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Northeast: Acid Precipitation

Minimizing Acid Precipitation in the Adirondacks

Introduction

Appearances are sometimes deceiving. Lakes in the Adirondacks region of New York look much as they always have. They are still crystal blue; still reflective of dawn's first light on a still morning. Jump into one on a hot summer day and its waters are still cool, wet, and bracing. But all is not well with the lakes, ponds, and waterways of the Adirondacks. In many, there are few or no fish. Neighboring trees are dying. The culprit? Acid precipitation.

Far to the west in the Ohio River valley, factories and power plants, largely fueled by coal, have for decades spewed an unpleasant brew of air-polluting smoke. When local citizens and governments complained, these industries built smokestacks hundreds of feet (hundreds of meters) high, to waft smoke high enough that winds carried the problem out of the immediate area. A local problem was solved, but at the expense of those downwind.

Some of the smoke's components, namely sulfur dioxide and oxides of nitrogen, react with water vapor in the atmosphere to form sulfuric and nitric acids. Downwind, over the Adirondacks, these acids precipitate, either dry as tiny crystals or wet dissolved in rain, snow, or sleet. In recent decades, the acidity of rain in the Adirondacks has steadily increased. So have problems.

Background

Acids in rain and melted snow soak into soils and cause several kinds of mischief. Normally, minerals and heavy metals, such as aluminum, mercury, and lead, are held in soils chemically, but acids remove these elements from their binding components.

Free aluminum is taken up by plant roots, especially trees. The aluminum then clogs the trees' vascular systems, diminishing their ability to take up other nutrients and water. Thus weakened, trees lose their ability to tolerate extreme cold, diseases, and insect pests.

Many trees form symbiotic relationships with certain fungi. In exchange for photosynthetic products, especially glucose used for energy, fungi assist trees in gathering nutrients and water. Acidic soil kills symbiotic fungi to the detriment of trees.

Normally, microscopic bacteria, fungi, and other organisms break down leaf litter and recycle nutrients. Acids in soil kill these essential components of the detrital food chain, resulting in nutrient-poor soil. Furthermore, thick layers of leaf litter interfere with the germination of tree seeds and growth of saplings.

Finally, acids in soil free up calcium, phosphorus, and magnesium—key nutrients for trees. Leached from soil by water, they become unavailable to plants.

Acid rain, along with nutrients and metals removed from soil, runs off into waterways. High nutrient levels, especially in ponds and lakes, stimulate growth of algae. Light penetration is diminished in bodies of water, and dissolved oxygen concentration is lowered, especially in deeper waters.

Animals are affected. Sudden snowmelt causes a rush of acid into waterways that causes acid shock to many. High acid concentrations in water may directly affect the young of many animals, including larval stages of insects, tadpole stages of amphibians, and fish fry. Aluminum, leached by acids from soil and dissolved in water, attaches to gills and suffocates aquatic animals, including fish. Mercury bioaccumulates as it is leached from soils and released from bottom muds. First, it gathers in the tissues of aquatic animals. As these are eaten first by small fish, then by larger ones, and in turn by birds and mammals, concentrations increase and may interfere with reproduction.

Humans, too, are susceptible to effects of acid precipitation. Drinking water is affected as high acidity dissolves lead and copper from pipes in houses. Both lead and copper cause health problems, especially in children. Although no effects have been directly linked to Adirondack waters, increasing levels of mercury are a concern to public health officials. Finally, there are economic impacts. Sport fishing is important throughout the region; its loss would be keenly felt.

No wonder there is a public outcry to reduce acid precipitation.

The Problem

Although dying trees are serious concerns in North America, most public attention to date has focused on acid precipitation's effects on waterways. In the United States, the Environmental Protection Agency (EPA) monitors environmental quality and recommends measures and enforces regulations to improve the environment. With respect to acid rain, EPA's overall goal is to reduce emissions of sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) as soon as possible. Regulations focus on public utilities, the biggest emitters. Strict standards on allowable emissions have been set. Noncompliance can result in significant fines and even closure of key facilities.

At first, utilities balked at expenses associated with emission reduction, claiming they had been unjustly singled out. Public utilities in the United States are highly competitive. Consumers demand that reliable electricity be delivered to homes and businesses as cheaply as possible. Every rate hike, no matter how necessary, is resisted vociferously. Utilities claimed that efforts to reduce emissions put them at a competitive disadvantage with other regions where such measures are unnecessary or nonenforced.

Sensitive to these criticisms, the EPA designed an innovative, market-based solution that allows individual utilities to design and implement their own compliance plan. Key to the plan's success in reducing SO_2 emissions is allowance trading. A utility that exceeds its emission goals—that is, emits less SO_2 than is allowed—can sell its excess allowance to other util-

ities that have not met their goals. This plan creates an economic incentive for compliance. It turns an unpopular expense into an economic opportunity. The plan appeared to be successful. In its first year (1995–1996), total emissions fell significantly below targeted goals.

But not everyone is happy. In the Adirondacks, citizen groups, notably the Adirondacks Council, took exception to the EPA plan. The council was concerned, not with total emission of SO_2 but with the amount of acid precipitation entering local waterways. Aren't the two directly related? Not necessarily, said the council. If utilities in the Midwest buy excess allowances from utilities in other parts of the country, their emissions will remain high and so will the amount of acid precipitation coming into the Adirondacks waterways. They took particular exception to the sale of allowances by utilities in the Adirondacks region.

Has the EPA plan been a success or not? The following readings explain the plan in greater detail, examine pros and cons, and suggest ways in which the plan could be further strengthened.

reading 1

EPA 1998 COMPLIANCE REPORT: Acid Rain Program

U.S. Environmental Protection Agency, July 1999, inside cover and pp. 1–19. Reprinted by permission.

Background

The Acid Rain Program was established under Title IV of the 1990 Clean Air Act Amendments. The program calls for major reductions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x), the pollutants that cause acid rain, while establishing a new approach to environmental protection through the use of market incentives. The program sets a permanent cap on the total amount of SO_2 that may be emitted by electric utilities nationwide at about one half of the amount emitted in 1980, and allows flexibility for individual utility units to select their own methods of compliance. The program also sets NO_x emission limitations (in lb/mmBtu) for electric utilities, representing about a 27 percent reduction from 1990 levels. The Acid Rain Program is being implemented in two phases: Phase I began in 1995 for SO_2 and 1996 for NO_x, and will last until 1999; Phase II for both pollutants begins in 2000 and is expected to involve over 2,000 units. In 1998, there were 408 units affected by the SO_2 provisions of the Acid Rain Program, 235 of which were also affected for NO_x, and an additional 305 utility units affected only by the NO_x provisions.

