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ANTHROPOGENIC EMISSIONS
DATA FOR THE
1985 NAPAP INVENTORY

Prepared for

The National Acid Precipitation Assessment Program

Prepared by

Air and Energy Engineering Research
Laboratory
Research Triangle Park NC 27711

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ANTHROPOGENIC EMISSIONS DATA FOR THE 1985 NAPAP INVENTORY

Final Report

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ENGLISH TO METRIC CONVERSION FACTORS

1 ton = 907.1860 kilograms

1 foot = 0.3048 meters

1 gallon = 3.785 liters

1 cubic foot = 28.317 liters

1 megawatt = 1 million Joules/second
= 948.6 BTU/second

1 BTU = 1055 Joules

degrees Fahrenheit = (1.8 x °C) + 32

1 mile/hour = 1.609 kilometers/hour

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SECTION 1
EXECUTIVE SUMMARY

1.1 Background

The National Acid Precipitation Assessment Program (NAPAP) was established by Congress in 1980 (Title VII of P.L. 96-294) to coordinate and expand research on problems posed by acid deposition in and around the United States. Among the contributors to acid deposition, anthropogenic emissions sources from both the United States and Canada as well as natural sources are believed to be of primary importance. This document covers U.S. anthropogenic point and area source emissions.

A fundamental objective of NAPAP's research program is the investigation of emissions sources that may contribute to acid deposition. NAPAP's Task Group on Emissions and Controls has achieved this objective by developing historical and current inventories of acid deposition precursor emissions. The Environmental Protection Agency's Office of Research and Development has the responsibility for developing the 1985 NAPAP anthropogenic emissions inventory. Emissions inventories are necessary to assess the impact of various source types and characteristics on the emissions and abatement of acid precipitation precursors; to investigate and verify atmospheric process models that simulate source-receptor relationships; and to assess historical trends in emissions.

The objective of the 1985 NAPAP Emissions Inventory was to meet the needs of both the NAPAP acid deposition assessment and atmospheric modeling teams. These NAPAP users had three main requirements of the inventory: (1) that the data base have a consistent baseline, so that anthropogenic emissions and operating data reflect as accurately as possible a single and consistent year, (2) that the data base be complete and that the data be of the highest possible quality, and (3) that any problems or errors found in the data be accurately tracked with an Audit Trail. In order to meet these objectives, it was imperative that cooperation be established between the U.S. EPA, Environment Canada, and the State air pollution control agencies. During the development of the 1985 NAPAP Emissions Inventory, budgetary and scheduling constraints resulted in a need to develop priorities in the inventory effort to ensure that the information of most importance to NAPAP would be obtained and that the NAPAP objectives would be met.

1.2 Methodology

The U.S. anthropogenic emissions inventory is divided into two major categories, point and area sources. Point sources have precise location data and emit at least 100 tons per year (TPY) of a criteria pollutant (NO_x, SO_2, TSP, VOC, or CO). Area sources comprise both mobile sources and point sources too small and too numerous to list individually. Point source data are supplied to EPA by the State agencies in an essentially bottom-up collection strategy. The area source emissions estimates are calculated by EPA using a series of computer programs. This is primarily a top-down strategy which allocates national emissions estimates to the State and county levels.

The data collection efforts for 1985 point source data were prioritized to reflect the needs of the NAPAP research and assessment programs. Estimates of SO_2, NO_x, and VOC emissions were given the highest priority. In addition, the effort concentrated on facilities emitting at least 1000 TPY because they represent 97, 90, and 61 percent of the point source SO_2, NO_x, and VOC emissions, respectively. Of the 50 data elements in a NEDS record, the data collection effort focused on the 14 items that are most important for the NAPAP community. These priority items include the annual emissions estimates for SO_2, NO_x and VOC; the maximum design and annual operating rates; the Source and Standard Industrial Classification codes (SCC and SIC); emissions control equipment and efficiencies; fuel characteristics; stack parameters; location data; and operating schedules. The final 1985 NAPAP Emissions Inventory will contain estimates of emissions of five criteria pollutants, SO_2, NO_x, VOC, CO, and TSP, and four other chemical species believed to play an important role in acid deposition. These four other species are primary sulfate, hydrogen chloride, hydrogen fluoride, and ammonia.

Meeting the objectives of the NAPAP program required the cooperation of many different agencies and organizations including the NAPAP task groups, the State and Territorial Air Pollution Program Administrators (STAPPA), the U.S.

State and Territorial Air Pollution Program Administration (STAPPA), the U.S. and Regional EPA offices, and the State air pollution control offices. STAPPA began the collection effort with a survey to determine the capabilities and needs of the State agencies to meet the objectives of the 1985 NAPAP Emissions Inventory. Over the course of the study, EPA offered financial and technical assistance to States in the development of their inventories. Workshops and seminars were provided to acquaint State personnel with the priorities and objectives of the NAPAP Emissions Inventory. In addition, Contractor assistance was made available to collect, encode, and execute quality control programs on the State point source data.

1.3 Quality Control

Quality control (QC) procedures consisting of manual and computerized checking procedures were specifically designed for the 1985 NAPAP Emissions Inventory. These procedures were designed to ensure that the quality of the data met the requirements of the NAPAP community as closely as possible, given the resource constraints of the inventory effort.

QC was conducted at all levels of the inventory development. A computerized edit checking program (NE061) was made available to the States, Regional offices, and Contractors to help identify problems in the data while the data were still in the hands of the people most knowledgeable about the sources. As the data were entered into the NEDS, more checks were employed to ensure that the data were within reasonable limits and were internally consistent. For each State, a report was developed discussing possible problems with the data submission and was returned to the State and Regional offices to afford the people most knowledgeable about the data a chance to correct errors and comment on the QC findings. The States returned the QC reports with comments and corrected data. This effort was the first national emissions inventory in which the data were actually returned to the responsible agencies for their comments and corrections. As a result, the quality of this annual inventory is better than that of any previously developed national inventory.

1.4 Summaries and Analyses of the 1985 NAPAP Emissions Inventory

The following tables and figures summarize current emissions data in the 1985 NAPAP Emissions Inventory. Table 1-1 gives a State-level profile of the number of plants, points, and different processes (SCC occurrences). Table 1-2 presents an emissions summary for the three primary pollutants of concern, broken down into point and area sources by source category. Table 1-3 aggregates these categories into six major categories. These tables clearly show that over 90 percent of the sulfur dioxide emissions are from point sources and that approximately 70 percent of the total sulfur dioxide emissions are from electric utilities. Nitrogen oxide emissions are split between point and area sources. The electric utilities represent approximately 30 percent of the total NO_x emissions or 70 percent of the point source NO_x, while mobile sources account for 43 percent of the total NO_x or 80 percent of the area source NO_x. VOC emissions are dominated by area source categories, with mobile sources representing 33 percent of the total or 37 percent of the area source VOC emissions. Solvent evaporation loss is the second largest source, representing 21 percent of the total or 23 percent of the area source VOC emissions.

The relative importance of point versus area sources for the three pollutants is illustrated Figure 1-1. SO_2 emissions are dominated by point sources, NO_x emissions are almost evenly split between point and area sources, and VOC emissions are dominated by area sources. Figure 1-2 shows that for point sources, combustion by electric utilities dominates the SO_2 and NO_x emissions. Figure 1-3 shows that mobile souces dominate NO_x emissions while mobile sources and solvent evaporation loss (industrial processes) dominate VOC emissions. Figures 1-4 through 1-6 reillustrate this information by pollutant using pie charts.

Tables 1-4 through 1-6 break down the primary pollutants by State. The first table lists total emissions nationwide by State. The second and third tables illustrate point and area source emissions by State.

Table 1-7 and Figure 1-7 both demonstrate the distribution of point source emissions by plant size. For SO_2, 81 percent of emissions are from facilities emitting at least 10,000 tons per year. These facilities are primarily

TABLE 1-1. 1985 STATIONARY POINT SOURCE PROFILE (NEDS)

STATE	PLANTS	POINTS	POINT-SCC
Alabama	171	1,100	1,371
Arizona	67	223	311
Arkansas	118	754	804
California	651	8,399	12,599
Colorado	97	380	442
Connecticut	55	572	722
Delaware	38	217	275
Dist. of Col.	13	53	121
Florida	127	1,107	1,654
Georgia	184	1,592	2,321
Idaho	23	84	85
Illinois	520	8,703	8,707
Indiana	366	2,211	3,818
Iowa	64	2,622	3,039
Kansas	153	998	1,699
Kentucky	224	627	943
Louisiana	315	7,808	8,976
Maine	59	245	283
Maryland	124	1,323	1,777
Massachusetts	186	2,269	3,440
Michigan	296	3,431	4,114
Minnesota	217	2,817	4,975
Mississippi	130	282	468
Missouri	259	2,466	3,212
Montana	28	385	485
Nebraska	41	153	175
Nevada	22	126	188
New Hampshire	31	194	259
New Jersey	191	2,961	2,971
New Mexico	183	899	900
New York	383	1,469	2,125
North Carolina	348	2,543	3,078
North Dakota	44	111	121
Ohio	430	2,726	3,544
Oklahoma	212	1,967	2,504
Oregon	51	110	151
Pennsylvania	552	3,024	3,987
Rhode Island	24	105	176
South Carolina	126	517	704
South Dakota	18	30	71
Tennessee	298	4,565	5,696
Texas	859	27,657	31,426
Utah	64	213	355
Vermont	17	104	117
Virginia	260	1,706	2,749
Washington	181	1,008	1,520
West Virginia	184	6,555	6,767
Wisconsin	224	1,760	2,649
Wyoming	108	482	577
TOTAL	9,336	111,653	139,451

TABLE 1-2. 1985 U.S. EMISSIONS BY CATEGORY FOR SO_2, NO_x, AND VOC (10^3 TONS)

EMISSION CATEGORIES	AREA SO_2	AREA NO_x	AREA VOC	POINT SO_2	POINT NO_x	POINT VOC
FUEL COMBUSTION	1,070.4	2,022.2	2,433.7	18,132.9	8,570.4	219.7
External Combustion	1,070.4	2,022.2	2,433.7	18,086.6	7,833.9	136.8
Residential	178.2	407.1	2,395.3	0.0	0.0	0.0
Anthracite Coal	7.7	0.8	2.8	0.0	0.0	0.0
Bituminous Coal	29.5	2.1	7.5	0.0	0.0	0.0
Distillate Oil	128.2	75.0	2.9	0.0	0.0	0.0
Residual Oil	0.5	0.1	0.0	0.0	0.0	0.0
Natural Gas	1.2	248.3	13.4	0.0	0.0	0.0
Wood	11.0	80.7	2,368.8	0.0	0.0	0.0
Electric Generation	0.0	0.0	0.0	16,166.9	6,701.1	54.0
Anthracite Coal	0.0	0.0	0.0	22.4	14.8	0.3
Bituminous Coal	0.0	0.0	0.0	14,835.3	5,602.6	35.1
Lignite	0.0	0.0	0.0	627.8	394.7	6.2
Residual Oil	0.0	0.0	0.0	597.5	187.2	2.8
Distillate Oil	0.0	0.0	0.0	56.0	33.9	0.5
Natural Gas	0.0	0.0	0.0	6.5	448.3	7.0
Process Gas	0.0	0.0	0.0	0.2	11.5	0.1
Other	0.0	0.0	0.0	21.3	8.1	2.1
Industrial	662.4	1,404.1	30.9	1,750.3	1,061.2	79.8
Anthracite Coal	0.1	0.1	0.0	11.1	2.9	0.0
Bituminous Coal	353.3	130.5	0.6	1,080.8	384.2	4.3
Lignite	0.0	0.0	0.0	48.5	9.5	0.2
Residual Oil	236.0	46.5	0.2	396.9	138.6	4.3
Distillate Oil	54.7	49.8	1.6	19.5	23.3	0.7
Natural Gas	0.7	1,176.9	28.3	38.9	296.5	8.5
Process Gas	0.1	0.1	0.0	105.4	92.8	3.8
Coke	0.2	0.0	0.0	11.9	6.8	0.1
Wood	17.3	0.3	0.2	15.1	84.1	49.8
LPG	0.0	0.0	0.0	0.0	0.7	0.0
Bagasse	0.0	0.0	0.0	0.2	1.7	2.6
Other	0.0	0.0	0.0	22.0	20.2	5.3
Commercial/Institution	229.9	211.1	7.5	169.4	71.6	3.0
Anthracite Coal	15.5	5.5	0.0	3.4	1.2	0.1
Bituminous Coal	24.5	6.4	0.2	114.6	23.4	0.7
Lignite	0.0	0.0	0.0	1.0	0.5	0.2
Residual Oil	103.6	31.4	0.6	43.4	16.4	0.5
Distillate Oil	85.7	51.9	0.7	5.7	3.0	0.1
Natural Gas	0.5	115.9	6.0	0.7	22.1	0.3
Wood	0.0	0.0	0.0	0.1	2.8	0.5
LPG	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.0	0.5	2.3	0.6

TABLE 1-2. (continued)

EMISSION CATEGORIES	AREA SO_2	AREA NO_x	AREA VOC	POINT SO_2	POINT NO_x	POINT VOC
Internal Combustion	0.0	0.0	0.0	46.2	736.6	82.9
Electric Generation...	0.0	0.0	0.0	11.0	68.5	2.9
Distillate Oil......	0.0	0.0	0.0	10.0	15.4	0.6
Natural Gas.........	0.0	0.0	0.0	1.1	53.1	2.3
Industrial............	0.0	0.0	0.0	32.9	644.5	73.2
Distillate Oil......	0.0	0.0	0.0	0.4	5.4	0.4
Natural Gas.........	0.0	0.0	0.0	31.0	633.9	71.8
Gasoline............	0.0	0.0	0.0	0.0	0.1	0.2
Diesel Fuel.........	0.0	0.0	0.0	0.1	2.0	0.1
Other...............	0.0	0.0	0.0	1.3	3.1	0.7
Commercial/Institution	0.0	0.0	0.0	1.9	17.8	3.3
Engine Testing.......	0.0	0.0	0.0	0.4	5.7	3.5
INDUSTRIAL PROCESS........	0.0	0.0	0.0	2,906.9	923.0	2,138.2
Chemical Manufacturing..	0.0	0.0	0.0	501.6	171.7	518.3
Food/Agriculture........	0.0	0.0	0.0	3.4	4.8	50.5
Primary Metals..........	0.0	0.0	0.0	976.2	54.2	55.6
Secondary Metals........	0.0	0.0	0.0	50.1	20.6	18.4
Mineral Products........	0.0	0.0	0.0	289.3	240.8	17.3
Petroleum Industry......	0.0	0.0	0.0	788.5	288.5	231.3
Wood Products...........	0.0	0.0	0.0	130.6	73.5	45.6
Organic Solvent Evap....	0.0	0.0	0.0	0.9	8.3	825.2
Petroleum Storage/Trans.	0.0	0.0	0.0	1.5	1.2	290.8
Metal/Fabrication.......	0.0	0.0	0.0	0.3	1.9	3.3
Textile Manufacturing...	0.0	0.0	0.0	0.0	0.1	8.6
Other/Not Classified....	0.0	0.0	0.0	164.6	57.2	73.2
SOLID WASTE DISPOSAL......	14.6	69.2	608.8	20.1	18.3	11.1
Government..............	0.0	0.0	0.0	5.7	7.8	5.9
Municipal Incineration	0.0	0.0	0.0	5.6	6.4	5.2
Open Burning..........	0.0	0.0	0.0	0.0	0.4	0.0
Other Incineration....	0.0	0.0	0.0	0.1	0.9	0.7
Residential.............	9.6	60.3	590.7	0.0	0.0	0.0
On-site Incineration..	1.4	3.0	288.5	0.0	0.0	0.0
Open Burning..........	8.3	57.3	302.2	0.0	0.0	0.0
Commercial/Institutional	4.6	7.1	9.8	3.6	5.5	1.0
On-site Incineration..	4.6	6.9	8.4	3.6	5.5	1.0
Open Burning..........	0.0	0.2	1.4	0.0	0.0	0.0
Industrial.............	0.4	1.7	8.4	10.7	5.0	4.2
On-site Incineration..	0.3	0.3	2.6	10.7	4.9	4.1
Open Burning..........	0.1	1.4	5.8	0.0	0.1	0.1

TABLE 1-2. (continued)

EMISSION CATEGORIES	AREA SO_2	AREA NO_x	AREA VOC	POINT SO_2	POINT NO_x	POINT VOC
TRANSPORTATION............	863.6	8,834.4	7,287.7	0.0	0.0	0.0
Land Vehicles..........	690.9	8,549.2	6,667.5	0.0	0.0	0.0
Gasoline.............	274.4	5,139.4	6,102.9	0.0	0.0	0.0
Light Duty Vehicles.	185.2	3,368.3	3,643.7	0.0	0.0	0.0
Light Duty Trucks...	69.0	1,320.3	1,538.1	0.0	0.0	0.0
Heavy Duty Vehicles.	14.1	297.2	425.1	0.0	0.0	0.0
Off-Highway........	6.2	153.5	496.0	0.0	0.0	0.0
Diesel Fuel..........	416.5	3,409.8	564.6	0.0	0.0	0.0
Heavy Duty Vehicles.	242.9	1,825.2	259.7	0.0	0.0	0.0
Off-Highway........	82.6	994.2	161.6	0.0	0.0	0.0
Rail...............	91.0	590.4	143.3	0.0	0.0	0.0
Aircraft................	14.1	125.6	173.2	0.0	0.0	0.0
Military.............	4.8	37.4	87.1	0.0	0.0	0.0
Civil................	1.0	10.5	29.6	0.0	0.0	0.0
Commercial...........	8.3	77.8	56.6	0.0	0.0	0.0
Vessels.................	158.5	159.6	447.0	0.0	0.0	0.0
Bituminous Coal.......	3.6	0.2	0.6	0.0	0.0	0.0
Diesel................	15.8	118.2	29.6	0.0	0.0	0.0
Residual Oil.........	135.8	22.3	1.3	0.0	0.0	0.0
Gasoline.............	3.3	18.9	415.5	0.0	0.0	0.0
MISCELLANEOUS AREA........	4.2	129.4	6,184.2	0.0	0.0	0.0
Forest Fires...........	1.2	33.6	161.5	0.0	0.0	0.0
Forest Managed Burning..	3.0	82.0	293.1	0.0	0.0	0.0
Agricultural Burning....	0.0	8.4	55.0	0.0	0.0	0.0
Structural Fires........	0.0	5.4	44.4	0.0	0.0	0.0
Gasoline Stn. Evap. Loss	0.0	0.0	999.0	0.0	0.0	0.0
Solvent Evap. Loss......	0.0	0.0	4,631.3	0.0	0.0	0.0
ADDITIONAL AREA...........	0.0	0.0	3,385.8	0.0	0.0	0.0
POTWs..................	0.0	0.0	25.4	0.0	0.0	0.0
Cutback A..............	0.0	0.0	191.9	0.0	0.0	0.0
SOCMI Fugitives.........	0.0	0.0	164.5	0.0	0.0	0.0
Bulk Terminals/Plants...	0.0	0.0	398.0	0.0	0.0	0.0
Refinery Fugitives	0.0	0.0	762.4	0.0	0.0	0.0
Bakeries................	0.0	0.0	50.0	0.0	0.0	0.0
Pharmaceutical Mfg......	0.0	0.0	33.6	0.0	0.0	0.0
Synthetic Fiber Mfg.....	0.0	0.0	160.9	0.0	0.0	0.0
Oil/Natural Gas Fields..	0.0	0.0	194.0	0.0	0.0	0.0
TSDFs..................	0.0	0.0	1,405.1	0.0	0.0	0.0
GRAND TOTAL..............	1,952.9	11,055.3	19,900.3	21,059.8	9,511.6	2,369.0

Based on the 48 contiguous States and the District of Columbia

TABLE 1-3. 1985 U.S. ANTHROPOGENIC EMISSIONS (MAJOR CATEGORIES)

CATEGORY	TYPE		EMISSIONS (10^3 TONS) SO_2	NO_x	VOC
Utility Combustion (UC)	Point		16,177.9	6,769.6	56.9
Industrial Combustion (IC)	Area		662.4	1,404.1	30.9
	Point		1,783.2	1,705.7	153.0
		Subtotal	2,445.6	3,109.8	183.9
Other Combustion (OC)	Area		408.1	618.2	2,402.8
	Point		171.7	95.1	9.8
		Subtotal	579.8	713.2	2,412.6
Industrial Process (IP)	Area*		0.0	0.0	6,200.7
	Point		2,906.9	923.0	2,138.2
		Subtotal	2,906.9	923.0	8,338.9
Transportation (TRAN)	Area		863.6	8,834.4	7,287.7
Other (OTH)	Area		18.9	198.6	3,978.2
	Point		20.1	18.3	11.1
		Subtotal	38.9	216.8	3,989.3
GRAND TOTAL			23,012.7	20,566.9	22,269.3

* For this analysis, certain area source emissions contained within the the Miscellaneous and Additional Area Sources have been compared to the Industrial Process point sources; these area sources include solvent evaporation loss, synthetic organic chemical manufacturing, bulk plants, refinery fugitives, bakeries, pharmaceutical manufacturing, and synthetic fiber manufacturing.

