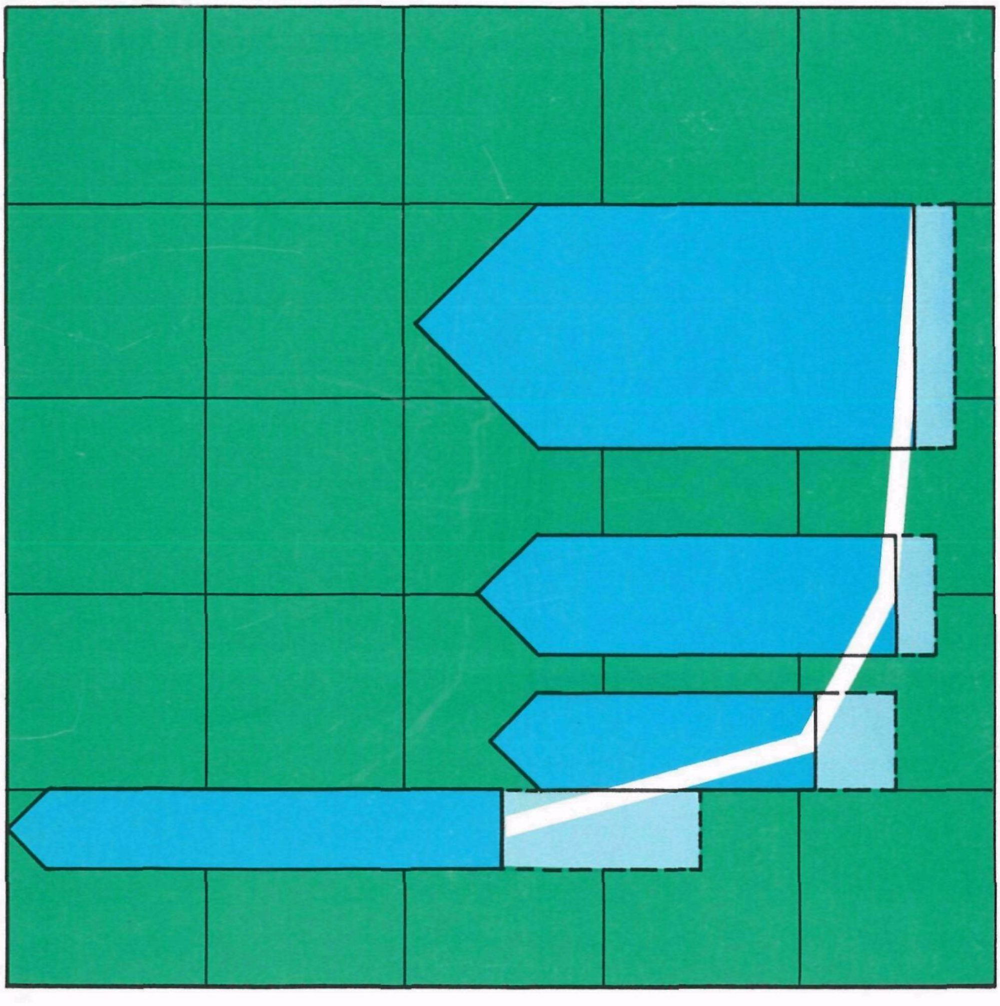
Economic Impact of Anticipated Pollution Abatement Costs

Primary Copper Industry

Report to
Environmental Protection Agency



Part 3 Economic Impact

Arthur D. Little, Inc.

ECONOMIC IMPACT OF ANTICIPATED POLLUTION ABATEMENT COSTS ON THE PRIMARY COPPER INDUSTRY

Report to

ENVIRONMENTAL PROTECTION AGENCY

PART III - ECONOMIC IMPACT

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PART III - ECONOMIC IMPACT

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PREFACE

This report was prepared in rough draft form during March-May, 1972. At that point in time, as required by law, the states had submitted their respective plans for implementation of pollution control (SIP or State Implementation Plans) but EPA had not decided whether or not these plans would be acceptable. Because of this, we evaluated the economic impact of pollution control legislation based on control standards that were judged by us to have a high probability of being enforced.

The acceptable SIPs were released by EPA on July 27, 1972 (Federal Register 37, 145, July 27, 1972, pp. 15094-15113). These standards vary significantly from the standards assumed by us for the "base case" in our economic impact analysis. Because of this, our analysis of economic impact, though consistent with the assumptions used by us, is somewhat dated. An analysis of the economic impact of the July 27 regulations would require rewriting of major portions of this report and the analysis would still be incomplete since the requirements for meeting the Secondary Ambient Standards will not be available for another 18 months. Also, these standards have been challenged in court by the industry.

In Appendix A, we have included a summary of the major differences between our assumptions and the July 27 regulations and the general consequences.

IX. INTRODUCTION

A. PURPOSE AND SCOPE

The purpose of this part of our report is to analyze the specific impacts and dislocations that would occur under the assumed pollution control standards. This analysis draws on the background information on the industry presented in Part II - Industry Structure. For convenience, the chapters have been numbered consecutively; Chapters I through VIII being bound separately as Part II.

Our findings and conclusions are summarized in Part I - Executive Summary.

B. APPROACH

The capital and operating costs for air and water pollution were compiled on a common basis based on data available from industry and other sources. These data, presented in Chapter X, are based on the selection of a pollution abatement strategy which would give the necessary results at minimum cost. The operating costs for a selected strategy were estimated in a similar fashion. Based on a study of probable netback prices for smelter-produced sulfuric acid (presented as Chapter XI), we have assumed a uniform negative netback for surplus acid produced.

In Chapter XII, the direct impact of pollution abatement costs has been evaluated for the "local" case - 90% sulfur recovery in Montana, Arizona and Puget Sound in Washington and lower in other states. This impact was evaluated plant-by-plant and company-by-company in terms of plant shutdown probabilities, the impact of the shutdown timing on the domestic mines and the possibility of a smelter bottleneck, the impact on the financial health of individual companies, and the impact on employment on a local level.

The indirect impacts on mine production, balance of payments and so on are presented in Chapter XIII.

X. CAPITAL AND OPERATING COSTS TO MEET ANTICIPATED POLLUTION ABATEMENT REQUIREMENTS

A. INTRODUCTION

The capital and operating costs of meeting air and water pollution regulations have been a subject of considerable controversy between the regulatory agencies and the primary copper, lead and zinc industries. A number of early estimates of capital and operating costs were apparently based on approaches which had little realism in the day-to-day operational aspects of smelters and some of these were apparently arrived at without due consideration of the operational variables inherent in the high temperature and often cyclic operations widely employed in the winning of these metals from their ores. The reasons for the differences between several early estimates were presented earlier in Chapter II.

The availability and limitations of technology to remove pollutants from air and water streams is relatively well known. Of course, the area of sulfur oxide removal has a surfeit of processes, the greatest majority of which are unproven on operational scales such as would be required for these industries. Given the time scale for implementation of pollution abatement plans, industries would have to rely on proven technologies. Hence, the industry has a choice between a small finite set of alternatives which were discussed in Chapter III. The selection of a particular strategy at a smelter would be based on local factors such as present smelter configuration and age, raw materials, energy cost and availability, and by-product or waste stream disposal alternatives.

B. ADL APPROACH AND METHODOLOGY

The basic premise in our approach to estimating the capital investments required for air and water pollution control was to accept the fact that the age and physical condition of many of the plants would require a judicious play-off of capital and operating expenses at each location to meet air and water quality or emission standards at "minimum" expense and disruption of an operating facility. The short timetable for achievement of environmental goals and the unproven nature of some of the SOx recovery and new smelting technology (and an apparent absence of strong economic incentives for a rapid change in the favor of the latter) would mean that in most instances proven add-on pollution control equipment would be utilized. A plant-by-plant approach was used in our analysis since capital investments and operating costs for air and water pollution control are highly dependent on the nature of specific plants and there are only a small number of plants.

Our capital investment estimates were prepared for each plant in the industry taking into consideration the specific plants and tailoring these estimates to an equivalent basis and to the present conditions insofar as possible. For example, we have added $1 to $2 million for in-plant emission control at each smelter. These costs tend to be sensitive to smelter age and layout and might not be representative of actual cost requirements in all cases. In all cases, costs were normalized through the use of the Engineering News Record Construction Cost Index to a value of 1675 (1913 = 100; i.e. approximately the first quarter of 1972) for all capital investments. In general, the individual costs reported should be considered to be of the "pre-engineering" type (i.e. prepared by using scaling factors and without detailed material or energy balances) and would at best be within ± 30% of the actual costs that might be incurred if the same abatement philosophy is adhered to. All costs are shown as the total capital investment required. The operating costs reflect the full impact of the pollution abatement technology after it has been installed and is operating normally. As mentioned later in Chapter XII, we expect a shortage of construction labor in areas such as Arizona and our costs have not been adjusted to reflect this scarcity.

As a result of industry cooperation, we were able to obtain a breakdown of costs in most instances through personal interviews and/or telephone conversations. Based on this, we were able to establish the source of the cost estimates, i.e., company engineering departments, quotations from vendors, or proposals from architect-engineering-construction firms. When new process additions were part of a company's estimate of the costs of attaining compliance with pollution control laws, we were able to establish if these additions would have any significant effect on operational capacities and to determine if alternate routes had been considered. In this way, we developed a common data base which permitted us to make judgmental decisions as to the probable range of capital expenditure requirements. Thus, the cost estimation procedure was based on the following sources of information:

1. Information from the industry.
2. Systems Study for Control of Emissions: Primary Non-Ferrous Smelting Industry - Arthur G. McKee and Company, PB 184 884-6, June, 1969.
3. Control of Sulfur Oxide Emissions in Copper, Lead and Zinc Smelting - Bureau of Mines Information Circular 8527, 1971.
4. The Impact of Air Pollution Abatement on the Copper Industry - An Engineering-Economic Analysis Related to Sulfur Oxide Recovery. Fluor Utah Engineers and Constructions, Inc. for the Kennecott Copper Corporation, 20 April 1971.
5. Study of Technical and Cost Information for Gas Cleaning Equipment in the Lime and Secondary Non-Ferrous Metallurgical Industries by the Industrial Gas Cleaning Institute - 1970.
6. Particulate Control Technology in Primary Non-Ferrous Smelters - A. P. Konopka, American Institute of Chemical Engineering, September, 1970.

7. Water Pollution Control in the Non-Ferrous Metal Industry, Volume I, Copper, Zinc and Lead Industires. Battelle Memorial Institute, Prepared for the Environmental Protection Agency, September, 1971. EPA Contract No. 14-12-870.

8. Industrial Waste Study of the Basic Non-Ferrous Metal Industries; Part III: The Lead and Zinc Industries. Unpublished report to the Environmental Protection Agency by Gurnham and Associates, Inc., December, 1971.

9. Cost of Conventional and Advanced Technology of Wastewater Treatment, Robert Smith, Cincinnati Water Research Laboratory, Environmental Protection Agency, July, 1968.

10. The Economics of Clean Water, Volume III, Inorganic Chemical Industries Profile, March, 1970.

11. Wastewater Treatment Technology, State of Illinois - Institute for Environmental Quality, PB-204-521, August, 1971.

12. A Manual of Electrostatic Precipitator Technology, Part II - Application Areas - PB 196-381.

13. User's Manual Automated Procedures for Estimating Control Costs and Emission Reductions for Specified Air Pollution Sources - PB 198-779.