Acid rain causes acidification of lakes and streams and contributes to the damage of trees at high elevations. In addition, acid rain accelerates the decay of building materials, paints, and cultural artifacts, including irreplaceable buildings, statues, and sculptures. While airborne, SO_2 and NO_x gases and their particulate matter derivatives, sulfates and nitrates, contribute to visibility degradation and impact public health.

The SO_2 component of the Acid Rain Program represents a dramatic departure from traditional command and control regulatory methods that establish source-specific emissions limitations. Instead, the program introduces a trading system for SO_2 that facilitates lowest-cost emissions reductions and an overall emissions cap that ensures the maintenance of the environmental goal. The program features tradable SO_2 emissions allowances, where one allowance is a limited authorization to emit one ton of SO_2. Allowances may be bought, sold, or banked by utilities, brokers, or anyone else interested in holding them. Existing utility units were allocated allowances for each future compliance year and all participants of the program are obliged to surrender to EPA the number of allowances that correspond to their annual emissions starting either in Phase I or Phase II of the program.

The NO_x component of the Acid Rain Program is more traditional, and establishes an emission rate limit for all affected utilities. Flexibility is introduced to this command and control measure, however, through compliance options such as emissions averaging, whereby a utility can meet the standard emission limitations by averaging the emissions rates of two or more boilers. This allows utilities to over-control at units where it is technically easier to control emissions, thereby achieving emissions reductions at a lower cost. Additionally, beginning in 1997, certain Phase II units could elect to become affected for NO_x early. By complying with Phase I limits, these early election units can delay meeting the more stringent Phase II limits until 2008.

At the end of each year, utilities must demonstrate compliance with the provisions of the Acid Rain Program. For the NO_x portion of the program, utilities must achieve an annual emission limitation at or below mandated levels. For SO_2, utilities are granted a 60-day grace period during which additional SO_2 allowances may be purchased, if necessary, to cover each unit's emissions for the year. At the end of the grace period (the Allowance Transfer Deadline), the allowances a unit holds in its Allowance Tracking System (ATS) account must equal or exceed the unit's annual SO_2 emissions. In addition, in 1995–1999 (Phase I of the program), units must have sufficient allowances to cover certain other deductions as well. Any remaining SO_2 allowances may be sold or banked for use in future years.

To the Reader

The Acid Rain Program 1998 Compliance Report summarizes compliance results that, for the fourth consecutive year since the Acid Rain Program began, show 100 percent compliance with both sulfur dioxide (SO_2) and nitrogen oxide (NO_x) requirements. Over the past year there were also a number of significant Program improvements.

First, the allowance transfer deadline, the date by which a unit's allowance account is required to hold enough allowances to account for the previous year's SO_2 emissions, was changed from January 30th to March 1 (Feb. 29 for leap years). This allows affected facilities additional time to determine their previous year's SO_2 emissions and to ensure the availability of sufficient allowances to account for those emissions.

Second, in order to expedite transfers and reduce transaction costs the Acid Rain Program revised its regulations to allow an authorized account representative to specify allowance accounts to which allowances can be transferred without requiring the buyer's signature on each individual allowance transfer form.

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Third, to avoid the imposition of extremely large excess emissions penalties for minor, inadvertent accounting errors, the Acid Rain Program now allows for the transfer of unused allowances from unit accounts at the same source to account for the emissions at a unit that lacks sufficient allowances. This leads to a smaller penalty, more in line with the violation, while still ensuring the environmental objective.

Fourth, the monitoring rule was revised to enhance flexibility for industry by reducing monitoring requirements for certain units with low mass emissions, creating new monitoring options for some units, reducing certain quality assurance requirements, and increasing fuel sampling flexibility for certain units. The sum of these changes make the rule more efficient and less burdensome for the regulated community, EPA, and the States.

Finally, the Acid Rain Program permits regulation was revised to make new and retired unit exemptions easier for sources to comply with and simpler for the States to administer. These changes provide States with additional flexibility in meeting public notice requirements in the issuance of Acid Rain permits and allow for "direct/final" issuance of draft and proposed Acid Rain permits. The Program also eased public notice requirements related to the appointment of, and changes to, the designated representative and alternate designated representative.

We will continue to look for ways to improve the Acid Rain Program as we prepare for the year 2000 and the beginning of Phase II, and will work with all interested persons in ensuring that the Acid Rain Program meets its environmental goals with minimum cost and burden for affected sources and States.

Brian J. McLean, Director,
Acid Rain Program

Summary

100 Percent Compliance with Both SO_2 and NO_x Requirements in 1998

All 713 boilers and combustion turbines (referred to as "units") affected by the SO_2 and NO_x regulations of the Acid Rain Program in 1998 successfully met their emissions compliance obligations.

- All 408 units subject to SO_2 requirements in 1998 held sufficient allowances to cover their emissions. Of the 5,300,861 allowances deducted from compliance accounts almost all (5,298,498 or 99.96 percent) were for emissions, but other deductions were also made as required by the Acid Rain Program regulations.
- All 540 units subject to the NO_x requirements in 1998 demonstrated compliance with applicable annual emission limitations. Of those 540 units, 235 were also subject to SO_2 requirements, while 305 units were affected only for NO_x (30 Phase I units and 275 Phase II "early election" units).

1998 SO_2 Emissions of Phase I Units were 24 Percent Below Allowable Level

SO_2 emissions in 1998 were 1.7 million tons (or 24 percent) below the 7 million ton allowable level as determined by 1998 allowance allocations. Since an additional 7.9 million allowances were carried over, or banked, from 1997, the overall number of allowances available in 1998 was 14.9 million, of which affected units consumed only about 35 percent. Actual emissions for the 408 units participating in 1998 were 5.3 million tons, down 180,000 tons from emissions of the 423 units affected in 1997.

1998 Phase I Unit NO_x Emission Rates 41 Percent Below 1990; NO_x Tons 29 Percent Lower Than in 1990

Emission rates for the 265 Phase I utility units dropped by 41 percent below 1990 levels, from an average of 0.70 pounds of NO_x per million Btu of heat input (lb/mmBtu) to an average of 0.41 lbs/mmBtu; this rate is 16 percent below the compliance of 0.49 lbs/mmBtu for these units. NO_x emission levels for these units were 390,254 tons (or 29 percent) below 1990 levels.