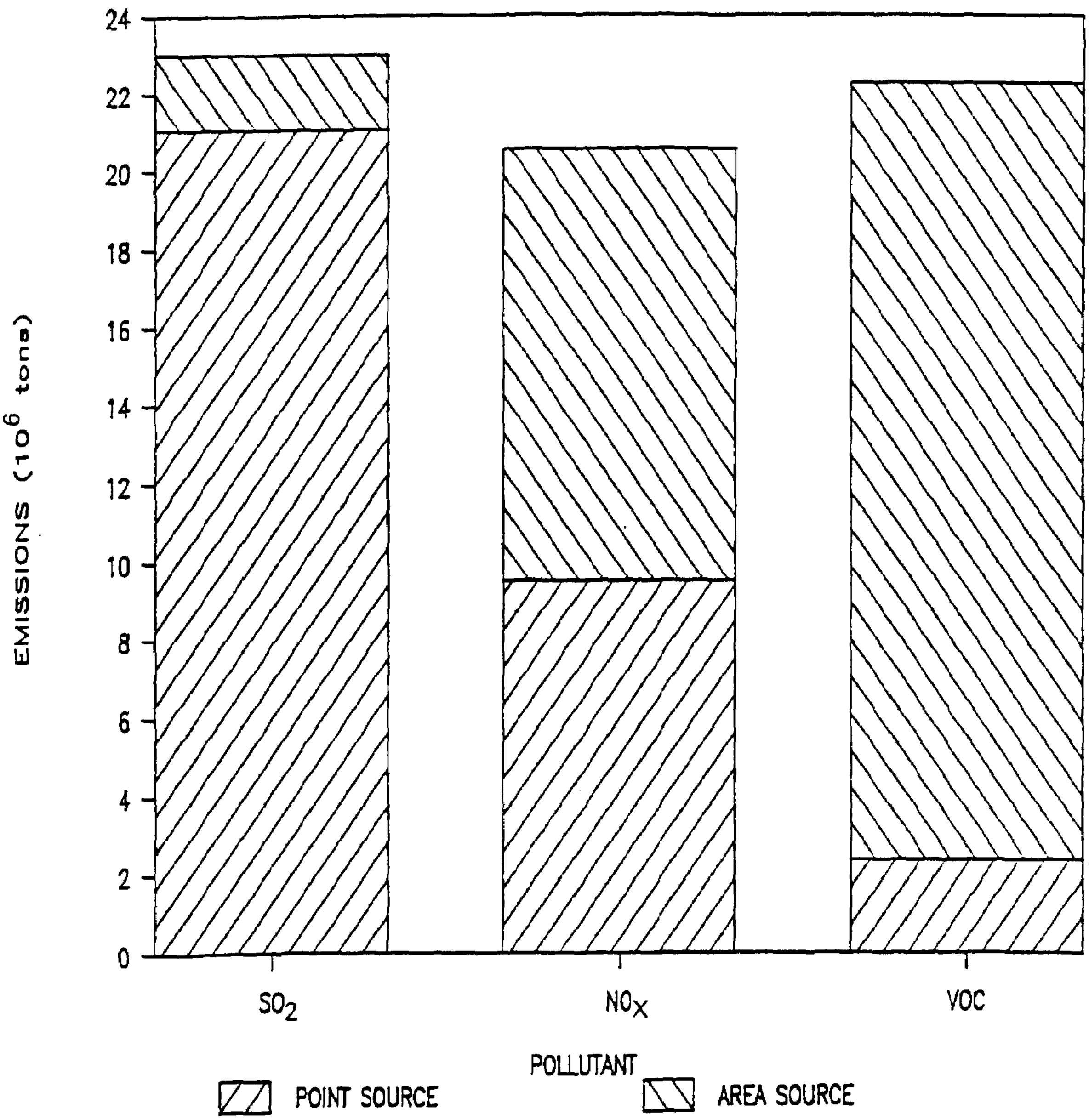
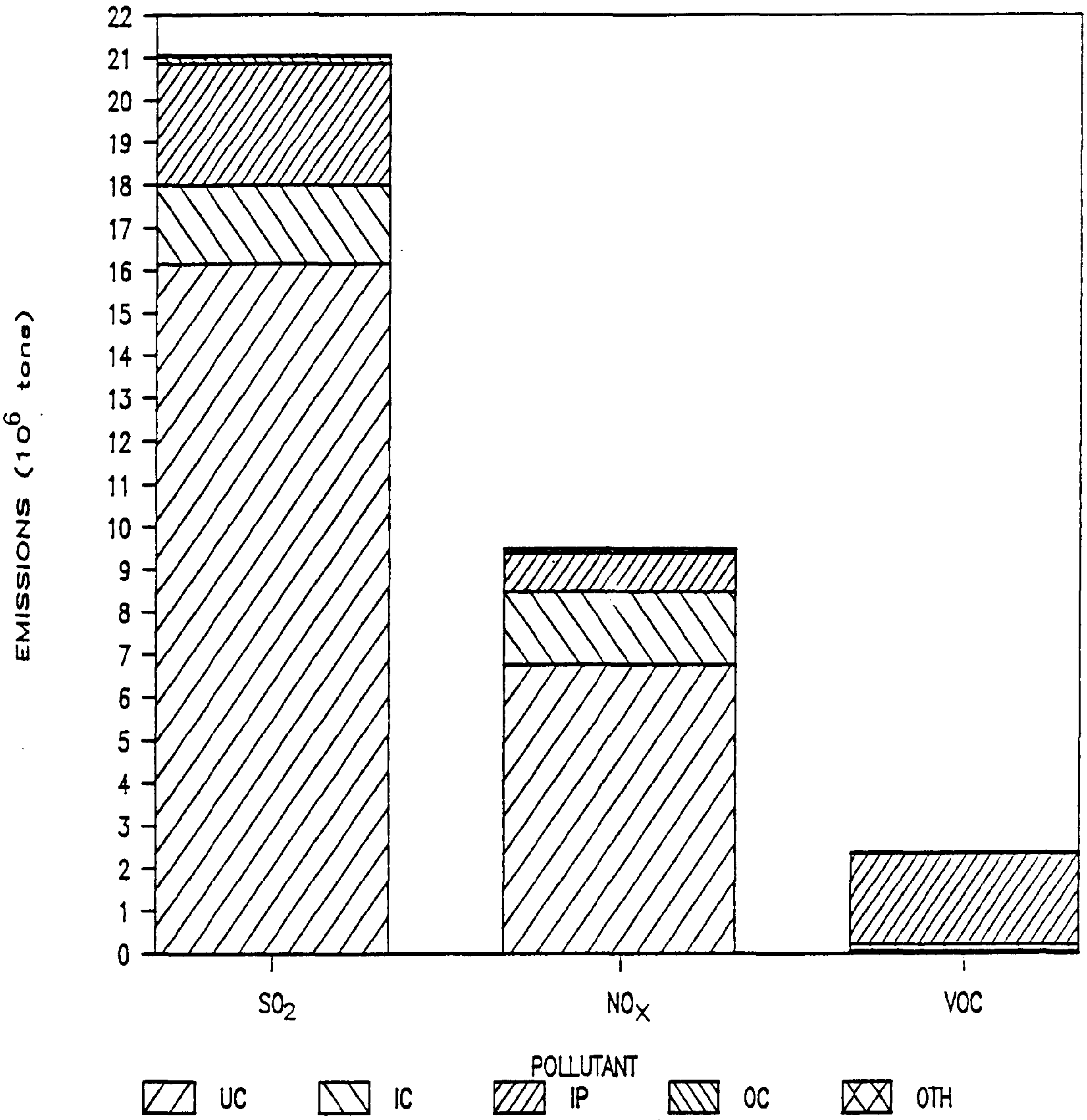
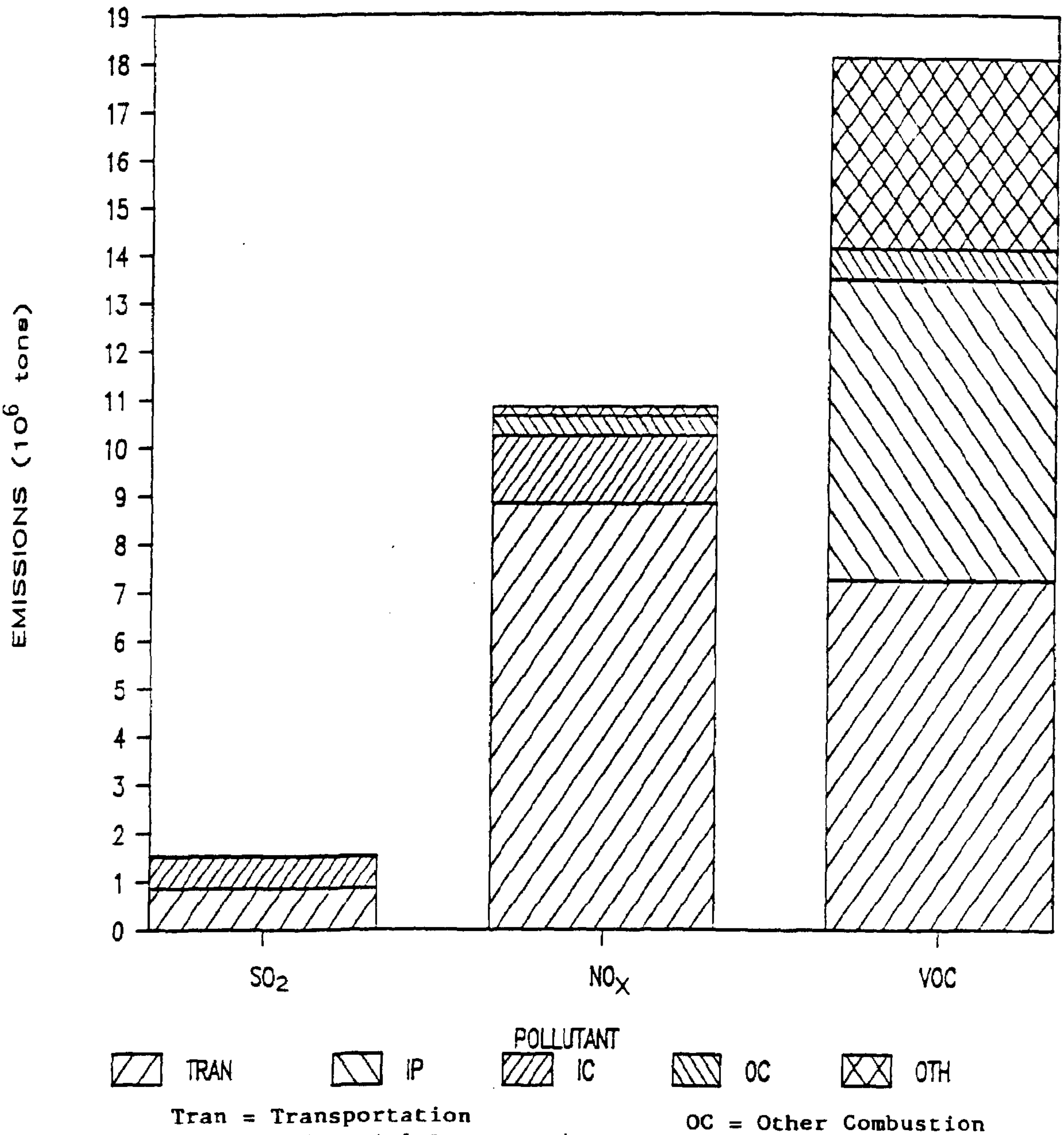


Figure 1-1. Comparison of point and area source SO_2, NO_x, and VOC emissions.



UC = Utility Combustion
IC = Industrial Combustion
IP = Industrial Processes
OC = Other Combustion
OTH = Other Sources

Figure 1-2. U.S. anthropogenic point source emissions.



Tran = Transportation
IP = Industrial Processes*
IC = Internal Combustion
OC = Other Combustion
OTH = Other Sources

* For this analysis, some Miscellaneous and Additional area source categories as listed in Table 1-3 have been included under Industrial Processes; this is not a NEDS area source category.

Figure 1-3. U.S. anthropogenic area source emissions.

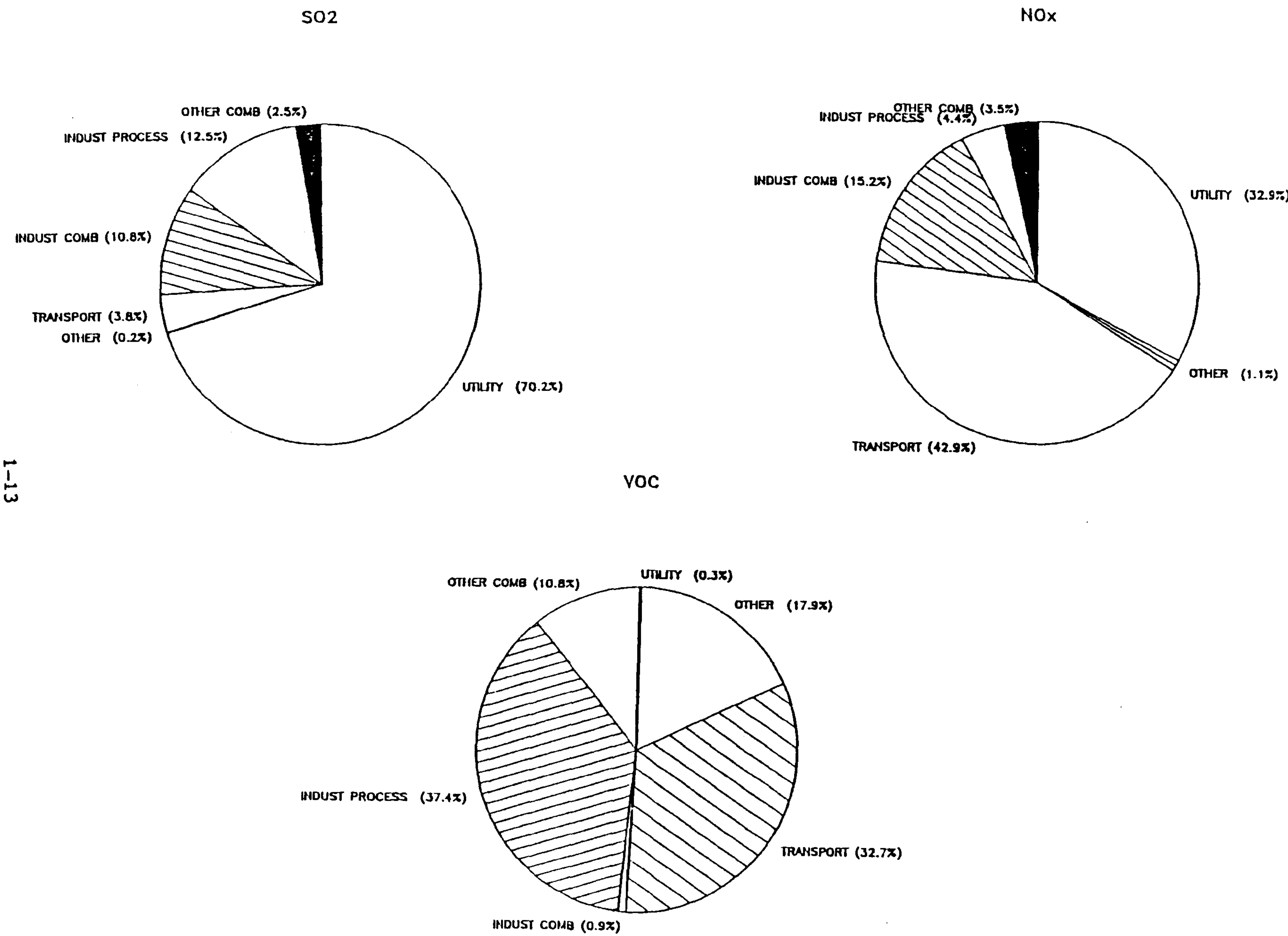


Figure 1-4. Distribution of 1985 SO_2, NO_x, and VOC emissions by major category.

TABLE 1-4. 1985 TOTAL SO_2, NO_x, AND VOC EMISSIONS (10^3 TONS)

STATE	SO_2	NO_x	VOC
Alabama	720.6	469.3	510.4
Arizona	699.4	245.5	225.3
Arkansas	109.5	238.0	223.6
California	225.2	1,244.6	2,111.7
Colorado	91.4	291.8	294.2
Connecticut	87.3	127.9	232.9
Delaware	117.6	68.5	68.3
Dist. of Col.	7.4	20.4	28.2
Florida	664.1	681.8	737.3
Georgia	1,111.5	590.7	587.6
Idaho	36.8	87.8	187.9
Illinois	1,397.8	971.6	957.1
Indiana	1,864.2	880.7	573.7
Iowa	289.7	265.2	205.5
Kansas	160.5	443.3	244.2
Kentucky	879.4	520.5	425.8
Louisiana	402.3	763.4	646.1
Maine	79.2	66.8	171.1
Maryland	307.4	281.7	257.4
Massachusetts	328.3	277.0	418.7
Michigan	550.6	658.4	789.0
Minnesota	174.8	355.9	430.6
Mississippi	174.6	238.8	275.1
Missouri	1,163.8	536.2	507.8
Montana	91.1	155.4	166.3
Nebraska	65.3	165.3	120.5
Nevada	40.3	112.7	76.2
New Hampshire	85.3	54.6	85.4
New Jersey	183.4	369.0	585.6
New Mexico	271.4	284.8	171.7
New York	665.1	626.3	987.7
North Carolina	484.8	501.1	678.7
North Dakota	221.3	183.2	60.8
Ohio	2,560.8	1,018.8	1,025.9
Oklahoma	150.1	396.4	357.8
Oregon	44.6	170.5	324.5
Pennsylvania	1,425.0	958.0	925.1
Rhode Island	9.2	30.3	67.3
South Carolina	236.8	259.1	355.7
South Dakota	43.2	72.7	84.0
Tennessee	977.3	511.4	554.9
Texas	1,476.3	2,477.6	2,324.1
Utah	71.8	170.7	165.1
Vermont	7.3	25.2	52.5
Virginia	311.5	390.1	577.9
Washington	168.5	274.9	479.5
West Virginia	1,058.4	461.4	410.7
Wisconsin	514.4	348.9	431.9
Wyoming	205.8	222.4	90.3
TOTAL	23,012.7	20,566.9	22,269.3

TABLE 1-5. 1985 POINT SOURCE SO_2, NO_x, AND VOC EMISSIONS (10^3 TONS)

STATE	SO_2	NO_x	VOC
Alabama	687.1	264.2	74.3
Arizona	674.6	75.4	3.7
Arkansas	83.3	71.0	22.8
California	81.2	230.8	97.1
Colorado	76.3	133.0	6.1
Connecticut	71.2	29.3	4.4
Delaware	113.8	42.0	7.8
Dist. of Col.	3.7	1.7	0.6
Florida	613.5	290.6	17.0
Georgia	1,084.5	292.5	35.8
Idaho	24.3	6.4	1.1
Illinois	1,361.6	565.4	163.9
Indiana	1,703.7	571.1	95.1
Iowa	272.0	99.2	7.3
Kansas	144.8	240.3	32.5
Kentucky	827.3	288.9	58.2
Louisiana	260.2	432.3	128.6
Maine	67.1	19.4	6.0
Maryland	254.0	95.8	13.9
Massachusetts	281.5	98.4	37.5
Michigan	519.2	318.5	94.4
Minnesota	154.7	154.5	49.3
Mississippi	158.9	74.5	36.2
Missouri	1,112.3	292.5	84.3
Montana	77.8	39.8	7.6
Nebraska	53.2	40.2	4.1
Nevada	34.3	62.5	0.6
New Hampshire	80.4	24.0	4.3
New Jersey	132.9	114.1	42.0
New Mexico	249.6	184.2	21.5
New York	571.3	183.5	53.2
North Carolina	436.0	233.9	74.1
North Dakota	200.4	115.9	2.9
Ohio	2,460.8	577.1	95.0
Oklahoma	118.4	155.1	31.8
Oregon	12.2	10.9	12.7
Pennsylvania	1,358.1	550.1	75.6
Rhode Island	4.0	2.7	6.0
South Carolina	219.6	118.1	25.9
South Dakota	36.5	17.1	5.6
Tennessee	945.6	277.6	96.9
Texas	1,255.0	1,163.4	450.4
Utah	53.1	86.8	16.1
Vermont	2.6	1.9	1.8
Virginia	262.8	139.0	86.6
Washington	137.4	73.3	29.6
West Virginia	1,049.5	381.7	78.9
Wisconsin	493.0	149.5	49.9
Wyoming	184.6	121.2	17.8
TOTAL	21,059.8	9,511.6	2,369.0

TABLE 1-6. 1985 AREA SOURCE SO_2, NO_x, AND VOC EMISSIONS (10^3 TONS)

STATE	SO_2	NO_x	VOC
Alabama	33.5	205.1	436.0
Arizona	24.9	170.0	221.6
Arkansas	26.2	167.0	200.3
California*	144.0	1,013.8	2,014.6
Colorado	15.1	158.8	288.1
Connecticut	16.1	98.6	228.4
Delaware	3.8	26.5	60.5
Dist. of Col.	3.6	18.8	27.5
Florida	50.6	391.2	720.3
Georgia	27.1	298.2	551.8
Idaho	12.5	81.3	186.9
Illinois	36.2	406.2	793.1
Indiana	160.5	309.6	478.6
Iowa	17.6	165.9	198.2
Kansas	15.7	203.0	211.7
Kentucky	52.2	231.5	367.6
Louisiana	142.1	331.1	517.4
Maine	12.1	47.4	165.1
Maryland	53.4	185.9	243.6
Massachusetts	46.9	178.6	381.2
Michigan	31.4	339.8	694.5
Minnesota	20.1	201.4	381.3
Mississippi	15.7	164.3	238.9
Missouri	51.5	243.8	423.5
Montana	13.3	115.6	158.7
Nebraska	12.0	125.1	116.4
Nevada	6.0	50.2	75.7
New Hampshire	4.9	30.6	81.0
New Jersey	50.5	254.9	543.6
New Mexico	21.8	100.7	150.2
New York	93.8	442.8	934.5
North Carolina	48.7	267.2	604.5
North Dakota	20.9	67.3	57.9
Ohio	100.0	441.8	930.9
Oklahoma	31.8	241.3	326.0
Oregon	32.4	159.7	311.3
Pennsylvania	66.9	407.9	849.4
Rhode Island	5.2	27.7	61.3
South Carolina	17.2	140.9	329.8
South Dakota	6.7	55.6	78.4
Tennessee	31.7	233.8	457.9
Texas	221.2	1,314.1	1,873.8
Utah	18.7	83.9	149.0
Vermont	4.8	23.3	50.7
Virginia	48.7	251.2	491.2
Washington	31.1	201.6	449.9
West Virginia	8.9	79.7	331.9
Wisconsin	21.4	199.4	381.9
Wyoming	21.2	101.1	72.5
TOTAL	1,952.9	11,055.3	19,900.3

* California maintains an extensive area source inventory that is not compatible with the NEDS. California area source totals from their State system are 87 x 10^3 TPY SO_2, 826 x 10^3 TPY NO_x, and 1,154 x 10^3 TPY VOC.

Table 1-7 and Figure 1-5 both demonstrate the distribution of point source emissions by plant size. For SO_2, 81 percent of emissions are from facilities emitting at least 10,000 tons per year. These facilities are primarily utilities and smelters. For NO_x, only 60 percent of emissions are from facilities emitting at least 10,000 tons per year. Again, these facilities are primarily utilities and large industrial sources. For VOCs, the distribution according to source size is far more uniform, reflecting the finding that VOC point source emissions originate in a wide variety of industrial processes.

Table 1-8 presents the relationship between point source emissions and stack height. Utility emissions of SO_2 and NO_x predominate the point source category; these boilers are typically associated with large stacks. Most point source VOC emissions, however, are contributed by industrial processes which typically vent emissions near ground level.

As is seen in Table 1-9, the 1985 NEDS inventory was largely successful in achieving its goal of a consistent baseline year. With few exceptions, the data represent 1985 emissions estimates and 1985 operating data. The second major objective was to compile a complete inventory of the data items that are most important to the NAPAP community. Table 1-10 illustrates that while some data elements are still missing in the 1985 NAPAP Emissions Inventory, the coverage of the data is excellent for large sources. These remaining missing items represent three categories: data intentionally left blank by the States, data not applicable to a particular source, or data which were not available. The first case includes emissions estimates which are designated by the States to be calculated by the NEDS software using State-supplied throughputs and standard emission factors. Inapplicable data include items such as blank stack heights for ground level sources (e.g., fugitives). As explained in Section 4, these data have been reviewed using computerized and manual checks at the State, Regional, and National levels. Large sources of SO_2, NO_x, and VOC have received the most scrutiny and most remaining missing items represent the first and second categories of missing data. However, several data elements, such as operating rate and maximum design rate, were specifically excluded from some States' requirements due to confidentiality restrictions, or because the existing State inventories lacked mechanisms to include the data.

