
FIGURE II



FORECAST DEMAND FOR
ALUMINUM [1]

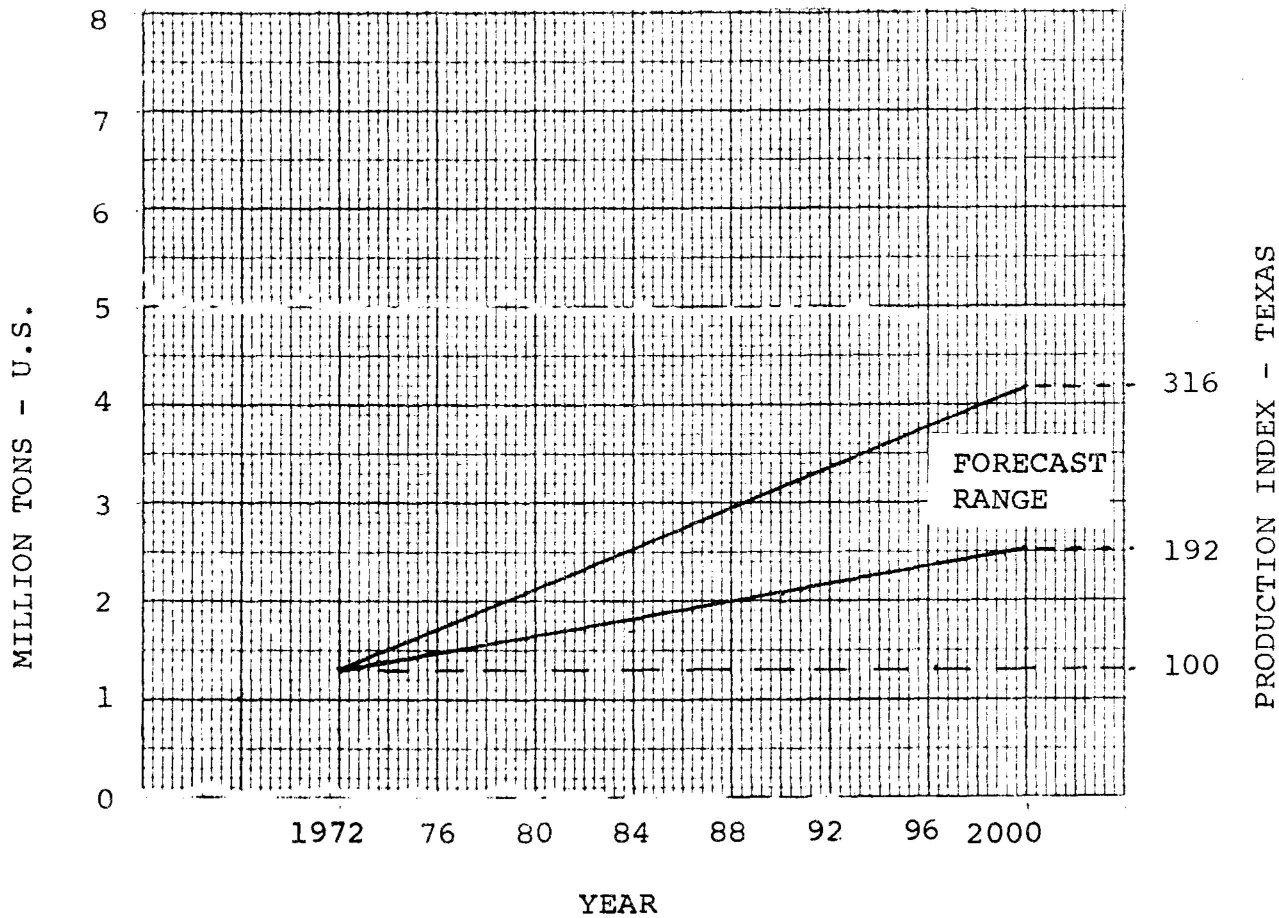
SOURCE
MINERAL FACTS AND PROBLEMS
1970
BUREAU OF MINES - U.S. DEPT. OF THE INTERIOR

FIGURE III



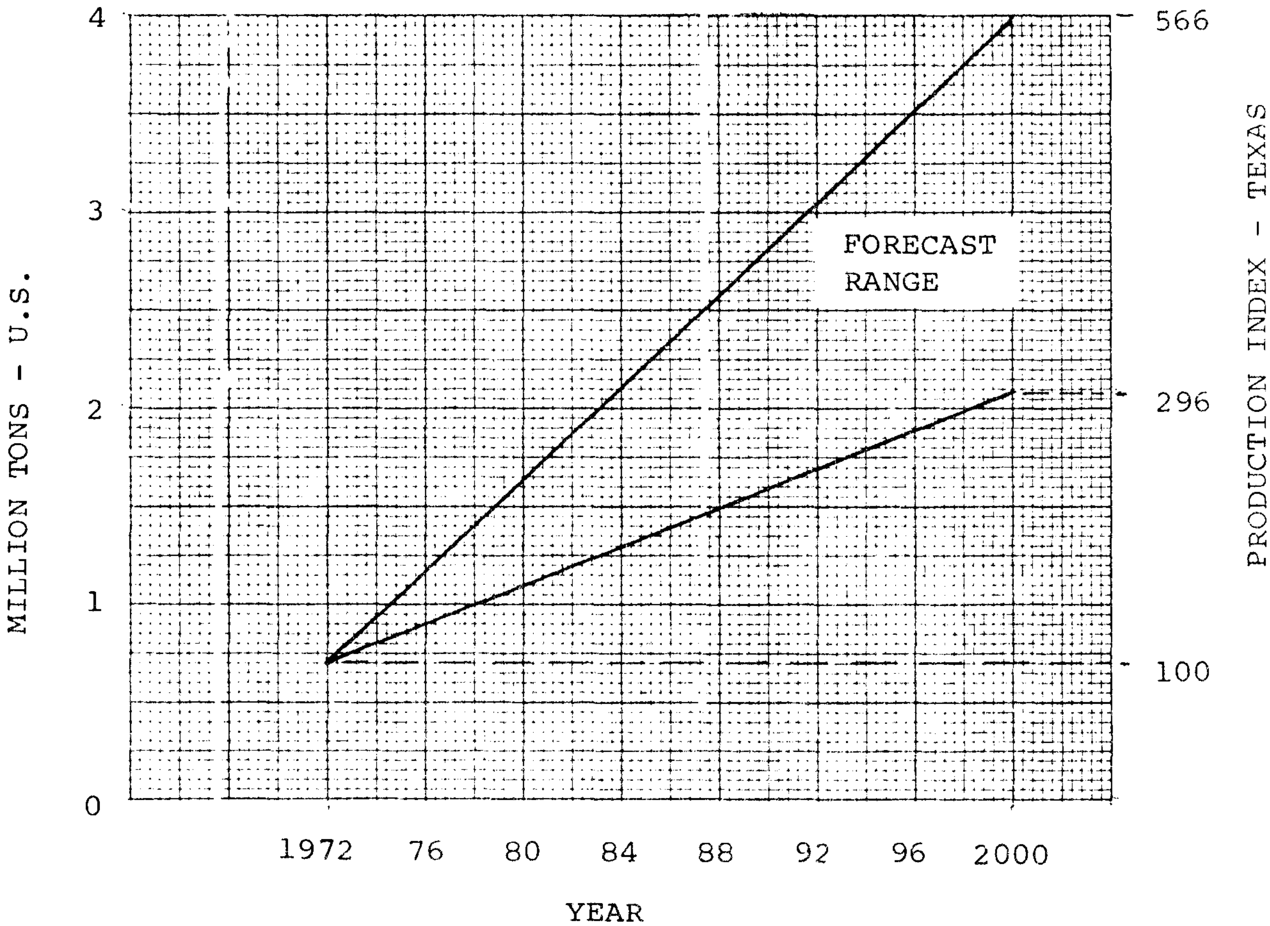
FORECAST DEMAND FOR
PRIMARY COPPER [1]

FIGURE IV



FORECAST DEMAND
FOR LEAD [1]
TOTAL

FIGURE V



FORECAST DEMAND
FOR PRIMARY ZINC[1]

TABLE 1

Ferrous Minerals[1]
U.S. Primary Production and Demand 1968 and Forecasts to 2000
1000 Tons

Metal	1968 Primary Demand	Year 2000 Primary Demand High	Year 2000 Primary Demand Low
Iron	84,000	175,000	130,000
Iron & Steel	120,000	255,000	165,000

TABLE II

Non Ferrous Metals[1]
U.S. Primary Production and Demand 1968 and Forecasts to 2000
1000 Tons

Metal	1968 Primary Demand	Year 2000 Primary Demand High	Year 2000 Primary Demand Low
Aluminum	3,888	36,800	18,500
Copper	1,540	7,860	4,900
Lead	898	2,800	1,300
Zinc	1,406	4,000	2,090

TABLE III

Production of Selected Metals
United States[2]
1000 Tons

Metal	1968	1969	1970	1971	1972
Iron					
Pig Iron	88,767	95,003	92,213	82,500	88,864
Steel	131,462	141,262	131,514	212,000	133,241
Castings	17,870	18,984	16,522	16,000	17,000
Aluminum					
Primary	3,255	3,793	3,974	3,935	4,122
Copper					
Primary	1,437	1,743	1,765	1,600	1,873
Lead					
Primary	487	655	678	650	695
Secondary	551	604	597	587	616
Zinc	1,021	1,041	878	833	707

TABLE IV

Primary Metals
1972 Emissions Data[3]
Tons

TACB REGION	NOx	SOx	HC	CO	Part	H_2SO_4
1	6		10	53	160	
2	302	50,590	30	7,650	3,840	
3	9,262	48,560	260	710	18,700	
4	2	170		650	15	
5	67,800	2,940	38,200	70	10,700	106
6	1		23	70	145	
7	2,100	2,585	2,870	34,800	10,750	50
8	130	5,500	165	5,500	820	48
9	4	2	2	1	70	
10	90		225	2,200	255	
11	980	110,000	105	24,700	680	28
12	14,600	5,390	3,320	49,250	7,085	218
TOTAL	95,277	225,737	45,210	125,654	53,220	450

TABLE Va
Year 1985 Emissions
Based on Bureau of Mines Projections
Related to TACB Region
Tons

Region	Range	NOx	SOx	HC	CO	Part
1	High	9	-	16	76	229
	Low	7	-	12	59	178
2	High	559	137	21	132	304
	Low	398	97	17	102	218
3	High	43,342	227,246	1,157	3,332	87,500
	Low	24,260	127,219	656	1,865	49,690
4	High	3	247	-	932	23
	Low	2	192	-	723	18
5	High	316,144	11,840	178,898	278	50,166
	Low	177,107	6,806	100,162	161	28,103
6	High	2	-	33	99	207
	Low	1	-	26	77	161
7	High	3,003	3,697	4,105	49,764	15,372
	Low	2,331	2,870	3,186	38,628	11,932
8	High	275	10,970	249	9,282	1,617
	Low	190	7,844	188	6,898	1,136
9	High	6	9	6	5	254
	Low	5	3	5	1	84
10	High	127	-	319	3,143	366
	Low	99	-	248	2,440	284
11	High	2,389	90,710	259	13,308	1,331
	Low	1,689	64,010	183	9,502	974
12	High	20,898	7,708	4,748	70,427	10,131
	Low	16,206	5,983	3,685	54,668	7,864
TOTAL	High	386,737	352,564	189,811	150,778	167,500
	Low	222,295	215,024	108,368	115,124	100,642

TABLE Vb
Year 2000 Emissions
Based on Bureau of Mines Projections
Related to TACB Region
Tons

Region	Range	NOx	SOx	HC	CO	Part
1	High	12	-	21	101	307
	Low	8	-	14	65	198
2	High	934	231	29	177	495
	Low	583	144	19	114	310
3	High	82,702	433,614	2,186	6,358	169,361
	Low	41,583	218,020	1,106	3,197	85,155
4	High	4	332	-	1,252	31
	Low	3	215	-	808	20
5	High	602,925	22,125	341,334	516	95,673
	Low	303,249	11,269	171,630	265	48,121
6	High	2	-	44	132	278
	Low	1	-	29	86	180
7	High	3,974	4,963	5,508	66,858	20,632
	Low	2,567	3,205	3,558	43,179	13,325
8	High	438	17,333	345	13,643	2,477
	Low	255	10,531	220	8,508	1,470
9	High	8	18	4	9	466
	Low	5	9	3	5	241
10	High	171	-	428	4,220	492
	Low	110	-	277	2,726	317
11	High	4,028	153,622	436	21,979	2,082
	Low	2,514	95,831	273	13,758	1,314
12	High	28,051	10,352	6,374	94,572	13,600
	Low	18,116	6,686	4,117	61,077	8,783
TOTAL	High	723,249	642,590	356,709	209,817	305,894
	Low	368,994	345,910	181,246	133,788	159,434

II Projections by the use of OBERS Projections of Indexes of Production of Primary Metals.

OBERS Projections are projections of economic activity in the United States prepared by the U. S. Department of Commerce, Social and Economic Statistics Administration, Bureau of Economic Analysis, Regional Economics Division and the U. S. Department of Agriculture, Economics Research Service, Natural Resources Economics Division.

These projections are based on past relationships believed to have future relevance and represent estimates of economic activity and land use expected to develop during the projected period.

The OBERS Projections were made in two major steps. First, the national economy was projected in industrial detail. Secondly, the national totals were distributed regionally in accordance with projected trends in regional distributions Of economic activity.

The indexes of production of primary metals industries used in this method of analysis are shown in Table VI. The water resources sub-areas shown were related to the Texas Air Control Board Regions and counties in these Regions. The indexes of production were used to project to year 2000 air contaminant emission levels from 1972 emission levels. These projections are shown in Table VII-A for 1985 and Table VII-B for the year 2000.

TABLE VI

Index of Production for Primary Metals Industries[4]
1969 Equals 100

Water Resources Sub Area	1969	1980	1990	2000
1112	100	132	157	191
1113	100	141	189	258
1114	100	137	167	209
1201	100	178	255	367
1202	100	160	216	295
1203	100	169	237	333
1204	100	163	221	303
1205	100	170	208	295
1206	100	-	-	(Use 200)
1207	100	152	195	256
1208	100	171	211	298
1209	100	130	166	220
1210	100	166	230	321
1211	100	156	206	275
1303	100	145	179	227
1308	100	-	-	(Use 200)
1309	100	-	-	(Use 200)
Texas	100	158	212	288

TABLE VIIA

Year 1985 Emissions
Based on Obers Projections
Related to TACB Region
Tons

Region	NOx	SOx	HC	CO	Part
1	9	-	16	74	220
2	317	75	21	126	189
3	14,033	73,571	399	1,079	28,739
4	3	240	-	903	22
5	110,714	4,643	62,828	119	17,861
6	2	-	31	94	198
7	3,381	4,236	4,698	57,055	17,551
8	226	9,372	282	9,373	1,380
9	7	3	3	2	119
10	144	-	360	3,551	414
11	1,412	52,778	153	8,425	986
12	20,246	7,446	4,712	71,113	10,178
TOTAL	150,494	152,364	73,503	151,914	77,857

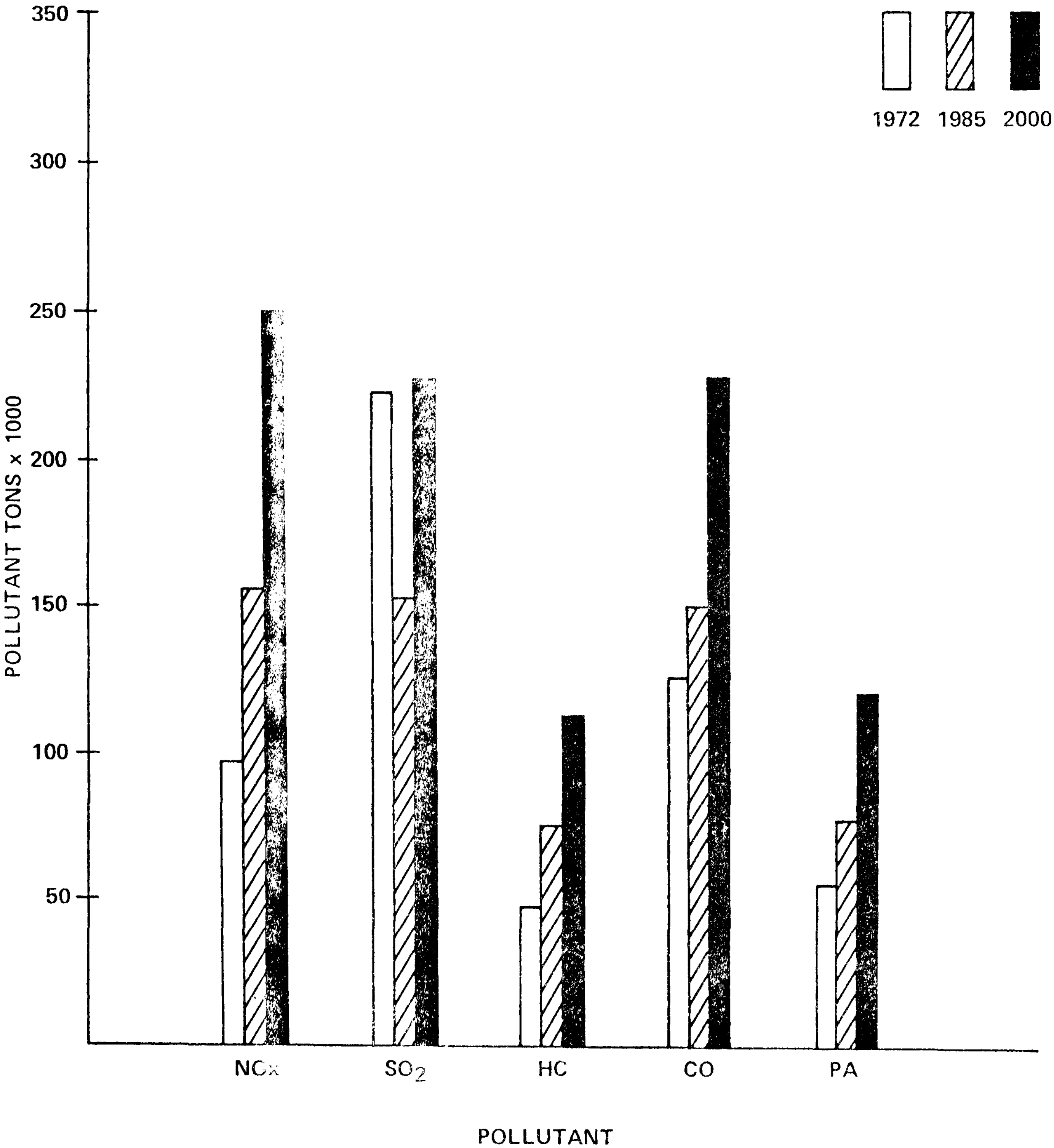
TABLE VIIB

Year 2000 Emissions
Based on Obers Projections
Related to TACB Region
Tons

Region	NOx	SOx	HC	CO	Part
1	13	-	24	115	335
2	427	100	32	189	262
3	20,765	108,865	590	1,595	42,525
4	4	346	-	1,305	32
5	174,885	7,106	99,845	189	28,575
6	2	-	47	141	295
7	5,332	6,688	7,413	90,065	27,645
8	370	15,350	461	15,341	2,253
9	11	5	5	3	193
10	226	-	566	5,582	650
11	1,978	73,955	214	11,805	1,382
12	27,940	10,236	6,654	102,110	14,528
TOTAL	231,953	222,651	115,851	228,440	118,675

FIGURE VI

PRIMARY METALS INDUSTRY
STATEWIDE POLLUTANT TOTALS



DISCUSSION OF FIGURE VI

The projected statewide emission of air contaminants from 1972 to 2000 are summarized in Figure VI. This graph reflects the use of best available control technology and New Source Performance Standards in the control of air contaminants from all new construction of primary metals facilities.

The increases of nitrogen oxides are from the dilute streams produced from the high temperature processes that are essentially uncontrolled.

The sulfur dioxide emissions show reduction from 1972 to 1985 due to the addition of control equipment and one plant shut down in Region 2.

The other air contaminants increase is due to projected growth of controlled facilities without any large intermediate reductions.

III Projections of Energy Consumption Primary Metallurgical Industries in Texas By Use of Bureau of Mines Projections

Average values of total energy requirements and electric power requirements to produce primary metals will be used to project the year 2000 energy requirements for primary metals industries in Texas.

