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# **Particulate-Related Health Impacts of Emissions in 2001 From 41 Major US Power Plants**

## **Executive Summary**

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# Particulate-Related Health Impacts of Emissions in 2001 From 41 Major US Power Plants

## Executive Summary

Extensive studies worldwide, including important studies by the Harvard School of Public Health and the American Cancer Society, link exposure to fine particle air pollution to heart disease, lung cancer, respiratory ailments, and premature death. Most fine particles are formed when emissions of sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) react with ammonia to form particles less than 2.5 microns in diameter, which interfere with the ability of the lungs to absorb oxygen. Power plants are responsible for about two thirds of the SO<sub>2</sub> and one quarter of the NO<sub>x</sub> emitted in 2001. While some progress has been made in gradually reducing these pollutants since the passage of the 1990 Amendments to the Clean Air Act, it has been unevenly distributed.

Title IV of the 1990 Amendments to the Clean Air Act (the “acid rain” provisions) and other programs have helped reduce SO<sub>2</sub> emissions from power plants by 32% from 1990 levels through a “cap and trade” program. Because companies can avoid pollution controls under Title IV by purchasing emission “credits” from plants that have cleaned up, SO<sub>2</sub> emissions have actually increased in some states, and declined by significantly less than the 32% national average in other states. Table A presents the state-wide totals for the 1990 and 2001 SO<sub>2</sub> emissions from power plants, and identifies whether each state increased or decreased its emissions over that period. Texas, North Carolina, and Virginia had the largest increases in total tons of SO<sub>2</sub> emitted. Other states, like Pennsylvania, reduced their emissions substantially less than the national average.

Progress in decreasing SO<sub>2</sub> at individual power plants also was uneven over this period. Of the nearly 600 sulfur-emitting plants operating in both 1990 and 2001, 42% (252 plants) increased their sulfur emissions by 2001, and another 10% (62) decreased by less than half the national average. Of particular concern are the major plants that increased their sulfur emissions or declined by less than 15%. Table B provides data for 41 large power plants that meet two criteria:

- ! Emitted at least 40,000 tons of SO<sub>2</sub> emissions in 2001, and
- ! Had SO<sub>2</sub> emissions either increase or decline by less than half the national average between 1990 and 2001

For example, SO<sub>2</sub> emissions from three large power plants in western Pennsylvania – Hatfield’s Ferry, Keystone, and Homer City – jumped from 408,000 tons in 1990 to 483,000 tons in 2001. In 2001, the 41 plants evaluated by this study accounted for one quarter of the SO<sub>2</sub> emissions from the 1,110 power plants covered by Title IV. Of the 41 plants, 31 increased their emissions, and 10 decreased their emissions by less than 15%.

Sulfur and nitrogen emissions from power plants significantly increase the amount of fine particles in the air. These emissions are associated with a wide range of adverse health effects, including premature mortality, hospital admissions, and work loss days. The Environmental Integrity Project (EIP) asked Abt Associates to estimate the health effects associated with the emissions from 41 of the power plants covered by Title IV.

Abt Associates used EPA's Source Receptor (S-R) Matrix to forecast the amount of fine particles formed from power plant emissions in each county within the continental U.S. The S-R Matrix is not as sophisticated as other models EPA uses to estimate fine particles. However, the S-R Matrix is not nearly as resource-intensive as these more complex models, and is readily able to estimate the impact of individual power plants. EPA has used the S-R Matrix for numerous policy analyses, including EPA's Regulatory Impact Analyses of the 1997 revisions to the Particulate Matter (PM) National Ambient Air Quality Standards (NAAQS), the 1998 State Implementation Plan (SIP) NO<sub>x</sub> Call, the 1999 Regional Haze Rule, and the 1990 Tier II automobile exhaust standards. Although more complex PM models exist and are being improved constantly, the S-R Matrix gives a reasonably good first approximation of the likely PM impacts of the power plant emissions.

Abt Associates estimates that between 4,800 and 5,600 premature deaths in 2001 are associated with the emissions from these 41 plants. The alternative estimates are based on two well known recent studies of the relationships between air pollution and premature mortality; the analysis by the Health Effect Institute (Krewski et al., 2000), and a newer analysis that examined the same people over a longer period of time (Pope et al., 2002). In addition to the premature mortality, Abt Associates also estimated over 3,000 hospital admissions or emergency room visits, 930,000 work loss days, 111,000 asthma attacks, and other health effects are associated with the emissions from the 41 plants. Table C shows some of the health effect estimates linked to the SO<sub>2</sub> and NO<sub>x</sub> emissions from each of the 41 power plants. Additional health results are provided in the report in Exhibits 3.7 through 3.9.

Power plant pollution spreads over a wide area, with most of the fine particle pollution occurring within a 500-mile radius of the plant. Accordingly, the premature mortality and other diseases that result from the specific power plants identified in Table C include estimated impacts both inside and outside the particular state.