TABLE 1-7. DISTRIBUTION OF EMISSIONS BY PLANT EMISSIONS SIZE CLASSES

POLLUTANT	RANCE (TONS)	NUMBER OF PLANTS	EMISSIONS (10^3 TONS)	PERCENT OF EMISSIONS
SO_2	>10,000	357	17,116	81%
	5,000 - 10,000	216	1,548	7%
	2,500 - 5,000	264	932	5%
	1,000 - 2,500	457	746	4%
	500 - 1,000	449	316	1%
	100 - 500	1,522	359	2%
	1 - 100	4,836	43	0%
			------	-----
			21,060	100%
NO_x	>10,000	224	5,632	60%
	5,000 - 10,000	173	1,174	12%
	2,500 - 5,000	248	873	9%
	1,000 - 2,500	549	867	9%
	500 - 1,000	564	403	4%
	100 - 500	2,026	473	5%
	1 - 100	4,317	90	1%
			------	-----
			9,512	100%
VOC	>10,000	17	231	11%
	5,000 - 10,000	44	299	13%
	2,500 - 5,000	120	416	17%
	1,000 - 2,500	317	492	21%
	500 - 1,000	473	327	13%
	100 - 500	2,355	518	21%
	1 - 100	4,775	86	4%
			------	-----
			2,369	100%

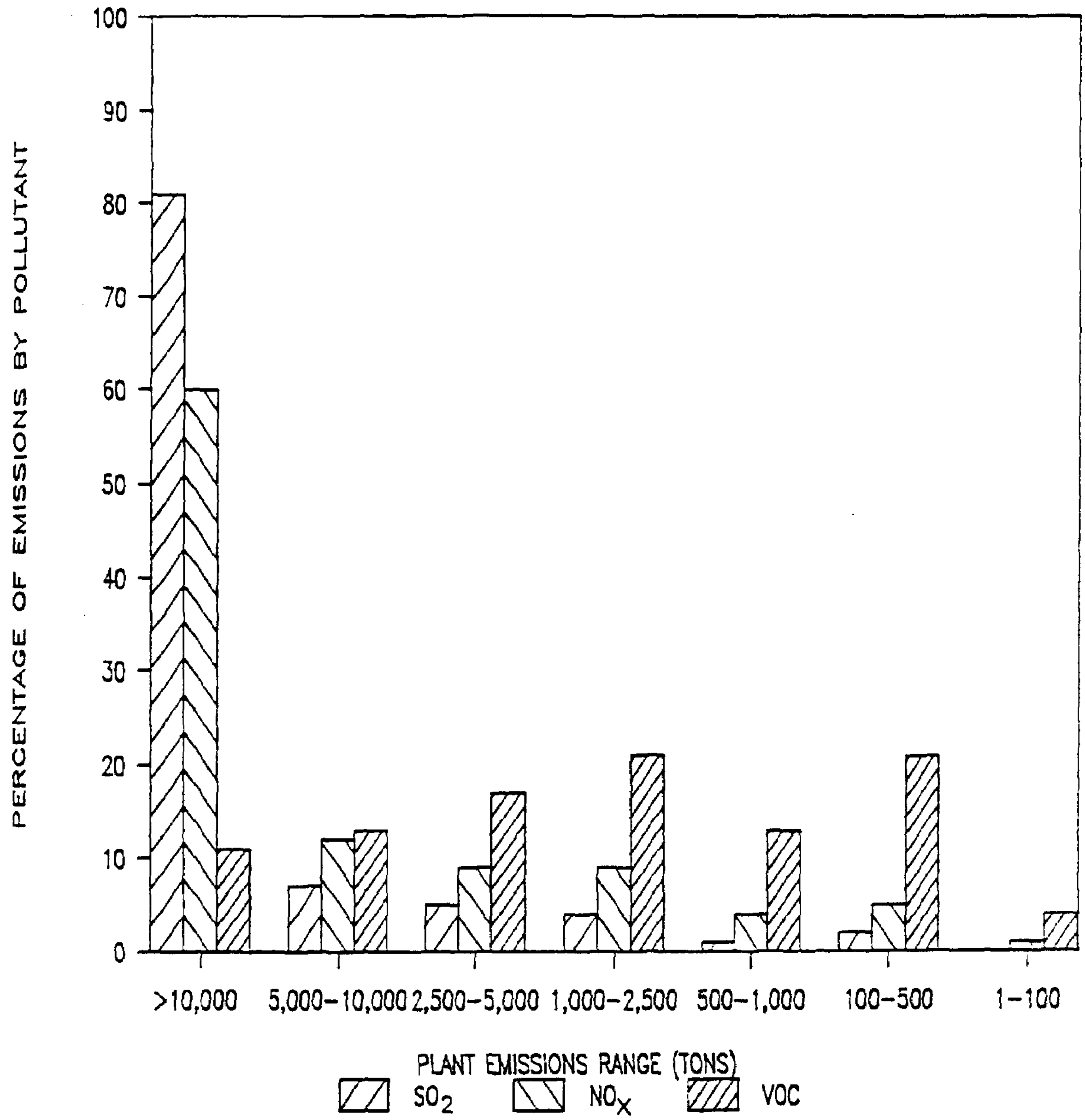


Figure 1-5. Distribution of emissions by plant emissions magnitude classes.

TABLE 1-8. SUMMARY OF 1985 SO_2, NO_x, AND VOC POINT SOURCE EMISSIONS BY STACK HEIGHT CATEGORIES (U.S. TOTAL)

STACK HEIGHT RANGE (Feet)	PERCENTAGE OF EMISSIONS		
	SO_2	NO_x	VOC
0 - 120	7.3	19.1	88.0
121 - 240	12.8	14.6	8.5
241-480	24.2	22.7	2.3
>480	55.7	43.6	1.2
EMISSIONS* (10^3 Tons)	20,974	9,474	2,374

* Do not equal total point source emissions because some point sources do not have stacks (e.g., process fugitive emissions)

TABLE 1-9. PERCENT EMISSIONS BY YEAR OF EMISSIONS (1000 TPY PLANTS)

STATE	SO_2 1985	SO_2 1982	NO_x 1985	VOC 1985	VOC 1984
Alabama	100%		100%	100%	
Arizona	100%		100%	100%	
Arkansas	100%		100%	100%	
California	100%		100%	100%	
Colorado	100%		100%	100%	
Connecticut	100%		100%	100%	
Delaware	100%		100%	100%	
Dist. of Col.	100%		100%	100%	
Florida	98%	2%	100%	100%	
Georgia	100%		100%	100%	
Idaho	100%		100%	100%	
Illinois	100%		100%	100%	
Indiana	100%		100%	100%	
Iowa	100%		100%	100%	
Kansas	100%		100%	100%	
Kentucky	100%		100%	100%	
Louisiana	100%		100%	100%	
Maine	100%		100%	100%	
Maryland	100%		100%	100%	
Massachusetts	100%		100%	100%	
Michigan	100%		100%	100%	
Minnesota	100%		100%	100%	
Mississippi	100%		100%	100%	
Missouri	100%		100%	100%	
Montana	100%		100%	100%	
Nebraska	100%		100%	100%	
Nevada	100%		100%	100%	
New Hampshire	100%		100%	100%	
New Jersey	100%		100%	100%	
New Mexico	100%		100%	100%	
New York	100%		100%	100%	
North Carolina	100%		100%	100%	
North Dakota	100%		100%	100%	
Ohio	100%		100%	100%	
Oklahoma	100%		100%	100%	
Oregon	100%		100%	100%	
Pennsylvania	100%		100%	100%	
Rhode Island	100%		100%	100%	
South Carolina	100%		100%	100%	
South Dakota	100%		100%	100%	
Tennessee	100%		100%	100%	
Texas	100%		100%	100%	
Utah	100%		100%	100%	
Vermont	100%		100%	100%	
Virginia	100%		100%	100%	
Washington	100%		100%	100%	
West Virginia*	100%		100%	83%	17%
Wisconsin	100%		100%	100%	
Wyoming	100%		100%	100%	

* Submitted 1984 data for certain VOC sources under agreement with EPA

TABLE 1-10. MISSING ITEMS FOR THE 1985 NAPAP EMISSIONS INVENTORY (1000 TON PLANTS, 25 TON POINTS)

NAPAP DATA ITEMS	MISSING ITEMS	
	1985*	Percent*
UTM Zone	8	0.4%
UTM Coordinates	4	0.2%
SIC	86	0.3%
Stack Height	158	0.5%
Stack Diameter	178	0.6%
Stack Temperature	726	2.4%
Stack Gas Flow Rate	220	0.7%
Plume Height	158	0.5%
Boiler Capacity	690	3.8%
Primary Control Equipment# (SO_2, NO_x, VOC)	18,332	19.9%
Secondary Control Equipment# (SO_2, NO_x, VOC)	19,958	21.6%
Control Efficiency# (SO_2, NO_x, VOC)	16,939	18.4%
Percent Annual Throughput	172	0.6%
Complete Normal Operating Schedule	704	2.3%
Emissions Estimate+ (SO_2, NO_x, VOC)	0	0.0%
Estimation Method (SO_2, NO_x, VOC)	6,409	6.9%
Year of Record (Emissions)	0	0.0%
Annual Operating Rate	1,316	5.9%
Maximum Design Rate	1,527	6.9%
Fuel Sulfur Content	807	3.6%
Fuel Ash Content	1,421	6.4%
Fuel Heat Content	1,463	6.6%

Based on 48 contiguous States and the District of Columbia

* Excludes exempted operating data from Texas for 1985

+ Excludes emissions estimates that are calculated by NEDS

Within NEDS, States may report control equipment as blank to indicate that no information is available to the State or that the status of the control equipment is uncertain; this situation overestimates the number of items actually missed by the inventory process.

1.5 Documentation

An extensive Audit Trail was developed to document both problems with the data and the history of the data. All the results of the Quality Control measures performed on the data have been documented in memos kept in a QC notebook. When the problems resulted in corrective action, the changes to the data were listed in computerized files called the Audit Trail. The Audit Trail lists the source identifiers, the old and new data values, the date of the change, and the party responsible for the change.

Data tapes containing the final 1985 U.S. anthropogenic point and area source data are available. These tapes contain a more comprehensive collection of data than is described in this report. The Audit Trail files are also available to users of the data to help them identify the source of a data element. The QC notebook is part of the project docket.

SECTION 2

INTRODUCTION

2.1 EMISSIONS RESEARCH AND THE NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM

The National Acid Precipitation Assessment Program (NAPAP) was established by Congress in 1980 (Title VII of P.L. 96-294) to coordinate and expand research on problems posed by acid deposition in and around the United States. A fundamental objective of NAPAP's research program is the investigation of emissions sources that may contribute to acid deposition.

NAPAP's Task Group on Emissions and Controls has achieved this objective by developing historical and current inventories of acid deposition precursor emissions. Information about historical trends in emissions is required to analyze long-term trends in precipitation acidity and dry deposition and to study these deposition effects on forest, aquatic, agricultural, and material resources. Current emissions inventories are required to assess the impact of various source types and characteristics on the emissions and abatement of acid precipitation precursors. Inventories of current emissions are also required to investigate and verify atmospheric process models that simulate source-receptor relationships.

The development of current emissions inventories requires the investigation of literally hundreds of thousands of sources of air pollution. These include stationary or point sources such as refineries and utility boilers as well as area or dispersed sources such as motor vehicle emissions along highways. The analysis of these sources must include the calculation of emissions and documentation of those engineering parameters which affect the atmospheric transport of emissions, such as stack height. Because transport of pollutants plays a critical role in acid deposition processes, emissions inventories must encompass geographic areas larger than those in which acidification and deposition are thought to occur. Thus, the investigation of acid precipitation in the northeastern United States and Canada requires the development of emissions inventories for all States and Provinces in both countries.

Assembling current emissions inventories across such a broad geopolitical scale has required careful planning and coordination among the principal agencies responsible for inventory development. This cooperation was explicitly anticipated in Public Law 96-294, Sections 704(b)(1) and (11), which described the need for joint research in the States and in interested nations such as Canada.

In the United States, the Environmental Protection Agency's (EPA's) Office of Research and Development has the responsibility for completing the 1985 NAPAP Emissions Inventory for NAPAP's Task Group on Emissions and Controls. To accomplish this objective, EPA has worked closely with both State air pollution control agencies and the State and Territorial Air Pollution Program Administrators to plan, fund, assemble, and ensure the quality of the 1985 inventory data. The EPA and States have the authority to collect required emissions data under Title 40 of the Code of Federal Regulations, Part 51, Section 51.321 - 51.323.

In Canada, Environment Canada has the responsibility for developing national emissions inventories. In a manner analogous to the State-EPA partnership in the United States, Environment Canada works with Provincial air pollution control programs to collect emissions data for Canadian industries. The individuals identified in the acknowledgement in the preface to this report represent only part of the team of scientists and engineers in the many agencies that cooperated to develop the 1985 NAPAP Emissions Inventory.

2.2 1985 EMISSIONS INVENTORY OBJECTIVES

The goals and specifications for the 1985 NAPAP Emissions Inventory were developed to meet NAPAP acid deposition assessment and atmospheric modeling research objectives. Figure 2-1 summarizes key chemical reactions in the complex acid deposition process. These indicate that not only SO_2 and NO_x, but also oxidants such as ozone and hydrogen peroxide are required for the production of acids which cause acid precipitation. For example, sulfuric acid is formed by the oxidation of sulfur dioxide by ozone and by hydrogen peroxide in acidic clouds. Nitric acid is formed by the oxidation of nitrogen dioxide with hydroxyl radicals, which in turn are formed from volatile organic

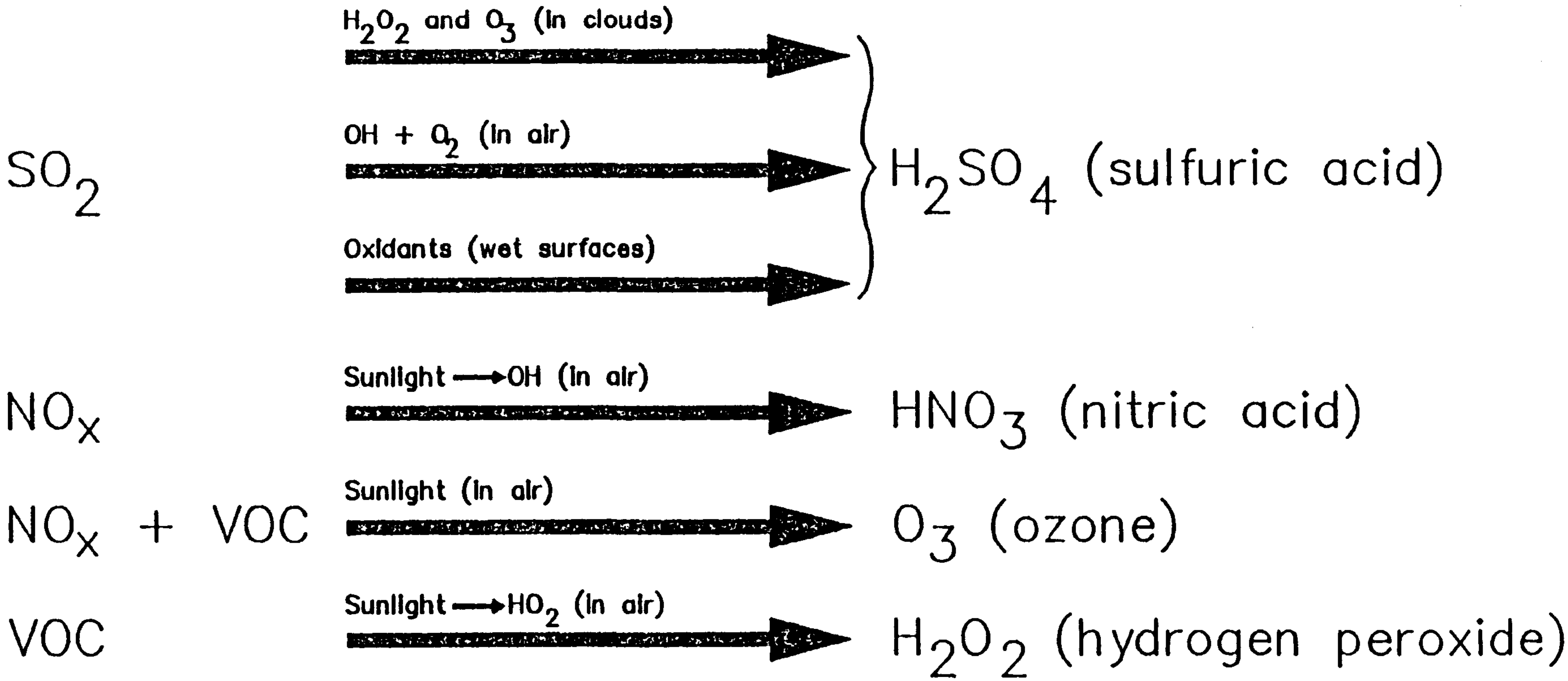


Figure 2-1. Acid rain precursors and products.

compounds and sunlight. Ozone is formed when nitrogen oxides and volatile organic compounds react in the presence of sunlight. Hydrogen peroxide is formed by volatile organic compounds reacting in the presence of sunlight.

In summary, the pollutant specifications for the 1985 NAPAP Emissions Inventory include sulfur dioxide, nitrogen oxides, volatile organic compounds, and, to a lesser extent, acid gases such as hydrochloric acid and hydrofluoric acid. The emissions inventory system employed by EPA and the States is designed to measure or directly estimate emissions of the first three of these pollutants. Emissions of many other pollutants, including the latter two listed above, can be estimated indirectly from other information collected by the inventory system. In the case of combustion sources such as boilers, the information required to estimate emissions of these other pollutants includes data on boiler design, the quantity and quality of fuel fired in the boiler, and the amount of fuel fired during the year. For other industrial process sources, required information includes an estimate of the feedstock or industrial process throughput during a year, and a detailed description of the industrial process.

Transformation and transportation of these acid precursor emissions begins almost immediately after they are emitted into the atmosphere. To a large extent, transformation processes depend on prevailing meteorological conditions, the atmospheric concentration of the pollutants, and the reaction rates of the available chemical species. However, the transport of these precursors emitted to the atmosphere through stacks or vents is determined in part by the height of the stack or vent above ground, and by the temperature, flow, and velocity of the pollutants leaving the stacks or vents.

Thus, specifications for the 1985 NAPAP Emissions Inventory must include not only pollutant emissions information, but also information about the location, engineering design, and performance of the industrial processes, stacks, and vents which inject the pollutants into the atmosphere. Some of this information is not required, however, for area or dispersed sources. These types of sources generally do not emit pollution through stacks or vents. Pollution from these sources is usually released at ground level; atmospheric transport of these emissions is determined by prevailing meteorological conditions.

Table 2-1 summarizes these objectives and specifications for the 1985 NAPAP Emissions Inventory. The specifications provide a logical prioritization for the inventory process that reflects the needs of the NAPAP research and assessment programs. The inventory process focuses on facilities emitting at least 1000 tons of SO_2, NO_x, or VOC. Fourteen data elements, the items of most importance to NAPAP, are given highest priority from among the 50 data items contained in each NEDS record. These priority elements include annual emissions estimates for SO_2, NO_x, and VOC, the maximum design and operating rates, the Source and Standard Industrial Classification Codes (SCC and SIC), emissions control equipment and efficiencies, fuel characteristics, location data, and operating schedules.

2.3 1985 Emissions Inventory Data

In analyzing and using the emissions inventory data contained in this report and the associated computer data bases, three factors should be considered carefully. These factors affect the type of conclusions that should be drawn from the use and analysis of the 1985 NAPAP Emissions Inventory data.

The first factor is that the emissions data contained in emissions inventories are based on estimates of emissions rather than on measured values. The development of an emissions inventory as broad in geographic and temporal resolution as the 1985 NAPAP Emissions Inventory would not be feasible if direct measurements were required for each of the hundreds of thousands of emissions sources that it encompasses.

Because of this constraint, the States and EPA have expended a great deal of effort to estimate emissions for each of approximately 3300 industrial processes currently operating in the United States and Canada. During the last decade, emissions from typical sources in most of the important industrial process categories have been measured using standardized and EPA-approved sampling techniques.

After a number of sources in each of the important industrial categories have been tested, the measured test results are averaged for each category to develop emission factors. These emission factors result from calculations that determine the quantity of a pollutant released as a function of some activity

Table 2-1. 1985 Emissions Inventory Priorities

Plant Size	Complete NEDS Submittal	Emission Estimates for SO_2	NO_x	VOC	TSP	CO	SCC	Control Equip/ Effic'y	Fuel/ Operat'n Data	Locat'n Data	Stack Data	Temporal Data	Other Key Data	Plants Confirm Emiss'n	SIC
I >500 TONS VOC & >1000 TONS OTHERS	H	H	H	H	M	L	H	H	H	H	1	H	M	2	L
II >100 TONS ALL	M	3	3	4	M	L	H	3	3	H	M	L	L	L	L

PRIORITY: H=HIGH M=MEDIUM L=LOW

1 - HIGH for stacks > 100 feet; LOW for stacks < 100 feet.

2 - HIGH for plants with emissions of SO and NO > 2500 tons.

3 - HIGH for combustion sources; MEDIUM for other industries.

4 - HIGH for petroleum refineries and chemical processors; MEDIUM for other industries.

that is directly associated with its release (such as the number of pounds of volatile organic compounds released to the atmosphere for each gallon of solvent used in a dry-cleaning process). The emission factor is multiplied by the activity level of that industrial process over a given period of time to estimate emissions. To estimate emissions at a given plant during a year, this calculation is carried out using annual activity estimates and emission factors for each of the industrial processes in operation during the year.

The second factor that must be considered when using and analyzing emissions inventory data is the uncertainty surrounding the emissions estimates. Because the inventory data are estimated rather than measured values, traditional methods of assuring data quality such as accuracy and precision cannot be used.

To date, research by NAPAP and EPA experts to develop new methods for calculating the uncertainty of emission estimates has not been completed. The research focuses on the most important parameters that must be accounted for in estimating emissions and transport for each of the industrial processes currently operating in the United States and Canada:

- the emission factor for each industrial process,
- the annual activity level,
- the variation of industrial feedstock constituents which can affect emissions over time (e.g., coal sulfur content),
- the efficiency and operational availability of air pollution control devices for each industrial process,
- the "allocation" factors used to disaggregate annual estimates into more resolved estimates such as seasonal or daily values, and
- data omission or translation errors which are introduced as the inventory data are first acquired in the field and then encoded on computer forms and transmitted electronically from one computer to another.

The third factor that must be considered when using emissions inventory data is the completeness and accuracy of the information in the data base. For the 1985 NAPAP Emissions Inventory, both EPA and State air pollution control agencies worked together to ensure that the data were as complete and accurate as possible. One indication of the level of attention that this effort received in both EPA and State agencies is the communication from EPA Administrator and Assistant Administrator to both EPA and State participants in the inventory (Appendix A).

Where funding or schedule constraints on the completion of the 1985 NAPAP Emissions Inventory prevented complete attainment of the NAPAP inventory objectives, priorities were established to ensure that the information of most importance to NAPAP would be obtained. These priorities, presented in Table 2-1, ensured that 1985 NAPAP Emissions Inventory data would, at a minimum, be accurate and comprehensive for virtually all of the stationary and dispersed sources of interest to NAPAP researchers.

2.4 OBJECTIVES AND STRUCTURE OF THIS REPORT

This report on the 1985 NAPAP Emissions Inventory is structured to provide users with the tools to enable accurate analysis of the computerized inventory information. It is divided into sections to meet four objectives: first, documentation of the development of the 1985 NAPAP Emissions Inventory; second, documentation of the quality control effort to ensure the quality of the inventory; third, presentations of selected analyses conveying the results of the quality control effort and summaries of 1985 emissions data with the conclusions that can be drawn from these data; and fourth, documentation of the QC and inventory data to provide users with the information necessary to properly assess the inventory content and data tapes.

Sections 3 and 4 are designed to meet the first two objectives of defining the inventory's process and scope. Section 3 describes in detail the methods which were used to assemble the 1985 NAPAP Emissions Inventory from design to implementation. Section 4 outlines the quality control plan and data quality objectives for the inventory.