Table VIII lists the values of total energy and electric energy required per ton of metal produced for selected metals. These values have been used with the projections of metals demand in the United States at year 2000 made by the Bureau of Mines, Department of the Interior and were related to estimates of Texas Production of these metals. (Figures 1, 2, 3, 4 and 5)

This projection indicates as shown on Table IX an estimation of a range of energy requirements as follows:

Total Energy Million KWH		Electric Energy Million KWH	
High	Low	High	Low
134,500	74,100	68,260	35,000

TABLE VIII

Energy Requirement for Metallurgical Industries[5]

Metal	Total Energy Used x 1000		Electric Power Used x 1000	
	BTU/Ton	KWH/Ton	BTU/Ton	KWH/Ton
Iron & Steel	26,000	7.62	2,600	0.76
Foundries	9,899	2.9	2,047	0.06
Aluminum	60,800	17.81	46,000	13.48
Copper	27,800	8.15	6,800	2.00
Lead	11,200	3.28	1,000	0.29
Zinc	46,000	13.48	11,000	3.22

TABLE IX

Energy Requirements in Texas for
Basic Metallurgical Industries

Metal	Demand - Year 2000 Million Tons				Energy Required - Texas Year 2000 - Million KWH			
	U.S.[A]		Texas[B]		Total		Electric	
	High	Low	High	Low	High	Low	High	Low
Iron & Steel	255	165	4.33	2.80	33,000	21,000	3,300	2,100
Foundries			2.43	1.57	7,000	4,500	1,500	900
Aluminum	36.8	18.5	4.46	2.24	79,000	39,900	60,000	30,000
Copper	7.86	4.90	0.55	0.34	4,500	2,800	1,100	700
Lead	4.14	2.52	0.54	0.33	1,800	1,100	160	100
Zinc	4.00	2.09	0.68	0.36	9,200	4,800	2,200	1,200
TOTAL					134,500	74,100	68,260	35,000

A. Total Production Estimated to Equal Total Demand
U.S. Total Demand Based on Bureau of Mines - Department of the Interior Projections

B. Estimates of Production and Demand in Texas

TABLE X

Power Equivalent of Purchased Fuels
Used for Heat and Power By Industry Group
And Industry - 1971[6]

Industry	KWH Equivalent x 10^9		
Primary Metals Industry - Total Texas			40.1
Primary Metals Industry - Total U.S.			595.4
A. Blast Furnace - Basic Steel		395.5	
1. Blast Furnace & Steel Mills	367.9		
2. Electrometallurgical Products	16.3		
3. Steel Wire & Related	3.8		
4. Cold Finished Steel Shapes	4.0		
5. Steel Pipes & Tubes	3.5		
B. Iron & Steel Foundries		38.5	
1. Gray Iron Foundries	24.8		
2. Malleable Iron Foundries	5.1		
3. Steel Foundries	8.5		
C. Primary Non-Ferrous Metals		81.3	
1. Primary Copper	19.6		
2. Primary Lead	3.9		
3. Primary Zinc	12.4		
4. Primary Aluminum	41.9		
5. Primary Non-Ferrous Metals - Misc.	3.5		
D. Secondary Non-Ferrous Metals		7.5	
E. Non-Ferrous Rolling & Drawing		37	
F. Non-Ferrous Foundries		10.3	
G. Miscellaneous Primary Metal Products		25.3	
H. Fabricated Metal Products			82.8

IV Projections of Texas Metallurgical Industry Energy Requirements in the Year 2000 by Use of Obers Projections

The power equivalent of purchased fuels used for heat and power by primary metals industries in the United States in 1971 is shown in Table X and the power equivalent of purchased fuels and electric power used for heat and power are shown in Table XI.

Two assumptions have been made: (1) primary metals industries in Texas will use an identical ratio of purchased fuels to electric power in Texas as the total United States in 1971[6] of 4.86/1 and this ratio will continue to the year 2000. (2) The ratio of purchased fuels to electric power will decrease indicating greater use of electric power. A ratio of 3.0/1 in the year 2000 will be considered.

Projections of these energy values to the year 2000 using Obers Projections of total state projections (Table VI) indicate the following values for Texas Primary Metals Industry energy requirements in the year 2000:

Ratio	Total Energy	Electric Energy
4.86/1	126×10^9 KWH	21×10^9 KWH
3.0/1	126×10^9 KWH	31×10^9 KWH

A comparison of the Projected Energy Requirements for Basic Metallurgical Industries in Texas in the Year 2000 is as follows:

Use of Bureau of Mines Projections of Demand - Year 2000

Total Energy			Electric Energy	
		Million KWH		
High	Low		High	Low
134,500	74,100		68,260	35,000

Use Of Obers Projections

Ratio	Total Energy	Electric Energy
	Million KWH	
4.86/1	126,000	21,000
3.0/1	126,000	31,000

TABLE XI

Fuels and Electric Energy Used for Heat and Power By Industry Group - 1971[6]

Industry Group	Purchased Fuels and Electric Energy - 10^9 KWH Total U.S.		Electric Energy x 10^9 KWH Total U.S.	
A. Primary Metals		717.8		122.4
1. Blast Furnace & Basic Steel	445.5		50.0	
2. Iron & Steel Foundries	46.4		7.9	
3. Primary Non-Ferrous Metals	131.2		49.9	
4. Secondary Non-Ferrous Metals	8.0		0.5	
5. Non-Ferrous Rolling and Drawing	46.9		9.9	
6. Non-Ferrous Foundries	12.0		1.7	
B. Fabricated Metal Products		103.1		20.3
C. Purchased Fuels Used for Heat and Power in Texas = 40.1 x 10^9 KWH				

TABLE XII

CONSUMPTION OF SELECTED TYPES OF ENERGY IN THE IRON AND STEEL INDUSTRY RELATED TO RAW STEEL OUTPUT[5]

1960-1968

	Gross Energy Consumption (trillions of Btu)							Raw Steel Output (millions of net tons)					Energy Used per Ton of Raw Steel Produced (millions of Btu)		
	Fuels					Purchased Electric Power	Fuel and Electric Power								
	Coal	Natural Gas	Fuel Oil	LPG	Total			Basic Oxygen	Electric	Open Hearth	Bessemer	Total	Fuels	Power	Total
1960	2,153	361	253	1	2,768	199	2,967	3	8	86	1	99	28.0	2.0	30.0
1961	1,954	399	229	1	2,583	203	2,786	4	9	85	1	98	26.4	2.1	28.5
1962	1,936	434	211	1	2,582	217	2,799	6	9	83	1	98	26.3	2.2	28.5
1963	2,012	464	234	1	2,711	242	2,953	9	11	89	1	109	24.9	2.2	27.1
1964	2,354	513	249	1	3,117	266	3,383	15	13	98	1	127	24.5	2.1	26.6
1965	2,428	547	239	2	3,216	287	3,503	23	14	94	1	131	24.5	2.2	26.7
1966	2,445	517	216	1	3,179	306	3,485	34	15	85	*	134	23.7	2.3	26.0
1967	2,306	534	186	1	3,027	313	3,340	41	15	71	*	127	23.8	2.5	26.3
1968	2,284	587	191	1	3,063	342	3,405	49	17	66	*	131	23.4	2.6	26.0

* Less than 500,000 net tons.

Source: Stanford Research Institute, based on AISI data.

TABLE XIII

Quantity of Purchased Fuels Used for Heat and Power
By Industry Group - United States[6]

Primary Metals

Year	Total KWH Equivalent x 10^9	Fuel Oil 1000 BBLS	Bituminous Coal 1000 Short Tons	Coke & Breeze 1000 Short Tons	Gas-Natural Mfg, Still, Blast Furnace x 10^9 Ft^3
1954	486	56,673	10,370	53,275	836
1958	467	47,083	11,325	12,999	634
1962	603	46,182	13,511	16,515	937
1967	600	40,712	9,883	12,990	1,141
1971	595	36,935	9,462	12,228	1,102

SUMMARY

Technological developments that are expected to have great impact on the power requirements of the metallurgical industry are presently being explored and developed. Two of these developments are (1) direct reduction of iron oxides to metallic iron, and (2) new processes for reduction of aluminium.

The total impact of these new processes must be viewed as developments that will occur or offer the greatest impact beyond the year 2000.

Regulatory restrictions are expected to keep the level of sulfur oxides emissions below that projected from industrial growth projections based on present emission levels.

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TEXAS NON METAL MINING AND PROCESSING INDUSTRY EMISSION PROJECTIONS

1972 - 2000

Project E/S-2

Manuel Aguirre, Jr., P.E.

Appendix H

APPENDIX H

TEXAS NON METAL MINING AND PROCESSING INDUSTRY EMISSION PROJECTIONS

TABLE OF CONTENTS

Rock Crushing Industry and Open Pit Mining	1
Projected Rock Crushing and Open Pit Mining Operations Particulate Emissions	3
Portland Cement Industry	5
Projected Portland Cement Industry Particulate SO_2 and NO_x Emissions	6
Projected Portland Cement Industry Gas, Oil, and Coal Consumption	7
Asphalt Concrete Plants	9
Projected Permanent Asphalt Concrete Plants Particulate Emissions	11
Projected Permanent Asphalt Concrete Plants SO_2 Emissions	12
Projected Permanent Asphalt Concrete Plants NO_x Emissions	13
Projected Portable Asphalt Concrete Plants Particulate SO_2 and NO_x Emissions	14
Projected Concrete Batching Plants Particulate Emissions	15
Lime Industry	17
Projected Lime Industry Particulate, SO_2 and NO_x Emissions	18
Non-Metal Mining Industry Statewide Particulate, SO_2, and NO_x Emission Totals	19

ROCK CRUSHING INDUSTRY AND OPEN PIT MINING

The crushed stone industry is widespread and varied in the size of plants. The size of individual firms varies from small independent producers with single plants to the larger diversified corporations with several crushed stone plants located throughout the state. Plant capacities range from less than 25,000 tons per year to about 2.5 million tons per year. Transient operations are numerous in this industry because of the necessity for establishing the production sites as near as practical to the consuming centers and to the resources available. The expected growth rate for this industry is 3.0-3.5% per year which, in general, correlates to the population growth. The rock crushing industry will be limited, somewhat, because of competing land use and environmental considerations. The environmental problems arise not because the particulate emissions generated by stone production are more offensive or dangerous than those accompanying other mineral production, but because of the necessity for having a great number of stone quarries and screening plants located in urban areas and near the principal crushed stone markets.

The environmental disturbance can be reduced to acceptable levels by institution of proper housekeeping practices such as water spray nozzles at all transfer points, chemical or water spray of the roads, and covering the truck beds that transport the mixed aggregate. Atmospheric contamination can be reduced by using dust collectors on the screening operations. As a final extreme measure, mining and processing operations can be conducted underground which will leave the surface free for other important uses, and will reduce ground level noise and dust emissions significantly. Although this type of operation was not considered in the projections presented in the following table, it is a violable alternative that can be pursued in the next 25 years.

The following table presents the particulate emission rate in tons per year for stone crushing operations and other open pit mining and processing such as clay, lime and gypsum throughout the state. The state is broken down into 12 designated Texas Air Control Board Regions, and the particulate emissions forecasts are presented for 1985 and the year 2000. Several sources of information were used to establish the present production rate, such as the U.S. Department of the Interior, Mining Enforcement and Safety Administration, to obtain the latest location, size and number of rock crushing, clay and other surface mining operations. The production rate information was obtained from the U.S. Bureau of Mines. OBERS Projections of Regional Economic Activity Indexes for Selected Industries was used to forecast a growth for each of the 12 Regions.

ROCK CRUSHING AND OTHER OPEN PIT MINING OPERATIONS

TACB Region Number	Particulate Emissions in Tons Per Year 1974	1985	2000
1	1,058.6	1,368.4	1,766.0
2	1,378.4	1,676.4	2,284.9
3	3,601.2	4,641.2	6,767.8
4	723.3	950.0	1,428.1
5	794.8	958.0	1,277.3
6	808.9	1,028.9	1,525.6
7	695.4	884.8	1,353.6
8	3,033.5	3,845.1	5,614.7
9	2,550.1	3,204.3	4,457.2
10	732.7	981.0	1,533.6
11	1,395.3	1,937.2	3,124.9
12	1,360.7	1,816.1	2,790.5
TOTALS	18,132.9	23,191.4	33,924.2

SOURCES:

1. "An Air Pollution Study of Portable Rock Crusher Emissions Using a Water Spray Control System," by Gerald Hudson, Staff Member of the Texas Air Control Board, dated July 16-17, 1968, p. 1.

2. "Compilation of Air Pollutant Emission Factors," (AP-42), Second Edition, pub. by U.S. Environmental Protection Agency Office of Air and Water Programs, April 1973, p. 8.20-1.

3. "Metal-Nonmetal Mine File Reference" dated June 6, 1974, p. 20-31, U.S. Department of the Interior, Mining Enforcement and Safety Administration, 1100 Commerce Street, Dallas, Tx. 75202.

4. Texas Almanac, 1972-73, p. 402. "Texas Mineral Production and Value," 1968, 1969 and 1970. Source: U.S. Bureau of Mines.

5. OBERS Projections, Regional Economic Activity in the U.S., pub. by: U.S. Water Resources Council, September 1972, Vol. IV, p.3, 156-189 (Indexes of Production for Selected Industries; Non-metallic except Fuels.)

6. "Mineral Facts and Problems," 1970, U.S. Department of the Interior, Bureau of Mines, 1970, (Bulletin 650), p. 1221.

PORTLAND CEMENT INDUSTRY

The fuel consumption and emissions for the Portland cement industry processes are presented in the following table. The pollution rates are exclusive of any open pit mining and crushing operations, but include the emissions from fuel combustion. The forecast for 1985 and the year 2000 assumes that the fuel consumed by the industry will be 3% sulfur coal.

The forecast predicts an average 3 to 3.5% annual increase in production output based upon the demand. The production increase correlates to selected production indexes and population growth of the twelve Texas Air Control Board designated regions.

The present fuel consumption and production rates were obtained from the Texas Air Control Board's Emission Inventory files. The pollution rates were obtained from stack sampling reports and Environmental Protection Agency emission factors for cement manufacturing.

Production rates were estimated for 1985 and the year 2000 for specific areas throughout the state from the 1972 edition of OBER'S Projections of Regional Economic Activity. The fuel consumption was then calculated based upon the amount of energy required to produce the projected production rates. The mass pollutant rates were calculated based on: (1) fuel to be fired in the kilns, (2) quantity and source of raw material, and (3) abatement devices already in use or foreseen to be in use, such as electrostatic precipitators, baghouses, etc.

PORTLAND CEMENT INDUSTRY

TACB Region No.	1974 NO_x	1974 SO_2	1974 Particulate	1985 NO_x	1985 SO_2	1985 Particulate	2000 NO_x	2000 SO_2	2000 Particulate
	Emissions in Tons per Year								
1	261.8	630.3	177.7	474.0	1,516.6	213.2	711.0	2,274.8	319.8
2	111.6	268.8	75.8	232.2	789.3	90.9	348.3	1,184.0	136.4
3	240.6	580.0	163.8	542.7	1,845.8	212.9	811.8	3,101.0	357.7
4	---	---	---	112.0	270.0	76.0	232.0	790.	91.
5	264.5	637.5	180.	491.	1,929.	221.4	580.0	3,064.	321.0
6	147.6	355.6	100.3	272.0	847.5	130.3	462.0	1,440.	221.6
7	808.8	1,950.0	549.5	1,873.7	6,440.	714.4	3,297.7	11,234.4	1,257.3
8	1,554.7	3,747.8	1,055.1	3,463.0	11,723.	1,371.6	5,748.6	19,460.0	2,276.9
9	610.1	1,469.4	413.7	1,468.4	5,117.	537.8	2,970.3	8,033.6	844.4
10	164.1	395.6	111.4	593.4	1,336.1	156.0	1,121.6	2,525.2	294.8
11	166.5	401.4	113.0	360.9	952.8	166.2	732.6	1,934.2	337.3
12	---	---	---	112.0	270.0	76.0	232.0	790.	91.0
TOTAL	4,330.3	10,536.4	2,940.0	9,995.3	33,037.1	3,966.7	17,247.9	55,831.2	6,549.2

PORTLAND CEMENT INDUSTRY

TACB Region No.	Fuel Consumption 1974 Gas x 10^6 ft^3	1974 Oil Bbl.	1985 Tons of Coal	2000 Tons of Coal
1	2,143	---	106,700	160,000
2	1,316	---	65,520	98,280
3	2,800	6,722	153,240	257,450
4	---	---	65,000	100,000
5	2,172	---	110,875	160,770
6	1,004	---	54,170	92,090
7	10,161	---	548,210	964,850
8	17,824	42,662	961,650	1,596,340
9	8,289	9,321	450,230	706,860
10	2,270	---	131,893	242,680
11	1,252	13,333	77,392	146,270
12	---	---	54,000	100,000
TOTAL	49,231	72,038	2,778,880	4,625,590

Sources:

1. "Compilation of Air Pollutant Emission Factors," (AP-42), Second Edition, pub. by U.S. Environmental Protection Agency of Air and Water Programs, April 1973, p. 8.6-3.

2. OBER'S Projections, Regional Economic Activity in the U.S., pub. by U.S. Water Resources Council, September 1972, Vol. IV, p.3, 156-189 (Indexes of Production for Selected Industries; Non-Metallic Except Fuels.)

3. Emission Inventory, Group 22, Texas Air Control Board. (1973 Emissions for Portland Cement Plants.)

4. Letter from A. M. Glombowski, Director, Market and Economic Research Dept. of the Portland Cement Association, dated August 16, 1974, to Mr. Manuel Aguirre of the Texas Air Control Board.

ASPHALT CONCRETE PLANTS

Particulate emissions for the asphalt concrete industry for the years indicated were determined primarily from data supplied by the Texas Hot Mix Paving Association and by using emission factors published by the Environmental Protection Agency.

Estimates were made on the total number of permanent and portable plants, region or regions of operation, average production rates, abatement equipment being used, and growth of the industry.

The final results indicate a decrease in emissions from this type of industry. This can be contributed to several factors: 1) an anticipated decrease in use of low energy scrubbers, 2) existing plants relocating in or near populated areas, 3) plants having to install the best available control technology because of permit procedures, 4) new plants having to meet all standards promulgated by the Environmental Protection Agency, 5) stricter air pollution regulations, and 6) an increased awareness of plant owners to the air pollution problem.

Estimates have been made for SO_2 emissions caused by using fuel oil in the dryer instead of natural or L.P. gas. Since the use of a wet scrubbing system will reduce SO_2 emissions, it has been assumed that the ratio of plants using baghouses to wet scrubbers will remain as it is presently. It should be noted that the use of fuel oil is largely determined by the lack of availability of other types of fuel. The Texas Hot Mix Paving Association projected use of fuel oil is based on the assumption that natural gas will become more readily available as large gas consuming industries convert to coal or fuel oil.

The use of coal for dryer fuel in the future is a possibility. Powdered coal mixed with lighter fuel oils produces satisfactory combustion. However, the cost of crushing equipment is so excessive that it discourages the use of powdered coal as a fuel. Also, as of now no safe practical way has been devised to ship powdered coal. If a satisfactory shipping method can be found, then one crusher can serve several plants and the use of coal as a fuel will definitely be feasible.

<u>Sources</u>:

1. Data received from the Texas Hot Mix Paving Association.
2. AP-42, 2nd Edition, "Compliation of Air Pollution Emission Factors."
3. Permits on file with the Texas Air Control Board.

PERMANENT ASPHALT CONCRETE PLANTS

Region	Particulate Emission Rates (Ton/yr) 1975	1985	2000
1	237.6	181.7	112.8
2	131.3	107.2	77.9
3	225.1	171.1	104.9
4	200.1	138.4	61.9
5	37.5	45.2	55.5
6	187.6	123.9	44.8
7	168.8	148.9	125.3
8	887.5	660.4	379.9
9	300.2	210.5	99.4
10	62.5	72.2	85.1
11	25.	28.9	34.2
12	281.4	185.9	67.2
TOTAL	2744.6	2074.3	1248.9

PERMANENT ASPHALT CONCRETE PLANTS

SO_2 Emissions in Ton per Year

TACB Region	1975	1985	2000
1	35.6	48.6	78.6
2	29.5	40.4	65.3
3	41.5	56.8	91.7
4	18.0	24.6	39.8
5	23.6	32.3	52.1
6	12.0	16.4	26.5
7	42.4	58.0	93.7
8	130.6	178.7	288.7
9	35.5	48.7	78.6
10	29.5	40.4	65.3
11	12.0	16.5	26.5
12	18.0	24.6	39.8
TOTAL	428.2	586.0	946.6

PERMANENT ASPHALT CONCRETE PIANTS

NOx Emissions in Ton per Year

TACB Region	1975	1985	2000
1	18.0	25.4	42.0
2	15.0	21.1	34.9
3	21.1	29.6	49.1
4	9.1	12.8	21.3
5	11.9	16.8	27.9
6	6.1	8.5	14.2
7	21.5	30.2	50.1
8	66.2	93.2	154.5
9	18.0	25.4	42.1
10	15.0	21.1	34.9
11	6.1	8.6	14.2
12	9.1	12.8	21.3
TOTAL	217.1	305.5	506.5

PORTABLE ASPHALT CONCRETE PLANTS

TACB Regions	1975	Particulate Emissions (Ton/yr) 1985	2000
1, 2, 8	775	523.2	211.7
6, 9, 11	669.1	448.9	177.7
4, 5	375.2	247.3	88.9
3, 7, 10, 12	975.5	661.2	273
TOTAL	2794.8	1880.6	750.7

TACB Regions	1975	SO_2 Emissions in Ton per Year 1985	2000
1, 2, 8	58.6	80.2	129.6
6, 9, 11	52.8	72.2	116.6
4, 5	23.4	32.0	51.7
3, 7, 10, 12	76.1	104.2	168.3
TOTAL	210.9	288.6	466.2

TACB Regions	1975	NOx Emissions in Ton per Year 1985	2000
1, 2, 8	29.7	41.8	69.4
6, 9, 11	26.7	37.6	62.3
4, 5	11.9	16.8	27.7
3, 7, 10, 12	38.6	54.3	90.1
TOTAL	106.9	150.5	249.5

CONCRETE BATCHING PLANTS

Region	Particulate Emissions (Ton/yr) 1974	1985	2000
1	90.6	76.8	59.0
2	82.1	78.6	60.2
3	111.0	107.4	81.4
4	36.0	36.6	27.1
5	72.4	71.0	54.3
6	36.0	34.6	27.1
7	106.3	105.6	81.4
8	195.6	192.0	145.2
9	74.8	73.0	55.5
10	43.6	42.2	31.9
11	16.9	17.3	13.0
12	68.6	65.3	49.6
TOTAL	933.9	900.4	685.7

Since the number of plants in this industry is great and no accurate count of their number is available, the base for calculating emissions is from data published by the Bureau of Business Research in the "Directory of Texas Manufacturers," random survey of data submitted to the Emissions Inventory Section, information obtained from the Technical Advisory Committee, and by using emission factors published by the Environmental Protection Agency.