**Table A State SO<sub>2</sub> and NO<sub>x</sub> Emission Data. 1990 and 2001**

State	SO <sub>2</sub>				NO <sub>x</sub>	
	1990 (Tons)	2001 (Tons)	Change	Ratio '01 to '90		
Oregon	4,936	17,837	12,901	361.4%	↑ Increased Emissions	
Nebraska	50,378	70,251	19,873	139.4%		
Kansas	87,676	120,307	32,631	137.2%		
Virginia	158,626	217,435	58,809	137.1%		
Montana	17,922	24,403	6,481	136.2%		
North Carolina	336,451	450,486	114,035	133.9%		
North Dakota	123,464	154,934	31,470	125.5%		
South Carolina	167,414	202,501	35,087	121.0%		
Texas	462,345	541,263	78,918	117.1%		
Mississippi	119,071	138,358	19,287	116.2%		
Washington	58,434	66,912	8,478	114.5%		
Louisiana	98,703	112,804	14,101	114.3%		
Arkansas	69,160	78,705	9,545	113.8%		
Minnesota	81,166	91,768	10,602	113.1%		
Colorado	83,186	90,388	7,202	108.7%		
Wyoming	80,877	84,471	3,594	104.4%		
Oklahoma	101,852	101,447	-405	99.6%		↓ Decreased Emissions
Nevada	55,780	54,703	-1,077	98.1%		
New Mexico	63,839	62,198	-1,641	97.4%		
Michigan	369,845	347,070	-22,775	93.8%		
Maryland	282,453	254,482	-27,971	90.1%		
Utah	32,051	28,321	-3,730	88.4%		
Florida	645,131	569,153	-75,978	88.2%		
Alabama	528,627	466,113	-62,514	88.2%		
Pennsylvania	1,213,385	944,877	-268,508	77.9%		
Iowa	173,033	133,562	-39,471	77.2%		
Delaware	46,918	35,411	-11,507	75.5%		
New Hampshire	67,863	48,124	-19,739	70.9%		
Wisconsin	282,243	189,374	-92,869	67.1%		
New Jersey	74,979	50,270	-24,709	67.0%		
Connecticut	52,408	34,117	-18,291	65.1%		
Arizona	119,898	73,329	-46,569	61.2%		
New York	414,789	250,715	-164,074	60.4%		
Maine	11,330	6,817	-4,513	60.2%		
Kentucky	905,084	535,445	-369,639	59.2%		
Georgia	874,630	489,626	-385,004	56.0%		
Indiana	1,499,176	795,506	-703,670	53.1%		
West Virginia	968,611	498,056	-470,555	51.4%		
Ohio	2,211,628	1,125,475	-1,086,153	50.9%		
South Dakota	28,906	13,619	-15,287	47.1%		
Tennessee	796,528	356,608	-439,920	44.8%		
Massachusetts	232,012	102,934	-129,078	44.4%		
Illinois	893,793	368,218	-525,575	41.2%		
Missouri	775,726	231,562	-544,164	29.9%		
Washington, DC	2,523	754	-1,769	29.9%		
California	7,365	1,886	-5,479	25.6%		
Rhode Island	1,090	9	-1,081	0.8%		
Idaho	0	4	4			
Vermont	0	5	5			
<b>Total</b>	<b>15,733,305</b>	<b>10,632,613</b>	<b>-5,100,692</b>	<b>67.6%</b>		



**Table B SO<sub>2</sub> and NO<sub>x</sub> Emission Data for 41 Power Plants**

		SO <sub>2</sub> Emissions (tons)			NO <sub>x</sub> Emissions (Tons)	
		1990	2001	Ratio, 2001/1990	2001	
<b>Emissions for Individual Major Power Plants</b>						
Jeffrey EC	KS	16,528	60,924	368.6%	↑ Increased Emissions ↓ Decreased Emissions	14,722
Brandon Shores	MD	22,077	46,766	211.8%		13,746
ED Edwards	IL	24,082	50,126	208.1%		9,612
Leland Olds	ND	27,364	51,456	188.0%		14,780
Greene County	AL	23,390	43,115	184.3%		11,536
Scherer	GA	41,417	75,423	182.1%		31,274
Harding St. Station	IN	32,735	43,053	131.5%		6,724
Big Brown	TX	55,278	70,594	127.7%		12,520
Homer City	PA	109,449	137,573	125.7%		24,991
Barry	AL	53,378	65,902	123.5%		23,026
Monticello	TX	71,056	87,263	122.8%		19,106
Chesterfield	VA	53,920	65,995	122.4%		16,418
Big Cajun	LA	41,930	50,217	119.8%		21,158
Cheswick	PA	41,279	49,002	118.7%		6,749
Keystone	PA	134,848	159,725	118.4%		19,239
FJ Gannon	FL	47,803	55,036	115.1%		25,332
Centralia	WA	58,434	66,906	114.5%		18,244
Hatfields Ferry	PA	163,432	185,496	113.5%		27,402
Roxboro	NC	83,332	94,206	113.0%		25,448
Marshall	NC	68,628	77,291	112.6%		20,124
Widows Creek	AL	38,291	42,788	111.7%		26,242
Crystal River	FL	86,824	94,851	109.2%		34,712
Big Sandy	KY	51,157	55,846	109.2%		19,899
Belews Creek	NC	76,251	83,077	109.0%		34,203
Johnsonville	TN	86,688	94,199	108.7%		20,394
Rockport	IN	53,755	57,365	106.7%		34,997
Pleasants	WV	42,066	44,815	106.5%		14,562
JH Campbell	MI	41,002	43,513	106.1%		30,887
Martin Lake	TX	62,392	66,134	106.0%		22,080
JH Miller	AL	46,323	47,615	102.8%		29,944
R Gallagher	IN	46,458	47,511	102.3%		6,663
Kingston	TN	92,821	90,291	97.3%		26,166
WA Parish	TX	54,528	52,534	96.3%		14,079
Fort Martin	WV	83,534	79,661	95.4%		12,334
Mohave	NV	44,372	41,299	93.1%		19,430
John E Amos	WV	84,943	78,851	92.8%		36,368
Bull Run	TN	47,146	43,049	91.3%		17,319
EW Brown	KY	55,104	49,106	89.1%		7,800
Warrick	IN	59,697	52,777	88.4%		17,228
Morgantown	MD	85,290	75,335	88.3%		16,760
Conesville	OH	113,635	96,738	85.1%		22,092
<b>Total</b>		<b>2,522,637</b>	<b>2,873,423</b>	<b>114.9%</b>	<b>826,308</b>	

