CHAPTER III

AIR IMPACT

The majority of gaseous airborne pollutants result from man-made combustion and abrasive processes, including commercial and residential heating, generation of electricity by fossil fuels, mobile sources (e.g., cars, boats, and other vehicles), various industrial processes, and refuse incineration. Industrial combustion processes are major sources of sulfur dioxide and nitrogen oxides. Automobile exhaust is rich in nitrogen oxides, hydrocarbons, and carbon monoxide.

Some particulates emissions are due to industrial processes. However, in many cases, the greatest mass of particulate emissions is due to blowing dust from activities such as handling of materials (e.g., coal and gravel), construction, and transportation (e.g., particulates dislodged along roadways by vehicles and emissions from uncovered trucks and rail cars). Erosion of exposed earth and sand by the wind is also a major source of blowing dust. In some cases, natural particulate emissions such as wind-blown dust and pollen can exceed man-made emissions by an order of magnitude (1).

A. Sources of Major Pollutants

Figures III-1 through III-5 present data on emissions of five major pollutants by source category for 1975 through 1978 in the State of Maryland. Table III-1 is the total statewide emissions inventory. During 1975 and 1976, Maryland power plants contributed 63 percent of the sulfur oxides, 30 percent of the particulates, and 28 percent of the nitrogen oxides (see Figure III-6 for plant locations). Since power plants use relatively efficient combustion processes, they contribute less than 1 percent of total hydrocarbon and carbon monoxide emissions.

Emissions from power plants vary depending on the composition of the fuel, operating conditions, and control equipment (precipitators and scrubbers). During combustion, sulfur in coal and oil is almost completely converted to SO_2 and emitted through the stack. The preponderance of NO_x emitted is due to reactions between O_2 and N_2 in the air at elevated temperatures. These NO_x emission rates are sensitive to fuel type, burner design, flame temperature, and the amount of excess air entering the furnace. Particulates emitted include noncombustible fuel residues (silicates, metal salts, sodium chloride) and incompletely burned organic materials. Coal combustion also releases large amounts of soil minerals embedded in the coal. Relatively small amounts of fluoride, mercury, beryllium, and various radioactive materials may also be released when coal is burned.

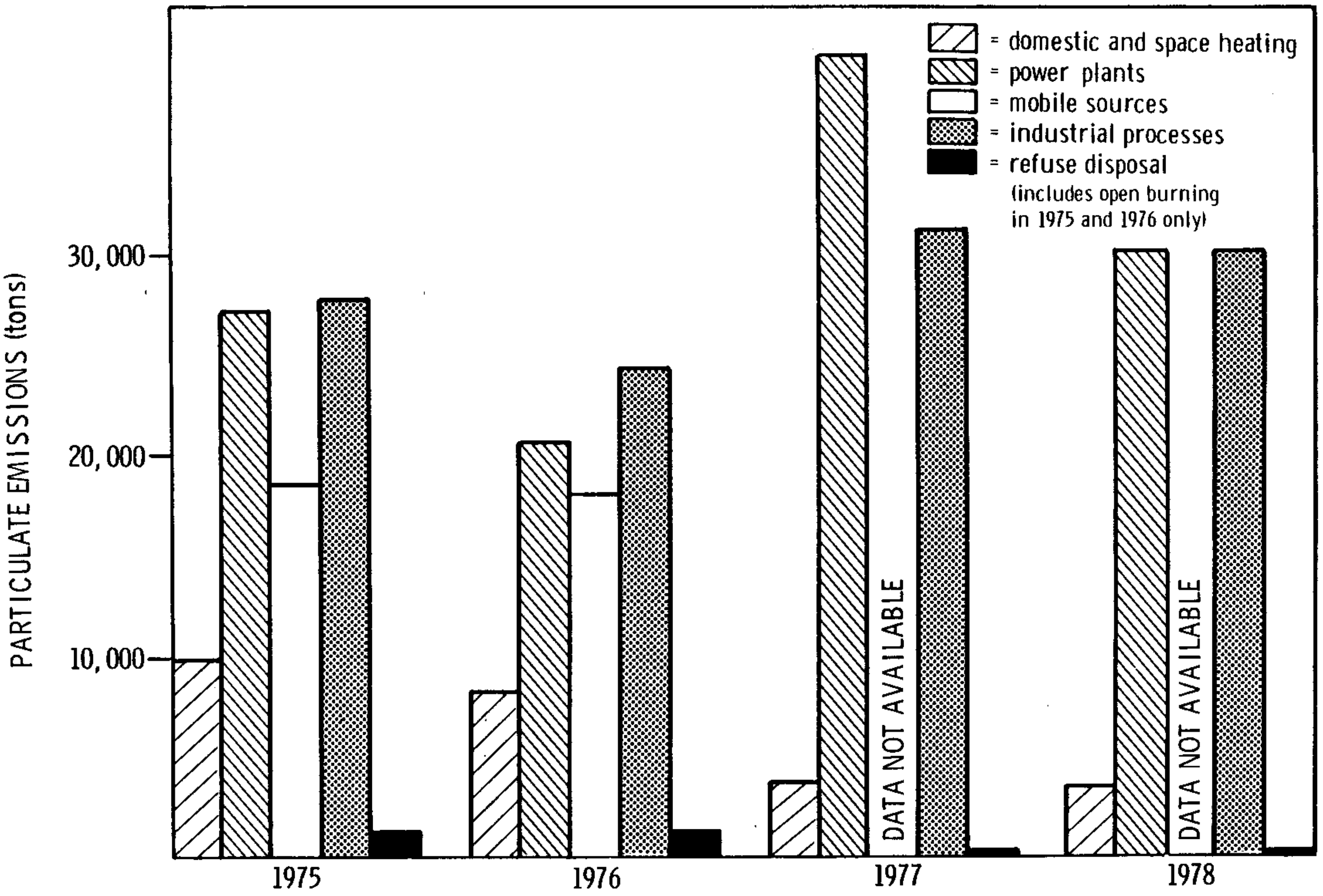

Figure III-1. Statewide particulate emissions, 1975-1978 (data from Ref. 2).

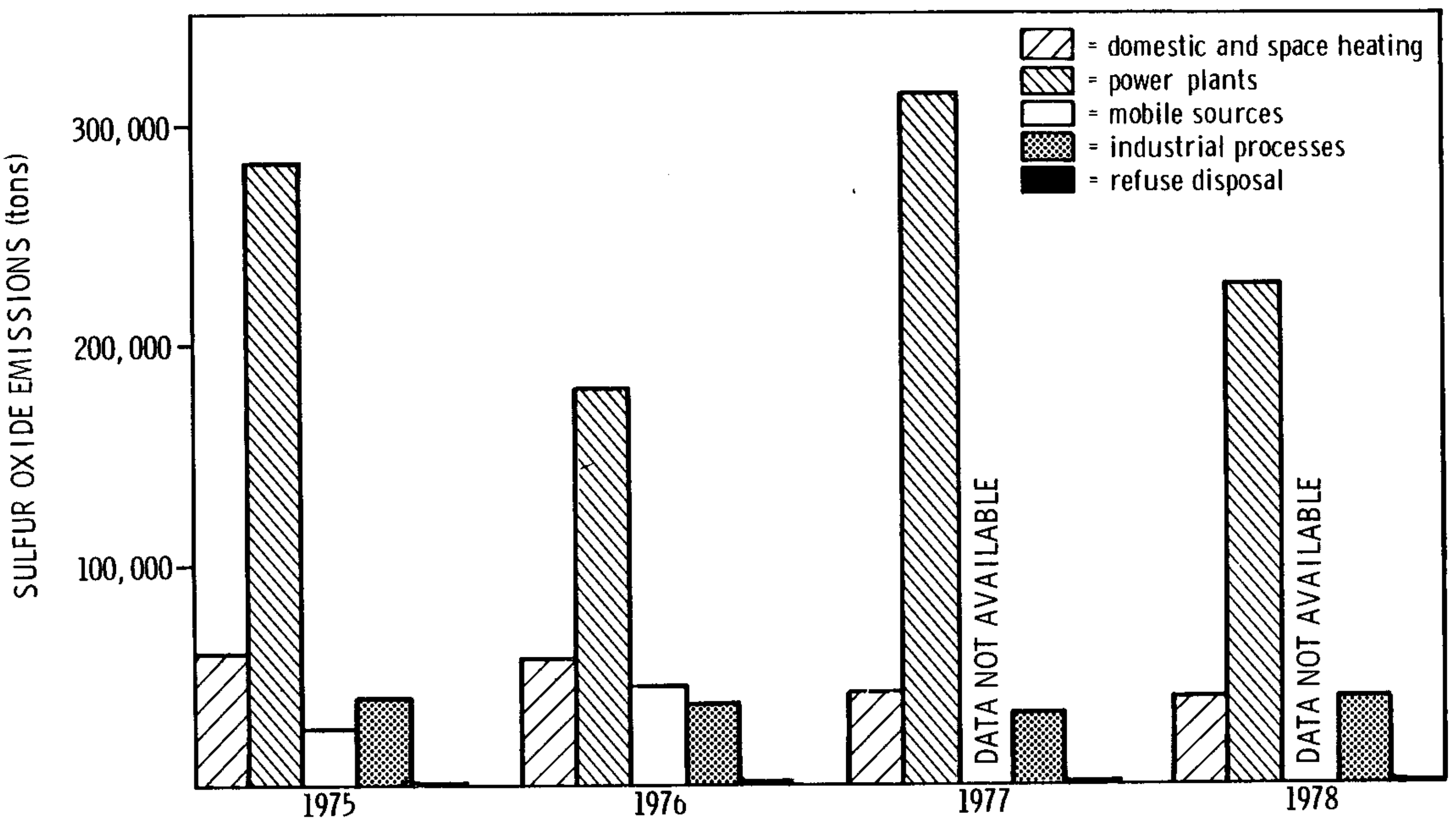

Figure III-2. Statewide sulfur oxide emissions, 1975-1978 (data from Ref. 2).

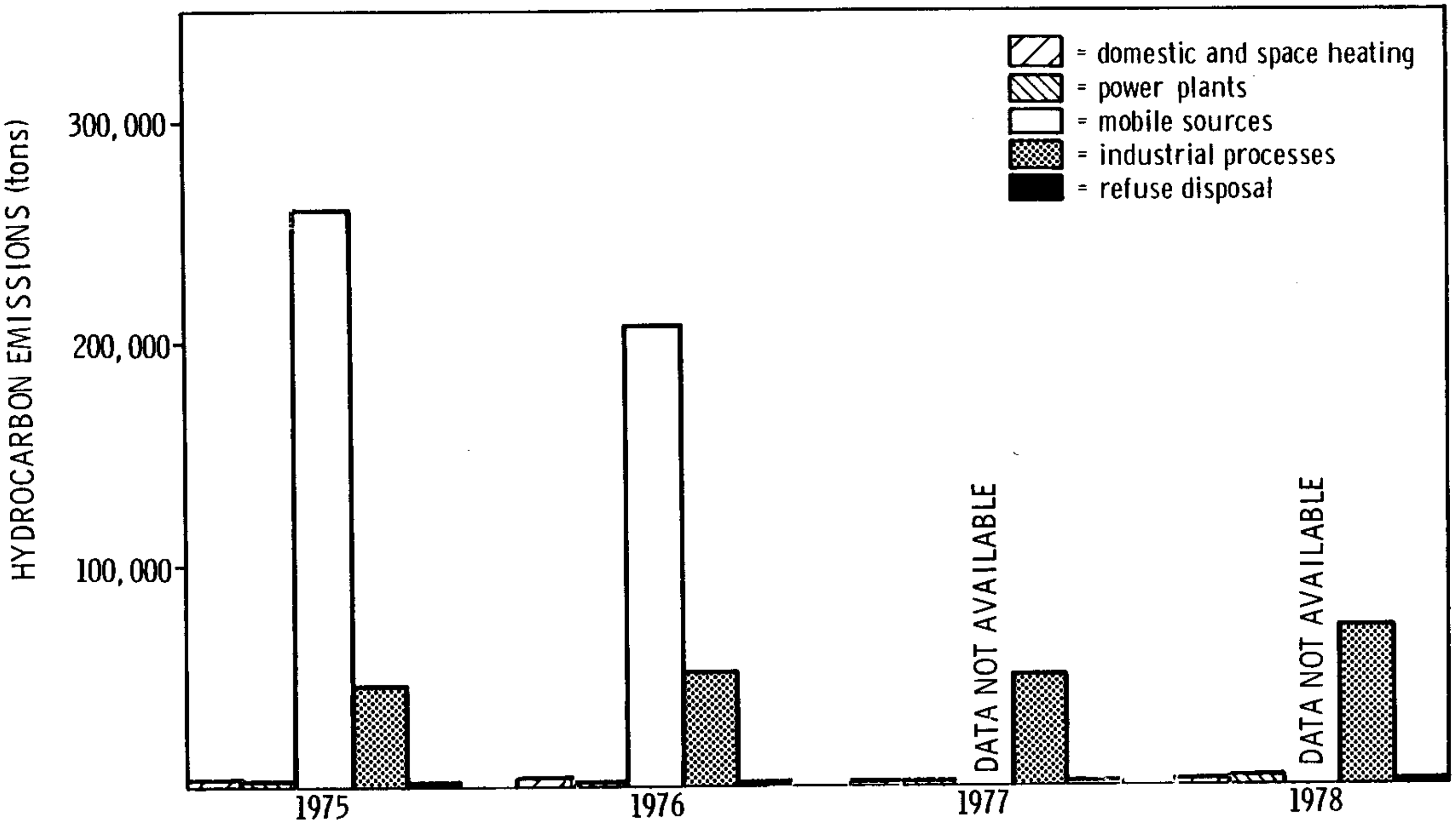

Figure III-3. Statewide hydrocarbon emissions, 1975-1978 (data from Ref. 2).

