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National Air Pollutant Emission Estimates, 1940-1976

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Monitoring and Data Analysis Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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ABSTRACT

This report presents estimates of trends in nationwide air pollutant emissions for the five major pollutants: sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides. Estimates are presented for 1940, 1950, 1960, and each year from 1970 to 1976. Emission estimates are broken down according to major types of air pollutant sources. A short analysis of emission trends is given, along with a discussion of methods used to develop the data.

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NATIONAL AIR POLLUTANT EMISSION ESTIMATES, 1940 - 1976

1. Introduction

The primary objectives of this publication are to provide current estimates of nationwide emissions for the five major pollutants: sulfur oxides (SO_x), total suspended particulates (TSP), carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NO_x), and to present and discuss trends of these emissions. Estimates are presented for 1940, 1950, and 1960 to give a historical perspective of national air pollutant emissions and for each year from 1970 to 1976 as an indication of recent trends. Emission estimates presented herein for 1940-1970 entirely replace those published earlier by the U. S. Environmental Protection Agency (EPA) in AP-115.[1]

Reporting of emissions on a nationwide basis, while useful as a general indicator of pollutant levels, has definite limitations. National totals, averages, and trends are not the best guide for estimating the effects that will be produced in a particular locality. Yet, it is important that some criteria be established to measure progress and decide where effort should be channeled. Ideally, nationwide emission estimates should result from a summation of county, state, and regional data in which each component is reported separately. The National Emissions Data System (NEDS) uses this procedure. The methods used to prepare data for this publication are as similar as possible to those used for NEDS data preparation. Since NEDs uses a more detailed procedure involving calculation of emissions for individual sources and summation of these individual emissions totals to produce national totals, there is a much greater chance for errors or omissions to occur in the NEDS data. Because of the basic similarity of techniques, discrepancies between national totals reported herein and those given in NEDS reports[2] are due largely to incomplete data reporting and errors in the NEDS data. In time, it is anticipated that the quality of NEDS data will improve so that the differences between future NEDS emissions reports and national emissions totals determined by the procedure used for this publication will be minimal.

A discussion of trends is meaningful only when there is a common basis for evaluation. It was necessary, therefore, to quantify emissions using the same criteria for each year. This meant using the same estimation techniques, using equal or equivalent data sources, covering the same pollutant sources, and using compatible estimates of pollutant control levels from year to year. Estimates for previous years were updated using current emission factors and including the most recent information available. The criteria used in calculating emissions was the same for all years. Data for years prior to 1960 are difficult to obtain for some types of sources and were estimated when necessary.

Emission estimates are reported by pollutant for five major source categories: transportation, fuel combustion in stationary sources, industrial processes, solid waste disposal, and miscellaneous.

2. Nationwide Emission Trends, 1940-1976

Table 1 gives a summary of total national emission estimates for 1940-1976. Tables 2 through 11 present summaries for each year according to the five major source groupings. A discussion of the factors influencing the emissions trends is given for each pollutant.

2.1 Sulfur Oxides

The largest source of sulfur oxides is fuel combustion in stationary sources, and the next largest contributor is industrial process losses. For each year, between 75 and 80 percent of total SO_x emissions result from stationary source fuel combustion, primarily from burning of coal.

In 1940 and 1950, a significant portion of the total coal burned was by industrial, residential, and commercial consumers. Coal use by these sources has been declining however. This decline has been more than offset by a major increase in coal use by electric utilities. SO_x emissions from electric utility fuel use were about six times as much in 1970 as in 1940. This increase is due to the increased burning of fossil fuels to meet larger demands for electricity.

Since 1970, electric utility SO_x emissions have fluctuated somewhat as the use of fuels with lower sulfur content has tended to offset the effects of burning larger quantities of fuels. To the extent that low-sulfur coal, fuel oil, and natural gas could be used in place of high-sulfur coal and oil, increases in SO_x emissions from fuel combustion were held in check. The overall result has been that after an increase in total national SO_x emissions of about 50 percent from 1940 to 1970, national SO_x emissions have not changed substantially from 1970 to 1976.

2.2 Particulates

Particulate emissions result primarily from fuel combustion in stationary sources and from industrial processes. Particulate emissions from miscellaneous sources, primarily from forest fires and agricultural burning, are also significant for years prior to 1970. Miscellaneous source emissions may fluctuate a great deal from year to year, but have generally been declining as a result of man's control efforts.

Emissions from fuel combustion and industrial processes showed only a slight increase from 1940 to 1970 as a result of increased industrial production and fuel burning. The increase is much less than the actual industrial growth rate due to expanded use of particulate control equipment. Since 1970, particulate emissions have been reduced as a result of air pollution control efforts involving installation of additional pollution control equipment on industrial processes and coal-fired electric utility boilers. There has also been a reduction in emissions from decreased coal use by residential, commercial, and industrial consumers, less burning of solid waste, and a decrease in agricultural burning. The extent of the emission reduction by industrial processes was further increased in 1975 as the result of economic recession, which curtailed production by a number of industries.

2.3. Carbon Monoxide

Carbon monoxide emissions result primarily from transportation sources. The percentage of total CO emissions from these sources has increased substantially since 1940. Major increases in CO emissions occurred until the early 1970's, when controls on automobiles began to achieve emission reductions. From 1970 through 1973, CO emissions from automobiles remained about constant as the controls applied approximately

balanced the growth in motor vehicle travel. Since 1973, highway vehicle CO emissions have been reduced despite continued increases in vehicle travel. This is because newer vehicles are required to meet more stringent emission control requirements and older, uncontrolled vehicles are gradually being retired from service.

Other significant sources of CO are industrial processes, solid waste disposal, and miscellaneous sources. Emissions from solid waste disposal and miscellaneous sources have declined substantially due to decreased burning of solid waste and declines in forest fires and agricultural burning. Industrial process emissions increased from 1940 to 1960 and since then have remained about constant or declined slightly as a result of emission controls or the obsolescence of certain high-polluting industrial processes.

2.4 Hydrocarbons

Hydrocarbons, as defined for this report, include all volatile organic compounds, not exclusively compounds composed only of hydrogen and carbon. As with national CO emissions, a substantial portion of total hydrocarbon emissions result from transportation sources. From 1940 to the late 1960's, major increases in hydrocarbon emissions resulted from increased motor vehicle travel. With the implementation of emission controls for highway vehicles, transportation emissions have been reduced despite continuing increases in motor vehicle travel.

