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GAO

Report to the Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce House of Representatives

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AIR POLLUTION

Sulfur Dioxide Emissions From Nonferrous Smelters Have Been Reduced

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GAO

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Resources, Community, and
Economic Development Division

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April 29, 1986

The Honorable John D. Dingell, Chairman
Subcommittee on Oversight and Investigations
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

In response to your January 30, 1984, request and clarified in subsequent discussions with your office, this report discusses the Environmental Protection Agency's and states' implementation of the Clean Air Act's requirements for sulfur dioxide emissions from nonferrous smelters.

As arranged with your office, unless you publicly announce its contents, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

J. Dexter Peach
Director

Executive Summary

Sulfur dioxide, a pollutant regulated under the Clean Air Act, aggravates symptoms of heart and lung disease and increases the incidence of acute respiratory disease Major sources of sulfur dioxide in the western United States are copper, lead, and zinc smelters

The Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, asked GAO to examine Environmental Protection Agency (EPA) and state implementation of the Clean Air Act's provisions concerning sulfur dioxide emissions by such smelters, including

- measures used to determine smelter compliance with the act and actions taken to enforce such compliance and
- factors considered in deferring smelters from certain requirements of the act.

Background

The Clean Air Act of 1970 required EPA to establish national ambient air quality standards for air emissions that endanger public health and welfare These standards represent the maximum amount of pollutant concentration allowed in the ambient air As provided by the act, attainment of the standards is generally implemented through state plans submitted for EPA approval The state plans contain emission limitations for sources of air pollution, including nonferrous (non-iron metals) smelters, to assure that their emissions do not cause violations of the standards (See pp 9 and 10)

In the early 1970's, nonferrous smelters used primarily two methods to reduce the concentration of sulfur dioxide in their vicinity The first method, tall smoke stacks, disperses the sulfur dioxide by releasing it at high elevations The other method, referred to as an intermittent control system, uses wind and atmospheric conditions to disperse the sulfur dioxide In this method, production is increased when weather conditions provide for good dispersion, and when conditions are not good, production is decreased. Except to the extent that production is curtailed with intermittent controls, tall smoke stacks and intermittent controls do not reduce the amount of sulfur dioxide emitted (See pp 10 and 11)

The 1977 amendments to the Clean Air Act generally prohibited stationary sources of air pollution, including smelters, from using these dispersion techniques. Instead, smelter companies were required to reduce emissions by using constant emission controls, necessitating many companies to install expensive pollution control equipment. (See p 11)

Because the Congress believed that this requirement might cause an unreasonable financial burden on some smelter operations, the amendments also allowed EPA or states to issue a nonferrous smelter order granting qualified smelters limited suspensions from the requirement to reduce emissions by constant controls. However, the order still required smelters to attain and maintain the national ambient air quality standards through the use of dispersion techniques such as intermittent controls. The amendment permitted issuance of first- and second-period nonferrous smelter orders, one deferring compliance with requirements to reduce emissions until January 1, 1983, and the other deferring compliance until January 1, 1988 Four smelters obtained first-period orders from their state; EPA is deciding whether to award second-period orders. (See p 11.)

Results in Brief

EPA and the states have generally been effective in getting smelters to take the steps necessary to comply with the Clean Air Act requirements for reducing sulfur dioxide emissions and violations of national ambient air quality standards The 1984 levels for both sulfur dioxide emissions and violations of standards for sulfur dioxide have been reduced by at least 75 percent of the levels experienced in the early or mid-1970's, although over 50 percent of the emission reductions was attributable to decreased smelter production

An issue remains regarding EPA and state review of applications for second-period nonferrous smelter orders Three smelters have requested a second-period order Two of those smelters, both located in Arizona, were unable to prevent violations of the standards, as required by the act, while operating under their first-period order. To qualify for a second-period order, EPA and Arizona have requested that these two smelters improve their intermittent control systems to assure that future violations do not occur

GAO Analysis

Compliance and Enforcement

Generally, smelters are following the requirements imposed by EPA and states to meet the Clean Air Act provisions for prevention of violations of national ambient air quality standards and, except for smelters operating under a nonferrous smelter order, reduction of sulfur dioxide emissions. As of May 31, 1985, 12 of the 18 operating nonferrous smelters were meeting the sulfur dioxide emissions limits Of the remaining six smelters, three had installed equipment to reduce emissions but were still experiencing emissions in excess of limits and thus, must make further operating modifications EPA and states are taking enforcement action or other measures to bring those smelters into compliance The other three smelter companies requested a second-period nonferrous smelter order to defer compliance with the requirement to reduce emissions. (See p. 16.)

In 1984, nationwide nonferrous smelter sulfur dioxide emissions were down by 75 percent of the 1970 level. In Arizona, Nevada, and New Mexico, 1984 violations of national standards for sulfur dioxide were reduced by 80 percent of the 1977 level. In the near future, violations of the standards should drop even further, when considering that over half of the 1984 violations were caused by smelters that closed in 1984 and 1985 (See pp. 21 to 24)

Reduced sulfur dioxide emissions and fewer violations of the standards can be attributed to reduced nonferrous metal production and to improvements in smelter emission controls. GAO estimated that 56 percent of the reduced emissions from 1970 to 1984 was due to reduced production, and 44 percent was due to improvements in controls (See pp 21 and 22)

Smelters With Nonferrous Smelter Orders

The act requires smelters operating with a nonferrous smelter order to use measures such as dispersion techniques to prevent violations of the national ambient air quality standards Of the three smelter companies that have applied for a second order, two have caused numerous violations of the standards while operating under their first order and the other has not caused any air violations (See pp. 29 to 31.)

Although some smelters operating under first-period nonferrous smelter orders have violated the national standards, EPA is allowing those smelters the opportunity to improve their intermittent control systems while deciding whether to award a second-period order EPA is currently evaluating whether the smelters have provided an adequate basis to assure that the national standards will not be violated during the second period (See p 31)

Recommendations

GAO is making no recommendations

Agency Comments

GAO discussed EPA and state nonferrous smelter compliance and enforcement processes with EPA and state program officials and has included their comments where appropriate However, GAO did not obtain the views of program officials on its conclusions, nor did it request official comments on a draft of this report

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Abbreviations

DHS	(Arizona) Department of Health Services
EPA	Environmental Protection Agency
GAO	General Accounting Office
NAAQS	national ambient air quality standards
NSO	nonferrous smelter order
RCED	Resources, Community, and Economic Development Division (GAO)
SIP	state implementation plan

Introduction

The 1977 amendments to the Clean Air Act required many primary nonferrous smelters[1] to reduce sulfur dioxide emissions with pollution control equipment which, depending on the smelter, could cost in excess of $500 million. In 1977 there were 28 primary nonferrous smelters in the United States—15 copper smelters, 7 zinc smelters, 4 lead smelters, and 2 smelters that produced a combination of the three metals (See app I for list of smelters) Prices for nonferrous metals were low in 1977, and the Congress was concerned about smelter and mine closures Consequently, the Congress included provisions in the 1977 amendments which allowed primary nonferrous smelters to seek waivers (nonferrous smelter orders) allowing them to defer compliance with requirements of the amendments

The Smelting Process

Nearly one-third of the material processed for the production of nonferrous metal is sulfur When nonferrous ores are mined, they contain relatively small amounts of the desired metal, ranging from less than 1 percent for copper to up to 10 percent for lead and zinc To increase the metal content and to remove other minerals, the ore is ground and concentrated Concentrated copper contains 18 to 28 percent copper, 23 to 33 percent iron, 23 to 38 percent sulfur, and about 11 percent other minerals. Lead concentrates contain 50 to 70 percent lead, 13 to 19 percent sulfur, and small amounts of other minerals Zinc concentrates contain 60 percent zinc, 30 percent sulfur, and small amounts of other minerals After the ore is concentrated, it is ready to begin the smelting process

Smelting methods vary, but all produce large amounts of sulfur dioxide[2] because of the sulfur in the nonferrous ore concentrates. Smelting involves heating the concentrate to separate the desired metal from sulfur and other materials When heated, the sulfur in the concentrate oxidizes to form sulfur dioxide The amount of sulfur dioxide produced during the smelting process is significant. For example, the average Arizona copper smelter in 1984 produced 611 metric tons[3] of sulfur dioxide a day

[1] A smelter is classified as primary if it uses raw ore as opposed to scrap metal Nonferrous smelters produce metals other than iron

[2] All of the sulfur dioxide produced by smelters is not necessarily emitted into the atmosphere A large portion is captured by emission control systems as discussed later in this report

[3] A metric ton equals 2,204 pounds

Nonferrous Smelters Are a Major Emitter of Sulfur Dioxide in the West

Emissions from primary nonferrous smelters have been a significant source of sulfur dioxide in the West.[4] In 1980,[5] the western smelters, which accounted for 18 of 28 smelters in the nation, were responsible for approximately 29 percent of the total sulfur dioxide emissions from all western sources. Electric utilities are the major producers of sulfur dioxide in the East and a close second to nonferrous smelters in the West.