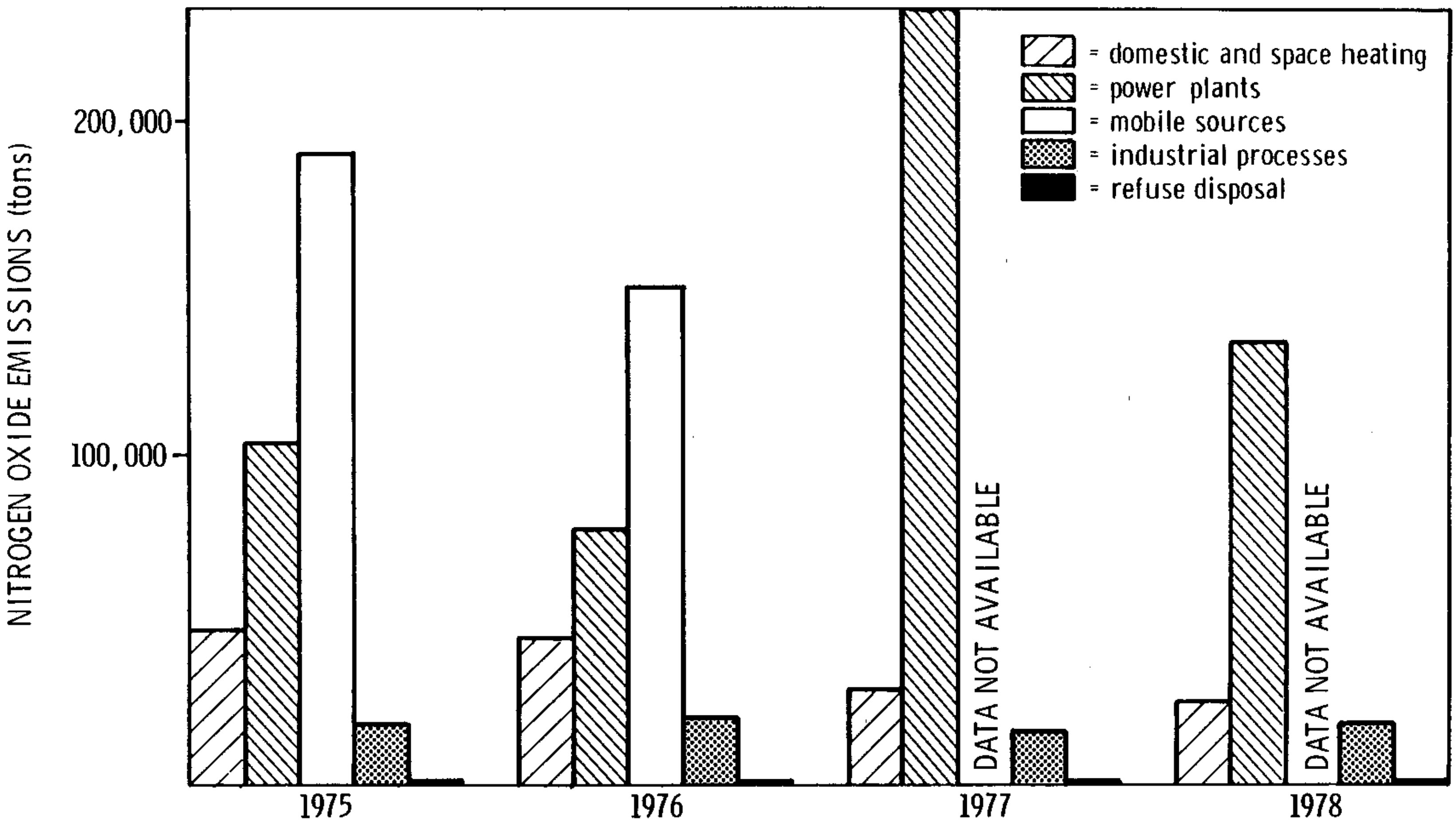

Figure III-4. Statewide nitrogen oxide emissions, 1975-1978 (data from Ref. 2).

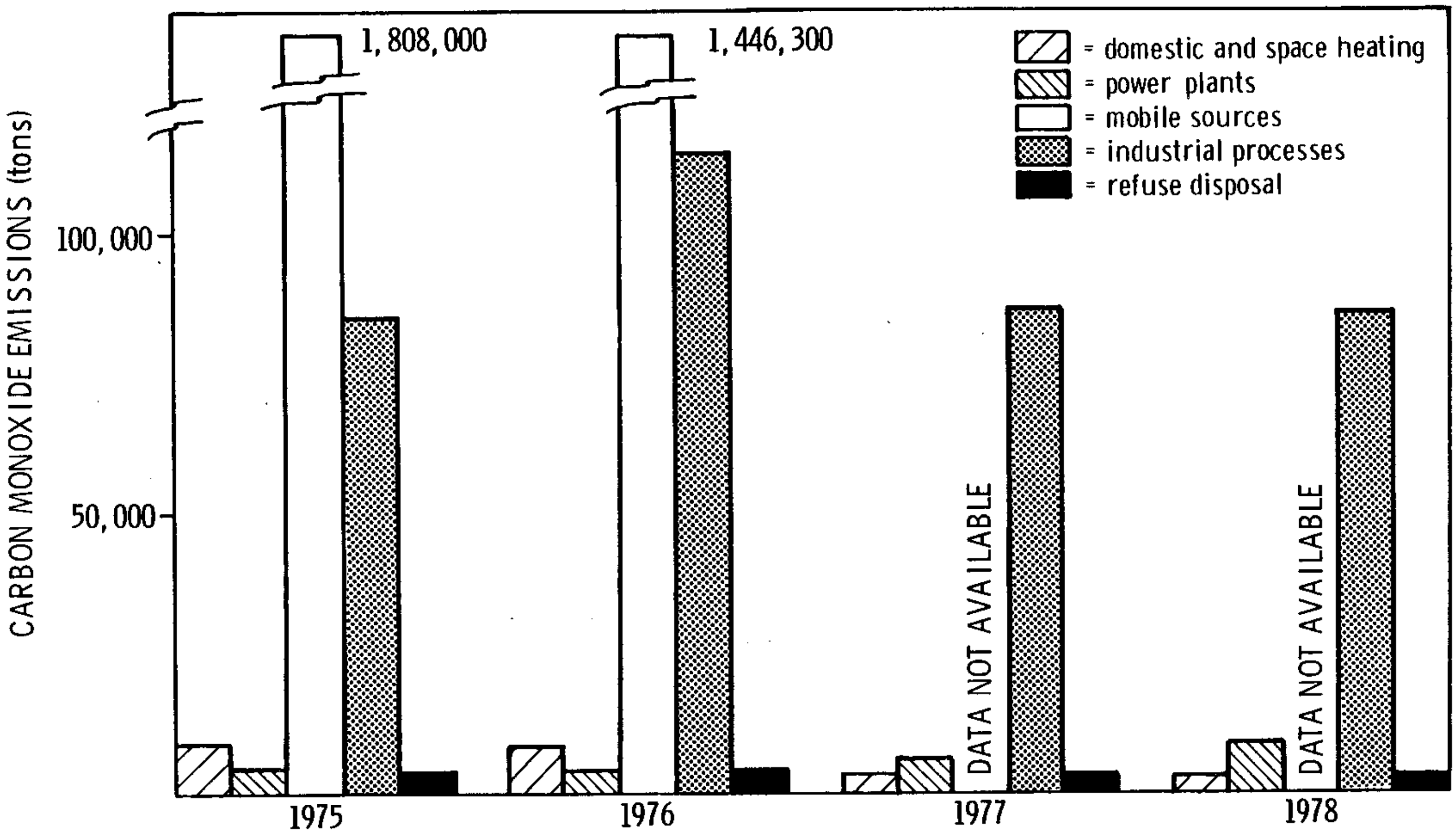

Figure III-5. Statewide carbon monoxide emissions, 1975-1978 (data from Ref. 2).

B. Emission Trends of Major Pollutants

Total Suspended Particulates (TSP)

National emissions of particulates showed considerable reduction from 1970 to 1978 (Fig. III-7). A continuation of this trend is predicted by a comprehensive simulation model developed by the U.S. Environmental Protection Agency (EPA) -- the Strategic Environmental Assessment System (SEAS) (4). This model incorporates recent modifications and data files developed by the Energy Research and Development Administration (ERDA), now a part of the Department of Energy. The model assumes the use of coal will approximately double by 1990. Figure III-8 shows the total predicted emissions of TSP for the U.S. in 1985 and 1990, relative to 1975 emissions. Estimates of total particulate emissions in Maryland (excluding mobile sources) for recent years fluctuate with time (see Table III-1) and show no clear trend.

Sulfur Dioxide (SO_2)

National emissions of SO_2 showed a general increase until 1970, but have decreased slightly since then. (see Fig. III-9). EPA projections made in 1978 predicted that increased use of coal would cause a reversal of this downward trend, with SO_2 emissions increasing about 10 percent over 1975 emissions by 1985 (see Fig. III-8).

Total sulfur oxide emissions in Maryland for 1975 - 1978 (Table III-1) (excluding mobile sources) have fluctuated with time, showing no clear trend.

Nitrogen Oxides (NO_2)

U.S. emissions of NO_x from power plants and motor vehicles have shown an increasing trend, but since 1976 the emissions from motor vehicles have stabilized because the increase in miles travelled has been offset by decreased emissions due to automotive pollution control techniques (5) and increased mileage per gallon.

Figure III-8 shows the total predicted emissions for nitrogen oxides for the U.S. for 1985 and 1990 to be about the 1975 level. In Maryland, NO_x emissions showed large variations from one year to the next due to changes in the emission inventories for power plants.

Hydrocarbons and Carbon Monoxide

Automobiles are the major sources of both hydrocarbons and carbon monoxide. Advanced automotive emission controls have significantly reduced emissions from new cars. As old cars are phased out, national HC and CO emissions will be reduced, as shown in Fig. III-8. Additional reductions may result if increased gasoline prices reduce a significant reduction in vehicle miles travelled. Emissions of hydrocarbons and carbon monoxide for Maryland in recent years are shown in Table III-1.

Power Plants (>90MW) Within or Adjacent to Maryland (●)

(Capacity in MW)

Plant Name	Utility	Steam	Gas Turbine	Fuel of Steam Unit
1. Benning Road(a)	PEPCO	597		Oil
2. Brandon Shores(b)	BG&E	1,250		Coal
3. Buzzard Point(c)	PEPCO	222	252	Oil
4. Calvert Cliffs	BG&E	1,620		Nuclear
5. Chalk Point(d)	PEPCO	1,105(e)	48	Coal/oil
6. C.P. Crane	BG&E	384	14	Oil(f)
7. Dickerson (g)	PEPCO	545	13	Coal
8. Gould Street	BG&E	103		Oil
9. Morgantown	PEPCO	1,163	248	Coal
10. Notch Cliff	BG&E		128	
11. Perryman	BG&E		204	
12. Potomac River(h)	PEPCO	480		Coal
13. Riverside	BG&E	321	172	Oil
14. R.P. Smith	Pot.Ed.	129		Coal
15. Vienna(i)	DELMARVA	241	17	Oil
16. Wagner	BG&E	988	14	Oil/coal
17. Westport(j)	BG&E	209	118	Oil

Plants Owned by Out-of-State Utilities (▲)

18. Conowingo (Philadelphia)
19. Mount Storm (VEPCO)
20. Possum Point (VEPCO)

Proposed Future Power Plant Sites (○)

21. Bainbridge(k)
22. Canal (Philadelphia)
23. Della Brooke Farm (So. Md. Elec. Coop.)
24. Douglas Point (PEPCO)
25. Elms (k)
26. Point of Rocks (Pot. Ed.)
27. Seneca Point (Philadelphia)
28. Summit (DELMARVA)

(a) Unit 13 (47 MW) is scheduled to be retired in 1982.

(b) Unit 1 is scheduled to begin operation in mid-1984, Unit 2 in early 1988.

(c) Units 1-6 (222 MW) are scheduled to be retired in 1982.

(d) Scheduled to add Unit 4 (600 MW, oil) in 1982.

(e) Capacity will increase to 1,335 MW at end of 1982 following the addition of more stringent emission controls.

(f) Commenced legal process for conversion to coal.

(g) Proposed addition of Unit 4 (300 MW, coal) in 1993.

(h) Units 1-2 (174 MW) are scheduled to be retired in 1984.

(i) Units 5-7 (74 MW) were scheduled to be retired in 1980; also scheduled is the addition of Unit 9 (500 MW, coal with DELMARVA retaining ownership of 325 MW) in 1987.

(j) Units 1, 13, 14 (19, 16, 16 MW) are scheduled to be retired in 1982; while Unit 3 (58 MW) is scheduled to be retired in 1987.

(k) Power Plant Siting Program required site.

Figure III-6. Power plants in the Maryland region.

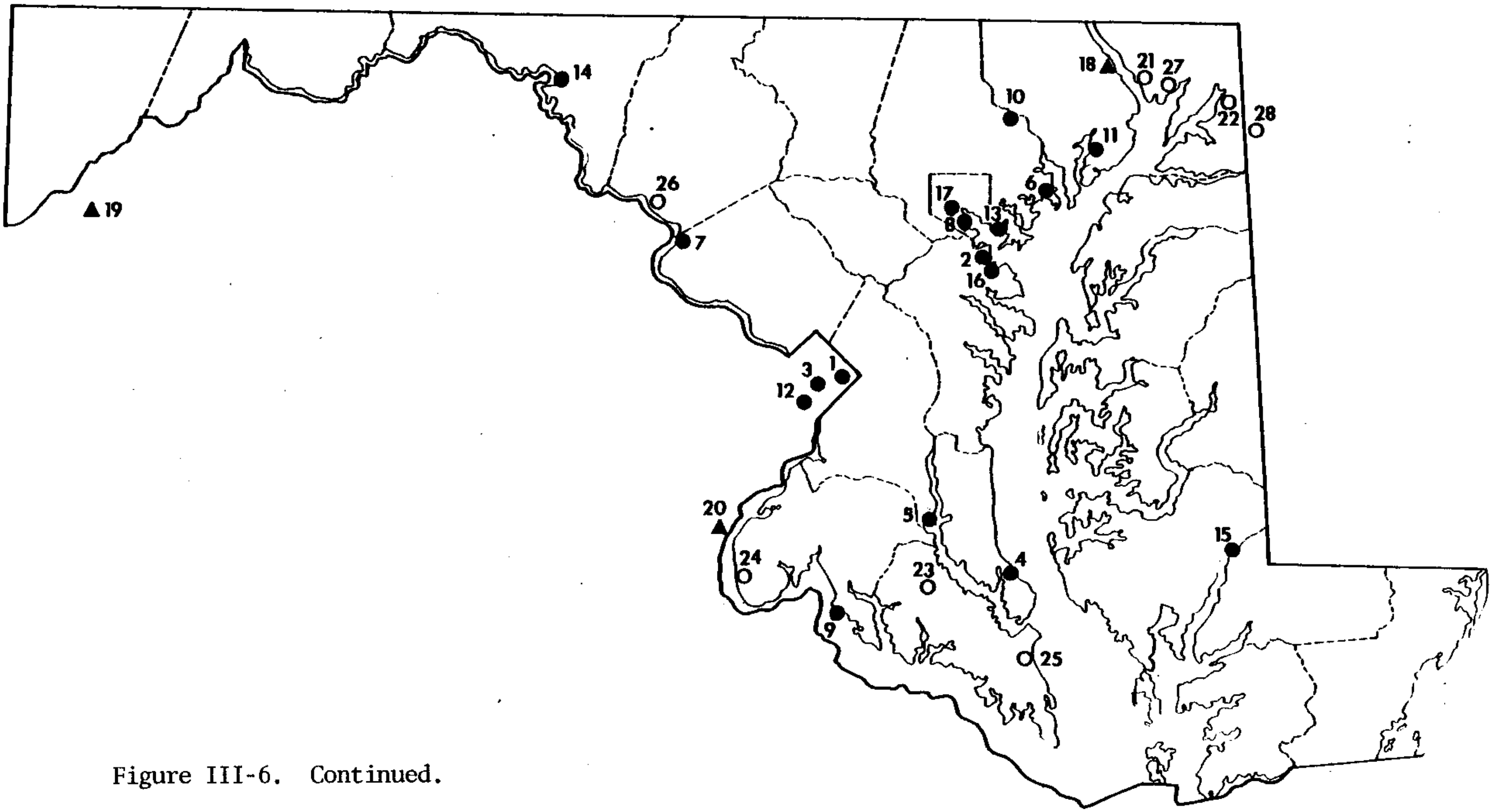

Figure III-6. Continued.