Other major sources of hydrocarbons are evaporative losses and industrial processes. Evaporative hydrocarbon emissions result primarily from the transportation and storage of crude oil and volatile petroleum products such as gasoline and distillate fuel oil, and the use of organic solvents for surface coating, degreasing, and other applications. Evaporative emissions have shown a steady increase over the years due to increased demands for motor vehicle fuels and organic solvents. Hydrocarbon emissions from other industrial processes have not changed greatly since 1950.

2.5 Nitrogen Oxides

Nearly all nitrogen oxide emissions result from fuel combustion by stationary sources and from transportation sources. National emissions show a continuing upward trend from 1940 to 1973. This is a result of increased fuel burning and increased motor vehicle travel. Since 1973 NO_X emissions from transportation sources have remained essentially constant. Automobile emission controls implemented in 1973 have prevented increases in NO_X emissions. A significant fraction (about one-fourth) of the transportation emissions result from off-highway fuel use by aircraft, railroads, vessels, and agricultural, construction, and industrial machinery. These sources are uncontrolled from an exhaust emission standpoint.

Stationary source fuel combustion NO_X emissions reflect the amounts of fuel consumed, since no significant control measures have been applied. NO_X emissions result primarily from coal combustion by electric utilities and natural gas combustion by utilities, natural gas companies, and industrial consumers.

Table 1. SUMMARY OF NATIONWIDE TOTAL EMISSION ESTIMATES

Units of measurement	Year	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	1940	21.9	27.5	86.7	19.0	6.7
	1950	24.5	29.1	96.6	23.5	9.0
	1960	24.1	28.3	111.0	31.2	11.5
	1970	32.1	24.8	109.9	32.9	22.3
	1971	30.8	23.4	110.2	32.1	23.3
	1972	31.7	22.3	112.3	32.8	24.3
	1973	32.7	21.8	108.2	32.7	25.1
	1974	30.9	19.2	100.7	31.6	24.7
	1975	28.5	16.0	95.3	29.1	24.4
	1976	29.9	14.9	96.6	30.9	25.4
10^6 metric tons per year	1940	19.5	24.8	78.3	17.0	6.0
	1950	22.0	26.2	87.0	21.2	8.1
	1960	21.4	25.6	100.0	28.0	10.5
	1970	29.1	22.6	99.8	29.7	20.4
	1971	27.9	21.4	100.2	29.3	21.3
	1972	28.8	20.3	102.0	29.7	22.2
	1973	29.7	19.9	98.3	29.8	22.9
	1974	28.2	17.5	91.5	28.6	22.6
	1975	25.7	14.4	85.9	26.2	22.2
	1976	26.9	13.4	87.2	27.9	23.0

Table 2. ESTIMATED NATIONWIDE EMISSIONS, 1940[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	Transportation	0.7	0.5	29.0	6.0	1.8
	Highway vehicles	0.0	0.2	26.3	5.4	1.5
	Nonhighway vehicles	0.7	0.3	2.7	0.6	0.3
	Stationary fuel combustion	16.8	9.6	3.7	0.8	3.5
	Electric utilities	2.9	2.0	0.0	0.0	0.6
	Industrial	9.3	6.2	0.3	0.3	1.9
	Residential, commercial, institutional	4.6	1.4	3.4	0.5	1.0
	Industrial processes	3.9	11.0	7.2	3.5	0.1
	Chemicals	0.1	0.4	4.4	1.5	0.0
	Petroleum refining	0.2	0.0	0.2	0.5	0.1
	Metals	3.2	3.7	2.3	0.1	0.0
	Mineral products	0.2	4.4	0.0	0.0	0.0
	Oil and gas production and marketing	0.0	0.0	0.0	1.2	0.0
	Industrial organic solvent use	0.0	0.0	0.0	0.1	0.0
	Other processes	0.0	2.5	0.3	0.1	0.0
	Solid waste	0.0	0.6	4.3	0.9	0.1
	Miscellaneous	0.5	5.8	42.5	7.8	1.2
	Forest wildfires and managed burning	0.0	3.8	32.1	5.5	0.9
	Agricultural burning	0.0	1.6	9.1	1.9	0.2
	Coal refuse burning	0.5	0.4	1.2	0.2	0.1
	Structural fires	0.0	0.0	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	0.2	0.0
	Total	21.9	27.5	86.7	19.0	6.7

[a] A value of zero indicates emissions of less than 50,000 short tons per year.

Table 2 (continued). ESTIMATED NATIONWIDE EMISSIONS, 1940[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 metric tons per year	Transportation	0.6	0.5	26.1	5.4	1.6
	Highway vehicles	0.0	0.2	23.7	4.9	1.3
	Nonhighway vehicles	0.6	0.3	2.4	0.5	0.3
	Stationary fuel combustion	15.1	8.7	3.4	0.7	3.1
	Electric utilities	2.6	1.8	0.0	0.0	0.5
	Industrial	8.4	5.6	0.3	0.3	1.7
	Residential, commercial, institutional	4.1	1.3	3.1	0.4	0.9
	Industrial processes	3.4	9.9	6.6	3.1	0.1
	Chemicals	0.1	0.4	4.0	1.3	0.0
	Petroleum refining	0.2	0.0	0.2	0.4	0.1
	Metals	2.9	3.3	2.1	0.1	0.0
	Mineral products	0.2	4.0	0.0	0.0	0.0
	Oil and gas production and marketing	0.0	0.0	0.0	1.1	0.0
	Industrial organic solvent use	0.0	0.0	0.0	0.1	0.0
	Other processes	0.0	2.2	0.3	0.1	0.0
	Solid waste	0.0	0.5	3.9	0.8	0.1
	Miscellaneous	0.4	5.2	38.3	7.0	1.1
	Forest wildfires and managed burning	0.0	3.4	28.9	4.9	0.8
	Agricultural burning	0.0	1.4	8.2	1.7	0.2
	Coal refuse burning	0.4	0.4	1.1	0.2	0.1
	Structural fires	0.0	0.0	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	0.2	0.0
	Total	19.5	24.8	78.3	17.0	6.0

[a] A value of zero indicates emissions of less than 50,000 metric tons per year.