1998 NO_x Emission Rates of Early Election Units Even Lower Than Rates for Phase I Units

For the 275 Phase II units which elected to meet Phase I NO_x rates early, emission rates dropped from an average of 0.46 lbs/mmBtu in 1990 to 0.38 lbs/mmBtu in 1998, a 17 percent decrease and 19 percent below the compliance rate of 0.47 lbs/mmBtu for these units. Therefore, while utilization of these units increased by 28 percent between 1990 and 1998, NO_x tons increased by only 8 percent.

Monitoring Performance Excellent Once Again

For the fourth year of the Acid Rain Program, the continuous emission monitors used by participants continue to provide some of the most accurate and complete data ever collected by the EPA. Statistics reflect excellent monitor operation of all units affected by both Phase I and Phase II of the program.

Accuracy: SO_2 monitors achieved a median relative accuracy (i.e., deviation from the

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reference test method) of 3.0 percent; flow monitors, 3.0 percent; and NO_x monitors, 3.1 percent.

Availability: SO_2 and flow monitors achieved a median availability of 99.5 and 99.7 percent, respectively, while NO_x monitors achieved a median reliability of 99.2 percent.

SO_2 Market Active; Volume of Allowances Transferred Between Distinct Entities in 1998 Continues to Increase

Activity in the allowance market continued to increase in 1998. The volume of allowances transferred between unrelated parties in economically significant trades increased from 7.9 million in 1997 to 9.5 million in 1998.

Affected Population in Phase I

Exhibit 1 provides a summary of the affected population of units under the Acid Rain Program from 1995 through 1999. The table illustrates that although the units listed in Table 1 of the CAAA are consistently affected for both SO_2 and NO_x beginning in 1997, the total universe of affected units varies year to year because of the flexibility offered by the program.

SO_2 Program

408 Units Underwent Annual Reconciliation for SO_2 in 1998

There were 398 affected utility units and 10 opt-in units that underwent annual reconciliation in 1998 to determine whether sufficient allowances were held to cover emissions. These 408 units include 263 utility units specifically required to participate during Phase I, 135 utility units not initially required to participate until Phase II, but electing to participate early as part of multi-unit compliance plans[1], and 10 other units that elected to join as part of the Opt-in Program.[2]

1998 SO_2 Emissions Target was 6.97 Million Tons

The number of allowances allocated in a particular year, the amount representing that year's allowable SO_2 emissions level, is the sum of allowance allocations granted to sources under several provisions of the Act. In 1998, the emissions target established by the program for the 408 participating units was 6.97 million tons. However, the total allowable SO_2 emission level in 1998 was actually 14.93 million tons, consisting of the 6.97 million 1998 allowances granted through the program and an additional 7.96 million allowances carried over, or banked, from 1997.

EXHIBIT 1. Affected Units During Phase I of the Acid Rain Program

		1995	1996	1997	1998	1999
SO_2	Table 1	263	263	263	263	263
	Substitution and Compensating	182	161	153	135	Variable
	Opt-in	0	7	7	10	Variable
	Total	**445**	**431**	**423**	**408**	**Variable**
NO_x	Table 1	NA	144	170	171	171
	Substitution	NA	95	95	94	94
	Early-Election	NA	NA	272	275	Variable
	Total	**NA**	**239**	**537**	**540**	**Variable**

[1] During Phase 1 of the Acid Rain Program, a unit not originally affected until Phase II may elect to enter the program early as a substitution unit or a compensating unit to help fulfill the compliance obligations for one of the Table 1 units targeted by Phase 1. A unit brought into Phase I as a substitution unit can assist a Table 1 unit in meeting its emissions reductions obligations. Utilities may make cost-effective emissions reductions at the substitution unit instead of at the Table 1 unit, achieving the same overall emissions reductions that would have occurred without the participation of the substitution unit. A Table 1 unit may designate a Phase II unit as a substitution unit only if both units are under the control of the same owner or operator. Additionally, Table 1 units that reduce their utilization below their baseline may designate a compensating unit to provide compensating generation to account for the reduced utilization of the Table 1 unit. (A unit's baseline is defined as its heat input averaged over the years 1985–1987). A Table 1 unit may designate a Phase II unit as a compensating unit if the Phase II compensating unit is in the Table 1 unit's dispatch system or has a contractual agreement with the Table 1 unit, and the emissions rate of the compensating unit has not declined substantially since 1985.

[2] The Opt-in Program gives sources not required to participate in the Acid Rain Program the opportunity to enter the program on a voluntary basis, install continuous emission monitoring systems (CEMS), reduce their SO_2 emissions, and receive their own allowances.

EXHIBIT 2. Origin of 1996 Allowable Emissions Level

Type of Allowance Allocation	Number of Allowances	Explanation of Allowance Allocation Type
Initial Allocation	5,550,820	Initial Allocation is the number of allowances granted to units based on their historic utilization, emissions rates specified in the Clean Air Act and other provisions of the Act.
Phase I Extension	178,211	Phase I Extension allowances are given to Phase I units that reduce their emissions by 90 percent or reassign their emissions reduction obligations to units that reduce their emissions by 90 percent.
Allowances for Substitution Units	948,708	Allowances for Substitution Units are the initial allocation granted to Phase II units which entered Phase I as substitution units.
Allowance Auctions	150,000	Allowance Auctions provide allowances to the market that were set aside in a Special Allowance Reserve when the initial allowance allocation was made.
Allowances for Compensating Units	15,838	Allowances for Compensating Units are the initial allocation granted to Phase II units which entered Phase I as compensating units.
Opt-in Allowances	97,932	Opt-in Allowances are provided to units entering the program voluntarily.
Small Diesel Allowances	27,656	Small Diesel Allowances are allocated annually to small diesel refineries that produce and desulfurize diesel fuel during the pervious year. These allowances can be earned through 1999.
Total 1998 Allocation	**6,969,165**	
Banked 1997 Allowances	7,959,656	Banked Allowances are those held over from 1995 through 1997 and can be used for compliance in 1998 or any future year.
Total 1998 Allowable	**14,928,841**	

The initial allocation and the allowances for substitution and compensating units represent the basic allowances granted to units that authorize them to emit SO_2 under the Acid Rain Program. Additional allowances for the year 1998 were also made available through the allowance auctions, held annually since 1993. Other allowances issued in 1998 were from special provisions in the Act, which are briefly explained in Exhibit 2 above. In addition, any allowances carried over from previous years (banked allowances) are available for compliance and included in the allowable total.