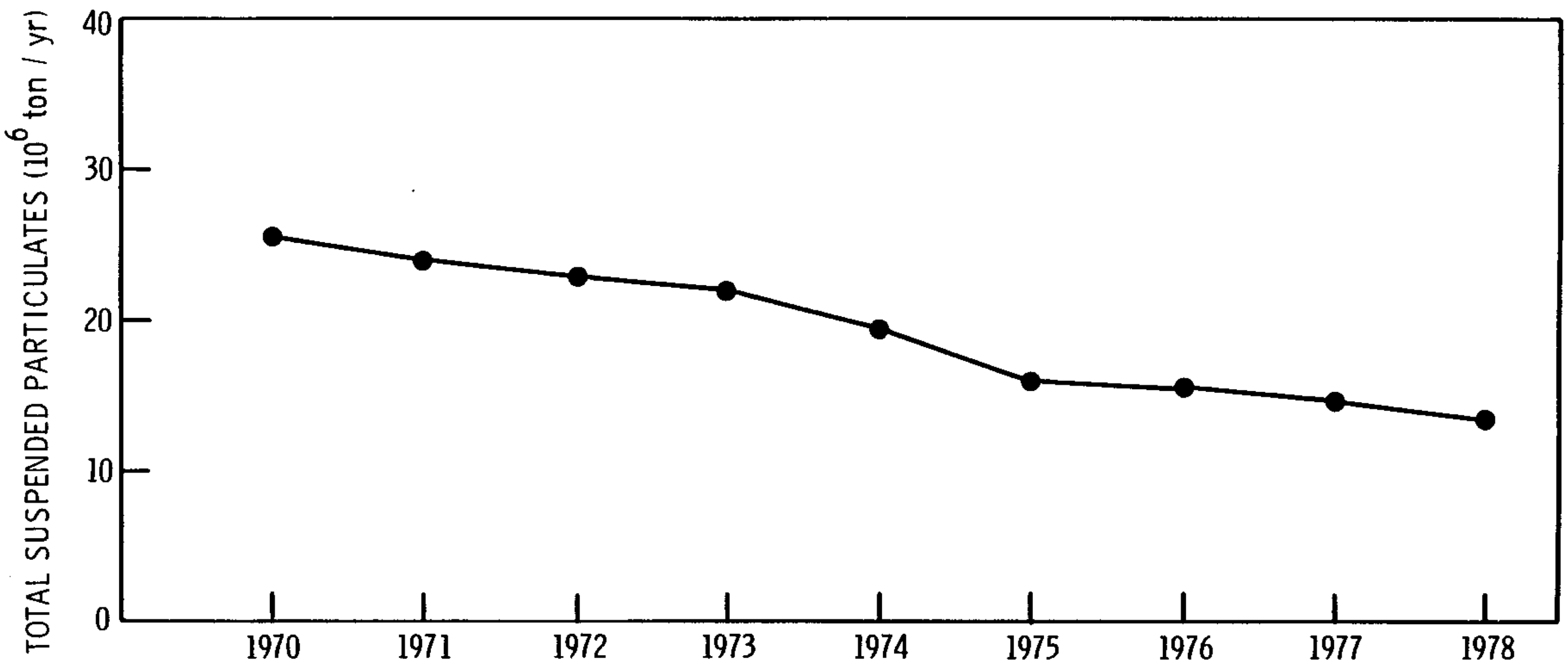

Figure III-7. Estimates of total suspended particulate emissions for the United States (data from Ref. 6).

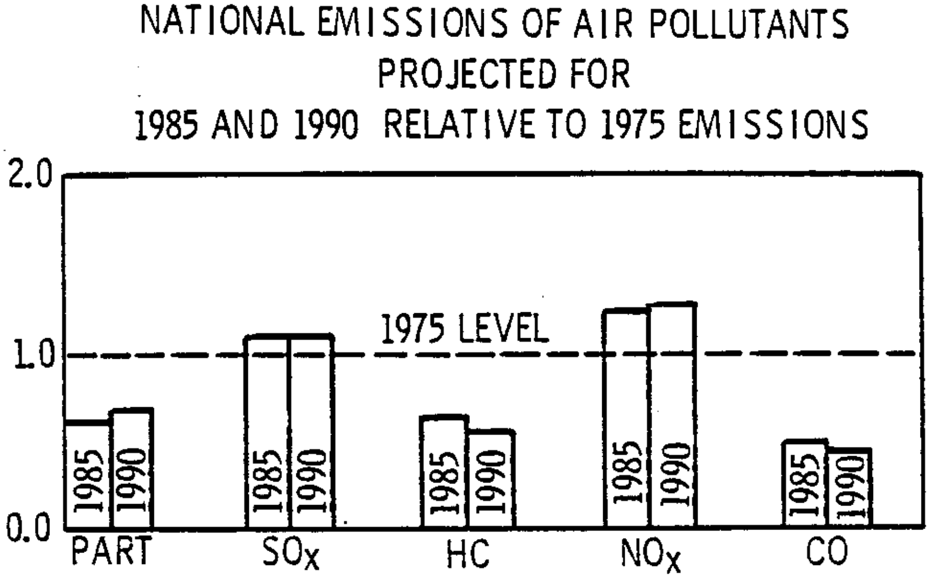

Figure III-8. National emissions of major air pollutants projected by EPA for 1985 and 1980 relative to 1975 emissions (data from Ref. 4).

Table III-1. Statewide Total Emissions Inventory for the Five Major Source Categories for 1975-1978[a]

	Total Emissions (tons/year)[b]			
	1975	1976	1977	1978
Particulates				
Including mobile sources	85,000[c]	73,500	--[d]	--
Excluding mobile sources	66,400	55,400	76,100	67,200
Sulfur Oxides				
Including mobile sources	409,800	318,700	--	--
Excluding mobile sources	383,300	274,100	390,200	308,300
Hydrocarbons				
Including mobile sources	311,600[e]	263,300	--	--
Excluding mobile sources	76,200	56,100	52,700	74,300
Nitrogen Oxides				
Including mobile sources	359,000	288,200	--	--
Excluding mobile sources	169,700	138,900	273,700	177,700
Carbon Monoxide				
Including mobile sources	1,910,200	1,577,000	--	--
Excluding mobile sources	107,400	130,700	99,300	100,400

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[a] Data from Ref. 2. Emission data are obtained from estimates of indicators such as fuel consumption, production rates, control efficiencies, and vehicle miles traveled. Average emission factors, which relate these indicators to emission rates for specific source categories, are used to derive total emissions (3).

[b] Does not include miscellaneous source categories.

[c] These are "man-made" particulate emissions. Particulate "emissions" due to natural causes (e.g., wind-blown dust and pollen) vary widely with place and time and can exceed man-made emissions by an order of magnitude.

[d] Data for mobile sources not available.

[e] In addition, about 150,000 tons per year is released from asphalt roads in the State. This quantity can be reduced to 20,000 to 25,000 tons per year by current use of a different type of road tar. Emission from an asphalt-surfaced road decreases significantly over a period of 1 to 2 years.

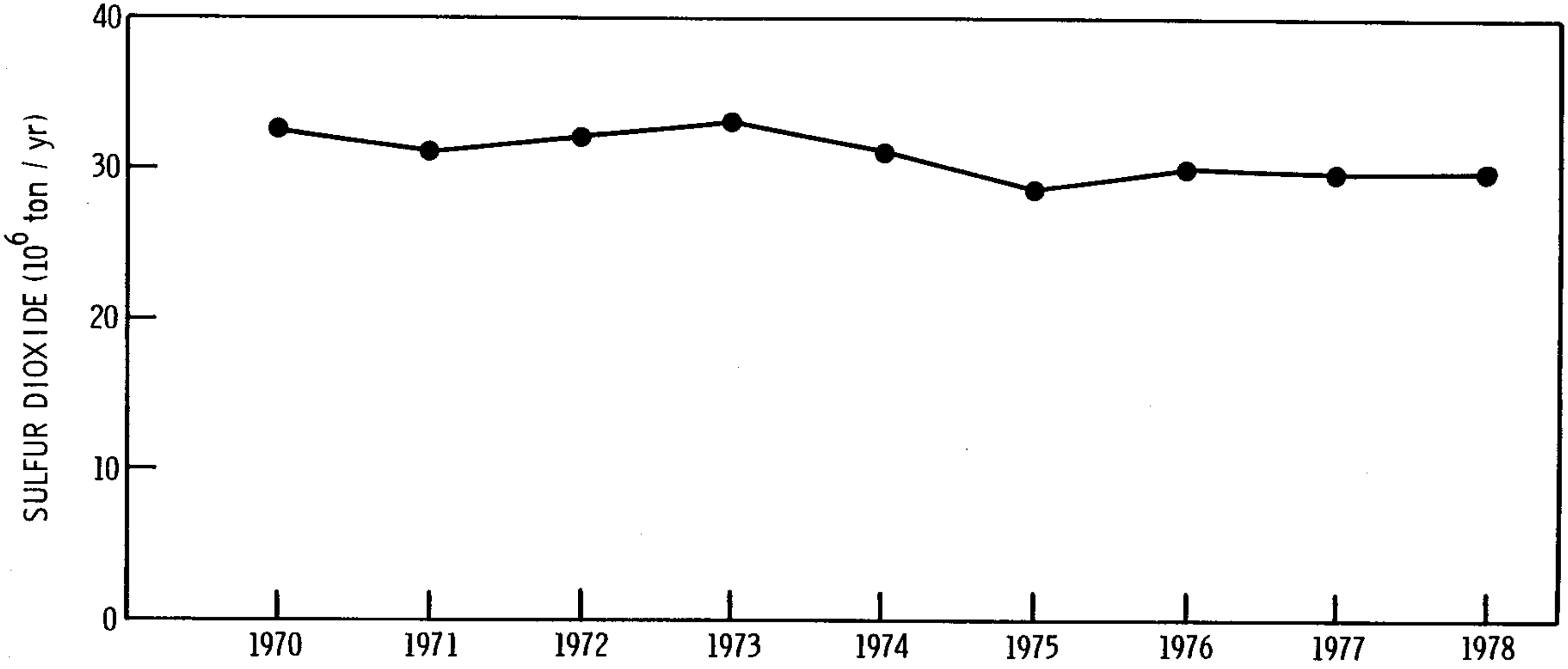


Figure III-9. Estimates of sulfur oxide emissions for the United States (data from Ref. 6).

C. Standards

Ambient air quality is measured and defined as ground-level concentrations of pollutants. Federal and State agencies are attempting to attain and maintain good air quality by: 1) regulating pollutant groundlevel concentrations through ambient air quality standards, 2) controlling emissions from new and existing sources through source-emission standards, and 3) restricting sulfur content of fuels. Emissions from new sources are controlled through an extensive new source review process.

Ambient Air Quality Standards

Ambient air quality standards have been established by the EPA for ground-level concentrations of certain pollutants and have been adopted by State of Maryland. The National Ambient Air Quality Standards (NAAQS) are listed in Table III-2. The national primary standards are designed to protect human health, whereas the secondary standards are concerned with the protection of human welfare (i.e., the material and aesthetic effects of pollution).

Emission Limitations for Existing Fuel-Burning Installations

Sulfur content of fossil fuels is controlled to reduce the ground-level concentration (GLC) of SO_2. Limitations are less strict in Maryland rural air quality areas (Areas I, II, V, and VI -- see Fig. III-10) than in urban areas (III and IV). Nitrogen oxide emissions are limited for all installations in areas III and IV and for installations that commenced operations after 12 May 1972, in other areas of the State. Visible emissions other than steam are restricted throughout Maryland. The total mass of particulate emissions is also regulated. Dust collectors are required for installations burning residual oil in areas III and IV. (See Table III-3).

New Source Review

New proposed utility steam-generating units with a heat input greater than 250 x 10^6 Btu/hr, or major modifications at installations of this size that increase controlled emissions of any pollutant by more than 100 tons per year, are subject to New Source Review. This review must demonstrate that all source emissions from these installations meet applicable New Source Performance Standards (NSPS). These standards were originally established by EPA in December 1971 under authority of the Clean Air Act of 1970 for certain new sources beginning operation after 17 August 1971 (7, 8). To satisfy the requirements of the Clean Air Act Amendments of 1977, EPA has adopted revised standards of performance for electric utility steam generating units for which construction commenced after 18 September 1978 (9). Table III-4 gives the two sets of NSPS for utility boilers.

In addition, the operator must demonstrate that the new unit it will not produce or exacerbate any violations of NAAQS, and that the increased emissions of SO_2 and TSP due to the unit will not produce increased ground-level concentrations in excess of allowable Prevention of Significant Deterioration

Table III-2. National Ambient Air Quality Standards and Prevention of Significant Deterioration Increments(a)

Pollutant	National				PSD increments ($\mu g/m^3$) by class		
	Primary		Secondary				
	$\mu g/m^3$	ppm	$\mu g/m^3$	ppm	I	II	III
Sulfur oxides							
Annual arithmetic	80	0.03			2	20	40
24-hr maximum(b)	365	0.14			5	91	182
3-hr maximum(b)			1,300	0.5	25	512	700
1-hr maximum(c)							
Suspended particulate matter							
Annual geometric mean	75		60(d)		5	19	37
24-hr maximum(b)	260		150		10	37	75
Carbon monoxide							
8-hr maximum(b), mg/m^3	10	9	10	9			
1-hr maximum(b), mg/m^3	40	35(e)	40	35			
Hydrocarbons (nonmethane)							
3-hr (6-9AM) maximum(b)	160	0.24	160	0.24			
Nitrogen dioxide							
Annual arithmetic mean(f)	100	0.05	100	0.05			
Ozone							
1-hr maximum(g)	235	0.12	235	0.12			
Lead							
Quarterly average	1.5						

(a) NAAQS figures from Ref. 10 and 11, PSD increments from Ref. 12.