Table 3. ESTIMATED NATIONWIDE EMISSIONS, 1950[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	Transportation	0.9	1.2	47.7	9.8	3.3
	Highway vehicles	0.1	0.4	40.3	8.4	2.2
	Nonhighway vehicles	0.8	0.8	7.4	1.4	1.1
	Stationary fuel combustion	18.4	9.0	3.6	1.2	4.3
	Electric utilities	5.4	3.0	0.1	0.0	1.2
	Industrial	8.2	4.6	0.3	0.5	2.0
	Residential, commercial, institutional	4.8	1.4	3.2	0.7	1.1
	Industrial processes	4.6	14.0	12.8	5.6	0.3
	Chemicals	0.3	0.7	6.2	2.3	0.0
	Petroleum refining	0.4	0.1	3.0	0.7	0.2
	Metals	3.4	4.2	3.1	0.1	0.0
	Mineral products	0.4	6.1	0.0	0.0	0.1
	Oil and gas production and marketing	0.0	0.0	0.0	1.8	0.0
	Industrial organic solvent use	0.0	0.	0.0	0.5	0.0
	Other processes	0.0	2.9	0.5	0.2	0.0
	Solid waste	0.1	0.8	4.8	1.1	0.2
	Miscellaneous	0.5	4.1	27.6	5.8	0.8
	Forest wildfires and managed burning	0.0	1.9	16.0	2.8	0.5
	Agricultural burning	0.0	1.8	10.4	2.1	0.2
	Coal refuse burning	0.5	0.4	1.2	0.2	0.1
	Structural fires	0.0	0.0	0.0	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	0.7	0.0
	Total	24.5	29.1	96.6	23.5	9.0

[a] A value of zero indicates emissions of less than 50,000 short tons per year.

Table 3 (continued). ESTIMATED NATIONWIDE EMISSIONS, 1950[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 metric tons per year	Transportation	0.8	1.1	43.0	8.9	3.0
	Highway vehicles	0.1	0.4	36.3	7.6	2.0
	Nonhighway vehicles	0.7	0.7	6.7	1.3	1.0
	Stationary fuel combustion	16.6	8.1	3.3	1.1	3.9
	Electric utilities	4.9	2.7	0.1	0.0	1.1
	Industrial	7.4	4.1	0.3	0.5	1.8
	Residential, commercial, institutional	4.3	1.3	2.9	0.6	1.0
	Industrial processes	4.1	12.6	11.5	5.0	0.3
	Chemicals	0.3	0.6	5.6	2.1	0.0
	Petroleum refining	0.4	0.1	2.7	0.6	0.2
	Metals	3.1	3.8	2.8	0.1	0.0
	Mineral products	0.3	5.5	0.0	0.0	0.1
	Oil and gas production and marketing	0.0	0.0	0.0	1.6	0.0
	Industrial organic solvent use	0.0	0.0	0.0	0.4	0.0
	Other processes	0.0	2.6	0.4	0.2	0.0
	Solid waste	0.1	0.7	4.3	1.0	0.2
	Miscellaneous	0.4	3.7	24.9	5.2	0.7
	Forest wildfires and managed burning	0.0	1.7	14.4	2.5	0.7
	Agricultural burning	0.0	1.6	9.4	1.9	0.4
	Coal refuse burning	0.4	0.4	1.1	0.2	0.1
	Structural fires	0.0	0.0	0.0	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	0.6	0.0
	Total	22.0	26.2	87.0	21.2	8.1

[a] A value of zero indicates emissions of less than 50,000 metric tons per year.

Table 4. ESTIMATED NATIONWIDE EMISSIONS, 1960[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	Transportation	0.6	0.7	69.0	14.3	5.0
	Highway vehicles	0.1	0.5	59.6	12.4	3.7
	Nonhighway vehicles	0.5	0.2	9.4	1.9	1.3
	Stationary fuel combustion	17.5	7.4	1.4	1.1	5.2
	Electric utilities	10.1	4.4	0.1	0.0	2.3
	Industrial	4.8	2.4	0.2	0.8	1.8
	Residential, commercial, institutional	2.6	0.6	1.1	0.3	1.1
	Industrial processes	5.4	15.6	12.0	7.7	0.4
	Chemicals	0.3	0.4	4.8	1.6	0.1
	Petroleum refining	0.6	0.1	3.3	0.8	0.2
	Metals	3.8	2.9	3.0	0.1	0.0
	Mineral products	0.5	8.9	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	2.7	0.0
	Industrial organic solvent use	0.0	0.0	0.0	2.0	0.0
	Other processes	0.1	3.3	0.9	0.5	0.0
	Solid waste	0.0	1.0	5.1	1.3	0.2
	Miscellaneous	0.5	3.6	23.5	6.8	0.7
	Forest wildfires and managed burning	0.0	1.1	9.8	1.7	0.3
	Agricultural burning	0.0	2.1	12.4	2.5	0.3
	Coal refuse burning	0.5	0.4	1.2	0.2	0.1
	Structural fires	0.0	0.0	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	2.4	0.0
	Total	24.1	28.3	111.0	31.2	11.5

[a] A value of zero indicates emissions of less than 50,000 short tons per year.

Table 4 (continued). ESTIMATED NATIONWIDE EMISSIONS, 1960[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 metric tons per year	Transportation	0.5	0.6	62.1	12.9	4.5
	Highway vehicles	0.1	0.4	53.6	11.2	3.3
	Nonhighway vehicles	0.4	0.2	8.5	1.7	1.2
	Stationary fuel combustion	15.7	6.7	1.3	1.0	4.7
	Electric utilities	9.1	4.0	0.1	0.0	2.1
	Industrial	4.3	2.2	0.2	0.7	1.6
	Residential, commercial, institutional	2.3	0.5	1.0	0.3	1.0
	Industrial processes	4.8	14.1	10.8	6.8	0.4
	Chemicals	0.3	0.4	4.3	1.4	0.1
	Petroleum refining	0.5	0.1	3.0	0.7	0.2
	Metals	3.4	2.6	2.7	0.1	0.0
	Mineral products	0.4	8.0	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	2.4	0.0
	Industrial organic solvent use	0.0	0.0	0.0	1.8	0.0
	Other processes	0.1	3.0	0.8	0.4	0.0
	Solid waste	0.0	0.9	4.6	1.2	0.2
	Miscellaneous	0.4	3.3	21.2	6.1	0.7
	Forest wildfires and managed burning	0.0	1.0	8.8	1.5	0.3
	Agricultural burning	0.0	1.9	11.2	2.2	0.3
	Coal refuse burning	0.4	0.4	1.1	0.2	0.1
	Structural fires	0.0	0.0	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	2.2	0.0
	Total	21.4	25.6	100.0	28.0	10.5

[a] A value of zero indicates emissions of less than 50,000 metric tons per year.