Data received indicates an increase in the total number of plants in the state and an increase in the total production by these facilities. The decrease in emissions is due to more plants controlling their cement silos, roads, cement weigh hoppers, and batch drop points.

REFERENCES:

1. Directory of Texas Manufacturers

2. AP-42, 2nd Edition, "Compliation of Air Pollution Emission Factors."

3. Technical Advisory Committee, member for the concrete ready-mix industry.

4. Records on file with Emission Inventory Section of the Texas Air Control Board.

LIME INDUSTRY

The projection of emissions from the lime industry were calculated based upon the industry converting to coal fired kilns by 1985 and continuing through the year 2000.

Emission factors were obtained using 1973 emission inventory information and EPA publications AP-42 and AP-40.

The main assumptions used to predict emissions presented in Tables 1, 2, and 3 were:

(1) By 1985 rotary kilns will be 2% sulfur, 10% fly ash, anthracite coal.

(2) Efficiencies of particulate control devices used for anthracite coal in the combustion process will be 85%.

(3) Efficiencies of control devices used for the manufacturing process will be 97.4% in 1975, 99% efficient in 1985 and 2000.

(4) NOx emissions will be uncontrolled.

(5) SO_2 emissions will be 50% controlled by the scrubbers during manufacturing process.

(6) Predicted production rates obtained using the SMSA (reference 1).

(7) Emissions from Texas Air Control Board Regions 3, 8, and 9 were significant.

TABLE 1

PREDICATION OF TEXAS LIME INDUSTRY
FOR 1975 BY TACB REGIONS

Region	Production Tons/Year	Energy $10^9 ft^3$	Emissions Particulate	Tons/Year SO_2	NOx
3	433,000	3.234	1,107	2259.3	598
8	330,000	2.409	825	1683.3	445.5
9	326,000	2.380	815	1662.6	440.1
TOTALS	1,089,000	8.023	2,747	5605.2	1483.6

TABLE 2

PREDICATION OF TEXAS LIME INDUSTRY
FOR 1985 BY TACB REGIONS

Region	Production Tons/Year	Energy Coal (Tons)	Emissions Particulate	Tons/Year SO_2	NOx
3	587,000	180,000	857	4218	1332
8	511,000	157,000	746.5	4541	1160.8
9	510,000	156,000	744.0	3669	1156.5
TOTALS	1,608,000	493,000	2347.5	12,428	3649.3

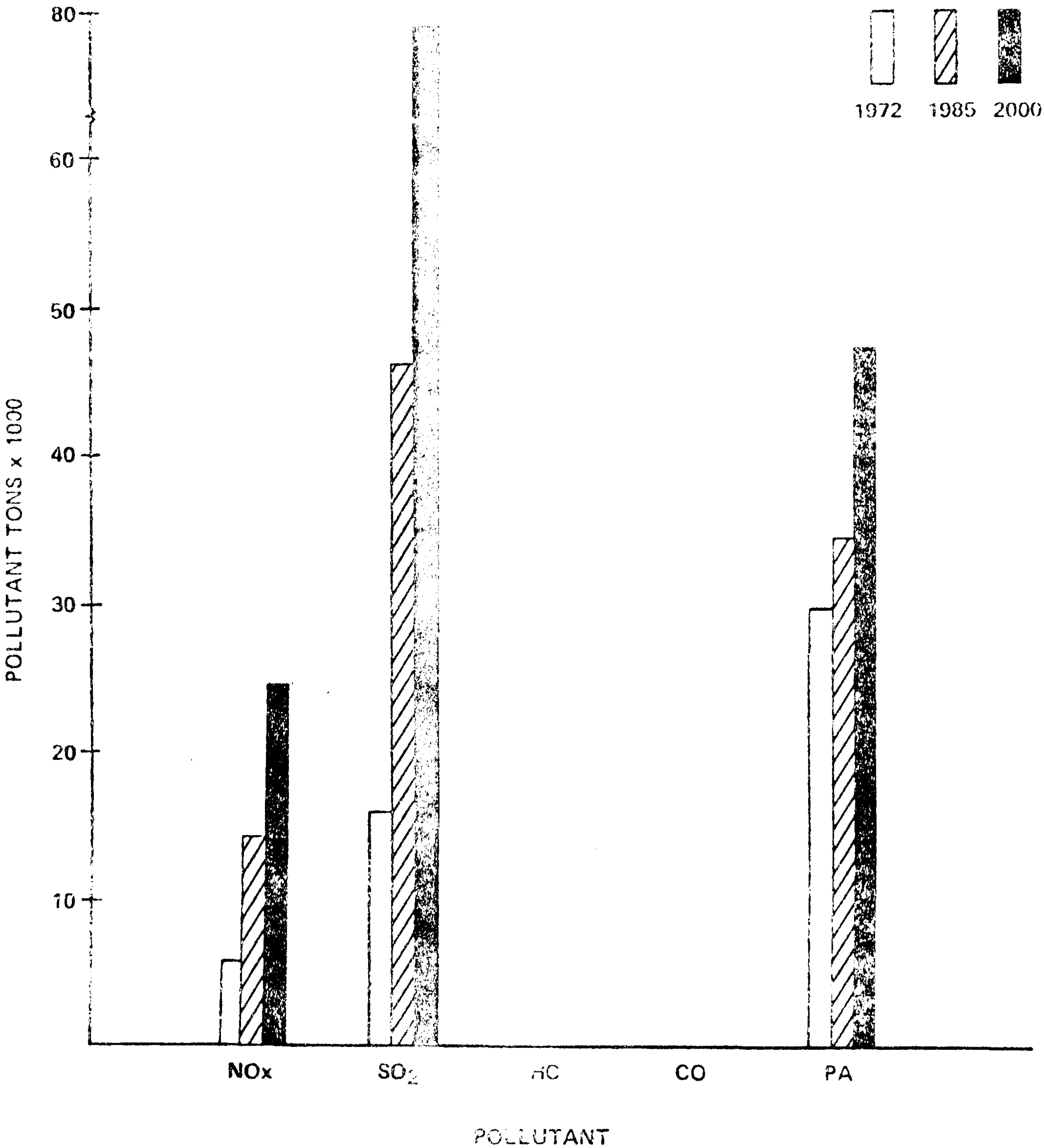
TABLE 3

PREDICATION OF TEXAS LIME INDUSTRY
FOR 2000 BY TACB REGIONS

Region	Production Tons/Year	Energy Coal (Tons)	Emissions Particulate	Tons/Year SO_2	NOx
3	1,020,000	313,000	1489.5	7330	2316
8	1,040,000	319,000	1518.5	7473	2361
9	1,020,000	313,000	1489.5	7330	2316
TOTALS	3,080,000	945,000	4497.5	22,133	6993

NON-METAL MINING INDUSTRY

STATEWIDE POLLUTANT TOTALS



APPENDIX I

TEXAS AGRICULTURAL PRODUCTION AND PROCESSING INDUSTRY EMISSION PROJECTIONS

TEXAS AGRICULTURAL PRODUCTION AND PROCESSING INDUSTRY EMISSION PROJECTIONS

1972 - 2000

Project E/S-2

Gary I. Wallin, P.E.

Appendix I

ABSTRACT

This report contains estimates of particulate emissions and comments on energy requirements from the States' major agricultural processes. Principal sources of emissions data were reports by the Midwest Research Institute prepared for EPA, EPA AP-42 Emission Factors and test results performed by the Agricultural Research Service. Information concerning production data came from 1972 OBERS PROJECTIONS, "1972 Texas County Statistics", Texas Feed and Fertilizer Control Service, the Rio Grande Valley Sugar Growers, Inc., Texas Air Control Board Emissions Inventory data and industry representatives. Estimates of existing abatement equipment and information on processing practices were obtained from Texas Air Control Board regional personnel, the Texas Agricultural Experimental Station at Texas A&M University, associations representing several segments of the agricultural industry, and industry representatives.

TABLE OF CONTENTS

	PAGE
Abstract	1
Summary	2
FEED MILLS - Particulate Emissions.............................	3
COTTON - Particulate Emissions from Cotton Gins................	6
SORGHUM - Particulate Emissions from Country Elevators.........	9
TERMINAL AND EXPORT ELEVATORS - Particulate Emission Rates.....	12
RICE - Particulate Emissions from Rice Driers..................	15
COTTONSEED - Particulate Emissions from Cottonseed Oil Mills...	18
PEANUTS - Particulate Emissions from Elevators and Shellers....	20
CORN - Particulate Emissions from Country Elevators............	23
SMALL GRAINS - Particulate Emissions from Country Elevators....	26
SOYBEANS - Particulate Emissions from Elevators................	29
SUGAR CANE - Particulate Emissions from Bagasse Fired Boilers..	31
SUGAR BEETS - Particulate Emissions from Sugar Beet Processing.	32
Graph - AGRICULTURAL PROCESSES STATEWIDE POLLUTANT TOTALS.........................	33

SUMMARY

Emissions from the processing of agricultural products consist primarily of particulate matter coming from the crop being handled such as stems, leaf material, bees' wings, chaff lint, etc. Many sources consist of fugitive emissions discharged at low levels. It is felt that these emissions contribute little to ambient levels of particulate matter, but do create nuisance conditions near the plants. This is reflected in a particle size analysis of dust collected from grain receiving and outloading areas which showed that of the particles emitted, 84.3% and 96.75% by weight, respectively, are larger than 63 microns. This indicates that the majority of the emissions settle out within a short distance from the plant.

Particulate emissions from the major agricultural processes for 1972, 1975, 1985 and 2000 are summarized in the following table:

PARTICULATE EMISSIONS FROM MAJOR AGRICULTURAL PROCESSES
(tons)

	REGIONS												
YEAR	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1972	3657.0	17375.0	2544.9	1100.0	3245.3	2918.0	6806.3	2839.8	1352.6	1838.5	419.3	1015.6	45112.3
PERCENT OF TOTAL PARTICULATE EMISSIONS (1972 Emissions Inventory)	6.7	42.0	3.4	40.5	13.5	32.7	6.7	3.5	3.6	2.0	6.0	2.4	11.9
1975	3637.3	18185.1	2756.3	1501.7	3727.0	2633.5	7271.3	3009.9	1439.4	1988.5	437.8	1145.9	47733.7
1985	3646.3	19958	2960.8	1608.7	2917.5	2551.7	5325.6	2578.7	1510.2	1730.6	472.8	1236.0	46496.9
2000	3433.0	21245.6	2889.6	1944.4	2994.1	2207.7	5789.8	2363.3	1426.4	1881.1	515.0	1344.2	48034.2

FEED MILLS

Particulate Emissions from Feed Mills in Texas

	1972					1975					1985					2000				
	PERCENT CONTROL				EMISSIONS[1]	PERCENT CONTROL				EMISSIONS[1]	PERCENT CONTROL				EMISSIONS	PERCENT CONTROL				EMISSIONS
	U	M	CC	W	(tons)	U	M	CC	W	(tons)	U	M	CC	W	(tons)	U	M	CC	W	(tons)
Commercial	5	10	45	40	3,923.5	5	10	45	40	4,236.2	5	5	30	60	4,252.3	1	4	15	80	3,468.3
Feedlots		100			8,066.0		100			8,709.1		80	20		9,915.1		60	40		11,456.0
Poultry		100			1,635.0		100			1,842.1		70	30		2,123.4		40	60		2,392.5
TOTAL					13,624.5					14,787.4					16,290.8					17,316.8

[1]Control: U - uncontrolled except grinding - 4.9 lb/ton

M - moderately controlled with enclosures and airtight systems (no pelletizing) - 2.18 lb/ton

CC - controlled with cyclones (65% pelletizing) - 1.205 lb/ton

W - well controlled with bagfilters except cyclones for pellet coolers - 0.33 lb/ton

Emissions from feed mills were not broken down by region because of the difficulty in obtaining production figures. However, broilers are raised primarily in the East Texas area, and turkeys in the central part of the State (Region 3). The high plains (primarily Region 2) account for approximately 90% of the cattle fed in feedlots. Commercial feed mills are located throughout the State. It is estimated that the large commercial feed mills process over 65% of the feed products. Many of these mills are located in the Dallas-Fort Worth area (Region 8), and Amarillo and Lubbock (Region 2).

FEED MILL PRODUCTION
(Million Tons)

Commercial	1972[1]	1975[1]	1985[2]	2000[2]
Commercial	6.9	7.45	9.31	11.94
Feedlots	7.4	7.99	9.99	12.8
Poultry and Turkeys	1.5	1.69	2.25	3.0

[1] Estimates from Texas Feed and Fertilizer Control Service, Texas A&M University

[2] Increases based on percentage increases in turkey, broiler and beef production from 1972 OBERS PROJECTIONS, Volume 5, U.S. Water Resources Council, Washington, D.C.

POWER REQUIREMENTS

The primary source of power in the feed mill industry is electrical. Some steam and heat is used for pelleting, flaking, and popping operations.

EMISSION FACTORS - FEED MILLS

Type of Source	Uncontrolled except[a/b] Where Indicated lb/ton	Controlled w/[d] Enclosures and Air-tight Systems lb/ton	Controlled w/[e] Hooding and Cyclones lb/ton
Receiving	1.3	0.78	0.36
Shipping	0.5	0.30	0.08
Handling	3.0	1.00	0.6
Grinding	0.1[c]	0.1[c]	0.1[c]
Pellet Coolers	0.1[c]	0.1[c]	0.1[c]

a - Shannon, L.J., R.W. Gerstle, P.G. Gorman, D.M. Epp, T.W. Devitt, and R. Anick, "Emission Control in the Grain and Feed Industry Vol. I - Engineering and Cost Study," Final Report by Midwest Research Institute prepared for EPA, Dec. 1973. (Preliminary EPA AP-42 Emission Factors)

b - Shannon, L.J., P.G. Gorman, M.P. Schray, D. Wallace, "Emission Control in the Grain and Feed Industry Vol. II - Emission Inventory," Final Report by Midwest Research Institute prepared for EPA, July 1974. (Preliminary EPA AP-42 Emission Factors)

c - Controlled emission factors from Preliminary EPA AP-42 Emission Factors (Abatement devices not given - assume cyclone).

d - Assume enclosures reduce emissions by 40% and a fairly airtight handling system typical in most small mills would reduce emissions by two-thirds.

e - Assume 90% capture by hooding at receiving and shipping operations and cyclones are 80% efficient.

COTTON

Particulate Emissions from Cotton Gins

	REGION	STATES PRODUCTION[1]	1972 EMISSION PER CENT[2] CONTROL U	M	W	RATE tons	1975 EMISSION PER CENT[2] CONTROL U	M	W	RATE tons	1985 PER CENT[2] CONTROL U	M	W	RATE tons	2000 PER CENT[2] CONTROL U	M	W	RATE tons
Stripped	1	13.24	10	80.5	9.5	1280.6	10	80.5	9.5	1029.6	5	60	35	947.1	1	14	85	659.6
"	2	41.20	10	80.5	9.5	3984.9	10	80.5	9.5	3203.9	5	60	35	2947.2	1	14	85	2052.5
"	3	5.1825	8	50	42	409.9	8	50	42	329.6	4	36	60	309.9	1	9	90	246.5
Picked	3	1.7275	10	50	40	54.9	10	50	40	44.1	5	30	65	32.6	0.5	4.5	95	17.3
"	4	6.8	10	50	40	216.2	10	50	40	173.8	5	30	65	128.5	0.5	4.5	95	68.1
Stripped	5	1.62	8	50	42	128.1	8	50	42	103.0	4	36	60	96.9	1	9	90	77.1
Picked	5	1.08	10	50	40	34.3	10	50	40	27.6	5	30	65	20.4	0.5	4.5	95	10.8
Stripped	6	18.31	10	80.5	9.5	1770.9	10	80.5	9.5	1423.8	5	60	35	1309.8	1	14	85	912.2
"	7	0.256	8	50	42	20.3	8	50	42	16.3	4	36	60	15.3	1	9	90	12.2
Picked	7	2.304	10	50	40	73.2	10	50	40	58.8	5	30	65	43.5	0.5	4.5	95	23.1
Stripped	8	5.5	8	50	42	435.1	8	50	42	349.8	4	36	60	328.9	1	9	90	261.6
"	9	0.26	8	50	42	20.6	8	50	42	16.6	4	36	60	15.5	1	9	90	12.4
"	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
"	11	0.127	8	50	42	10.0	8	50	42	8.0	4	36	60	7.6	1	9	90	6.0
Picked	11	1.136	10	50	40	36.1	10	50	40	29.0	5	30	65	21.5	0.5	4.5	95	11.4
Stripped	12	1.24	8	50	42	98.1	8	50	42	78.9	4	36	60	74.1	1	9	90	59.0
	TOTAL	99.983				8573.2				6892.8				6298.8				4429.8

[1]Percentages based on "1972 Texas Cotton Statistics", Texas Dept. of Agriculture & U.S.D.A.

[2]Per cent of cotton ginned taken from Texas Air Control Board Regional staff and estimates :
U - uncontrolled 7 lbs/bale; M - moderately controlled 4.726 lbs/bale for stripper cotton and 1.351 lbs/bale picked
W - well controlled 2.173 lbs/bale stripped and 0.447 lbs/bale picked.

COTTON PRODUCTION

1972: 4,106,262 bales (500 lb.)[1]

1975: 3,301,350 bales (500 lb.)[2]

1985: 3,625,622 bales (500 lb.)[2]

2000: 3,863,830 bales (500 lb.)[2]

[1]Obtained from "1972 Texas Cotton Statistics", Texas Dept. of Agriculture and U.S.D.A. Statistical Reporting Service

[2]Obtained from 1972 OBERS PROJECTIONS, Volume 5, U.S. Water Resources Council, Washington, D.C.

POWER REQUIREMENTS

The primary source of power for cotton gins is electrical. However, all gins must dry seed cotton for effective cleaning and ginning. An average rate of 381 cubic feet of natural gas is required to dry one bale of cotton.

YEAR	Million Cubic Feet of Natural Gas Required for Drying
1972	1564.5
1975	1257.8
1985	1381.4
2000	1472.1

EMISSION FACTORS - COTTON GINS

Type Source	Uncontrolled lb/bale[a]	Uncontrolled lb/bale[b]	Controlled lb/bale[c]	Controlled lb/bale[d]
Unloading System	5	5.0	0.482	0.114
Cleaner	1	0.3		
Stock & Burr Machine	3	0.2		
Miscellaneous	3	1.5	(Condenser and lint-cleaner trash cyclone)	0.18
Seed Cotton-Cleaning System			.492	0.018
Overflow System			.050	
Lint-cotton Handling System			1.149	1.039 (uncontrolled) 0.135 (controlled)
Total	12	7.0	2.173	1.351 (uncontrolled lint-cotton) 0.447 (controlled)

a - Represents emissions of particulate matter obtained from U.S. EPA AP-42, April 1973.

b - Represents emissions of particulate matter released to the atmosphere obtained from U.S. EPA AP-42, April 1973.

c - Parnell, Jr. C.B. and Roy V. Baker, "Particulate Emissions of a Cotton Gin in the Texas Stripper Area" Prod. Report N. 149, Agricultural Research Service, U.S.D.A. 1970-71. Gins controlled with high efficiency cyclone and inline lint filters. Emission results were averaged; therefore, these factors represent 75% average type stripper cotton and 25% very dirty cotton. Because of varying conditions affecting the cleanliness of cotton ginned, it is difficult to determine what represents a typical season. Feel 25% dirty cotton may be a little on the high side.

d - Factors were derived from report entitled "Tests Conducted on Exhausts of Gins Handling Machine Picked Cotton" by Oliver L. McCaskill and Richard A. Wesley, Agricultural Research Service, U.S.D.A. 1969. Gin sampled was controlled by high-efficiency cyclones only with no controls on lint cleaners on condenser. Lint cleaner and condenser exhausts controlled with lint filters would reduce overall emissions from these sources by 87%. (from ARS 42-103 Sept. 1964, U.S.D.A., Agricultural Research Service "An Inline Filter for Collecting Cotton Gin Condenser Air Pollutants" by David M. Alberson and Roy V. Baker, 1964).

SORGHUM

Particulate Emissions from
Country Elevators Handling Sorghum

REGION	PER CENT[1] PRODUCTION	1972 EMISSIONS (tons) NO CONTROLS[2]	1975 EMISSIONS PER CENT[2] CONTROLLED	1975 EMISSIONS tons	1985 EMISSIONS PER CENT[2] CONTROLLED	1985 EMISSIONS tons	2000 EMISSIONS PER CENT[2] CONTROLLED	2000 EMISSIONS tons
1	3.96	311	-	406	10	528	25	633
2	57.21	4498	-	5873	10	7620	25	9146
3	8.23	647	-	845	30	1024	60	1069
4	5.59	439	15	546	50	647	80	630
5	11.92	937	20	1146	50	1378	80	1344
6	2.61	205	-	268	10	348	25	417
7	2.95	232	-	303	50	341	30	459
8	3.5	275	-	359	50	405	80	394
9	3.46	272	-	355	30	431	60	449
10	.009	1	-	1	50	1	80	1
11	.095	7	-	10	30	12	60	12
12	0.45	35	-	46	10	60	25	72
TOTALS		7859		10158		12795		14626

[1]Percentage based on 1972 production figures.

[2]Emission rates controlled: dried sorghum - 1.965 lb/ton, not dried - 1.036 lb/ton
uncontrolled: dried sorghum - 2.688 lb/ton, not dried - 1.559 lb/ton
Assumed 17.5% on sorghum dried in 1972, 1975 and 1985 with no drying in 2000.