14. Process Costs and Economics of Pyrites Coal Beneficiation, Report to Department of Health, Education and Welfare, Jan., 1968, Arthur D. Little, Inc.

15. Treatment-Cost Relationships for Industrial Waste Treatment - Barnard & Eckenfelder, Technical Report No. 13, Environmental and Water Resources, Vanderbilt University 1971.

16. Cost of Wastewater Treatment Processes - Report No. TWRC-6, Robert A. Taft Research Center - 1960.

17. Advanced Wastewater Treatment - Culp & Culp. Van Nostrand.

18. Plant Design and Economics for Chemical Engineers, Peters & Timmerhaus - McGraw-Hill Book Company.

19. Chemical Engineering Costs - Dryden & Furlow - Ohio State University.

20. Sulphur: A Hidden Asset in Smelter Gases. E/MJ August, 1970.

21. Sulfur Dioxide and Sulfur from Fluosolids Systems - Groves & Heath, AIME Annual Meeting, February 21, 1967.

22. Copper Smelting - Current Practices & Future Developments - Foard & Beck. AIME Annual Meeting 1971.

23. Recovery of Copper from Converter Slags by Flotation, USBM, Report of Investigations 7562 (Revised) 1972.

24. Arthur D. Little, Inc. Files on Specific Process and Pollution Control System Experience.

The sources cited above were used for cost estimation in the following subject categories:

- Roasters	1, 14, 21, 22, 24
- Reverbs	1, 22, 24
- Converters	1, 22, 24
- Converter gas collection	1, 4, 24
- Flues	1, 24
- Slag flotation	23, 24
- Gas cooling & gas cleaning	1, 2, 4, 5, 6, 12, 13, 21, 22, 24
- DMA scrubbing	1, 4, 24
- Lime/limestone scrubbing	4
- Stacks	4, 22
- Field monitoring equipment	1, 24
- Acid plants	1, 2, 4, 14, 21, 24
- Elemental sulfur reduction	1, 2, 24
- Water pollution control	7, 8, 9, 10, 11, 15, 16, 17

The overall cost estimating procedure was as follows:

- Industry costs were verified by comparison with ADL estimates based on the sources listed above. The McKee report(2) was used for information on mass-flow rates and off-gas volumes for the ADL estimates. If the discrepancy between ADL estimates and industry estimates was less than ± 20%, the industry estimates were used.

- If the discrepancy between industry and ADL estimates was greater than ± 20% and could not be resolved, the ADL estimate was used.

- ADL estimates were used when industry estimates were unavailable.

C. CAPITAL & OPERATING COSTS

The technical literature* contains detailed descriptions of the announced plans of the individual companies. In several cases, the company plans are not finalized and because of this the plans of individual companies are not presented here.

*Engineering and Mining Journal, July, 1971, p. 61-71.
Metals Week, June 21, 1971, p. 16-26.

The capital costs of air pollution abatement for the 13 western smelters are shown in Table X-1. The Michigan smelter was not considered since it already meets Federal ambient primary and secondary standards and the Cities Service smelter in Tennessee was not considered because the plant is undergoing extensive modernization and will presumably meet all anticipated requirements after the modernization is completed. Furthermore, copper production is only a small portion of their overall operation.

A major issue in the copper industry is the question of meeting either Federal ambient standards or state emission standards in addition, such as the recovery of 90% of all sulfur entering the smelter. Consequently, the costs reported in Table X-1 are in three categories - Federal Ambient, "Local" and 90% Sulfur Recovery. The technology selected for meeting each standard is shown via footnotes.

Technologies for dilution of SOx discharges were included where appropriate as a means of meeting ambient standards. The "Local" emission standards were based on State Implementation Plans which had been submitted to the EPA. The costs developed under this "local" case have been used for the financial analysis in Chapters XII and XIII. These assumed "local" emission standards (which would apply in addition to ambient standards and dictate the pollution control strategy) are as follows:

State	Assumed % Sulfur Recovery for "Local" Case
Arizona[1]	90
Idaho	0*
Missouri	0*
Montana	90
Nevada	60
New Mexico	60
Oklahoma	0*
Pennsylvania	0*
Texas	43
Utah	0*
Washington (Puget Sound)	90

*Zero denotes Federal Ambient Standard is more stringent than local emission standard, or no local emission standard.

The final column is an estimate of capital costs for the uniform 90% sulfur recovery standard. These costs are presented for comparison purposes only and the economic impact analysis considers only those costs listed as "local". In states requiring 90% sulfur recovery, the "local" cost is,

[1] Subsequent to the writing of this report, Arizona regulations were amended so that 90% sulfur recovery was not required by the State regulations. These new regulations have not been approved by EPA.

TABLE X-1

ESTIMATED CAPITAL INVESTMENT NECESSARY TO ADAPT EXISTING COPPER SMELTERS FOR AIR POLLUTION ABATEMENT

(millions of $)

	For Federal Ambient Standards		Total Cost with Emission Standards in Addition		
	Cost	Approximate[1] % S Recovery	"Local"[2,3]	90% S Recovery	
1.	27	90	27	27	
2.	13[4]	0	-	74	(Plant will close)
3.	82	55	85	122	
4.	45	55	90	90	
5.	36	65	46	46	
6.	30	60	45	45	
7.	15	90	15	15	
8.	23	60	23	35	
9.	24	60	24	36	
10.	45	70	45	78	
11.	20	55	20	33	
12.	17	55	50	70	
13.	16	55	52	52	
Total Capital Investment	393		522	723	

[1]Actual recovery might vary ± 15% from the number shown.

[2]In states with 90% control, local includes alternate technology.

[3]Local costs have been considered as the base case in evaluating the economic impact. "Local" assumes 90% sulfur recovery in Arizona, Montana and Washington.

[4]Plant output will decrease significantly.

SOURCE: ADL Estimates

TABLE X-1 (Cont'd)

ASSUMED TECHNOLOGY FOR EACH PLANT

PLANT NO.

1. Dust collection, precipitators, DMA and acid plant
2. Ambient: Roaster, reverb, converter gas handling and gas cleaning, field monitoring equipment.
   90%: Company estimate.
3. Ambient: Reverb modernization (1), converter aisle changes, gas handling and gas cleaning, acid plants.
   Local: Roasters, converter aisle changes, gas handling and gas cleaning, acid plants, slag flotation.
   90% Sulfur Recovery: Closed-in reverbs, waste-heat boilers, gas handling and cleaning, acid plants.
4. Ambient: Converter gas handling, gas cleaning, dust collection, acid plant.
   Local: Roasting, electric furnace, converter gas handling, gas cleaning, dust collection, acid plants.
5. Ambient: Converter gas handling, gas cleaning, dust collection, acid plant, neutralization.
   Local: Converter gas handling, gas cleaning, dust collection, acid plant, neutralization, limestone scrubbing.
6. Ambient: Converters, converter gas handling, gas cleaning, dust collection, acid plant.
   Local: Electric furnace, converters, converter gas handling, gas cleaning, dust collection, acid plant.
7. Ambient: Converter gas handling, gas cleaning, dust collection, slag flotation, acid plant expansion, monitoring equipment.
8. Ambient: Converter gas handling, gas cleaning, dust collection, acid plant, neutralization, monitoring equipment.
   90%: Ambient plus lime/limestone scrubbers.
9. Ambient: Converter gas handling, gas cleaning, dust collection, acid plant, tall stack, monitoring equipment.
   90%: Ambient plus lime/limestone scrubbers.
10. Ambient: Roasters, converter gas handling, gas cleaning, monitoring equipment.
    90%: Roasters, dryer, new furnace (1), converter gas handling, gas cleaning, dust collection, slag flotation, monitoring equipment.
11. Ambient: Converter gas handling, gas cleaning, dust collection, acid plant, monitoring equipment.
    90%: Ambient plus acid plant expansion, lime/limestone scrubbing.
12. Ambient: Converter gas handling, gas cleaning, dust collection, acid plant, monitoring equipment.
    Local: Ambient plus roasters, acid plant expansion, slag flotation, furnace modernization.
    90%: Ambient plus closed-in furnaces, DMA scrubbers, SO_2 plant, elemental sulfur plant.
13. Ambient: Converter gas handling, gas cleaning, DMA scrubbing, liquid SO_2 plant, monitoring equipment.
    Local: Ambient plus closed-in reverb, gas cleaning, DMA scrubbing, SO_2 plant, elemental sulfur plant.

in some cases, based on the selection of alternate technology. Emission standards requiring sulfur recoveries above 90% were not considered.[1]

Particulate control standards considered were those that would require recovery of particulates of over 99.8% of the throughput (Federal Register, 36-158, August 14, 1971, p. 15495-6). (This standard affects only those smelters with old Cottrells on their reverb offgases when these gases are vented directly via the stack.)

Estimated yearly direct operating and maintenance expenses (exclusive of amortization and debt service charges), are shown in Table X-2. In preparing these estimates, we made allowance for maintenance as a function of capital investment varying this according to the severity of the operations. Based on a survey of sulfuric acid markets (presented in Chapter XI) it appears that there will be surplus acid available which would have to be disposed of by sales to distant customers, limestone neutralization or oxide ore leaching - its equivalent from an acid disposal viewpoint. We have assumed a uniform negative netback of $4 per ton of surplus acid.

Although air pollution abatement costs predominate in the copper industry, investments in water pollution control will be required in mines, smelters and refineries.

The water pollution standards were assumed to be those based on the removal of suspended solids by settling and permitting a level of residual heavy metal concentrations in discharge streams that might be obtained after heavy metal ion removal as the hydroxides. Filtration systems for removal of suspended solids were not considered.[2]

In general, the mines and smelters have excellent water management programs because these are largely located in arid regions where such practices are mandatory. On the other hand, refineries are often located in water-plentiful regions and have not incorporated such good water management programs. Our estimates for water pollution control are based on very little data from the industry since, except in a few isolated instances, the paramount problem in capital and operating costs lies in air pollution and most of their internal work has been concentrated in that area. The results of our estimates are shown in Table X-3 and X-4. It is seen that the investments in water pollution are an order of magnitude less than for air pollution control.

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[1] The July 27, 1972, standards require over 90% sulfur recovery at three copper smelters.

[2] It appears that this technique might not be adequate to meet the latest guidelines from Federal and state agencies in all instances.

TABLE X-2

ESTIMATED DIRECT OPERATING & MAINTENANCE COSTS

AT EXISTING COPPER SMELTERS FOR AIR POLLUTION ABATEMENT*

Plant Number	Millions of Dollars/Year For Federal Ambient Standards	Total Costs with Emission Standards in Addition: Local	Total Costs with Emission Standards in Addition: 90%S Rec.
1	1.6	1.6	1.6
2	0.4	-	- (Plant will close)
3	2.7	5.1	7.3
4	3.2	7.6	7.6
5	3.9	5.0	5.0
6	2.2	2.7	2.7
7	1.2	1.2	1.2
8	1.9	1.9	2.8
9	1.6	1.6	2.4
10	2.2	2.2	2.9
11	2.4	2.4	3.6
12	2.3	3.6	6.1
13	0.9	5.7	5.7
Total	26.9	40.6	48.9

SOURCE: ADL Estimates

*No indirects, amortization or debt service charges

TABLE X-3

ESTIMATED INVESTMENT COSTS FOR WATER POLLUTION CONTROL*

IN THE COPPER INDUSTRY

Company Number	Millions of Dollars
1.	3.0
2.	10.0
3.	0.5
4.	3.0
5.	4.0
6.	5.5
7.	4.0
8.	0.5
Total	30.5

*The technology selected might not be adequate to meet latest Federal and state guidelines in all cases.