Table 5. ESTIMATED NATIONWIDE EMISSIONS, 1970[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	Transportation	0.7	1.2	87.2	13.9	9.2
	Highway vehicles	0.3	0.8	76.7	12.2	6.9
	Nonhighway vehicles	0.4	0.4	10.5	1.7	2.3
	Stationary fuel combustion	24.6	7.8	1.4	1.6	12.0
	Electric utilities	17.3	4.5	0.2	0.1	5.6
	Industrial	5.1	2.9	0.6	1.4	5.6
	Residential, commercial, institutional	2.2	0.4	0.6	0.1	0.8
	Industrial processes	6.6	13.6	8.8	10.6	0.6
	Chemicals	0.6	0.3	3.3	1.7	0.2
	Petroleum refining	0.7	0.1	2.2	0.8	0.3
	Metals	4.5	2.3	2.3	0.2	0.0
	Mineral products	0.6	8.5	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	3.0	0.0
	Industrial organic solvent use	0.0	0.0	0.0	4.1	0.0
	Other processes	0.1	2.4	1.0	0.8	0.0
	Solid waste	0.1	1.2	6.7	1.9	0.3
	Miscellaneous	0.1	1.0	5.8	4.9	0.2
	Forest wildfires and managed burning	0.0	0.6	3.9	0.8	0.1
	Agricultural burning	0.0	0.3	1.5	0.3	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.0	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.7	0.0
	Total	32.1	24.8	109.9	32.9	22.3

[a] A value of zero indicates emissions of less than 50,000 short tons per year.

Table 5 (continued). ESTIMATED NATIONWIDE EMISSIONS, 1970[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 metric tons per year	Transportation	0.7	1.1	79.2	12.6	8.4
	Highway vehicles	0.3	0.7	69.7	11.1	6.3
	Nonhighway vehicles	0.4	0.4	9.5	1.5	2.1
	Stationary fuel combustion	22.3	7.1	1.2	1.5	10.9
	Electric utilities	15.7	4.1	0.2	0.1	5.1
	Industrial	4.6	2.6	0.5	1.3	5.1
	Residential, commercial, institutional	2.0	0.4	0.5	0.1	0.7
	Industrial processes	5.9	12.4	8.0	9.5	0.6
	Chemicals	0.5	0.3	3.0	1.5	0.2
	Petroleum refining	0.6	0.1	2.0	0.7	0.3
	Metals	4.1	2.1	2.1	0.2	0.0
	Mineral products	0.5	7.7	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	2.7	0.0
	Industrial organic solvent use	0.0	0.0	0.0	3.7	0.0
	Other processes	0.1	2.2	0.9	0.7	0.0
	Solid waste	0.1	1.1	6.1	1.7	0.3
	Miscellaneous	0.1	0.9	5.3	4.4	0.2
	Forest wildfires and managed burning	0.0	0.5	3.5	0.7	0.1
	Agricultural burning	0.0	0.3	1.4	0.3	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.0	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.3	0.0
	Total	29.1	22.6	99.8	29.7	20.4

[a] A value of zero indicates emissions of less than 50,000 metric tons per year.

Table 6. ESTIMATED NATIONWIDE EMISSIONS, 1971[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	Transportation	0.7	1.2	87.5	13.6	9.8
	Highway vehicles	0.3	0.8	77.3	11.9	7.4
	Nonhighway vehicles	0.4	0.4	10.2	1.7	2.4
	Stationary fuel combustion	23.8	7.2	1.4	1.6	12.3
	Electric utilities	17.3	4.4	0.2	0.1	5.9
	Industrial	4.4	2.4	0.6	1.4	5.6
	Residential, commercial, institutional	2.1	0.4	0.6	0.1	0.8
	Industrial processes	6.1	12.9	8.7	10.4	0.6
	Chemicals	0.6	0.3	3.0	1.5	0.2
	Petroleum refining	0.6	0.1	2.3	0.8	0.3
	Metals	4.0	2.1	2.4	0.2	0.0
	Mineral products	0.7	8.0	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	3.1	0.0
	Industrial organic solvent use	0.0	0.0	0.0	4.0	0.0
	Other processes	0.1	2.4	1.0	0.8	0.0
	Solid waste	0.1	0.9	5.2	1.5	0.3
	Miscellaneous	0.1	1.2	7.4	5.0	0.3
	Forest wildfires and managed burning	0.0	0.8	5.6	1.1	0.2
	Agricultural burning	0.0	0.2	1.4	0.3	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.5	0.0
	Total	30.8	23.4	110.2	32.1	23.3

[a] A value of zero indicates emissions of less than 50,000 short tons per year.

Table 6 (continued). ESTIMATED NATIONWIDE EMISSIONS, 1971[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 metric tons per year	Transportation	0.7	1.1	79.6	12.3	8.9
	Highway vehicles	0.3	0.7	70.3	10.8	6.7
	Nonhighway vehicles	0.4	0.4	9.3	1.5	2.2
	Stationary fuel combustion	21.5	6.6	1.2	1.5	11.2
	Electric utilities	15.6	4.0	0.2	0.1	5.4
	Industrial	4.0	2.2	0.5	1.3	5.1
	Residential, commercial, institutional	1.9	0.4	0.5	0.1	0.7
	Industrial processes	5.5	11.8	7.9	9.5	0.6
	Chemicals	0.5	0.3	2.7	1.4	0.2
	Petroleum refining	0.6	0.1	2.1	0.7	0.3
	Metals	3.6	1.9	2.2	0.2	0.0
	Mineral products	0.6	7.3	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	2.8	0.0
	Industrial organic solvent use	0.0	0.0	0.0	3.7	0.0
	Other processes	0.1	2.2	0.9	0.7	0.0
	Solid waste	0.1	0.8	4.7	1.4	0.3
	Miscellaneous	0.1	1.1	6.8	4.6	0.3
	Forest wildfires and managed burning	0.0	0.7	5.1	1.0	0.2
	Agricultural burning	0.0	0.2	1.3	0.3	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.2	0.0
	Total	27.9	21.4	100.2	29.3	21.3

[a] A value of zero indicates emissions of less than 50,000 metric tons per year.

Table 7. ESTIMATED NATIONWIDE EMISSIONS, 1972[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	Transportation	0.7	1.3	92.4	13.9	10.3
	Highway vehicles	0.3	0.9	82.3	12.1	7.8
	Nonhighway vehicles	0.4	0.4	10.1	1.8	2.5
	Stationary fuel combustion	24.0	7.0	1.5	1.6	12.9
	Electric utilities	17.6	4.4	0.3	0.1	6.5
	Industrial	4.4	2.2	0.6	1.4	5.6
	Residential, commercial, institutional	2.0	0.4	0.6	0.1	0.8
	Industrial Processes	6.8	12.2	8.7	11.1	0.7
	Chemicals	0.7	0.3	2.9	1.7	0.3
	Petroleum refining	0.8	0.1	2.3	0.8	0.3
	Metals	4.4	2.1	2.4	0.2	0.0
	Mineral products	0.7	7.4	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	3.2	0.0
	Industrial organic solvent use	0.0	0.0	0.0	4.4	0.0
	Other processes	0.1	2.3	1.1	0.8	0.0
	Solid Waste	0.1	0.8	4.4	1.2	0.2
	Miscellaneous	0.1	1.0	5.3	5.0	0.2
	Forest wildfires and managed burning	0.0	0.6	4.0	0.8	0.1
	Agricultural burning	0.0	0.2	0.9	0.2	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.9	0.0
	Total	31.7	22.3	112.3	32.8	24.3

[a] A value of zero indicates emissions of less than 50,000 short tons per year.