SORGHUM PRODUCTION

1972:	8,952,430 tons[1]
1975:	11,688,043 tons[2]
1985:	15,662,898 tons[2]
2000:	18,453,243 tons[2]

[1]Obtained from "1972 Texas County Statistics", by the Texas Dept. of Agriculture and U.S.D.A. Statistical Reporting Service

[2]Obtained from 1972 OBERS PROJECTIONS, Volume 5, U.S. Water Resources Council, Washington, D.C.

POWER REQUIREMENTS

The primary source of power in country elevators is electrical with some butane and natural gas used for drying. However, with increasing cost in fuels, more and more drying is done by using normal atmospheric air forced ventilation in storage. In the future, use of fuel for drying will be negligible.

EMISSION FACTORS - COUNTRY ELEVATORS

"Sorghum"

TYPE SOURCE	Uncontrolled[a] lb/ton	Uncontrolled[b] lb/ton	Uncontrolled[d] lb/ton	Controlled lb/ton
Truck Unloading	0.3	0.95	0.63	0.227[e] (suction to cyclone) 0.378[f] (enclosure)
Car Loading		0.29	.30	0.18[f] (enclosure and/or surge bin)
Gallery Belt		0.05	.005	
Tunnel Belt		1.4	.14	
Headhouse		2.42	.242	
Drier	1.06	2.0 (rack)[c] 0.5 (column)[c]	2.0 (rack)[c] .5 (column)[c]	1.2[f] .3[f]

a - Factors developed from Southwestern Laboratories "Texas Grain Elevator Survey", July-August, 1972

b - Midwest Research Institute Report on "Potential Dust Emissions from Grain Elevator in Kansas City Missouri", May, 1974

These emission factors were obtained by weighing all dust collected by bag filters collected from aspiration systems. Therefore, these figures represent emissions of uncontrolled - open systems including all particle sizes. Elevator tested was a terminal elevator.

c - Shannon, L.J., P.G. Gorman, M. P. Schray, D. Wallace, "Emissions Control in the Grain and Feed Industry Volume II - Emission Inventory". Final Report by Midwest Research Institute prepared for EPA, July 1974.

d - Represents my estimate of emissions from typical country elevators in Texas based on Southwestern Laboratories test result and the fact that milo sorghum received by country elevators has just been harvested and not handled as often as grain received by terminal elevators. Therefore, this grain will have fewer fines and lower emission rates at unloading operation. The loading emission factor is not adjusted from the MRI report since no additional data is available. Emission factors developed by MRI for transferring grain were reduced by 90% since their factors were based on dust collected by an aspiration system and practically all country elevators have closed elevator legs and closed auger systems. Emissions from these points are very insignificant.

e - Controlled unloading with vacuum hooding assuming 80% capture and 80% collection efficiency from cyclones. Efficiency of cyclone tested by Southwest Laboratories ranged from 81.77% to 86.9%.

f - Drier emissions are large particles and are controlled with a small settling chamber with screened exhaust openings. I estimate a 40% reduction in emissions.

TERMINAL AND EXPORT ELEVATORS
Particulate Emission Rates

EGION	PRODUCT	PERCENT STATES (1972) RECEIVED	PERCENT STATES (1972) SHIPPED	1972 EMISSIONS PERCENT CONTROL C[1]	B[2]	RATE (tons)	1975 EMISSIONS PERCENT CONTROL C	B	RATE (tons)	1985 EMISSIONS PERCENT CONTROL C	B	RATE (tons)	2000 EMISSIONS PERCENT CONTROL C	B	RATE (tons
2	Wheat	0.5	0.5	100	-	30.38	100	-	28.72		100	5.92		100	6.7
2	Sorghum	9.95	12.03	100	-	353.07	100	-	403.09		100	171.74		100	202.3
4	Wheat	0.84	0.86	-	100	10.97	-	100	10.48		100	9.94		100	11.2
4	Sorghum	8.13	7.82	-	100	79.44	-	100	104.71		100	140.33		100	165.3
5	Wheat	4.2	4.3	100	-	252.82	100	-	241.29		100	49.72		100	56.
5	Sorghum	37.42	36.25	100	-	1156.43	100	-	1468.55		100	645.89		100	760.
5	Corn	77.77	79.32	100	-	56.71	100	-	46.45		100	10.70		100	15.
7	Wheat	66.6	65.3	50.6	49.4	2389.90	50.6	49.4	2346.65		100	788.37		100	894.
7	Sorghum	26.11	25.22	85.4	14.6	726.24	85.4	14.6	952.42		100	450.67		100	530.
7	Corn	22.23	20.67	87.2	12.8	13.95	87.2	12.8	11.88		100	3.06		100	4.
7	Soybean	90.3	85.1	-	100	45.22	-	100	95.07		100	140.53		100	118.
8	Wheat	4.5	4.9	100	-	281.75	100	-	258.54		100	53.27		100	60.
8	Sorghum	11.61	12.06	100	-	374.30	100	-	470.34		100	200.39		100	236.
10	Wheat	23.3	24.1	18	82	505.46	18	82	479.37		100	275.81		100	312.
10	Sorghum	6.78	6.61	100	-	210.33	100	-	274.67		100	117.03		100	137.
10	Soybean	9.7	14.9	-	100	6.8	-	100	10.21		100	15.09		100	12.
			TOTAL			6493.77			7202.44			3078.46			3526.

[1] Emission rate - cyclone controlled with uncontrolled loadout

Wheat:	Unloading plus 20% turning (assumed) - 0.3708 lb/ton	Loadout:	0.642 lb/ton
Sorghum:	- 0.5018 lb/ton		0.75 lb/ton
Corn:	- 0.3908 lb/ton		0.68 lb/ton
Soybean:	- 0.5338 lb/ton		0.779 lb/ton

[2] Emission rate - baghouse controlled (assumed 90% capture @ receiving and uncontrolled loadout)

Wheat:	Unloading - 0.05 lb/ton	Loadout:	0.17 lb/ton
Sorghum:	- 0.108 lb/ton		0.29 lb/ton
Corn:	- 0.062 lb/ton		0.28 lb/ton
Soybean:	- 0.151 lb/ton		0.44 lb/ton

SEED PROCESSED

		Received	Shipped
1972[1]	Wheat	11,985,000	11,555,871
	Sorghum	4,957,510	5,083,188
	Corn	136,276	133,502
	Soybean	239,933	154,125
1975[2]	Wheat	11,345,000	11,345,000
	Sorghum	6,472,525	6,472,525
	Corn	109,402	109,402
	Soybean	356,300	356,300
1985[2]	Wheat	10,761,331	10,761,331
	Sorghum	8,673,659	8,673,659
	Corn	80,485	80,485
	Soybean	526,653	526,653
2000[2]	Wheat	12,206,722	12,206,722
	Sorghum	10,218,420	10,218,420
	Corn	114,731	114,731
	Soybean	445,268	445,268

[1]Texas Air Control Board's 1972 Emissions Inventory Questionnaire

[2]Increase or decrease in material processed is based on production figures for the United States from 1972 OBERS PROJECTIONS, Volume 5 U.S. Water Resources Council, Washington, D.C. using 1972 as base year.

POWER REQUIREMENTS

The primary source of power in terminal and export elevators is electrical.

EMISSION FACTORS - TERMINAL AND EXPORT ELEVATORS

	Uncontrolled[a]				Cyclone Controlled[b]			
Type Source	Corn lb/ton	Milo lb/ton	Small Grains lb/ton	Soybeans lb/ton	Corn lb/ton	Milo lb/ton	Small Grains lb/ton	Soybeans lb/ton
Truck Unloading	0.47	0.95	0.52	1.63	.115	.232	.127	.398
Car Unloading	0.62	1.08	0.50	1.51	.151	.263	.122	.368
Loading	0.28	0.29	0.17	0.44	.068	.069	.041	.107
Corn Cleaning	5.78				.925			
Gallery Belt	.12	.12	.04	.04	.019	.018	.006	.006
Tunnel Belt	1.40	1.40	1.4	1.4	.224	.224	.224	.224
Headhouse	1.1	1.1	1.24	0.72	.176	.176	.198	.115
Turning	1.4	1.4	1.4	1.4	.224	0.224	.224	.224

a - Midwest Research Institute Report on "Potential Dust Emissions From Grain Elevators in Kansas City, Missouri" May 1974.

These factors were obtained by weighing all dust collected by bagfilters collected from aspiration systems.

b - Cyclone efficiency averaged 84% in test conducted by Southwestern Laboratories from report entitled "Texas Grain Elevator Survey" July-August 1972.

RICE

Particulate Emissions from Rice Driers

REGION	PER CENT OF[1] STATES' PRODUCTION	1972 EMISSIONS[2] (tons)	1975 EMISSIONS[2] (tons)	1985 EMISSIONS[2] (tons)	2000 EMISSIONS[2] (tons)
5	11.23	410.3	427.6	446.8	480.3
7	76.53	2795.9	2914.3	3045.0	3273.2
10	12.24	447.2	466.1	487.0	523.5
TOTAL	100.0	3653.4	3808.0	3978.8	4277.0

Percentage based on 1972 production

Emission Rates: approximately 80% rice handled by well controlled commercial rice driers with total rate of 7.320 lb/ton average of 5-pass cleaning and drying, 15% of States' rice handled in privately owned installation with no cleaning and tank aeration drying, and 5% of rice handled in private installation with one pass cleaning and tank aeration drying.

RICE PRODUCTION

1972: 1,106,100 tons[1]

1975: 1,152,920 tons[2]

1985: 1,204,600 tons[2]

2000: 1,294,900 tons[2]

[1]Obtained from "1972 Texas County Statistics", Texas Department of Agriculture and U.S.D.A. Statistical Reporting Service

[2]Obtained from 1972 OBERS PROJECTIONS, Volume 5, U.S. Water Resources Council, Washington, D.C.

POWER REQUIREMENTS

The primary source of power in rice driers is electrical with butane and natural gas used for drying in commercial installations which represents 80% of states' rice production. It requires an average of 247 cubic feet of natural gas per ton of rice dried in commercial rice driers.

YEAR	NATURAL GAS REQUIRED Million Cubic Feet
1972	218.5
1975	227.8
1985	238.0
2000	255.9

EMISSION FACTORS - RICE DRIERS

Source Type	Uncontrolled[a] lb/ton	Controlled[b] lb/ton
Unloading	0.52	0.187
Loading	0.17	0.085
Gallery Belt	0.04	0.006
Tunnel Belt	1.40	0.21
Headhouse	1.24	0.186
Drier	0.5[c]	0.20[e]
Cleaner	2.0[d]	0.30[f]

a - Midwest Research Institute Report on "Potential Dust Emissions from Grain Elevators in Kansas City, Missouri", May 1974. These factors were obtained by weighing dust collected by bag filters from aspiration systems in a terminal elevator handling wheat. Since no factors are available from rice driers, factors for wheat were used because of their similar characteristics.

b - Controlled emissions represent estimate of 80% capture from hooding device vented to high efficiency cyclone with 80% collection efficiency. Loading operations reduced by 50% because of enclosure and use of surge bins. Controlled emissions from conveyance systems represents cyclone controls rated at 85% collection efficiency.

c - Shannon, L.J., P.G. Gorman, M.P. Schray, D. Wallace, "Emissions Control in the Grain and Feed Industry Vol. II - Emission Inventory." Final Report by Midwest Research Institute prepared for EPA, July 1974. Emissions from column-type driers which are common to all rice drier installations.

d - No test data is available on emissions from rice cleaning. Assumed 4 times as great as drier emissions.

e - Majority of rice driers vent drier exhaust to large settling chambers with screened exhausts. Assume 60% reduction in emissions.

f - Cleaners are exhausted to cyclones. Assumed collection efficiencies for high efficiency cyclones at 85% (large particles).

COTTONSEED

Particulate Emissions
from Cottonseed Oil Mills

REGION	PER CENT OF STATES' PRODUCTION[1]	1972 EMISSIONS (tons)	1975 EMISSIONS (tons)	1985 EMISSIONS (tons)	2000 EMISSIONS (tons)
1	13.24	208.5	167.6	92.1	58.9
2	41.2	648.9	521.7	286.5	183.2
3	8.26	130.1	104.6	57.4	36.7
4	7.06	111.2	89.4	49.1	31.4
6	18.31	288.4	231.8	127.3	81.4
7	3.91	61.6	49.5	27.2	17.4
8	6.74	106.1	85.3	46.9	30.0
11	1.27	20.0	16.1	8.8	5.6
TOTAL		1,574.8	1,266.0	695.3	444.6

[1]Cottonseed processed in each region was assumed to be in proportion to cotton produced in each region. Cottonseed produced in regions not containing oil mills was assumed to be processed in neighboring regions.

COTTONSEED PRODUCTION

1972: 1,575,000 tons[1]

1975: 1,266,266 tons[2]

1985: 1,390,643 tons[2]

2000: 1,482,011 tons[2]

[1]Obtained from "1972 Texas Cotton Statistics", Texas Dept. of Agriculture, and U.S.D.A. Statistical Reporting Service based on 767.12 pounds of seed per bale of cotton sold to oil mills.

[2]Obtained from 1972 OBERS PROJECTIONS, Volume 5, U.S. Water Resources Council, Washington, D.C. based on 767.12 pounds of seed per bale of cotton sold to oil mills.

POWER REQUIREMENTS

The primary source of power in cottonseed oil mills is electrical.

Emission Rate: Only source for emission rates from cottonseed oil mills is a paper presented at the Southern Section, Air Pollution Control Association Conference, March 1974, by Gary D. Rawlings, "Air Pollution Control at Cottonseed Oil Mills".

ESTIMATE OF EMISSIONS FROM CYCLONES

Process	Emission Rate (lb/ton)
Lint Room	1.0
Trash from Linters	0.3
Hulls	0.2
Meats or Meal	0.05
Oil	-
	1.55

Rawlings stated in his discussion that the 1.55 lb/ton emission factor is probably very conservative and 2 pounds per ton is probably more realistic.

Emission Factors Used:

1972 and 1975	2 lb/ton
1985	1.55 lb/ton
2000	0.6 lb/ton (use of bag filters)

PEANUTS

Particulate Emissions from Country Elevators for Peanuts

REGION	PERCENT[1] PRODUCTION	1972 PERCENT[2] CONTROLLED U	1972 C	1972 EMISSIONS (tons)	1975 PERCENT[2] CONTROLLED U	1975 C	1975 EMISSIONS (tons)	1985 PERCENT[3] CONTROLLED U	1985 C	1985 EMISSIONS (tons)	2000 PERCENT[4] CONTROLLED U	2000 C	2000 EMISSIONS (tons)
1	35.93	100		476.9	100		481.1	50	50	399.7	20	80	303.3
2	0.94	100		4.2	100		4.3	50	50	3.3	20	80	2.5
3	6.04	100		27.2	100		27.4	50	50	21.1	20	80	15.9
5	0.76	100		3.4	100		3.5	50	50	2.7	20	80	2.0
6	4.77	100		21.5	100		21.7	50	50	16.7	20	80	12.5
7	2.91	100		13.1	100		13.2	50	50	10.2	20	80	7.6
8	15.07	100		141.2	100		142.4	50	50	167.7	20	80	127.2
9	30.67	100		377.6	100		380.9	50	50	341.2	20	80	258.9
12	2.90	100		13.1	100		13.2	50	50	10.2	20	80	7.6
TOTAL	99.99			1078.2			1087.7			972.8			737.5

[1] Percentage of States' production based on "1972 Texas County Statistics", Texas Dept. of Agriculture and U.S.D.A. Statistical Reporting Service

[2] 1972 and 1975 emission factors - assumed 90% of country pick-up elevators performed cleaning operations in Region 1; 50% in Region 8; and 80% in Region 9 with 100% drying in Region 1; 50% in Region 8 and 100% in Region 9. All other regions assumed to have receiving, storage and loadout operations.
Factors: Region 1 - 11.05 lb/ton; Region 8 - 7.08 lb/ton; Region 9 - 10.25 lb/ton; and all others 3.75 lb/ton (all uncontrolled)

[3] 1985 emission factors - assumed 100% of country elevators to perform cleaning and drying operations with 50% controlled in Regions 1, 8 and 9 for a factor of 7.15 lb/ton. Assumed receiving, storage and loadout operations for all other regions with 50% controlled for factor of 2.25 lb/ton.

[4] 2000 emission factors - assumed 100% of country elevators to perform cleaning and drying operations with 80% controlled for emission factor of 4.33 lb/ton. Assumed receiving, storage and loadout operations for all other regions with 80% controlled for factor of 1.35 lb/ton.

PEANUTS

Particulate Emissions from Shellers

REGION	PERCENT[1] PRODUCTION	1972 EMISSIONS[2] (tons)	1975 EMISSIONS[2] (tons)	1985 EMISSIONS[2] (tons)	2000 EMISSIONS[2] (tons)
1	47.68	63.00	63.55	81.61	102.26
8	17.97	23.74	23.95	30.76	38.54
9	34.34	45.37	45.77	58.78	73.65
TOTAL	99.99	132.11	133.27	171.15	214.45

[1] Regions 1, 8 and 9 contain the major shellers in the State. Peanuts produced in regions having no shellers are assumed to be shelled in neighboring regions.
[2] Emission rates: assume controlled emissions of 1.1 lb/ton

PEANUT PRODUCTION

1972: 240,227 tons[1]

1975: 242,352 tons[2]

1985: 311,213 tons[2]

2000: 389,953 tons[2]

[1] Obtained from "1972 Texas County Statistics", Texas Dept. of Agriculture and U.S.D.A. Statistical Reporting Service
[2] Obtained from 1972 OBERS PROJECTIONS, Volume 5, U.S. Water Resources Council, Washington, D.C.

POWER REQUIREMENTS

The primary source of power in these country elevators and shellers is electrical with some natural gas used for drying. However, future drying will probably be done with ambient air with some supplemental electrical heating.

PEANUTS

Emission Factors - Country Elevators

Type of Source	Uncontrolled lb/ton	Controlled[f] Cyclones & Enclosures lb/ton
Receiving Operations	2.5[a]	0.5
Cleaning Operations	8.0[b]	1.6
Drying	0.1[c]	0.1
Storage Operations	0.75[d]	0.15
Loadout	0.5[e]	0.1

[a] Assumed to be greater than soybeans which equals 2.39 lb/ton.(See emissions for terminal and export elevators.)

[b] Assumed to be greater than transferring soybeans and the cleaning of corn (See emissions for terminals and export elevators.)

[c] Very light emissions because of very slow air flow rates. Assumed to be same as emissions from controlled pellet coolers. (See emissions for feed mills.)

[d] Assumed to be same as moving soybeans.

[e] Assumed to be similar to soybeans.

[f] Assume 80% control efficiency.

EMISSIONS FROM PEANUT SHELLING OPERATIONS

Source of Emissions	Uncontrolled lb/ton	Controlled lb/ton
Receiving and Handling	0.5[a]	0.1[c]
Cleaning Operations	4.0[b]	0.8[e]
Drying	0.1[c]	0.1[c]
Grinding	0.1[d]	0.1[d]

[a] Assumed to be similar to soybeans.

[b] Very rough estimate of uncontrolled emissions. Assumed to be one-half of cleaning operations from country receiving points.

[c] Very light emissions because of very slow air flow rates. Assumed to be same as emissions from controlled pellet coolers. (See emissions for feed mills.)

[d] Estimated from feed mill emissions.

[e] Assume 80% control efficiency.

CORN

Particulate Emissions from Country Elevators Handling Corn

REGION	PER CENT[1] PRODUCTION	1972 EMISSIONS[2] PARTIAL CONTROL (tons)	1975 EMISSIONS[2] PARTIAL CONTROL (tons)	1985 EMISSIONS[3] PER CENT WELL CONTROLLED	1985 EMISSIONS[3] EMISSION RATE (tons)	2000 EMISSIONS[3] PER CENT WELL CONTROLLED	2000 EMISSIONS[3] EMISSION RATE (tons)
1	-	-	-	-	-	-	-
2	78.0	774.9	401.4	10	289.4	25	134.5
3	-	-	-	-	-	-	-
4	1.14	11.3	5.9	50	4.0	80	1.8
5	4.77	47.4	24.5	50	16.5	80	7.4
6	-	-	-	-	-	-	-
7	5.05	50.2	26.0	50	17.5	80	7.9
8	0.6	6.0	3.1	50	2.1	80	0.9
9	9.07	90.1	46.7	30	32.6	60	14.7
10	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-
12	1.36	13.5	7.0	10	5.1	25	2.3
	99.89	993.4	514.6		367.2		169.5

[1]Percentage based on 1972 production

[2]Assumed elevators have controlled (closed) headhouse, gallery and tunnel auger system, and driers with uncontrolled receiving and loadout giving emission factor of 1.794 lb/ton

[3]Well controlled emission factor used of 1.494 lb/ton

CORN PRODUCTION

1972:	1,107,567 tons[1]
1975:	573,748 tons[2]
1985:	422,131 tons[2]
2000:	200,581 tons[2]

[1]Obtained from "1972 Texas County Statistics", Texas Dept. of Agriculture and U.S.D.A. Statistical Reporting Service

[2]Obtained from 1972 OBERS PROJECTIONS, Volume 5, U.S. Water Resources Council, Washington, D.C.

POWER REQUIREMENTS

Primary source of power for country elevators handling corn is electrical except for drying. Drying about 6% of the moisture from corn requires approximately 280 cubic feet of natural gas per ton of corn dried. If 100% of the states' corn is dried, 159.81 million cubic feet of gas is required for drying corn in 1975. However, more and more grain is being dried in storage with little heated air used for drying.