(b) Not to be exceeded more than once per year.

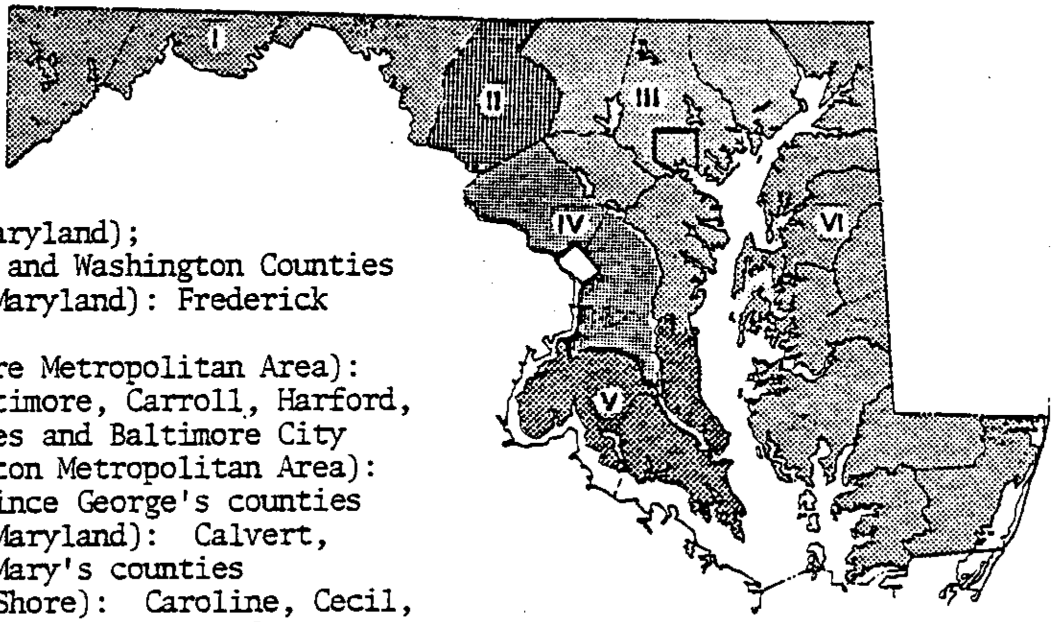
(c) Not to be exceeded more than once per month.

(d) A guide to be used in assessing implementation plans to achieve the 24-hour standard.

(e) The EPA is proposing to lower the primary 1-hour standard to 25 ppm.

(f) A short-term (e.g., 1-hour average) standard for NO_2 is under consideration by the EPA.

(g) The ozone standard was changed from 160 $\mu g/m^3$ and 0.08 ppm in January 1979.



AREA I (Western Maryland);
Allegany, Garrett and Washington Counties
AREA II (Central Maryland): Frederick County
AREA III (Baltimore Metropolitan Area): Anne Arundel, Baltimore, Carroll, Harford, and Howard counties and Baltimore City
AREA IV: (Washington Metropolitan Area): Montgomery and Prince George's counties
AREA V (Southern Maryland): Calvert, Charles, and St. Mary's counties
AREA VI (Eastern Shore): Caroline, Cecil, Dorchester, Kent, Queen Anne's, Somerset, Talbot, Wicomico, and Worchester counties.

Figure III-10. The six air quality control areas in Maryland. From Ref. 13.

Table III-3. Restrictions in Fuel Sulfur Content and Emissions of Criteria Pollutants from Fuel Burning Equipment for Rural and Urban Areas of Maryland.

Parameter	Rural Limitation (Regions I, II, V, VI)	Urban Limitation (Regions III, IV)
Visible emissions other than water	20% opacity except 40% opacity not more than 6 min/hour during startup and soot blowing	None allowed except 40% opacity not more than 6 min/hour during startup and soot blowing
TSP emissions:		
Residual oil	0.1 lb/10^6 Btu[a]	0.01 gr/dscf,[b] dust collectors required
Solid fuel	Same as oil	0.03 gr/scfd,[c] dust collectors required
Sulfur limitation:[d]		
Solid fuel	3.5 lb/10^6 Btu[e]	1.0% (1.7 lb/10^6 Btu[e])
Residual fuel oil	2.0%	1.0%
Distillate fuel oil	0.3%	0.3%

(a) For new installations with more than 250 x 10^6 Btu/hour heat input. Higher emissions are allowed for installations existing before 17 Jan 1972 and for smaller installations (up to 0.6 lb/10^6 Btu).

(b) 0.02 gr/dscf for equipment constructed prior to 1 July 1975; 0.03 gr/ascf for equipment with a heat input less than 50 x 10^6 Btu/hour.

(c) 0.05 gr/dscf for installaions with a heat input less than 250 x 10^6 Btu/hour.

(d) Or equivalent if flue gas desulfurization is used.

(e) Not regulated if total fuel-burning equipment on premises has a heat input less than 100 x 10^6 Btu/hour.

Table III-4. Original (1971) and Revised (1978) New Source Standards of Performance for Steam Generators Fired by Fossil Fuels

Pollutant	Original Standard Applicable to boilers constructed 17 Aug 1971 to 18 Sept 1978	Revised Standard Applicable to boilers constructed after 18 Sept 1978
Particulate matter	0.10 lb per million Btu heat input, maximum 2-hr average	0.030 lb per million Btu heat input, maximum 2-hr average
	20 percent opacity; except that 27 percent opacity is permissible for not more than 6 min in any hour	Same
		99% of uncontrolled emissions when solid fuel is combusted or 70% when combusting liquid fuel
Sulfur dioxide	0.80 lb per million Btu heat input, maximum 2-hr average when liquid fossil fuel is burned	Same(b)
	1.2 lb per million Btu heat input, maximum 2-hr average when solid fuel is burned	Same(b)
		90 percent reduction of uncontrolled emission(c)
Nitrogen oxides	0.2 lb per million Btu heat input, maximum 2-hr average, expressed as NO_2, when gaseous fossil fuel is burned	Same(b)
	0.30 lb per million Btu heat input, maximum 2-hr average, expressed as NO_2, when liquid fossil fuel is burned	Same(b)
	0.70 lb per million Btu heat input, maximum 2-hr average, expressed as NO_2, when solid fossil fuel (except lignite) is burned	0.60 lb per million Btu heat input, maximum 2-hr average, expressed as NO_2, from combustion of bituminous coal.
		0.50 lb per million Btu heat input, maximum 2-hr average, expressed as NO_2, from combustion of subbituminous coal, shale oil, or any solid liquid or gaseous fuel derived from coal.

(a) Revised from 1978 CEIR (14)

(b) 30-day rolling average.

(c) 30-day rolling average. For sources emitting less than 0.60 lb per million Btu, the percent reduction required is 70%. No reduction is required when the facility uses liquid or gaseous fuel and emits less than 0.2 lb per million Btu.

Table III-5. Emissions of TSP and Trace Contaminants Subject to PSD Analysis for a Hypothetical Coal-Fired Power Plant Consuming 100 ton/hr of Coal

	Uncontrolled Emissions		Controlled Emissions			
	Content in Coal[a] (ppm)	Uncontrolled Emission Rate (lb/hr)	Assumed Control Efficiency (%)	(g/s)	(ton/yr)	PSD[b] *de minimus* (ton/yr)
TSP	224 lb/ton[c]	22,400	99.7	8.0	350	10
Pb	35 ± 44	7.0	99.0	0.0085	0.3	0.6
Hg	0.20 ± 0.20	0.04	5.0	0.0050	0.17	0.10
Be	1.6 ± 0.8	0.31	90.0	0.004	0.13	0.004
F	61 ± 21	12.0	90.0	0.15	5.4	3.0
As	14 ± 18	2.8	90.0	0.035	1.3	N/A[d]

(a) Measured standard deviations for 101 coals. Data from Ref. 15.

(b) New sources and modifications which are "major" under the PSD and non-attainment regulations of 8 August 1980 require an air quality analysis for all pollutants emitted in amounts greater than PSD *de minimus* values.

(c) Flyash production; assumes 14% ash content.

(d) Not established.

(PSD) increments (see Table III-2). An ambient air quality analysis must be carried out for all other pollutants emitted at rates greater than specified de minumus values. Several of these will be relevant for coal-fired power plants (see Table III-5). Utilities desiring to build plants in or near nonattainment areas must also demonstrate that their emission control equipment meets Lowest Achievable Emission Rate (LAER) requirements. If units are added in or near areas where ambient air quality standards are violated, other sources in the area must, in most cases, make offsetting emission reductions.

D. Health and Welfare Effects of Pollutants

The Clean Air Act of 1970 directs the Administrator of the EPA to compile a list of hazardous air pollutants and issue criteria documents describing the environmental effects of each. Ambient air quality standards are to be set for these material, using the best scientific evidence cited in the criteria documents. A safety factor is to be incorporated to protect the most sensitive elements of the population and to account for uncertainties in the data. The criteria documents and the resulting standards are to be reviewed and revised every 5 years.

To date, criteria documents have been issued and ambient air quality standards established for six pollutants: sulfur oxides, nitrogen oxides, total suspended particulates, photochemical oxidants (ozone), carbon monoxide, and lead. A hydrocarbon standard was issued as a guide for attaining ozone standards. The health effects on which the primary standards are based, and some of the welfare effects, are summarized below.

Total Suspended Particulates and Lead

Total suspended particulate material has been associated with a variety of adverse health effects in humans. These include decreased respiratory function, asthma, silicosis, asbestosis, and perhaps lung cancer. They are due both to the particulate nature of the suspended material and to its chemical composition. In addition, suspended particulate material impairs visibility and causes soiling.

The TSP ambient air quality standards established by the EPA in 1971 placed limits on the total mass of suspended material in the environment. However, more recent information suggests that the health effects are caused primarily by the smaller particles in the aerosol (16). The TSP standard is thus currently being revised to limit the mass of particles in the smaller size fractions as well as the total mass.

Emissions of specific components such as mercury, beryllium, and asbestos are regulated under national emission standards for hazardous pollutants. An ambient air quality standard for lead was promulgated in 1978 and standards may be forthcoming for other components of TSP as well.

Fluoride

Significant ambient concentrations of fluoride can alter bone metabolism in humans and animals. Exposures to moderate concentrations may cause bone deformation and kidney damage in humans. Prolonged exposure to low levels caused mottling of tooth enamel. Dairy cows are especially sensitive to the effects of fluoride because of their rapid rate of calcium metabolism. Even trace amounts in forage caused disabling bone and hoof disorders in dairy herds (17). Certain plants, including fruit trees and ornamentals, are injured by exposure to levels of atmospheric fluoride which are readily tolerated by animals.

The State of Maryland (18) has established ambient air quality standards for fluoride that limit the concentration in the ambient air to that which results in fluoride concentrations of 20 ppm in unwashed vegetable crops, 35 ppm in field crops, and 50 ppm in fruit tree leaves. (For applicable concentrations in other crops see COMAR, 1978, 10.18.04-01). In areas where vegetative sampling is not feasible, ambient air sampling may be required. The applicable standard is then 1.2 $\mu g/m^3$ of Fluor (as gaseous fluoride) (24-hour average) and 0.4 $\mu g/m^3$ of Fluor (72-hour average). If lime papers are used to monitor fluoride, the allowable catch is 2 μg Fluor per 100 cm^2 of paper.

Carbon Monoxide

Carbon monoxide interfers with the transport of oxygen from the lungs to body tissues. Symptons of carbon monoxide poisoning include headaches, impaired vision, and loss of coordination. These effects are accentuated at high altitudes (5,000 ft). Persons having heart or respiratory diseases are at increased risk. The severity of symptoms is related to both the concentration of carbon monoxide in the ambient air and the duration of the exposure.

In a healthy person engaged in normal activities, exposures to 20 $\mu g/m^3$ of carbon monoxide (twice the primary standard) for 8 hours produce no adverse effects. Eight-hour exposures to levels between 34 and 40 $\mu g/m^3$ (or 3.4 to 4 times the primary standard) may result in headaches, while levels between 40 and 100 $\mu g/m^3$ (or 4 to 10 times the primary standard) may impair visual perception, manual dexterity, or coordination (19). During strenuous activity, carbon monoxide is taken up more rapidly. The EPA recently (18 August 1980) proposed revising the 1-hour standard downward (to 25 ppm) to more adequately protect persons engaged in strenuous activity (51).

Sulfur Dioxide

Sulfur dioxide is a mild respiratory irritant which may produce bronchial asthma in susceptible persons (20). Continued and repeated exposure has been linked to the development of emphysema, bronchitis, and other chronic lung problems. However, some of the respiratory effects previously thought to result from SO_2 exposure appear to be due, instead, to sulfuric acid mist (see below). There is also some evidence of synergism between the effects of SO_2 and TSP, but this mechanism is not yet understood. High levels of sulfur dioxide produce leaf damage in susceptible plants; destruction of vegetative cover has occurred near some major SO_2 sources.

Mandated review of the SO_2 ambient standards is in progress. A draft criteria document has been circulated summarizing the results of recent studies on SO_2 toxicity. New ambient standards have not yet been proposed, however.

Under conditions of high humidity, or in the presence of ozone or suspended particulate material contaning vanadium or other transition metals, sulfur dioxide is rapidly oxidized to form sulfuric acid mists and sulfate aerosols (see below). These are strong respiratory irritants. Monkeys exposed to moderate concentrations develop distinctive changes in lung tissue similar to those seen in obstructive lung diseases in humans (21). Sulfuric acid mists also cause damage to limestone and plants.

Sulfates

Sulfates are formed from sulfur oxides and sulfuric acid mist in the presence of other reactants such as fine particulates, nitrogen dioxide, hydrocarbons, ammonia, catalytic metals, and photochemical reaction products. Sulfate aerosols are transported long distances and may produce significant deteroration of visibility in rural areas. The presence of sulfuric acid and sulfates in the atmosphere is one major cause of the increased acidity of rain and snow found particularly in the northeastern part of the United States. Sulfates account for about 60 percent of the total non-carbonate acidity in precipitation while nitrates account for about 30 percent; the remaining 10 percent is caused by chlorides, ammonia, and other acids (22).

The use of tall stacks decreases local SO_2-sulfate pollution levels because of dispersion, but the pollutants will be carried far from their sources. This long-range transport, along with the complex precursor relationships between sulfur dioxide and sulfates, explains why a general decrease in SO_2 levels is not necessarily reflected in a similar trend for sulfates, as illustrated in Fig. III-11.