Table 7 (continued). ESTIMATED NATIONWIDE EMISSIONS, 1972[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 metric tons per year	Transportation	0.7	1.2	84.0	12.6	9.4
	Highway vehicles	0.3	0.8	74.8	11.0	7.1
	Nonhighway vehicles	0.4	0.4	9.2	1.6	2.3
	Stationary fuel combustion	21.8	6.4	1.3	1.5	11.7
	Electric utilities	16.0	4.0	0.3	0.1	5.9
	Industrial	4.0	2.0	0.5	1.3	5.1
	Residential, commercial, institutional	1.8	0.4	0.5	0.1	0.7
	Industrial processes	6.1	11.1	7.9	10.0	0.7
	Chemicals	0.6	0.3	2.6	1.5	0.3
	Petroleum refining	0.7	0.1	2.1	0.7	0.3
	Metals	4.0	1.9	2.2	0.2	0.0
	Mineral products	0.6	6.7	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	2.9	0.0
	Industrial organic solvent use	0.0	0.0	0.0	4.0	0.0
	Other processes	0.1	2.1	1.0	0.7	0.0
	Solid waste	0.1	0.7	4.0	1.1	0.2
	Miscellaneous	0.1	0.9	4.8	4.5	0.2
	Forest wildfires and managed burning	0.0	0.5	3.6	0.7	0.1
	Agricultural burning	0.0	0.2	0.8	0.2	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.5	0.0
	Total	28.8	20.3	102.0	29.7	22.2

[a] A value of zero indicates emissions of less than 50,000 metric tons per year.

Table 8. ESTIMATED NATIONWIDE EMISSIONS, 1973[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	Transportation	0.8	1.3	89.4	13.4	10.6
	Highway vehicles	0.4	0.9	79.2	11.7	8.0
	Nonhighway vehicles	0.4	0.4	10.2	1.7	2.6
	Stationary fuel combustion	25.2	7.1	1.5	1.7	13.4
	Electric utilities	19.2	4.7	0.3	0.1	7.0
	Industrial	4.1	2.0	0.6	1.5	5.6
	Residential, commercial, institutional	1.9	0.4	0.6	0.1	0.8
	Industrial processes	6.5	11.9	9.0	11.6	0.7
	Chemicals	0.6	0.3	3.1	1.8	0.3
	Petroleum refining	0.9	0.1	2.4	0.9	0.3
	Metals	4.1	2.3	2.4	0.2	0.0
	Mineral products	0.7	6.9	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	3.2	0.0
	Industrial organic solvent use	0.0	0.0	0.0	4.6	0.0
	Other processes	0.1	2.3	1.1	0.9	0.0
	Solid waste	0.1	0.7	4.0	1.1	0.2
	Miscellaneous	0.1	0.8	4.3	4.9	0.2
	Forest wildfires and managed burning	0.0	0.5	3.2	0.7	0.1
	Agricultural burning	0.0	0.1	0.7	0.1	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	4.0	0.0
	Total	32.7	21.8	108.2	32.7	25.1

[a] A value of zero indicates emissions of less than 50,000 short tons per year.

Table 8 (continued). ESTIMATED NATIONWIDE EMISSIONS, 1973[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 metric tons per year	Transportation	0.8	1.2	81.3	12.2	9.7
	Highway vehicles	0.4	0.8	72.0	10.6	7.3
	Nonhighway vehicles	0.4	0.4	9.3	1.6	2.4
	Stationary fuel combustion	22.9	6.5	1.3	1.6	12.1
	Electric utilities	17.5	4.3	0.3	0.1	6.3
	Industrial	3.7	1.8	0.5	1.4	5.1
	Residential, commercial, institutional	1.7	0.4	0.5	0.1	0.7
	Industrial processes	5.8	10.9	8.2	10.5	0.7
	Chemicals	0.5	0.3	2.8	1.6	0.3
	Petroleum refining	0.8	0.1	2.2	0.8	0.3
	Metals	3.7	2.1	2.2	0.2	0.0
	Mineral products	0.6	6.3	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	2.9	0.0
	Industrial organic solvent use	0.0	0.0	0.0	4.2	0.0
	Other processes	0.1	2.1	1.0	0.8	0.0
	Solid waste	0.1	0.6	3.6	1.0	0.2
	Miscellaneous	0.1	0.7	3.9	4.5	0.2
	Forest wildfires and managed burning	0.0	0.4	2.9	0.6	0.1
	Agricultural burning	0.0	0.1	0.6	0.1	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.7	0.0
	Total	29.7	19.9	98.3	29.8	22.9

[a] A value of zero indicates emissions of less than 50,000 metric tons per year.

Table 9. ESTIMATED NATIONWIDE EMISSIONS, 1974[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	Transportation	0.8	1.3	81.4	12.5	10.5
	Highway vehicles	0.4	0.9	72.2	10.8	8.0
	Nonhighway vehicles	0.4	0.4	9.2	1.7	2.5
	Stationary fuel combustion	24.1	6.1	1.5	1.6	13.1
	Electric utilities	18.7	4.2	0.3	0.1	6.8
	Industrial	3.6	1.5	0.6	1.4	5.5
	Residential, commercial, institutional	1.8	0.4	0.6	0.1	0.8
	Industrial processes	5.8	10.3	9.0	11.4	0.7
	Chemicals	0.4	0.3	2.8	1.8	0.3
	Petroleum refining	0.9	0.1	2.5	0.9	0.3
	Metals	3.6	2.1	2.6	0.2	0.0
	Mineral products	0.7	5.9	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	3.2	0.0
	Industrial organic solvent use	0.0	0.0	0.0	4.4	0.0
	Other processes	0.1	1.9	1.1	0.9	0.0
	Solid waste	0.1	0.6	3.5	1.0	0.2
	Miscellaneous	0.1	0.9	5.3	5.1	0.2
	Forest wildfires and managed burning	0.0	0.6	4.3	0.7	0.1
	Agricultural burning	0.0	0.1	0.6	0.3	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	4.0	0.0
	Total	30.9	19.2	100.7	31.6	24.7

[a] A value of zero indicates emissions of less than 50,000 short tons per year.