EMISSION FACTORS - COUNTRY ELEVATORS

"Corn"

Type Source	Uncontrolled[a] lb/hr	Controlled[b] lb/ton
Truck Unloading	0.47	0.28
Loading	0.28	0.17
Gallery Belt	0.12	0.012
Tunnel Belt	1.40	0.14
Headhouse	1.1	0.11
Drier	2.0 (rack)[c] .5 (column)[c]	1.2 (rack)[d] .3 (column)[d]

a - Midwest Research Institute Report on "Potential Dust Emissions from Grain Elevators in Kansas City Missouri", May, 1974. These emission factors were obtained by weighing dust collected by bag filters from aspiration systems. Therefore, these figures represent uncontrolled-open systems.

b - Many country elevators use only enclosures to reduce fugitive emissions from unloading and loading operations. Since the major portion of particles emitted are large, it is felt enclosures reduce emissions as much as 40%. Most small elevators have closed, airtight conveying systems which would reduce emissions as much as 90% over uncontrolled emissions derived from the MRI report.

c - Shannon, L.J., P.G. Gorman, M.P. Schray, D. Wallace, "Emissions Control in the Grain and Feed Industry Vol. II - Emission Inventory". Final Report by Midwest Research Institute prepared for EPA, July 1974.

d - It is estimated that small settling chambers with screened exhaust openings reduce emissions by 40%.

SMALL GRAINS

Particulate Emissions From Country Elevators Handling Small Grains

REGION	PERCENT OF STATES' PRODUCTION[1]	1972 PERCENT WELL CONTROLLED	1972 EMISSIONS[2] (tons)	1975 PERCENT WELL CONTROLLED	1975 EMISSIONS[2] (tons)	1985 PERCENT WELL CONTROLLED	1985 EMISSIONS[2] (tons)	2000 PERCENT WELL CONTROLLED	2000 EMISSIONS[3] (tons)
1	23.95		216.1		279.6	10	287.4	25	270.2
2	58.50		527.8		683.0	10	702.1	25	660.1
3	2.63		23.7		30.7	30	29.9	60	26.8
5	0.26		2.3	20	2.9	50	2.8	80	2.5
6	2.68		24.2		31.3	10	32.2	25	30.2
7	0.11		1.0		1.3	50	1.2	80	1.0
8	8.22		74.2		96.0	50	88.3	80	78.6
9	2.05		18.5		23.9	30	23.3	60	20.9
11	0.44		4.0		5.1	30	5.0	60	4.5
12	0.5		4.5		5.8	10	6.0	25	5.6
TOTAL	100.00		896.3		1159.6		1178.2		1100.4

[1]Based on 1972 production figures

[2]Assumed 10% of grain is dried, uncontrolled receiving, loadout and drying emission factor of 1.974 lb/ton; uncontrolled receiving and loadout with no drying emission factor of 1.082 lb/ton; controlled receiving, loadout and drying emission factor of 1.494 lb/ton; and controlled receiving and loadout with no drying emission factor of 0.802 lb/ton.

[3]Assumed no drying in driers.

SMALL GRAIN PRODUCTION

1972: 1,540,680 tons[1]

1975: 1,993,638 tons[2]

1985: 2,103,335 tons[2]

2000: 2,229,984 tons[2]

[1]Obtained from "1972 Texas County Statistics", Texas Dept. of Agriculture and U.S.D.A. Statistical Reporting Service

[2]Obtained from 1972 OBERS PROJECTIONS, Volume 5, U.S. Water Resources Council, Washington, D.C.

POWER REQUIREMENT

The primary source of power in elevators handling small grains is electrical with natural gas used for drying. Very little grain is dried and will primarily be dried in storage tanks in the future using ambient air.

EMISSION FACTORS - COUNTRY ELEVATORS

"Wheat and Small Grains"

Source Type	Uncontrolled[a] lb/ton	Controlled[b] lb/ton
Truck Unloading	0.52	.31
Loading	0.17	.10
Gallery Belt	.04	.004
Tunnel Belt	1.4	.14
Headhouse	1.24	.124
Drier	2.0 (rack)[c] 0.5 (column)[c]	.12 (rack)[d] .3 (column)[d]

a - Midwest Research Institute Report on "Potential Dust Emissions from Grain Elevators in Kansas City, Missouri", May 1974. These factors were obtained by weighing dust collected by bag filters from aspiration systems. Therefore, these figures represent uncontrolled-open systems.

b - Many elevators use enclosures to reduce fugitive emissions from unloading and loading operations. Since the majority of the particles emitted are large, it is felt enclosures reduce emissions as much as 40%. Most small elevators have closed, airtight conveying systems which would reduce emissions as much as 90% over uncontrolled emissions derived from the MRI report.

c - Shannon, L.J., P.G. Gorman, M.P. Schray, D. Wallace, "Emissions Control in the Grain and Feed Industry Vol. II - Emission Inventory." Final Report by Midwest Research Institute prepared for EPA, July 1974.

d - It is estimated that small settling chambers with screened exhaust openings reduce emissions by 40%.

SOYBEANS

Particulate Emissions from
Elevators Handling Soybeans

REGION	PER CENT OF STATES' PRODUCTION[1]	1972 EMISSIONS[2] (tons)	1975 EMISSIONS[2] (tons)	1985 EMISSIONS[3] (tons)	2000 EMISSIONS (tons)
2	5.76	11.6	21.3	16.1	22.9
5	1.23	2.5	4.5	3.4	4.9
6	0.32	0.7	1.2	0.9	1.3
7	46.98	97.3	173.7	131.7	186.8
8	6.48	13.4	24.0	18.2	25.8
10	8.35	17.3	30.9	23.4	33.2
12	30.88	64.0	114.2	86.6	122.8
TOTAL	100.0	206.8	369.8	280.3	397.7

[1]Percentage based on 1972 production

[2]Emission rate for 1972 and 1975 estimated at 2.530 lb/ton with uncontrolled receiving and loading (see emission factors for terminal and export elevators).

[3]Emission rate for 1985 and 2000 estimated at 1.293 lb/ton for controlled emissions except for loading (see emission factors for terminal and export elevators).

SOYBEAN PRODUCTION

1972: 163,799 tons[1]

1975: 292,308 tons[2]

1985: 432,045 tons[2]

2000: 612,570 tons[2]

[1]Obtained from "1972 Texas County Statistics", Texas Department of Agriculture and U.S.D.A. Statistical Reporting Service

[2]Obtained from 1972 OBERS PROJECTIONS, Volume 5, U.S. Water Resources Council, Washington, D.C.

POWER REQUIREMENTS

The primary source of power in soybean elevators is electrical.

SUGAR CANE

Particulate Emissions from Bagasse Fired Boilers

	1975-76	1985-86	2000-01
tons	321	355	745

SUGAR CANE PRODUCTION[1]

1975-76: 1.12 million tons

1985-86: 1.24 million tons

2000-ol: 2.60 million tons

[1] Rio Grande Valley Sugar Growers, Inc. estimates

Emission Rates:

Rate = 1.91 lb/ton of bagasse burned

Emission rate based on test data performed in February 1974 and on efficiency curves of low energy scrubber system (assume average efficiency of 97.5%). Bagasse represents 30% of sugar cane harvested.

POWER REQUIREMENTS

Over 95% of the power required is generated from the burning of bagasse with the remaining fuel requirements coming from natural gas and fuel oil.

SUGAR BEETS

Particulate Emissions from Sugar Beet Processing

REGION	1972 EMISSIONS (tons)	1975 EMISSIONS (tons)	1985 EMISSIONS (tons)	2000 EMISSIONS (tons)
2 (Deaf Smith County)	27.95	33.41	35.51	49.22

Major source of emissions from sugar beet processing comes from the pulp driers. Average emission rate obtained from stack sampling performed in January 1973 was 1.57 lb/ton of dry pulp. Dried pulp represented 6.16% of field beet production in 1972.

SUGAR BEET PRODUCTION

1972: 578,000 tons[1]
1975: 690,900 tons[2]
1985: 734,400 tons[2]
2000: 1,017,900 tons[2]

[1] Obtained from Texas Air Control Board emission inventory

[2] Obtained from 1972 OBERS PROJECTIONS, Volume 5, U.S. Water Resource Council, Washington, D.C.

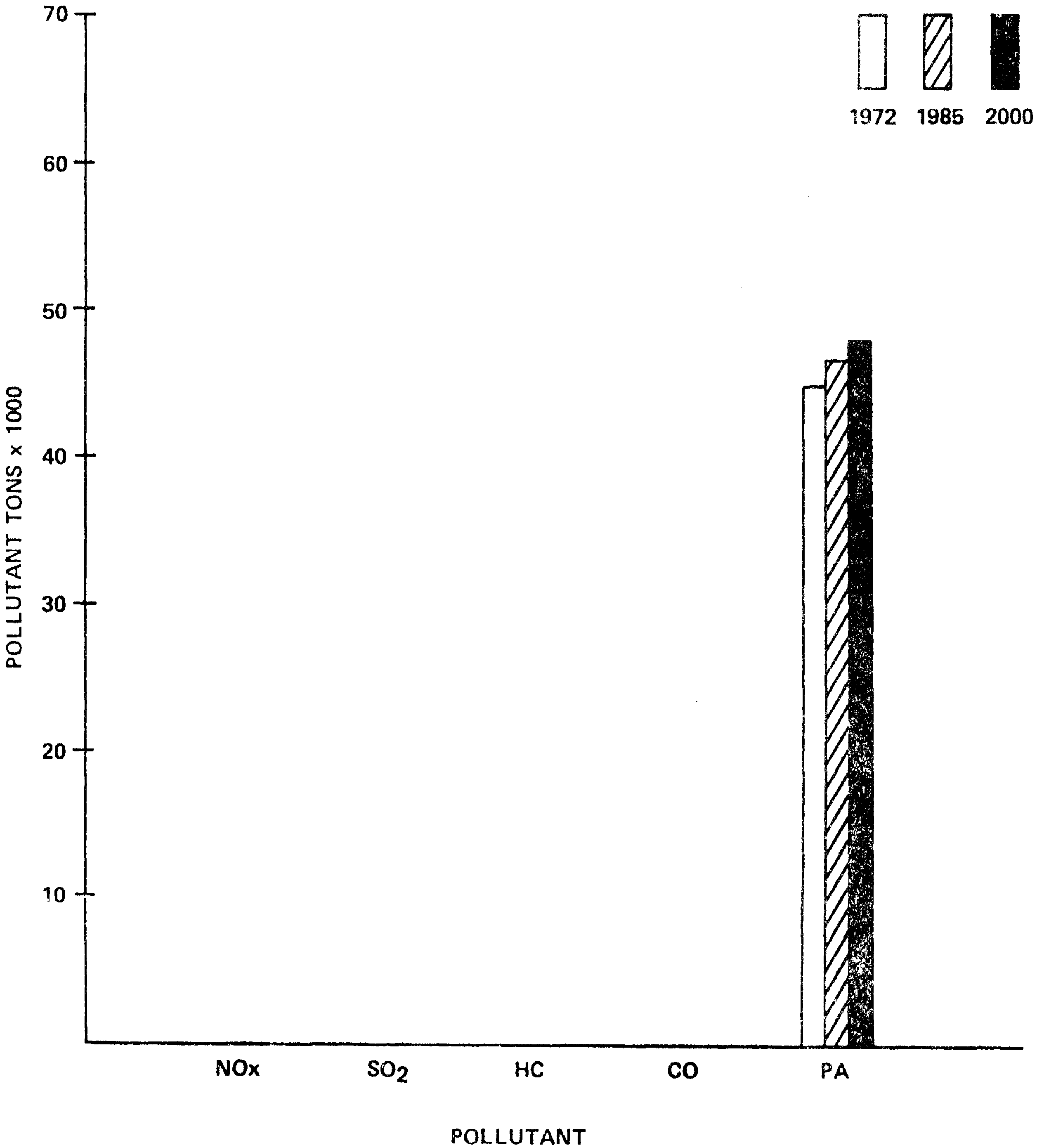
POWER REQUIREMENTS

Power requirements in 1972 averaged 2.679 mcf of natural gas per ton of beets.

YEAR	MMCF Natural Gas
1972	1548.5
1975	1850.9
1985	1967.4
2000	2726.9

AGRICULTURAL PROCESSES

STATEWIDE POLLUTANT TOTALS



APPENDIX J

TEXAS CHEMICAL PULPING INDUSTRY

EMISSION PROJECTIONS

TEXAS CHEMICAL PULPING INDUSTRY EMISSION PROJECTIONS

1972 - 2000

Project E/S-2

Gary I. Wallin, P.E.

Appendix J

ABSTRACT

This report contains estimates of emissions from the production of pulp by the kraft (sulfate) process for the years 1972, 1975, 1985 and 2000. All emissions were tabulated by the Texas Air Control Regions. Information was obtained from the following sources:

- Texas Forest Service, Texas A&M University System
- Industry representative

- PATTERNS OF ENERGY CONSUMPTION IN THE UNITED STATES, Office of Science and Technology, Executive Office of the President, Washington, D.C., January 1972

- ATMOSPHERIC EMISSIONS FROM PULP AND PAPER MANUFACTURING INDUSTRY, EPA-450/1-73-002, Environmental Protection Agency, September 1973

- "Compilation of Air Pollutant Emission Factors", AP-42, Supplement No. 3, 2nd Edition, Environmental Protection Agency, July 1974

- 1972 OBERS PROJECTIONS, Regional Economic Activity in the U.S., Volume 1, U.S. Water Resources Council, Washington, D.C.

SUMMARY

The increase in emissions of air contaminants from kraft pulp mills in Texas from 1972 to the year 2000 parallels the projected increase in the production of pulp except for emissions of sulfur dioxide and nitrogen oxides. Instead of an increase of 160 to 180%, an increase of 820% in sulfur dioxide and an increase of 325% in nitrogen oxides is predicted. The use of fuel oil and lignite for the generation of steam and electricity is the primary reason for these high increases.

POWER GENERATION FACTS

Plant Requirement

Steam - 12,500 lbs/ton pulp (@1,350 Btu/lb)

Electricity - 3,000 kwh/ton pulp (@4,000 Btu/kwh)

PRODUCTION

Steam - Approximately 64% of steam is produced from recovery boilers and 16% from burning of bark (4,240 Btu/lb) which is also used to generate approximately 50% (1,500 kwh) of the electrical demand. This leaves 2,500 pounds of steam which is assumed to be produced by the mills. This 2,500 pounds of steam can also be used to generate about 375 kwh of electricity. The use of the following fuels was assumed for the production of this additional steam:

1972 - 100% natural gas (1,030 Btu/ft^3)
1975 - 75% natural gas
25% fuel oil (149,000 Btu/gal and 0.8% sulfur)
1985 & 2000 - 50% fuel oil
50% lignite (7,500 Btu/lb and 2% sulfur)

Electricity - Of the 3,000 kwh/ton of pulp required, approximately 1,125 kwh additional electricity must be purchased or generated by the mill. State and national figures indicate approximately 50% of the electrical requirements of a mill or self-generated and 50% purchased.

Fuel used for the generation of this electricity is assumed to be the same as the production of steam.

EMISSION FACTORS FOR KRAFT PULPING PROCESS

	PART.	SO_2	CO	H_2S
Well controlled 1972-75	12	5.3	41	8.7
Expansion after 1975	7	3.3	41	8.7

EMISSIONS POWER GENERATION

	PART.	SO_2	CO	H_2S
Nat. Gas lb/MMCF[1]	10	0.6	17	175
Fuel Oil lb/1000 gal[1]	23	126.9	4	60
Bark lb/ton[1]	15	1.5	31	10
Lignite lb/ton[2]	1.5	18	2	10.5

[1]AP-42 Supplement No. 3 for "Compilation of Air Pollutant Emission Factors", Second Edition, U.S. Environmental Protection Agency, July 1974

[2]New Source Performance Standards promulgated by the Environmental Protection Agency

PRODUCTION OF PULP

REGION	1972[1] (tons)	1975[2] (tons)	1985[3] (tons)	2000[3] (tons)
7	428,448	472,000	472,000	472,000
10	877,120	933,000	1,061,600	2,506,000
12	insig.	217,000	247,400	584,000

[1]Texas Air Control Board Emission Inventory data

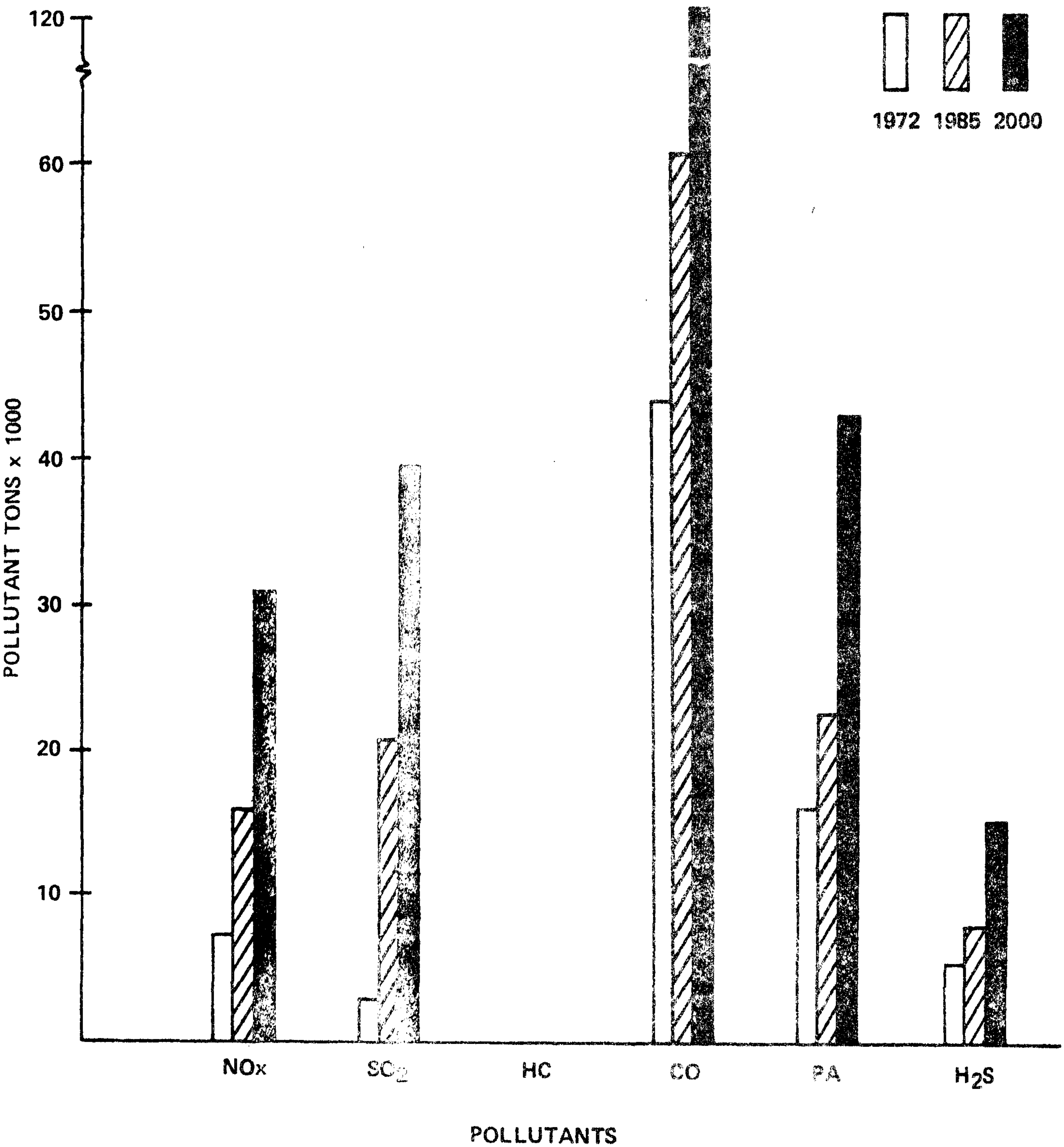
[2]Texas Air Control Board Emission Inventory data and company representatives

[3]1972 OBERS PROJECTIONS, Regional Economic Activity in the U.S., Volume 1, U.S. Water Resources Council, Washington, D.C. (Assume no growth in Region 7 after 1975 with growth in Region 10 and Region 12 in proportion to 1975 production.)

EMISSIONS FROM CHEMICAL PULPING PROCESSES
(Kraft Process)

	Particulate (tons)	Sulfur Dioxide (SO_2) (tons)	Carbon Monoxide (tons)	Hydrogen Sulfide (tons)	Nitrogen Oxides (tons)
1972 Process					
Reg. 7	2,571	1,135	8,783	1,864	-
Reg. 10	5,263	2,324	17,981	3,815	-
Reg. 12	insig.	insig.	insig.	insig.	-
1972 Power Generation					
Reg. 7	2,725	271	5,619	-	2,388
Reg. 10	5,577	555	11,501	-	4,888
Reg. 12	insig.	insig.	insig.	-	insig.
1972 Totals	16,136	4,285	43,884	5,679	7,276
1975 Process					
Reg. 7	2,832	1,251	9,676	2,053	-
Reg. 10	5,596	2,471	19,119	4,057	-
Reg. 12	1,304	576	4,456	946	-
1975 Power Generation					
Reg. 7	3,084	807	6,189	-	2,707
Reg. 10	6,094	1,594	12,230	-	5,350
Reg. 12	1,420	371	2,850	-	1,247
1975 Totals	20,330	7,070	54,520	7,056	9,304
1985 Process					
Reg. 7	2,832	1,251	9,676	2,053	-
Reg. 10	6,046	2,683	21,745	4,616	-
Reg. 12	1,410	626	5,079	1,078	-
1985 Power Generation					
Reg. 7	3,453	4,242	6,433	-	4,096
Reg. 10	7,766	9,540	14,468	-	9,212
Reg. 12	1,811	2,225	3,374	-	2,148
1985 Totals	23,318	20,567	60,775	7,747	15,456
2000 Process					
Reg. 7	2,832	1,251	9,676	2,053	-
Reg. 10	11,101	5,066	51,364	10,899	-
Reg. 12	2,589	1,182	11,980	2,543	-
2000 Power Generation					
Reg. 7	3,444	4,231	6,416	-	4,086
Reg. 10	18,368	22,563	34,221	-	21,790
Reg. 12	4,279	5,256	7,972	-	5,076
2000 Totals	42,613	39,549	121,629	15,495	30,952

CHEMICAL PULPING (KRAFT)
STATEWIDE POLLUTANT TOTALS



TEXAS TRANSPORTATION EMISSION PROJECTIONS

1972 - 2000

Project E/S-2

Henry Sievers, P.E.