TABLE X-4

ESTIMATED DIRECT OPERATING COSTS FOR WATER POLLUTION CONTROL*

IN THE COPPER INDUSTRY

Company Number	Millions of Dollars/Year
1.	1.50
2.	1.00
3.	0.05
4.	0.50
5.	0.50
6.	0.75
7.	0.50
8.	0.05
Total	4.85

*No indirects, amortization or debt service charges.

XI. PROBABLE PRICES FOR SMELTER DERIVED SULFURIC ACID*

Sulfuric acid is one of the largest volume chemicals produced and consumed in the United States. Thus, at first glance, it would appear that there would be ample market for acid produced from smelter gases. However, sulfuric acid is a fairly low valued product selling at prices as low as $10-20 per ton delivered. Major consumers attempt to maintain nearby supplies so as to avoid freight costs. Sulfuric acid production centers are usually placed adjacent to major consuming points. Very few of the smelters have large sulfuric acid markets nearby, and therefore, they will have to ship sulfuric acid great distances. It is likely that in many instances the freight bill will equal or exceed the delivered price of the product to the ultimate customer.

The following analysis provides estimates as to where the Western smelters will be able to find markets, at what price acid must be delivered to the markets, and what resulting netback price (price f.o.b. smelter) will be necessary to sell all of the acid produced.

A. ACID CAPACITY FROM SMELTING

Our projections of excess or uncommitted capacity by smelter in 1976 are presented on Table XI-1. These figures are less than total installed smelter acid capacity by the amounts of acid which the smelters believe they can use or sell for leaching or to serve local markets. Some companies were not certain how much acid could be disposed of easily, and so the total estimates presented on Table XI-1 are our estimates of the most likely excess acid available. It is possible that somewhat less as well as considerably more acid could be available from these and other smelters.

Given these approximations, we estimate that something over 2.5 million tons per year of sulfuric acid (100% basis) will be available for sale other than for leaching and some small local market use. Of this, 1.6 million tons, or more than 60% will be from smelters in southern Arizona, New Mexico and West Texas.

B. MARKETS FOR ACID

The total non-leaching market for sulfuric acid west of the Mississippi in 1976 should be about 10.6 million short tons. Acid markets by region and source are presented on Table XI-2. Of the total, about 3.3 million tons will be regenerated acid, which market is unavailable to other

* This chapter is identical in the copper, lead and zinc reports.

TABLE XI-1

UNCOMMITTED SULFURIC ACID CAPACITY - 1976

Locations	TPD ACID	Thousand Tons of 100% Acid Per Year (350 Day Basis)
Morenci, Arizona	2400	840
San Manuel, Arizona	800	280
Hurley, New Mexico	380	133
Garfield, Utah	500 ?	175 ?
Hayden, Arizona	750	262
Tacoma, Washington	150	53
Kellogg, Idaho	307	108
Anaconda, Montana	1700	595
East Helena, Montana	350	122
El Paso, Texas	300	105
TOTAL	7637	2573

SOURCE: ADL Estimates

TABLE XI-2

PROJECTED MARKETS FOR SULFURIC ACID - 1976 (EXCLUDING LEACHING)

(Millions of Short Tons)

	SOURCE			
	Elemental	Smelter	Regenerated	Total
PACIFIC COAST	1.1	0.2	0.9	2.2
MOUNTAIN STATES	0.7	0.9*	-	1.6
TEXAS & LOUISIANA	2.6	0.2	2.4	5.2
ALL OTHER WEST OF MISSISSIPPI RIVER	1.4	0.2	-	1.6
TOTAL	5.8	1.5	3.3	10.6

*2.5 available

SOURCE: ADL Estimates

suppliers. Petroleum refiners use sulfuric acid in their processing and return the spent acid or sludge to nearby sulfuric acid plants for regeneration. This is a closed loop, requiring only small amounts of makeup sulfur. If new acid were to be used instead, this would generate significant disposal problems for the acid sludge which is now being recycled.

This leaves 7.3 million tons in 1976 to be provided by sulfuric acid produced either from elemental sulfur or from by-product SO_2. Except for the mountain states, we estimate that this amount of sulfuric acid will be available from smelters and by subtraction, we have determined that amount of sulfuric acid which would be supplied using elemental sulfur as a raw material. We do not expect recovered acid from power plant stack gas cleanup to be significant before 1980. In these other regions, the by-product smelter acid will be small enough in volume and close enough to markets that it will be able to find markets in preference to that produced from elemental sulfur.

This situation does not occur in the mountain states. The major consumption of sulfuric acid other than for leaching is in southern Idaho and northern Utah while the major uncommitted production will be in southern Arizona and New Mexico. There are no rail linkages between these areas and to get from the producing area to Pocatello, Idaho would require moving by rail to El Paso, north to Cheyenne, Wyoming, and then west to Pocatello, Idaho on three separate railroads, a distance of some 1370 miles which would cost on the order of $25 per ton. The other alternative would be to ship west to Los Angeles and then north to Pocatello via Salt Lake City, a distance of some 1680 miles. Thus, it seems evident that while the Mountain States could in total absorb nearly all of the available smelter acid, in reality the material will have to move out of the area to southern California and perhaps as far east as Houston. This means that in order to move into these areas it will be necessary to compete directly with producers of sulfuric acid from elemental sulfur in California and in Texas.

C. PROBABLE MARKET PRICES

If it were possible to sell sulfuric acid in relatively small quantities compared to the size of that market, it would be possible to obtain delivered prices approximately equaling normal prices. However, in most cases, markets will not be large enough to easily absorb this new acid supply. This will mean that in order to supply acid to most markets it will be necessary to take significant markets away from existing producers of sulfuric acid. In order to maintain these markets, the existing sulfuric acid producers will reduce their prices as necessary down to the point where it no longer pays them to keep a plant operating. This point would be reached when their revenues no longer exceed their out-of-pocket costs. Out-of-pocket costs are largely the cost of sulfur itself. Thus, the price at which these plants will stop producing is approximately the price of sulfur times 0.336 (which is the number of tons of sulfur per ton of sulfuric acid produced) plus about 50¢ to $1.00 per ton.

There is even a further price reduction possibility which could be brought about by the sulfur producers. If it appears that a number of sulfuric acid plants will be closed or will have significant production cutback, this will reduce the market for sulfur. It may then be in the best interest of the sulfur producers to reduce the price of sulfur in order to allow their customers to stay in business. It is not simple to determine how low sulfur prices are likely to go under such circumstances. For instance, it may be preferable for the sulfur producers not to lower their prices at all because by lowering prices to benefit the Gulf Coast sulfuric acid producers, for example, they may have to lower their prices to all customers. In such a circumstance it may be preferable to lose a part of the Gulf Coast market rather than lower the price to all customers. Furthermore, there is much greater variability in the cost of producing sulfur between the various producers than there is in cost of manufacturing sulfuric acid among the various producers. While some sulfur producers cannot make a profit at $15 per ton of sulfur, others can at less than $10 per ton.

We have presented two cases of potential sulfuric acid prices based on two different estimates of sulfur price. In 1971, the average sulfur price f.o.b. Gulf Coast was about $18 per long ton or $16 per short ton. The cost to deliver this material to consumers on the Gulf Coast varies but assuming an average of $2 per short ton, would have resulted in a price to consumers of $18 per short ton on the Gulf Coast in 1971. While this is the lowest that prices have been in many years, the apparent long-term oversupply in sulfur would indicate that there is very little potential for prices to rise while there is still potential for prices to fall still further. We have selected a range of $15 to $20 per short ton delivered on the Gulf Coast which appears as a reasonable long-term range for prices.

Sulfur prices on the West Coast have even greater flexibility than those on the Gulf Coast. Sulfur production on the West Coast is from desulfurization of crude oil and it is necessary for the petroleum companies on the West Coast to get rid of sulfur stockpiles at any price. As the price continues downward, however, it will reach a level where it is advantageous to export sulfur. We have selected a minimum price on the West Coast of $5 lower than that in Houston to reflect the likely lower export price on the West Coast. Sulfur exports from the West Coast go both to Asia and to Europe. The very large overcapacity in Alberta which is being exported through the port of Vancouver, assures that not all of the sulfur can be exported to the more lucrative Asian market and that some would have to be diverted to the less attractive European market in competition with Gulf Coast sulfur. Prices in Pocatello, Idaho, Kansas City, and northern New Mexico tend to be influenced by those in Alberta, California, and the Gulf Coast. We have assumed that they will continue to maintain their present relationships to these other basing points.

Using these sulfur prices, we estimated the f.o.b. price necessary to achieve a 20% pre-tax return on the sulfuric acid facilities to cover general and selling expenses, profits and income taxes. This should be the approximate acceptable price for sulfuric acid f.o.b. plant. Once again, freight from the plant to the customer varies widely, but in most large producing centers is quite small. Many plants produce acid for captive uses and the transfer is made by pipeline. In other cases short truck hauls are required, and some acid is hauled further distance. We have applied an average freight of $2 per ton of acid except in Pocatello, Idaho where nearly all of the acid produced is transferred within the plant complex.

The minimum or marginal price which can be tolerated by a sulfuric acid producer before he will shut his plant down partially or completely would be his variable costs which are equivalent to approximately his cost for sulfur, utilities, that labor which can be dispensed with, and freight. These prices as presented on Tables XI-3 and XI-4 are on the order of $4 per ton less than what he would consider to be an adequate price.

D. TRANSPORTATION COSTS

Accurate rail costs are not really obtainable on large volume shipments except through negotiation. Standardized rates are based on occasional car shipments and while available would likely be considerably higher than those which could be achieved assuming large volume shipments and negotiated rates. We have looked at a few isolated rates of large-scale movement and determined that over short distances, sulfuric acid in large volumes moves for from 2¢ to 3¢ per ton mile while over longer distances it moves at from 1.7¢ to 2¢ per ton mile. Using these rough averages, we have estimated rail rates from each of the potential producing points to some likely destinations on Table XI-5.