Table 9 (continued). ESTIMATED NATIONWIDE EMISSIONS, 1974[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 metric tons per year	Transportation	0.8	1.2	74.0	11.3	9.6
	Highway vehicles	0.4	0.8	65.6	9.8	7.3
	Nonhighway vehicles	0.4	0.4	8.4	1.5	2.3
	Stationary fuel combustion	21.9	5.6	1.3	1.5	11.9
	Electric utilities	17.0	3.8	0.3	0.1	6.2
	Industrial	3.3	1.4	0.5	1.3	5.0
	Residential, commercial, institutional	1.6	0.4	0.5	0.1	0.7
	Industrial Processes	5.3	9.4	8.2	10.3	0.7
	Chemicals	0.4	0.3	2.5	1.6	0.3
	Petroleum refining	0.8	0.1	2.3	0.8	0.3
	Metals	3.3	1.9	2.4	0.2	0.0
	Mineral products	0.6	5.4	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	2.9	0.0
	Industrial organic solvent use	0.0	0.0	0.0	4.0	0.0
	Other processes	0.1	1.7	1.0	0.8	0.0
	Solid waste	0.1	0.5	3.2	0.9	0.2
	Miscellaneous	0.1	0.8	4.8	4.6	0.2
	Forest wildfires and managed burning	0.0	0.5	3.9	0.6	0.1
	Agricultural burning	0.0	0.1	0.5	0.3	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.6	0.0
	Total	28.2	17.5	91.5	28.6	22.6

[a] A value of zero indicates emissions of less than 50,000 metric tons per year.

Table 10. ESTIMATED NATIONWIDE EMISSIONS, 1975[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	Transportation	0.8	1.3	79.4	12.1	10.9
	Highway vehicles	0.4	0.9	70.3	10.4	8.4
	Nonhighway vehicles	0.4	0.4	9.1	1.7	2.5
	Stationary fuel combustion	22.9	5.8	1.3	1.5	12.5
	Electric utilities	18.6	4.3	0.3	0.1	6.8
	Industrial	2.8	1.2	0.6	1.3	5.0
	Residential, commercial, institutional	1.5	0.3	0.4	0.1	0.7
	Industrial processes	4.7	7.7	7.8	10.5	0.7
	Chemicals	0.3	0.2	2.4	1.7	0.3
	Petroleum refining	0.8	0.1	2.5	0.9	0.3
	Metals	2.8	1.5	1.9	0.2	0.0
	Mineral products	0.6	4.1	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	3.2	0.0
	Industrial organic solvent use	0.0	0.0	0.0	3.7	0.0
	Other processes	0.1	1.8	1.0	0.8	0.0
	Solid waste	0.0	0.5	3.2	0.9	0.2
	Miscellaneous	0.1	0.7	3.6	4.1	0.1
	Forest wildfires and managed burning	0.0	0.4	2.6	0.5	0.1
	Agricultural burning	0.0	0.1	0.6	0.1	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.4	0.0
	Total	28.5	16.0	95.3	29.1	24.4

[a] A value of zero indicates emissions of less than 50,000 short tons per year.

Table 10 (continued). ESTIMATED NATIONWIDE EMISSIONS, 1975[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 metric tons per year	Transportation	0.8	1.2	71.5	10.9	9.9
	Highway vehicles	0.4	0.8	63.3	9.4	7.6
	Nonhighway vehicles	0.4	0.4	8.2	1.5	2.3
	Stationary fuel combustion	20.6	5.3	1.2	1.4	11.2
	Electric utilities	16.7	3.9	0.3	0.1	6.1
	Industrial	2.5	1.1	0.5	1.2	4.5
	Residential, commercial, institutional	1.4	0.3	0.4	0.1	0.6
	Industrial processes	4.2	6.9	7.1	9.4	0.7
	Chemicals	0.3	0.2	2.2	1.5	0.3
	Petroleum refining	0.7	0.1	2.3	0.8	0.3
	Metals	2.5	1.3	1.7	0.2	0.0
	Mineral products	0.5	3.7	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	2.9	0.0
	Industrial organic solvent use	0.0	0.0	0.0	3.3	0.0
	Other processes	0.1	1.6	0.9	0.7	0.0
	Solid waste	0.0	0.4	2.9	0.8	0.2
	Miscellaneous	0.1	0.6	3.2	3.7	0.2
	Forest wildfires and managed burning	0.0	0.3	2.3	0.4	0.1
	Agricultural burning	0.0	0.1	0.5	0.1	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.1	0.0
	Total	25.7	14.4	85.9	26.2	22.2

[a] A value of zero indicates emissions of less than 50,000 metric tons per year.

Table 11. ESTIMATED NATIONWIDE EMISSIONS, 1976[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 short tons per year	Transportation	0.8	1.3	77.4	12.0	11.2
	Highway vehicles	0.4	0.9	68.2	10.3	8.7
	Nonhighway vehicles	0.4	0.4	9.2	1.7	2.5
	Stationary fuel combustion	24.4	5.1	1.3	1.5	13.1
	Electric utilities	19.6	3.6	0.3	0.1	7.3
	Industrial	2.9	1.2	0.6	1.3	5.0
	Residential, commercial, institutional	1.9	0.3	0.4	0.1	0.8
	Industrial processes	4.6	7.0	8.5	11.6	0.7
	Chemicals	0.3	0.3	2.6	1.8	0.3
	Petroleum refining	0.8	0.1	2.6	1.0	0.3
	Metals	2.7	1.5	2.1	0.2	0.0
	Mineral products	0.6	3.5	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	3.3	0.0
	Industrial organic solvent use	0.0	0.0	0.0	4.4	0.0
	Other processes	0.1	1.6	1.2	0.9	0.0
	Solid waste	0.0	0.5	3.1	0.9	0.1
	Miscellaneous	0.1	1.0	6.3	4.9	0.3
	Forest wildfires and managed burning	0.0	0.7	5.3	0.9	0.2
	Agricultural burning	0.0	0.1	0.6	0.1	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.8	0.0
	Total	29.9	14.9	96.6	30.9	25.4

[a] A value of zero indicates emissions of less than 50,000 short tons per year.