Beginning in the year 2000 at the onset of Phase II, the volume of allowances allocated annually to the Phase I units will be reduced and the requirement to hold allowances will be extended to smaller, cleaner plants. Nationwide, the cap for all utilities with an output capacity of greater than 25 megawatts will be 9.48 million allowances from 2000–2009. In 2010, the cap will be reduced further to 8.95 million allowances, a level approximating one half of industry-wide emissions in 1980.

SO_2 Compliance Results

Phase I Units Better 1998 SO_S Allowable Emissions Level by 24 Percent

The Phase I units affected in 1998 emitted at a level approximately 24 percent below 1998 allocations, as shown in Exhibit 3. This percentage is about the same as in 1997, with both emissions and allocations registering slight decreases.

Relative to 1997, the 263 Table 1 units decreased their emissions by about 110,000 tons or more than two percent in 1998, while increasing their utilization by just over one half of one percent. The 4.7 million tons emitted by these Table 1 units were still substantially below their 1998 allocation of 5.6 million allowable tons.

Substitution and compensating units in 1998 expended about the same percentage of their annual allocation as in 1997. In 1998, these 135 units were responsible for emitting

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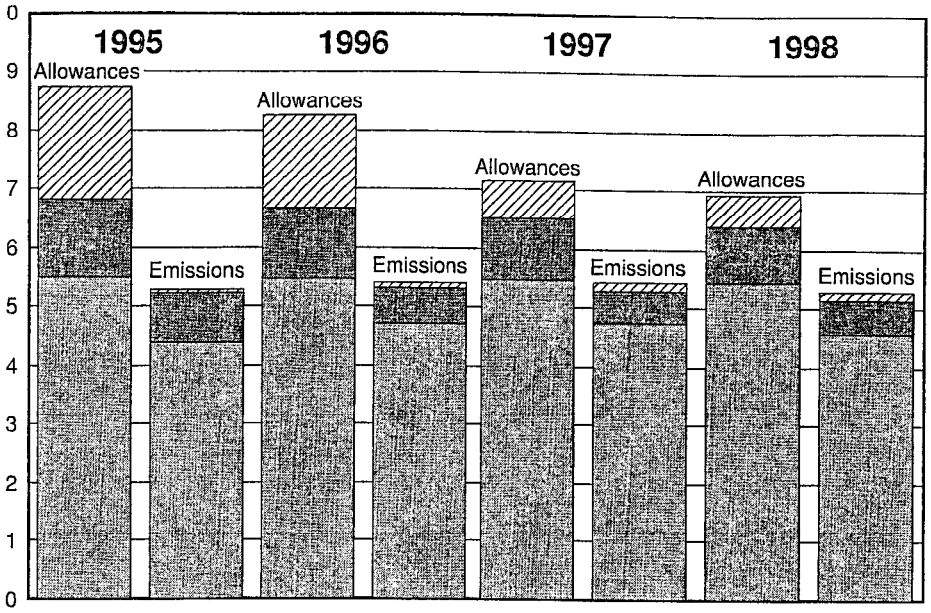
EXHIBIT 3. Summary of SO_2 Emissions versus Allocations (Millions of Tons)



	'95Allocation	'95Emissions	'96Allocation	'96Emissions	'97Allocation	'97Emissions	'98Allocation	'98Emissions
Table 1 Units	5.55	4.45	5.55	4.77	5.55	4.77	5.55	4.66
S&C Units	1.33	0.85	1.18	0.63	1.04	0.62	0.95	0.55
Other	1.86	0.00	1.57	0.04	0.56	0.08	0.45	0.08
TOTALS	8.74	5.30	8.30	5.44	7.15	5.47	6.95	5.29

approximately 550,000 tons of SO_2, about 58 percent of their 950,000 allocation. In 1997, 153 substitution and compensating units emitted approximately 620,000 tons of SO_2, or 60 percent of their 1.04 million allowable level.

Three new opt-in units joined the program in 1998, raising the total allocation to 98,000 allowances and the emissions level to 80,000 tons. The percentage of emissions to allowances allocated to opt-in units in 1998 increased by approximately 1% compared to 1997.

Deducting Allowances for Compliance

The total number of allowances deducted in 1998 was 5,300,861 which represents approximately 76 percent of all 1998 allowances issued. Almost all (99.95 percent) of the deducted allowances were for emissions. Exhibit 4 displays these allowance deductions, as well as the remaining bank of 1995 through 1998 allowances.

At an individual unit, the number of allowances surrendered was equal to the number of tons emitted at the unit, except where the unit shared a common stack with other units. For the purposes of surrendering allowances for emissions at a common stack, the utility was allowed to choose the proportion of allowances deducted from each unit sharing the stack, as long as enough allowances were surrendered to cover the total number of tons emitted. If no apportionment was made, EPA deducted allowances equally among the units sharing the stack to cover total emissions reported by the stack.

Under the Acid Rain Program, certain units applied for and received approval of Phase I Extension plans during the Phase I permitting process. These units fell into two categories: "control units" which were required to cut their emissions by 90 percent using qualifying technology[3] by 1997, and "transfer units" which reassigned their emissions reduction obligations to a control unit. Both kinds of units received extra SO_2 emissions allowances to cover the SO_2 they emitted beyond their basic Phase I allocations during 1995 and 1996. In addition, the control units were given Phase I extension allowances for 1997, 1998, and 1999. A total of 3.5 million allowances was distributed to all Phase I extension control and transfer units.[4]

For 1998, all 19 control units demonstrated meeting the 90 percent reduction requirement and, therefore, did not surrender any 1998 extension allowances. The 1998 tonnage emissions limitation, though, was exceeded by five control units and eleven transfer units and resulted in a surrender of a total of 99,240 vintage 1999 allowances.

SO_2 Allowance Market

The flexibility provided by the Acid Rain Program enabled the 408 units affected in 1998 to pursue a variety

[3] Qualifying technology is defined in 40 CFR 72.2

[4] Beginning in 1997, each of the 19 units designated as control units was required to show it had reduced its annual emission by at least 90 percent using qualifying control technology. If a unit could not make this demonstration, all or a portion of the extension allowances it received for the year under the Phase I Extension provisions were required to be surrendered. In addition, also beginning in 1997, each of the same 19 control units and each of the 61 other units designated as transfer units was required to meet a tonnage emission limitation approved in its permit. A unit that exceeded its limitation was required to surrender allowances for the following year.