E. PROBABLE NETBACK PRICES

Using the approximate freight rates developed on Table XI-5 and delivered prices either to meet the likely market or marginal costs of existing sulfuric acid producers under two different assumptions of sulfur price, we have derived the estimated netback prices to reach several markets from each of the possible origins of by-product acid. This analysis is presented on Tables XI-6 and XI-7. It can be seen that in most cases netback prices will be negative no matter what assumptions are made as to sulfur price, or whether the acid will be sold at prices reflecting full profitability to existing acid producers

TABLE XI-3

SULFURIC ACID PRICES (Delivered) - 1976

LOW SULFUR PRICES

	HOUSTON	WEST COAST	POCATELLO IDAHO	KANSAS CITY	NORTHERN NEW MEXICO
Sulfur Prices $/ST. Dlvd.	15	10[a]	15	23	20
Variable Costs	5.55	3.85	5.55	8.25	7.20
Fixed Costs	1.50	1.50	1.50	1.50	1.50
Total Costs	7.05	5.35	7.05	9.75	8.70
20% Return	2.40	2.40	2.40	2.40	2.40
F.O.B. Price	9.45	7.75	9.45	12.15	11.10
Freight	2.00	2.00	-	2.00	2.00
Delivered Price	11.45	9.75	9.45	14.15	13.10
Delivered Price to Close Plants Based on Sulfur[b] ($/S.T.)	7.55	5.85	5.55	10.25	9.20

[a] By-product of petroleum refining, value based on its alternate value for export.
[b] Variable cost plus freight

SOURCE: ADL Estimates

TABLE XI-4

SULFURIC ACID PRICES (Delivered) - 1976

HIGH SULFUR PRICES

	HOUSTON	WEST COAST	POCATELLO IDAHO	KANSAS CITY	NORTHERN NEW MEXICO
Sulfur Price $/ST Dlvd.	20	15[a]	20	28	25
Variable Cost	7.20	5.55	7.20	9.90	8.90
Fixed Costs	1.50	1.50	1.50	1.50	1.50
Total Costs	8.70	7.05	8.70	11.40	10.40
20% Return	2.40	2.40	2.40	2.40	2.40
F.O.B. Price	11.10	9.45	11.10	13.80	12.80
Freight	2.00	2.00	-	2.00	2.00
Delivered Price	13.10	11.45	11.10	15.80	14.80
Delivered Price to Close Plants Based on Sulfur[b] ($/S.T.)	9.20	7.55	7.20	11.90	10.90

[a] By product of petroleum refining. Value based on its alternate value for export.
[b] Variable cost plus freight.

SOURCE: ADL Estimates

TABLE XI-5

ESTIMATED RAIL COSTS FOR SULFURIC ACID

ORIGIN	DESTINATION	APPROXIMATE RAIL MILEAGE	RATE ¢/T mile	COST $/Ton
Hurley, New Mexico	Grants, New Mexico	250	2.0	5.00
	Houston, Texas	950	1.8	17.10
Morenci, Arizona	Los Angeles, Calif.	735	1.8	13.25
	Pocatello, Idaho	1370	1.8	24.50
	Houston, Texas	1040	1.8	18.70
	Grants, New Mexico	400	1.8	7.20
San Manuel, Arizona	Los Angeles, Calif.	700	1.8	12.60
	Houston, Texas	1270	1.8	22.85
Hayden, Arizona	Los Angeles, Calif.	670	1.8	12.10
	Houston, Texas	1240	1.8	22.30
Garfield, Utah	Kansas City	1250	1.8	22.50
	Pocatello, Idaho	183	2.2	4.05
	San Francisco, Calif.	790	1.8	14.20
Kellogg, Idaho	Pocatello, Idaho	527	1.8	9.50
	Kansas City	1495	1.8	26.90
	Seattle, Washington	405	1.8	7.30
Anaconda, Montana*	Pocatello, Idaho	300	2.0	6.00
	Seattle, Washington	660	1.8	11.90
	Kansas City	1360	1.8	24.50
East Helena, Montana*	Pocatello, Idaho	340	1.8	6.10
	Seattle, Washington	670	1.8	12.00
	Kansas City	1330	1.8	24.00
El Paso, Texas	Grants, New Mexico	300	2.0	6.00
	Houston, Texas	810	1.8	14.60

*Because the freight cost is about the same for these two locations, an average rail cost has been used for Montana.

SOURCE: ADL Estimates

TABLE XI-6

ESTIMATED NETBACK PRICES - 1976
Assuming $15/ST Sulfur on Gulf Coast
($ per short ton)

ORIGIN	DESTINATION	FREIGHT	DELIVERED PRICE MARKET	DELIVERED PRICE MARGINAL	F.O.B. PRICE TO MEET MARKET	F.O.B. PRICE TO MEET MARGINAL
Hurley, New Mexico	Grants, New Mexico	5.00	13.10	9.20	8.10	4.20
	Houston, Texas	17.10	11.45	7.55	(5.65)	(9.55)
Morenci, Arizona	Los Angeles, Calif.	13.25	9.75	5.85	(3.50)	(7.40)
	Pocatello, Idaho	24.60	9.45	5.55	(15.15)	(19.05)
	Houston, Texas	18.70	11.45	7.55	(7.25)	(11.15)
	Grants, New Mexico	7.20	13.10	9.20	5.90	2.00
San Manuel, Arizona	Los Angeles, Calif.	12.60	9.75	5.85	(2.85)	(6.75)
	Houston, Texas	22.85	11.45	7.55	(11.40)	(15.30)
Hayden, Arizona	Los Angeles, Calif.	12.10	9.75	5.85	(2.35)	(6.25)
	Houston, Texas	22.30	11.45	7.55	(10.85)	(14.75)
Garfield, Utah	Kansas City	22.50	14.15	10.25	(8.35)	(12.25)
	Pocatello, Idaho	4.05	9.45	5.55	5.40	1.50
	San Francisco, Calif.	14.20	9.75	5.85	(4.45)	(8.35)
Kellogg, Idaho	Pocatello, Idaho	9.50	9.45	5.55	(0.50)	(3.95)
	Kansas City	26.90	14.15	10.25	(12.75)	(16.65)
	Seattle, Washington	7.30	9.75	5.85	2.45	(1.45)
Tacoma, Washington	Washington State	2.00	9.75	5.85	7.75	3.85
Montana	Pocatello, Idaho	6.05	9.45	5.55	3.40	(0.50)
	Washington State	11.95	9.75	5.85	(2.20)	(6.10)
	Kansas City	24.25	14.15	10.25	(10.10)	(14.00)
El Paso, Texas	Houston, Texas	14.60	11.45	7.55	(3.15)	(7.05)
	Grants, New Mexico	6.00	13.10	9.20	7.10	3.20

( ) Indicates negative

SOURCE: Tables XI-4 and XI-5

TABLE XI-7

ESTIMATED NETBACK PRICES - 1976
Assuming \$20/ST Sulfur on Gulf Coast
(\$/Short Ton)

ORIGIN	DESTINATION	FREIGHT	DELIVERED PRICE MARKET	DELIVERED PRICE MARGINAL	F.O.B. PRICE TO MEET MARKET	F.O.B. PRICE TO MEET MARGINAL
Hurley, New Mexico	Grants, New Mexico	5.00	14.80	10.90	9.80	5.90
	Houston, Texas	17.10	13.10	9.20	(4.00)	(7.90)
Morenci, Arizona	Los Angeles, Calif.	13.25	11.45	7.55	(1.80)	(5.70)
	Pocatello, Idaho	24.60	11.10	7.20	(13.50)	(17.40)
	Houston, Texas	18.70	13.10	9.20	(5.60)	(9.50)
	Grants, New Mexico	7.20	14.80	10.90	7.60	3.70
San Manuel, Arizona	Los Angeles, Calif.	12.60	11.45	7.55	(1.15)	(5.05)
	Houston, Texas	22.85	13.10	9.20	(9.75)	(13.65)
Hayden, Arizona	Los Angeles, Calif.	12.10	11.45	7.55	(0.65)	(4.55)
	Houston, Texas	22.30	13.10	9.20	(9.20)	(13.10)
Garfield, Utah	Kansas City	22.50	15.80	11.90	(6.70)	(10.60)
	Pocatello, Idaho	4.05	11.10	7.20	7.05	3.15
	San Francisco, Calif.	14.20	11.45	7.55	(2.75)	(6.65)
Kellogg, Idaho	Pocatello, Idaho	9.50	11.10	7.20	1.60	(2.30)
	Kansas City	26.90	15.80	11.90	(11.10)	(15.00)
	Seattle, Washington	7.30	11.45	7.55	4.15	0.25
Tacoma, Washington	Washington State	2.00	11.45	7.55	9.45	5.55
Montana	Pocatello, Idaho	6.05	11.10	7.20	5.05	1.15
	Washington State	11.95	11.45	7.55	(0.50)	(4.40)
	Kansas City	24.25	15.80	11.90	(8.45)	(12.35)
El Paso, Texas	Houston, Texas	14.60	13.10	9.20	(1.50)	(5.40)
	Grants, New Mexico	6.00	14.80	10.90	8.80	4.90

( ) Indicates negative

SOURCE: Tables XI-4 and XI-5

using elemental sulfur or whether prices will tend more to reflect marginal costs. It would of course be to the by-product acid producers' advantage to ship all of his acid to those markets giving him the greatest netback price. However, in many cases, particularly for those producers in southern Arizona and New Mexico, the nearby markets are not nearly sufficient to absorb the amount of acid to be produced. Thus, it will be necessary for them to move to more distant markets such as Houston and Los Angeles in spite of the lower netbacks to be achieved there.

Since the netbacks by shipping to the West Coast will be higher than those for shipping to the Gulf Coast, we have assumed that the southern Arizona and New Mexico producers would emphasize shipment to the West Coast. An approximate distribution of sales by each of the producers is presented on Table XI-8. It can be seen that in order to achieve such a distribution, it will be necessary to take a very large proportion of the West Coast market away from existing acid producers. It will not be possible to do this without forcing the closure of many sulfuric acid plants on the West Coast; and therefore, it will not be possible to do this unless delivered prices are such that an acid producer cannot cover his marginal costs as defined earlier. Even with this enormous shipment to the West Coast it will still probably be necessary to ship some material to the Gulf Coast at substantial losses. Even though shipments to the Gulf Coast are small compared to the total acid available from these producers, it will amount to almost 20% of the total Gulf Coast consumption. We have assumed in the Table that this too will force some of the Gulf Coast producers in a marginal cost situation, although this may be too severe an assumption to make. If instead Gulf Coast sales are possible at more reasonable levels of about $4 higher than we have indicated on Table XI-8, this would result in weighted average netback prices for the Arizona companies of about $1 per ton higher.

It can be seen from the Table that the weighted average netback prices are significantly below zero for most of the smelters. The Garfield, Utah smelter may be able to obtain a positive netback price because of the relatively short rail transport costs to consumers in Geneva, Utah and Pocatello, Idaho. Similarly the Tacoma, Washington and El Paso, Texas producer might be able to dispose of his sulfuric acid in the relatively near vicinity. However, the Tacoma situation is very sensitive to movement of acid out of Montana.

The prices presented on Table XI-8 assume the lower sulfur price of $15 per short ton delivered on the Gulf Coast. If the higher price of $20 per short ton delivered is used, this would represent an increase in the sulfuric acid price of about $1.65 per ton. This would help the smelters, of course, but would still result in negative prices at the plant for most of the producers.