Table 1.1: 1980 Emissions of Sulfur Dioxide in the United States (Millions of Metric Tons)

	National		East		West	
Source	**Tons**	**Percent**	**Tons**	**Percent**	**Tons**	**Percent**
Electric utilities	15.80	65.56	14.58	73.52	1.22	28.57
Nonferrous smelters	1.40	5.81	16	81	1.24	29.04
Transportation	80	3.32	49	2.47	31	7.26
Other[a]	6.10	25.31	4.60	23.20	1.50	35.13
Total	**24.10**	**100.00**	**19.83**	**100.00**	**4.27**	**100.00**

[a]Residential, commercial, and industrial

The 18 western smelters are located in Arizona, Idaho, Montana, New Mexico, Nevada, Oklahoma, Texas, Utah, and Washington These smelters were responsible for approximately 89 percent of the sulfur dioxide emissions from all nonferrous smelters

Clean Air Act Required Sulfur Dioxide Emission Controls

The 1970 Clean Air Act amendments required that the Environmental Protection Agency (EPA) establish national ambient air quality standards (NAAQS) for emissions of air pollutants that endanger public health and welfare. The NAAQS are maximum allowable amounts of pollutant concentrations in ambient air There are two standards for each pollutant: a primary standard and a secondary standard The primary standard is intended to protect public health, while the secondary standard protects public welfare, which includes effects on vegetation, wildlife, and visibility

In 1971, EPA issued NAAQS for six air pollutants, including sulfur dioxide. Sulfur dioxide aggravates symptoms of heart and lung disease and

[4]The relationship between these emissions and the acid deposition damage in the West is discussed in appendix II

[5]Although more current emission data are available (and are shown later in this report), we chose to use 1980 data here because most of the nonferrous smelters (24 of 28) existing at the time of the 1977 Clean Air Act amendments were in operation

increases the incidence of acute respiratory disease It is also toxic to plants, it can destroy paint pigments, erode statues, corrode metals, and harm textiles, it impairs visibility; and it contributes to acid deposition (commonly referred to as acid rain)

Achievement of the NAAQS is generally implemented through a state implementation plan (SIP), a plan submitted by states to EPA for approval, specifying how the NAAQS will be achieved and maintained The SIP includes emission limits that must be met by air pollution sources, including smelters, to assure that their emissions do not cause violations of the NAAQS Generally, SIPs require compliance with air quality standards through constant controls by December 31, 1982, but Arizona smelters were allowed until January 14, 1986, because EPA approved Arizona's SIP in 1983 and the act allows up to 3 years between EPA approval and final SIP implementation. According to EPA's Region IX Compliance Chief, EPA's approval of the Arizona SIP was delayed due to the time needed to process a SIP based on a new type of emissions limit

Emission limits imposed by states on their smelters vary because the level of emissions which would cause a NAAQS violation at one smelter is generally different from the level which would cause a violation at another smelter. These differences exist primarily because terrain and weather characteristics in the vicinity of smelters vary

Smelters use two methods to meet NAAQS constant emission controls and dispersion techniques

- Constant emission controls are systems that reduce the amount of sulfur dioxide in the emissions. Acid plants are the most common constant control method used by nonferrous smelters. When using this method, smelters capture their emissions prior to release and process them through an acid plant producing sulfuric acid which is sold as a by-product.
- Dispersion techniques spread emissions over a large area They do not reduce emissions, except to the extent that they result in reduced production. Smelters use primarily two methods to disperse emissions The first, tall smoke stacks, disperses the sulfur dioxide gases by releasing them at high elevations. The second method, referred to as an intermittent control system, consists of a weather station and an ambient air monitoring network.[6] The weather station is used to predict when

[6]An ambient air monitoring network consists of one or more monitors strategically located in those areas around a smelter where the concentration of emissions from a source (e g , smelter) is expected

weather conditions (such as cloud cover, wind, and atmospheric pressure) will provide for good or bad dispersion of emissions Smelters curtail production when dispersion is bad and increase production when dispersion is good The ambient air monitoring network is used to measure whether the emissions were dispersed effectively.

Several federal court opinions interpreting the 1970 amendments held that the Congress intended that NAAQS be met through the use of constant emission controls The courts indicated, however, that dispersion techniques could be used if constant control technology was shown to be unavailable, for example, those instances where the installation of control equipment would be economically unreasonable.

1977 Amendments Restrict Methods for Controlling Emissions

The 1977 Clean Air Act amendments were more explicit than the 1970 amendments in restricting the use of dispersion techniques to achieve NAAQS Consequently, the only choice for many nonferrous smelters was constant control equipment The Congress restricted dispersion techniques for several reasons, including

- difficulty in identifying who causes ambient air violations when several pollution sources are located in one area,
- polluting of other areas and states far from the pollution source, and
- reduced productivity because intermittent control systems curtail production during periods of poor dispersion

Although the 1977 Clean Air Act amendments generally required that nonferrous smelters use constant controls, the amendments also allowed EPA or states to issue nonferrous smelter orders (NSOs) which permitted qualifying smelters to use dispersion techniques until 1988. The Congress included NSO waiver provisions in the 1977 amendments because of adverse economic conditions faced by smelters, including declining market prices for nonferrous metals and foreign competition The Congress was concerned that requiring smelters to install expensive constant emission controls could cause some closures [7] The amendments provided for first- and second-period NSOs; one deferring compliance with requirements to reduce emissions until January 1, 1983, and the other deferring compliance until January 1, 1988

to be the greatest These monitors determine whether a source's emissions are causing NAAQS violations

[7] A Legislative History of the Clean Air Act Amendments of 1977, U S Senate Committee on Environment and Public Works (August 1978), vol 3, pp 785-92

Objectives, Scope, and Methodology

In response to the Subcommittee's request and subsequent discussions with the Chairman's office, we examined the effectiveness of EPA and state actions as they relate to Clean Air Act provisions regarding sulfur dioxide emissions of primary nonferrous smelters. Specifically, we reviewed the following issues:

- What measures have EPA and states used to determine compliance with the act?
- What enforcement actions have EPA and states taken?
- What factors were considered by EPA and states regarding the granting of NSOs?

The Chairman's office also asked us to provide information on the extent of acid deposition damage in the West and the contributions of smelters to that damage. A discussion of this issue is contained in appendix II.

We performed our review from April to September 1985. We interviewed officials and gathered information at EPA headquarters (Washington D.C.), EPA Regions VI (Dallas, Texas) and IX (San Francisco, California); and Arizona, Nevada, and New Mexico air quality regulatory agencies. We interviewed officials from two smelter companies that have applied for second-period NSOs and agreed to such an interview to obtain background information on the status of the smelter industry and the difficulties encountered in complying with environmental regulations. To assist us in our basic understanding of how a smelter operates, we visited two copper smelters in Arizona, one that uses constant controls to reduce emissions and another that uses tall smoke stacks and intermittent control systems to disperse emissions. In addition, we talked with environmentalists who have actively been assessing the extent of acid deposition damage in the West and smelters' contribution to any such damage.

We selected EPA Regions VI and IX and Arizona, Nevada, and New Mexico because these regions and states contain the four smelters that have applied for NSOs. Additionally, EPA Regions VI and IX contain 13 of 28 U.S. primary nonferrous smelters in existence at the time of the 1977 amendments.

To determine how effective EPA and the states have been in implementing the Clean Air Act, we compared 1970 nationwide sulfur dioxide emissions of nonferrous smelters with 1984 emissions, and 1977 violations of NAAQS caused by nonferrous smelters in the three states reviewed with 1984 violations We acquired information on the nationwide compliance status of nonferrous smelters as of May 31, 1985, and data on the violations caused by smelters operating under NSOs to see if those smelters were maintaining the NAAQS

We obtained information on the compliance and operating status of the 13 smelters within EPA Regions VI and IX during our visits to those regions Information for the 15 remaining nonferrous smelters was provided by each of the cognizant EPA Regions (III, IV, V, VII, VIII, and X) by responding to a questionnaire we developed

Information on sulfur dioxide emissions and NAAQS violations by smelters in Arizona, Nevada, and New Mexico was provided by the cognizant state air quality agency To obtain information on the measures EPA and states used to determine nonferrous smelter compliance with the Clean Air Act, we interviewed officials in EPA headquarters, EPA Regions VI and IX, Arizona, Nevada, and New Mexico We also examined, in these states and EPA regions, documents showing their compliance assessment efforts Our review covered EPA and state efforts to determine smelter compliance with the following

- Sulfur dioxide emission limits
- The NAAQS for sulfur dioxide
- Continuous control equipment and operating requirements.