EXHIBIT 4. SO_2 Allowance Reconciliation Summary

Total Allowances Held in Accounts as of 3/1/99 (1995 trough 1998 Vintage)*	**14,928,841**
Table 1 Unit Accounts	8,585,043
Substitution & Compensating Unit Accounts	1,306,220
Opt-in Accounts	83,962
Other Accounts**	4,953,616
1998 Allowances Deducted for Emissions	**5,298,498**
Table 1 Unit Accounts	4,664,898
Substitution & Compensating Unit Accounts	553,349
Opt-in Unit Accounts	80,251
1998 Allowances Deducted Under Special Phase I Provisions * **	**2,363**
Table 1 Unit Accounts	65
Substitution & Compensating Unit Accounts	1,755
Opt-in Unit Accounts	543
Banked Allowances	**9,627,980**
Table 1 Unit Accounts	3,920,080
Substitution & Compensating Unit Accounts	751,116
Opt-in Unit Accounts	3,168
Other Accounts**	4,953,616

*The number of allowances held in the Allowance Tracking System (ATS) accounts equals the number of 1998 allowances allocated (see Exhibit 2) plus the number of 1997 banked allowances. March 1, 1999 represents the Allowance of Transfer Deadline, the point in time at which the 1998 Phase I affected unit accounts are frozen and after which no transfers of 1995 through 1998 allowances will be recorded. The freeze on these accounts is removed when annual reconciliation is complete.
**Other accounts refers to general accounts within the ATS that can be held by any utility, individual or other organization, and unit accounts for units not affected in Phase I.
***Allowances were deducted for both underutilization and state cap provisions in 1998.

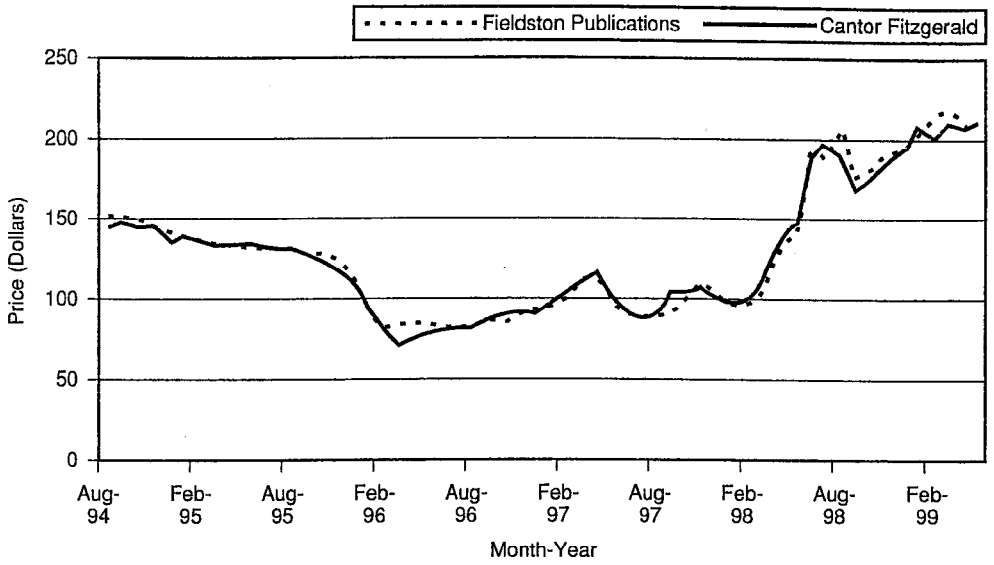
of compliance options to meet their SO_2 reduction obligations, including scrubber installation, fuel switching, energy efficiency, and allowance trading. The presence of the allowance market has given some sources the incentive to overcontrol their SO_2 emissions in order to bank their allowances for use in future years. Other sources have been able to postpone and possibly avoid expenditures for control by acquiring allowances from sources that overcontrolled. The flexibility in compliance options is possible because of the accountability provided through strict monitoring requirements for all affected units that ensure one allowance is equivalent to one ton of SO_2. The program's flexibility enabled all 408 sources to be in compliance in 1998 and significantly reduced the cost of achieving these emissions reductions as compared to the cost of a technological mandate.

The marginal cost of reducing a ton of SO_2 from the utility sector should be reflected in the price of an allowance. The cost of reductions continues to be lower than anticipated when the Clean Air Act Amendments were enacted, and the price of allowances reflects this. The cost of compliance was initially estimated at $400–1000/ton, but was $207/ton at the 1999 allowance auction. Prices have remained in the $205 to $215 range since January of 1999. Some market observers believe lower than expected allowance prices during the first several years of the program were due primarily to lower than expected compliance costs and larger than expected emission reductions, which have increased the supply of allowances and put downward pressure on prices. Exhibit 5 displays the price trend since mid-1994, based on monthly price reports from Cantor Fitzgerald Environmental Brokerage Services, and a market survey conducted by Fieldston Publications.

Activity in the allowance market created under the Acid Rain Program remained strong in 1998, with 1,584 transactions moving about 13.5 million allowances in the Allowance Tracking System (ATS), the accounting system developed to track holdings of allowances. In terms of economically significant transfers, or those between unrelated parties, the volume of allowances transferred rose from 7.9 million in 1997 to 9.5 million in 1998. A record of 70 percent of annual activity consisted of allowances transferred between economically distinct organizations, with more than half representing allowances directly acquired by utilities.

The most active market segment in 1998 in terms of allowance volume was composed of exchanges between brokers/traders and utilities, accounting for 6.3 million allowances. The next most active was the reallocation category, which covered an additional 3.2 million allowances. The category of transfers between unrelated utilities increased to 1.9 million allowances.

EXHIBIT 5. SO_2 Allowance Prices



All transactions, along with data on account balances and ownership, are posted on the Acid Rain Division's Internet site (www.epa.gov/acidrain) on a daily basis in order to better inform trading participants. Also available are cumulative market statistics and analysis.