TABLE XI-8

NETBACK CALCULATIONS[1]

SOURCE	ACID AVAILABLE (000T)	DESTINATION: MTN. (000 T)	DESTINATION: W. COAST (000T)	DESTINATION: GULF COAST (000T)	DESTINATION: MIDWEST (000T)	MARGINAL PRICE[1] -- $/ST: MTN.	MARGINAL PRICE[1] -- $/ST: W. COAST	MARGINAL PRICE[1] -- $/ST: GULF COAST	MARGINAL PRICE[1] -- $/ST: WTD. AVERAGE*
Hurley, New Mexico	133	50	83			4.20		(9.55)	(4.40)
Morenci, Arizona	840	150	390	300		3.20	(7.40)	(11.15)	(6.85)
San Manuel, Arizona	280	30	150	100		3.20	(6.75)	(15.30)	(8.70)
Hayden, Arizona	262	30	132	100		3.20	(6.25)	(14.75)	(8.40)
Garfield, Utah	175	175				1.50			1.50
Kellogg, Idaho	108	50	58			(3.95)	(1.45)		(2.60)
Tacoma, Washington	53		53				3.85		3.85
Montana	717	400	47		270	(0.50)	(6.10)	(14.00)[2]	(5.95)
El Paso, Texas	105	40		65		3.20		(7.05)	(3.14)
	2573	965	913	565	270				
TOTAL MKT.		1600	1300	2800	1600				

[1]Assumes the lower sulfur price ($15/ST delivered on the Gulf Coast). If the higher price ($20/ST) is used these prices will be about $1.65 higher.

[2]Midwest shipment.

SOURCE: Tables XI-1, XI-2 and XI-6

XII. DIRECT IMPACT ON THE PRIMARY COPPER INDUSTRY

A. INTRODUCTION

The cost of production of nonferrous metals, as is the case with most natural resource based commodities, can vary over a wide range within the industry. The smelters, presently based on similar operating practice, have similar costs and are essentially "service operations" for transforming the concentrates to the primary metal. The major variations in production cost occur at the mines and mills.

As an illustration of the magnitude of this variation, we include Figure XII-1 which shows out-of-pocket operating costs of 19 uranium mines plotted versus cumulative production of U_3O_8. The mines have been ranked so that the lowest cost mines are on the left. Figures such as this can be read in two ways:

- to find the probable production when the price is fixed by external factors; and
- to determine the costs associated with a certain level of production; for example, when production is to be increased, the price has to rise to at least cover the costs of the highest cost producer.

Cost data for individual mines and mills in the primary copper industry are proprietary and were not available to us directly from the industry and could not be estimated by us in detail within the scope of this study. (Based on our knowledge of the industry, we were able to classify the mines into high, medium and low cost categories, and isolate those mines that would be sensitive to increased operating costs; see Table IV-3). Had these cost data been available for the nonferrous industry, a figure similar to Figure XII-1 would have been obtained. Recently, security analysts have indicated[1] that copper production costs (from mining to primary metal) vary from about 33¢/pound to 50¢/pound for the major copper companies. These reported costs are composites for the major companies and wide variations in production cost can occur at the individual mines operated by a major producer. For example, in the case of Phelps Dodge (the lowest cost producer), the costs are the lowest at Morenci, are somewhat higher and about the same as the average cost at all PD mines at Ajo and Tyrone and by far the highest at Bisbee.

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[1] R. Shorr, "Copper Industry," Dean Witter & Co., Inc., New York (1971)

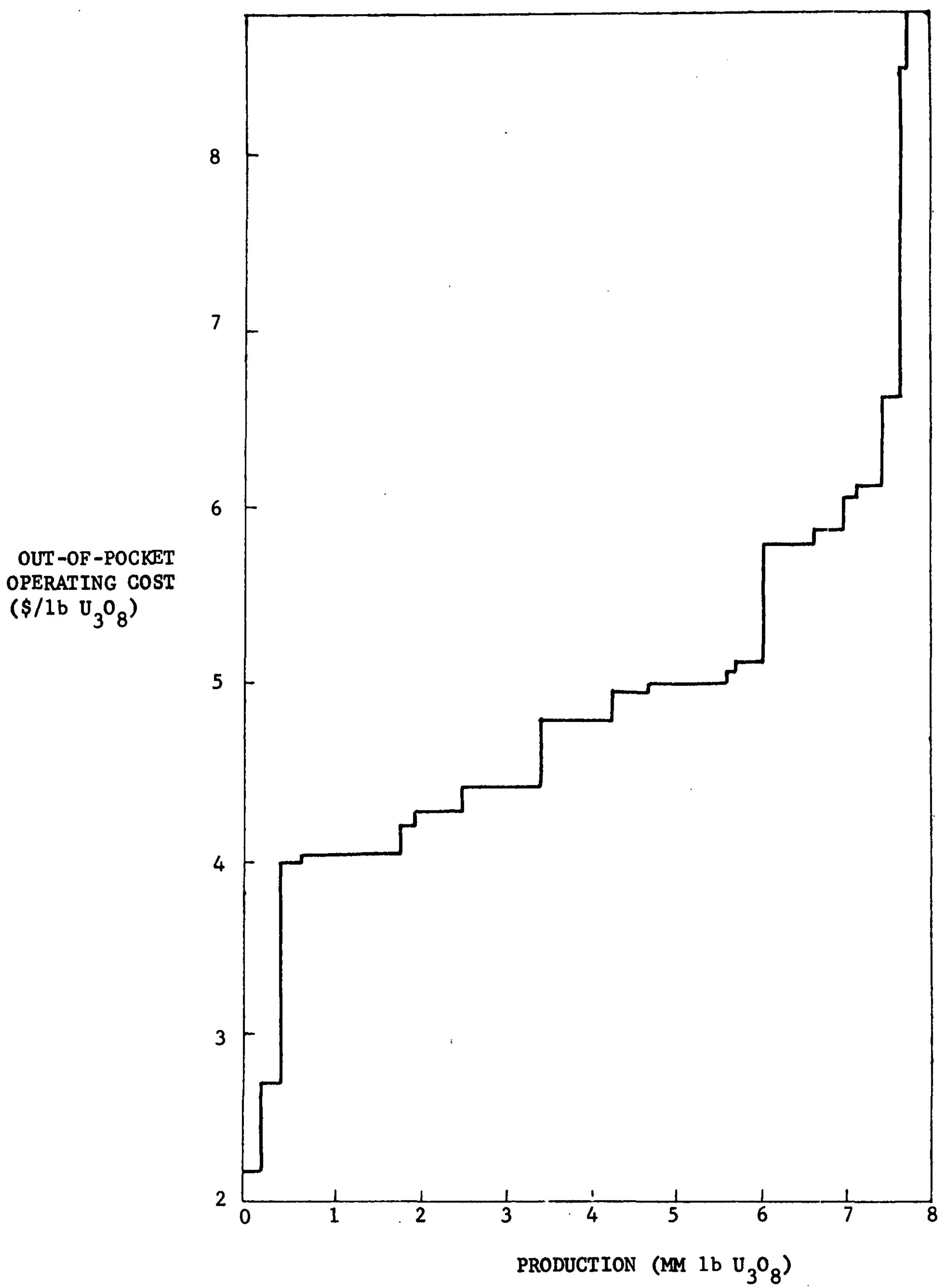

FIGURE XII-1: OUT-OF-POCKET OPERATING COSTS AND PRODUCTION OF 19 UNDERGROUND URANIUM MINES

The industry-wide capital and operating costs for pollution control were presented in Chapter X. It should be noted that only those costs reported for meeting the "local" standard have been used in this chapter. These costs were estimated on a plant-by-plant and company-by-company basis. As might be expected, our estimates show that these costs do not fall equally or "fairly" on all the firms or facilities. The age and condition of existing facilities, vagaries of nature insofar as the richness of an orebody and the kinds and amounts of contained impurities, weather and location factors, determine how hard a particular mine and mill, smelter, refinery or corporate entity will be hit.

A major portion of the cost of pollution control occurs at the smelters. However, as shown in Chapter IV, the smelters are "service operations" and, because of the current structure of the industry, can only reflect back these costs to the mines. When these costs are reflected back to the mines, again a figure similar to Figure X-1 would be obtained and the impact of these costs on the industry would have to be analyzed from two viewpoints: one representing an excess of supply over demand (which would not permit a price increase) and an excess of demand over supply, in which case, a price increase would permit a complete pass on of pollution costs. Copper prices are sensitive to the imbalance between supply and demand and a relatively small difference between these two large numbers (supply and demand) can have a major impact on price. Factors such as accidents, natural catastrophes, rumors of political changes, strikes, large purchases by Eastern Block countries and Red China, and so on, have shifted the supply-demand balance in the past and have had a major impact on the price. Thus, based on past market behavior, we would expect both types of supply-demand imbalance to occur at different times through and beyond 1976 and hence have considered both types of imbalances to be equally likely and have addressed ourselves to the implications of these alternatives in each case. The two cases which we have considered for the impact analysis can be described as:

- Full pass on, i.e., the market price is increased enough to cover the cost experienced by the marginal producer who has the highest overall cost; i.e., lies on the right-hand extreme of a figure such as Figure X-1; and
- Zero pass on, i.e., all pollution abatement costs are absorbed by the primary producers.

Conceptually, the consequences of the <u>full pass-on</u> assumption would be a decrease in consumption (as predicted by long-term elasticity of demand), substitution by other materials (the cross elasticity phenomenon), increased profits for the lower cost producers and a disruption in the traditional trade pattern (imports of primary copper, recently at about 5% of primary consumption, would increase if overseas prices are lower than domestic prices). Also, the increased price would affect the fabricators, the major consumers of primary copper and this impact would have to be analyzed in the context of their ability to absorb or pass on these increased costs.

On a more practical level, the following factors appear to be more significant. Based on information developed in Chapter X, it appears that the full pass on assumption would require the major marginal or high cost copper producer to increase the price by about 4-5¢/lb above present levels. Costs for transporting copper internationally rarely exceed 2¢/lb and adding the current tariff of 0.8¢/lb, a ceiling of about 3¢/lb above the international (LME) price would be established. This ceiling would influence the ability of the domestic producers to fully pass on their costs. This price increase is such that its effects would be of the same order of magnitude as the normal background of supply-consumption irregularities, cyclical variations and long-term growth patterns, though it may be argued that pollution control costs affect the baseline rather than the cyclical variations.

The zero pass-on assumption has numerous consequences and these are discussed in detail in the remainder of this chapter. Basically, because smelting and refining are low profit "cost plus" operations, the pollution abatement costs would be borne mainly by the mines. However, they also affect the smelters, stockholders (via reduced income) and government entities (via reduced tax collections). Under the present tariff situation, minimal impact is felt by the fabricators or other subsequent consumers, since their demand would be fulfilled either from domestic or foreign sources under this assumption.

B. PLANT SHUTDOWN PROBABILITIES

1. Introduction

The closing of any plant is a decision based on a wide variety of factors and includes consideration of factors other than just the incremental cost of pollution control. These decisions include comparisons of the cost of production from a refitted plant versus alternatives such as producing at other domestic or international plants or new locations, purchasing unfinished or semifinished products for down-stream operations or stopping production altogether. Also, increased production costs at mines usually imply a loss of reserves. These decisions have to be made on the basis of anticipated future capital and operating expenses and they are particularly difficult for an outsider to predict because they require access to the company's highly sensitive, direct out-of-pocket cost information and full knowledge of the alternatives open to the company's management.

In the absence of this information for the entire industry, our judgments have to be necessarily qualitative. However, we believe that we have isolated the areas where the maximum impact would occur under the zero pass-on assumption.