We did not, however, verify the accuracy of EPA's or the states' compliance assessments

We discussed enforcement policy and procedures with EPA Regions VI and IX and the states of Arizona, Nevada, and New Mexico. We also reviewed EPA and/or state files on smelters in the states visited and obtained information on enforcement action taken by EPA or the states

We discussed the EPA and state nonferrous smelter compliance and enforcement processes with EPA and state program officials and have included their comments where appropriate However, in accordance with the requestor's wishes, we did not obtain the views of these officials on our conclusions, nor did we request official agency comments on a draft of this report With the exception noted above, our review was performed in accordance with generally accepted government auditing standards

Nonferrous Smelters Are Generally Complying With Clean Air Act Requirements for Controlling Sulfur Dioxide Emissions

Nonferrous smelters, following requirements imposed by EPA and state agencies, have generally taken the steps necessary to comply with Clean Air Act requirements for controlling sulfur dioxide emissions Of the 28 nonferrous smelters in existence at the time of the 1977 Clean Air Act amendments, 18 were in operation as of May 1985 Of the 18, 12 had met sulfur dioxide emission limits by installing new equipment and/or making process modifications Regarding the other six smelters, three had installed the equipment to meet the act's requirements to reduce emissions but still experienced emissions in excess of limits, and three have sought deferrals from emission limits by requesting NSOs Because of smelters' efforts to reduce emissions and because 10 smelters discontinued operations since 1977, smelter sulfur dioxide emissions and violations of NAAQS have been significantly reduced Nationwide, nonferrous smelter sulfur dioxide emissions in 1984 were down about 75 percent from the 1970 level In the three western states reviewed, the number of sulfur dioxide violations of NAAQS for 1984 was down about 80 percent from the number in 1977

How Smelter Compliance Is Determined

EPA has primarily relied on states to implement the Clean Air Act's requirements for nonferrous smelters. The three states included in our review—Arizona, Nevada, and New Mexico—placed the burden of demonstrating compliance on the smelter itself Each state required smelters to monitor their emissions to determine the amount of sulfur dioxide released into the environment and to monitor the ambient air around the smelter to determine the effect of smelter emissions on air quality.[1] All three states required smelters to report the results of their monitoring to the state and audited the reports from the smelter The following is a description of Arizona's system for determining smelter compliance with sulfur dioxide emission requirements. Nevada's and New Mexico's systems are similar

Under Arizona's SIP, a smelter must meet Clean Air Act requirements by installing constant control equipment (e.g., acid plants) to reduce emissions or it must apply for an NSO to defer compliance with that requirement; the emission limit suspension starts when the application is submitted If the smelter chooses to meet requirements by installing the equipment, the SIP requires that the smelter also install monitors that continually record emissions Continual monitoring is necessary to show

[1] New Mexico does not require the Phelps Dodge/Hidalgo smelter to monitor ambient air because the smelter was designed and built to meet clean air standards by reducing emissions The state, however, has maintained ambient air monitors in the vicinity of the smelter since before its initial start-up in 1976

compliance with Arizona's multipoint emission limit that allows a limited number of peak emission levels

Smelters that install constant control equipment to reduce emissions must also have ambient air monitoring networks. When installing constant control equipment, smelters must prevent NAAQS violations by using dispersion techniques and must use ambient air monitors to determine whether their dispersion techniques are working. Smelters must maintain their ambient air monitoring networks for 3 years after the constant control equipment has been installed to show whether they are effective in eliminating NAAQS violations.

Smelters that have applied for an NSO also must have ambient air monitoring networks. While an NSO defers requiring a smelter to install constant control equipment to reduce emissions, the smelter is still required to prevent violations of the NAAQS. Dispersion techniques are used by NSO smelters to avoid such violations

Arizona's SIP requires smelters to report emissions and ambient air data to the Arizona Department of Health Services (DHS) monthly Arizona also requires smelters to report any exceedances[2] of emission limits or of the NAAQS within 12 hours The Arizona DHS has taken several steps to assure that smelters provide accurate data to the state The DHS requires that smelters exercise quality control procedures, including the calibration of monitoring equipment and the performance of preventive maintenance The DHS also conducts annual audits of smelters, testing such items as the calibration of monitoring equipment, the adequacy of the smelters' quality control practices, and the accuracy of reported data. We verified that the auditing was performed; however, we did not determine the accuracy of the audit results

The accuracy of a smelter's monitoring network is further assured by Arizona's own ambient air monitoring network Arizona DHS operates one or two ambient air monitors in the vicinity of each smelter as part of a system referred to as the State and Local Air Monitoring Stations Network These monitors provide Arizona with data on sulfur dioxide ambient air concentrations on a continuous basis. According to the Manager of the Compliance Section, Bureau of Air Quality Control, Arizona DHS, this data is used to verify the accuracy of smelters' reports.

[2]An exceedance may or may not be a violation Arizona allows one exceedance for each ambient air monitor each year before it considers an exceedance a violation

Smelters Are Generally Meeting Sulfur Dioxide Emission Limits

Nonferrous smelters have generally followed the requirements imposed by EPA and states, taking the steps necessary to comply with Clean Air Act requirements for reducing sulfur dioxide emissions and preventing NAAQS violations. The next sections discuss the compliance status of smelters, including those that are (1) operating and either meeting emission requirements by installing equipment, having excess emissions after installing equipment, or requesting an NSO deferral from the requirement to install equipment and (2) closed

Operating Smelters

Information provided by the EPA regions showed that 18 of the 28 smelters in existence at the time of the 1977 amendments were in operation on May 31, 1985 Twelve of the 18 smelters were meeting sulfur dioxide emission limits by installing acid plants and/or making other process changes (e.g , replacing the furnace) to reduce emissions According to EPA, three of the six remaining smelters have installed the necessary equipment to meet emission limits but still had emission violations The other three smelters sought deferrals from complying with sulfur dioxide emission limits by requesting NSOs One of these smelters has no constant control equipment The other two smelters had constant control equipment (acid plants) which controlled over 60 percent of emissions. However, these controls were insufficient to achieve sulfur dioxide emission limits

Table 2 1 lists the 18 operating smelters, the smelter type, and the compliance status as of May 31, 1985

Table 2.1: Operating Smelters' Compliance With Sulfur Dioxide Emission Limits May 31, 1985

Smelter name	Location	Smelter type	Compliance status
Amax Lead Co	Boss, MO	Lead	In
ASARCO/Columbus	Columbus, OH	Zinc	In
ASARCO/E Helena	East Helena, MT	Lead	In
ASARCO/El Paso	El Paso, TX	Copper, Lead, and Zinc	In
ASARCO/Glover	Glover, MO	Lead	In
ASARCO/Hayden	Hayden, AZ	Copper	In
Jersey Miniere	Clarksville, TN	Zinc	In
National Zinc Co	Bartlesville, OK	Zinc	In
New Jersey Zinc Co	Palmerton, PA	Zinc	In
Phelps Dodge/Hidalgo	Hidalgo, NM	Copper	In
St Joe Lead Co	Herculaneum, MO	Lead	In
Tennessee Chemical	Coperhill, TN	Copper	In
St Joseph Resources	Monaca, PA	Zinc	Out
Amax Zinc Co	Sauget, IL	Zinc	Out
Inspiration	Miami, AZ	Copper	Out
Phelps Dodge/Douglas	Douglas, AZ	Copper	NSO[a]
Chino Mines Co	Hurley, NM	Copper	NSO[a]
Magma Copper Co	San Manuel, AZ	Copper	NSO[a]

[a]Smelter did not have the capability to comply with SIP requirements and applied for a second period NSO

Brief discussions of the conditions at the three smelters experiencing sulfur dioxide emission violations and the conditions of the three smelters requesting NSOs follow

Operating Smelters With Excess Emissions

EPA Region III has found the St. Joseph Resources zinc smelter in non-compliance with the sulfur dioxide emission limit because of emissions from coal-fed boilers in its electric power plant St Joseph Resources meets sulfur dioxide emission limitations for all other smelter operations EPA has negotiated a consent decree with the smelter company to bring the smelter into compliance by April 1987