NO_x Program

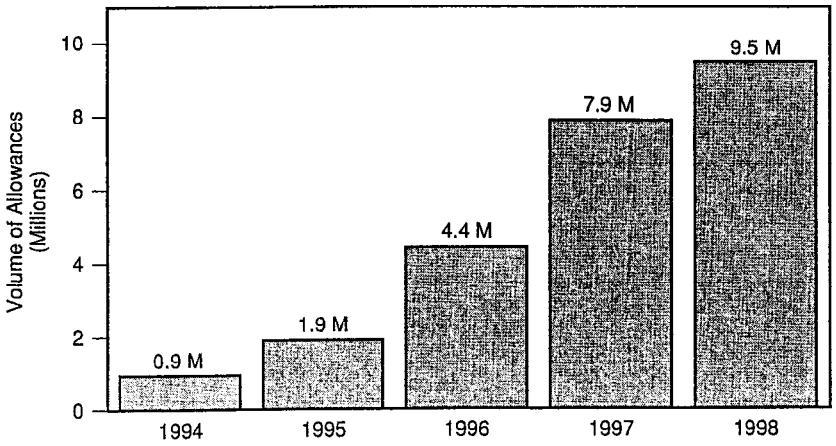
Instead of using allowance trading to facilitate emissions reductions, the Title IV NO_x program establishes standard emission limitations for affected units. Title IV of the 1990 Clean Air Act Amendments required EPA to establish NO_x annual average emission limits (in pounds of NO_x per million British thermal units of fuel consumed [lb/mmBtu]) for coal-fired electric utility units in two phases.

In April 1995, EPA promulgated 40 CFR Part 76 which established NO_x emission limits beginning on January 1, 1996 for Group 1 boilers that were also part of the Phase I SO_2 program. (Group 1 boilers are dry bottom, wall-fired boilers and tangentially-fired boilers.) Phase I dry bottom wall-fired boilers are subject to a NO_x emission limit of 0.50 lb/mmBtu; Phase I tangentially-fired boilers are subject to a NO_x emission limit of 0.45 lb/mmBtu.

In addition, the April 1995 regulations allowed Phase II Group 1 units to use an "Early Election" Compliance Option. Under this regulatory provision, Group 1, Phase II NO_x affected units can demonstrate compliance with the higher Phase I limits for their boiler type from 1997 through 2007 and not meet the more stringent Phase II limits until 2008. If the utility fails to meet this annual limit for the boiler during any year, the unit is subject to the more stringent Phase II limit for Group 1 boilers beginning in 2000, or the year following the exceedance, whichever is later.

In December 1996, EPA revised the NO_x emission limits for Phase II, Group 1 boilers (0.46 lb/mmBtu for dry bottom wall-fired boilers and 0.40 lb/mmBtu for

EXHIBIT 6. Volume of SO_2 Allowances in Economically Significant Transfers



tangentially-fired boilers) and established emission limits for cell burner, cyclones, wet bottom and vertically-fired boilers (referred to as "Group 2 boilers") effective on January 1, 2000. As a result of the April 1995 and December 1996 rulemakings, NO_x reductions were projected to be approximately 400,000 tons per year in 1996 through 1999 (Phase I), and 2,060,000 tons per year in 2000 and subsequent years (Phase II).

Phase I NO_x Units

265 Phase I Units Were Subject to Emissions Limitations in 1998

In 1998, 265 coal-fired utility units were subject to the Title IV Phase I emission limitations for NO_x.[5] The 265 Phase I NO_x affected units include 171 Table 1 units and 94 substitution units whose owners chose to participate in Phase I as part of an SO_2 compliance strategy. This group of units is subject to the Phase I and Phase II. Exhibit 7 shows the number of Phase I NO_x affected units by boiler type.

EXHIBIT 7. Phase I NO_x Units by Boiler Type

Boiler Type	Standard Emission Unit	Table 1 Units	Substitution Units	All Units
Tangentially Fired Boilers	0.45	94	41	135
Dry Bottom Well-fired Boilers	0.50	77	53	130

Phase I NO_x Compliance Options

For each Phase I NO_x affected unit, a utility can comply with the applicable standard emission limitation, or may qualify for one of two additional compliance options which add flexibility to the rate-based compliance requirements:

- Emissions Averaging. A utility can meet the standard emission limitation by averaging the heat-input weighted annual emission rates of two or more units.
- Alternative Emission Limitation (AEL). A utility can petition for a less stringent alternative emission limitation if it uses properly installed and operated low NO_x burner technology (LNBT) designed to meet the standard limit, but is unable to achieve that limit. EPA determines whether an AEL is warranted based on analyses of emissions data and information about the NO_x control equipment.

Exhibit 8 summarizes the compliance options chosen by Phase I affected NO_x units for 1998. As in 1996 and 1997, averaging was the most widely chosen compliance option. For 1998, there were 24 averaging plans involving 204 Phase I NO_x units.

EXHIBIT 8. Summary of Compliance Options Chosen in 1998

Compliance Option	# of Units
Standard Emission Limitation	51
Emissions Averaging	204
Alternative Emission Limitation	10
Total	**265**

Phase I NO_x Compliance Results

For 1998, EPA has determined that all 265 Phase I NO_x units met the required emission limit through compliance with either the standard emission limitation, emissions averaging, or an alternative emission limitation.

NO_x Emission Rate Reduction

From 1990[6] to 1998, the average NO_x emission rate of the 265 Phase I units declined by 41% (from 0.70 lb/mmBtu to 0.41 lb/mmBtu). As shown in Exhibit 9, on average, both Table 1 and substitution units were below the average Phase I emission limit of 0.49 lb/mmBtu (the heat input weighted average of the applicable limits).

NO_x Mass Emissions Reduction

Exhibit 10 illustrates the change in NO_x mass emissions since 1990 for Table 1 and substitution units. For the 265 units, total NO_x mass emissions in 1998 were 29 percent lower than in 1990, but 3 percent higher than in 1997. While this is the second year total NO_x mass emissions have increased, the ascent can be attributed in part to greater electrical production, as evidenced by an increase in heat input in 1997 and 1998 of 3 percent and 6 percent, respectively, compared to 1996. Without further reductions in emissions rates, NO_x emissions would be expected to rise with increased utilization.