**Table C Health Effects from SO<sub>2</sub> and NO<sub>x</sub> Emissions from 41 Power Plants**

	Mortality		Chronic Disease	Hospital Admission	ER Visits	Daily Illness	
	Pope et al. '02	Krewski et al. '00	Chronic Bronchitis	3 Different Types, Combined	Asthma (ages < 65)	Work Loss Day	Asthma Attack
<b>Health Effects for Individual Major Power Plants</b>							
Barry AL	60	69	40	21	15	11,066	1,340
Belews Creek NC	149	171	107	55	40	29,503	3,458
Big Brown TX	71	82	52	27	21	14,604	1,761
Big Cajun 2 LA	43	50	29	15	11	8,317	979
Big Sandy KY	102	118	70	37	26	19,528	2,260
Brandon Shores MD	86	99	62	33	23	16,893	2,001
Bull_Run TN	73	85	51	27	19	14,144	1,643
Centralia WA	29	34	26	13	10	6,930	855
Chesterfield VA	132	152	97	50	36	26,827	3,136
Cheswick PA	99	114	67	37	25	18,524	2,149
Conesville OH	201	232	138	74	51	37,868	4,424
Crystal River FL	107	123	69	39	24	17,500	2,282
ED Edwards IL	103	118	70	37	27	19,661	2,325
EW Brown KY	90	103	60	32	23	17,127	1,951
FJ Gannon FL	95	110	62	34	21	15,416	2,019
Fort Martin WV	155	179	106	57	39	29,558	3,395
Greene County AL	52	60	34	18	13	9,659	1,140
Harding St Station IN	101	116	70	36	27	19,331	2,292
Hatfields Ferry PA	360	415	246	132	90	68,601	7,856
Homer City PA	269	310	187	100	68	51,337	5,962
Jeffrey EC KS	41	47	28	15	11	7,868	931
JH Miller AL	68	79	48	25	18	12,997	1,581
JH Campbell MI	91	105	63	33	24	17,415	2,054
John E Amos WV	146	168	103	54	38	28,089	3,295
Johnsonville TN	155	179	110	57	42	29,315	3,613
Keystone PA	302	348	208	112	76	57,634	6,663
Kingston TN	149	171	127	63	48	28,727	4,128
Leland Olds ND	101	116	69	37	26	19,405	2,301
Marshall NC	139	161	118	59	44	27,734	3,852
Martin Lake TX	68	79	49	26	19	13,042	1,634
Mohave NV	41	47	35	18	14	9,264	1,214
Monticello TX	84	96	58	31	23	16,033	1,959
Morgantown MD	130	149	91	48	34	25,269	2,938
Pleasants WV	85	98	59	32	22	16,194	1,897
R Gallagher IN	101	116	68	36	26	19,166	2,222
Rockport IN	112	129	75	39	28	21,083	2,450
Roxboro NC	153	176	115	59	43	30,462	3,737
Scherer GA	107	123	73	38	28	20,924	2,414
WA Parish TX	56	65	42	21	18	12,783	1,474
Warrick IN	155	179	103	54	39	29,242	3,374
Widows Creek AL	79	91	56	29	21	15,123	1,818
<b>Total</b>	<b>4,740</b>	<b>5,457</b>	<b>3,341</b>	<b>1,758</b>	<b>1,250</b>	<b>910,165</b>	<b>108,774</b>

Additional health results are provided in the report in Exhibits 3.7 through 3.9.