EPA Region V found that sulfur dioxide emissions of the Amax Zinc Company exceeded the 2,000 pounds per-minute limit by 20 percent An EPA Region V official believes the smelter has sufficient controls to meet sulfur dioxide emission limits and is negotiating a plan with Amax Zinc to bring the smelter back into compliance with sulfur dioxide limits

The Inspiration Consolidated Copper Company has exceeded both the allowable sulfur dioxide emission limits and the NAAQS even though it has installed equipment to meet these limits Inspiration has advised the state that acid plant breakdowns have required the by-passing of the acid plant causing violations of the NAAQS. EPA and state enforcement actions are proceeding against this smelter The types of enforcement actions taken by EPA and states are discussed later in this chapter

Operating Smelters That Requested NSO Exemptions

The Phelps Dodge/Douglas smelter has no continuous control equipment to remove sulfur dioxide emissions Phelps Dodge sought an NSO to defer compliance with Arizona's sulfur dioxide emission limit which would have required it to remove 87 percent of the sulfur dioxide from its emissions Arizona granted the first-period NSO to Phelps Dodge/Douglas in September 1982 EPA did not take action on this NSO application because part of its first-period NSO regulations had been nullified by a federal court[3] Phelps Dodge applied directly to EPA for a second-round NSO exemption EPA had not reached a decision on this request as of March 10, 1986

The Chino Mines smelter had constant control equipment which allowed it to capture 60 percent of its sulfur dioxide emissions. However, the New Mexico SIP requires the Chino smelter to remove approximately 90 percent of its emissions Consequently, an NSO was obtained to temporarily exempt the smelter from that requirement. Chino Mines later agreed to install a new flash furnace[4] and acid plant and demonstrate compliance with emission limits by July 1, 1985. Chino Mines installed the equipment as agreed and was in the process of demonstrating compliance to New Mexico on May 31, 1985 The Chief of the New Mexico Air Quality Bureau said that the smelter was in compliance with sulfur dioxide emission limits as of July 1, 1985

The Magma Copper Company has sought an NSO exemption from Arizona's sulfur dioxide emission limit. The smelter has constant control equipment which allows it to control 60 percent of sulfur dioxide emissions, but Arizona's SIP requires the smelter to control approximately 88 percent of sulfur dioxide emissions. The state granted the first-round

[3] Kennecott Corp v EPA 684 F 2d 1007 (D C Cir 1982) The court said that EPA's test required, in effect, a smelter to show that installing constant control equipment would create such a financial burden that the smelter would close if required to do so The court ruled that this test was a closure test and, as such, was too strict

[4] A furnace that uses air or oxygen-enriched air and fuel to produce heat from a chemical reaction with the ore concentrate

NSO to Magma in December 1982. Arizona was reviewing Magma's second-round NSO application, submitted in May 1985, as of March 10, 1986

Closed Smelters

The information obtained from EPA regions showed that 10 of the 28 smelters in existence in 1977 were not operating on May 31, 1985, but EPA expects some closed smelters to resume operation if and when economic conditions improve Data provided by EPA regional offices showed that 5 of the 10 closed smelters have adequate sulfur dioxide control equipment to meet sulfur dioxide emission limits. The remaining five closed smelters did not have adequate equipment to control sulfur dioxide emissions, but two of these smelters have closed permanently, having no plans to resume operations Table 2 2 lists the 10 smelters that had operated sometime since 1977, but were closed as of May 31, 1985

Table 2.2: Closed Smelters' Compliance Status May 31, 1985

Smelter name	Location	Smelter type	Adequate control equipment installed
Indefinitely closed			
ASARCO/Corpus Christi	Corpus Christi, TX	Zinc	Yes
Kennecott/Magna	Magna, UT	Copper	Yes
Phelps Dodge/New Cornelia	Ajo, AZ	Copper	Yes
Kennecott/Ray Mines	Hayden, AZ	Copper	Yes
White Pine Copper	White Pine, MI	Copper	Yes
Bunker Limited	Kellogg, ID	Lead, Zinc	No
Kennecott/McGill	McGill, NV	Copper	No
Phelps Dodge/Morenci	Morenci, AZ	Copper	No
Permanently closed			
Anaconda Reduction	Anaconda, MT	Copper	No
ASARCO/Tacoma	Tacoma, WA	Copper	No

States Have Used Formal and Informal Enforcement Actions to Seek Smelter Compliance

EPA has primarily relied upon the states to enforce smelter compliance with emission limits and NAAQS. As required in the Clean Air Act, states include in their SIP a program for enforcement of emission limitations needed to insure attainment of the NAAQS The act provides no further details on what provisions should be included in the program. In implementing their programs, states have taken various types of enforcement actions to seek compliance

Arizona and New Mexico have taken enforcement actions for violations of the NAAQS at eight of their nine smelters These actions ranged from informal actions, such as meetings between the Arizona DHS and the smelter company, to such formal actions as obtaining a court order which in part required the company to install additional ambient air monitors for its intermittent control system Nevada has not taken enforcement action against its only smelter, but this smelter has not had a NAAQS violation since 1978 nor has it operated since June 1983

Arizona and New Mexico officials told us that it is state policy to seek voluntary compliance before initiating formal enforcement action. The compliance section chief, Bureau of Air Quality, Arizona DHS, said that informal enforcement is used to obtain compliance because of the time and expense of pursuing formal enforcement action The chief said that formal enforcement actions require documentation that takes considerable time to develop He further said that formal enforcement actions are often slow and must compete for priority among many actions being pursued by the Arizona Attorney General's office He said that formal enforcement action is not usually pursued unless the smelter company indicates that it will not comply and the continued violation might risk human health

New Mexico's Air Quality regulations state that the Health and Environmental Department should seek voluntary cooperation from a smelter company and that formal enforcement action should be pursued if appropriate corrective action cannot be obtained within a reasonable time The Director of New Mexico's Health and Environment Department said that his agency has been following this policy. For example, in September 1981, the department told the Chino Mines Company that its continuous emission monitoring equipment should be calibrated periodically to assure accurate readings The company agreed to perform such calibrations monthly

EPA Collected Penalties From Three Arizona Smelters Under Consent Decrees

EPA Region IX negotiated agreements (consent decrees) with three Arizona smelter companies, establishing penalties for ambient air violations and schedules for effective operation of continuous control equipment at each smelter. These consent decrees were negotiated in 1981 when Arizona's SIP for sulfur dioxide control had not yet been approved by EPA. When EPA approved Arizona's SIP, it amended the consent decrees to be consistent with Arizona's plan except that compliance dates established by the consent decrees were not extended to the January 1986 deadline in the Arizona SIP

All three smelters violated the NAAQS and were assessed penalties by EPA The consent decrees provided for initial penalties of $5,000 per ambient air violation but raised penalties to $7,500 and $10,000 for later violations. Table 2.3 shows the three consent decree smelters and the penalties paid by each

Table 2.3: EPA-Assessed Penalties at Consent Decree Smelters 1981-1985

Smelter name	Penalties
ASARCO/Hayden	$ 25,000
Phelps Dodge/Morenci	682,500
Phelps Dodge/Ajo	52,500
Total	**$760,000**

The deadline for achieving emission limits agreed to in the consent decrees was met by the ASARCO smelter, the other two have shut down. ASARCO agreed to conventional controls using a new flash furnace and an additional acid plant. This smelter demonstrated the effectiveness of its system in controlling emissions on schedule in April 1984

The two smelter companies that shut down originally agreed to use innovative technology[5] to achieve emission limits. Phelps Dodge/Morenci installed the innovative technology but it did not work. This smelter closed prior to its agreed upon compliance date Phelps Dodge/Ajo negotiated an amended consent decree which did not involve innovative technology and made the improvements to its acid plant called for in the amended consent decree This smelter shut down prior to demonstrating that its system was effective in controlling emissions.