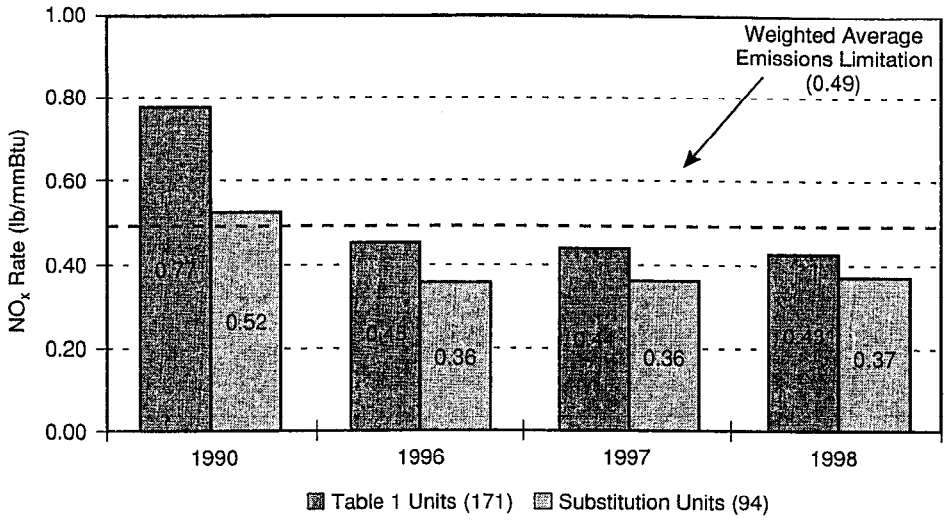
Phase II Early Elections Units

275 Units Were Subject to Early Election Requirements in 1998

Nineteen ninety-eight was the second year in which early election utility units were required to meet the Phase I

[5] Compared with 1997, the universe of units remained the same, except that Mt. Storm Unit 2 (WV) was added because its compliance extension expired and Gadsby Unit 3 (UT) was deleted because it was mistakenly identified in previous years as a coal-fired utility unit.
[6] For a more detailed description of the 1990 baseline refer to the Acid Rain Program 1996 Compliance Report.

EXHIBIT 9. Average NO_x Emission Rates for 265 Phase 1 Units



NO_x limit[7]. Exhibit 11 shows the number of Early Election units by boiler type and their corresponding limit.

Early Election Compliance Results

For 1998, EPA determined that all 275 units complied with the Phase I, Group 1 emission limitations and have continued eligibility for Early Election in 1999 through 2007.

Average NO_x emission rates for Early Election units have declined by 17% from 0.46 lb/mmBtu in 1990 to 0.38 lb/mmBtu in 1998. This decline is less dramatic than the decline at Phase I NO_x units because 51% of the Early Election units are newer units already subject to the New Source Performance Standards (NSPS) NO_x emission limits. The overall NO_x emission rate for these units is comparable to the average rate of 0.41 lb/mmBtu for all Phase I NO_x units. Exhibit 12 summarizes the NO_x emission rate reductions from 1990 to 1998 by boiler type for the 265 Early Election units that were operating in 1990.

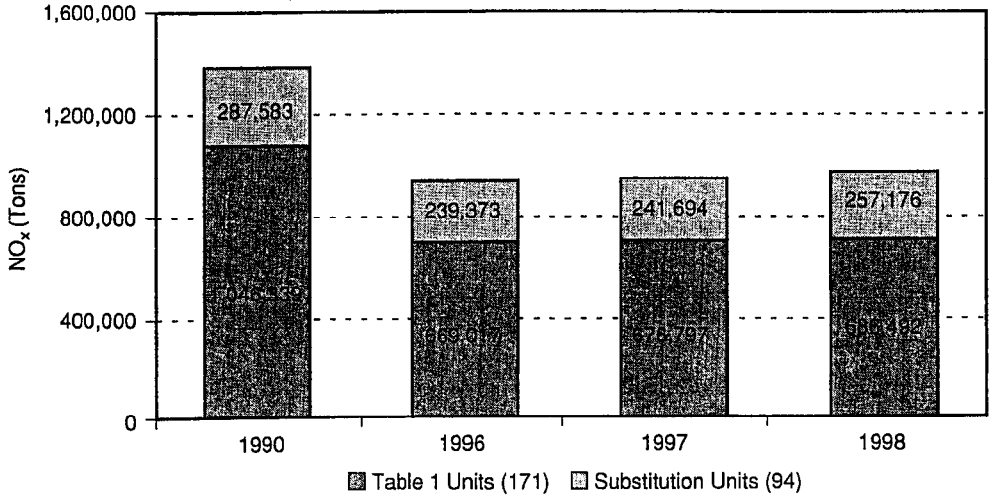
NO_x Mass Emissions Reduction

The total NO_x mass emissions from the operating Early Election units increased by 106,619 tons (or 8 percent) from 1990[8] to 1998, reflecting an increase in utilization (see Exhibit 13). For the 265 Early Election units operating in 1990, heat input increased during the eight year period by approximately 28%.

SO_2 and NO_x Monitoring in 1998

In order to verify the reductions of SO_2 and NO_x emissions mandated under the Clean Air Act and to support the SO_2 allowance trading program, a fundamental objective of the Acid Rain Program is to ensure accurate accounting of pollutant emissions from affected boilers

EXHIBIT 10. NO_x Mass Emissions for 256 Phase I Units



[7] Compared with 1997, the universe of early election units remained the same, except for W C Dale Units 3 and 4 (KY) and H L Spurlock Unit 2 (KY), which were added after being inadvertently omitted in 1997.

EXHIBIT 11. Distribution of 1998 Early Election Units by Boiler Type

Boiler Type	Standard Emission Unit	Operating Group 1, Phase 2 Units	Early Election Units	Percent of Units Electing
Tangentially Fired Boilers	0.45	300	171	57%
Dry Bottom Well-fired Boilers	0.50	314	104	33%
Total		614	275	45%

and turbines. To implement this objective, concentrations of emitted SO_2 and NO_x from each affected until (boiler or turbine) are measured and recorded using Continuous Emissions Monitoring Systems (CEMS)(or an approved alternate measurement method) certified by EPA to meet the high accuracy standards of the Acid Rain Program.

CEMS are used to determine SO_2 mass emissions and NO_x emission rates. SO_2 mass emissions are determined using CEMS to measure SO_2 concentration and stack flow rate. NO_x emission rates, on the other hand, are determined with NO_x and diluent gas (CO_2 or O_2) concentration monitors. These monitors are required to meet strict initial and on-going performance standards to demonstrate the accuracy, precision, and timeliness of their measurement capability.

One measure of the accuracy of a CEMS is the relative accuracy test audit (RATA), which is required for initial certification of a CEMS and for on-going quality assurance. The relative accuracy test audit ensures that the installed monitor measures the "true" value of the pollutant by comparing the monitor to a reference method which simultaneously measures the stack gas pollutant. Thus, the lower the relative accuracy resulting from the test audit, the more accurate the monitor.