Table 11 (continued). ESTIMATED NATIONWIDE EMISSIONS, 1976[a]

Units of measurement	Source	SO_x	TSP	CO	HC	NO_x
10^6 metric tons per year	Transportation	0.8	1.2	69.7	10.8	10.1
	Highway vehicles	0.4	0.8	61.4	9.3	7.8
	Nonhighway vehicles	0.4	0.4	8.3	1.5	2.3
	Stationary fuel combustion	21.9	4.6	1.2	1.4	11.8
	Electric utilities	17.6	3.2	0.3	0.1	6.6
	Industrial	2.6	1.1	0.5	1.2	4.5
	Residential, commercial, institutional	1.7	0.3	0.4	0.1	0.7
	Industrial processes	4.1	6.3	7.8	10.5	0.7
	Chemicals	0.3	0.3	2.4	1.6	0.3
	Petroleum refining	0.7	0.1	2.4	0.9	0.3
	Metals	2.4	1.3	1.9	0.2	0.0
	Mineral products	0.5	3.2	0.0	0.0	0.1
	Oil and gas production and marketing	0.1	0.0	0.0	3.0	0.0
	Industrial organic solvent use	0.0	0.0	0.0	4.0	0.0
	Other processes	0.1	1.4	1.1	0.8	0.0
	Solid waste	0.0	0.4	2.8	0.8	0.1
	Miscellaneous	0.1	0.9	5.7	4.4	0.3
	Forest wildfires and managed burning	0.0	0.6	4.8	0.8	0.2
	Agricultural burning	0.0	0.1	0.5	0.1	0.0
	Coal refuse burning	0.1	0.1	0.3	0.1	0.1
	Structural fires	0.0	0.1	0.1	0.0	0.0
	Miscellaneous organic solvent use	0.0	0.0	0.0	3.4	0.0
	Total	26.9	13.4	87.2	27.9	23.0

[a] A value of zero indicates emissions of less than 50,000 metric tons per year.

3. Methods

The generation of an emission inventory involves many steps to achieve the desired result, which is to estimate the amount of emissions for selected pollutants in a defined geographical area. Because it is impossible to test every pollutant source individually, particularly area sources, an estimating procedure must be used. In order to do this, however, one must either estimate the emissions directly or estimate the magnitude of other variables that can then be related to emissions. These indicators include fuel consumption, vehicle miles, population, sales, tons of refuse burned, raw materials processed, etc., which are then multiplied by appropriate emission factors to obtain emission estimates.

The limitations and applicability of emission factors must be understood. In general, emission factors are not precise indicators of emissions from a single source; rather, they are quantitative estimates of the average rate of pollutant release as a result of some activity. They are most valid when applied to a large number of sources and processes. If their limitations are recognized, emission factors are extremely useful in determining emission levels. A detailed discussion of emission factors and related information is contained in Reference 3. The emission factor thus relates quantity of pollutants emitted to indicators such as those noted above, and is a practical approach for determining estimates of emissions from various source categories.

The methodology used in generation of emissions estimates for individual source categories follows.

3.1. Transportation

3.1.1. Motor Vehicles

Emission estimates from gasoline- and diesel-powered motor vehicles were based upon vehicle-mile tabulations and emission factors. Four vehicle categories are considered: light duty gasoline (mostly passenger cars), light duty trucks (trucks less than 8500 pounds in weight), heavy duty gasoline trucks and buses, and heavy duty diesel trucks and buses. The emission factors used are based on the latest available data from AP-42.[3] The factors are based on national average conditions and do not include corrections for specific geographical areas to account for local model year distributions, altitude, temperature, or hot/cold vehicle operation differences. For each of these variables, only national averages were considered in the emission factors. Average speed is taken into account on a nationwide basis according to the published distribution of vehicle-miles travelled (VMT) for urban and rural fractions. These data are published in Reference 4. For rural VMT, the average speed is considered to be 45 miles per hour, and for urban VMT, 19.6 miles per hour.

3.1.2. Aircraft

Aircraft emissions are based on emission factors and aircraft activity statistics reported by the Federal Aviation Administration.[5] Emissions are based on the number of landing-takeoff (LTO) cycles. Any emissions in cruise mode, which is defined to be above 3000 feet (1000 meters) are ignored. Average emission factors, which take into account the national mix of aircraft types for general aviation, military, and commercial aircraft, are used to compute the emissions.

3.1.3. Railroads

The Bureau of Mines reports consumption of diesel fuel and residual fuel oil by railroads.[6] Average emission factors applicable to diesel fuel consumption were used to calculate emissions. The average sulfur content of each fuel was used to estimate SO_x emissions.

3.1.4. Vessels

Vessel use of diesel fuel, residual oil, and coal is reported by the Bureau of Mines.[6,7] Gasoline use is based on national boat and motor registrations, coupled with a use factor (gallons/motor/year) from Reference 8. Emission factors from AP-42[3] are used to compute emissions. Since AP-42[3] does not contain an emission factor for coal use by vessels, an average emission factor for coal combustion in boilers was used.

3.1.5. Nonhighway Use of Motor Fuels

Gasoline and diesel fuel are consumed by off-highway vehicles. The fuel use is divided into seven categories: farm tractors, other farm machinery, construction equipment, industrial machinery, small general utility engines such as lawnmowers and snowthrowers, snowmobiles, and motorcycles. Fuel use is estimated for each category from estimated equipment population and an annual use factor of gallons per unit per year.[8]

3.2 Fuel Combustion in Stationary Sources

3.2.1. Coal

Bituminous coal, lignite, and anthracite coal use are reported by the Bureau of Mines.[7] Most coal is consumed by electric utilities. Average emission factors and the sulfur content of each type of coal were used to estimate emissions. Degree of particulate control was based on a report by Midwest Research Institute[9] together with data from NEDS[10] and the Compliance Data System (CDS).[11]

3.2.2. Fuel Oil

Distillate oil, residual oil, and kerosene are consumed by stationary sources nationwide. Consumption by user category is reported by the Bureau of Mines.[6] Average emission factors and the sulfur content of each fuel were used to estimate emissions.

3.2.3. Natural Gas

Natural gas consumption data are also reported by the Bureau of Mines.[7] Liquified petroleum gas (LPG) use is also included with natural gas for the purpose of estimating emissions. Average emission factors from AP-42[3] were used to calculate the emission estimates.

3.2.4. Other Fuels

Consumption of wood, process gas, and bagasse is based on data reported in NEDS.[10] Average emission factors were used to calculate emissions, which are relatively minor on a national basis.

3.3. Industrial Process Losses

In addition to fuel combustion, certain other industrial processes generate and emit varying quantities of pollutants into the air. The lack of published national data on production, type of equipment, and controls, as well as an absence of emission factors, makes it impossible to include estimates of emissions from all industrial process sources.