Appendix K

APPENDIX K

TEXAS TRANSPORTATION EMISSION PROJECTIONS

Impact on Air Quality of Alternate Strategies for Production, Distribution and Utilization of Energy in Texas

Transportation

Statement of the Problem:

To determine the probable change in emissions from transportation sources between the present (1972) and the year 2000.

Facts:

1. In Texas the private automobile is the primary mode of transportation.

2. In 1972 a total of 8,414,854 vehicles were registered in Texas.[1/] Of these, 5,570,214 were passenger vehicles, 1,408,187 were commercial trucks, 1,046 were motor buses, 848 were city buses, and 215,269 were motorcycles.

3. Mass transit ridership levels have declined in the last 20 years in Texas.[2/]

Assumptions:

1. Motor vehicle usage will continue to increase with decreasingly less yearly increases after 1975. Annual vehicle miles traveled in 2000 will be approximately 20% less than those estimated in 1972 by the Texas Highway Department[3/] because of increasing shortages and cost of vehicles and gasoline.

2. In the absence of data to the contrary, it is assumed that the existing mixture of automobiles and trucks (obtained from registration data[4/]), vehicle age

mixtures and relative mileage driven per year will remain relatively constant through 2000.

3. The pollutant emissions per vehicle mile can be approximated by the emission factors given in the EPA publication AP-42.[5]

4. General aviation operations in 2000 will be 2.5 times that of 1972. This value was extrapolated from the Texas Transportation Institute estimate[6] that 1990 operations will be 2.3 times the 1970 total.

5. Aircraft operations (and hence, emissions) will grow at the same rate from 1990 to 2000 as from 1972 to 1990.

6. Electric vehicles, now being developed, will be in fairly widespread use in urban areas by 2000, but will not represent any significant portion of the total vehicle miles traveled. For computation purposes, a value of 10% of the urban vehicle miles traveled has been assumed.

7. Pollution from vessels will increase in approximately the same ratio as population increases.

8. The 1972 population of Texas is assumed to be 11.6 million, with growth to 14.2 million by 1985 and 18.2 million in 2000. These projections were derived from 1970 data and 1990 projections from the United States Bureau of the Census.

9. Existing plans will result in significantly greater mass transit usage by the year 2000.[2]

Discussion:

From the above facts and assumptions, one can project the vehicle miles traveled by each type of vehicle to the years 1985 and 2000 as shown in Table 1.

TABLE 1

Type of Vehicle	Annual Vehicle Miles Traveled (Millions) 1972	1985	2000
Light duty gasoline vehicles	69,215	93,731	115,705
Light duty electric vehicles	0		5,790
Heavy duty gasoline vehicles	3,261	4,416	5,738
Diesel trucks	4,051	5,469	7,072
Buses	55	90	151
Rail system (urban)	0.3	5	50
Others	0	2	15
Total	76,582	103,714	134,817

Using the EPA emission factors[5/] and the other assumptions, the probable air pollutant emissions from the various transportation sources can be computed as shown in Tables 2 - 4. Projections for motor vehicles and aircraft were derived from computer programs used in the Texas Air Control Board while those for railroads and vessels were obtained from extrapolations from the 1972 inventory data. Table 2 shows the total emissions from transportation in 1972, while Tables 3 and 4 show projected emissions in 1985 and 2000 respectively. Tables 5-1 through 5-12, 6-1 through 6-12, and 7-1 through 7-12, at the end of this report show the breakdown of the total emissions of Tables 2, 3 and 4 into the 12 Air Quality Regions in Texas.

TABLE 2

Major Air Pollution Emissions

from Transportation Sources in 1972

State Total

Source	Pollutant (1000 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline Powered	452	16	622	3326	47
Diesel Powered	155	11	16	93	5
Aircraft	8	2	39	93	3
Railroads	49	8	12	17	3
Vessels	30	24	32	115	27
Total	694	61	721	3644	85

Total all pollutants: 5205

TABLE 3

Major Air Pollution Emissions

from Transportation Sources in 1985

State Total

Source	Pollutant (1000 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline Powered	173	22	119	726	63
Diesel Powered	207	15	22	125	7
Aircraft	16	3	35	122	2
Railroads	54	9	13	19	3
Vessels	38	31	40	147	34
Total	488	80	229	1139	109

Total all pollutants: 2045

TABLE 4

Major Air Pollution Emissions
from Transportation Sources in 2000
State Total

Source	Pollutant (1000 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline Powered	161	28	115	586	82
Diesel Powered	259	19	26	156	9
Aircraft	25	3	40	155	2
Railroads	59	9	15	21	4
Vessels	47	38	50	181	42
Total	551	97	246	1099	139

Total all pollutants: 2132

A rather significant conclusion to be drawn from Table 1 is that even with optimistic projections of mass transit usage in the year 2000, the percentage of the total vehicle miles traveled by mass transit vehicles will still be less than 0.2%. This is consistent with the conclusions of a recent EPA study[7/] that mass transit improvements cannot be expected to significantly decrease VMT in any major metropolitan area.

Tables 2, 3 and 4 show significant decreases in Carbon Monoxide, Hydrocarbon and Nitrogen Oxide emissions from 1972 to 1985 primarily because of federal controls on light duty vehicles. Beyond about 1990, anticipated growth in all kinds of transportation catches up with emission reductions, resulting in increasing pollution emissions beyond that date unless additional controls are imposed. However, total emissions in 2000 will still be less than half of the 1972 levels. Figures 1, 2, and 3 show these anticipated changes in graphic form for all Air Quality Control Regions and for the State.

As controls on new light duty vehicles become effective, the relative importance of emissions from other transportation sources, particularly diesel vehicles, becomes greater.

Conclusion:

Transportation is a significant source of pollution in Texas as well as a major consumer of energy. Nothing that is currently planned seems likely to significantly alter the predominance of the privately owned gasoline-powered motor vehicle as a pollution source and consumer of energy.

References:

1. "Table showing the Number of Registrations for Texas by Counties for 1972 Reg. Year", Texas Highway Department, Motor Vehicle Division, 1973.
2. Narrative Report on Urban Public Transportation Portion of 1974 National Transportation Study for Texas.
3. "Schedule TF-1 Mileage, Travel Projections, and Related Data for the 1972 Estimate of the Cost of Completing the Interstate System." Texas Highway Department, 1972.
4. "Motor Vehicle Registrations by Registered Weight Groups." A computer print-out obtained from the Texas Highway Department. As of December, 1972.
5. Compilation of Air Pollutant Emission Factors, Second Edition, U.S. Environmental Protection Agency, AP-42, April 1973, including Supplement 2, September 1973.
6. Texas Airport System Plan, Phase II Report, Texas Transportation Institute, Texas A&M University, November 1973.
7. "Evaluating Transportation Controls to Reduce Motor Vehicle Emissions in Major Metropolitan Areas", Environmental Protection Agency Report #APTD-1364, November 1972.

TABLE 5-1

Major Air Pollution Emissions from Transportation Sources Year 1972 Air Quality Control Region I

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	253	9	351	1768	25
Diesel	111	8	11	67	4
Aircraft	8	2	17	45	3
Railroads	40	6	10	14	3
Vessels	4	0	14	76	0
Total	416	25	403	1970	35
Total all pollutants:	2849				

TABLE 5-2

Major Air Pollution Emissions from Transportation Sources Year 1972 Air Quality Control Region II

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	340	11	456	2320	33
Diesel	141	11	14	84	4
Aircraft	9	2	33	78	2
Railroads	53	8	14	19	4
Vessels	1	0	3	17	0
Total	564	32	520	2518	43
Total all pollutants:	3677				

TABLE 5-3

Major Air Pollution Emissions
from Transportation Sources
Year 1972
Air Quality Control Region III

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	468	16	604	3026	46
Diesel	185	13	19	111	6
Aircraft	3	1	16	47	1
Railroads	69	11	17	24	47
Vessels	4	0	15	80	0
Total	729	41	671	3288	100

Total all pollutants: 4829

TABLE 5-4

Major Air Pollution Emissions
from Transportation Sources
Year 1972
Air Quality Control Region IV

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	127	4	182	951	13
Diesel	47	4	4	28	2
Aircraft	1	0	4	17	0
Railroads	6	1	2	2	0
Vessels	53	44	34	99	35
Total	234	53	226	1097	50

Total all pollutants: 1660

TABLE 5-5

Major Air Pollution Emissions
from Transportation Sources
Year 1972
Air Quality Control Region V

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	222	8	296	1531	22
Diesel	86	6	9	52	3
Aircraft	9	2	51	228	1
Railroads	30	5	8	11	2
Vessels	60	62	38	63	76
Total	407	83	402	1885	104

Total all pollutants: 2881

TABLE 5-6

Major Air Pollution Emissions
from Transportation Sources
Year 1972
Air Quality Control Region VI

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	206	7	264	1335	20
Diesel	94	7	10	56	4
Aircraft	3	1	10	27	1
Railroads	34	5	9	12	2
Vessels	2	0	7	39	0
Total	339	20	300	1469	27

Total all pollutants: 2155

TABLE 5-7

Major Air Pollution Emissions
from Transportation Sources
Year 1972
Air Quality Control Region VII

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	849	31	1096	5771	88
Diesel	249	18	25	149	9
Aircraft	10	2	49	83	6
Railroads	53	8	13	19	4
Vessels	62	56	48	131	59
Total	1223	115	1231	6153	166

Total all pollutants: 8888

TABLE 5-8

Major Air Pollution Emissions
from Transportation Sources
Year 1972
Air Quality Control Region VIII

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	1051	37	1331	6670	106
Diesel	237	18	25	142	8
Aircraft	22	5	114	182	13
Railroads	64	10	16	22	4
Vessels	11	-	38	203	1
Total	1385	70	1524	7219	132

Total all pollutants: 10330

TABLE 5-9

Major Air Pollution Emissions
from Transportation Sources
Year 1972
Air Quality Control Region IX

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	418	14	530	2528	41
Diesel	121	9	12	73	4
Aircraft	13	3	50	105	4
Railroads	30	5	8	11	2
Vessels	3	0	11	59	0
Total	585	31	611	2776	51
Total all pollutants:	4054				

TABLE 5-10

Major Air Pollution Emissions
from Transportation Sources
Year 1972
Air Quality Control Region X

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	239	9	320	1692	25
Diesel	94	7	10	56	4
Aircraft	0	0	3	14	0
Railroads	36	6	9	13	2
Vessels	93	82	88	285	96
Total	462	104	430	2060	127
Total all pollutants:	3183				

TABLE 5-11

Major Air Pollution Emissions
from Transportation Sources
Year 1972
Air Quality Control Region XI

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	116	4	180	1006	12
Diesel	34	3	4	20	1
Aircraft	3	1	19	45	2
Railroads	21	3	5	7	1
Vessels	0	0	0	1	0
Total	174	11	208	1079	16
Total all pollutants:	1488				

TABLE 5-12

Major Air Pollution Emissions
from Transportation Sources
Year 1972
Air Quality Control Region XII

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	323	11	429	2179	32
Diesel	146	11	15	88	5
Aircraft	1	0	4	12	1
Railroads	54	8	14	19	3
Vessels	5	0	18	98	0
Total	529	30	480	2396	41
Total all pollutants:	3476				

TABLE 6-1

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region I

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	84	9	53	329	27
Diesel	114	8	11	69	4
Aircraft	8	2	16	54	3
Railroads	44	7	11	15	3
Vessels	5	0	18	97	0
Total	255	26	109	564	37
Total all pollutants:	991				

TABLE 6-2

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region II

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	122	13	84	505	37
Diesel	152	11	15	91	5
Aircraft	10	2	27	89	1
Railroads	58	9	15	21	4
Vessels	1	0	4	22	0
Total	343	35	145	728	47
Total all pollutants:	1298				

TABLE 6-3

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region III

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	181	22	113	704	63
Diesel	246	18	25	148	9
Aircraft	6	1	13	68	1
Railroads	76	12	19	26	52
Vessels	5	0	18	98	0
Total	514	53	188	1044	125
Total all pollutants:	1924				

TABLE 6-4

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region IV

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	54	6	37	232	17
Diesel	62	5	6	37	2
Aircraft	1	0	2	22	0
Railroads	7	1	2	2	0
Vessels	65	54	42	122	43
Total	189	66	89	415	62
Total all pollutants:	821				

TABLE 6-5

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region V

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	78	10	54	329	28
Diesel	107	8	11	64	4
Aircraft	10	2	52	245	1
Railroads	33	6	9	12	2
Vessels	74	76	47	77	93
Total	302	102	173	727	128
Total all pollutants:	1432				

TABLE 6-6

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region VI

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	67	8	43	257	22
Diesel	102	7	10	61	3
Aircraft	3	1	7	39	0
Railroads	37	6	10	13	2
Vessels	2	0	9	48	0
Total	211	22	79	418	27
Total all pollutants:	757				

TABLE 6-7

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region VII

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	296	44	202	1147	128
Diesel	359	26	37	216	13
Aircraft	22	3	35	131	2
Railroads	58	9	14	21	4
Vessels	76	69	59	161	73
Total	811	151	347	1676	220
Total all pollutants:	3205				

TABLE 6-8

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region VIII

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	383	52	241	1404	151
Diesel	333	24	34	200	12
Aircraft	68	7	104	312	4
Railroads	71	11	18	24	6
Vessels	14	0	47	250	1
Total	869	94	444	2190	174
Total all pollutants:	3771				

TABLE 6-9

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region IX

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	166	19	99	595	56
Diesel	160	12	16	96	6
Aircraft	21	3	43	137	2
Railroads	33	6	9	12	2
Vessels	4	0	14	73	0
Total	384	40	181	913	66
Total all pollutants:	1584				

TABLE 6-10

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region X

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	85	11	55	330	32
Diesel	126	9	13	78	4
Aircraft	1	0	2	19	0
Railroads	40	7	10	14	2
Vessels	114	101	108	351	118
Total	366	128	188	790	156
Total all pollutants:	1628				

TABLE 6-11

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region XI

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	42	6	31	208	16
Diesel	42	3	4	25	1
Aircraft	7	1	11	55	1
Railroads	23	3	6	8	1
Vessels	0	0	0	1	0
Total	114	13	52	297	19

Total all pollutants: 495

TABLE 6-12

Major Air Pollution Emissions
from Transportation Sources
Year 1985
Air Quality Control Region XII

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	127	15	79	480	43
Diesel	194	14	20	116	7
Aircraft	1	0	2	17	0
Railroads	60	9	16	21	3
Vessels	6	0	22	121	0
Total	388	38	139	755	53

Total all pollutants: 1373

TABLE 7-1

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region I

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	74	11	51	266	34
Diesel	142	10	14	85	5
Aircraft	10	2	18	62	4
Railroads	48	8	12	17	4
Vessels	6	0	22	119	0
Total	280	31	117	549	47
Total all pollutants:	1024				

TABLE 7-2

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region II

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	119	16	88	476	48
Diesel	194	14	20	116	7
Aircraft	12	3	30	101	2
Railroads	64	10	17	23	5
Vessels	1	0	5	27	0
Total	390	43	160	743	62
Total all pollutants:	1398				

TABLE 7-3

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region III

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	168	29	116	592	85
Diesel	326	24	33	196	11
Aircraft	9	1	16	84	1
Railroads	84	13	21	29	57
Vessels	6	0	24	126	0
Total	593	67	210	1027	154
Total all pollutants:	2051				

TABLE 7-4

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region IV

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	39	6	30	164	16
Diesel	61	4	6	37	2
Aircraft	1	0	2	26	0
Railroads	7	1	3	3	0
Vessels	83	69	54	156	55
Total	191	80	95	386	73
Total all pollutants:	825				

TABLE 7-5

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region V

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	76	13	58	309	37
Diesel	139	10	14	83	5
Aircraft	12	2	56	260	1
Railroads	36	6	10	13	2
Vessels	94	98	60	99	120
Total	357	129	198	764	165
Total all pollutants:	1613				

TABLE 7-6

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region VI

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	63	10	44	229	28
Diesel	128	9	13	77	4
Aircraft	4	1	9	53	0
Railroads	41	7	11	14	2
Vessels	3	0	11	61	0
Total	239	27	88	434	34
Total all pollutants:	822				

TABLE 7-7

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region VII

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	314	61	235	1182	176
Diesel	491	36	50	295	17
Aircraft	32	4	68	168	3
Railroads	64	10	16	23	5
Vessels	98	80	76	206	93
Total	999	191	445	1874	294
Total all pollutants:	3803				

TABLE 7-8

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region VIII

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	371	69	260	1287	201
Diesel	438	32	45	263	15
Aircraft	101	11	158	492	8
Railroads	78	12	20	27	6
Vessels	17	0	60	320	2
Total	1005	124	543	2389	232
Total all pollutants:	4293				

TABLE 7-9

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region IX

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	151	26	99	489	75
Diesel	210	15	21	126	7
Aircraft	26	4	50	174	3
Railroads	36	6	10	13	2
Vessels	5	0	17	93	0
Total	428	51	197	895	87

Total all pollutants: 1658

TABLE 7-10

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region X

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	77	14	55	281	39
Diesel	156	11	16	93	5
Aircraft	1	0	3	25	0
Railroads	44	8	11	15	2
Vessels	146	129	139	449	151
Total	424	162	224	863	197

Total all pollutants: 1870

TABLE 7-11

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region XI

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	38	7	31	170	22
Diesel	52	4	5	31	2
Aircraft	10	1	15	66	1
Railroads	26	4	6	9	1
Vessels	0	0	0	2	0
Total	126	16	57	278	26
Total all pollutants:	503				

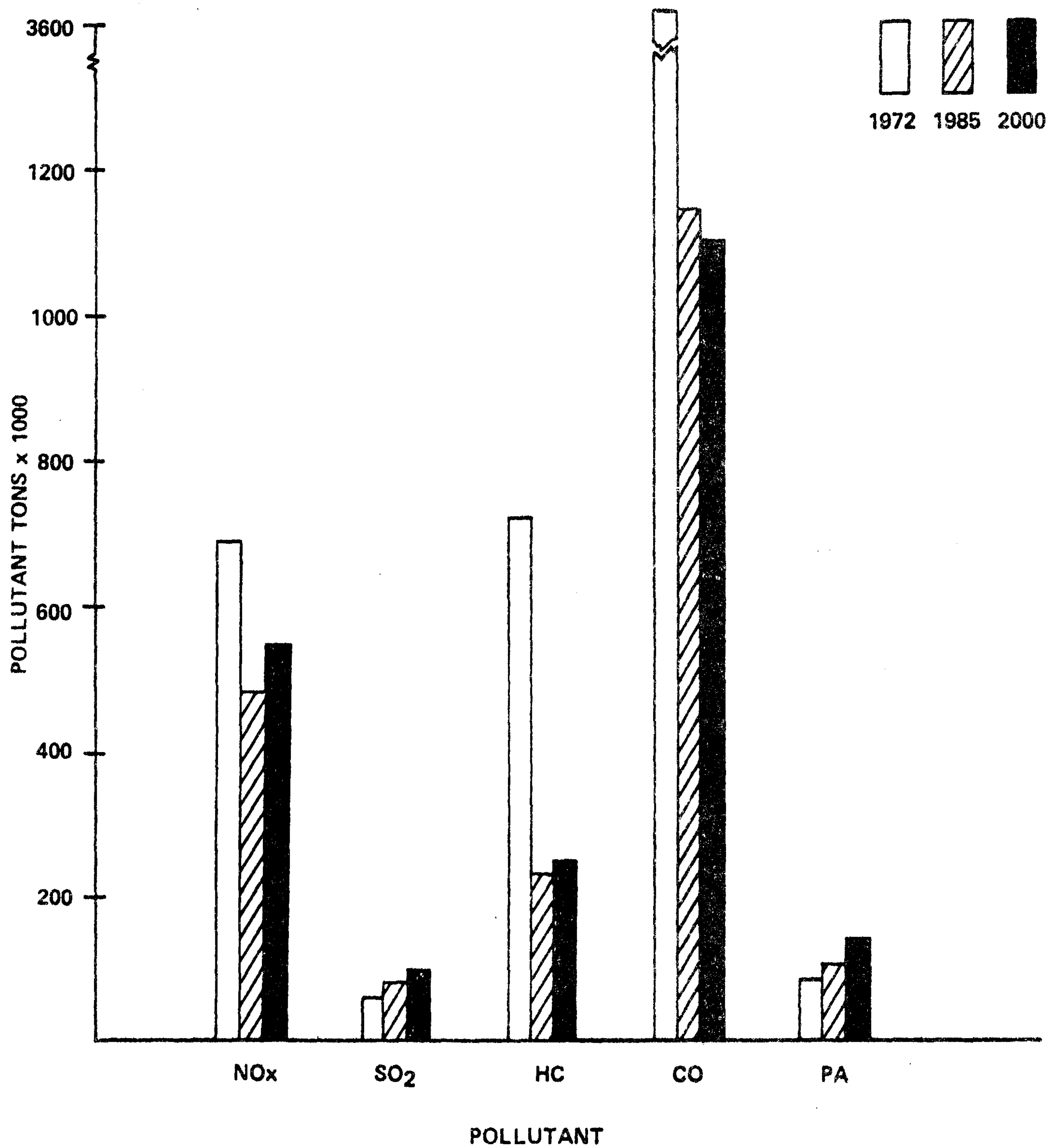
TABLE 7-12

Major Air Pollution Emissions
from Transportation Sources
Year 2000
Air Quality Control Region XII

Source	Pollutant (100 tons/yr)				
	NO_x	SO_2	HC	CO	PA
Motor Vehicles:					
Gasoline	120	19	82	418	57
Diesel	255	19	26	153	9
Aircraft	1	0	3	19	0
Railroads	66	10	17	23	4
Vessels	8	0	28	154	0
Total	450	48	156	767	70
Total all pollutants:	1491				

TRANSPORTATION SOURCES

STATEWIDE POLLUTANT TOTALS



RADIAN CORPORATION

RC Project No. 100-067

CAPITAL COSTS FOR EMISSION CONTROLS FROM STATIONARY INDUSTRIAL PLANTS IN TEXAS

Submitted to:

TEXAS AIR CONTROL BOARD
Austin, Texas

14 January 1975

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Appendix L

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APPENDIX L

CAPITAL COSTS FOR EMISSION CONTROLS FROM STATIONARY INDUSTRIAL PLANTS IN TEXAS

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	ELECTRIC GENERATION	3
	2.1 Scenario 2a	3
	2.2 Scenario 2b	7
3.0	AGRICULTURE	8
	3.1 Feed Mills	9
	3.2 Cotton Gins	13
	3.3 Grain Elevators	16
	3.4 Rice Driers	20
	3.5 Summary of Agricultural Pollution Control Costs, Scenario 1	23
	3.6 Scenario 2	24
4.0	PETROCHEMICAL	26
	4.1 Hydrocarbons	26
	4.2 Particulates	26
	4.3 Carbon Monoxide	27
	4.4 Nitrogen Oxides	27
	4.5 Sulfur	27
5.0	INDUSTRIAL	28

TABLE OF CONTENTS
Page Two

Page

5.1 Oil Refining 29
5.1.1 Hydrocarbons. 29
5.1.2 Nitrogen Oxides 30
5.1.3 Carbon Monoxide 30
5.1.4 Particulates. 30
5.1.5 Sulfur. 31
5.1.6 Refinery Totals 32
5.2 Glass, Clay, Stone and Cement. 33
5.3 Primary Metal Processing 37
5.3.1 Primary Aluminum Production 37
5.3.2 Primary Steel Production. 42
5.4 Summary of Industrial Capital Costs. 48

6.0 SUMMARY 50

7.0 BIBLIOGRAPHY. 52

6. Petrochemical

7. Household

8. Industrial.

From these eight categories, four were selected as requiring significant capital expense for emission control, as related to stationary plants.