Section 5 fulfills the third objective of this report by describing the inventory quality achieved and summarizing the data collected. It presents two different data analyses important to the user community: first, the degree to which the inventory met NAPAP objectives for content and completeness is analyzed, and second, the inventory emissions data are summarized and major conclusions from these data are drawn.

Finally, the final objective of additional documentation for an accurate assessment of the quality and extent of the NAPAP Emissions Inventory is provided in the Appendices, which present additional information: Appendix A contains the communication from the EPA Administrator and Assistant Administrator which defined the importance of the inventory effort, Appendix B provides a list of NEDS edit check software error messages, Appendix C details each State's emissions of SO_2, NO_x, and VOC by descriptive category, and Appendix D lists criteria pollutant emissions by SCC and area source category to provide an accurate benchmark when assessing the data tapes. Appendix E is a glossary of terms used in NAPAP inventory work with which readers may not be familiar.

The 1985 NAPAP Emissions Inventory is an assessment inventory, focusing on U.S. anthropogenic annual and seasonal emissions data for five criteria pollutants and four non-criteria pollutants. The criteria pollutant data have been obtained from the States and the non-criteria estimates have been calculated based on State-reported source-specific information. This inventory and report are not relevant to U.S. biogenic emissions, Canadian anthropogenic or biogenic emissions, or the speciated and temporally/spatially-resolved estimates which are specific to the modeling inventory. These inventories will be addressed in subsequent efforts and reports.

SECTION 3

METHODOLOGY

The purpose of this section is to describe the methods which were used to develop and collect emissions inventory data for the 1985 NAPAP Emissions Inventory. For the NAPAP inventory, the National Emissions Data System (NEDS), an existing EPA inventory computer system, was used to convey and store information. However, EPA and the States have modified, supplemented, and improved the NEDS for the 1985 effort, so that the system is substantially different than the conventional system used in previous years.

The organization of this section reflects the bipartite NEDS file structure. The first file, which consists of State-reported point source data, is discussed in Section 3.1. The second file, which contains area source data calculated by EPA, is described in Section 3.2. This chapter also presents information on two other types of data collected at the national level: (1) utility-related fuel use and boiler data (Section 3.1.6), and (2) sources, procedures, and estimates of noncriteria pollutant emissions of interest to acid deposition assessment (Section 3.3), including primary sulfates, hydrogen fluoride, hydrogen chloride, and ammonia. These methods were developed to calculate NAPAP anthropogenic emission estimates from point and area sources for acid rain precursors in the U.S.

The point source emissions data base is collected at the State level. It includes emissions estimates and supporting data gathered by State air pollution control agencies from point sources within each State. The national data base is the sum of these State-level source inventories, collected for each industrial process and compiled successively at the source, State, and national levels.

The area source data base represents anthropogenic emissions from true area sources (e.g., mobile sources), from plants which emit less than 100 tons per year (TPY), and from point sources which emit less than 25 TPY or which are too difficult to inventory individually. Area source emissions are calculated by EPA through a process in which county-level emissions are estimated using category-specific emission factors and activity levels (e.g., published fuel deliveries), and then summed to produce national emissions estimates. These fundamentally different approaches characterize the distinction between the point and area source data bases, which are described below in detail.

3.1 POINT SOURCE DATA

3.1.1 NEDS Structure

Subpart Q of 40 CFR Part 51 (Sections 51.320 through 51.323) authorizes annual reporting by the States to EPA of emissions inventory data for all stationary sources (i.e., plants) emitting 100 TPY or more of criteria pollutants. An exception to the 100-ton limit is made for carbon monoxide (1000 TPY). For plants meeting these requirements, any points (e.g., stack or process within the plant) emitting 25 TPY or more of any criteria pollutant (250 tons for CO) are to be reported. Points with lower emissions may also be reported by the State if resources are available. Points and sources not meeting these criteria and not reported in the NEDS point source inventory are considered area sources. Their emissions are included in county-wide area source emissions estimates as described in Section 3.2.

Data reported for point sources in NEDS may be categorized according to the following groups:

General source information -- name, address, type(s) of sources(s), Standard Industrial Classification, year of record, and comments.

Emissions data -- operating or production rates and capacities, estimated emissions, estimation method, and type and efficiency of control devices for each pollutant.

Modeling parameters -- UTM coordinates of source, stack height and diameter, exhaust gas temperature, and gas flow rate.

Compliance information -- allowable emissions, compliance status, and compliance schedules.

NEDS point source data are organized into three hierarchical levels: plant, point, and process.

Plant level data apply to an entire facility.

Point level data apply to individual emission points within a plant. A plant may contain any number of emission points. A point is that portion of a facility that may be considered individually for emission purposes. A point may contain one or more processes or pieces of equipment that contribute to the emissions from the point. In most cases, a point emits pollutants through a single confined location such as a stack. A point may also be an aggregation of two or more similar pieces of equipment which, taken separately, would not qualify for inclusion due to emissions of SO_2, NO_x, or VOC of less than 25 TPY. In addition, defined emissions sources without stacks may be included in NEDS as point sources (for example, fugitive emissions from plant equipment, storage piles, and lagoons).

Process level data apply to individual processes within a point and are utilized to calculate emissions. Each process is defined by a Source Classification Code (SCC).[1] In general, for each SCC there are emission factors which relate the quantity of pollutants generated by a process to an annual process operating rate. These emission factors are used to compute emissions. Multiple processes and multiple SCCs may be grouped under one emission point, as in the cases of boilers using two fuels or two separate processes sharing the same stack.

Table 3-1 illustrates the hierarchical structure of the NEDS point source data file and the individual data items at each level. Individual data items of importance to NAPAP are discussed in the following section. Table 3-1 has omitted the "year of record" entries for all levels, as well as other items not currently in use.

3.1.2 Priority Data Elements/NAPAP Emissions Inventory Priorities for 1985

To help guide data collection efforts for 1985, data collection objectives were prioritized as summarized in Table 3-1. This prioritization reflected the needs of the NAPAP research and assessment programs for atmospheric transport, as well as EPA and State inventory needs.[2] Emissions of SO_2, NO_x, and VOC

TABLE 3-1. NATIONAL EMISSIONS DATA SYSTEM (NEDS) DATA STRUCTURE

PLANT LEVEL DATA
- State, county, Air Quality Control Region, city and UTM zone codes
- Plant identification number
- Plant name, address and contact person

POINT LEVEL DATA
- Point identification number
- Standard Industrial Classification code
- UTM coordinates
- Stack/plume data (height, diameter, temperature, flow rate)
- Points with common stack
- Boiler design capacity
- Control equipment (primary amd secondary device codes for each criteria pollutant and overall efficiencies by pollutant)
- Operating schedule (by season, hrs/day, days/wk, wks/yr)
- Emission estimates for criteria pollutants (actual, with estimation method, and allowable)
- Compliance data (status, schedule, update, regulations)

PROCESS LEVEL DATA
- Source Classification Code
- Operating rates (annual, maximum hourly design)
- Fuel content (sulfur, ash, heat)

were assigned highest priority. Emissions of TSP were assigned an intermediate priority level. The highest priority level was assigned to plants emitting at least 1000 tons of these pollutants during 1985. The next level of priority for these pollutants was assigned to plants emitting 100 to 1000 tons during 1985.

Table 2-1 reflects the NAPAP/EPA consensus on the fourteen highest priority data elements from among the fifty available in NEDS. To obtain a nationally consistent baseline, it was critical to obtain actual 1985 data for emissions estimates and operating rates. The other priority data elements fell into three categories: emissions estimation data, spatial/temporal data, and data to identify inconsistencies. All these items were selected for their importance to the acid deposition research and assessment communities.

Annual Emissions Estimate--Complete reporting of emissions for all significant emission points (defined as points emitting more than 25 tons in 1985 of SO_2, NOx, or VOC) was most important. To establish the best possible national emissions inventory for 1985, maximum use of standard procedures for calculating emissions was recommended. Emissions calculation procedures are discussed in more detail in Section 3.1.7. The inclusion of calendar year 1985 estimates was critical to establish a consistent baseline.

Annual Operating Rate--The annual operating rate is the amount of fuel consumed, amount of product produced, or other material throughput during 1985, as defined by the SCC (below). In most cases this information was obtained from plant records. It was inappropriate to estimate annual operating rates by simply multiplying the hourly maximum design rate by the hours of operation, unless it was known that the source operated at or near full capacity throughout the year. Estimates of annual operating rates took into account a "capacity utilization factor," i.e., the fraction of full production or consumption capacity reflecting normal operations during 1985. Again, 1985 data were critical to the effort.

SCC--To properly classify sources in a standard manner, SCC numbers were obtained from the NEDS SCC listing.[1] An SCC is an 8-digit code divided into four levels of identification, signifying 1) the category process, 2) the major industry group, 3) the major product, and 4) different operations at the point source. The SCC defines specific units for operating rates and carries with it a set of emission factors, which may be used to calculate emissions (if appropriate). A maximum of 10 SCCs could be assigned for any point, and no duplication of SCCs was allowed at a single point.

Control Equipment and Control Efficiency--Entries were required for all emission points where control equipment applicable to SO_2, NO_x, or VOC emissions was in place. Control efficiencies were taken to be the best available estimates of annual average actual control efficiencies. NEDS provides for reporting both primary and secondary control devices and their control efficiencies for each pollutant.

Fuel Sulfur/Fuel Ash--Fuel sulfur and ash contents were reported as weight percents, representing weighted annual averages for the fuel burned. Fuel sulfur was necessary for the calculation of SO_2 emissions from coal, oil, process gas, and coke combustion; fuel ash was used to calculate particulate emissions from coal and coke combustion.

UTM Zone and Coordinates--The Universal Transverse Mercator (UTM) zone and coordinates provided geographical reference within a standard grid system. These coordinates permitted each point or source to be located to the nearest 0.1 kilometer.

Stack Data--Height (above ground level) and inside diameter of each emissions stack were reported. Height was ordinarily reported to the nearest 10 feet and diameter to within one-tenth foot. In addition, the exhaust gas temperature (^{o}F) and flow rate (actual cubic feet per minute) were reported. Emission points with common stacks were designated where applicable. A plume height (i.e., release height) was reported in cases where no stack existed (e.g., storage tanks). These data are essential to estimate plume rise and atmospheric transport of emissions.

Normal Operating Schedule--The normal number of hours per day, days per week, and weeks per year each point operated was indicated. This schedule allows the temporal resolution of emissions estimates by defining the variability of operations.

Percent Annual Throughput--Seasonal variations in production rate or throughput at a point were indicated by percentages for each season, to allow temporal resolution of emissions estimates among the four seasons.

Fuel Heat Content--Fuel heat content represented the gross or higher heating value of each fuel. This value was combined with boiler design capacity and hourly maximum design for a cross-check to identify inconsistencies between these three items and annual operating rate.

Boiler Design Capacity--Boiler design capacity was defined as the maximum gross heat input rate for a boiler. It was reported in million BTU/hour. This rate was applicable only to emission points representing boilers. For all other points, including other combustion sources, the entry was zero. If a point represented a number of small boilers grouped together, the boiler capacity was taken as the total for all boilers at the point.

Hourly Maximum Design Rate--Maximum design rate was defined as the highest operating rate expected for a source. Where the SCC units were not time dependent (e.g., capacity of storage tanks), a value of zero was used.

SIC--The Standard Industrial Classification was recorded for the source. This item provided a cross-check with the SCC to identify inconsistencies, and is used as a standard identifier in data retrievals and analyses.

3.1.3 1985 Emissions Data Collection Effort

To meet the objectives of the 1985 NAPAP Emissions Inventory, EPA and State air pollution control agencies developed a plan to improve the quality and comprehensiveness of the point source data base. A major portion of the plan covered data collection efforts. EPA committed substantial resources to assisting the States in developing and executing the 1985 NEDS. This planning resulted in standardized data collection and emissions estimation methods. The organization of the collection effort addressed the following eight areas, which are discussed individually below:

- Survey by the State and Territorial Air Pollution Program Administrators (STAPPA) to establish realistic objectives,
- Analysis of data gaps in each State's inventory,
- Written guidance developed for the States and EPA prior to the inventory,
- Standardization of emissions estimation procedures,
- Organization of the inventory process to the State level,
- Implementation of emissions confirmation procedures,
- Institution of quality control procedures, and
- Reliable transfer of emissions data from the State to EPA.

3.1.4 STAPPA Survey

The EPA worked with the STAPPA Acid Rain Subcommittee to identify the capabilities and needs of the States in the development and execution of the inventory. STAPPA surveyed the States to determine the level of inventory effort the States could provide for 1985 with existing resources, and the types and levels of support needed by the States to meet the objectives of the 1985 NAPAP Emissions Inventory. The STAPPA survey demonstrated that States would encounter resource shortfalls in meeting schedule and data quality objectives. As a result, EPA committed financial and contractor support during 1986 and 1987 to States requesting assistance in five inventory areas: inventory development, emissions confirmation, quality control, data coding, and data editing.

3.1.5 Written Analysis of Deficiencies

In order to assist States in targeting resources for the 1985 NAPAP Emissions Inventory, NADB reviewed each State's most recent (i.e., 1984) NEDS data in early 1986. Each State NAPAP contact and EPA Regional contact received a written analysis of NEDS data. This analysis identified data problems for sources of SO_2, NO_x, or VOC, greater than 1000 TPY which, if not corrected, would cause data to fall short of the NAPAP requirements or would require State resolution during quality control review. These potential problems included these items:

- Missing high priority data items,
- Allowable emissions reported as actual emissions, and
- Systematic problems such as invalid control codes or missing emissions estimates.

3.1.6 Guidance

Establishing a common methodology for EPA and the States for data collection, emissions estimation, and quality control (QC) was an important early step in assembling an adequate and consistent data base. This step was important for two reasons. First, the resulting State data bases would be developed on a nationally consistent basis. Second, QC procedures could be developed to build QC directly into the data collection process, where errors could be located and corrected most efficiently. Essential elements of procedural and technical guidance were communicated to EPA, State, and contractor personnel through two workshops and companion manuals. In addition, utility data collected by DOE were furnished to the States to aid compilation of utility data in this inventory.

3.1.6.1 Technical Guidance

The first workshop was held in October 1985 for EPA, NAPAP, and State personnel. Manuals addressing data collection procedures,[3] emissions confirmation for major source categories,[4] hydrocarbon emissions estimation[1] (factors for reactive VOC), and 1985 DOE utility fuel use data[5] were distributed at the workshops and also made available to interested State inventory personnel. The subjects covered by these documents will be discussed later in this chapter. Additional written guidance concerning NAPAP inventory priorities, confirmation procedures, and QA/QC checks[6,7] was distributed to EPA Regional Offices and States in December, 1985.

A second workshop, specifically for Contractors assisting the States, was held in May 1986. In addition, States were supplied criteria pollutant emission factors,[1] and particulate speciation[8] and VOC speciation guidance,[9] for use in the inventory effort. These workshops and manuals established a common methodology for collecting, coding, editing, and transferring the 1985 NAPAP Emissions Inventory.

3.1.6.2 Utility Data

The electric utility industry represents a significant source of acid precipitation precursors in the United States, accounting for approximately two-thirds of total anthropogenic SO_2 emissions and one-third of total anthropogenic NO_x emissions. The increasing trend toward tall stacks at utilities has increased the likelihood of long-range pollutant transport, making facility data such as stack parameters important to modeling efforts. NAPAP priority data were collected from utilities within the framework of the NEDS inventory; however, there are other data bases which contain similar information.

The Department of Energy (DOE) requires utilities to report emissions and operating data on DOE Forms 767, 759, and 423. Form 767 provides boiler-level data, while 759 and 423 report plant-level information. Historically, DOE data have been considered to be the most comprehensive available. For 1985, summaries of the utility data from these forms were made available to the States at the beginning of the inventory effort. These data were employed to supplement the 1985 NAPAP Emissions Inventory data, as well as to identify inconsistencies between data bases on a State, plant, and point basis. In addition, a comprehensive review of Forms 767, 759, and 423, and of the 1985

NAPAP Emissions Inventory was conducted in order to identify any systematic problems in the NAPAP inventory regarding utilities. Further information on these comparisons is found in Sections 4.0 and 5.0. Based on this review, NAPAP-reported data appeared as reasonable and accurate as DOE data.

A few States were not able to provide all the utility data requested by NAPAP. In these cases, DOE data supplemented State data collected through NEDS. The State reviewed the DOE information, and updated NEDS information in light of the DOE results. In each instance, the State chose the data best representing operations at individual utilities.

3.1.7 Emissions Estimation Procedures

One of the emissions estimation objectives for the 1985 NAPAP Emissions Inventory was to use calculated estimates of actual emissions during 1985. NEDS recognizes two distinct estimation procedures: one using individual source-specific emissions data and one using emission factors. EPA requested that States use standard emissions estimation methods, which are described below, whenever applicable, and presented a hierarchy for utilization of the acceptable methods.[2] Each method is documented with a unique code in NEDS and can be tracked over time for each emission point.

States were asked to report estimated emissions based on individual source data if available. These calculations are based on continuous emissions monitoring (CEM) data, source test data, or materials balance information as reported by the source or calculated by the control agency. Source-specific data are considered the most accurate data for estimating emissions.

If individual source data were not available, States were asked to calculate emissions using an emission factor. EPA recommended that the AP-42[10] emission factors and methods be reviewed in selecting an emission factor. If no AP-42 factor was available, emission factors appearing in the NEDS SCC and Emission Factor Listing[1] were to be used if available. This resource lists AP-42 factors as well as additional factors not from AP-42, and AP-42 factors assumed to be transferable to other SCC categories. States also had the option of selecting State emission factors based on knowledge of the operation of sources within the State.

If a State was not able to estimate emissions with any of the methods discussed, two options were still available. For data from sources without emission factors, the State could code data so that NEDS would calculate emissions when appropriate emission factors were developed. States could also use this option to indicate that AP-42 factors on file in NEDS should be applied to operating data to calculate emissions. As a last option, the State could use its judgment to estimate emissions based on knowledge of the particular point (e.g., emissions test data from similar State sources).

3.1.8 Inventory Process at State Level

Point source data were collected by State air pollution control agencies for the calendar year 1985. The format and logistics for the actual collection were handled by each State individually. A majority of States used either the NEDS or the Emission Inventory System/Point Source (EIS/PS) system to store the collected inventory data. In either case, conducting the inventory entailed four steps:

- Identification of facilities,
- Questionnaire development and/or distribution,
- Codification of resulting data, and
- Development of a NEDS-compatible computer tape.

The resources for planning and conducting this inventory varied from State to State. In many cases, States needed to contact all major emission sources. Where States' resources permitted, the States utilized their normal annual inventory procedures while emphasizing NAPAP priority data items in their collection effort. Due to resource constraints, not every State was prepared to conduct an inventory of this scope for 1985. Financial aid and Contractor assistance were provided to States, according to each specific State's needs, as described below.

When requested, EPA provided assistance to the States in collecting and coding data. This effort relied on previous inventories, expertise of State personnel responsible for air pollution sources, and/or an evaluation of SICs and number of employees. In general, State expertise was sought through consulting the central air pollution control agency, working with State personnel, and accessing current files. Working with a designated State inventory contact, EPA helped the State devise a questionnaire to request all key NAPAP data elements, actual emissions estimates, and any additional data of interest to the State. This questionnaire was sent out by the State and results were received and filed at the State air pollution control agency. Facility response was excellent, due in part to efficient State follow-up. This contact allowed missing or questionable data elements to be reviewed directly with the facility, and permitted prompt initiation of applicable confirmation procedures with the facility, as discussed in the following section.

Most States required assistance to translate the raw data returned from facilities into a NEDS-compatible format (i.e., NEDS coding forms, State Emissions Inventory System, or microcomputer data base) and to complete the necessary QC procedures. Because of the diversity of inventory formats among States, carrying out the standardized methodology for data coding was a significant challenge. One efficient method of data coding was to use a microcomputer and software developed for this purpose. The software allowed a user with an IBM™ or compatible PC to load data into dBase™ data base management files through a series of menus. These files were then used to produce a magnetic tape in NEDS card image format.

3.1.9 Confirmation

Where State resources permitted, emissions estimates for large emitters were confirmed. Confirmation involved affording large emitters an opportunity to review the reasonableness and acceptability of State emissions estimates and make comments to the State. A lower limit of 2500 TPY SO_2 or NO_x emissions was chosen for confirmation. The effort was intended to improve the accuracy of the inventory for very large SO_2 and NO_x sources without imposing undue burden on the State.

Confirmation was accomplished in one of two ways. In the first, predominant method, the State provided emissions estimates and calculations for each unit process (SCC) to the facility contact for review. After review of the State estimate, the source indicated agreement with the estimate or provided an alternative estimate that was more accurate. In case of disagreement, the source provided alternative calculations for its estimate. State and source were to attempt to reach a final agreement on the appropriate emissions estimate, but ultimate responsibility for selecting the most accurate estimate rested with the State.

A second method involved requesting the facility to provide emissions estimates and supporting data for each unit process at the time of the yearly inventory. The State would then review each estimate and either accept or reject it. As above, the State retained responsibility for submitting the most accurate estimate.

For each facility emitting at least 2500 tons of SO_2 or NO_x in 1985, a confirmation report was prepared by the State or by the Contractor assisting the State. This report consisted of a cover memorandum from an appropriate State agency official and a table representing all facilities meeting the criteria. The table contained source name, NEDS ID number, actual 1985 SO_2 and NOx emissions, and confirmation status. The confirmation status could be one of the following: (1) agreement of State and source, (2) disagreement -- State estimate chosen, (3) disagreement -- source estimate chosen, (4) no comment by source, or (5) no confirmation attempted. Provisions were made for distinguishing between major facility-level conflicts and minor point-level disagreements. A final confirmation report was required from the State by the date of the final NEDS submittal.

States were encouraged to confirm estimates below the 2500 ton criterion. Also, large sources of VOC were confirmed in a number of States. Insofar as States were able to confirm emissions below levels mandated as part of the effort, confidence in emissions totals was improved.

3.1.10 Quality Control

For 1985 emission submittals, EPA Regional Offices were responsible for working with State air pollution control agencies to perform quality control (QC) of NEDS data on computer tape.[11] A computerized edit routine was specifically revised for this purpose, and assistance was provided to run QC checks on State data prior to submittal to the Regional Office. The purpose of these checks was to identify missing and questionable data so that the States could correct errors and validate questionable data. These efforts are discussed extensively in Section 4.

The preliminary edit identified two types of problems in the data. First, data were rejected due to incorrect coding; points having these errors were unacceptable to NEDS and could not be entered into the system without correction. These were the most serious errors, and included invalid NEDS identification codes (i.e., the alphanumeric code that uniquely identifies each plant and point in the NEDS point source file), invalid estimation method codes, or invalid SCCs. The second type of problem identified was questionable data. Such data included inconsistent or missing emissions estimates; inconsistent or incorrect stack and location parameters; and inconsistent design, operating, and emissions parameters.

After the State and Regional Office investigated and corrected these error messages, the tape was forwarded to EPA'S OAQPS and AEERL. These groups then reviewed the submittal to identify any remaining questions or problems, which were returned to the Regional Offices for resolution. This quality control loop for the point source data base is described in much greater detail in Section 4.0.