Sulfur Dioxide Emissions Are Down

The installation of pollution control equipment and smelter closures have resulted in decreased sulfur dioxide emissions from nonferrous smelters In 1984, sulfur dioxide emissions from nonferrous smelters were down by about 75 percent from the 1970 level In 1970, U.S nonferrous smelters emitted approximately 3 6 million metric tons of sulfur dioxide By 1984, nonferrous smelters had reduced total sulfur dioxide emissions to 0 9 million metric tons

[5] A system that injected oxygen into the smelter's furnace to increase the concentration of sulfur dioxide in the furnace s emissions so that they could be effectively processed through the smelter's acid plant

Based on data published in the U S Bureau of Mines Yearbook on the production of nonferrous metals and on EPA emission data, we determined that the smelters' use of emission controls account for a significant portion of the reduced emissions However, decreased smelter production was the major reason for this drop The 1984 smelter production was about 42 percent less than 1970 production, while 1984 emissions were down by 75 percent Thus, we estimate that 56 percent (42/75) of the reduced emissions were due to decreased production, and 44 percent (100-56) were due to improvements in emission controls

Much of the improvement in copper smelter sulfur dioxide control had come by the mid-1970's as these smelters installed acid plants to attempt to meet the NAAQS for sulfur dioxide emissions For example, 7 of the 10 Arizona, Nevada, and New Mexico copper smelters had installed acid plants by 1975 In 1975, these seven smelters eliminated 53 percent of the sulfur dioxide from their emissions

Much of the improvement after 1975 resulted from smelters replacing their reverberatory furnaces[6] with flash or electric furnaces In 1975, six of the seven above mentioned Arizona, Nevada, and New Mexico smelters with acid plants used reverberatory furnaces The smelters' reverberatory furnaces accounted for about 25 percent of their sulfur dioxide emissions and were too weak to be treated in acid plants However, flash and electric furnaces produce a strong sulfur dioxide emission that can be treated in an acid plant, making it possible for smelters with such furnaces to eliminate a larger percentage of the sulfur dioxide in their emissions As of May 31, 1985, four Arizona, Nevada, and New Mexico copper smelters were operating with flash or electric furnaces, eliminating 82 percent of the sulfur dioxide from their emissions

Smelter Violations of NAAQS Are Down

NAAQS violations for sulfur dioxide are dropping as a result of reduced smelter emissions For example, the number of violations in the vicinity of Arizona, Nevada, and New Mexico smelters in 1984 was down by about 80 percent from the 1977 amount (346 violations in 1977 versus 68 in 1984) Violations of the primary NAAQS were down even more The 11 violations of the primary NAAQS in 1984 were 91 percent less than the 120 violations experienced in 1977

Table 2.4 shows that all but 3 of the 68 violations of NAAQS experienced in 1984 were caused by Arizona smelters Over half (38 of 68) were

[6]A furnace that uses natural gas oil or coal to heat a chamber fed with ore concentrate

caused by Arizona smelters that have subsequently closed (New Cornelia and Morenci).

Table 2.4: NAAQS Violations by Smelters in Arizona, Nevada, and New Mexico 1977-1984

		Year							
Smelter name	**Smelter location**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**
ASARCO/Hayden	Hayden, AZ	173	14	51	15	23	5	0	0
Kennecott/Ray Mines	Hayden, AZ	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Inspiration	Miami, AZ	68	45	72	15	35	56	5	17
Kennecott/ Chino Mines	Hurley, NM	0	0	0	0	0	0	0	3
Kennecott/McGill	McGill, NV	18[b]	1[b]	0	0	0[b]	0	0	0[c]
Magma	San Manuel, AZ	15	19	16	4	4	5	2	0
Phelps Dodge/ Douglas	Douglas, AZ	8	3	9	2	12	0	1	10
Phelps Dodge/ Hidalgo	Playas, NM	0	0	0	0	0	0	0	0
Phelps Dodge/ Morenci	Morenci, AZ	64	43	20	86	116	11	106	29
Phelps Dodge/ New Cornelia	Ajo, AZ	0	2	0	7	1	0	0	9
Total		**346**	**127**	**168**	**129**	**191**	**77**	**114**	**68**

[a]The two smelters in Hayden, Arizona, share the same air monitoring network because they are in close proximity

[b]The data differ from data shown in the Nevada Air Quality Report for 1981 and 1983 Corrected data were provided by the Nevada Division of Environmental Protection

[c]The smelter shut down in 1983

This drop in violations is attributed primarily to three factors: reduced production, use of constant control equipment to reduce emissions, and the use of dispersion techniques to spread emissions. We did not determine the relative contribution of these three factors, but note that only through the use of constant controls to reduce emissions were violations completely eliminated

In 1984, two smelters in the three states reviewed used only constant controls to prevent NAAQS violations and experienced no violations The Phelps Dodge/Hidalgo smelter was built in the mid-1970's with acid plants designed to remove over 90 percent of sulfur dioxide emissions This smelter has never had a sulfur dioxide violation of the NAAQS and has always used constant controls. The ASARCO/Ray Mines smelter was redesigned to achieve 90 percent sulfur dioxide emission control in 1983.

Since April 1984 this smelter has relied solely on its constant control system to achieve the NAAQS and has had no violations of the NAAQS.

Arizona, Nevada, and New Mexico smelters using dispersion techniques have generally been successful in reducing the numbers of NAAQS violations, but none of those smelters have completely prevented such violations. The Chino Mines smelter successfully prevented sulfur dioxide NAAQS violations from 1977 to 1983 However, this smelter did incur three ambient air violations in 1984 as it was starting its new furnace. The Kennecott/McGill smelter also successfully avoided ambient air violations from 1979 to 1983 when the smelter closed, but did experience a total of 19 violations in 1977 and 1978 Other smelters using dispersion techniques have had NAAQS violations almost every year, with the Phelps Dodge/Morenci smelter having 106 violations as recently as 1983.

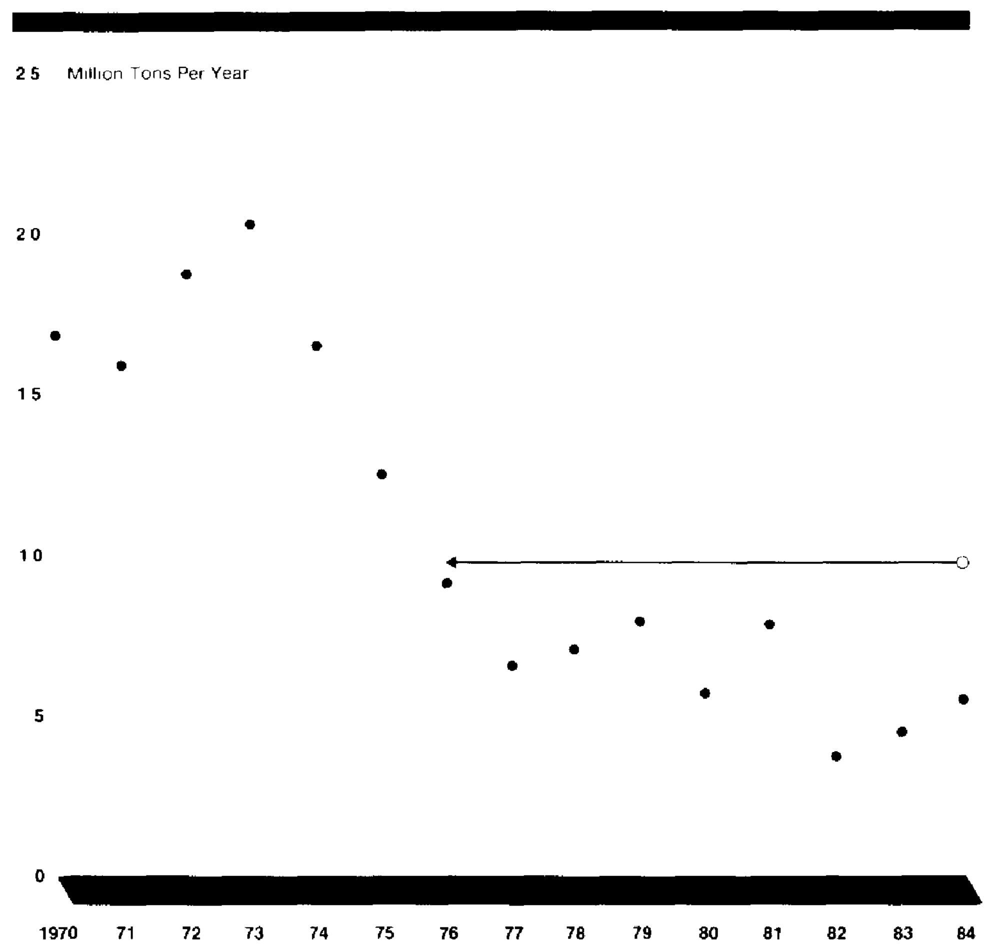
Sulfur Dioxide Emissions Could Increase If Mexico Operates Its New Smelter Without Controls