All monitoring systems must meet a certain relative accuracy standard in order to be qualified to report emissions to the Acid Rain Program; 10 percent for SO_2 and NO_x and 15 percent for flow (beginning January 1, 2000, the flow standard will also be 10 percent). As a further incentive for high quality maintenance, CEMS that achieve a superior accuracy result, less than or equal to 7.5 percent for SO_2 and NO_x and less than or equal to 10 percent for flow (beginning January 1, 2000, the flow standard for superior accuracy will also be 7.5 percent), are granted a reduced frequency annual RATA requirement in place of the semiannual requirement. Because the RATA determines relative accuracy as an absolute value, it does not detect whether the difference between the reference method values and the readings from the CEMS being tested is due to random error or to systematic bias. Therefore, an additional test is required to ensure that emissions are not underestimated: the bias test. This test determines if the CEMS is systematically biased low compared to the reference method and if so, a bias adjustment factor is calculated and applied to all reported data from that monitoring system to ensure there is no systematic underreporting. Exhibit 14 highlights the relative accuracy results achieved by Acid Rain CEMS in 1998.

Another metric used to determine the effectiveness of a CEMS is the percentage of hours that a monitoring system is operating properly and meeting all performance standards and therefore, able to record and report an emissions value. This metric is defined as the percent monitor availability (PMA). Exhibit 15 shows the monitor availabilities reported in 1998 and indicates that the CEMS used to determine SO_2 mass emissions and NO_x emission rates are well maintained and fulfilling the high performance standards required by the Acid Rain Program.

EXHIBIT 12. Average NO_x Emission Rate for 265 Early Election Units (Operating in 1990)

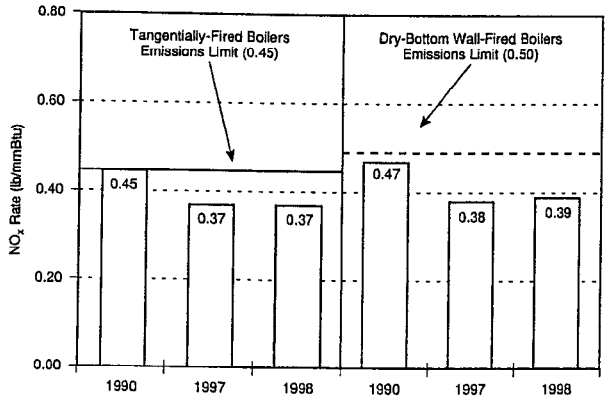


EXHIBIT 13. NO_x Mass Emissions for 265 Early Election Units (Operating in 1990)

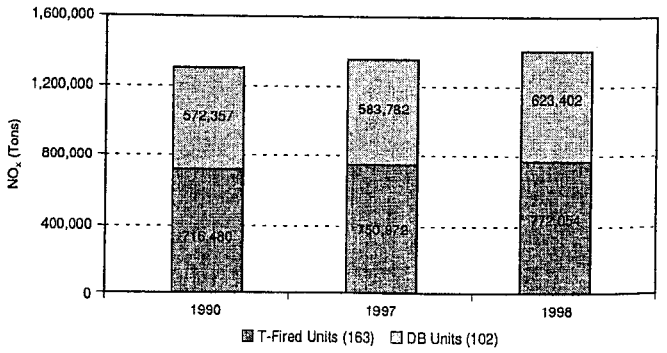


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EXHIBIT 14. 1998 Relative Accuracy Test Audit (RATA) Results

	SO_2 Concentration	Volumetric Flow Rate	NO_x Rate
Mean Relative Accuracy	4.2%	3.7%	4.1%
Median Relative Accuracy	3.0%	3.0%	3.1%
Percent Meeting Relative Accuracy Standard	95%	97%	91%

EXHIBIT 15. 1998 CEMS Availability

Parameter	Median % Availability at End of 1998	
	Coal-Fired Units	Oil and Gas Units
SO_2	99.5	98.5
Flow	99.7	98.8
NO_x	99.2	98.0

Conclusion

1998 proved to be another successful year for both the Acid Rain Program's rate-based approach to NO_x reduction and cap-and-trade approach to SO_2 reduction. In 1998, all Phase I affected utility units not only met their compliance goals, but exceeded them, achieving an overall reduction of 390,254 tons of NO_x from 1990 levels, and maintaining the extraordinary reductions of more than 5 million tons of SO_2 from 1980 levels, first achieved in 1995. Additionally, the 275 Phase II NO_x early election units had increased emissions of eight percent since 1990, while their utilization increased by 28 percent during the same period.

Exceedance of compliance goals translates into additional environmental and health benefits. For example, the greater and earlier reductions of SO_2 have resulted in a 10–25 percent drop in rainfall acidity in the Northeast in 1995.[9]

One factor mitigating the benefit of the overcompliance in the SO_2 program, of course, is the ability to use banked allowances in the future. The 40 percent of 1995 allowances, 35 percent of 1996 allowances, 23 percent of 1997 allowances, and 24 percent of 1998 allowances that were not retired for compliance purposes can be used to cover emissions in a later year. However, immediate health and environmental benefits are arguably more valuable than a benefit several years from now.

The NO_x program, based on the more traditional rate-based approach, offers less flexibility and displays a lesser degree of overcompliance. It requires each unit to achieve reductions or, at a minimum, for a group of units to achieve an average emission rate equal to or lower than their individual units. This approach does not allow emissions reductions in one year to be used in another year, and as a result, the incentive to overcomply is diminished.

The pattern and certainty of emissions reductions over time will also differ between the two programs. After the year 2000 when both programs are in full implementation, SO_2 emissions are expected to decline steadily to the emissions cap level of 8.95 million tons, whereas NO_x emissions, in the absence of an emissions cap, are expected to rise as existing sources are utilized more and new sources, which are not required to offset their emissions, are built and operated.

Despite these differences, both the SO_2 and NO_x components of the Acid Rain Program are continuing their success in 1998. The significant progress evident at this stage of the program is encouraging. Through the continued efforts of Phase I participants and by additional reductions from Phase II units beginning in 2000, the long term goals of the Acid Rain Program—a 10 million ton reduction of SO_2 emissions and two million ton reduction of NO_x emissions—will be achieved.

[9] U.S. Geological Survey, Trends in Precipitation Chemistry in the United States, 1983–94—An Analysis of the Effects in 1995 of Phase I of the CAAA of 1990, Title IV, USGS 96-0346, Washington, DC, June 1996.