3.1.11 Transfer to NEDS

Each State's submittal was entered into NEDS after final QC processing. The goal was to transfer the State's data to NEDS accurately, ensuring that NEDS reflected the data on file at the State. This update procedure was complicated by compatibility problems with the data formats available from some States. In some cases, these problems arose from unique State storage and retrieval systems. At other times, when a State had modified EIS/PS to better serve its own needs, the change created translation difficulties when data were transferred to NEDS.

These problems were resolved in two ways. First, adjustment or creation of a translation program was attempted by OAQPS/AEERL in cooperation with the State. Transfer of high priority data elements was emphasized during these procedures. If this process was not successful, then either a data translation was carried out and corrections were made by hand, or the data were entered directly into NEDS from NEDS forms. In either case, the final NEDS product faithfully transcribed high priority 1985 NAPAP Emissions Inventory data from the State's data base.

3.2 AREA SOURCES

3.2.1 Overview

For the 1985 NAPAP Emissions Inventory, extensive modifications were made to the traditional NEDS area source methodologies, which extended the inventory to sources not previously considered (e.g., treatment, storage, and disposal facilities), and improved VOC emissions coverage (e.g., fugitives). Area source data files developed from NEDS serve as the basis for the 1985 NAPAP area source inventory. These include mobile sources and point sources too numerous or difficult to classify individually. Historically, NEDS area source data have been developed mainly by OAQPS from data voluntarily submitted by State agencies. More complete documentation and references are available in Area Source Documentation for the 1985 NAPAP Inventory.[12]

NEDS area source emissions estimates are updated annually by a series of computer programs which multiply each current area source activity level (e.g., fuel delivery) by the appropriate emission factor which accounts for emissions removed by any control technology. County emissions estimates are then summed to produce national emissions estimates.

Activity levels are derived primarily from related information published by other Federal agencies, supplemented by special data developed by EPA for the purpose of developing NEDS area source inventories. Published data such as fuel use by State, motor vehicle miles of travel (VMT) by State and county, and forest fire acres burned by State are used with related data such as employment, population, and miscellaneous geographic or economic data to derive annual county estimates of the activity levels for each of the NEDS area source categories. The activity levels derived are adjusted to account for point source activity (such as fuel use by point sources) so that the area source data reflect only the activity levels (and resulting calculated emissions) that are not accounted for by point sources.

Area source emissions estimates for five pollutants (particulates, SO_2, NO_x, VOC, and CO) are calculated for each area source category utilizing appropriate emission factors from the NEDS area source emission factor file. For most categories, emission factors were originally obtained from the EPA Compilation of Air Pollutant Emission Factors (AP-42).[10] For many categories, the same emission factors are used for all counties; however, for some source categories, State- or county-specific emission factors account for local variables that affect emissions. These more specific factors are used in NEDS calculations for all highway motor vehicle categories, fugitive dust categories, and for other selected categories in a few counties where data are available to develop more applicable emission factors than the national emission factors. Computer-calculated emissions can also be overrridden by hand-calculated emissions that may be more accurate than values calculated from emission factors.

As shown in Table 3-2, area sources in the 1985 NAPAP Emissions Inventory are divided into five major groups: Stationary Sources, Mobile Sources, Solid Waste Disposal, Miscellaneous Area Sources, and Additional Area Sources. Additional Area Sources include categories for which methodologies have been developed to estimate emissions for the 1985 NAPAP Emissions Inventory. Brief summaries of the methods used for these five major groups are provided below, followed by detailed descriptions for each group.

3.2.1.1 Stationary Sources

Many stationary emissions sources are point sources which emit less than 25 TPY and which are thus not included individually in the point source

Table 3-2. 1985 NAPAP AREA SOURCE CATEGORY GROUPS

Stationary Sources
- Residential Fuel
- Commercial and Institutional Fuel
- Industrial Fuel

Mobile Sources
- Highway Vehicles
- Off-Highway Vehicles
- Railroad Locomotives
- Aircraft
- Marine Vessels

Solid Waste Disposal
- On-Site Incineration
- Open Burning

Miscellaneous Area Sources
- Evaporative Losses from Gasoline Marketing
- Evaporative Losses from Organic Solvent Consumption
- Unpaved Roads
- Unpaved Airstrips
- Construction
- Miscellaneous Wind Erosion
- Land Tilling
- Forest Wildfires
- Managed Burning (Slash/Prescribed Burning)
- Agricultural Burning
- Frost Control (Orchard Heaters)
- Structural Fires

Additional Area Sources
- Publicly Owned Treatment Works (POTWs)
- Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDFs)
- Fugitive Emissions from Synthetic Organic Chemical Manufacturing
- Bulk Terminals and Bulk Plants
- Fugitive Emissions from Petroleum Refinery Operations
- Process Emissions from Bakeries
- Process Emissions from Pharmaceutical Manufacturing
- Process Emissions from Synthetic-Fibers Manufacturing
- Crude Oil and Natural Gas Production Fields
- Cutback Asphalt Paving Operations

inventory. The stationary sources category consists of small fuel-burning sources, and is divided into three major categories: Residential Fuel, Commercial and Institutional Fuel, and Industrial Fuel. Each category is further subdivided into fuel types for which consumption data are estimated using algorithms and published fuel use data. Consumption estimates used as the measure of activity levels are then multiplied by emission factors from AP-42 to obtain emissions estimates.

Residential Fuel--The residential fuel category includes estimated emissions for residential activities which utilize fuel for water heating, space heating, and cooking. Emissions contributed by residential fuel consumption are calculated for five fuel types using an algorithm that considers heating degree-days, number of residential units, and median number of rooms per dwelling. The estimated county activity levels for each fuel type are then normalized to be consistent with published State data.

Commercial/Institutional Fuel--Area source emissions from fuel use by commercial and institutional sources include emissions from hospitals, hotels, laundries, schools, and universities. County consumption data for five fuel types are estimated for the five identified commercial subcategories. Algorithms are based on data such as employment, climatological data, population, enrollment, and number of beds per institution. Total fuel consumption is distributed by the subcategories to each fuel type, using housing data and published State fuel consumption data. Fuel consumption estimates for the five subcategories are summed and compared with published State fuel totals. If the estimated fuel use exceeds the published State total, county estimates are normalized to agree with the State total. If the estimated fuel use is less than the State total, the difference is added to the estimated subcategory totals and allocated to counties by population.

Industrial Fuel--Emissions for the industrial sector are calculated as follows. First, State-level industrial area source fuel consumption estimates are determined by subtracting industrial point source fuel consumption totals from published State totals. Next, the area source fuel use estimates are allocated to counties using county employment data for the manufacturing sector

(Standard Industrial Classification groups 20 through 39). The county employment data are adjusted to exclude employment at point sources and are weighted to reflect differences in fuel use per employee for each two-digit SIC group. The industrial sector includes both external and internal combustion sources.

3.2.1.2 Mobile Sources

Mobile sources which contribute to area source emissions are divided into Highway Vehicles, Off-Highway Vehicles, Railroad Locomotives, Aircraft, and Marine Vessels.

Highway Vehicles--For the purpose of calculating fuel consumption, highway vehicles are disaggregated into four categories on the basis of use and gross vehicle weight. The categories include light duty gasoline vehicles, light duty gasoline trucks, heavy duty diesel vehicles, and heavy duty gasoline vehicles. NEDS allocates fuel consumption based on vehicle registration data and published average miles traveled (where available) by vehicle type. Fuel consumption, average fuel efficiencies, and mileage by road type in each county are used to determine vehicle miles traveled (VMT) for three road classes: limited access roads, rural roads, and urban roads. This allocation separates the total VMT for a county into road speed classes. Emission factors obtained from the execution of an EPA computer model are applied to determine emissions for each vehicle type and speed class.

Off-Highway Vehicles--Emissions from off-highway vehicles are generated by activities of gasoline and diesel vehicles which do not utilize road systems. Vehicles contributing to off-highway emissions are divided into six general categories: farm equipment, construction equipment, industrial equipment, motorcycles, lawn and garden equipment, and snowmobiles. Consumption is estimated separately for each category by either apportioning national fuel consumption to counties on the basis of employment, population, etc., or by calculating county or State totals by applying fuel consumption rates to average usage figures and equipment populations. Estimated fuel use is normalized to agree with published State totals, where available. For each category, emission factors from AP-42 are weighted using equipment populations. Off-highway motorcycle emissions are calculated using data representing uncontrolled emissions from an EPA computer model.

Railroad Locomotives--The activity level for railroad locomotive use of distillate oil is calculated by allocating published State consumption data to the county level based on county population statistics. Resulting consumption data are used with AP-42 emission factors to determine emissions.

Aircraft--Activity level estimates for aircraft (private, military, and commercial) utilize aircraft operations data and aircraft type populations to estimate number of landing/takeoff cycles (LTOs) in each group. Emission factors from AP-42, defined as emissions per LTO, are multiplied by LTOs to obtain emissions.

Marine Vessels--Estimation of marine vessel consumption for distillate oil, residual oil, and gasoline is based on published consumption data. Distillate oil and residual oil used by vessels are allocated to counties using data on the number of vessels visiting major ports and tonnage of cargo handled in each port. Gasoline vessel consumption computations utilize inboard and outboard motorboat registrations and published average consumption data to determine consumption. County allocation is based on inland water area, coastline, and the number of months suitable for recreational boating. Consumption data are multiplied by emission factors from AP-42 to obtain emissions estimates.

3.2.1.3 Solid Waste Disposal

The solid waste disposal category includes on-site refuse disposal activities by residential, commercial/institutional, and industrial sectors. Solid waste generation for open burning and on-site incineration is calculated using population data, per capita generation factors, and information from related point source categories. Activity levels are multiplied by specific emission factors from AP-42 to obtain emissions estimates.

3.2.1.4 Miscellaneous Area Sources

NEDS area sources which are not defined by the other categories are compiled in the Miscellaneous Area Sources category. Miscellaneous area sources include Gasoline Marketing, Organic Solvent Consumption, Unpaved Road Travel, Unpaved Air Strip Use, Forest Wildfires, Managed Burning, Agricultural Burning, and Structural Fires.

In brief, activity levels estimated using category-specific data are multiplied by emission factors to obtain emissions estimates. Activity levels for Gasoline Marketing are determined using county retail service station sales data. Activity levels for Organic Solvent Consumption are determined by allocating national estimates of organic solvent consumption by end-use category to counties according to manufacturing employment data or population. The Unpaved Road Travel category utilizes unpaved road miles and rural population as the basis of county allocation. Unpaved Airstrip Use is estimated by landing/takeoff (LTO) cycles occurring in the county. Number of acres burned and fuel loading factors are used as activity levels for Forest Wildfires, Managed Burning, and Agricultural Burning categories. The Structural Fires category utilizes the number of building fires, allocated to the county level by population.

3.2.1.5 Additional Area Sources

The 1985 NAPAP Emissions Inventory will provide detailed county-level VOC emissions estimates for additional area sources which previously have not been included in the NEDS area source categories. In this section, methods have been developed for many categories traditionally considered point source categories, such as Bakeries and Synthetic Fiber Manufacturing. These categories were included to reconcile the difference between reported total national air pollutant emissions estimates for these categories and emissions already accounted for by the NEDS point source data files. The remaining categories such as Publicly-Owned Treatment Works (POTWs) and Hazardous Waste Treatment Storage and Disposal Facilities (TSDFs) have been included as area sources due to the difficulty in measuring emissions from specific points in these facilities (e.g., aeration basins).

In the following sections, detailed activity level and emission factor calculations are described with references.

3.2.2 Stationary Sources

Stationary sources which contribute to area source emissions have been divided into three major categories: Residential Fuel, Commercial and Institutional Fuel, and Industrial Fuel. Collectively, these categories account for all stationary fuel combustion activity not usually reported as point sources. Methodologies for activity level estimation and emission factor derivation are discussed for each category and fuel type.

3.2.2.1 Residential Fuel

The residential fuel category estimates emissions for residential activities which utilize fuel for water heating, space heating, and cooking. Emissions contributed by residential fuel consumption are broken down by five fuel types including anthracite coal, bituminous coal, distillate oil, natural gas, and wood. For each of the listed fuel types, activity levels measured by fuel quantity consumed in weight or volume units are multiplied by emission factors from AP-42 to obtain emissions estimates.

In the following methodologies for the calculations of activity levels, consumption is determined for each type of fuel using two general steps:

- County consumption is calculated using an algorithm based on significant variables for which county-specific data are available (i.e., degree-days, number of rooms per dwelling, number of dwellings, etc.).
- Resulting county consumption estimates are normalized to reflect published State consumption data by the following equation:

$$\text{Normalized County Consumption} = \text{Estimated County Consumption} \times \frac{\text{Published State Consumption}}{\text{Estimated State Consumption}}$$

Anthracite and Bituminous Coal--The basic methodology for allocating residential consumption of anthracite and bituminous coal to individual counties involves the use of an algorithm which calculates coal consumption from the number of dwelling units and heating degree days. Adjustments are made to census housing data to account for trends in the number of coal-heated dwelling units, and to disaggregate the total coal consumption into anthracite and bituminous components using current coal market data. The results are then normalized as necessary to reflect published coal consumption.

Distillate Oil--Consumption of distillate oil by residential sources is determined using an algorithm which calculates consumption of fuel for space heating and water heating using the annual heating degree days and the median number of rooms of occupied dwelling units for each county for the most recent census year. The value of each county's consumption is then normalized as necessary to agree with total State consumption.

Natural Gas--In the NEDS inventory, residential natural gas consumption is defined as the sum of natural gas consumption and liquefied petroleum gas (LPG) consumption for the purposes of cooking, water heating, and space heating. In general, the methodology is designed to produce county consumption estimates for each use by fuel type using algorithms based on the annual heating degree days, the number of occupied dwelling units using gas for cooking or water heating fuel, and the median number of rooms per dwelling. County estimates are normalized with published data and then combined to produce the final county estimates for natural gas and LPG.

Wood--Residential wood consumption is estimated by updating published State figures with annual regional data and then allocating to the county level based on the number of dwelling units which reported heating with wood in each county. Emission factors for woodstoves and fireplaces obtained from AP-42 are weighted based on the proportions of wood burned in woodstoves and in fireplaces. Weighting is accomplished by performing a series of calculations on computed wood consumption estimates which include the following steps: (1) estimating the number of stoves based on shipments and imports, (2) calculating an obsolescence rate to determine the total stove inventory in current use, and (3) determining the stove population in primary and secondary use based on the number of dwellings in the county. Stove efficiency is also taken into account.

3.2.2.2 Commercial and Institutional Fuel

Area source emissions from fuel use by commercial and institutional sources consist of emissions from all fuel burned in stationary sources that are not included under residential sources, industrial sources, power plants, or commercial point sources. Important commercial/institutional area sources are hospitals, hotels, laundries, schools, and universities.

Activity levels are estimated for anthracite coal, bituminous coal, distillate oil, residual oil, and natural gas using the methodology which is described in the Anthracite Coal section for Residential Fuel.

County commercial/institutional area source activity levels for anthracite coal, bituminous coal, distillate oil, residual oil, natural gas, and LPG are calculated for five major subcategories, namely, hospitals, hotels, commercial laundries, schools, and universities. The methodology obtains consumption data for each fuel type in the following steps: (1) estimating total county fuel consumed by the five identified commercial subcategories using algorithms based on employment, annual heating days, bed counts, and number of rooms; (2) distributing total fuel consumption to each fuel type by the five subcategories according to State proportion of occupied residential units using each type for space heating; (3) determining State total commercial area source fuel consumption, taking into account point source emissions; (4) normalizing State estimates against published State consumption; and (5) determining and allocating county consumption by "other" commercial categories. Emission factors are taken from AP-42.

3.2.2.3 Industrial Fuel

Area source emissions generated by the industrial sector which are not accounted for by point source categories are estimated by the following methodology. County industrial fuel consumption for bituminous coal, distillate oil, residual oil, and natural gas is calculated. This step is accomplished by adjusting county area source employment figures for SIC categories 20 through 39 by a fuel intensity factor determined by dividing the State consumption of fuel for each SIC category by the respective State employment. County values for fuel consumption are summed and then normalized with State-published values for respective fuel types.

3.2.3 Mobile Sources

The following section discusses methodologies for activity level and emission factor estimation for the following five major categories: Highway Vehicles, Off-Highway Vehicles, Railroad Locomotives, Aircraft, and Marine Vessels.

3.2.3.1 Highway Vehicles

For the purpose of calculating emissions, NEDS disaggregates highway motor vehicles into four categories on the basis of use and gross vehicle weight. Light duty gasoline vehicles are defined as gasoline-powered passenger vehicles weighing 8500 pounds or less. Light duty gasoline trucks include gasoline cargo vehicles weighing 8500 pounds or less. Heavy duty vehicle categories separate diesel and gasoline-powered trucks and buses weighing more than 8500 pounds. Motorcycles, light duty diesel vehicles, and light duty diesel trucks are assumed to contribute minor emissions relative to the four categories above.

Fuel consumption and average fuel efficiencies are used to determine vehicle miles traveled (VMT) for four average speed classes to reflect road usage, namely, limited access roads (55 mph), rural roads (45 mph), suburban roads (35 mph), and urban roads (19.6 mph). At the present time, NEDS calculates emissions for limited access roads, rural roads, and urban roads. Each speed class includes the following Federal Highway Administration (FHWA) assigned functional classes:

Limited Access Roads (55 mph)	Rural and Urban Interstate Rural and Urban Other Principal Arterials Other Freeways and Expressways Rural and Urban Minor Arterials
Rural (45 mph)	Rural Major Collector Rural Minor Collector Rural Local
Urban (19.6 mph)	Urban Collector Urban Local

Emission factors in grams per mile obtained from the execution of the EPA MOBILE3 emission factor model are applied to determine county-level emissions for the vehicle types and speed classes described above.[13] County-specific emission factors for each vehicle class are computed with standard MOBILE3 inputs and default values for most fleet and travel variables. County-specific inputs include vehicle registration distributions, representative annual average temperatures for each State, local inspection/maintenance program characteristics and local VMT per speed class data. For California, MOBILE3 is run with modified basic exhaust emission rates by model year to reflect California emissions standards.

For highway vehicles, activity levels include fuel consumption by fuel type for each vehicle type, and speed-class-specific annual VMT, as discussed for each vehicle type below.

Light Duty Gasoline Vehicles (LDGV)/Light Duty Gasoline Trucks (LDGT)-- County use of gasoline by LDGV and LDGT is obtained by subtracting county estimates of gasoline consumed by heavy duty gasoline vehicles (computed as described below) from the total county consumption. Total gasoline consumption reported for each State is allocated to counties by one of two methods, depending on the availability of State-submitted data for vehicle miles traveled in each county. For States for which county-level-measured VMT data are available, the total State consumption is distributed to counties based on the proportion of county to State VMT totals. For States which do not report annual VMT by county, State consumption is allocated by the number of cars and trucks weighing less than 6000 pounds registered in each county, adjusted by an index of rural/urban miles per vehicle. The light duty vehicle consumption estimate is then broken down into separate estimates for LDGV and LDGT based on registration data.

County consumption estimates for each vehicle group are then converted to total vehicle miles traveled using fuel efficiency figures in miles per gallon. Total VMT for each vehicle type are then allocated to each of three speed classes (limited access roads, rural roads, and urban roads), according to the miles of each road type constructed in the county relative to the miles of each type constructed in the State.

Heavy Duty Gasoline Vehicles (HDGV)--County gasoline consumption by heavy duty vehicles is determined by calculating county estimates of gasoline consumed by three truck weight classes and institutional buses. For trucks, county truck registrations for each weight class are multiplied by the average annual miles traveled by each weight class in each State and divided by the national average weight class fuel efficiency. State gasoline consumption by institutional buses is calculated using State bus registrations and average gasoline consumption (gallons per year), and is then allocated to counties by current county population. County-level truck consumption estimates are multiplied by average fuel efficiencies and summed to yield total State VMT for HDGV. Total State HDGV VMT are allocated to county speed classes based on the county miles of each speed class.

Heavy Duty Diesel Vehicles (HDDV)--Much of the fuel consumption of HDDV is accrued outside the county of registration. To account for this behavior, the methodology makes separate HDDV fuel consumption estimates for long-range travel and short-range travel. Published State consumption is allocated to the county level on the basis of total, out-of-state, and local VMT, using survey data on annual miles traveled and percentage of the miles traveled outside the State for diesel trucks over 8500 pounds.

Long-range VMT estimates for each State are summed to form a national HDDV long-range VMT pool. The national long-range VMT pool is allocated to counties by estimated county fractions of total National Network mileage. Short-range VMT are allocated to the county level on the basis of truck registrations.

Short-range VMT and long-range VMT are then totaled for each county and multiplied by the average fuel efficiency to obtain fuel consumption by HDDV. Each county's long-range HDDV VMT are assumed to occur on limited access roads; short-range HDDV VMT are divided equally between rural and urban roads.

3.2.3.2 Off-Highway Vehicles

Off-highway vehicles fall into six general categories: farm equipment, construction equipment, industrial equipment, motorcycles, lawn and garden equipment, and snowmobiles. Gasoline is consumed by all six categories, while diesel fuel is utilized only by farm equipment, construction equipment, and industrial equipment.

Emission factors for all gasoline and diesel off-highway vehicles are taken from AP-42, except for motorcycle emission factors, which are estimated by the MOBILE2 model. Separate reactivity profiles for gasoline and diesel fuel are used to estimate the reactive portion of total VOC emission estimates. All off-highway emission factors are based on fuel consumption. Consumption estimation methodologies are described for each vehicle category and fuel type below.

Farm Equipment--To estimate State fuel consumption by farm equipment, consumption values are calculated separately for farm tractors, combines, motorized balers, forage harvesters, and general purpose large utility engines. Consumption by fuel type is calculated using State populations for each type of equipment, average annual usage (hours per year), and average hourly consumption by fuel type per unit (gallons per hour). For diesel fuel, the sum of the estimated fuel use for all subcategories is normalized to agree with published State totals for agricultural diesel fuel use. Total State gasoline and diesel fuel consumption is then allocated to the county level according to the ratio of county tractor population to State tractor population.

Construction Equipment--National gasoline consumption for construction equipment is estimated by OAQPS, while published national totals are available for diesel fuel. National consumption of each fuel is apportioned to States according to total non-building construction employment in each State. State totals for diesel fuel are normalized to agree with DOE published totals for construction equipment. County consumption of fuel is then allocated from State construction consumption on the basis of county population.

Industrial Equipment--For industrial equipment, national fuel use figures (obtained as described for construction equipment) are apportioned to counties according to relative differences between combined county employment and combined national employment in the manufacturing, mining, and wholesale trade industries. State totals for diesel fuel are normalized to agree with DOE fuel use statistics.

Motorcycles--County-level gasoline consumption is estimated with an algorithm based on population, State motorcycle registrations, average annual usage, and average fuel consumption rate. The algorithm separates off-road and combined use motorcycles, and weights the distribution of the two types according to regional variations. Emission factors are calculated using data representing uncontrolled emissions in the EPA MOBILE2 model.[14]

Lawn and Garden Equipment--National consumption of gasoline by lawn and garden equipment is estimated by NADB and allocated to individual counties based on the number of single-unit dwelling structures, the number of freeze-free days annually, the fraction of national snow zone population in the county, snowthrower fuel consumption rate, average snow removal rate, and county snowfall.

Snowmobiles--County consumption of gasoline by snowmobiles is derived from the OAQPS-established national snowmobile gasoline consumption levels, and allocated on the basis of estimated county snowmobile population. Snowmobile population is based on algorithms relating the percent of State snowmobiles used in the county to population and snowfall, and taking into account the impact of population density on snowmobile usage.