Increased smelter operations in Mexico could offset much of the progress made by Arizona in reducing emissions during the past 8 years However, EPA does not expect this increased activity to cause NAAQS violations

A large Mexican smelter located about 60 miles from the Arizona border in Nacozari, Mexico, is expected to begin operation in early 1986 without emission controls. According to EPA, the new smelter could emit about 460,000 metric tons of sulfur dioxide a year when operating at capacity The smelter's design includes a flash furnace which results in highly concentrated sulfur dioxide emissions that can be easily treated in an acid plant However, the initial configuration of the plant will not include an acid plant, and the highly concentrated emissions will be released through a 932-foot stack to allow for dispersion away from the smelter's vicinity

As shown in figure 2 1, based on data provided by the Bureau of Air Quality of the Arizona DHS, the uncontrolled emissions of the newly constructed Mexican smelter could set sulfur dioxide emissions in the Arizona/Northern Mexico area back to the level experienced in Arizona in 1976

Figure 2.1: Arizona Smelter Sulfur Dioxide Emissions 1970-1984



ᵒArizona 1984 emissions plus projected emissions at the new Mexican smelter

EPA Region IX's preliminary analysis indicates that operation of the new smelter without controls will not likely result in NAAQS violations in the United States However, the region has not modeled emissions of the Mexican smelter to verify its preliminary conclusions.

EPA has been negotiating with Mexican representatives to obtain an agreement on emission controls for the Nacozari smelter These negotiations are the result of an August 1983 Border Environmental Cooperative Agreement between the U S. and Mexican Presidents In July 1985, a joint communique from the U S and Mexican negotiators announced plans for building an acid plant at the Nacozari smelter by January 1988 The U S negotiators also gave Mexico a commitment that the

Douglas, Arizona, smelter, currently operating without constant emission controls, would install an acid plant or cease operation by January 1988.

The Nacozari smelter began testing on January 15, 1986, without even intermittent controls, with full operations to begin in 6 to 8 months. In a December 1985 meeting of the negotiators, the actions required of Douglas and Nacozari by January 1988 were reaffirmed The negotiators also agreed to present a program describing the interim and final emission controls required for these smelters by June 1986 An EPA official said, however, that EPA is not confident that the United States will be able to prevent Nazcozari from beginning operations without intermittent controls. A Department of State official told us that Nacozari officials are making a case that in order to pay off their loan for the acid plant (approximately $40 million), they must consistently operate for a period of time at full capacity Instituting intermittent controls requires that operating capacity be reduced during periods where weather factors do not allow for good dispersion of emissions.

Conclusion

EPA and states have been effective in getting smelters to reduce emissions and NAAQS violations for sulfur dioxide Generally, smelters are following the requirements imposed by EPA and states to meet the Clean Air Act's provisions for preventing violations of the NAAQS and, except for smelters operating under an NSO, reducing sulfur dioxide emissions Both sulfur dioxide emissions and NAAQS violations of nonferrous smelters were down by at least 75 percent of the levels experienced in the mid- or early 1970's; and in the near future, NAAQS violations should drop even further, when considering that those smelters that closed during 1984 and 1985 had caused over half of the violations

EPA has primarily relied on states to implement and enforce the Clean Air Act's requirements regarding nonferrous smelters. States have placed the burden of demonstrating compliance with the act's requirements on the smelter itself The three states reviewed required smelters to monitor emissions and report the results to the states The states have established systems to verify the accuracy of reported data

EPA and states have used different enforcement strategies, and each has been relatively successful in bringing about compliance. EPA has entered into consent decrees with compliance schedules and fixed fines for violations States have taken informal and formal enforcement action to bring about changes in smelter operations without imposing fines

Smelters Seeking Nonferrous Smelter Orders Have Experienced NAAQS Violations

The Clean Air Act requires smelters operating under NSOs to take those measures necessary to assure that their sulfur dioxide emissions will not cause NAAQS violations Three smelters have requested second-period NSOs Two of those smelters violated the NAAQS several times while operating intermittent control systems under first-period NSOs (Magma and Phelps Dodge/Douglas) EPA is addressing this situation in its review of the Phelps Dodge/Douglas application, the only second-period NSO application EPA has received for review as of December 1985 EPA requested the smelter to improve its intermittent control system to provide reasonable assurance that its sulfur dioxide emissions will not cause NAAQS violations during the time the second-period NSO is in effect

NSO Smelters May Delay Compliance With Continuous Control Requirements but Should Meet NAAQS

Section 123 of the Clean Air Act prohibits the use of dispersion techniques in lieu of constant emission controls to meet the NAAQS. However, section 119 of the act establishes conditions under which EPA or a state[1] may issue an NSO allowing a qualifying nonferrous smelter to defer compliance with this requirement These conditions, covered under section 119(b), are (1) the smelter must have been in existence on August 7, 1977, (2) the requirement for which the order is issued is a sulfur dioxide emission limit, and (3) the smelter is unable to meet this limit using constant controls because the technology for achieving this limit is not reasonably available[2] to the smelter

In providing for the NSO, the Congress did not exempt smelters from the act's requirement to protect the public health and welfare from the adverse effects of air pollution Section 119(d)(1)(A) requires smelters that are awarded NSOs to take those measures EPA deems necessary to assure attainment and maintenance of primary and secondary national ambient air quality standards

The act provides for a first- and a second-period NSO. The first-period NSO postpones compliance with the act's requirements to use constant controls to reduce sulfur dioxide emissions until January 1, 1983, and the second-period postpones compliance until January 1, 1988

Four smelters received a first-period NSO from their respective states, one each from Nevada and New Mexico and two from Arizona EPA

[1] The Clean Air Act states that if the NSO is issued by a state, the order is not effective until approved by EPA

[2] The act states that this condition is to be determined by the EPA Administrator after considering the cost of compliance, health and environmental impacts, and energy considerations

approved the New Mexico smelter's NSO (Chino Mines Company, Hurley, New Mexico), and a decision on the remaining three was left pending because of a federal court decision nullifying part of EPA's first-period NSO regulations

One Nevada and two Arizona smelters have applied for an NSO under EPA's second-period regulations EPA had not approved or disapproved any of these applications as of March 10, 1986[3] The New Mexico NSO smelter did not apply because the smelter was installing constant control equipment at the time EPA issued its second-round regulations in February 1985 As of July 1, 1985, this smelter had demonstrated compliance with Clean Air Act requirements using continuous control equipment

Mixed Success of NSO Smelters in Preventing NAAQS Violations

Smelters seeking second-round NSOs have used intermittent control systems to limit violations of NAAQS but have had mixed success in avoiding such violations Under its NSO regulations, Nevada issued a first-round NSO to the the Kennecott/McGill smelter in January 1982. This smelter had no ambient air violations from that date through its closure in June 1983. Arizona issued first-round NSOs to the Phelps Dodge/Douglas and Magma smelters in September 1982 and December 1982, respectively. When operating, each of these three smelters used intermittent controls to avoid ambient air violations Table 3.1 shows the ambient air violations caused by these smelters

Table 3.1: NAAQS Violations for Smelters Seeking Second-Period NSOs 1977-1985[a]

Smelter name	Date state issued 1st period NSO	Combined primary and secondary NAAQS violations by year								
		77	78	79	80	81	82	83	84	85
Magma Copper Co	Dec 1982	15	19	16	4	4	5	2	0	2
Phelps Dodge/ Douglas	Sep 1982	8	3	9	2	12	0	1	10	2
Kennecott/ McGill	Jan 1982	18	1	0	0	0	0	0	0	0
Total		**41**	**23**	**25**	**6**	**16**	**5**	**3**	**10**	**4**

[a]Violations through the first 9 months of 1985

[3]Even though the first-period NSOs expired on January 1, 1983, EPA allowed first-period NSO smelters to continue to operate under the provisions of the first-period NSOs because of its delay in issuing second-period NSO regulations and the time required to review second-period NSO applications

The Magma Copper Company smelter in San Manuel, Arizona, applied to Arizona for a second-period NSO in May 1985, after EPA issued second-period NSO regulations The Office of Air Quality Management, Arizona DHS, has asked Magma to make improvements to its intermittent control system, but had not completed its review of the Magma application as of March 10, 1986 Arizona plans to have a decision on the NSO by late March 1986 If Arizona approves the application, it will forward the NSO to EPA for review

The Kennecott/McGill smelter in McGill, Nevada, applied to Nevada for a second-period NSO in October 1982 In January 1983, Nevada issued a second-period NSO to the Kennecott/McGill smelter and submitted the NSO to EPA EPA responded in April 1983, stating it was premature to review the NSO since EPA had not issued second-period NSO regulations. After the second-period regulations were issued in February 1985, the Kennecott/McGill smelter expressed interest in having its Nevada-issued NSO approved by EPA The EPA Region IX Air Management Division Director said that the region has assigned a lower priority to review of the Kennecott NSO request because the smelter has not operated since July 1983 and is not expected to operate before 1988

The Phelps Dodge/Douglas smelter in Douglas, Arizona, applied to EPA for a second-period NSO in May 1985 In a September 18, 1985, letter, EPA requested that Phelps Dodge/Douglas make specific improvements to its intermittent control system. The improvements requested by EPA concerned the smelter's inability to prevent NAAQS violations According to the EPA Region IX meteorologist, the smelter has not consistently prevented NAAQS violations because the smelter's current intermittent control system is based on a meteorologist's subjective judgment rather than objective air quality dispersion model estimates.