1. Electric Generation

2. Agriculture

3. Petrochemical

4. Industrial.

These groups were selected as having significant controllable emissions by projections of total emissions for the goal years (1985 and 2000) prepared by the Texas Air Control Board.

For some industries emitting significant quantities of sulfur, the proposed method of control results in a salable product (i.e., sulfuric acid or elemental sulfur). Cost data for these processes have not been included on the assumption that such processes will eventually pay for themselves.

2.0 ELECTRIC GENERATION

Scenario 1 projections of fuel use patterns for the electric utility industry are extrapolations of present-day patterns which do not include the use of coal or the need for emission controls on oil burning plants. For these reasons, the Scenario 1 projections of capital costs for emission controls for the electric utility industry are zero for all three years.

2.1 Scenario 2a

The fuel use pattern predicted by Scenario 2 for the electric utility industry is given in Table 2.1.

TABLE 2.1

Fuel Use For Electric Utility Industry, Scenario 2

	1970	1985	2000
Natural Gas (Liquid)(BBLx10^3)	-0-	-0-	-0-
Fuel Oil (BBLx10^3)	693	3292	4505
Natural Gas (10^6MCF)	846	506	692
Coal (10^3tons)	-0-	23300	31883
Uranium (tons)	-0-	24.4	2.6

Only the emissions from the coal burning plants require emission control equipment. The rates of gas emission are:

For 1985

$$(7000)(\text{tons of coal/hr}) = (7000)(2660\ \text{tons/hr})\left(\frac{280+460°R}{70+460°R}\right)$$

$$= 26.0\text{x}106\ \text{acfm}$$

For 2000

$$(7000)(3640)\left(\frac{280+460}{70+460}\right) = 35.6\times10^{6}\text{acfm}$$

(EN-027, II-2)

The type of particulate control equipment is assumed to be electrostatic precipitators. Cost data for ESP's (SO-005) on the order of 100,000 acfm or larger indicate \$2.19/acfm installed, in 1974 dollars. The particulate removal costs are then:

TABLE 2.2

Particulate Removal Capital Costs for the Texas Electric Utility Industry

Year	10^6\$
1970	-0-
1985	56.94
2000	77.96

This scenario assumes that best available technology will be used to control sulfur emissions. For the purposes of this report, the capital costs of desulfurizing fuel oil have been charged to the petroleum refineries and for this reason, the only capital charges assigned to the electric utility industry will be for flue gas desulfurization on coal fired plants by wet scrubbing. The following unit costs will be used:

Existing Plants ---------------	$65.00/kw	
New Plants --------------------	$50.00/kw	(GA-118)

Note that these costs are in addition to particulate removal costs.

Scenario 2 projections of utility generation are summarized in Table 2.3.

TABLE 2.3

Scenario 2 Utility Generation (10^{10}kwh)

	1970	1985	2000
Total	8.99	12.30	16.19
Coal-Fired	-0-	6.26	8.57

The "total" figures were obtained from total energy use figures and assuming 35% overall efficiency for utility power plants.

From these figures, the capacities requiring desulfurization can be obtained.

TABLE 2.4

Texas Electric Utility Generating Capacity Requiring Desulfurization

Year	10^{10}kwh
1970	-0-
1985	2.95 existing plants* 3.31 new plants
2000	2.31 increase in capacity

*Assumes that all growth from 1970 to 1985 was coal fired.

The desulfurization capital costs are:

TABLE 2.5

Texas Electric Utility Desulfurization Capital Costs

Scenario 2a

Year	10^6 1974 Dollars
1970	-0-
1985	408
2000	540

The total emission control (sulfur + particulate) costs are given in Table 2.6

TABLE 2.6

Texas Electric Utility Emission Capital Costs

Scenario 2a

Year	10^6 1974 Dollars
1970	-0-
1985	465
2000	618

2.2 Scenario 2b

An emission reduction allowance is made for technology which is assumed to become available in the future. This is visualized to be, for example, a larger scrubber for 95 percent SO_2 removal. In such visualizations, a size increase is required in a main unit of a system, but not in all units such as pumps, tanks, settler, etc. A cost allowance is required in accordance with the emissions allowance. A cost allowance of 20% over 2a is suggested. The resulting costs for Scenario 2b are as shown in Table 2.7.

TABLE 2.7

Texas Electric Utility Emissions Capital Costs

Scenario 2b

Year	10^6 1974 Dollars
1970	-0-
1985	547
2000	726

3.0 AGRICULTURE

The Agriculture Industrial Group is defined as consisting of the following sub-groups:

1. Irrigated Crops
2. Dryland Crops
3. Livestock and Poultry
4. Agricultural Services
5. Primary Forestry and Fisheries

Within these sub-groups no significant sources of NO_x, SO_x, HC or CO were identified. The major sources of particulate emissions were in the area of grain handling and are shown in Table 3.1:

TABLE 3.1

Principal Sources of Particulate Emissions in the Agriculture Industry in Texas

Type	Fraction of Total Emissions
Feed Mills	30.2%
Cotton Gins	19.0%
Grain Elevators	36.4%
Rice Driers	8.4%
TOTAL	93.7%

The total particulate emissions given under Scenario 1 are given in Table 3.2.

TABLE 3.2

Scenario 1 Projections of Particulate Emissions for the Agriculture Industry

Year	Particulate Emissions (tons)
1970	41,347
1985	59,364
2000	70,946

3.1 Feed Mills

Scenario 1 production predictions are given in Table 3.3.

TABLE 3.3

Scenario 1 Projections of Feed Mill Production

Year	Production (10^6 tons)
1970	15.1
1985	24.3
2000	33.5

Assumptions

1. Milo production is typical of all grain handling.

2. The average size of a milo feed mill is 11,250 lb/hr process rate, generating 6,290 acfm of pollutant carrying gas (EN-027, p. V-18) and operates 6800 hr/year (EN-027, p. V-16).

3. Exhaust gases are near standard conditions (i.e., 70°F, 1 atm).

4. The extent of controls on Texas feed mills in 1970 was:

Uncontrolled	-	2%
Cyclones	-	81%
Fabric Filters	-	17%[1]

5. The controlled emission factor for feed mills will decrease by 12% for the period 1970 to 1985 and by 23% for the period 1970 to 2000.[1]

6. The cost of control for systems on the order of 10,000 acfm (material and construction) is:

   Cyclones - $0.39/acfm (SO-005, p. 849, 854)
   Fabric Filters - $0.75/acfm (SO-005, p. 852, 854)

in 1963 dollars. The fabric filter was assumed to be woven natural fibers, intermittently cleaned, single compartment; the cyclone, medium efficiency. Installation costs were computed as \$ installation/\$ construction with cyclone installation assumed to be the same as for wet scrubbers (i.e., \$7500 per 100,000 acfm) (SO-005, p. 854).

7. 1963 dollars were converted to mid-1974 dollars using the Marshal and Swift equipment cost index which resulted in a multiplier of 1.61 (Chem. Engr.)

Costs for 1970

Uncontrolled ---------------------------------- \$0

Cyclones =

$$\frac{(15.1\text{x}10^6\text{ tons/yr})(2000\text{ lb/ton})(.81)(6290\text{scfm})(.39\text{\$/scfm})(1.61\text{ 1974\$/1963\$})}{(6800\text{ hr/yr})(11{,}250\text{ lb/hr})}$$

$$= \$1.26 \times 10^6$$

$$\text{Fabric Filters} = \frac{\$1.26\text{x}10^6(.75\text{\$/scfm})(.17)}{(.39\text{ \$/scfm})(.81)}$$

$$= \$0.51 \times 10^6$$

$$\text{Total} = \$1.77 \times 10^6$$

Costs for 1985

The assumption that the emission factor has decreased by 12% implies the following adjustment in the degree of control:

Assuming cyclones are 70% efficient (VA-091) and baghouses are 99% efficient (VA-091) and that there will be no uncontrolled sources:

TABLE 3.4

Degree of Control for 1985 by Scenario 1

Uncontrolled	0%
Cyclones	77%
Fabric Filters	23%

Cyclone Costs =

$$\frac{(24.3 \times 10^6 \text{ tons/yr})(2000 \text{ lb/ton})(6290 \text{ scfm/ton})(.77)(.63 \text{ 1974\$/scfm})}{(6800 \text{ hr/yr})(11{,}250 \text{ lb/hr})}$$

$$= \$1.94 \times 10^6$$

$$\text{Fabric Filter Costs} = \frac{(\$1.94\text{x}10^6)(.23)(1.21 \text{ 1974\$/scfm})}{(.77)(.63 \text{ \$/scfm})}$$

$$\text{Total 1985 Cost} = \$3.05 \times 10^6$$

Costs for 2000

The assumption that the emission factor for 2000 will be decreased by 23% implies the following adjustment in the degree of control: (Using the same efficiencies for control devices as in 1985)

TABLE 3.5

Degree of Control for 2000 by Scenario 1

Uncontrolled	0%
Cyclones	67%
Fabric Filters	33%

Cyclone Costs =

$$\frac{(33.5\text{x}10^6\,\text{tons/yr})(2000\ \text{lb/ton})(6290\ \text{scfm/ton})(.67)(.63\ \$/\text{scfm})}{(6800\ \text{hr/hr})(11{,}250\ \text{lb/hr})}$$

$$= 2.32 \times 10^6$$

$$\text{Fabric Filter Costs} = \frac{(2.32\text{x}10^6\$)(.33)(1.21\ \$/\text{scfm})}{(.67)(.63\ \$/\text{scfm})}$$

$$= \$2.19\text{x}10^6$$

$$\text{Total 2000 Costs} = \$4.52 \times 10^6$$

3.2 Cotton Gins

Scenario 1 production predictions are given in Table 3.6:

TABLE 3.6

Scenario 1 Projections of
Cotton Gin Production

Year	Production (10^6 of 500 lb bales)
1970	3.9
1985	6.3
2000	8.7

Assumptions:

1. The average cotton gin processes 12 bales/hr while producing 43,500 scfm of waste gas (EN-027, V-13).

2. The average operation of a cotton gin is 1008 hr/yr (6 weeks of 24 hrs/day) (EN-027, V-12).

3. The only cleaning device which will be employed is the dry cyclone which will cost:

   $0.79/acfm----------high efficiency

   $0.63/acfm----------medium efficiency

   $0.42/acfm----------low efficiency

   (SO-005, p. 849 and 854)

4. 1970 calculations based on low efficiency cyclones, 1985 on medium efficiency, 2000 on high efficiency.

1970 Costs

9% uncontrolled, 91% controlled by low efficiency cyclones

$$\frac{(3.9\text{x}10^6\text{bales/yr})(43{,}500\ \text{acfm})(\$0.42/\text{acfm})(.91)}{(1008\ \text{hr/yr})(12\ \text{bales/hr})}$$

$= \$5.36 \text{ x } 10^6$

1985 Costs

100% controlled by medium efficiency cyclones.

$$\frac{(6.3\text{x}10^6\text{bales/year})(43{,}500\ \text{acfm})(\$0.63/\text{acfm})}{1008\ \text{hr/yr})(12\ \text{bales/hr})}$$

$= \$14.27 \text{ x } 10^6$

2000 Costs

100% controlled by high efficiency cyclones.

$$\frac{(8.7\text{x}10^6\text{bales/year})(42{,}500\ \text{acfm})(\$0.79/\text{acfm})}{(1008\ \text{hr/yr})(12\ \text{bales/hr})}$$

$= \$24.15 \text{ x } 10^6$

3.3 Grain Elevators

Scenario 1 production predictions are given in Table 3.7:

TABLE 3.7

Scenario 1 Projections of Grain Elevator Production

Type	Year	Production (10^6 tons/year)
Country Elevators	1970	11.2
Country Elevators	1985	18.0
Country Elevators	2000	24.9
Terminal Elevators	1970	16.5
Terminal Elevators	1985	26.6
Terminal Elevators	2000	36.6

Assumptions:

1. Again assume cyclones are 70% efficient and fabric filters are 99% efficient (VA-091).

2. Assume country elevators 100% uncontrolled in 1970.[1]

3. Assume 6800 hr/year operation for country elevators and 8600 hr/year for terminal elevators (EN-027, V-16).

4. Assume that the operation of a milo feed mill is typical of Texas operations. This gives an emission rate of 6290 scfm for each 11,250 lb/hr "average" elevator (EN-027, V-18).

5. For 1970 controls:

   Country Elevators------------100% uncontrolled
   Terminal Elevators----------- 36% cyclones
   63% fabric filters

6. For 1985 controls:[1]

   Country Elevators------------ 12% decrease in emissions
   Terminal Elevators----------- 15% decrease in emissions

7. For 2000 controls:[1]

   Country Elevators------------ 22% decrease in emissions (from 1970)
   Terminal Elevators----------- 30% decrease in emissions (from 1970)

<u>1970 Costs</u>

Country Elevators --------------- $0

Terminal Elevators =

$$\frac{(16.5\times10^{6}\ \text{tons/yr})(2000\ \text{lb/ton})(6290\ \text{scfm})}{(8600\ \text{hr/yr})(11250\ \text{lb/hr})}$$

$$[(36\%)(63¢/\text{acfm})+(63\%)(\$1.21/\text{acfm})]$$

$$= \$2.12 \times 10^{6}$$

1985 Costs

Country Elevators

A 12% decrease in country elevators emissions implies .12/.70 = 17% application of 70% efficient cyclones

$$\frac{(18\text{x}10^6 \text{tons/yr})(2000 \text{ lb/ton})(6290 \text{ scfm})(\$0.63/\text{scfm})(.17)}{(6800 \text{ hr/yr})(11,250 \text{ lb/hr})}$$

$= \$0.32 \times 10^6$

Terminal Elevators

A 15% decrease in terminal elevator emissions implies

$$\varepsilon_{1970} = (.36)(.70)+(.64)(.99) = .89$$

$$\varepsilon_{1985} = 1 - [(1-.89)(1-.15)] = .91$$

If f_{1985} is the fractional application of fabric filters in 1985 (f_{1970} = .63)

$$f_{1985} = \frac{.91-.70}{.99-.70} = 0.72$$

Then the degree of application of controls to terminal elevators for 1985 is:

Fabric Filters---------------------- 72%

Cyclones -------------------------- 28%

And the cost is:

$$\frac{(26.2\text{x}10^{6}\,\text{tons/yr})(2000\ \text{lb/ton})(6290\ \text{scfm})}{(8600\ \text{hr/yr})(11{,}250\ \text{lb/hr})}$$

$$[(.28)(\$0.63/\text{scfm}) + (.72)(\$1.21/\text{scfm})]$$

$$= \$3.62\text{x}10^{6}$$

Total

Country Elevators -----------------	$\$0.32\text{x}10^{6}$
Terminal Elevators ----------------	$\$3.62\text{x}10^{6}$
Total ----------------	$\$3.94\text{x}10^{6}$

2000 Costs

A 22% reduction in emissions from country elevators implies a .22/.70 = 31% application of 70% efficient cyclones.

Country Elevator Costs

$$\frac{(24.9\text{x}10^{6}\,\text{tons/yr})(2000\ \text{lb/ton})(6290\ \text{scfm})(.31)(\$0.63/\text{scfm})}{(6800\ \text{hr/yr})(11{,}250\ \text{lb/hr})}$$

$$= \$0.80\text{x}10^{6}$$

A 30% reduction in emissions from terminal elevators implies:

$$\varepsilon_{2000} = 1 - [(1-.89)(1-.30)] = 0.92$$

$$f_{2000} = \frac{.92-.70}{.99-.70} = 0.76$$

And the degree of application of controls to terminal elevators for 2000 is:

Fabric Filters ---------------------- 0.76

Cyclones ---------------------------- 0.24

The cost is then:

$$\frac{(36.6\text{x}10^6 \text{tons/yr})(2000 \text{ lbs/ton})(6290 \text{ scfm})}{(8600 \text{ hr/yr})(11{,}250 \text{ lbs/hr})}$$

$$[(.76)(\$1.21/\text{scfm}) + (.24)(\$0.63/\text{scfm})]$$

$$= \$5.10 \times 10^6$$

Total:

Country Elevators ------------------ $\$0.80\text{x}10^6$

Terminal Elevators ----------------- $\underline{\$5.10\text{x}10^6}$

Total ----------------- $\$5.98\text{x}10^6$

3.4 <u>Rice Driers</u>

Scenario 1 production predictions are given in Table 3.8:

TABLE 3.8

Scenario 1 Projections of

Rice Drier Production

Year	Production (10^6 tons)
1970	1.1
1985	1.8
2000	2.4

Assumptions:

1. Degree of application of controls in 1970:

   80% - cyclones

   20% - uncontrolled[1]

2. A 15% reduction in emission factor by 1985.[1]

3. A 30% reduction in emission factor by 2000.[1]

4. The emission rate for the average drier is 4500 scfm for each 1000 lb/hr processed. The average size is 3,000 lb/hr and the average operation is 4400 hr/yr (24 hr/ day for 6 months of the year) (EN-027, p. V-16 and V-1).

1970 Costs

$$\frac{(1.1\text{x}10^6\,\text{tons/yr})(2000\ \text{lb/ton})(4500\ \text{scfm})(.80)(\$0.63/\text{scfm})}{(4400\ \text{hr/yr})(1000\ \text{lb/hr})}$$

$= \$1.13\text{x}10^6$

1985 Costs

Degree of control $\varepsilon_{1970} = (.8)(.7) = .56$

$\varepsilon_{1985} = 1-[(1-.56)(1-.15)] = 0.63$

Degree of application $f_{1970} = .8$

$f_{1985} = .63/.7 = .090$

Cost:

$$\frac{(1.8\text{x}10^6\,\text{tons/yr})(2000\ \text{lb/ton})(4500\ \text{scfm})(.9)(\$0.63/\text{scfm})}{(4400\ \text{hr/yr})(1000\ \text{lb/hr})}$$

$= \$2.08\text{x}10^6$

2000 Costs

Degree of control $\varepsilon_{2000} = 1-[(1-.56)(1-.30)] = 0.69$

Degree of application $f_{2000} = .69/.7 = 0.99$

Cost

$$\frac{(2.4\text{x}10^6 \text{ tons/yr})(2000 \text{ lbs/ton})(4500 \text{ scfm})(.99)(\$0.63/\text{scfm})}{(4400 \text{ hr/yr})(1000 \text{ lb/hr})}$$

$$= \$3.06\text{x}10^6$$

3.5 Summary of Agricultural Pollution Control Costs, Scenario 1

TABLE 3.9

Scenario 1 - Cost Summary for Texas Agriculture

Type	10^6 1974 Dollars 1970	1985	2000
Feed Mills	1.77	3.05	4.52
Cotton Gins	5.36	14.27	24.15
Country Grain Elevators	(-0-)	(0.32)	(0.80)
Terminal Grain Elevators	(2.12)	(3.62)	(5.10)
Total Grain Elevators	2.12	3.94	5.98
Rice Driers	1.13	2.08	3.06
Total	10.38	22.34	37.71
Adjusted Total(*)	11.08	24.91	40.25

*The "Total" represents 93.7% of the emissions from the agricultural industry.