3.2.3.3 Railroad Locomotives

This category includes fuel utilized by railroad locomotives and fuel used by railroad stations and workshops for space heating. The latter fuel consumption has been included primarily because it is difficult to separate from total railroad fuel use and is considered minor compared to locomotive consumption. The emission factors for railroad fuel use are taken from AP-42. The primary fuel consumed by railroad locomotives is distillate oil (diesel fuel). Published State consumption of diesel fuel by railroad locomotives is allocated to the county level on the basis of current population distribution.

3.2.3.4 Aircraft

Emissions estimates for aircraft are divided into three categories: civil aircraft, commercial aircraft, and military aircraft. Estimates of aircraft landing and take-off cycles (LTOs) by county, based on operation records from county airports or aircraft registration data, are multiplied by emission factors based on LTOs to obtain emissions estimates.

Weighted average emission factors are computed for each type of aircraft within each aviation category. In some categories, flying hours are used as a unit of measure, under the assumption that the number of flying hours is proportional to the number of LTOs. Emission factors are then combined using aircraft type population data to form one factor for each pollutant.

Military and Civilian Aircraft--Initial emission factors are averaged and weighted by usage and population data for six aircraft types. Emission factors for each aircraft type are taken from AP-42.

Commercial Aircraft--Emission factors for commercial aircraft are calculated separately for air taxi and commercial service. Air taxi emission factors are population-weighted averages of AP-42 emission factors for turbojets, turboprops, and piston planes. Commercial service aircraft emission factors from AP-42 are updated and weighted using the previous year's NEDS data on LTOs and population data. The number of operations is estimated using the number of aircraft in service for nine plane types. The resulting values are compared with reported values obtained from the Federal Aviation Administration (FAA). The weighting factors are applied to the emission factors to produce an average for all plane types.

3.2.3.5 Marine Vessels

Marine vessel categories include distillate oil (diesel) vessels, residual oil vessels, and gasoline vessels. Consumption methodologies and emission factor derivation are presented for each category below.

The diesel vessel category includes large cargo and passenger ships, oil tankers, tugboats, and other steamships and motorships that are known to consume distillate oil. Estimates of county-level fuel consumption were originally based on numbers, types, and sizes of ships, and on time spent in port and underway. Consumption by vessels at ports was assigned to the port counties where data were available. The remaining fuel consumption was distributed to ports and waterways according to tonnage handled. Estimating current consumption of distillate oil by marine vessels requires the updating of previous county estimates using DOE State vessel fuel use data, excluding fuel used by ships outside the U.S. continental limits.

The residual oil vessels category includes large cargo and passenger ships, oil tankers, and tugboats. Historic county-level residual oil consumption estimates were based on the number, types, and sizes of ships, and on time spent in port and underway. Consumption by vessels at ports was assigned to the port counties where data were available. The remaining fuel consumption was distributed to ports and waterways according to tonnage handled. Current consumption estimates required the updating of previous county estimates with State-level DOE data on residual oil use by bunkering vessels, excluding fuel used by ships outside the U.S. continental limits.

For distillate oil vessels, emission factors are the weighted averages of AP-42 factors for commercial diesel motorships and steamships. For residual oil vessels, emission factors are the weighted average of AP-42 emission factors for commercial residual oil motorships and steamships. For both diesel and residual fuels, the weighting procedure uses the following assumptions.

Commercial vessels include 75 percent motorships and 25 percent steamships. Commercial steamships spend 80 percent of the time hotelling and 20 percent under full power. Diesel steamships spend 20 percent of the time under auxiliary power and 80 percent underway.

State gasoline vessel fuel consumption is derived from State boat registration (inboard and outboard), and average fuel consumption for each boat type. State consumption is then allocated to counties according to county inland water area, coastline, and the number of warm months suitable for recreational boating activities. Average weighted emission factors for gasoline vessels are based on inboard and outboard motorboat registrations. Weighting accounts for higher fuel consumption per hour of operation by inboard motors.

For all vessel types, VOC emission factors are adjusted to reflect appropriate species profiles, and efforts are made to exclude operations conducted outside the continental U.S.

3.2.4 Solid Waste Disposal

The area source category for solid waste disposal includes on-site refuse disposal activities by residential, commercial/institutional, and industrial sectors. In this section, emissions from the disposal practices of open burning and on-site incineration are discussed separately. Solid waste generation in hundreds of tons is used as a measure of activity level.

3.2.4.1 On-Site Incineration

For the purposes of determining the amount of solid waste generated, on-site incineration is defined as disposal in a small incinerator, encompassing the following types of disposal units: backyard burners; industrial incinerators; and incinerators used by food and department stores, hospitals, and schools. Since large municipal incinerators are usually classified as point sources, emissions resulting from disposal in this type of incinerator have not been included in this category. The quantity of solid waste generated by each sector was estimated for the base year 1976 using population statistics and per capita generation factors for each EPA region.

Since 1976, the previous year's estimates of waste generated by each sector have been updated each year according to the relative national percentage increase or decrease in the amount of waste generated (or incinerated) by NEDS point sources in each respective sector. For the commercial/institutional and industrial sectors, NEDS calculations use the annual increase or decrease in waste incinerated by SCC point source categories within each sector. The annual residential update factor is based on engineering judgment and calculations by NADB. County allocation is based on population.

Adjustments are made to county estimates based on information about specific point sources and data submitted by States. If a number of on-site incinerators have been identified as point sources, it might be appropriate to reduce or eliminate area source estimates. Also, it is important to note that State estimates of waste generated replace the extrapolated data for the year they are submitted. Submitted data are then annually updated by the above method using the relative percentage increase in waste generated. Emission factors for intermediate-size incinerators from AP-42 are used for all on-site incineration.

3.2.4.2 Open Burning

For the purposes of estimating open burning practices, the term "open burning" refers to uncombined burning of wastes such as leaves, landscape refuse, and other rubbish. Large open burning dumps are usually included under point sources.

The quantity of solid waste burned is computed by updating the previous year's waste generation for each sector in a manner analogous to updates for On-Site Incineration. The update factor is determined by engineering judgment. Estimates of the quantity of solid waste burned by point sources in the most recent year are obtained from the NEDS point source data. County allocation is based on population.

The emission factors for open burning of refuse and organic materials are taken directly from AP-42.

3.2.5 Miscellaneous Area Sources

Area sources which are not defined by Stationary Sources, Mobile Sources, or Solid Waste categories are compiled in the Miscellaneous Area Sources category. Although total emissions from each source are relatively small compared to those from the three major categories, emissions from each miscellaneous category may be significant because of size, geographic distribution, or periodic intensity over time.

3.2.5.1 Evaporative Losses From Gasoline Marketing

This source category covers evaporative losses of volatile organic compounds from gasoline marketing operations, such as filling losses from loading underground storage tanks at service stations, and spillage and filling losses from filling automobile tanks. Losses from refineries and bulk distribution terminals are excluded from this category, because emissions from refineries and terminals are assumed to be accounted for in point source categories and in Additional Area Sources. Emissions are calculated by multiplying emission factors by the activity level for this category, measured by retail gasoline sales. Retail sales of gasoline include all sales of gasoline for highway, marine, and aviation use, and for use by the construction equipment, industrial equipment, and farm equipment off-highway subcategories. County retail gasoline sales are used directly when reported by States. For counties for which retail sales of gasoline are not compiled, sales to the above user categories are estimated separately and summed to generate total county sales.

State retail sales of gasoline for highway and marine use are allocated to each county according to the county's proportion of the statewide gross dollar receipts from gasoline service stations. Published State aviation retail sales of gasoline are allocated to the county according to the total LTO cycles in the county for each of the military, civilian, and commercial aircraft categories.

County retail sales of gasoline for off-highway sources are assumed to be the same as the consumption derived in the activity levels section of Farm

Equipment, Construction Equipment, and Industrial Equipment in Off-Highway Sources (3.2.3.2).

Emission factors for gasoline marketing are obtained from AP-42, weighted by an assumed distribution of types of filling practices used.

3.2.5.2 Evaporative Losses From Organic Solvent Consumption

Area source evaporation from organic solvent usage is divided into six major categories: dry cleaning operations, degreasing operations, surface coating application operations, printing, rubber and plastics, and other miscellaneous uses. In each category, usage of specific solvents is identified and enumerated to compute total solvent usage in tons per year. Eventual evaporation of all solvents is assumed so that solvent usage is equivalent to VOC emissions.

The methodology for allocating organic solvent consumption by county consists of apportioning national consumption of nineteen primary solvent groups by major user category according to county population or user category employment data. User categories are listed in Table 3-3. Two of the major user categories, Surface Coatings and Other Uses, are further classified into subcategories as shown. Table 3-4 contains a list of the primary solvent groups used to determine losses from organic solvent consumption. The category "Special Naphthas" includes the aliphatic naphthas such as V. M. & P. naphthas, Stoddard solvents, rubber solvents, and mineral spirits.

National consumption of the primary solvent groups is distributed to each of the user categories according to the user category's percent of total solvent consumption. Percentage usage obtained from published sources is compiled for each user category. National area source solvent use estimates are determined by subtracting point source solvent use or emissions for each user category from total solvent use for each user category.

County consumption for each solvent group and user category is then computed by allocating calculated national area source consumption on the basis of county area source employment in applicable SICs (see Table 3-3) or by population. Area source employment is determined by subtracting point source employment from total county employment for each SIC category. To reflect

TABLE 3-3. AREA SOURCE ORGANIC SOLVENT USER CATEGORIES

User Categories	Population or Employment Data by SIC Used For County Allocation
Surface Coatings	
Trade Paints	County Population
Auto Refinishing	7535 (Paint Shops)
Automotive	371 (Motor Vehicles)
Wood Furniture and Fixtures	25 (Furniture and Fixtures)
Metal Furniture and Fixtures	25 (Furniture and Fixtures)
Metal Containers	34 (Fabricated Metal Products)
Sheet Strip and Coil	34 (Fabricated Metal Products)
Appliances	35 and 36 (Machinery, Electrical Equipment and Supplies)
Machinery and Equipment	
Paper	26 (Paper and Allied Products)
Factory-Finished Wood	243, 244 (Millwork, Plywood-Related Supplies, Wooden Containers)
Transportation (Non-Auto)	37 (Transportation Equipment) Less 371 (Motor Vehicles) and 373 (Shipbuilding Repair)
Electric Insulation	36 (Electrical Equipment and Supplies)
Other, Exterior, Interior	19-39 (Total Manufacturing)
Marine	373 (Shipbuilding and Repair)
Degreasing	34-39 (Metal Products, Machinery, Transportation Equipment, Instruments, Miscellaneous)
Dry Cleaning	2 x 7216, Plus 7215 and 7218 (Dry Cleaning and Combination with Wet Laundering)
Printing	264, 265, and 27 (Paper Products, Containers, Printing and Publishing)
Rubber and Plastics	30 (Rubber and Plastics)
Other Miscellaneous Use	1/2 of 19-39 Employment + 1/2 County Employment

TABLE 3-4. AREA SOURCE ORGANIC SOLVENTS

Special Naphthas
Perchloroethylene
Ethanol
Trichloroethylene
Isopropanol
Acetone
Glycol Ethers
Cyclohexanone
Methyl Ethyl Ketone
Ethyl Benzene
Propylene Glycol
Methanol
Butyl Acetate
Ethyl Acetate
Butyl Alcohols
Methyl Isobutyl Ketone
Monochlorobenzene
o-Dichlorobenzene
p-Dichlorobenzene

unequal solvent use between establishments within SIC groups, consumption is multiplied by a factor which compares the number of individuals in the county in each area source user category to the number of individuals in the nation in each area source user category. County consumptions of all solvent types are then summed to yield a total county consumption.

3.2.5.3 Unpaved Roads

Vehicle traffic over unpaved roads, parking areas, and recreational areas generates fugitive dust emissions which are estimated in NEDS. Primary factors which affect the amount of dust generated are vehicle speed, surface type, wind speed, surface moisture, and type of vehicle. The activity level (in vehicle miles traveled) is calculated using county population and mileage of unpaved roads. The emission factor is derived using an equation in AP-42.

3.2.5.4 Unpaved Airstrips

Unpaved airstrip emissions are affected by the same primary factors as unpaved roads. Fugitive emissions from unpaved airstrip use are measured by annual landing-take off (LTO) cycles on airstrips made of dirt, sand, gravel, or gravel pavement, excluding airports with no based aircraft, airports no longer in operation, heliports, and seaplane bases in each county. The activity level estimate derived for each county in NEDS is multiplied by an adjusted emission factor from AP-42 to obtain a particulate emissions estimate.

3.2.5.5 Forest Wildfires

Each year emissions are generated by forest wildfires covering large tracts of forested land. For this category, emissions estimates are generated by multiplying the number of acres burned per county by a fuel loading factor and emission factors from AP-42. VOC emissions are adjusted to include only reactive species by assuming 79.9 percent by weight of total hydrocarbons are reactive. Since 1974, the NEDS wildfire activity level for each county from the previous year has been updated with wildfire statistics from the U.S.

Forest Service. Regional fuel loading factors in tons per acre for each EPA Region from AP-42 are applied to State averages within each Region to yield tons consumed.

3.2.5.6 Managed Burning

Managed burning activities include slash burning and prescribed burning. In slash burning operations, wastes from logging operations are burned under controlled conditions to reduce fire hazard and remove brush considered to host destructive insects. Prescribed burning is used as a forest management practice to establish favorable seed beds, remove competing underbrush, accelerate nutrient cycling, control tree pests, and contribute other ecological benefits.

For this category, emissions estimates are generated by multiplying the number of acres burned in each county by a fuel loading factor and the emission factor for each pollutant. Original State estimates of acreage consumed by both managed burning techniques were determined for the NEDS inventory year of 1974. Individual State officials and the U.S. Forest Service were contacted to provide estimates of acreage burned, burning technique, and fuel loading ratios. The 1985 NAPAP Emissions Inventory utilizes State data generated for 1974 which were allocated to the county level according to forest acreage per county, as obtained from contact with local officials or State land usage maps. If not provided, fuel loadings for slash burning and prescribed burning are assumed to be 75 tons per acre and 3 tons per acre, respectively. Particulate and CO emission factors are obtained from the Source Assessment.[16] SO_2 and NOx emission factors are taken directly from AP-42.

3.2.5.7 Agricultural Burning

This miscellaneous area source category estimates emissions from agricultural burning practices routinely used to clear and/or prepare land for planting. Specific operations include grass stubble burning, burning of agricultural crop residues, and burning of standing field crops as part of harvesting (e.g., sugar cane).

Emissions estimates are generated by multiplying the number of acres burned in each county by a fuel loading factor and the emission factor for each pollutant. The original estimates for 1974 measured activity level in terms of acres burned per State. It is assumed that the total quantity of agricultural products burned in 1974 is the same quantity which will be consumed by fire each year. If no specific crop data were available, it was assumed that the number of acres burned annually is divided equally between sugar cane and field crops. Emission factors are taken from the Procedures Document for Development of National Pollutant Emissions Trends Reports[15] and AP-42.

3.2.5.8 Structural Fires

Structural fires have been included in NEDS because building fires have been linked to short-term emissions of air contaminants. The activity level for this category, measured by the total number of fires per county, is multiplied by a loading factor and an emission factor to obtain emissions estimates. In the absence of county-level data, a national average of four fires per 1,000 population is assumed to occur each year.[15] Estimates of the material burned are obtained by multiplying the number of structural fires by a fuel factor of 6.8 tons of material per fire.[15] Emission factors are taken from the OAQPS Technical Tables.[17]

3.2.6 Additional Area Sources

The 1985 NAPAP Emissions Inventory will provide detailed county level VOC emissions estimates for additional area sources which previously have not been included in the NEDS area source categories. This section presents methods which have been developed for many categories which have been traditionally considered point source categories, such as Bakeries and Synthetic Fiber Manufacturing. These categories were included to reconcile the difference between the total emissions reported in the National Air Pollutant Emissions Estimates 1940-1984[17] and the emissions already accounted for by the NEDS point source data files. The remaining categories such as Publicly-Owned Treatment Works (POTWs) and hazardous waste Treatment, Storage, and Disposal Facilities

(TSDFs) have been included due to the difficulty of measuring emissions from specific points within these categories (e.g., aeration basins). Because the additional categories are believed to generate significant VOC emissions, existing methodologies and data used by NEDS have been improved to provide accurate emissions estimates.

In this section, methodologies for estimating VOC emissions are presented for the following area sources: POTWs and hazardous waste TSDFs; fugitive emissions from synthetic organic chemical manufacturing; bulk terminals and bulk plants; fugitive emissions from petroleum refining operations; process emissions from bakeries, pharmaceutical, and synthetic-fiber manufacturing; crude oil and natural gas production fields; and cutback asphalt paving operations.

For most categories, national VOC emissions are allocated to the county level to produce county VOC emissions estimates. Activity levels, emission factors, and control efficiencies are used to determine emissions for the remaining sources.

3.2.6.1 Publicly-Owned Treatment Works (POTWs)

The published national VOC emissions estimate for the worst case scenario for unacclimated treatment systems was selected for use in the calculation of county VOC emissions in the 1985 NAPAP Emissions Inventory. Because research on VOC concentrations in POTW influents and effluents indicates that the removal mechanisms for these pollutants are relatively constant and only a percentage of incremental loadings is removed by POTWs, the national VOC emissions estimate for unacclimated treatment systems is allocated to the county level based on the percentage of industrial flow per county. To eliminate double counting, emissions accounted for by point source categories are subtracted from the national emissions estimate before county allocation. The total VOC emissions from POTWs for the nation are estimated in the EPA Domestic Sewage Study.[18]

3.2.6.2 Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDFs)

National VOC emissions estimates are developed using facility-specific process descriptions, waste characterization and quantities, and process-specific emission factors.[19] Emissions from all TSDFs in the U.S. are summed at the county level to form the national emissions estimates. Emissions at a TSDF are defined as the total VOCs emitted by all plant processes; emissions from each plant process are calculated as the product of the quantity of a specific waste handled and a process-specific emission factor. To eliminate double counting, emissions accounted for by point source categories are subtracted from the county-level emissions estimate.

3.2.6.3 Fugitive Emissions from Synthetic Organic Chemical Manufacturing

The fugitive emissions from synthetic organic chemical manufacturing are estimated using OAQPS estimates of national emissions from the manufacture of petrochemicals. Assuming that the potential for fugitive emissions (i.e., the number of pumps, valves, flanges, etc.) increases with the number of employees, the national VOC emissions are allocated to specific counties based on the ratio of the county to national employment in SIC 2869 (Industrial Organic Chemicals - Not Classified).

Currently, NEDS point source entries under several Source Classification Codes (SCCs) already account for a portion of fugitive emissions, including 3-01-800 (General Processes-Fugitive Leaks), 3-01-888 (Fugitive Emissions-Not Classified), and many chemical production-specific SCCs designated as Fugitive Emissions: General. The total VOC emissions for these SCCs are summed by county and then subtracted from the national emissions estimates. If a county has greater point source VOC emissions reported in NEDS than the overall emission level allocated from the national fugitive VOC emissions estimate, it is assumed that the fugitive VOC emissions for area source emission levels are adequately represented by point source VOC emissions data reported in NEDS. The national sum of all negative emissions is reallocated to the counties exhibiting positive emission levels based on the relative proportion of employment for SIC 2869 located in each county.

3.2.6.4 Bulk Terminals and Bulk Plants

Current methodology uses national VOC emissions estimates for gasoline bulk terminals and bulk plants based on total annual throughput and assumes that control is negligible at bulk plants. The national VOC emissions estimate is allocated to the county level based on the county employment in SIC 5171. The VOC county emissions totals for the point source data files for SCC 4-04-001 (Bulk Terminals) and SCC 4-04-002 (Bulk Plants) are then subtracted from the portion of the corresponding national VOC emissions estimate. Negative emissions are reallocated to the counties as previously described, using employment data for SIC 5171.

3.2.6.5 Fugitive Emissions from Petroleum Refinery Operations

Annual national VOC emissions estimates for petroleum refinery operations have been developed by OAQPS using capacity or production data. Under the assumption that these national VOC emissions estimates represent the sum of the fugitive and point source emissions for refinery processes, fugitive emissions are quantified by subtracting the total county point source VOC emissions of SCC categories 3-06-004 through 3-06-88 (Refinery Processes, excluding process heaters and catalytic cracking units) from the total emissions estimated for petroleum refinery processes in each county. National emissions data are allocated to each county based on refinery capacity. Negative emissions are reallocated to counties as previously described, using refinery capacity data.

3.2.6.6 Process Emissions from Bakeries

Annual national VOC emissions estimates for bakery operations are allocated to each county based on the county employment census data for SIC categories 2051 and 2052. Total county point source VOC emissions for SCC 3-02-032 (Bakeries) listed in NEDS are subtracted from the national VOC emissions estimate allocated to each county. Negative emissions are reallocated to counties as previously described, using employment data for SIC categories 2051 and 2052.

3.2.6.7 Process Emissions from Pharmaceutical Manufacturing

Annual national VOC emissions estimates from pharmaceutical manufacturing operations developed by OAQPS are allocated to specific counties based on the county employment census data for SIC category 2834. Total point source VOC emissions for SCC 3-01-060 (Pharmaceutical Preparations) listed in NEDS for each county are subtracted from the national VOC emissions estimate allocated to each county. Negative emissions are reallocated to counties as previously described, using employment data for SIC 2834.

3.2.6.8 Process Emissions from Synthetic-Fibers Manufacturing

The annual national VOC emissions estimate from synthetic-fibers manufacturing operations is allocated to the county level based on the combined county employment for SIC categories 2823 and 2824. NEDS point source VOC emissions for SCC 3-01-024 (Synthetic Organic Fiber Production) and 3-01-025 (Cellulosic Fiber Production) for each county are then subtracted from the national emissions estimate allocated to each county. Negative emissions are reallocated to counties as previously described, using employment data for SIC categories 2823 and 2824.

3.2.6.9 Crude Oil and Natural Gas Production Fields

Annual national VOC emissions estimates for crude oil and natural gas production developed by OAQPS are distributed to the State level in proportion to the volume of State annual production. The State VOC emissions are then allocated to specific counties based on county employment for SIC 1310. VOC emissions for these sources currently accounted for in NEDS point source data files for SCC 3-10-001 (Crude Oil Production) and SCC 3-10-002 (Natural Gas Production) are subtracted from the estimates. If point source emissions exceed the total emissions estimates, then negative emissions are reallocated to counties as previously described, using employment data for SIC 1310.

3.2.6.10 Cutback Asphalt Paving Operations

State VOC emissions for cutback asphalt paving operations are calculated by multiplying an emission factor by the activity level, measured in total quantity of cutback asphalt sales. The State emissions totals are then allocated to specific counties based on employment for SIC 1611. The VOC emission factor is based on the weight of asphalt used, assuming complete evaporation of all organic solvents used in paving operations.