In a November 1985 letter, Phelps Dodge provided the information that it believed satisfied EPA's request of September 1985 Phelps Dodge stated, in the November letter, that it had hired a consultant to assist in analyzing a 10-year Phelps Dodge data base on hourly meteorological and air quality observations According to Phelps Dodge, this data would be used to develop an operational manual that would identify the circumstances when and the extent to which production should be varied to prevent NAAQS violations The letter further stated that the analysis would begin when EPA issues the second-period NSO and that the analysis would be completed 6 months later Such a schedule for improving an NSO smelter's intermittent control system is allowed under

EPA's regulations EPA was in the process of reviewing the revised Phelps Dodge application as of March 10, 1986.

Conclusion

The Congress, seeking to minimize smelter closures, gave nonferrous smelters the opportunity to defer compliance with emission limitations, and thus the installation of expensive constant controls, by obtaining an NSO Smelters operating under an NSO could continue to operate by using dispersion techniques, but were still expected to attain and maintain the NAAQS. Although some smelters operating under first-period NSOs have violated the NAAQS, EPA is allowing those smelters the opportunity to improve their intermittent control systems while deciding whether to award second-period NSOs.

The Magma and Phelps Dodge/Douglas smelters need to improve their intermittent controls systems to provide reasonable assurance that their sulfur dioxide emissions will not cause future NAAQS violations. Under these circumstances, EPA and Arizona have requested that the improvements be made. Whether the recent letter from Phelps Dodge outlining a planned strategy for preventing NAAQS violations constitutes an adequate basis for awarding a second-period NSO is a matter currently being evaluated by EPA

List of U.S. Primary Nonferrous Smelters

Smelter name	Smelter location	Smelter type	Operating status[a]
Arizona			
ASARCO-Hayden	Hayden, Ariz	Copper	Operating
Inspiration	Miami, Ariz	Copper	Operating
Kennecott-Ray Mines	Hayden, Ariz	Copper	Shutdown 1982
Magma Copper Co	San Manuel, Ariz	Copper	Operating
Phelps Dodge-Douglas	Douglas, Ariz	Copper	Operating
Phelps Dodge-Morenci	Morenci, Ariz	Copper	Shutdown 1984
Phelps Dodge-New Cornelia	Ajo, Ariz	Copper	Shutdown 1985
Idaho			
Bunker Limited	Kellogg, Ida	Lead, Zinc	Shutdown 1981
Illinois			
Amax Zinc Co	Sauget, Ill	Zinc	Operating
Michigan			
White Pine Copper	White Pine, Mich	Copper	Shutdown 1982
Missouri			
Amax Lead Co	Boss, Mo	Lead	Operating
ASARCO-Glover	Glover, Mo	Lead	Operating
St Joe Lead Co	Herculaneum, Mo	Lead	Operating
Montana			
Anaconda Reduction	Anaconda, Mont	Copper	Shutdown 1980
ASARCO E Helena	East Helena, Mont	Lead	Operating
Nevada			
Kennecott-McGill	McGill, Nev	Copper	Shutdown 1983
New Mexico			
Chino Mines Co	Hurley, N Mex	Copper	Operating
Phelps Dodge-Hidalgo	Hidalgo, N Mex	Copper	Operating
Ohio			
ASARCO-Columbus	Columbus, Ohio	Zinc	Operating
Oklahoma			
National Zinc Co	Bartlesville, Okla	Zinc	Operating
Pennsylvania			
New Jersey Zinc Co	Palmerton, Penn	Zinc	Operating
St Joseph Resources	Monaco, Penn	Zinc	Operating
Tennessee			
Jersey Miniere	Clarksville, Tenn	Zinc	Operating
Tennessee Chemical	Copperhill, Tenn	Copper	Operating
Texas			
ASARCO-Corpus Christi	Corpus Christi, Tex	Zinc	Shutdown 1985
ASARCO-E Paso	El Paso Tex	Copper, Zinc, Lead	Operating

Smelter name	Smelter location	Smelter type	Operating status[a]
Utah			
Kennecott-Magna	Magna, Utah	Copper	Shutdown 1985
Washington			
ASARCO-Tacoma	Tacoma, Wash	Copper	Shutdown 1985

[a]As of May 31, 1985

Information on the Relationship Between Smelter Emissions and Acid Deposition Damage in the West

The Chairman's office also asked that our report include summaries of two studies which provide information on acid deposition in the West [1] Specifically, we were asked to discuss the (1) prospects of acid deposition damage in the West and (2) contributions made by smelters to that deposition, including details on why disagreements have arisen within the scientific community on this issue To develop this information, we reviewed two studies, previous GAO reports, including An Analysis of Issues Concerning Acid Rain (GAO/RCED-85-13, Dec 11, 1984); testimonies from congressional hearings on acid rain, and emission inventories contained in EPA documents and data bases In addition, we interviewed various scientists conducting research on acid deposition.

Background

Acid deposition, popularly referred to as acid rain, occurs when oxides of sulfur and nitrogen emitted by man-made and natural sources (such as fossil-fueled power plants, smelters, and vehicles) are transported through the atmosphere and returned to earth as acid compounds. This process occurs both in precipitation, where it is known as "wet deposition," and in gases, particles, and fog and cloud droplets, collectively termed "dry deposition " Acid deposition has become a significant issue after scientific evidence was developed indicating that it can cause or threaten to cause environmental damage in jurisdictions far from the sources of the emissions

A key point in evaluating the potential risk of damage by acid deposition is the balance between the relative sensitivity of the systems exposed and the amount of acid deposited on them Sensitivity for aquatic areas has generally been estimated by alkalinity, a measure of the concentration of acid-neutralizing material present in the water Sensitivity for forests, on the other hand, has only been discussed qualitatively in terms of such factors as bedrock characteristics, thickness and texture of the underlying soil, and the amount of neutralizing elements (e g , calcium and magnesium) available in the soil

The acidity delivered to a site can be estimated in terms of either the average pH (potential of hydrogen) of deposition or the annual amount of sulfur deposited. Annual wet sulfate deposition no higher than 20

[1] P Roth, C Blanchard, J Harte, H Michaels and M T El-Ashry, The American West's Acid Rain Test, World Resources Institute Research Report #1, March 1985, and R E Yuhnke and M Oppenheimer, Safeguarding Acid-Sensitive Waters in the Intermountain West, Environmental Defense Fund, Nov 26, 1984

kilograms per hectare[2] (kg/ha) has been suggested by some scientists as a threshold point for avoiding damage to most areas However, studies of extremely sensitive waters in Canada and Sweden have suggested that annual wet sulfur deposition would have to be no higher than 15 kg/ha—or even 9kg/ha—to avoid damage to the most vulnerable aquatic system.

Summaries of Two Acid Deposition Studies

The following discussions provide the major issues addressed and conclusions contained in studies published by the World Resources Institute and the Environmental Defense Fund on western acid deposition The conclusions of the Environmental Defense Fund study have been the subject of controversy These conclusions, including details on the nature of the controversy, are discussed in detail beginning on page 37

World Resources Institute

This study examines the acid deposition issue in 11 western (Rocky Mountain and Pacific Coast) states. It includes evidence on (1) acid-forming emissions (i.e , sulfur dioxide and nitrogen oxides) in the West, (2) areas receiving deposition more acidic than that resulting from natural sources, (3) areas most at risk to acid-caused damage, (4) areas impacted by acid deposition in the West, and (5) the relationship between emission sources and deposition in the areas possibly affected by such sources In addition to a survey of scientific literature on the subject, the evidence on which the study is based includes field studies of high-altitude waters in the Colorado Rockies done, in part, by some of the authors of the study

The areas cited by the study to be most at risk are the mountain regions in the Sierras, Cascades, and Rockies Risk was determined by a combination of deposition acidity and high sensitivity to that acidity.