2. General Considerations

The increase in the generalized cost of air pollution control with increasing degrees of sulfur recovery at the smelter was discussed earlier in Chapter III. It was indicated that about 83% of the sulfur in the feed could be recovered by utilizing modern roasters, properly hooded converters, proper gas collection systems, and an acid plant utilizing both roaster and converter gases. The costs for recovering higher percentages of sulfur increase rapidly above this level.

The estimated costs of pollution control (presented in Chapter X) for individual smelters were examined to see whether the variations in incremental costs resulted from the age of the smelter, inclusion of extraneous repairs not related to pollution control or from differences in assumed "local" regulations. It was found that the maximum cost increase occurs at smelters when 90% sulfur recovery or more is required. (Because of poor location, one or two smelters might have to approach 90% sulfur recovery to meet Federal ambient standards or utilize production curtailment under adverse weather conditions which could result in a significant reduction in output.) We find that only one Arizona smelter will have low incremental costs. The reason for this is that this particular smelter has been moving in the direction of increasing sulfur recovery for many years and a major portion of the funds necessary for achieving 90% sulfur recovery have already been spent.

The increased costs at the smelter have to be considered in the context of the mine-mill-smelter interrelationship and, generally, this increased cost has to be passed back to the mines since we have assumed zero pass-on to the consumer*. Under these conditions, the general alternatives open to the mine management (of both independent or integrated companies) are:

a. divert concentrates to a smelter offering better netbacks;

b. absorb the increased costs;

c. shut down because the increased costs cannot be absorbed;

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* It should be noted that even if we make the questionable assumption that the smelters forego all profit (estimated at less than 10% of their operating margin) in order to decrease the pass-back to the mines, this does not provide significant relief to the mines -- the pass-back decreases by less than 10% in the case of an "average" smelter and by about 5% in the case of a high (incremental) cost smelter.

d. selectively mine high grade portions of the ore, if possible (this decreases reserves and mine life);

e. significantly increase the capacity to take advantage of the economies of scale.

The mines can also be affected by decisions at the smelter; for example:

f. The shutdown of marginal mines or diversion of concentrates to other smelters can leave a smelter with insufficient feed materials and lead to a smelter shutdown. This, in turn, can result in closing of mines that cannot ship their concentrates to more distant smelters.

g. If mine production is in excess of smelting capacity, mines have to curtail production or shut down because of the absence of a concentrate outlet.

In the period through 1976, we believe that there will be little or no excess smelting capacity; instead there is a strong possibility of a smelter bottleneck (discussed separately). Under these conditions, mine-to-smelter concentrate flows would tend to freeze and alternatives (a), (e) and (f) have a low probability of occurrence.

3. Smelter Closings

Assuming the requirements of 90% sulfur recovery, we believe that the Douglas, Arizona smelter of Phelps Dodge and the Tacoma, Washington smelter of Asarco will be severely affected and might shut down. Although the impact on the remaining smelters will be less severe and is not expected to lead to a smelter shutdown under the present assumption, more stringent standards could have a severe impact on these remaining smelters and the mines supplying them. For example, recent Kennecott testimony in Nevada indicates that any standard requiring over 60% sulfur recovery at the McGill smelter (and therefore requiring other technology in addition to acid manufacture from converter off-gases) would push the mine-smelter complex into a sub-marginal situation and lead to the termination of the Nevada operations.

Douglas is in part a custom smelter but it also smelts material from Phelps Dodge's Bisbee and other mines. (The open pit Bisbee mine is scheduled to close in 1973 due to exhaustion of reserves). Phelps Dodge believes that this smelter could be modified to meet ambient standards (by permanent reduction of sulfur input plus intermittent curtailment of operations), but feels that conversion of the smelter for

SO_2 recovery, as would be required for emission standards, is not justified. Therefore, this smelter would remain open only if an emission standard is not imposed in Arizona.* The imposition of an emission standard in this case would hasten the demise of an old smelter which otherwise has years of available operating life. Phelps Dodge has announced plans for a new smelter in Hidalgo County, New Mexico, which is being sized to meet Phelps Dodge's mine output in Tyrone. Thus, the closing of the Douglas smelter would not affect PD's capability for smelting its own concentrates in the long term but only affect its toll and custom smelting customers (Pima and others) and Phelps Dodge mine expansion plans.

The other smelter in danger of shutdown (again, as a result of emission control regulations) is the Tacoma smelter of Asarco. This decision-making process is complicated by the fact that Asarco as the major custom smelter is dependent on outside sources for smelter feed, cannot participate directly in decisions affecting its supply of concentrates, and has to compete in an international market for them. For example, about 35% of Tacoma's intake of copper in 1970 was imported. Already Asarco cannot compete for certain concentrates out of British Columbia because Japanese smelters offer better netbacks to the Canadian mines. With increased pollution abatement costs **, we expect Asarco to be even less competitive internationally for concentrates, except perhaps the high arsenic concentrates unacceptable to other smelters. Also, because of Tacoma's urban location, some of the lower cost pollution abatement technologies, such as acid production and neutralization or lime/limestone scrubbing, might not be usable because of Tacoma's urban location and possible solid & liquid waste disposal problems.

Based on discussions with Asarco's management, we believe that the decision regarding the Tacoma smelter will not be reached before the end of 1973 and a major factor will be whether or not a 90% emission standard will be imposed in the Puget Sound area.

Tacoma is the only processor of arsenical materials in the U. S. The concentrates or residues from lead, silver and copper producers in the northwest contain arsenic. The economics at these plants are strongly dependent on obtaining a credit for values contained in the arsenical stream and this is presently possible since Tacoma accepts these materials

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* The latest Arizona regulations do not impose such a standard, but the regulation has not been approved by the EPA.

** Asarco is sharing the costs of pollution abatement measures already undertaken with the mines by requiring a "pollution surcharge" of 1-1.5¢/lb of copper accounted for.

(see Table IV-11). Thus Tacoma's arsenic handling capacity is irreplacable and should Tacoma close, an arsenic treatment facility similar to Tacoma's would have to be provided. In general, these arsenical residues contain soluble arsenic compounds and cannot be disposed of except by covered storage such as silos.

If an arsenic treatment facility is not available, a severe impact would be felt by the Montana smelter of Anaconda and a large portion of the northern Idaho mines*. (In the remainder of this discussion, we assume that in the event that Tacoma closes, an alternative arsenic treatment facility will be constructed and will be available to the northwestern producers.)

4. Capacity Impact

As indicated in Chapter V, there appears to be a theoretical surplus of both worldwide and U. S. mine capacity over consumption between the period 1972-1976, and perhaps beyond until 1980. Accidents such as slides, cave-ins, shortages of essentials, unscheduled delays, strikes, etc. can reduce the magnitude of these surpluses and the industry in general has adequate flexibility and maturity in planning so as not to produce substantially excess amounts of metals that cannot be sold readily. Hence, these surpluses reflect the capability for increasing mine production in the short term in response to increased demand. In line with the basic assumption of a 4% real growth in GNP which has been used for this study, we would expect copper consumption to grow at about 3% per year during the same period. During the recent past, production and consumption in the U. S. have been more or less in equilibrium and imports of refined metal contribute a small portion of the domestic consumption of refined metal. If we assume that the volume of imports does not change significantly, the question then becomes one of examining whether the domestic smelting and refining capacity is adequate to process the incremental mine production to fulfill the demand.

We believe that a shortage of smelting capacity in the U. S. would occur if the two smelters -- Douglas and Tacoma -- are closed. This loss in smelting capacity would be for "custom smelting" and the non-integrated mines would suffer a major impact since the new smelter (Phelps Dodge in New Mexico) will primarily treat the output of PD's Tyrone mine. Because

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* It should be noted that the high silver copper concentrates containing arsenic and antimony from several northern Idaho mines are smelted at Asarco's East Helena lead smelter in order to prevent problems caused by high silver concentrations during electrorefining of copper. By treating these concentrates in the lead smelter, silver is retained at East Helena while the copper arsenide-antimonides and sulfides (speiss and matte) are transferred to Tacoma. Thus the East Helena lead smelter is also part of the link between northern Idaho miners and Tacoma.

of this potential shortage, the non-integrated mines have recently proposed to form a consortium to consider the building of a new smelter. Except for the PD smelter, we do not expect serious consideration of other smelter construction plans until after all uncertainties relating to Douglas and Tacoma have been resolved.

It should be noted that acid leaching of oxide ores, waste dumps or tailings might substantially increase the domestic production of primary copper. This would tend to maintain the equilibrium or narrow the gap between the demand and domestic production. However, this would not directly solve the problem confronting the independent mines--finding a smelter for treating their sulfide concentrates. On the other hand, if the increased production of copper from oxide ore leaching (with surplus acid) by the major producers is able to satisfy all the increased demand, the independent mines might be forced into a marginal situation. In the absence of detailed data on leachable ore reserves or information on plans for exploiting these reserves, the possible increase in domestic copper production from this source cannot be estimated.

In recent years, the export of concentrates (and the accompanying pollution) to foreign smelters and reimport of primary copper has been proposed as a solution to domestic environmental problems. The implications of this suggestion are discussed in the next section.

5. Mine Impact

As mentioned under "General Considerations," when the lack of excess smelter capacity freezes mine-to-smelter concentrate flow patterns, an impact can occur on a mine from two general causes: pass-back of increased smelter costs, and absence of concentrate outlets.

The economic impact on the mines was evaluated by utilizing the mine and mill costs estimated by us on the basis of published information (Table IV-3) and by reflecting back the pollution abatement cost at each smelter using the flow pattern of concentrates between mines and smelters shown in Table IV-5. This, of course, assumes that the flow of concentrates between the mines and smelters will not change.

We believe that the mines of Duval Corporation (who ship their concentrates to Asarco) and of the Anaconda Company will suffer a large impact. This impact arises primarily from the fact that the concentrates produced by these mines would be treated at smelters with higher-than-average incremental pollution control costs because these smelters would have to recover 90% of the sulfur under the basic assumptions, and because the mines are medium to high cost mines. We believe that these increased costs alone will not be severe enough to cause mine closings. The other mine is the Ruth, Nevada mine of Kennecott that can suffer a potentially severe impact if more stringent standards are imposed in Nevada.

There are many small mines that might also be affected but nothing is known about their operating costs or operating margins. Data from the Census Bureau indicate that these mines produce less than five percent of the domestic mine output of copper and employ less than five percent of the total employment in copper mining. Thus even if this segment were eliminated completely, the impact on mine production or total industry employment will not be severe.

We believe that the proposal for large-scale export of concentrates (and pollution) abroad is not realistic over the short term for several reasons. The only country with a reservoir of excess smelting capacity at the present time is Japan, the excess capacity being a result of decreased copper consumption from a slowdown in Japan's industrial activity. In the past, the Japanese smelters have been able to offer better terms for concentrates because of lower labor costs and because they obtained positive netbacks from acid sales. The latter is no longer true. Also, the Japanese smelters are faced with pollution regulations as stringent as the United States and would be reluctant to import pollution above and beyond what is unavoidable in obtaining copper for its internal use. The expansion of Japanese smelting capacity has been undertaken as a means of assuring the supply of copper for their domestic fabricating industry. A significant amount of new mine capacity in the world results from tie-ins or long-term contracts with Japan and these projects would have priority over U. S. concentrates for toll smelting. Thus, we believe that it will be easy to sell concentrates to Japan when their domestic demand is high and reimport semifinished or finished, high value-added products but that Japanese smelters will undertake only a minimal amount of toll smelting (i.e., returning significant quantities of lower value-added primary metal).