3.3 NONCRITERIA POLLUTANTS

3.3.1 Noncriteria Pollutant Inventory

The 1985 NAPAP Emissions Inventory of anthropogenic sources focuses on three NEDS criteria pollutants: SO_2, NO_x, and VOC. Although SO_2, NO_x, and VOC are considered the primary precursors of acid deposition, other pollutants are also regarded as significant. Four non-criteria pollutants included in the 1985 Emissions Inventory are primary sulfates (SO_4^{2-}), hydrogen chloride (HCl), hydrogen fluoride (HF), and ammonia (NH_3). Estimates for these pollutants are not supplied by the States, as there is no extant reporting structure. Historically, EPA has not collected emissions data on these pollutants, and neither EPA nor the States have the capability to develop source-specific inventories. Therefore, this sector of the 1985 NAPAP Emissions Inventory represents a unique effort by EPA to develop emission factors and make emissions estimates. Estimates for these four noncriteria pollutants were made at the request of the NAPAP modeling community and the Western Governor's Association Acid Rain Study Group. In order to create as comprehensive a data base of acid rain precursors as possible, estimates for the pollutants were made and have been included in the report. Due to a lack of standardized, reliable sources of data for these pollutants, EPA developed emission factor reports for these pollutants.[20,21,22,23] These reports analyzed existing data for a variety of source categories and recommended emission factors appropriate for use in the 1985 NAPAP Emissions Inventory. These factors were rated qualitatively, in a manner similar to the way that AP-42 factors are rated.

These documents may be referenced for further information on these factors.

These emission factors and resulting emissions estimates represent the first time that a comprehensive emissions inventory for primary sulfates, hydrogen chloride, hydrogen fluoride, and ammonia has been attempted by EPA. These estimates should not be considered to be as accurate or reliable as the criteria pollutant inventory. The estimates were not generated or reviewed by the States or the sources, and although operating rate data were provided by the States, errors in the data will affect these emission estimates.

Emissions estimates for noncriteria pollutants from existing NEDS point sources were developed using SCC-level emission factors applied to NEDS process-level throughput data. Applicable SCCs were identified during review of emission factors. It should be emphasized that, in contrast to the criteria pollutant estimates, the resulting emissions estimates are not the result of estimates made by the States.

Emissions of SO_4^{2-}, HCl, HF, and NH_3 from area sources were also estimated. Emission factors were developed to be used with the area source estimation methodologies, and these factors were combined with activity levels obtained at the county level.

Where applicable, emission factors account for control practices used within the relevant source categories. Emission factors consider average control efficiencies and prevalence of controls in a source category. Although actual emissions at the plant and point-process level will be under- or over-estimated to the extent that control practices and efficiencies deviate from the industry averages, these assumptions were necessary since there is no structure available for States to report non-criteria pollutant control devices and efficiencies to NEDS.

3.3.2 Emissions Estimation Methods

3.3.2.1 Primary Sulfates

Primary sulfate is emitted directly from emission sources as SO_4^{2-}, unlike secondary sulfate, which is derived from the atmospheric transformation of SO_2. Source categories that emit primary sulfate include external combustion, chemical manufacturing, primary metals, mineral products, and petroleum refining. Sulfate emission factors were compiled for these categories as part of the 1985 NAPAP Emissions Inventory effort (Table 3-5).[20]

Two previous programs have made assessments of sulfate emission factors: the Electric Power Research Institute's (EPRI's) sulfate regional experiment and the United States/Canada Work Group 3B. The NAPAP effort reviewed these two assessments and also took advantage of the recent acceptance of a standard sampling and analysis procedure by the source emissions measurement technical community. This method, controlled condensation sampling (CCS), is currently considered to be the most accurate approach to measuring sulfate from stationary sources. CCS-derived measurements were abstracted from the literature and primary sulfate emission factors were calculated.

Calculation of source-specific sulfate emission factors was based on a hierarchical selection process:

1) Where available, field measurements using the CCS procedure were considered as the prime data set,

2) Sulfate emissions assessments were aggregated for different point sources within the same category only if fuel composition and emissions controls were similar, and

3) Non-CCS emissions data were used only if multiple measurements produced data with minimal variation.

NEDS throughput data were multiplied by appropriate emission factors for relevant SCCs to produce process-level emissions estimates for the 1985 NAPAP Emissions Inventory.

3.3.2.2 Hydrogen Chloride

HCl is emitted from coal combustion, waste incineration, and organic chemical manufacture (Table 3-5). The primary source is coal combustion. NAPAP compiled and rated emission factors from the literature for these source categories for use with the 1980 NAPAP Emissions Inventory.[21] Emission estimates were calculated by EPA based on these emission factors and throughput data at the SCC-level for the relevant point source categories (SCCs).

TABLE 3-5. EMISSIONS SOURCES OF PRIMARY SULFATE, HYDROGEN CHLORIDE, HYDROGEN FLUORIDE, AND AMMONIA IN THE NAPAP INVENTORY.

SOURCE CATEGORY	SO_4^{2-}	HCl	HF	NH_3
Combustion				
Coal	X	X	X	X
Distillate Oil				X
Residual Oil	X			
Natural Gas				X
Wood/Bark Waste	X			
Primary Metals				
Copper	X			
Zinc	X			
Aluminum	X		X	
Iron Production	X			
Coke Production	X			X
Petroleum Industry				
FCC	X			X
TCC				X
Claus Plants	X			
Engine Compressors				X
Wood Products				
Kraft Pulp Mill	X			
Sulfite Pulp Mill	X			
Mineral Products				
Cement Manufacture	X			
Gypsum Manufacture	X			
Chemical Manufacturing				
Sulfuric Acid - Contact Process	X			
Propylene Oxide		X		
By-product HCl Production		X		
HF Production			X	
Ammonium Nitrate				X
Phosphate Fertilizer			X	
Ammonia Synthesis				X
Urea Manufacture				X
Ammonium Phosphate				X
Incineration		X		
Area Sources				
Mobile Gasoline Combustion				X
Mobile Diesel Combustion				X
Anhydrous NH_3 Fertilizer Application				X
Livestock Waste				X

3.3.2.3 Hydrogen Fluoride

The primary source of HF is coal combustion; HF is also emitted from hydrogen fluoride manufacture, the primary aluminum industry, and the phosphate fertilizer industry (Table 3-5). NAPAP compiled and rated emission factors from the literature for these source categories for use with the 1985 NAPAP Emissions Inventory.[21] Emissions estimates were calculated by EPA based on these emission factors and throughput data at the SCC-level for the relevant point source categories.

3.3.2.4 Ammonia

NH_3 is emitted in significant quantities from both point and area sources. Major anthropogenic source categories include field application of livestock wastes, beef cattle feedlots, fertilizer manufacture and use, mobile and stationary fuel combustion, ammonia synthesis, petroleum refining, waste water treatment, and coke manufacture (Table 3-5). Emission factors for the categories were developed from the literature by NAPAP.[22] AP-42 data were used to characterize emissions from fertilizer manufacture, ammonia synthesis, petroleum refining, and coke manufacture.

Before being included in the 1985 NAPAP Emissions Inventory, NH_3 emission factors developed for the inventory were compared to similar factors developed for inventories by Environment Canada, EPRI, and the National Aeronautics and Space Administration (NASA). The factors selected were deemed the most appropriate available, based on criteria concerning test method validity, and currentness and representativeness of the data.

Point source category emissions were calculated by EPA using throughput data at the SCC-level for the relevant categories. Area sources constituted the majority of NH_3 emissions; estimates were derived from activity levels specific to the category. Where no activity levels could be developed, no NH_3 estimate was made.

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SECTION 4

QUALITY CONTROL FOR POINT AND AREA SOURCE DATA

This Section describes relevant EPA quality assurance/quality control (QA/QC) policy, clarifies the use of QC for inventory data, and identifies specific EPA objectives met in order to create a comprehensive and accurate 1985 emissions inventory.

4.1 BACKGROUND

4.1.1 EPA Policy

EPA'S current QA/QC program on emissions measurements was initiated in May 1979. Detailed program requirements were issued in April 1984 under EPA Order 5360.1, "Policy and Program Requirements to Implement the Mandatory Quality Assurance Program." This order was developed to ensure that all environmental measurements conducted by EPA's Regional Offices, program offices, laboratories, contractors, and other sources resulted in data that were both scientifically valid and defensible. Valid and defensible data would include documentation of measurement precision, accuracy, representativeness, and comparability, as well as sample custody.

The stringency of these requirements varies with the use of the measurements being made. The most stringent requirements are reserved for engineering and environmental measurements that might be incorporated into EPA regulatory, enforcement, legal, or policy decisions.

Table 4-1 illustrates the elements of a typical QA/QC plan for engineering research or development projects that might be used for EPA policy decisions. Almost half of these elements (i.e., elements 3, 5, 7, 8, 10, 11) focus on topics intrinsic to environmental measurements: measurement equipment, calibration procedures, analytical procedures, data reduction, equipment performance audits, and preventive maintenance checks.

However, these elements have no counterparts in nationwide emissions inventory projects, because inventory data are almost exclusively based on emissions estimates rather than measured data. In general, the emissions data contained in emissions inventories are annual estimates that have been

TABLE 4-1. QUALITY ASSURANCE/QUALITY CONTROL ELEMENTS FOR ENGINEERING RESEARCH AND DEVELOPMENT PROJECT PLANS

1. Project objectives and constraints
2. Project and QA/QC organization
3. Data quality objectives for measurements
4. Sampling procedures
5. Calibration procedures and frequency
6. Sample custody
7. Analytical procedures
8. Data reduction, validation, and reporting
9. Internal QA/QC checks
10. Plans for performance and systems audits
11. Preventive maintenance
12. Calculation of data quality indicators
13. Plans for corrective action
14. Plans for QA/QC reports

developed by multiplying emission factors by activity indicators such as fuel consumption, by extrapolating from short-term test data, or by using engineering judgment. Therefore, the fundamental concepts of data accuracy and QA (assessing the differences between measured and true values) do not apply to emissions inventories. The traditional QA/QC approach developed for environmental measurements such as emissions tests is not applicable to the 1985 NAPAP Emissions Inventory, where QC procedures are limited to verifying the reasonableness--as opposed to the accuracy--of the emissions inventory.

The development of QC procedures for the 1985 NAPAP Emissions Inventory is complicated further by the size of the inventory and its component data bases. For example, the anthropogenic point source data base maintained by EPA's National Emissions Data System (NEDS) contains 50 data elements for each of about 200,000 emission points--or about 66 million bytes of data. Ultimately, the 1985 NAPAP Emissions Inventory, which includes these point source data, will contain hourly emissions estimates for approximately 35 pollutant species along with the 100 area source emissions categories for each of 63,000 grid cells (each cell is a geographic area roughly 20 km square)--or about 4 billion bytes of data. For data bases of this magnitude, QC procedures must be maintained and applied on large computers.

The conceptual framework for QC procedures for the 1985 NAPAP Emissions Inventory was adapted from the QC elements developed by EPA for environmental measurements and from an EPA study identifying QA/QC approaches to emissions inventory activities.[1,2] The QC program for the 1985 NAPAP Emissions Inventory represents a pioneering effort in QC procedures for emissions inventory projects within EPA.

4.1.2 Emissions Inventory Quality Control

Table 4-2 presents eight recommended QA/QC elements for emissions inventory projects. Note that the elements in this table are similar to the eight elements which remain in Table 4-1, except that those elements germane only to environmental measurements have been deleted. These eight elements constitute the conceptual framework for the *ad hoc* EPA emissions inventory QC program that has been developed for the 1985 NAPAP Emissions Inventory. The QC

TABLE 4-2. RECOMMENDED QUALITY ASSURANCE/QUALITY CONTROL ELEMENTS FOR EMISSIONS INVENTORY PROJECT PLANS

1. Project objectives and constraints
2. Project and QA/QC organization
3. Data collection procedures
4. Data custody
5. Data validation and QA/QC checks
6. Internal data handling procedures
7. Calculation of data quality indicators
8. Plans for QA/QC reports and corrective action

loop developed for the inventory concentrates on elements four through eight in Table 4-2.

4.2 OBJECTIVES

One of the major objectives of the EPA QC effort for the 1985 NAPAP Emissions Inventory was to provide a communications process permitting systematic identification and resolution of problems identified concerning reported or missing data. Other objectives are listed below.

4.2.1 Identification of Key Data Elements and Data Quality Objectives

A basic objective of the 1985 NAPAP Emissions Inventory was to compile a comprehensive and accurate inventory of emissions and facility data for anthropogenic sources for the 1985 base year, in order to serve several needs articulated by EPA and NAPAP. Both NAPAP and EPA wanted to develop point and area source data bases with emissions estimates that were confirmed by the participating sources and States. Additionally, NAPAP planned to use the inventory developed from these data bases in an atmospheric process model which analyzes relationships between emissions and acidic deposition.

In order to ensure that the data quality objectives considered important by NAPAP and EPA received the most attention, NAPAP developed guidelines for high priority data elements and data quality objectives to help the States effectively allocate their limited staff resources. High priority data elements for the 1985 NAPAP Emissions Inventory were indicated in Table 3-1. Table 4-3 summarizes NAPAP data objectives.

The QC procedures focus on the largest point source emissions categories, e.g., electric utilities, petroleum refining, cement manufacturing, pulp and paper mills, motor vehicle coating, and iron and steel mills. In addition, QC procedures focus on several data elements that have been identified as priorities for NAPAP research, i.e., emissions estimates, unit process identifiers (source classification codes), control equipment and efficiencies, fuel and operating rate data, location, throughput, and temporal profile data. All five criteria pollutants--nitrogen oxides (NO_x), sulfur dioxide (SO_2),

TABLE 4-3. NAPAP 1985 EMISSIONS INVENTORY DATA QUALITY OBJECTIVES

	Emissions Inventory for Support of Assessment Activities	Emissions Inventory for Support of Eulerian Atmospheric Modeling
Geographic Domain	48 U.S. States, District of Columbia, and Canada	Same
Temporal Resolution	Annual/seasonal	Hourly emissions values for typical weekday, Saturday, and Sunday for all four seasons
Spatial Resolution	Coordinates for point sources; area sources at the county level in the U.S. and at the province levels in Canada; natural sources at county, State, or province level; release height	Coordinates for point sources; area sources assigned to 20 x 20 km grid cells; release height
Species	SO_2, NO_x, reactive VOC, TSP, CO	SO_2, SO_4, TSP (Ca, Mg, K, Na), CO, HCl, HF< NO, NO^2, NH_3, VOC (methane, ethane, ethylene, propane propylene, N-butane, 1,2-butane, isobutane, isobutene, trans-2 butene pentane, isopentane, 2,3-dimethylbutane, other alkenes, other alkanes, formic acid, acetic acid, other organic acids, formaldehyde, acetaldehyde acetone, other ketones, other aldehydes, xylene, benzene, toluene, ethylbenzene, other aromatics) natural emissions (S, alkaline dust, NO_x, from lightning and biota, isoprene, 4 major turpenes, NH_3)
Sources	Anthropogenic stationary sources emitting >100 tons of criteria pollutants in 1985; area source estimates for small stationary and mobile sources; natural sources	Same

volatile organic compounds (VOC), total suspended particulates (TSP), and carbon monoxide (CO)--are included in the NAPAP inventory. The point source QC methodology focuses on NO_x, SO_2, and VOC because they are expected to play major roles in the acid deposition models.

Another major objective of the point source data base QC checks was to communicate results effectively to field inventory personnel who are most knowledgeable about sources in their States. For this reason, the point source QC process for 1985 is a three-step screening process. The first step, at the field level, involves State and EPA Regional Office personnel. The second step, which occurs after the data are submitted to OAQPS/AEERL, is a search for systematic errors and omissions in the data. The third step, which takes place after the data are compiled into a preliminary NEDS file, is the return of detailed QC documents outlining any problems found with the data to the States so that they may comment and correct the data. A flow chart of the QC procedures is shown in Figure 4-1.

4.2.2 Identification of Problems in Existing State Emissions Inventories

Early in 1986, the most recent emissions inventory file for each State was examined by OAQPS/AEERL for missing high priority data items, missing estimated emissions, and any systematic errors involving invalid coding or processing (see Section 3.1.5). These reviews indicated several consistent deficiencies in the EPA data bases: emissions estimation methods were not recorded correctly, allowable emissions were reported instead of actual emissions, and blanks rather than zeros were left in the spaces for control equipment/ efficiencies to indicate no control equipment. These data problems did not necessarily reflect problems specific to the State point source data. For example, some of the data gaps resulted from incomplete translation of data from the State systems to NEDS. Subsequently, the Regions and States were able to identify many of the sources of these errors and institute corrective measures within the data collection, coding, and transfer steps. This action alerted EPA to potential problem areas for the 1985 NAPAP Emissions Inventory.

4.2.3 Standard Inventory Techniques

Establishing a common methodology at the State level for data collection, emissions estimation, and QC was an important early step in assembling an adequate and consistent data base. First, the resulting State data bases would be developed on a nationally consistent basis. Second, QC procedures could be developed to build QC directly into the data collection process, where errors could be located and corrected most efficiently. Essential elements of procedural and technical guidance were communicated to State and contractor personnel through two workshops and companion manuals (see Section 3.1.6).

4.2.4 Emissions Estimation Procedures

Emissions estimates from the States for the 1985 NAPAP Emissions Inventory are calculated estimates of actual emissions during 1985. NEDS recognizes two types of estimation procedures: one using individual source data and one using emission factors. EPA requested that States, whenever applicable, use the standard emissions estimation procedures, described in Section 3.7, and presented a hierarchy for utilization of the acceptable methods. Each method has a unique code in NEDS so that the method is documented and can be tracked over time for each emissions point.

4.2.5 Utility Quality Control Checks

Utilities represent the single largest point source category of NO_x and SO_2 emissions. For this reason, a comprehensive methodology of QC checks was developed specifically for this source category. The focus of this methodology was on complete coverage of the electric utility industry, proper classification of all electric utilities, and agreement between specific data reported to EPA and data reported to DOE.

The first part of this methodology was a review of NEDS data to identify plants that might be electric utilities. The first three digits of the SCC codes for electric utility boilers are 101 or 102. In addition, the Standard Industrial Classification (SIC) Code for electric utilities is 4911. The review identified both facilities which met these criteria and facilities which met the criteria in part but appeared to have internally inconsistent data. The utilities found in NEDS were compared to those provided by DOE. In order to ensure that all potentially large utilities were covered, all discrepancies that involved utilities expected to emit at least 100 TPY of NO_x, SO_2, or VOC were noted.

The second part of the electric utility review was a direct comparison of data elements reported by the utility plants to EPA through NEDS and to DOE through Energy Information Administration (EIA) Form 767. The NAPAP high priority data elements were of particular concern in this comparison.

4.3 THE POINT SOURCE QC LOOP

To meet the objectives of the EPA QC policy for emissions inventories, a systematic QC loop was developed involving State agencies, EPA Regional Offices, and EPA OAQPS/AEERL. Problem resolution, correction, and review entailed all three levels in a cooperative process. At each major stage in the QC process, an option existed to refer problems back to State agencies, to permit engineers closest to the sources to resolve problems. The QC loop is outlined generally below, with the components of each phase subsequently explained. Figure 4.1 provides a graphic presentation of the loop.

4.3.1 Overview of QC Loop

The QC loop begins with the States, which were responsible for the initial compiling and reporting of 1985 point source data via NEDS to EPA. States obtained emissions and other source data regarding criteria pollutant emissions directly from plants. The State role in the QC process continued throughout each step, as the option existed to refer problems or questions about the data back to the State agencies generating the data for resolution.

EPA Regional Offices then subjected the State data submittals to the NE061 edit checking program, and enlisted State help in resolving identified problems or errors in the data. OAQPS then updated the State emissions inventory data to create a preliminary NEDS point source file. As the data were corrected, a

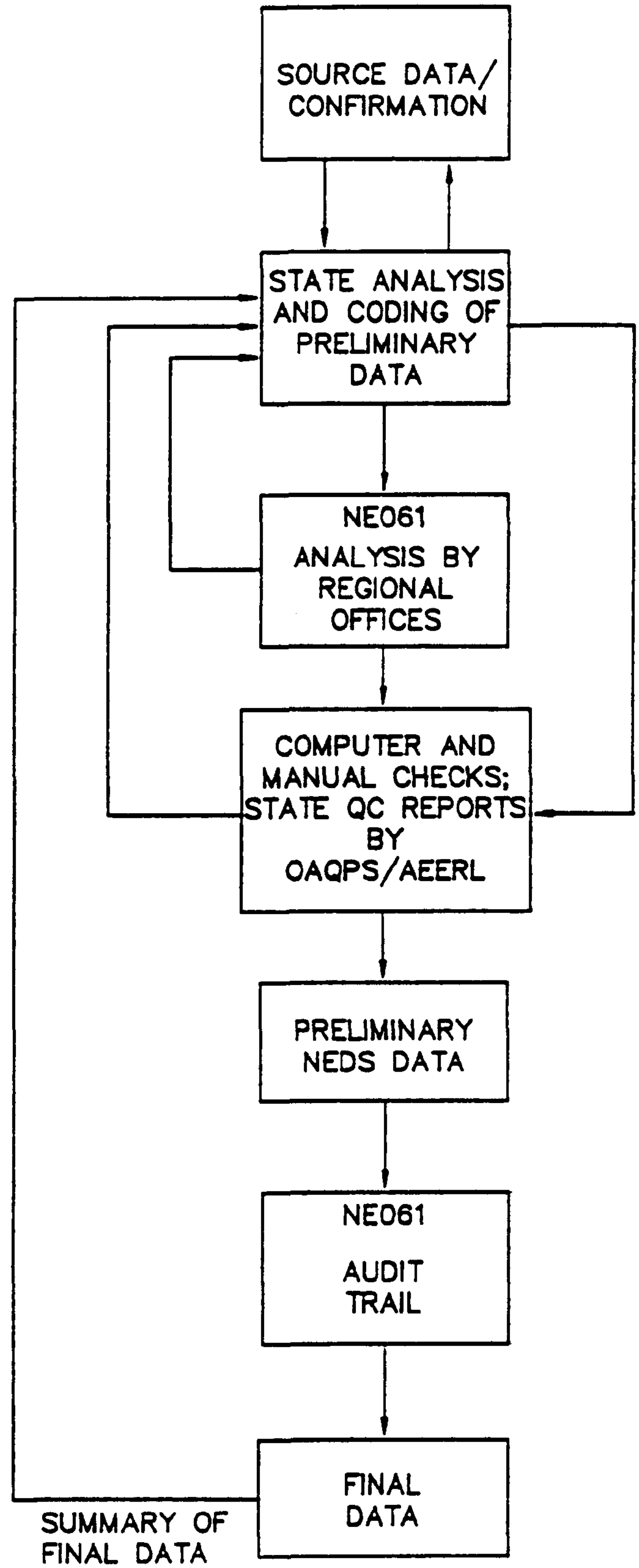

Figure 4.1. QC Loop for Point Source Emissions Data

computerized Audit Trail system kept track of all changes to the original State-submitted data and ensured that all identified problems had been addressed.

After the data were screened by EPA Regional Offices, they were subjected to a second set of screening procedures developed specifically for the 1985 NAPAP Emissions Inventory by OAQPS/AEERL. In this screening process, four computerized programs and two manual checks were used to indicate inconsistencies and errors in the data. The results of these programs were compiled into a six-part QC document for each State, which was sent to the State and EPA Regional Offices for corrective action or confirmation of questionable data.

After final corrections and updates to the State's emissions inventory had been made, a final review of the complete 1985 point and area source data base constituted a last step in the QC process. A check of the largest sources was made in an attempt to guarantee that all errors were detected and corrected. Inconsistencies in confirmation results and the use of NEDS-calculated emissions were also reviewed. In February 1988, each State received its final NEDS point and area source data for a final review. At this time questionable data identified in the final QC step were verified or corrected through the same channels established for the NEDS inventory. All changes were documented by the Audit Trail program.