3.6 Scenario 2

The total energy use for agricuture, according to Scenario 2 is:

TABLE 3.10

Scenario 2 - Texas Agriculture Energy Use

1970	200.3×10^{12} BTU
1985	273.7×10^{12} BTU
2000	373.6×10^{12} BTU

From these, the growth factors are calculated:

TABLE 3.11

Scenario 2 - Texas Agriculture Growth

1970	1.00
1985	1.37
2000	1.87

Since none of the emissions found significant in the agricultural industry depend upon the type of fuel use, cost projections can be made using only the growth factors for Scenario 2 and the baseline 1970 cost:

TABLE 3.12

Capital Investment in Emission Control for Stationary Sources According to Scenario 2 for Texas Agriculture

Year	10^6 1974 Dollars
1970	11.08
1985	15.18
2000	20.72

4.0 PETROCHEMICAL

In general, best available control technology for the reduction of criteria pollutants coincides with good economic practice for the petrochemical industry. The costs reported in this report exclude those costs for which environmental control is not the sole justification. Further discussion of this premise is contained in Section 5.1 of this report. The following paragraphs summarize some of the concepts.

4.1 Hydrocarbons

The hydrocarbons handled in the petrochemical industry are relatively high-value products or intermediates, with value added above that used in the example in Section 5.1. In accordance with that example, best available control technology would be implemented for economic reasons, and the cost of that technology is therefore considered outside of the scope of the costs considered in this report.

4.2 Particulates

The predominant process source of particulates in the petrochemical industry is the polymer industry. Again the value of the product recovered justifies the use of best available control technology.

4.3 Carbon Monoxide

As in Section 5.1, the energy value of carbon monoxide emissions is expected to justify incineration.

4.4 Nitrogen Oxides

Nitrogen oxide emissions result from combustion sources and from nitric acid plants. Best available control technology is consistent with standard current nitric acid plant design practice taking economics into consideration, and is not a result of new, recent regulatory action alone. Regulations are not promulgated for industrial furnaces for nitrogen oxide control, and specific technology is not available. No costs are included.

4.5 Sulfur

Potential sulfur emissions in the petrochemical industry result from removal of sulfur contaminants from products, from combustion, and from sulfuric acid tail gases. Tail gas cleanup is a standard current design practice taking economics into consideration, and is not a result of recent regulatory action alone. The cost of sulfur removal from fuel oils which are used in combustion in some scenarios has been included as a cost to the oil refining industry. Sulfur removal from petrochemical products is considered to be a necessary cost of production, not a specific environmental cost. Disposal of hydrogen sulfide containing tail gas streams must be considered, but it is expected that the costs are small in the overall totals being projected in this report. No costs have been included for sulfur emissions abatement from petrochemical plants.

5.0 INDUSTRIAL

The industrial classification consists of the following sub-groups:

- Food Processing
- Textile and Apparel
- Logging, Wood and Paper
- Petroleum Refinery
- Other Petroleum Products
- Tires, Rubber, Plastic and Leather
- Glass, Clay, Stone and Cement
- Primary Metal Processing
- Industrial Equipment Manufacture
- Electrical Appliance Manufacture
- Aircraft, Motor Vehicle, Transportation Manufacture
- Instruments, Photography and Games

Of these sub-groups, three were selected as requiring significant capital expense for emission control equipment:

5.1 Petroleum Refining

5.2 Glass, Clay, Stone, and Cement

5.3 Primary Metal Processing

5.1 Oil Refining

The costs that are under consideration for purposes of this report are the capital costs for facilities to reduce air emissions from stationary plants in Texas. Costs are not included for the production of low lead and/or low sulfur fuel for the transportation sector. Costs are also excluded for the processing of fuels for stationary plants outside Texas. No costs are included for the purpose of meeting other environmental requirements, such as the treating of water effluents, the control of thermal discharges, the control of noise, etc.

It is assumed that capital costs for emissions reduction that are economically justified by recovery of valuable material are not chargeable as a cost of meeting an emissions regulation, and that these costs would be incurred in the absence of a regulation. The costs included in this report are summarized by emission category in the following paragraphs.

5.1.1 Hydrocarbons

In general, hydrocarbon loss reduction or hydrocarbon recovery is economically justified. At a value of $14 per barrel, or about $84 per ton an expenditure of $420 per annual ton is justified on the basis of a 5 year before-tax payout. This value exceeds the actual costs of loss prevention or recovery reported in API Publication No. 928 (AM-055) for most systems considered. Hydrocarbon recovery systems are therefore not costed as an environmental control investment.

5.1.2 Nitrogen Oxides

No controls are required for industrial furnaces by regulation for nitrogen oxides, nor is demonstrated technology available. No costs are included.

5.1.3 Carbon Monoxide

Carbon monoxide incineration is considered to be economically justified on the basis of energy recovery (EN-072). No costs are included.

5.1.4 Particulates

The costs incurred for particulate emissions control in refineries are predominantly those associated with catalyst removal from catalytic crackers. A cost of $1,150,000 per 100,000 barrels per day of refinery capacity is used (EN-179).

Capacities used are as follows, in millions of barrels per day.

TABLE 5.1

Texas Refinery Capacity (10^6 bbls/day)

	1985	2000
Scenario 1	4.2	6.0
Scenario 2	5.5	7.5

The resulting rounded costs are as follows in millions of dollars.

TABLE 5.2

Capital Costs for Particulate Control of Texas Refineries ($ 10^6)

	1985	2000
Scenario 1	50	75
Scenario 2	60	85

5.1.5 Sulfur

Hydrogen sulfide removal and sulfur recovery are considered to be standard practice and are considered to be economically justified (EN-072). No costs are included.

Costs are included for fuel oil desulfurization for fuel oils consumed in Texas. Costs for desulfurization to a sulfur level of 0.7 for a combination of distillate and residual fuel oils is taken as $400 per daily barrel (HY-013). A cost of $500 per daily barrel is used for reaching a 0.3 sulfur level (HY-013). The following values are used for Texas fuel oil consumption in stationary plants, including consumption in refineries, in barrels per day.

TABLE 5.3

Texas Fuel Oil Industry Consumption (10^6 bbl/day)

	1985	2000
Scenario 1	400,000	600,000
Scenario 2	400,000	600,000

The following costs result, in millions of dollars.

TABLE 5.4

Capital Costs for Fuel Oil Desulfurization (10^6 \$'s)

	1985	2000
Scenario 1	160	240
Scenario 2a	160	240
Scenario 2b	200	300

5.1.6 Refinery Totals

The following table summarizes the included costs for refineries, in millions of dollars.

TABLE 5.5

Summary of Emission Control Costs for Texas Refineries

	1985	2000
Scenario 1	210	315
Scenario 2a	220	325
Scenario 2b	260	385

5.2 Glass, Clay, Stone and Cement

In this category, the significant activity, in the State of Texas, consists of rock crushing and cement manufacturing.

Rock crushing results, generally, in fugitive emissions for which the primary control device is water spray. Because of the difficult nature of the emissions and the low cost of the control technique, the cost of control equipment for the rock crushing industry has been taken as zero.[2]

For cement manufacturing, the production rate for 1970 has been taken as the same as for 1974 since the number of operating plants has remained the same for the period. Using the growth factors of Scenario 1 gives the following projections of production:[2]

TABLE 5.6

Cement Production Projections for Texas

Year	10^6 tons
1970	7.4
1985	10.1
2000	13.8

Assumptions:

1. 95% of all cement plants had control devices as of 1970. (VA-091)

2. The type of control devices employed as of 1970 were:

   18% - Dry Cyclones

   65% - Electrostatic Precipitators

   17% - Fabric Filters

3. The weighted average efficiency of controls is 94% (VA-091, p. 222-223)

4. The average size plant is:

   1218 tons/day

   0.44×10^6 tons/year (EN-027, p. VII-20,22)

5. The average emission is

   155,000 scfm/plant

   252,000 acfm/plant (EN-027, VII-26)

6. No change in the degree, type or efficiency of equipment used is assumed.[2]

Unit Costs

For a 252,000 acfm cyclone system (medium efficiency)

$46,000 + $14,400 Installation = $60,400

For a 252,000 acfm electrostatic precipitation system of medium efficiency:

$114,200 + $79,900 = $194,100

For a 252,000 acfm fabric filter system

\$121,000 + \$36,300 Installation = \$157,300
(SO-005, p. 849-854).

Then the statewide capital investment in control equipment is:

1970

$$\frac{7.4\text{x}10^6 \text{ tons/yr}}{.44\text{x}10^6 \text{ tons/yr-plant}} [(.18)(\$60,400)+(.65)(\$194,100)+(.17)(\$157,300)]$$

$= \$2.75\text{x}10^6$

1985

$$\frac{10.1\text{x}10^6 \text{ tons/yr}}{.44\text{x}10^6 \text{ tons/yr-plant}} [163,800^{\$}/\text{plant}]$$

$= \$3.76 \times 10^6$

2000

$$\frac{13.8\text{x}10^6 \text{ tons/yr}}{.44\text{x}10^6 \text{ tons/yr-plant}} [163,800^{\$}/\text{plant}]$$

$= \$5.14\text{x}10^6$

Scenario 2

The projected energy use patterns for the glass, clay, stone and cement industry are:

TABLE 5.7

Glass, Clay, Stone, and Cement Energy Use Patterns

	(trillions of BTU's)		
	1970	1985	2000
Scenario 1	104.3	166.3	226.4
Scenario 2	104.3	96.8	128.2
Scenario 2 Growth Fractions	1.00	.928	1.23

Note that Scenario 2 predicts a decrease in energy use for this industry in the period 1970 to 1985.

Since the type of fuel being used has little effect on the amount or nature of the emissions from this industry, the costs for Scenario 2 projections are obtained from the 1970 costs from Scenario 1 and the growth fractions from Scenario 2:

TABLE 5.8

Scenario 2 Capital Costs for the Glass, Clay, Stone, and Cement Industry in Texas

Year	10^6 1974 $'s
1970	2.75
1985	2.55
2000	3.38

5.3 Primary Metal Processing

Since most metal processing production figures are proprietary information, cost projections will be estimated from the 1972 particulate emissions inventory and industrial growth projections from Scenarios 1 and 2.

The sum of the emissions from the two largest aluminum plants and the three largest steel mills in the state represent 93% of the statewide particulate emissions and will be taken as typical of the state. These emissions (from the 1972 emissions inventory files) are:

TABLE 5.9

Particulate Emission Summary for the Primary Metals Industry in Texas

Aluminum	27,886 tons
Steel	17,616 tons

5.3.1 Primary Aluminum Production

Air Volumes:

1. Prebaked electrolytic cell

   a. Emission factor (uncontrolled) = 81.3 lb particulate/ton Al (EN-071)

   b. Grain Loading (uncontrolled) = 1 g/scf (CA-088, 7-59)

   c. $$\text{Volume} = \frac{(81.3 \text{ lb/ton})(7000 \text{ g/lb})}{1 \text{ g/scf}}$$

   $$= 570{,}000 \text{ acf/ton-Al}$$

2. Material Handling

   a. Emission factor (uncontrolled) = 10 lb/ton (EN-071)

   b. Grain Loading (uncontrolled) = 1 g/acf (assumed)

   c. Volume = 70,000 acf/ton

3. Bauxite Grinding

   a. Emission factor (uncontrolled) = 6 lb/ton (EN-071)

   b. Grain Loading (uncontrolled) = 1 g/acf (assumed)

   c. Volume = 42,000 acf/ton-bauxite

4. Calcining of Hydroxide

   a. Emission factor (uncontrolled) = 200 lb/ton (EN-027)

   b. Grain Loading (uncontrolled) = 2 g/acf (assumed)

   c. Volume = 700,000 acf/ton hydroxide

Table 5.10 gives the type of control device normally used, the extent of application, the efficiency of control, the net efficiency and the fraction of the total emissions represented by the particular source.

TABLE 5.10

Primary Aluminum Manufacturing, Type and Extent of Emission Controls

Source	Type of Control	Application	Efficiency	Net Control	Fraction of Total
line	Scrubber	1.00	.64	.64	.21
erial Handling	Fabric Filter	.35	.90	.32	.11
xite Grinding	ESP	.85	.95	.80	.08
cining of droxide	ESP	.95	.95	.90	.60
				TOTAL	1.00

(VA-091, p.134)

It is assumed that the following weight ratios are typical of the industry (ratios obtained from chemical equations):

$$\frac{\text{Bauxite}}{\text{Alumina}} \sim 1.0$$

$$\frac{\text{Alumina}}{\text{Aluminum}} \sim 1.9$$

Further it is assumed that only 10% of the aluminum produced in Texas involves grinding and calcining within the state.

Combining these data yields a weighted average controlled emission factor for 1972:

1.	Prebaked cell with scrubber - (81.3 lb/ton)(.36)	-	29.3 lb/ton
2.	Material Handling with Fabric Filter (10 lb/ton) (.68)	-	6.8 lb/ton
3.	Bauxite Grinding with ESP - (6 lb/ton-baux) (1.9 ton-baux/ton-al)(.20)(.1)	-	0.2 lb/ton
4.	Calcining of Hydroxide with ESP - (200 lb/ton) (1.9)(.1)(.1)	-	3.8 lb/ton
	Total	-	40.1 lb/ton

Then an estimate of the aluminum production from these sources is:

$$\frac{(27{,}886 \text{ tons-particulate})(2000 \text{ lb/ton})}{40.1 \text{ lb-particulate/ton-Al}} = 1.39\text{x}10^{6} \text{ tons/year}$$

$$= 2.65 \text{ tons/min}$$

The following unit costs for control equipment were used (100,000 acfm or larger, including installation):

TABLE 5.11

Unit Costs of Control Equipment
For the Primary Aluminum Industry

Electrostatic Precipitators------	\$2.19/acfm
Fabric Filters ------------------	\$1.78/acfm
Wet Scrubbers -------------------	\$0.60/acfm

The total capital investment in control equipment for the Texas primary aluminum manufacturing industry in 1972 is estimated to be:

1. Potline

   (570,000 acf/ton-Al)(2.56 tons-Al/min)(\$0.60/acfm)

   = $\$0.88\text{x}10^6$

2. Material Handling

   (70,000 acf/ton-Al)(2.56 ton-Al/min)(\$1.78/acfm)

   = $\$0.32\text{x}10^6$

3. Bauxite Grinding

   (42,000 acf/ton-bauxite)(1.9 ton bauxite/ton Al)
   (.1)(2.56)(\$2.19/acfm)

   = $\$0.04\text{x}10^6$

4. Calcining of Hydroxide

   (700,000 acf/ton-Hyd)(1.9 ton Hyd/ton-Al)(.1)(2.56)
   (\$2.19/acfm)

   = $\$0.75\text{x}10^6$

5. Total

Potline ------------------------	$\$0.88x10^6$
Material Handling --------------	$\$0.32x10^6$
Bauxite Grinding ---------------	$\$0.04x10^6$
Calcining of Hydroxide ---------	$\$0.75x10^6$
Total ---------	$\$1.99x10^6$

5.3.2 Primary Steel Production

Assumptions:

1. The major sources of emissions from steel mills consist of pig iron manufacture and steel making. These sources comprise 90% of the emissions. (VA-091)

2. Steel making requires 70% pig iron and 30% scrap. (EN-071)

3. In 1972 the degree of control was 100% on steel making furnaces and blast furnaces. (VA-091)

4. The emission factors are:

   a. Blast FCE with wet scrubbers -
      1.5 lb particulate/ton iron =
      2.1 lb particulate/ton steel

b. Steel furnace with scrubber =
   0.2 lb particulate/ton steel

c. Weighted total = $\frac{2.1 + .2}{.9}$ = 2.56 lb/ton steel (EN-071)

5. Steelmaking is 40% open hearth furnaces and 60% electric furnaces.

6. The specific gas volumes in steelmaking are:

   a. Blast furnace - 0.5 scfm/lb iron/hr

   b. Electric furnace - 6000 acfm/ton-steel/hr

   c. Open hearth furnace - 1500 acfm/ton steel/hr. (EN-027)

The particulate inventory for 1972 combined with the weighted controlled emission factor gives an estimate of the 1972 steel production for Texas:

$$\frac{(17{,}616 \text{ tons-part/year})(2000 \text{ lb/ton})}{2.56 \text{ lb-part/ton-steel}}$$

$= 13.76 \times 10^6$ tons/year

$=$ 26.18 tons/min

$=$ 1571 tons/hr

which yields the following 1972 statewide production rates:

Blast furnaces ---------------- 1100 tons/hr

Steel furnaces ---------------- 1571 tons/hr

The gas volumes to be cleaned are:

Blast Furnaces

$$(1100 \text{ tons/hr})(2000 \text{ lb/ton})(0.5 \text{ scfm/lb-hr})\left(\frac{400+460}{70+460}\right)$$

$$= 1.78\text{x}10^6 \text{acfm}$$

Electric Furnaces

$$(1571 \text{ ton/hr})(.6)(6000 \text{ acfm/ton-hr})\left(\frac{400+460}{70+460}\right)$$

$$= 9.18\text{x}10^6 \text{acfm}$$

Open Hearth Furnaces

$$(1571 \text{ tons/hr})(.4)(1500 \text{ acfm/ton-hr})\left(\frac{400+460}{70+460}\right)$$

$$= 1.53\text{x}10^6 \text{acfm}$$

The types of control equipment to be costed are:

Blast Furnaces - wet scrubbers @ $0.60/acfm

Electric Furnaces - fabric filters @ $1.78/acfm

Open Hearth - wet scrubbers @$0.60/acfm

(EN-027, SO-005)

These costs are:

TABLE 5.12

Capital Cost Estimates for Control Equipment for the Texas Primary Steel Industry in 1972

Blast Furnaces	$\$0.74 \times 10^6$
Open Hearth Furnaces	$\$0.92 \times 10^6$
Electric Furnaces	$\$16.34 \times 10^6$
Total	$\$18.00 \times 10^6$
Weighted Total	$\$20.00 \times 10^6$

The total 1972 capital investment in control equipment by the primary metal industry in Texas is then:

$$\frac{\$(20.00 + 1.99) \times 10^6}{.93} = \$23.65 \times 10^6$$

Scenario 1 projections of primary metal industry growth in Texas are given in Table 5.13:

TABLE 5.13

Scenario 1 Growth Factors for the Texas Primary Metals Industry

Year	Growth
1970	1.00
1985	1.60
2000	2.19

By interpolation, the growth factor for the period 1970 to 1972 is 1.08. The appropriate multipliers for cost calculations based on 1972 investments are then:

TABLE 5.14

Growth Factors for Texas Primary Metals Industry, 1972 Base

Year	Growth
1970	0.93
1985	1.48
2000	2.03

and the investment projections are:

TABLE 5.15

Capital Investment Projections for the Primary Metals Industry in Texas

Scenario 1

Year	10^6 1974 $'s
1970	21.99
1985	35.00
2000	48.01

The total energy use by the primary metals industry as projected by the two scenarios is given in Table 5.16:

TABLE 5.16

Projected Energy Use
Texas Primary Metals Industry
(Trillions of BTU's)

	1970	1985	2000
Scenario 1	192.07	306.9	420.5
Scenario 2	192.07	246.2	330.4
Scenario 2 Growth Factor	1.00	1.28	1.72

Again, since the amount and nature of pollutant emissions is not a strong function of the type of fuel used, and since no significant desulfurization is forecast, the Scenario 2 costs are obtained simply from the Scenario 1 1970 figure and the Scenario 2 growth fractions:

TABLE 5.17

Capital Investment Projections for the
Primary Metals Industry in Texas
Scenario 2

Year	10^6 1974 $'s
1970	21.99
1985	28.15
2000	37.82

5.4 Summary of Industrial Capital Costs

Tables 5.18 through 5.20 summarize the capital cost projectsions for Texas industry for the projection years.

TABLE 5.18

Capital Costs for Texas Industry For Emission Controls, Scenario 1 (10^6 \$'s)

Category	1970	1985	2000
Refineries	-0-	210	315
Glass, Clay, Stone & Cement	3	4	5
Primary Metals	22	35	48
Total	25	249	368

TABLE 5.19

Capital Costs for Texas Industry For Emission Controls, Scenario 2a (10^6 \$'s)

Category	1970	1985	2000
Refineries	-0-	220	325
Glass, Clay, Stone & Cement	3	3	3
Primary Metals	22	28	38
Total	25	251	366

TABLE 5.20

Capital Costs for Texas Industry
For Emission Controls, Scenario 2b
(10^6 $'s)

Category	1970	1985	2000
Refineries	-0-	260	385
Glass, Clay, Stone & Cement	3	3	3
Primary Metals	22	28	38
Total	25	291	426

6.0 SUMMARY

The following tables summarize the capital cost projections for the State of Texas according to the major industrial classifications.

TABLE 6.1

Scenario 1 Summary of the Capital Cost Projections for Emission Control Equipment for Texas (10^6 $'s)

Category	1970	1985	2000
Electric Generation	-0-	-0-	-0-
Agricultural	11	25	40
Petrochemical	-0-	-0-	-0-
Industrial	25	249	368
Total	36	274	408

TABLE 6.2

Scenario 2a Summary of the Capital Cost Projections for Emission Control Equipment for Texas (10^6 $'s)

Category	1970	1985	2000
Electric Generation	-0-	465	618
Agricultural	11	15	21
Petrochemical	-0-	-0-	-0-
Industrial	25	251	366
Total	36	731	1005

TABLE 6.3

Scenario 2b Summary of the Capital Cost Projections for Emission Control Equipment for Texas (10^6 $'s)

Category	1970	1985	2000
Electric Generation	-0-	547	726
Agricultural	11	15	21
Petrochemical	-0-	-0-	-0-
Industrial	25	291	426
Total	36	853	1173

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