Although there is mounting evidence of health hazards associated with inhalation of sulfates, no standards for ground-level concentrations have been established. Regulation of atmospheric sulfates has been under consideration by EPA, but advances in monitoring and analytical techniques, as well as improved assessment of health hazards, are required before standards can be set (23).

Photochemical Air Pollution: Hydrocarbons, Ozone, Nitrogen Oxides, PAN

Nitrogen oxides and hydrocarbons react in sunlight to form a variety of oxidation products including ozone, peroxyacetyl nitrate (PAN), aldehydes, and particulate material (haze). The resulting mixture causes eye and lung irritation and increased susceptibility to infections. Exposures to oxidant levels commonly found in urban areas during stagnation conditions may lead to decreased lung function and asthematic attacks in susceptible individuals.

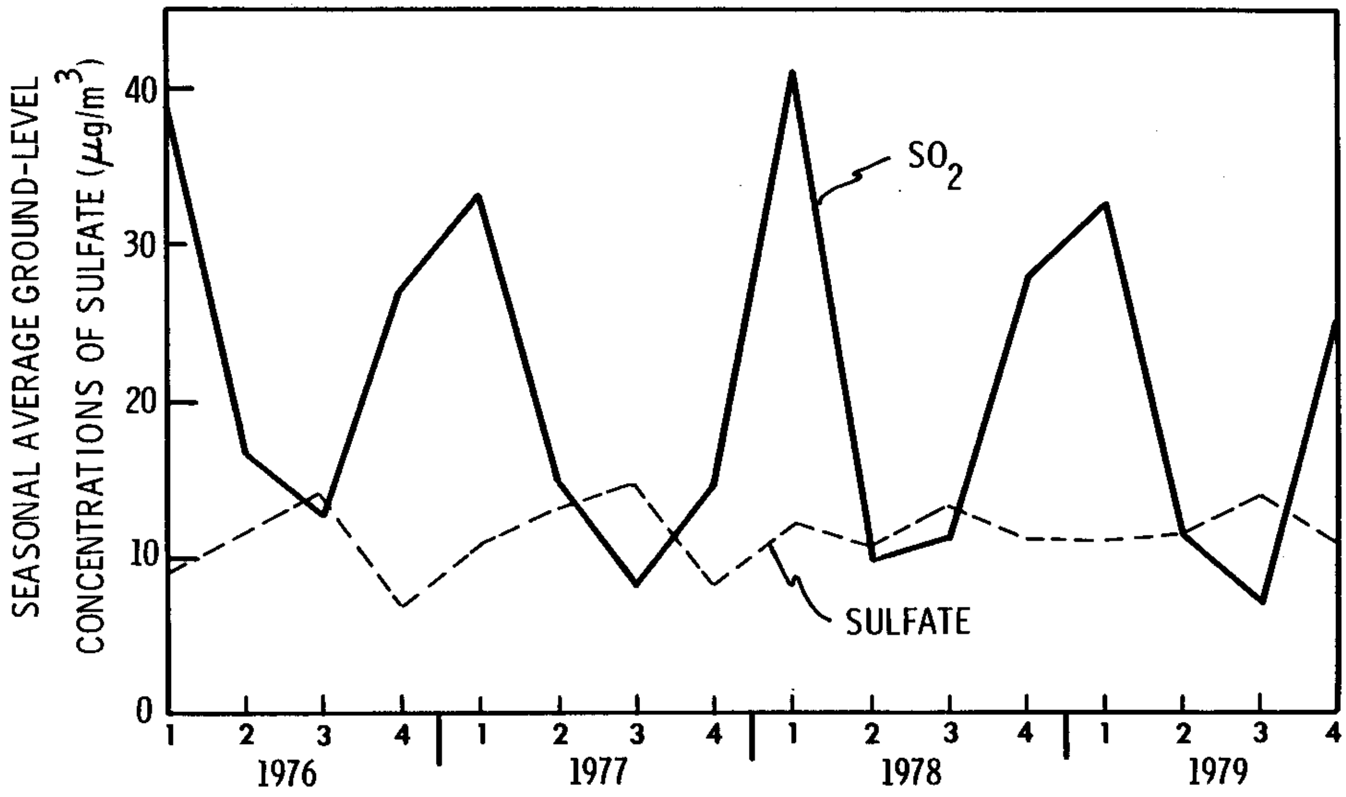


Figure III-11. Composite quarterly means of sulfate and SO_2 ground-level concentrations for all stations using the flame photometric method. Graph is for readers' information only -- many stations have less than 75% of the prescribed number of readings. (Graph based on data from Ref. 2).

The ozone component of smog produces rapid degradation of rubber and nylon and increases the rate of SO_2 oxidation in power plant plumes to form sulfuric acid mist. Both PAN and ozone damage commercial crops at concentrations below the current ambient air standard.

Many, if not most, areas of the eastern United States have ozone (oxidant) concentrations greater than the original standard of 80 ppb (oxidant). The sources of these exceedances have not been determined, but are believed to be natural or regional in many cases. The standard has recently been revised to allow 1-hour average concentrations up to 120 ppb (ozone). This change has greatly reduced the number and extent of rural nonattainment areas.

The ususal concentrations of hydrocarbons in ambient air have no adverse effects on health. However, prolonged exposure to levels of nitrogen oxides somewhat above the existing standard may lead to chronic obstructive lung disease.

Other Pollutants

A number of other compounds found in trace amounts in ambient air are known to have various adverse health effects. Emissions of some of these (e.g., beryllium, mercury, and asbestos) have been limited under the National Emissions Standards for Hazardous Pollutants (24). However, until more is known about the complex precursor relationship between emitted pollutants and the pollutants which ultimately cause health hazards, the EPA feels a sound and meaningful general strategy is to control ground-level concentrations only for the six major "criteria" pollutants: particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, hydrocarbons, and lead.

E. Status and Trends of Maryland Air Quality

All areas of Maryland are currently in compliance with the National Ambient Air Quality Standards, with the folowing exceptions: the Baltimore Metropolitan area is nonattainment for total suspended particulates, as shown in Fig. III-12. A previous TSP nonattainment area, Election District 8 in Luke, Maryland, is now unclassified. Portions of the cities of Hagerstown, Cumberland, and Baltimore and areas of high traffic density near Washington, D.C., are designated nonattainment for carbon monoxide. A proposal to change these CO areas to unclassifiable is presently under consideration. The Baltimore Metropolitan area (Air Quality Control Region III), shown in Fig. III-10, is nonattainment for ozone, as is Washington County and the Maryland portion of the metropolitan Washington, D.C., area. Previous ozone nonattainment areas in Garrett and Alleghany counties are now unclassified or have ambient levels below national standard (25, 26).

Trends in ambient air quality can be determined from analyses of ground-level concentrations measured at air quality monitoring stations. The national air quality trends are based on data from EPA's National Aerometric Data Bank (NADB). These data are gathered primarily through the monitoring activities of state and local air pollution control agencies (27).

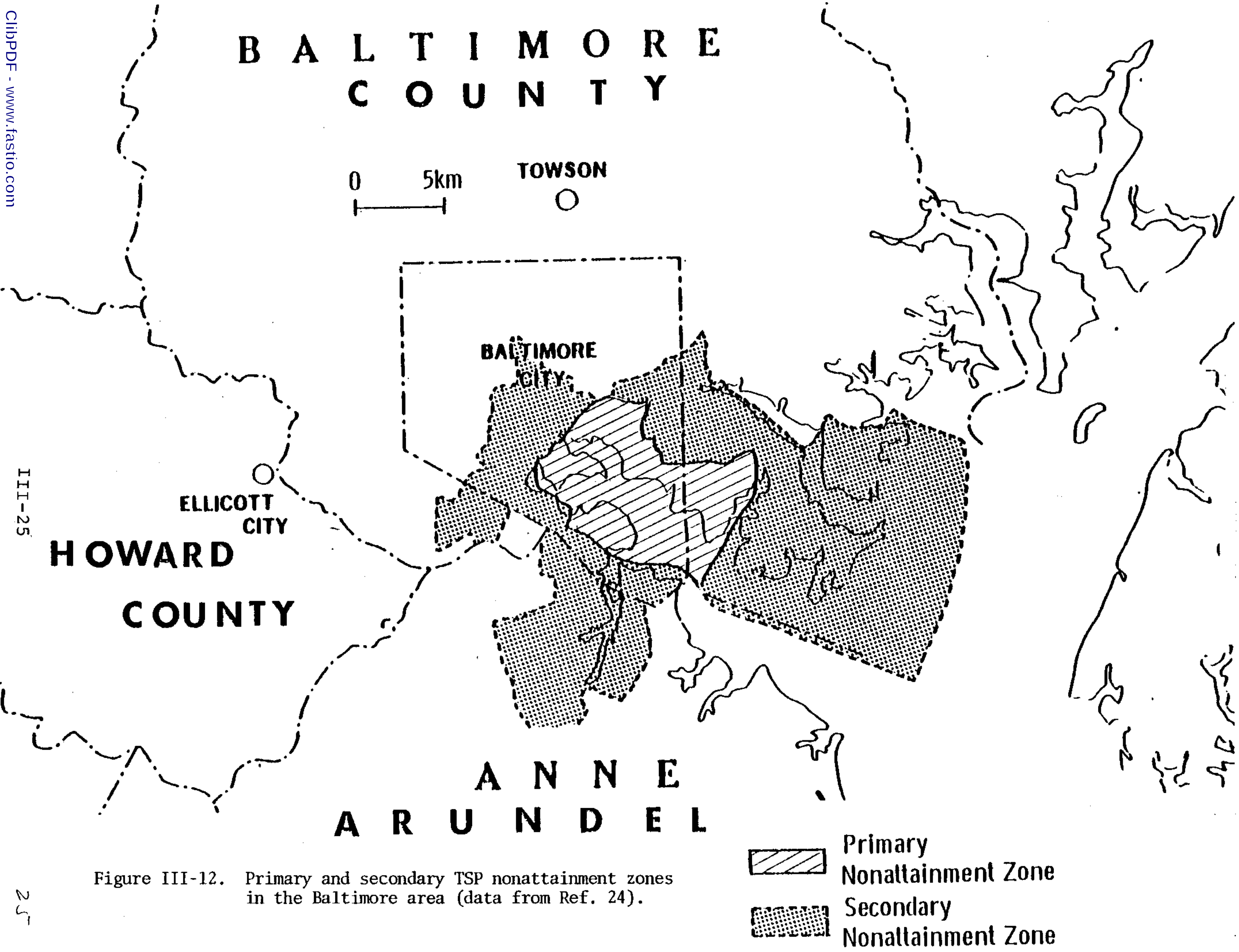


Figure III-12. Primary and secondary TSP nonattainment zones in the Baltimore area (data from Ref. 24).

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Maryland data are reported by the Air Quality Program of the Department of Health and Mental Hygiene, which has stations throughout the State, mainly in the urban areas (2). Because stations are not distributed uniformly, the ground-level concentrations reported may not be representative of the overall status of air quality; but the trends, or changes, at these stations do indicate the statewide trends. Also, since many stations have been moved and the measurement methods have changed over the years, it is sometimes difficult to select stations with sufficient continuous data records to establish long-term trends. Therefore, in some cases, annual data may not be directly comparable.

Total Suspended Particulates

There has been a downward trend in TSP ground-level concentrations in Maryland over the past 10 years. Among 21 stations from which data were continuously available for the period, the number of sites showing a violation of the primary annual standard (75 $\mu g/m^3$) decreased from 9 in 1971 to 1 in 1979. The composite average for these stations was 78 $\mu g/m^3$ in 1971 and 49 $\mu g/m^3$ in 1979 (see Fig. III-13). The mean annual average value for all stations in Maryland decreased from 75 $\mu g/m^3$ in 1971 to 50 $\mu g/m^3$ in 1979 (see Fig. III-14).

A State Implementation Plan (SIP) has been prepared to bring the Baltimore Metropolitan nonattainment region into attainment with the primary NAAQS during 1982 and with the secondary standard by 1986. The SIP addresses the major causes of high values, which seem to be fugitive emissions from roads and industrial installations. The impact of the existing oil-fired power plants in this region appears minimal.

However, there are several power plants in attainment areas that are not in compliance with emission limitations. For example, Chalk Point Units 1 and 2 will be subject to a delayed compliance order (under a recently submitted SIP revision) calling for final compliance by January 1, 1983 (28).[1] Recent testimony indicates that the fugitive emission inventories used in preparing the SIP may have been greatly underestimated. SIP revisions are in preparation calling for additional emission reductions based on a corrected inventory. The need for stricter emission controls and a longer compliance period than originally proposed has become an issue in the pending coal conversions at Crane and Brandon Shores (29, 30).

Sulfur Dioxide (SO_2)

The entire State of Maryland is in compliance with the NAAQS for sulfur dioxide (25). Measurements of ambient sulfur dioxide levels made by the Maryland Department of Health and Mental Hygiene show a consistent downward trend in average SO_2 ground-level concentrations since 1974 (see Fig. III-15).

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[1] Wagner Unit 3 also was not in compliance as of January 1, 1982, but management has been granted 90 days to achieve compliance (28). Note that, Wagner and Chalk Point do not produce ambient TSP concentrations in excess of NAAQS at nearby air quality monitors.

Figure III-16 shows the seasonal trend in SO_2 ground-level concentration (measured by the flame photometric method). Higher levels in the heating months (first and fourth quarters) indicate that much of the SO_2 comes from local sources, primarily space heating using sulfur-containing fossil fuel. The SO_2 emissions from power plants may be expected to run counter to this seasonal variation since electrical demand and power plant generation rates in Maryland are traditionally highest in the summer months.

Nitrogen Oxides (NO_x)

The entire State of maryland is in compliance with NAAQS for nitrogen oxides (25). Figure III-17 shows that the annual average ground-level concentration of NO_2 has remained relatively constant in Maryland from 1974 to 1979 (2).

Photochemical Oxidants and Hydrocarbons

All of Maryland is in attainment for ozone, except for sections of Baltimore City, Washington County, and the Washington, DC area. Previous nonattainment areas in Garrett and Allegany counties are now unclassified or have ambient levels lower than national standards (25, 26).

F. Pollution Control

Ambient air quality can be improved by reducing emissions of pollutants from power plants (via emission control, conservation, cleaner fuel, or alternative power sources such as solar or nuclear) or by enhancing dispersion. The need for emission control can be assessed by comparing uncontrolled emission factors to allowable emissions under new Source Performance Standards. Table III-6 relates NSPS to the emissions resulting from burning coal, oil, or gas without any emission control. The NO_2 standard set by NSPS can be met by controlling the combustion process in the power plant boiler.

Table III-6 shows that natural gas is the only fuel with particulate emissions low enough to meet NSPS without additional particulate emission controls. Plants burning coal with an ash content of 15 percent would need precipitators with an efficiency of about 99.7 percent. Although modern precipitator technology now permits efficiencies exceeding 99 percent (31), actual performance is often critically dependent on fly ash composition, sulfur content, and equipment maintenance, and must be carefully monitored.