4.3.2 State Level - Data Collection and Confirmation

Quality control (QC) of the State emissions inventory submittals proceeded in several steps. The process began with a State's submittal of 1985 emissions inventory data. For many States, this effort required contacting each major source, obtaining detailed emissions and facility data for each point within that source, obtaining confirmation of plant emissions totals, encoding the data onto NEDS forms, and checking the forms for errors. The State could run a computerized edit-checking program on the data and make appropriate corrections. Additionally, States were asked to help NAPAP resolve any questions that were identified at later stages of the QC process for sources that emitted at least 1000 tons of SO_2, NO_x, or reactive VOC.

The States then submitted their 1985 NEDS data to EPA Regional Offices. The Regional Offices broke the data down into standard NEDS subfile and card image files. If the files passed the general validity scan performed on them, they were copied to computer disk for further processing. At this point, the edit program NE061 was run on the card image file, and an error report was generated. (See Appendix B for a list of rejection and warning messages used by NE061.) The Regional Offices enlisted State assistance in resolving identified problems or errors. The Regional Offices then transmitted the emissions inventory data and confirmation status reports to OAQPS, along with a State transmittal letter describing the coverage of the inventory.

4.3.3 EPA Screening Level

OAQPS then updated the State data to create a preliminary NEDS point source file. Once the State data were in a preliminary point source file, a tape of the file was transferred to AEERL. AEERL entered the file into its data base and subjected it to a variety of QC checks, which are described in detail below. These initial checks included the NE061 edit checks to verify that problems identified by the Regions had been resolved, completeness checks for missing facilities, comparisons with State utility data submitted to DOE, and additional QC checks to identify erroneous data.

4.3.3.1 NE061 Edit Checks

The NE061 edit program creates two reports with each execution. The first report is a reject edit diagnostics report. It identifies data entries that were rejected for invalid State, Air Quality Control Region (AQCR), plant or point identifiers (IDs), Source Classification Code (SCC), action code, transaction type, or card number. These errors must be corrected by the States and the data must be resubmitted before the entries can be considered valid.

The second report is a warning edit diagnostics report. Cards identified in this report contain likely errors (certain data items missing, data items exceeding limits established in external data files, or internally inconsistent data), but are not necessarily invalid. The warning report was reviewed to identify any real errors that needed to be corrected or any important missing data items that needed to be obtained. Warning messages did not always indicate an error; however, EPA Regional Offices and States were asked to verify that inventory data flagged with warning messages for facilities emitting more than 1000 tons per year of SO_x, NO_x, and VOC were correct.

If no rejection errors or warning messages apply for a particular card image record, no message is printed. A summary is generated which includes a count of the total number of card images read, the number that passed the minimum data quality requirements, and the number that were flagged with reject messages.

4.3.3.2 Completeness Checks

After the NE061 edit checking program was run, a completeness checking procedure was performed to identify possible omissions of large sources in the 1985 State NEDS submittals. Data from the 1985 submittals were compared with data from the 1984 NEDS Large Source File and with plants listed in the Independent Completeness File. The 1984 NEDS Large Source File contains the NEDS codes, names, addresses, and emissions for plants in the current 1984 NEDS point source file emitting more than 1000 tons/year of SO_2, NO_x, or VOC. The Independent Completeness File was compiled from several reference sources including trade association publications, current industrial directories, and EPA New Source Performance Standards files.

The results of the completeness checks for each State submittal were summarized in three tables. The first table listed plants in the Independent Completeness File not found in the 1985 State submittal. The second table contained a listing of plants in the 1984 Large Source File not found in the 1985 submittal. The third table listed the 1984 NEDS-computed emissions which differed greatly from the 1985 State-submitted emissions for SO_2, NO_x, and VOC.

Other computerized and manual data checks were also run on the State NEDS submittals. These included checks for missing data and checks against standard data ranges to ensure the completeness and accuracy of the final data base, as described below.

Checks for missing data--A pre-update screening of the data was performed to check that (1) major sources emitting over 100 tons/year were not improperly deleted, and (2) plant names matched with current plant IDs to ensure that plant IDs were not changed.

The data were updated to the NEDS file and the update reports returned to the Regional Office. The update process stored the new data in NEDS and calculated emissions or apportioned reported emissions to the SCC level. The update created the Calculation Validation Report, the Update Rejection Report, and the Update Validation Report. The Calculation Validation Report identified inconsistencies in the parameters (estimation methods, emission factors, operating rates, sulfur and ash content, estimated point emissions, and SCC emissions) that were rejected because the data were incomplete (missing cards) or because the update action code (add, change, delete) was incorrect. The Update Validation Report identified some of the inconsistencies between related data items.

OAQPS/AEERL procedures include a post-edit inventory of data received. This inventory was created to determine the amount of data submitted and whether the coverage agreed with the letter from the State. Major problems such as incomplete card sets were identified by this procedure.

Checks against standard data ranges--The State NEDS inventory was edited by the NEDS edit program to identify any items outside the bounds of "reasonableness" criteria that were not resolved by the State or Regional Office. Problems for sources above the NAPAP thresholds were referred to the Regional Office and the State for resolution.

The UTM coordinates for each point source were checked against correct ranges for the county. For the sources above the NAPAP threshold, the apparent errors were referred for resolution. For all other problems, NAPAP substituted the county centroid for the coordinates.

NEDS stack, control device, control efficiency, emissions, and activity data for a given source underwent statistical checking procedures. Reported data were checked against mean values for that SIC/SCC combination. Data that fell more than two standard deviations outside the mean for that SIC/SCC were flagged for investigation.

4.3.3.3 DOE EIA-767 Utility Fuel Data Comparison

The electric utility sector is a major source of SO_2 and NO_x emissions in the U.S., contributing about two-thirds of total SO_2 and one-third of total NO_x emissions. Because this sector represents such a large portion of the total emissions for these pollutants, it was imperative that the highest possible quality data be reported to NEDS for the 1985 NAPAP Emissions Inventory. In addition to running NE061 and other computerized and manual QA checks on State NEDS submittals, EPA also used utility data submittals to the Department of Energy (DOE) for QC purposes. Since the utilities are required by Federal law to report certain information to DOE's Energy Information Administration (EIA), those items should serve as an appropriate basis for comparison with utility data submitted to NEDS.

Of particular interest for the 1985 NEDS/NAPAP Inventory were the data reported on Form EIA-767. This report includes data that are very similar or identical to data required in NEDS. Every steam electric generating plant with a total generator nameplate rating of 100 megawatts or greater is required to submit a Form EIA-767. In 1985, this group included about 500 fossil fuel-fired steam electric plants.

The EIA-767 data were compared with data received from NEDS as a QC check for utilities above the NAPAP emissions thresholds. For State or local agencies, EIA-767 could serve either to supplement the data normally collected from electric utilities or to provide a quality assurance crosscheck. Ideally, State agencies worked in cooperation with utilities in their domain to ensure that the data reported to DOE by the utility and the data reported to EPA by the State were correct and consistent with each other. At this stage in the QC process, resolution of discrepancies found by OAQPS/AEERL was likely to be less awkward and time-consuming than it would be later in the QC process. Significant discrepancies in location, stack parameters, activity levels, and emissions data were referred to the States for resolution. EPA felt that the time and effort spent by the States to work with utility companies concerning their report to EIA were more efficiently used than time spent later trying to resolve discrepancies between NEDS and EIA data.

4.3.3.4 Additional QC Checks

OAQPS applied a series of additional QC checks to the State NEDS submittals to indicate systematic errors. These checks included both computerized and manual checks, and focused on the NAPAP high-priority data items. Five checks were used: the State Emissions Summary Report, the State Fuel Summary Report, the County/Plant Emissions Report, Quick Look Reports, and the Calculation Validation Report.

The State Emissions Summary Report was used for large-scale comparisons of emissions data. It summarizes emissions data by combustion source type and fuel type, and presents total statewide emissions for NO_x, SO_2, and VOC. These totals were compared to the previous year's totals and to previous emissions trends to ensure that 1985 data were in line with past emissions totals.

The State Fuel Summary Report was used for large-scale comparison of fuel consumption data. It was compared to the 1984 State Fuel Summary Report for each combustion category and for each type of fuel. Data on fuel consumed by electric utilities were also compared to the DOE Generating Unit Reference File (GURF).[3] State consumptions of coal, oil, and gas were compared to fuel delivery data provided by DOE.[4,5,6] Generally, coal consumption by point sources should have equaled coal delivered. Oil and gas consumption by point sources should have been less than the fuel deliveries because a large portion of these fuels is consumed by area and mobile sources. During this analysis, the most frequent problem encountered was the over-reporting of fuel consumption in the NEDS submittals.

The County/Plant Emissions Report gives emissions by individual plants sorted by county. Other data fields, including year of record and location data, are also listed. This report was quickly scanned to ensure that the new data had a 1985 year of record.

NEDS can calculate emissions by multiplying the annual operating rate by an emission factor from the emission factor file. Because these emissions estimates are computer-calculated, they are not as valid as estimated emissions data entered by the State agency. The Quick Look Reports were used to identify two possible problems. First, a check was made for instances where NEDS could have calculated positive emissions for a source that reported zero emissions.

Small sources were ignored, but those with potential emissions exceeding 25 TPY of NO_x, SO_2, or VOC were noted. Second, instances in which the State requested that NEDS calculate emissions, but no emission factor existed in the emission factor file, were noted.

The Calculation Validation Report identified any instance where NEDS could not allocate emissions from the point level to the SCC level. This problem generally occurred when one of the SCCs assigned to the point had no emission factor or its operating data were missing. This scan was performed for SCCs expected to emit 25 TPY or greater of criteria pollutants. If a decrease in emissions was found during the scan of the State Emissions Summary Report, then additional information on the possible miscalculation of emissions was sought in the Calculation Validation Report, which prints out all instances where estimated point emissions differ from computed emissions by more than a factor of three.

4.3.3.5 Audit Trail

The 1985 NAPAP Audit Trail Program was designed to document all changes made to the NAPAP Emissions Inventory point source data base. The SCC-level NEDS data were used as input to this program. SCC-level data are defined as sources having unique State, County, plant, point, and SCC code combinations. All information resulting from the execution of this program was stored in an "electronic notebook" disk file.

Each record in the new version of the data base was compared to the corresponding record in the previous version of the data base. All parameters, such as stack height, flow rate, emissions estimates, etc., were checked for matching new and old values. If a match was not found for a particular source, the record was flagged and the old and new values of the parameter were printed. If a record was present in the new data base but not the old data base, the record was flagged as a new (added) record and was printed. Similarly, if a record appeared in the old data base but not in the new data base, the record was flagged as an old (deleted) record and was printed.

4.3.4 QC Reports

After NE061 edit checks, completeness checks, and other QC checks were performed on the State submittal, the results of these efforts were assembled into a State QC report. This report included the following information:

(1) the results of the NE061 edit checks for plants reported to emit at least 1000 TPY SO_2, NO_x, or VOC;

(2) emissions sorting, parameter validations, and large source completeness reports;

(3) a report showing what portion of total plant emissions were calculated, rather than reported, for plants where EPA was requested to calculate emissions from any point by using the NEDS emission factor file; and

(4) annotation of these reports to indicate, where possible, which warning messages should be investigated and resolved by States.

Once a State QC report had been assembled, OAQPS/AEERL reviewed the results of the QC checks made on each State NEDS submittal to identify specific problems in the results, such as misleading or incorrect error/warning messages, and to identify significant data quality problems revealed by the checks. After analyzing the results of this review, OAQPS made recommendations for resolution of any problems found. Appropriate modifications were then carried out to resolve the detected problems.

The QC results for each State submittal were then assembled into a formal report ("State Report") complete with explanatory notes for each section and a cover letter from OAQPS. An attempt was made to minimize the time required to generate the State Reports to fewer than 15 working days from receipt of the State submittals.

The State QC Reports were then submitted to OAQPS and sent on to the State agencies responsible for the data. The State agencies pursued QC questions and problems, corrected errors, and provided missing data items for as many sources as possible. In order to facilitate response to the State Reports, States were requested to respond to the results of the NE061 edit checks, the completeness checks, and miscellaneous QC questions on a priority basis. Based on State responses, EPA completed final updates to the State emissions inventory data submissions.

After these data updates to the State NEDS submittals were completed, a final review by each State of its final NEDS point and area source data was initiated. As part of this final review, three additional data screens were made. First, a final check of the largest sources was made to guarantee that all errors were located and corrected. In this check, the 1000 largest points for SO_2, NO_x, and VOC were identified from the NEDS point source file. (These points represent 81, 68 and 47 percent of the total point source SO_2, NO_x, and VOC emissions, respectively). The data for each point source were examined by a qualified reviewer for consistency and realistic values. In addition, other points emitting at least 500 tons per year were screened for missing stack parameters. Second, inconsistencies between State confirmation reports and NEDS emissions were identified. Third, NEDS-calculated emissions were again summarized at the point level for calculated emissions of at least 100 TPY for SO_2, NO_x, and VOC.

The complete point and area source NEDS data and the results of these three additional data screens were reviewed by the States. Questionable data were verified or corrected where possible through the same channels established for the previous State reviews. These changes were then updated to the 1985 NAPAP Emissions Inventory. All changes were documented through the Audit Trail Program.

4.4 RESULTS OF QC PROCEDURES

4.4.1 Analysis of Quality Control Results

Through the use of an extensive QC program on the 1985 NEDS State submittals, the resulting NAPAP interim point source data base represents the most complete and accurate inventory of acid rain precursors assembled to date. Essentially all data have a 1985 year of record; by contrast, in a typical NEDS year only 10 States are able to submit substantially current data. All States have participated in the 1985 inventory effort and submitted current data; whereas in general, previous NEDS data represent annual submissions by only

34 States. Previous inventories contain significant data omissions, even among priority data items, but in 1985, States delivered substantially all high priority data items.

Through cooperative work between States, Regional Offices, and several branches of EPA, and through regular updates of all data bases, State inventories and the 1985 NAPAP Emissions Inventory should have substantial agreement. In the case of records rejected by the NE061 program, complete replacement submittals of the data alleviated potential continued problems with erroneous data elements. EPA emphasized that States should submit emissions estimates for large sources wherever possible rather than allow NEDS to calculate emissions. EPA requested confirmation of emissions with facilities emitting over 2500 tons of SO_2 and NO_x to assure the accuracy of the emissions data for the largest point sources; about two-thirds of the States responded with confirmation letters. Computer checks served to ensure that data were within standard data ranges, and when data did fall out of range, consultation with State or local air pollution agencies could often confirm or resolve data issues.

4.4.2 Resolution of QC Problems

However, the QC program was not without its problems. Time and resource constraints, present at all levels of QC, made it difficult to track down missing data items and data elements which lay outside standard ranges. State data which had been confirmed with sources sometimes fell outside the data ranges, and therefore still evoked a warning message each time NE061 was run on the EPA data base. A more substantial problem occurred when emissions data were confirmed between a facility and the State, yet these confirmed emissions were still not in agreement with the data in NEDS. Lack of confirmation was a problem in over one-third of the States. It was often difficult to resolve discrepancies in source names and emissions data between 1984 and 1985 NEDS submittals. For example, Illinois and Michigan renumber their NEDS data submittals each year, making matchups between data from consecutive years especially difficult. Problems such as these were referred to the participating State agency for resolution, and in almost every case, the State was able to verify or correct these questionable items.

4.4.3 Remaining QC Questions

Several more serious problems remained in the emission inventory. Individual State confidentiality restrictions prevented the complete reporting of some priority data elements (e.g., fuel use, operating rate data). In consideration of this problem, EPA and the States worked together to reach compromises respecting both these confidentiality restrictions and the need for accurate and complete data. Specific cases are outlined below.

The State of Texas' Clean Air Act prohibits the public disclosure of facility operating rate data. Texas agreed to compare summaries of data submitted by Texas utilities to the Department of Energy with confidential utility information and to indicate where DOE data were in error, since these actions would not violate Texas Clean Air Act restrictions. EPA then estimated fuel consumption for Texas industrial boilers missing this data item as a check on the reasonableness of the emissions data provided by Texas. Texas consequently reviewed EPA's fuel consumption estimates and identified boilers with inaccurate emissions.

West Virginia had problems due to confidentiality restrictions and a shortfall of resources. The State agency had obtained 1984 operating rates and maximum design rates for chemical plants under an agreement which stipulated that the data remain confidential. In addition, State officials indicated that because of the effort expended in compiling the 1984 VOC emissions data base, the State would not have the resources to collect VOC emissions data for these sources for 1985. West Virginia and EPA agreed that the 1984 VOC data would fulfill the 1985 inventory objectives.

New Jersey and New York also had specific problems. Initially, State officials doubted that they could provide operating rate and actual emissions data, because the State agencies do not collect these data from plants. In both cases, EPA agreed to allow the State to report allowable emissions for plants emitting less than 1000 TPY of criteria pollutants but requested actual emissions data for plants emitting greater than 1000 TPY. New York was able to submit actual emissions data as reported by the plant for plants emitting greater than 100 TPY. For most points in the New Jersey inventory, operating rates were not reported. For New Jersey sources reporting over 1000 TPY of SO_2, NO_x, or VOC, operating rates were reported, but were not collected or reviewed according to NAPAP specifications. Consequently, these data do not meet the inventory criterion for quality.

Ohio and Virginia initially indicated confidentiality problems in reporting operating rate data. Ohio eventually was able to provide these data. Virginia did not submit operating rate data for noncombustion sources.

A potentially serious deficiency was recognized during the QC procedures designed to recognize missing facilities. Department of Defense (DOD) facilities were reported inconsistently in the 1985 NEDS submittals, and only a low percentage of those listed were identified as large point sources. Further investigation with State personnel revealed that most missing DOD facilities had not submitted data to the State. At that stage of the inventory effort, no resolution of this problem could be made for 1985. However, DOD facilities have been identified on a State-by-State basis to indicate those contained in the inventory, as well as those potentially missing from the inventory.

Another major problem with the entire NEDS data collection and QC effort was the incompatibility of various State computer systems with the NEDS system. In addition to delays caused by the extra work involved in translating data, this inconsistency caused some incomplete or garbled translation of data. Consequently, a more extensive data correction effort was required than would have been necessary if all the computer systems had been compatible. In cases where States had their emissions inventories stored in other forms (e.g., on micro-files), data translation and QC was an even lengthier process. In addition, the fact that State emissions tracking systems are typically designed for permit enforcement work meant that some data items were not in the form prescribed for NEDS and required some reworking. Although these problems were overcome, future inventory efforts will be subject to similar problems unless long-term solutions for data incompatibilities are developed and implemented.

4.5 QA/QC OF AREA SOURCE DATA

Quality assurance and quality control of area source emissions inventory data, like QA/QC of point source data, do not involve checks for data accuracy. Because there is no measured standard with which to compare area source emissions data nor previously defined QA/QC procedures, QC procedures were developed which focused on completeness and reasonableness of the county and gridded (SO_2, NO_x and VOC) emissions data, in addition to various input data.

Due to the quantity of data involved, activity level and emissions data from significant area source categories were plotted to locate missing data, gross errors, border discontinuities, and improper location of urban centers. Plots (maps) of the final area source emissions were then compared with appropriate plots of selected surrogate activity levels (e.g., population distribution). Direct visual comparisons of the emissions plots and plots of the surrogate data used to develop the estimates were used to isolate potential problems by illustrating dissimilar patterns in the data.

For the purposes of this study, since Regional Acid Deposition Modeling activities do not include any terrain west of the Rocky Mountains, areas in the U.S. located east of the Rocky Mountains received more attention, most specifically the Ohio River Valley. In addition, certain regions which have exhibited erroneous spatial distributions in previous inventories received more scrutiny in the QA process. These areas include St. Louis, northern West Virginia, Pittsburgh, Massachusetts, and Virginia.

In a separate analysis, emission factors for each area source category were reviewed for reasonableness. Sources of the original factors and their methods of calculation were sought to verify the factors which were used as NEDS input data.

Potential problems discovered during the QA analyses were recorded for later verification. Errors in the data were corrected when found, but in general, area source emissions estimates, activity level data, and emission factor data were found to be reasonable and complete.

4.5.1 Emission Factors

Emission factors for each area source category were traced back to the reference materials. Most emission factors for area sources were adapted from EPA's Compilation of Air Pollutant Emission Factors (AP-42). In some source categories, however, data were available to develop more applicable local factors. In addition, ten new categories for VOC emissions were added to the 1985 NAPAP Emissions Inventory that were not included in the 1980 inventory. The National Air Data Branch (NADB) and Alliance developed emission factors for these additional categories and for ammonia emissions categories. The emission factors associated with them may require further checks if discrepancies appear in area source emissions for these new categories.

4.5.2 Activity Levels

Activity levels were derived primarily from related information published by other Federal agencies, supplemented by special data developed by EPA for the purpose of developing NEDS area source inventories. Published data such as fuel use by State and county and forest fire acres burned by State are used with related data such as employment, population, and miscellaneous geographic or economic data to derive annual county estimates of the activity levels for each of the NEDS area source categories.

Surrogate indicators are defined as those variables used to spatially allocate area source activity levels to the county level in NEDS. Area source emissions are similarly allocated to the county level by county population, number of dwelling units, vehicle registration, and employment for various economic sectors. Surrogates examined in the area source QA efforts were selected based on the magnitude of national emissions contributed by respective area source categories. Surrogate information plotted at the county level included the following:

Population
Dwelling Units
Vehicle Registration
Manufacturing Employment
Commercial Employment
Solvent User Category Employment

For the most part, allocation variables were easily identified. However, default surrogates were assigned to those categories where either insufficient surrogate data were available or the NEDS allocation process used an algorithm based on more than one significant variable.

Initial comparisons of population, land use, dwelling units, employment, and vehicle registration plots indicated the general reliability of the data, as well as identifying potential errors early in the QC process. Correction of basic information before it was used to allocate State emissions to the county or grid should reduce errors in the final emissions estimates. Missing and incorrect data were flagged and corrected where possible.

4.5.3 Emissions

County emissions for the area source categories were estimated by NEDS using category-specific activity level data and the appropriate emission factors as shown in Section 3.2. Specific area source categories were selected for evaluation in the activity level QA efforts based on the magnitude of emissions contributed by particular area source categories. For each pollutant (SO_2, NO_x and VOC), the categories were ranked by emissions magnitude and the top categories were selected for detailed examination. These categories included:

Stationary Sources -
- Residential
- Commercial/Institutional
- Industrial

Mobile Sources -
- Light Duty Gasoline Vehicles
- Light Duty Gasoline Trucks
- Heavy Duty Gasoline Vehicles
- Off Highway Vehicles
- Locomotives

Aircraft
Marine Vessels

Miscellaneous Sources -
Solvents Purchased
Gasoline Marketed

Additional Sources -
Hazardous Waste TSDFs
Fugitives from Refinery Operations
Bulk Plants/Bulk Terminals

Emissions plots were then generated using county level data from NEDS. Each plot was reviewed for completeness before comparison with its surrogate activity level plot. This review included checks for inconsistencies, missing data, proper location of urban centers, and border problems. Emissions plots were then compared to the surrogate plots to ascertain inconsistencies in the data.

Final comparisons of the plots showed general agreement between the NEDS input data and the final emissions estimates for many of the significant categories. No major problems were found; however, potential minor concerns were noted. A small number of missing data items were corrected.

Section 4 References

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2. Development of an Emission Inventory Quality Assurance Program, EPA-450/4-79-006 (NTIS PB80-112345), U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, December 1978.

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