The transportation costs involved in shipping Arizona concentrates to Japan and reimporting the copper are of the order of 3-4¢/lb. This is about the same as the incremental cost of pollution control at most locations in the U.S.; hence, the netback to a U.S. mine is lower after a Japanese pollution abatement surcharge is taken into account.

In the long term, increased capacity at existing smelters as a result of process changes and new plant construction (based on pyro or hydrometallurgy) might be expected to provide an outlet for domestic mine production. However, increased operating costs at domestic plants would increase the attractiveness of locating smelters abroad, preferably in remote locations, and could accelerate a trend for the major nonferrous metal companies to invest abroad.

6. Water Pollution

The water pollution control costs affect mainly the Coastal refineries since the scarcity of water in the west has required proper water management at western mines, mills, smelters and refineries. Assuming that the effluent water standards correspond to the type of residual concentrations obtainable after heavy metal ion removal as hydroxide, and suspended solids removal by settling, we find these costs to be small when compared to the air pollution costs and are not expected to have any significant impact. Furthermore, the impact is more or less uniform within the industry.

C. IMPACT ON INDIVIDUAL COMPANIES

In general, the capital and operating costs to achieve pollution abatement would not be incurred by the companies in the absence of pollution abatement regulations, i.e., they cannot be justified on the basis of conventional return-on-investment criteria.

We assessed the factors affecting the individual plants during our consideration of plant shutdown probabilities. In this section, we assess the impact on the corporate entities of the decision to invest in the pollution abatement facilities. Independent analysis of what a proposed venture or program of expenditures might do to the firm in the eyes of the financial community can be undertaken with more confidence (as opposed to predictions of plant shutdowns) by securities analysts and investment bankers, for there are usually somewhat analogous situations from which to draw inferences and because such inferences can be drawn from data of the kind generally supplied to such individuals and organizations and to the SEC. In general, we would assume that a large industrial corporation which is clearly viable, profitable, and is acknowledged to have strong managerial and technical resources, has access to substantial capital--in the form of debt or equity or both. However, there exist practical limits on the rates of debt to total capitalization; as a rule, the stability or predictability of earnings and the coverage of fixed charges are factors in determining the financial community's limits on that debt and what the interest charges will be. Furthermore, each company has its own philosophy in the extent to which it will employ debt as opposed to equity (including retained earnings) for financing.

In a plant-by-plant and company-by-company analysis of pollution abatement impact, two viewpoints have to be considered. The availability of capital for pollution abatement equipment at each plant has to be viewed from the standpoint of the resources available to the entire corporation. However, the justification for spending this capital at a particular plant would result from a study of that particular plant's economics which would take into account alternatives such as the cost of production from a refitted plant, shifting production to other plants, and most important, the probability that this particular plant will remain a profitable entity.

The impact on individual companies was analyzed by aggregating the company-by-company capital expenditures and operating and maintenance cost requirements for the "local" case for meeting air and water pollution abatement standards. These were then compared with each company's sources of revenues, earnings, cash flow, debt-equity structure, and record of performance in terms of operating margin, return on equity, capital expenditure, etc.

Background information on the financial structure of each of the major companies was presented earlier in Tables VIII-1 and VIII-2. Table XII-1 places future pollution abatement costs in the perspective of total company operations. These costs estimated by us for copper, lead and zinc were adjusted to reflect post-1972 costs by deducting the amount already spent and reported in sources such as individual company annual reports. It should be noted that Table XII-1 compares the magnitude of pollution abatement costs derived in Chapter X with each company's operating income and capital spending rate. The purpose of this is to highlight those companies which appear to be most impacted by pollution control costs in relation to their normal pattern of earnings, capital spending and financial position. There are other incremental costs confronting the primary non-ferrous industry such as Occupational Safety and Health. The table should not be interpreted to imply that the pollution abatement costs shown cover the entire spectrum of increased costs facing the industry.

A short discussion of the impact on the major copper companies follows based on the information presented in Table XII-1.

- Asarco: The impact on Asarco is a result of expenditures necessary for pollution abatement at its copper, lead and zinc facilities. The impact of pollution abatement equipment operating costs, exclusive of fixed charges, could be large in the absence of the ability to pass back the cost increases. Asarco has, so far, instituted a 1-1.5 cents/lb surcharge on copper concentrates it receives for smelting, to defray a portion of the costs of its pollution abatement facilities installed to date.

  The capital expenditures necessary for pollution abatement are large in comparison to Asarco's average capital spending rate. Presumably, Asarco's extremely low debt-to-equity ratio and its earnings record will enable the company to raise long-term debt if it so chooses.

- Inspiration: Inspiration (27%-owned by Anaconda) has arranged financing, including $13 million from a toll customer, for its copper smelter pollution abatement program. The financial requirements of this program (a major reconstruction of the smelter) are quite large compared to Inspiration's past earnings record but are not expected to have a deleterious impact in the long term on the company.

- Anaconda: Anaconda has been a source of some concern because of its Chilean property loss and the high emission standards* affecting a significant portion of its remaining production. The financial impact of the cost of pollution abatement to Anaconda is affected by the accounting for the 1971 expropriation of its Chilean properties; this had the effect of creating a massive deficit for the year, establishing a large tax loss carryforward and increasing its debt-to-equity ratio.

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*The procedures related to the imposition of the high emission standards in Montana have been challenged in the courts.

TABLE XII-1

SELECTED PRIMARY NONFERROUS METALS* COMPANIES POLLUTION ABATEMENT COSTS

[From perspective of total company operations]

	1971 Sales Level X 1968-71 Avg. Operating Margin	Base Level or "Normal" Operating Income Pre-Tax $MM/Year	Avg. Capital Spending Rate 1968-71 $MM/Year	Cum. Capital Outlay for PA 1972-1975 (Estimated) $MM	÷ 4 = $MM/Year	Annualized Rate as Percent of Avg. Capital Spending % (Rounded)	Probable Oper. & Maint. Costs of Pollution Abatement Equip. $MM/Year (Rounded)	O&M Cost As Percent of Normal Base OP Income % (Rounded)	Annual PA O&M + 10% Outlay ÷ Normal OP Income %
AMAX	757 x 13.6%	103	103	9.3	2.2	2	0.8	1	1.8
ASARCO	657 x 11.0%[(a)]	72	42	119.6	30.0	71	14.5	20	37
Anaconda	947 x 15.4%	146	102	93.0	23.3	23	7.0	5.0	11.2
Gulf Resources & Chem.	115 x 10.0%	11.5	7	5.0	1.25	18	0.2	2	6.1
Inspiration	66 x 28.1%	19	10	45.5	11.4	114	2.8	15	39.0
Kennecott	1,053 x 24.4%	257	157	111.0	27.8	18	7.4	3	7.2
National Zinc	N.A.	0.2-2.0**	<1.0	<10.8	<2.7	large	1.4	large	large
Newmont	198 x 39%	77.4	95.0	40.5	10.1	10.6	4.9	6.4	11.7
Phelps Dodge	704 x 20.7%	146	82	90.5	22.6	27	7.5	5.1	11.6
St. Joe Minerals	194 x 22.8%	44	15	10.9	2.7	18	1.0	2	4.8

(a) The ratio of net income to sales was used as a more meaningful figure for ASARCO in this context.

*For a discussion of New Jersey Zinc Company, a subsidiary of Gulf and Western Industries, see text.

**Estimated.

SOURCE: The information presented above has been obtained from company annual reports and SEC filings, statistical services, financial manuals, and other sources believed to be reliable but its accuracy and completeness are not guaranteed.

ADL estimates.

However, indications are that with the Chilean and related write-offs and reserves behind it, and under current industry conditions, Anaconda will return to profitability in 1972 and remain so in the future; a consequence in part of a major reorganization and withdrawal from certain industry sectors; e.g., zinc, lead and forest products.

The cash flow from operations and its borrowing power (including industrial revenue bond financing) should enable Anaconda to finance pollution abatement expenditures in addition to "normal" operations and debt repayment.

- Duval: Duval Corporation, a wholly-owned subsidiary of Pennzoil United, Inc., could be affected over the next three years to the extent its mine output and/or costs are affected by changes in copper concentrate smelting arrangements--particularly at Asarco arising from pollution abatement programs in Arizona and Washington.

- Kennecott: A major impact on Kennecott would occur if more stringent requirements in Nevada lead to the closing of the Ruth, Nevada mine and the McGill smelter. In the absence of this, the impact is not severe.

- Newmont: The impact of Newmont is not expected to be severe.

- Phelps Dodge: Because of the construction of a new smelter in New Mexico, the closing of the Douglas smelter will not have a major impact on Phelps Dodge's capability to smelt its own concentrates. Thus, the impact on the company is not expected to be severe.

Thus, while individual plants may close, indications are that there will be no corporate bankruptcies or substantial involuntary reorganizations arising from pollution abatement expenditures. On the other hand, environmental and other considerations in the U.S. can be expected to influence the direction of new capital expenditures and growth of the copper industry worldwide and the changing role of the U.S. copper companies.

D. EMPLOYMENT IMPACT

1. Employment Loss

- Smelters

  The closing of the Tacoma smelter would directly affect its employees, estimated at 600, and indirectly affect 1200 other jobs (on the assumption of a 2:1 multiplier). If the electrolytic refinery in Tacoma is closed with the smelter, a total of 1000 employees and indirectly 2000 other jobs would be affected. Because of Seattle-Tacoma's urban environment, the local impact would be diffuse.

The closing of the Douglas smelter (employment of 650) will have a major impact on the immediate surrounding area since (after the Lavender Pit closes in 1973 due to exhaustion of reserves) it would be the remaining major industry in the towns of Douglas (population 12,000) and Bisbee (population 10,000). The economic impact will be especially severe on service industries in these towns since we can expect a sizable portion of mine employees to move away from the area and find alternative employment in Arizona's mining industry. Depending on the timing of the closing of Douglas, a portion of the employees might find employment at Phelps Dodge's new smelter in New Mexico.

- Mines

An employment impact could occur with respect to the smaller mines either as a result of a smelter capacity bottleneck and/or small mine closing as a result of passback of increased smelting costs. (For the purposes of this discussion we define small mines as those not listed separately in Table IV-3.) We find that the employment in the small mines in the western base metal industry (copper, lead and zinc) is about 2800. Of these, about 1500 employees (in Arizona, Colorado, New Mexico and Utah) might be susceptible should the small mines close in these states.

The closing of the Tacoma smelter and the loss of the arsenic handling capability can affect both the larger and smaller mines in the northwest and potentially affect 3000-4500 miners in Idaho, Montana and Washington.

- Acid Plants

Our survey of sulfuric acid markets in Chapter XI indicated that a large surplus of sulfuric acid will be available in the west which would have to be disposed of by a variety of methods--neutralization, leaching or sales to distant customers. If it becomes cheaper to haul the acid to the market, the merchant acid plants might be forced to shutdown. We have not examined the implications of this move on employment in the sulfuric acid industry.