Particulate emissions also result from coal delivery, storage, conveying, and sizing for optimum combustion, and from transfer of fly ash and bottom ash from control devices and boilers. Such emissions are termed "fugitive" (i.e., they do not emanate from a stack or vent).

Power plants located in the Baltimore and Washington, D.C., metropolitan areas are required to apply reasonable available control measures to abate fugitive emissions. Such measures might include unloading coal cars in an enclosure equipped with water sprays, enclosing conveyors, and equipping

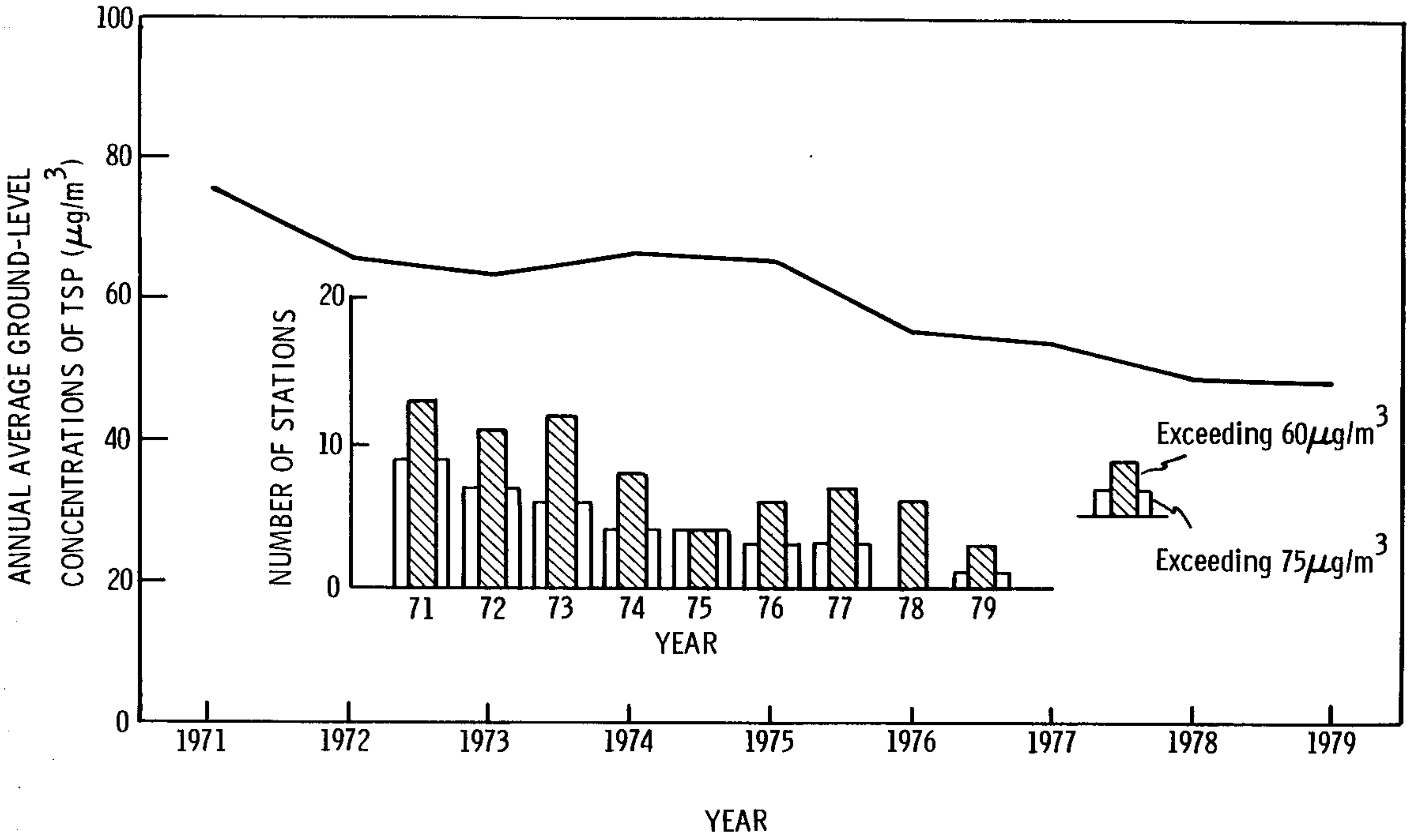

Figure III-13. Composite means of annual average TSP ground-level concentration at 21 stations throughout Maryland which have a continuous record since 1971. Violations of primary and secondary TSP NAAQS for the same 21 stations. Based on Ref. 2.

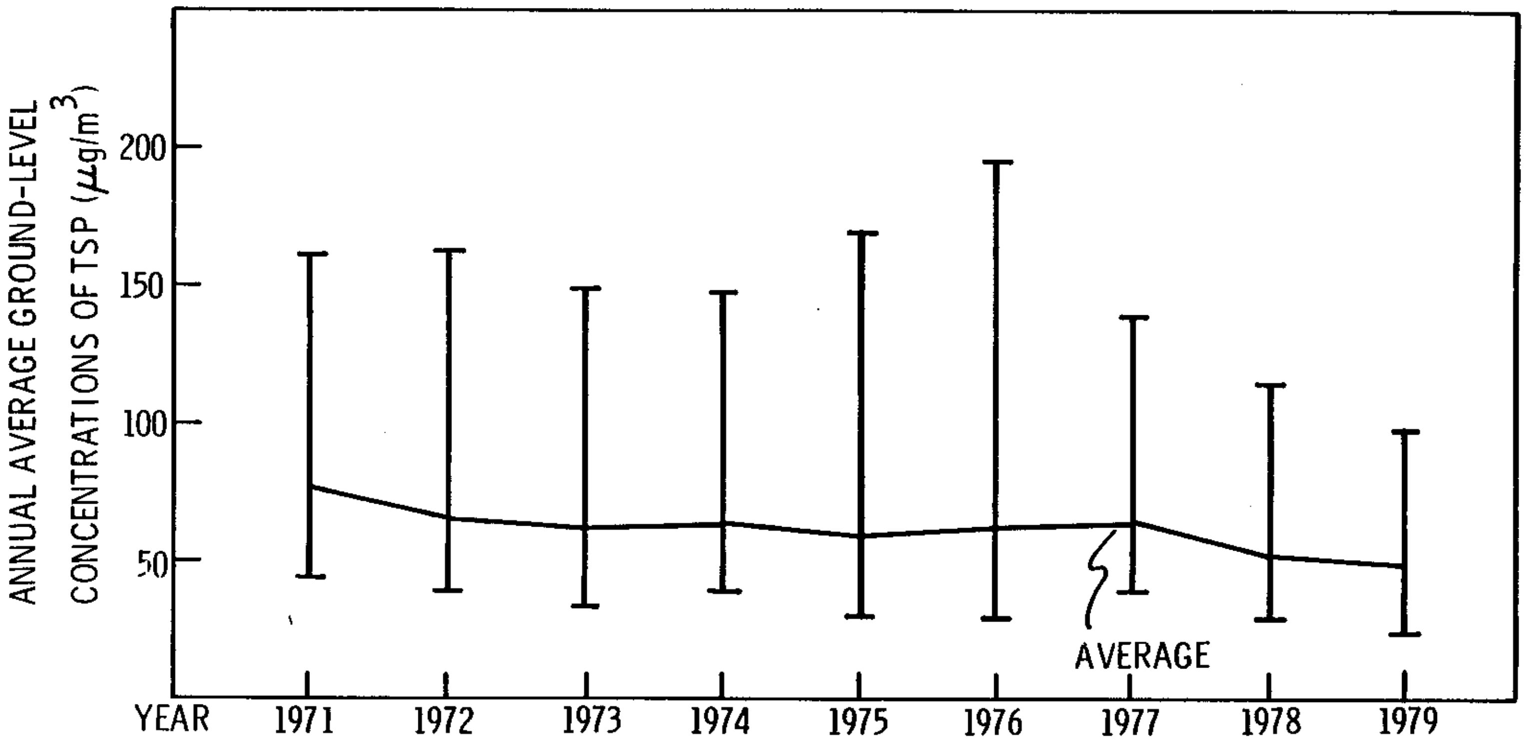

Figure III-14. Composite mean of the annual average TSP ground-level concentration for all Maryland stations with adequate data (at least 75% of the prescribed number of readings). The bars indicate the range of values. Based on Ref. 2.

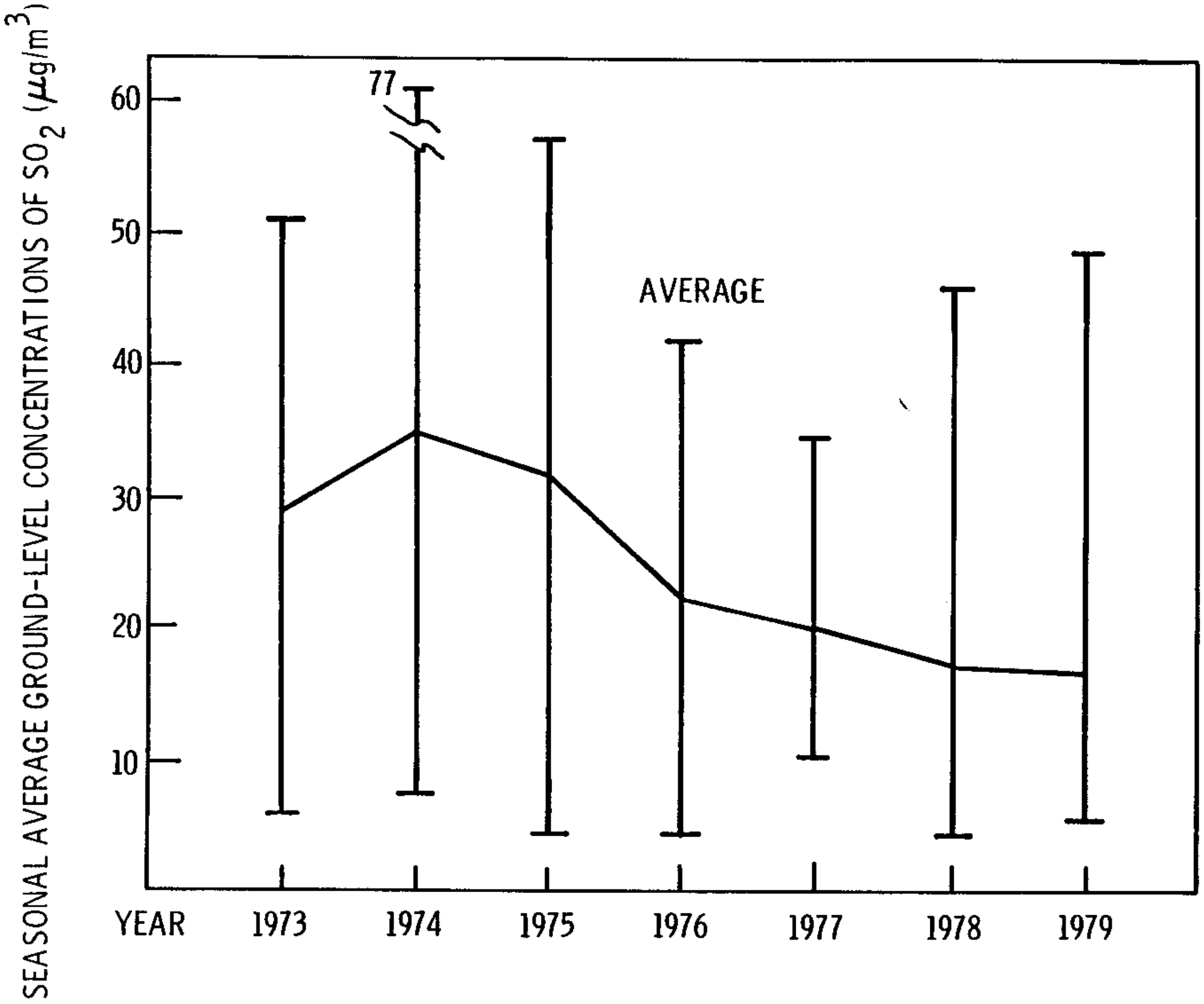

Figure III-15. Composite mean of annual SO_2 ground-level concentrations average for those Maryland stations with data for the entire year. For informational purposes only; many stations have less than 75% of the prescribed number of readings. Measurements are by the flame photometric method. Range of values is indicated by the bars. Based on Ref. 2.

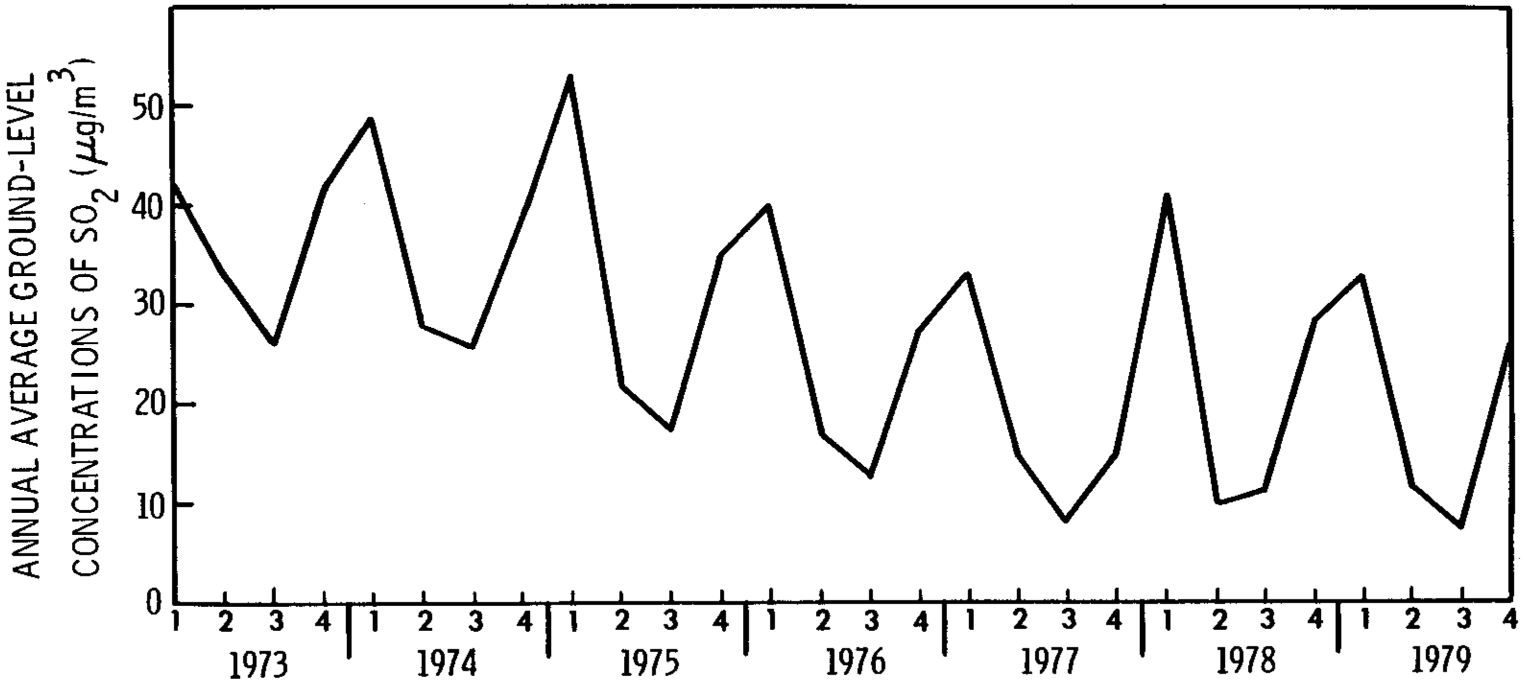

Figure III-16. Seasonal trend in SO_2 ground-level concentrations, average for all Maryland stations (flame photometric method). For informational purposes only; many stations have less than 75% of the prescribed number of readings. Based on Ref. 2.