The study recommends expanding support for monitoring of, and research on, acid deposition and its effects in the West. Other recommendations include assessing the impacts of western power plant and smelter emissions on acid deposition in sensitive mountain regions.

It also proposes some emission reduction actions In the near term, the study recommends that nonferrous smelter orders not be allowed to extend beyond the current January 1, 1988, expiration date in the Clean Air Act, and that an agreement be negotiated to control emissions from

[2]One hectare equals 10,000 square meters or about 2 47 acres

Mexican smelters near the Arizona border In the longer term, the study recommends making a proposed facility's effect on acid deposition in sensitive regions a consideration in permitting the siting of the facility The study also calls for an effort to reduce nitrogen oxide emissions from motor vehicles and an examination of the potential roles of energy conservation and renewable energy resources in reducing sulfur dioxide and nitrogen oxide emissions

Environmental Defense Fund

This study addresses and reaches strong conclusions on two issues.

- The possibility of acid deposition damage to aquatic resources in the intermountain West (the region between the continental divide in the Rockies and the Sierra crest)
- The extent to which sulfur dioxide emissions from smelters in the four southwestern states (Arizona, New Mexico, Nevada, and Utah) are responsible for intermountain acid deposition.

On the first issue, the study contends that current deposition rates reach or exceed acidification thresholds for some sensitive waters in the intermountain region. The study, therefore, argues that emissions from uncontrolled existing sources must be reduced and emissions from new sources, including Mexican smelters, must be controlled

On the issue of smelter responsibility for intermountain acid deposition, the study demonstrates a correlation between annual smelter sulfur dioxide emissions for 1980-1983 and the annual average concentrations of sulfur in deposition in a number of monitoring sites in locations ranging from Arizona to as far north as Wyoming and southern Idaho. Based on this correlation, the study argues that smelter emissions are the predominant source of acid deposition in the intermountain region

The study's issues—the possibility of acid deposition damage in the West and the extent to which smelters contribute to the deposition—are discussed in more detail in the following sections

Acid Deposition Damage in the West

The Environmental Defense Fund report states that amounts of acid deposition in precipitation at monitoring stations in the intermountain West run by the National Atmospheric Deposition Program (NADP)[3] have generally been measured as reaching or exceeding an average of 4 to 5 kg/ha of sulfate annually Since western intermountain acid deposition thus appears to be less than the threshold points for avoiding damage (cited earlier as between 9 and 20 kg/ha), it does not, at first, seem to pose much of a threat of damage However, two factors make total acid deposition in the intermountain West of greater concern than shown by this wet deposition data First, the World Resources Institute study states that the proportion of all emissions deposited dry rather than wet is greater in the West than in the East because there is less precipitation to carry it down in the West Second, as stated in August 1985 testimony by the NADP Coordinator, NADP monitoring stations are not reporting deposition at the higher altitudes in the intermountain West, so that available data do not reflect wet deposition at these altitudes Failure to gather these data is important because (1) precipitation—and therefore wet deposition—is greater at the higher altitudes of a mountain region, and (2) forests in mountain regions draw up to several times as much acid deposition from dry deposition—cloud and fog droplets that are not measured in precipitation collectors—as from normal wet deposition

At this time, while the effects of neither factor can be quantified, they do suggest that total acid deposition in higher altitude areas of the intermountain West is closer to damaging levels than indicated by existing western wet deposition data alone

Regarding the sensitivity to acid deposition in the West, the NADP Coordinator's August 1985 testimony stated that the high mountain lakes and streams in the Rocky Mountain region "are some of the most sensitive to acidification in the world " The World Resources Institute study states that western mountains are generally steep and have thin soil. As a result, acids may flow into lakes and streams without being neutralized as much as when less steep slopes and deeper soils permit the precipitation to percolate more deeply into the soil

In addition to these geochemical factors affecting sensitivity, both the NADP Coordinator's testimony and the World Resources Institute study

[3]The NADP provides emissions monitoring data to the Acid Precipitation Task Force, a federal interagency group established in 1980 to perform a comprehensive 10-year assessment of the causes and effects of acid deposition and to research actions to limit or reduce its harmful effects

point out that the effects of acidity are intensified by the following plant life and environmental interactions and conditions resulting from high altitudes For example

- Alkaline soil particles, such as calcium salts which neutralize acid deposition at low altitudes, are not present to the same degree at high altitudes
- Acid stored in a snowpack is released in the first runoff of snow melt. Since a larger percentage of high altitude deposition (some 60 to 70 percent) occurs in snow, first runoff will be proportionately more acidic, compared to the regular annual waterflow in other terrain which gets less snow
- Since the growing season is shorter at high altitudes, plants consume and neutralize less nitric acid Any nitric acid not consumed will further amplify the intensity of acid concentrations during snowmelt

Once again, however, as with deposition, we did not find any evidence quantifying the extent of these effects

While the NADP coordinator pointed out that firm evidence of biological damage in western U S surface waters has not yet been found, deposition has been sufficiently acidic to noticeably acidify surface waters in parts of the West, as shown by trends in surface water quality evaluated by the U S. Geological Survey [4] Furthermore, certain waters in mountain areas of the western United States are very vulnerable to severe acidification and biological damage While these points are valid and provide justification for study of western waters, they do not appear sufficient to prove that a damage "threshold" has been reached

Share of Acid Deposition in Intermountain West Derived From Smelter Emissions

Another issue relating to acid deposition in the intermountain region is the extent to which it is derived from smelter emissions. Since the publication of the original Environmental Defense Fund study in November 1984, this issue has been the subject of debate among interest group representatives and atomspheric scientists

The Environmental Defense Fund study asserts that "smelters are responsible for the vast majority of sulfate [sulfur]deposited across the intermountain region " This contention was made by correlating the variations in the average annual sulfur concentrations in precipitation at a

[4] R A Smith and R B Alexander, Evidence for Acid-Precipitation Induced Trends in Stream Chemistry at Hydrolic Bench-Mark Stations Geological Survey Circular 910, Washington, D C , 1983

set of 10 monitoring stations located between Arizona and southern Idaho, with variations in total annual sulfur dioxide emissions from smelters in Arizona, New Mexico, Nevada, and Utah for the years 1980-1983 This same correlation analysis was again discussed by the authors of the study in an article published in an August 1985 peer-reviewed scientific journal, Science. In the journal article, however, the connection of smelter emissions to acid deposition is stated much less strongly, claiming only that the correlation shows that "smelters are a probable cause of sulfate detected in precipitation" at these stations

The link between sulfur deposition and smelter emissions, particularly as presented in the Environmental Defense Fund's work, was the focus of a November 1985 informal workshop sponsored by the National Oceanic and Atmospheric Adminstration's Air Resources Laboratory for scientists performing research related to this issue The minutes record the results and analyses presented and some discussions of this material, but do not attempt to resolve conflicts among the presentations The areas of disagreement include

- The validity of the correlation approach used The most serious challenge to this approach resulted from a disaggregation from annual to monthly data. In particular, in three 1980 months when smelter emissions were low because of a labor strike, sulfur concentrations remained high.
- The directions of air movements in the intermountain region. The Environmental Defense Fund study discusses an overriding south-to-north wind movement to support the contention that southwestern smelters exert major influences on deposition as far north as Wyoming and southern Idaho The workshop participants discussed both south-to-north and west-to-east wind movements, the proportions of such movements at different altitudes, and their net result on the direction of deposition movement.
- The distance smelter emissions travel. This ranged between the view that deposition resulting from southwestern smelters does not extend much north of the Arizona and New Mexico borders to the view published by the Environmental Defense Fund that indicates a substantial effect as far north as southern Idaho—a distance of over 600 miles.
- The impact of weather patterns. This debate focused on the extent to which variations in weather patterns, rather than smelter emissions, are responsible for variations in deposition

- The sulfur measuring approach The validity of the Environmental Defense Fund's approach was challenged since it used the sulfur concentration in precipitation method rather than the more usual measure of the total amount of sulfur deposited.

Even though the precise share of intermountain acid deposition resulting from southwestern smelter emissions has not been resolved, we found no other scientific studies supporting the Environmental Defense Fund contention that "smelters are responsible for the vast majority of sulfate deposited across the intermountain region " Furthermore, whatever this share is, it should fall with the additional smelter emission decreases expected by 1988.

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