2. Employment Gains

There are two types of employment gains that will result from pollution abatement procedures at smelters and refineries. The first will be an increase in operating and maintenance labor required by the added pollution abatement equipment. We have not made detailed plant-by-plant estimates of the increased employment but believe that on the average, plant employment would increase from 25 to 60 employees at each plant or 330 to 780 employees industry-wide. (This would lead indirectly to 660 to 1560 more jobs.) Most of these increases will occur at smelters rather than refineries.

The other impact of pollution abatement requirements would be temporary but can have a major bearing on some of the costs presented in this report. The installation of pollution abatement equipment and repairs would increase the demand for specific types of construction labor and specific types of engineering design and construction skills. Again, because of the limited timescale in which these repairs have to be made, the repairs and installation would have to go on concurrently at all smelters and serious labor shortages would occur in the west, especially in Arizona. This shortage of skilled labor can be expected to considerably increase construction costs, cause construction delays and so on and could significantly increase the capital costs above those estimated in this report.

XIII. INDIRECT IMPACTS

A. DOMESTIC MINE PRODUCTION

The direct impact resulting from cost passback and/or a smelter bottleneck was discussed earlier. In the long-term, the cost of pollution abatement at smelters and refineries decreases the netbacks available to the mines and we can expect a decrease in netbacks to inhibit exploration and the development of new mines. We believe, however, that government policy in other areas (See Chapter VI) will be a much more serious consideration in future mining activity in the U.S. than reduced netbacks resulting from pollution abatement. Current trends in government policy impact these industries at many levels and, in general, these impacts tend to be additive.

B. FUEL, ENERGY AND RAW MATERIAL AVAILABILITY

Copper smelters normally generate sufficient electricity from waste-heat boilers on reverberatory furnaces for all their in-plant use plus a small surplus. The increased energy consumption resulting from pollution abatement requirements would result in a net power consumption as high as 80-100 megawatts for the entire copper industry. The predicted natural gas shortage would affect the smelters. All (except one) presently use natural gas for firing their reverbs though alternate fuels are being considered.

Similarly, should the demand for limestone for use in SO_2 recovery in power plants affect its cost and availability, an impact can occur on the primary copper industry.

C. STRATEGIC CONSIDERATIONS

Since copper is a strategic material which is stockpiled, any factor that decreases the domestic production of copper has strategic implications. We believe that the pollution abatement costs is only one input out of several others resulting from government policies which affect the mine production of copper in the U.S.

D. BALANCE OF PAYMENTS

In recent years the imports of refined copper into the U.S. have averaged around 130,000 tons per year. During the same period over 200,000 tons per year of blister copper was imported primarily for Chile, Peru and South Africa. More or less an equivalent amount of refined copper has been exported in the same period so it can be assumed that copper entering the United States as blister has not been consumed locally. An adverse change in the balance of payments situation can occur if the consumption increases at a rate of 3% as assumed in the previous discussions and this increase in demand cannot be satisfied from increased domestic production but by importing refined copper. This particular scenario is realistic only if we assume that Tacoma and Douglas smelters are shut down before new smelting capacity is available and domestic mine capacity is stagnant. The additional copper that would have to be imported under these conditions (and assuming that domestic production is not increased by other hydrometallurgical methods) could be as much as 400,000 tons. Thus the premature shutdown of Douglas and Tacoma would result in a balance of payment deficit of up to $400 million per year. If the Tacoma and Douglas smelters were not closed, and the availability of cheap acid or new processes increases non-smelter copper production, we believe the impact on the balance of payments resulting from increased imports of copper will be minimal.

It should be noted that the balance of payment deficit can be larger than shown if copper is imported in the form of higher value-added semi-finished or finished goods.

E. ALTERNATE MATERIALS

Plastics and aluminium are considered substitutes for copper. These industries are also being severely impacted by changing raw material costs, increases in other operating costs and new pollution abatement costs. In the absence of detailed comparative impact studies on the latter commodities, we are unable to reach firm conclusions regarding the possibilities of substitution of copper by these materials.

F. MERCHANT ACID INDUSTRY

As discussed under "Employment Impact", our survey of sulfuric acid markets indicates that the acid has a negative value at the smelter and in some instances neutralization of smelter acid would be cheaper than sale in direct competition with merchant acid production. The leaching of oxide copper ores, waste piles and tailings is an attractive alternative to neutralization with limestone and would be pursued wherever possible since this approach (besides disposing the acid) has the potential for increasing copper production. Should the demand for limestone (for SO_2 removal and other purposes) substantially increase its price and the smelter acid is not all used up for leaching, the sale of smelter acid would force the closing of the western merchant acid industry.

G. FINANCIAL AND TAX ASPECTS

If the "passing-back" of the pollution abatement cost were to either decrease the value of the concentrate or raise the cost of mining, this could have the effect of lowering the amount of depletion allowed for tax purposes. Other things being equal, this would have the effect of further reducing net after tax income from mining and decreasing the cash flow.

To the extent that effective tax rates are relatively low for the major primary nonferrous metal companies, they may have more incentive to use investment tax credit provisions than rapid amortization for pollution abatement facilities.

Industrial development bonds could be advantageous for the financing of pollution abatement equipment since they allow a corporation to conserve cash over the short term (by taking advantage of the leasing provisions typically incorporated) and serve as a source of "off-balance-sheet" financing. The tax-exempt feature generally means a lower effective interest cost; one to two percentage points less than regular commercial financing. At this point in time, it is not clear what percentage of total pollution abatement cost could be financed in this fashion.

APPENDIX A

IMPACT OF EPA REGULATIONS OF JULY 1972

The purpose of this appendix is to assess qualitatively the effects of the new regulations promulgated by EPA in July 1972. (See Federal Register - July 27, 1972, Volume 37, No. 145, Part III).

These new regulations have the following features:

- The regulations are of the "emission type", i.e. they limit SO_2 emissions from each smelter (in lb. SO_2/hour) to a specified amount. Thus, they require the recovery of a substantial fraction of sulfur in the feed materials when the smelters are operating at capacity and/or require a production curtailment.

- We understand that the permissible SO_2 emission rates for each smelter were calculated on the basis of available air quality data and atmospheric dispersion models. We also understand that "emission type" regulations were adopted because EPA believes that other SO_2 control philosophies such as "closed-loop" control (based on measuring ambient SO_2 concentrations and utilizing this information to control the smelter operating rate), might be more difficult to enforce and would lead to degradation of air in areas where air quality is superior to the Federal standards. However, recent conversations with EPA indicate that it would accept a "closed-loop control" scheme if it can be shown that these systems are workable.

- The proposed regulations are for achieving Primary or health-related ambient air quality standards only, and EPA believes that these would be achievable by the utilization of acid plant technology and production curtailment. If the standards cannot be met by this technology but require scrubbers, a two-year extension, until July 31, 1977, is available.

- An 18-month extension has been granted to the states for submitting implementation plans acceptable to the EPA for meeting the Secondary ambient air quality standards. Presumably, these standards would be more stringent and might be based on the further utilization of then available technology (e.g., scrubbers) and production curtailment.

- All SO_2 emissions have to be captured and vented via a stack. This presumably includes low level emissions such as "converter aisle emissions."

A. GENERAL CONSEQUENCES

In general, the adoption of fixed emission standards is more expensive because it eliminates certain lower cost strategies which could be used for meeting ambient standards. For example, tall stacks and preheated dilution air can no longer be used even in cases where they might be the lowest cost strategy for meeting the Federal ambient standards.

The other aspect of these fixed emission standards is that in most cases they require sulfur recoveries considerably in excess of those achievable by using acid plants and would require scrubbers and/or a permanent production curtailment. This is because under a fixed emission standard, the smelter cannot increase its operating rate under favorable weather conditions. The closed-loop control approach, on the other hand, provides such a mechanism so that a smelter can make up to some extent the production lost during unfavorable weather.

The regulation on low level emissions can have a major impact if they are interpreted to apply to all low level emissions. For example, if converter aisle emissions are included, the air in the aisles will have to be collected and vented via a stack.

A detailed and complete analysis of the impact of these regulations is not possible with the scope of the present effort. Furthermore, such an analysis would be incomplete since new and presumably more stringent standards would be passed in 18 months for meeting Federal Secondary Ambient standards. Also, because of litigation and the fact that the specific approach for meeting the secondary standards has not been delineated, the smelters could not properly plan their compliance schedules.

We have evaluated the extent of the permanent production curtailment required at each smelter by the new regulations under the assumption that scrubbers are not used and this has been presented in Table A-1. The table shows the percent SO_2 recovery required when the plant is operating normally, the approximate sulfur recovery that might be achieved by using acid plants (using converter gases and roaster gases if roasters are already present) and an estimate of the extent of the permanent production curtailment.

In our opinion, permanent production curtailments of greater than about 10-15% are serious and, if enforced, indicate a high probability of plant shutdown.

TABLE A-1

	% SOx Recovery at Normal Plant Throughput Required by New Regulations	% SOx Recovery Achievable with Acid Plants	Estimated Degree of Production Curtailment - %
Copper Smelters			
1. Phelps Dodge, Douglas, Ariz.	90	-	100[4]
2. Phelps Dodge, Morenci, Ariz.	90	55-60	15-25
3. Phelps Dodge, Ajo, Ariz.	70	NA	0
4. Kennecott, Garfield, Utah	76	65-70	5-10
5. Kennecott, Hayden, Ariz.	96.7	90	5-8
6. Kennecott, McGill, Nev.	60	60	0
7. Kennecott, Hurley, N.M.	60	60	0
8. Asarco, Hayden, Ariz.	96.7	55	35-45
9. Asarco, El Paso, Texas	43	55	0
10. Asarco, Tacoma, Wash.	90	55-60	20-30
11. Anaconda, Montana	89	55-60	30-35
12. Newmont, San Manuel, Ariz.	94.5	65	25-30
13. Inspiration, Ariz.	73	NA	0
Lead Smelters			
1. St. Joseph Minerals, Mo.	75[1]	75[6]	0
2. Missouri Lead, Mo.	75[1]	75[6]	0
3. Asarco, Mo.	75[1]	75[6]	0
4. Asarco, El Paso, Texas	A.P.[2]	NA	0
5. Asarco, E. Helena, Mo.	87	70-80	10-20
6. Bunker Hill, Idaho	96	70-80	15-25
Zinc Plants			
1. Asarco, Corpus Christi, Texas	A.P.[2]	85-95	-
2. Bunker Hill, Idaho	96	85-95	0-10
3. Amax, E. St. Louis, Ill.	A.P.[2]	85-95	-
4. National Zinc, Bartlesville, Okla.	?	80-90	-
5. Asarco, Amarillo, Texas[4]	-	-	-
6. Amax, Blackwell, Okla.[4]	-	-	-
7. New Jersey Zinc, Pa.	85[3]	85-95	-
8. St. Joseph Minerals, Pa.	85[3]	85-95	-

[1] Estimated; regulations for 2000 ppm of SOx

[2] A.P. - acid plant will be adequate

[3] Estimated; regulations for 500 ppm of SOx

[4] Plants will close

[5] N.A. - not applicable - plant modified for a higher recovery

[6] Acid plants modified

SOURCE: ADL Estimates.