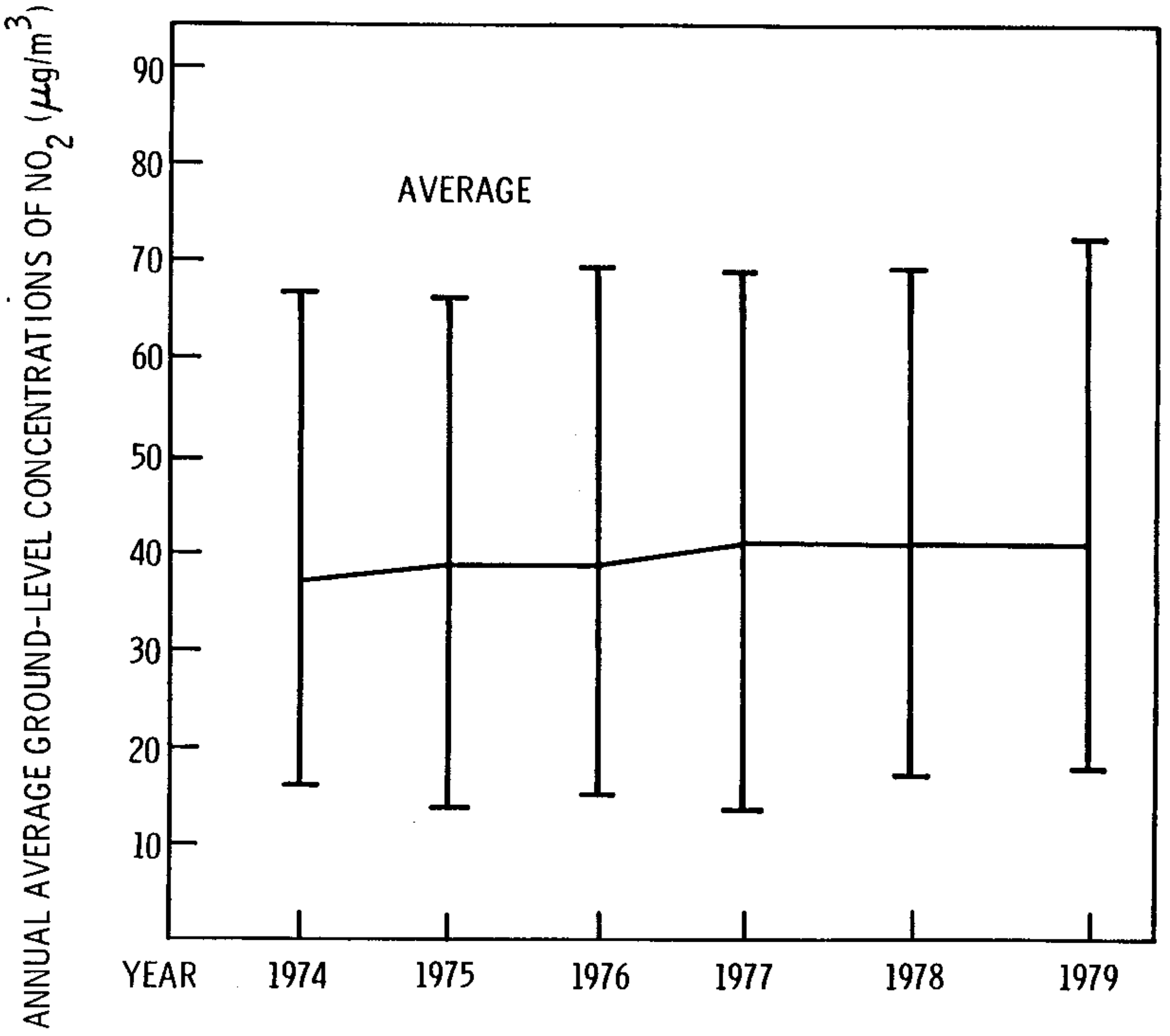

Figure III-17. Composite mean of annual average NO$_2$ ground-level concentrations (measured by 24-hr gas bubbler) for all Maryland stations with adequate data (at least 75% of the readings). Range of values is indicated by bar. Based on Ref. 2.

Table III-6. Comparison of New Source Performance Standards (NSPS) and Emission Factors for Combustion in Utility Boilers

POLLUTANT	PARTICULATE MATTER			SULFUR DIOXIDE			NITROGEN DIOXIDE		
FOSSIL FUEL AND FURNACE TYPE	STANDARD (lb/10^6 Btu) Old	New	EMISSION[(a)] FACTOR	STANDARD (lb/10^6 Btu) Old	New[(b)]	EMISSION[(a)] FACTOR	STANDARD (lb/10^6 Btu) Old	New	EMISSION[(a)] FACTOR
Pulverized Coal	0.10	0.03		1.2	1.2		0.70	0.60[(c)] (0.50)	
General			0.67A			1.58S			0.75
Wet bottom			0.54A						1.25
Dry bottom			0.71A						0.75
Cyclone			0.08A						2.29
Fuel Oil	0.10	0.03		0.80	0.80		0.30	0.30	
Tangentially fired			0.055			1.08S			0.34
Other									0.72
Natural Gas	0.10	0.03		No std.	0.80		0.20	0.20	
Tangentially fired			0.014			0.00055			0.27
Other									0.64

Note: The old standards did not apply to lignite.

(a) A is ash content of coal in percent by weight. S is sulfur content in percent by weight. Emission factors have been converted from weight and volume units to Btu's using the following conversion, which approximates conditions prevailing in Maryland:

Coal: 12,000 Btu/lb = 24 x 10^6 Btu/ton
Oil : 145,000 Btu/gal = 145 x 10^6 Btu/thousand gals
Gas : 1,100 Btu/ft^3 = 1,100 x 10^6 Btu/million ft^3

Emission factors are only approximate guidelines and may be conservative (high). The emission factor of 1.58S for sulfur dioxide assumes that 95 percent (by weight) of the sulfur in the coal is released as sulfur dioxide (3).

(b) The new NSPS also require a 90 percent reduction (presumably by scrubbing) of the uncontrolled SO_2 emissions from solid, liquid, and gaseous fuels. An 85% reduction is required when solvent refined coal is used. For sources emitting less than 0.6 lb SO_2 per million Btu, the percent reduction required is 70%. No reduction is required when the facility uses liquid or gaseous fuel and emits less than 0.2 lb SO_2 per million Btu.

(c) The new NO_x coal standard of 0.60 applies to bituminous coal, and 0.50 applies to subbituminous coal, shale oil, or any solid, liquid, or gaseous fuel derived from coal.

transfer points with water sprays; equipping screens and crushers with water sprays, at the inlet and outlet, periodically applying a crusting agent to inactive storage piles; handling fly ash in enclosed systems; and storing fly ash in fabric-filtered bins prior to disposal.

Under the provisions of Prevention of Significant Deterioration (PSD) regulations, new power plants are required to apply Best Available Control Technology for stack and fugitive emissions. For these plants, the previously discussed control measures would be the minimum required, no matter where the plant is located in Maryland.

The old (1971) NSPS could be met through use of clean (or cleaned) fuels. For example, control of SO_2 emissions was not needed for gas. Oil could meet the old and new emission standards, provided that the sulfur content was about 0.8 percent or lower. Attainment of this sulfur level presents no technical problem, although there may be a related economic penalty (see Table III-7). SO_2 emission control for coal-burning power plants could potentially be achieved by:

- Use of coal of inherently low sulfur content (less than 0.8 percent)

- Conversion of coal to cleaner fuels

- Use of advanced combustion systems (fluidized-bed combustion).

Extensive research programs funded by private and public interests are underway in these areas. The requirement of the new (1978) NSPS that almost all power plant effluents must be scrubbed to reduce SO_2 may remove much of the economic incentive for development of these technologies, although some credit will be given for precleaning fuel. The advanced technologies will probably be commerically available for power plant operations in the late 80's (32). Many of these technologies are not complicated for small-scale uses but are difficult to transfer to the large scale of a power plant. See the 1978 CEIR (14) for a review of these programs.

G. Mathematical Modeling

Mathematical modeling is becoming increasingly important for predicting air quality impacts caused by present and future sources. Section 320 of the 1977 Amendments to the Clean Air Act (33) recognizes modeling as a necessary tool, especially for predicting the extent of increment consumption by proposed sources and modifications subject to PSD.

The most widely favored dispersion models are based on the concept of the Gaussian plume. These models assume that the pollutants are dispersed by the wind such that the average concentrations across the plume (i.e., perpendicular to the mean wind direction) are distributed as the bell-shaped normal (or Gaussian) curve. Both vertical and horizontal dispersion are assumed to have this form although their widths generally are different. The plume centerline will rise to a height determined by the buoyancy of the effluent gasses.

The Gaussian formulation is attractive because it is simple -- the basic equations can be evaluated with a hand calculator. It is also applicable to a wide variety of physical conditions. The ground-level concentration (GLC)

Table III-7. Fuel Costs for Maryland Utilities (1980 Prices, in Dollars).

Utility Steam Coal

Percentage Sulfur	Costs		Differential	
	Cost per ton	Cost per 10^6 Btu	Per ton	Per 10^6 Btu
0.5 - 1.0	44.31	1.73	Base	
1.5 - 2.0	37.22	1.57	7.09	0.16
2.0 - 3.0	37.98	1.55	6.33	0.18
> 3.0	19.66	0.90	24.65	0.83

Residual Oil

Percentage Sulfur	Costs		Differential	
	Cost per Barrel	Cost per 10^6 Btu	Per Barrel	Per 10^6 Btu
0.5 - 1.0	27.32	4.38	Base	
1.0 - 2.0	25.18	4.03	2.14	0.35
2.0 - 3.0	22.54	3.62	4.78	0.76

Data based on Reference 52.

for a variety of pollutants may be projected for a number of wind conditions and atmospheric stabilities and averaged over sets of meteorological conditions. Various additional computations can and have been built into specific models to simulate the effects of momentum-dominated plume rise, chemical reactions and ground deposition (which are especially important in long-range plume transport), building interference, impact of terrain features, etc. Because the selection of such options may drastically change the projected GLCs, the EPA has recently issued guidelines designed to improve the uniformity of model applications. Some of the models that have recently been accepted as "guideline" models are CRSTER (a single point-source model for use in rolling terrain), RAM (a multiple-point and-area source model used in urban areas), and ISC (an industrial source complex model containing provisions for modeling multiple-point, -volume, and -area sources).

Because the results from these models determine regulatory requirements for many projects, it is important that these projections be accurate. Underestimates of GLCs may lead to inadequate protection of public health and welfare, while overestimates of GLCs will result in installation of unnecessarily expensive emission control equipment. Because of the assumptions of Gaussian distribution, the empirical nature of the coefficients used, and the vagaries of real atmospheres, these models frequently project GLCs that disagree with measured values by more than a factor of two (34).

Research is therefore continuing at a variety of public and private installations to improve these models and develop additional types that may provide more reliable projections than the conventional Gaussian formulation. These new models emphasize better characterization of the ambient flow fields, both mean and turbulent, into which pollutants are emitted, although the models often still rely on a Gaussian distribution within the plume. Also, in recent years, the question of fugitive dusts has become a major air quality consideration. No model have been validated (proved acceptable) for estimating impacts of fugitive dusts at nearby downwind receptors. Hence, considerable work is being done to develop models that can be used to estimate emissions and dispersion of fugitive dusts from material storage piles under a variety of wind conditions.

Current models are also deficient in accurately describing plume transport and dispersion in complex terrain. In recent studies, the flow field about the terrain has been modeled with simple potential flow methods for neutral stability (35) or similarly simple approaches (35, 36) for stable conditions and certain types of terrain. The flow fields are used to locate the plume centerline within the flow while the pollutant distribution about the centerline is still assumed to be Gaussian. Summaries of ongoing large-scale field programs pertaining to complex terrain problems can be found in References (37) and (38).

Work is also continuing on modeling the effects of enhanced turbulence in building wakes on plume diffusion within such wakes. Although the Gaussian formulation is used, the height of the plume centerline is sometimes decreased, and the dispersion parameters are increased by an amount depending on building size, geometry, and downwind distance. These modifications depend strongly on the results of wind-tunnel simulations, and field confirmation is still needed. A recent review of these approaches is given in Reference (39).

An example of improved modeling of flow fields where the Gaussian formulation is not retained, is the calculation of pollutant dispersion during convectively unstable conditions within a region of limited vertical extent (the mixing depth). It is under these meteorological conditions that tall stacks in flat terrain usually produce their highest ground-level concentrations. Recent laboratory experiments (40) and numerical simulations (41) of pollutant dispersion in convective conditions show that the vertical distribution of pollutants is not Gaussian. This deviation is attributed to the characteristics of the thermal velocity field -- updrafts and downdrafts -- which distribute the pllutants. The findings from these detailed research studies (40. 41) have led to simpler models for stack plume dispersion during convective conditions (42, 43).

H. Regulatory Effects

The Clean Air Act Amendments of 1977 are of major importance in the regulation of air quality in two crticial areas: 1) they specify acceptable approaches in controlling atmospheric emissions from industry; and 2) they give specific legislative direction to "prevention of significant deterioration", one of the most controversial concepts of air pollution control.

Some of the most signinificant provisions related to power plant siting and operations are discussed below. The Clean Air Act is scheduled for congressional review during 1982. Some of the provisions described here may be changed at that time.