Production data for industries that are known to produce the great majority of emissions were derived from literature data. Generally, the Minerals Yearbook,[7] published by the Bureau of Mines, and Current Industrial Reports,[12] published by the Bureau of the Census, provide adequate data for most industries. Average emission factors were applied to production data to obtain emissions. Control efficiencies applicable to various processes were estimated on the basis of published reports,[9] from NEDS data,[10] or from CDS data.[11]

3.4. Solid Waste Disposal

A study conducted in 1968 on solid waste collection and disposal practices[13] was the basis for estimating emissions from solid waste disposal. Results of this study indicate that the average collection rate of solid waste is about 5.5 pounds per capita per day in the United States. It has been stated that a conservative estimate of the total generation rate is 10 pounds per capita per day. The results of this survey were used to estimate, by disposal method, the quantities of solid waste generated. Average emission factors were applied to these totals to obtain estimates of total emissions from the disposal of solid wastes.

3.5. Miscellaneous Sources

3.5.1. Forest Fires

The Forest Service of the Department of Agriculture publishes information on the number of forest fires and the acreage burned.[14] Estimates of the amount of material burned per acre are made to estimate the total amount of material burned. Similar estimates are made to account for managed burning of forest areas. Average emission factors were applied to the quantities of materials burned to calculate emissions.

3.5.2. Structural Fires

The United States Department of Commerce publishes, in their statistical abstracts, information on the number and types of structures damaged by fire.[13] Emissions were estimated by applying average emission factors for wood combustion to these totals.

3.5.3. Coal Refuse

Estimates of the number of burning coal-refuse piles existing in the United States are made in reports by the Bureau of Mines.[16] Their publication presents a detailed discussion of the nature, origin, and extent of this source of pollution. Rough estimates of the quantity of emissions were obtained using this information by applying average emission factors for coal combustion.

3.5.4. Organic Solvent Evaporation

Organic solvent use includes surface coating, degreasing, dry cleaning, printing and publishing, and a large number of miscellaneous solvent applications. Estimates of national usage are derived from chemical production reports of the United States Tariff Commission,[17] together with estimates of the portion of total production for use as solvent for a

number of organic chemicals.[18] In the emissions summary tables, emissions from estimated industrial use of organic solvents are shown under industrial processes. This includes emissions from industrial surface coating, degreasing, and printing. Solvent use not accounted for by industrial sources (architectural coatings, dry cleaning, other solvent applications) is reported as miscellaneous organic solvent use.

3.5.5 Oil and Gas Marketing and Production

This category includes estimated emissions from domestic crude oil production and emissions associated with the storage and transfer of crude oil and petroleum products. Evaporation of motor fuels during the filling of tank vehicles, service station tanks, and automobile tanks are included. Other sources are the evaporation of hydrocarbons from storage tanks at oil fields, refineries, and bulk terminals. Average emission factors for each of these sources were applied to the amount of crude oil, gasoline, and distillate fuel produced[7] in order to estimate emissions.

3.5.6. Agricultural Burning

Large quantities of agricultural refuse are burned annually in the United States. Estimates of the amounts burned were obtained from state agricultural departments or extension services. Emission estimates were obtained by applying factors to these rough totals.

4. References

1. Nationwide Air Pollutant Emission Trends, 1940-1970. US Environmental Protection Agency, Research Triangle Park, NC. Publication No. AP-115. Jan 1973.
*2. National Emissions Report, National Emissions Data System (NEDS). NADB, OAQPS, US Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA-450/2-76-007. May 1976.
3. Compilation of Air Pollutant Emission Factors, Third Edition (Including Supplements 1-7). US Environmental Protection Agency, Research Triangle Park, NC. Publication No. AP-42. Aug 1977.
*4. Highway Statistics. Federal Highway Administration, US Department of Transportation, Washington, DC. 1976.
*5. FAA Air Traffic Activity. Federal Aviation Administration, US Department of Transportation, Washington, DC. 1976.
*†6. Mineral Industry Surveys, Sales of Fuel Oil and Kerosene. Bureau of Mines, US Department of the Interior, Washington DC. 1976.
*7. Minerals Yearbook. Bureau of Mines, US Department of the Interior, Washington, DC. 1975.
8. Exhaust Emissions from Uncontrolled Vehicles and Related Equipment Using Internal Combustion Engines. Southwest Research Institute, San Antonio, TX. Prepared for US Environmental Protection Agency, Research Triangle Park, NC. EPA Contract No. EHS 70-108. Oct 1973.
9. Particulate Pollutant Systems Study. Midwest Research Institute, Kansas City, MO. Prepared for US Environmental Protection Agency, Research Triangle Park, NC. Natural Air Pollution Control Administration Contract No. CPA 22-69-104. May 1971.
10. Standard Computer Retrievals from the National Emissions Data System (NEDS). Unpublished computer report available from NADB,OAQPS, US Environmental Protection Agency, Research Triangle Park, NC.
11. Data from the Compliance Data System (CDS). Unpublished computer report available from Division of Stationary Source Enforcement, US Environmental Protection Agency, Washington, DC.
*12. Current Industrial Reports. Bureau of the Census, US Department of Commerce, Washington, DC.
13. 1968 National Survey of Community Solid Waste Practices. Public Health Service, US Department of Health, Education, and Welfare, Cincinnati, OH. PHS Publication No. 1867. 1968.
*14. Wildfire Statistics. Forest Service, US Department of Agriculture, Washington, DC. 1976.
*15. Statistical Abstract of the United States. Bureau of the Census, US Department of Commerce, Washington, DC. 1976 (97th ed.)
16. Coal Refuse Fires, an Environmental Hazard. Bureau of Mines, US Department of the Interior, Washington, DC. Information Circular 8515. 1971.
*17. Synthetic Organic Chemicals, U.S. Production and Sales. US Tariff Commission, Washington, DC.
18. Methodologies for Countywide Estimation of Coal, Gas, and Organic Solvent Consumption. Walden Research Division of Abcor, Inc., Cambridge, MA. Prepared for US Environmental Protection Agency, Research Triangle Park, NC. EPA Contract No. 68-02-1410, EPA Publication No. EPA-450/3-75-086. Dec 1975.

*These publications are issued periodically. The most recent publication available when this document was prepared is cited.

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16. ABSTRACT

This report presents estimates of trends in nationwide air pollutant emissions for the five major pollutants: sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides. Estimates are broken down according to major types of air pollutant sources. A short analysis of emission trends is given, along with a discussion of methods used to develop the data.

17. KEY WORDS AND DOCUMENT ANALYSIS

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