Stack Height and Intermittent Control

In response to the Clean Air Act Amendments of 1977, which called for reductions in pollutants, some electric utilities sought simply to decrease the GLC of the pollutant in the air shed rather than reduce the actual amounts limited. Three methods were proposed: 1) the use of very tall stacks, 2) switching of fuel, and 3) switching of load between plants. The EPA argued against the acceptability of these methods because they did not diminish emissions. Although better air quality, as defined by GLC, was atained by spreading the pollutants, the improvement was an artifact.

The new Act essentially eliminated the use of these dispersion methods by denying credit for pollution abatement attributed to them. This approach was recently upheld in the case of Dow vs EPA in the U.S. Court of Appeals for the 6th Circuit. In particular, credit is denied for stack height exceeding "good engineering practices", which is "the height necessary to insure that emissions from the stack do not result in excessive concentrations of any air pollutant in the immediate vicinity of the source as a result of atmospheric downwash eddies and wakes which may be created by the source itself, nearby structures or nearby terrain obstacles" (33). Proposed EPA regulations pertaining to tall stacks (44) set the height for good engineering practice (GEP) as the height of the structure plus 1.5 times the lesser of the height or width of the structure. "Nearby" (Section 123) is taken to be a distance up to five times the height or width of the structure, but not more than 0.5 miles (0.8 km) away unless a greater height is necessary to avoid the excessive concentrations referred to above. Typically, the GEP stack height of a power plant is 500 to 600 feet.

Nonattainment Areas

When air quality in a region does not meet National Ambient Air Quality Standards, the area becomes "nonattainment", and no further increase in total pollutant emissions from major sources in the area is allowed. To permit new industries to locate in such regions, the EPA has promulgated a policy of "emission offsets" (38). The policy states that a new power plant to be located in such a region must not only meet an emission limitation specified as the Lowest Achievable Emission Rate (LAER) for that source, but must also provide for sufficient reduction of emissions from its own or other sources in the area to offset the new emissions. The objective is to achieve "reasonable progress toward attainment of the applicable NAAQS." Any power plant outside the nonattainment region producing a "significant" degradation in the air quality of the nonattaniment region is also subject to an offset requirement.

Although the intent of this policy is to satisfy the competing needs of growth and maintenance of air quality, it engenders several significant consequences. First, it appears to give industries now emitting major amounts of pollutants the power to sell "pollution rights". That is, they could sell the right to clean up their output levels to the highest bidder. As a result, one company can be economically responsible for the operation and maintenance of another company's pollution controls. In fact, the new source, rather than the sources already located in the area, would be forced to bear the economic burden of controls both for its own plant and the offset plants. Thus, unless there are compelling economic considerations for locating in a particular region, plant owners will tend to choose sites where they will not be subject to an offset.

The State of Maryland is presently encouraging the development of an "offsets market" for the Baltimore nonattainment area. The first agreement of this nature was recently established between Maryland Slag, Bethlehem Steel, and Atlantic Cement Company. Under the agreement, Maryland Slag will sell emission offsets to Atlantic Cement so that Atlantic can process slag from Bethlehem Steel. Bethlehem will reduce emissions from open storage piles to provide additional required offsets. The air quality analysis that provided the basis for the trade-off was facilitated by the close proximity of the three companies.

Maryland presently has nonattainment areas for three pollutants: particulates (Baltimore area), carbon monoxide (Baltimore and Western Maryland), and photochemical oxidants (Baltimore, Washington D.C., and scattered areas elsewhere).

The Baltimore TSP nonattainment area is the one which affects power plants most. Recent analyses indicate that up to 70 percent of the total blowing dust there is due to fugitive emissions. The recently submitted Maryland SIP revisions (45) propose paving roads and covering storage piles in the nonattainment region to reduce blowing dust. In addition, power plants converting to coal contributing more than 5 $\mu g/m^3$ (24-hour) or 1 $\mu g/m^3$ (annual) in this region will be a subject to stringent fugitive emission controls and may be required to obtain emission offsets. These requirements will particularly affect the design of coal-handling facilities at plants undergoing coal conversion.

To estimate the implications of this policy for siting new power plants near such areas, a typical 1,000-MW coal-fired station was modeled. It was assumed that emissions were at the levels permitted by the New Source Performance Standards (Table III-5). The results indicated that, to avoid an offset, such a plant could be located no nearer than 10 to 15 miles from the border of a nonattainment area, depending upon the local meteorology.

Thus, the siting of future fossil-fueld power plants in Maryland will be influenced to a large extent by the existing TSP nonattainment areas.

Prevention of Significant Deterioration (PSD)

The most significant change within the Clean Air Act relates to PSD (46, 47). The law establishes upper limits on allowable air quality changes for SO_2 and particulates. It designates three classes of areas (I, II, and III) with differing restrictions on increases in pollution levels.

The Class I area designation is reserved for regions where it is desirable to maintain the present air quality. Automatically classified within this category are international parks, national wilderness and memorial parks over 5,000 acres, and national parks over 6,000 acres. Other areas may be added to this list by the State, in some cases at the suggestion of the Federal Land Manager. Maryland has no Class I areas at this time, although there are several such areas in nearbly Virginia and West Virginia (see Fig. III-18).

Class II areas are assigned allowable increments that permit moderate industrial growth. All areas of the country not originally classified as Class I start out in this category.

Class III areas are less restricted and may allow fuller industrial development. A Class II area may be redesignated Class III only after a process involving the Governor, the legislature, and "general purpose units of local governments." The actual procedure is not determined at this time.

The allowed increase (increments) for each area and the comparable standards are shown in Table III-2. The total increments used by all emitters must stay within the specified limits.

According to the Clean Air Act Amendments of 1977, Sec. 163 (a):

> "In the case of sulfur oxides and particulates, each applicable implementation plan shall contain measures assuring that maximum allowable increases over baseline concentrations of, and maximum allowable concentrations, such pollutants shall not be exceeded. In the case of any maximum allowable increase (except an allowable increase specified under 165 (d) (2) (C) (iv) for a pollutant based on concentrations permitted under national ambient air

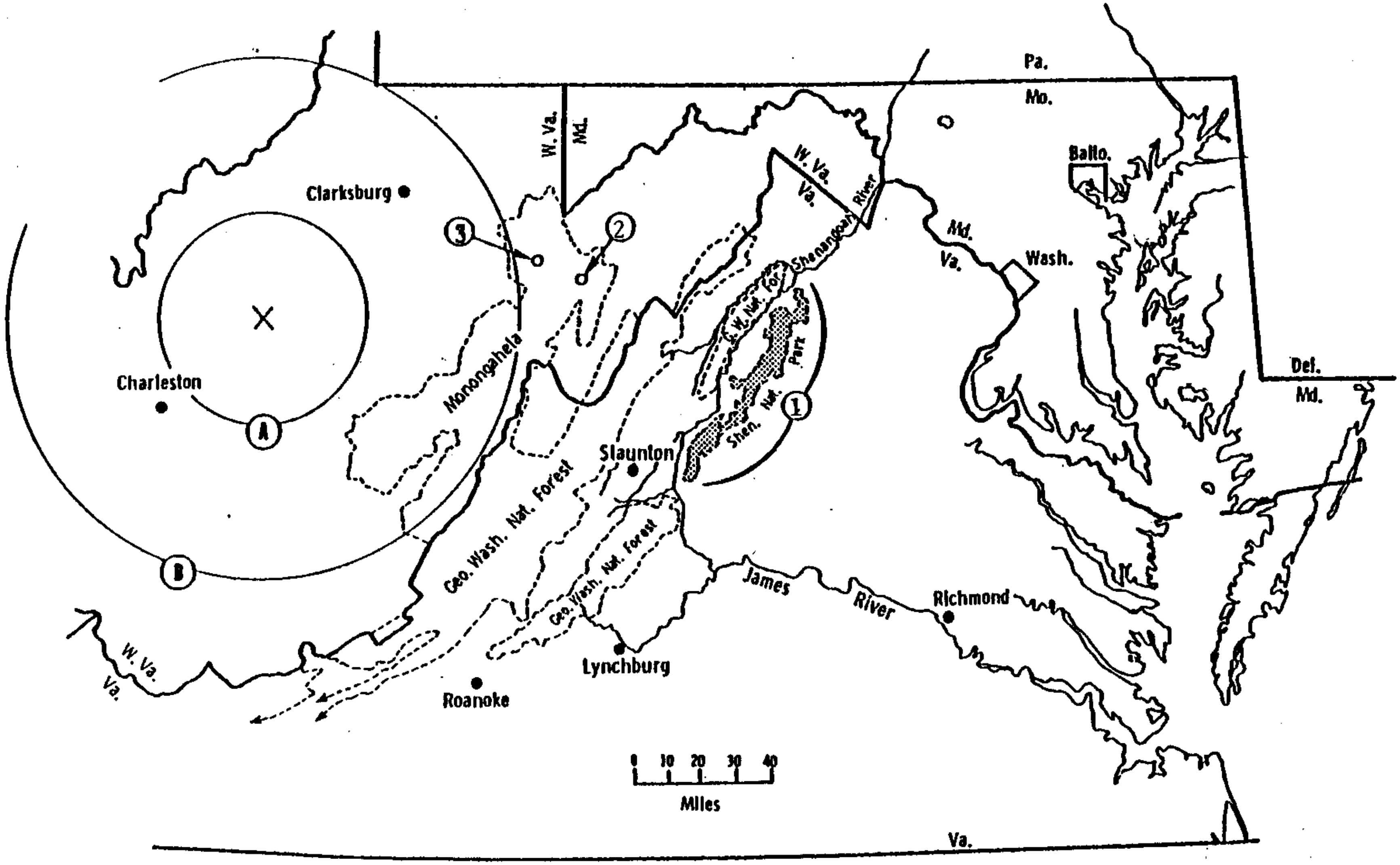

Figure III-18. Mandatory Class I areas around Maryland. There are no mandatory areas in Pennsylvania.

1) Shenandoah National Park
2) Dolly Sods
3) Otter Creek

Circle A shows the Class I exclusion area for a hypothetical 1000-MW power plant located at X burning 1% sulfur coal with an 80%-efficient scrubber; circle B shows the exclusion area for the same plant burning 2% sulfur coal.

> quality standards for any period other than an annual period, such regulations shall permit such maximum allowable increase to be exceeded during one such period per year."

This section clearly indicates that the total GLC (from all sources) should be considered in a before-and-after analysis. Certainly, if no changes have been made in the sources before and after, no PSD increment should be consumed. Therefore, to conduct such an analysis, the same meterological data must be used for both "before" and "after".

The annual average PSD increment can be calculated for each receptor point by calculating the annual averages due to only the changes (plus and minus) in emissions at the sources. This simple procedure can be used for calculating the annual PSD increment consumption because source contributions to the annual average GLCs are additive. The maximum annual PSD increment consumed is then the greatest of the calculated increments for the set of receptors. This maximum is usually less than the sum of the maxima (at the respective maximum locations) for individual source alternations.

The 24-hr. PSD increment consumption is more difficult to model. The PSD increment consumed at each receptor is obtained by calculating the highest (or second-highest) 24-hr. GLC due to all sources after the change and subtracting from these values the highest (or second-highest) modeled "baseline" 24-hr. GLC at that receptor. The maximum 24-hr. PSD increment consumed is then the greatest of the calculated increments for any receptors in the set. Because GLCs depend strongly on wind speed and direction, the 24-hr. PSD increments consumed at any receptor can be less than the total PSD increments consumed due to a number of changes at the various individual sources, even when measured at the same receptor.

To aid the U.S. in becoming less dependent on foreign oil, EPA has allowed a temporary suspension of PSD provisions for power plants that may be ordered to revert to coal under provisions of the Energy Supply and Environmental Coordination Act of 1974. These reversions are exempt from the requirements of NSPS and not subject to PSD review. However, where allowable PSD increments are exceeded due to coal burning the State will be required after 5 years to obtain emission reductions at other installations sufficient to restore the increment to the allowable limit.

Since pollutants may travel across political boundaries, the question arises of what disposition to make in cases where long-range transport of pollutants from a large coal-fired plant in, for example, Ohio or West Virginia consumes part of the available PSD increment for neighboring states. By federal regulation, the maximum allowable consumption by an out-of-state utility is 50 percent of the remaining increment. However, this amount may not be acceptable to the affected state. It is not clear at this time what recourse a state so affected would have, especially if the additonal pollutants do not cause a violation of standards. The present amendments (Section 126) call only for "written notice to all nearby states. . . at least sixty days prior to the date on which commencement of construction is to be permitted."

PSD analysis requirements also include an estimation of SO_2 and TSP transport into distant Class I areas, and the results are relevant for siting decisions. This analysis is difficult since 1) the Gaussian plume model is not accurate at distances beyond 20-30 miles, 2) the meteorological data necessary for realistic calculations (vertical profiles of wind every 20-30 miles) are not available, and 3) the interaction of pollutant plumes from various sources is not well understood. Typical "exclusion distances" for a 1000-MW power plant operating at normal fuel consumption (2% S coal and 90% flue gas desulfurization) would be 30-70 km.

Coal Conversion

At one time, virtually all of the power plants in Maryland were coal-fired. Because of stringent pollution control requirements and lower cost, many of these plants were converted to oil in the late 1960′s or early 70′s. However, reconversion to coal is now being considered in response to the current oil supply and price situation.

At the present time, eight units — Crane 1 and 2, Brandon Shores 1 and 2, Wagner 1 and 2, and Riverside 4 and 5 -- are under "prohibition orders" issued under the Energy Supply and Conservation Act (ESCA) and the Fuel Use Act (FUA). Should these orders be made final, these facilities will be prohibitied from burning oil or gas. The environmental consequences of these conversions need to be carefully examined: six of the eight units are located in, or nearby, an area that does not presently meet standards for particulates. Fueling with coal also will generally increase SO_2 ground-level concentrations and consume PSD increments.

Baltimore Gas and Electric Company has voluntarily applied to the Maryland Public Service Commission for conversion of the Brandon Shores and Crane plants to coal. (PSC cases #6516 and #7443, respectively). Final briefs have been filed for Crane and Brandon Shores (48, 49, 50). General agreement has been reached on the equipment and fuel necessary to control particulate and sulfur oxide emissions to permissible levels.

Of the two remaining plants, only conversion at Wagner appears economically sound. Riverside is relatively old (29-30 years), has a low capacity factor, and is subject to severe space and environmental limitations. Wagner Units 1 and 2, on the other hand, are younger (21-24 years), have a higher capacity factor, and already have coal facilities in use for Unit 3. Rough estimates of cost savings due to fuel conversion indicate a payback period of 1-2 years. Thus, it is likely that Wagner Units 1 and 2 will be ordered to burn coal.

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