JDY
This should go to
6/22 RJM, J Lee P, G. Bernstein, Ed S.
JFS, Dan V ASAP
for their comments - assuming EPA
meeting on 6/24! W

7/15/87

LEAD POINT SOURCE
CONTROL COSTS FOR MEETING
LOWER AMBIENT AIR QUALITY
STANDARDS

To: DAN VORNBERG (DERun)
FR: REC Jr.

(1) The Exec Summary needs work -- it should hit hard and sway the policy makers!

(2) Price / lb. impacts need to be developed to demonstrate the competitive market impacts. Costs in aggregate $ do not explain magnitude of impact.

(3) We must make clear what sectors of LIA cannot financially bear the costs in a world market, i.e. competitiveness.

Prepared for:

Lead Industries Association

Prepared by:

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Project 3952-P51

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EXECUTIVE SUMMARY

This report estimates the costs of air pollution controls which would be required by the lead industry (primary and secondary smelting, battery manufacture and tetraethyl lead production) should EPA promulgate either a 1.0 $\mu g/m^3$ or a 0.5$\mu g/m^3$ National Ambient Air Quality Standard for Lead. The report concludes that $401 million in capital costs and $35 million in annual operating costs would be required to meet a 0.5$\mu g/m^3$ NAAQS. This total cost has been arrived at by adopting the costs to the primary smelting industry for complete enclosure of smelting operations derived by the Bureau of Mines and adding to that the costs expected for other controls at primary smelters and the costs expected for the other industry sectors.

Gross #'s have no meaning, beyond qualifying this as a major reg. Must also add #'s that describe actual industrial impact, e.g. costs per lb of Pb for primaries; describe what this means in a competitive sense.

1.0 INTRODUCTION

In preparation for hearings of the Clean Air Science Advisory Committee (CASAC) of the Environmental Protection Agency (EPA) in March of 1986, both the Lead Industries Association (LIA) and the U.S. Bureau of Mines (BOM) prepared cost estimates of air pollution control requirements to meet a 1.0 or 0.5 $\mu g/m^3$ NAAQS for lead. This report combines the work of both efforts into a unified estimate since neither earlier effort satisfactory covered all facets of control costs.

2.0 LIA COST ESTIMATES

2.1 Cost Estimate Methodology

A lower NAAQS for lead would require that stationary sources be re-evaluated for compliance with a new standard. In addition, State Implementation Plans would need to be revised and new controls placed upon existing stationary sources. While the full impact of that process can hardly be anticipated, a preliminary estimate of the costs was attempted by LIA through a questionnaire. The LIA questionnaire to all point source lead facilities[1] asked for data on control costs to meet the existing standard of 1.5 $\mu g/m^3$ and two alternatives, 1.0 and 0.5 $\mu g/m^3$. It was assumed in all cases that the quarterly averaging time would be retained for the standard. This assumption makes for easier engineering judgements of how much control would be required to reduce emissions by 1/3 or 2/3. To the extent that EPA chooses a monthly average standard or an increased sampling frequency, these projected decreases in emissions are underestimated. A host of other variables such as modeling uncertainties, regulatory uncertainties and local and public pressure also cannot be quantified in these evaluations but may also cause these projected costs to be underestimated. That means that a 1/3 emission reduction will, in all likelihood, be insufficient to obtain an acceptable SIP to insure attaining a 1.0 $\mu g/m^3$ standard at the plant fenceline. Similarly a 2/3 emission reduction would not insure attaining a 0.5 $\mu g/m^3$ standard.

The costs of control presented here represent a single focus view of the cost, i.e. what the plant-level engineer expects the costs would be to achieve the stated emissions reductions. In many cases although not generally for battery plants, the plant-level engineer has a reasonable idea of the expected costs because of the recent completion or near completion of the SIP's for attainment of the 1.5 $\mu g/m^3$ standard. What is not generally reflected is the impact on that specific plant site, or the corporation, or the lead industry as a whole of these increased control costs. The industry, especially the primary segment, was not in a position to provide comprehensive estimates since the feasibility of 0.5$\mu g/m^3$ was doubted. In many cases the plant-level engineer decided that reaching a 0.5 $\mu g/m^3$ standard would be "technologically infeasible". In a few more cases the plant-level engineer offered that the plant would be closed before incurring the significant costs to reduce emissions. In most cases, however, the viability of the plant site was not actively considered in developing a control cost. In no case was the viability of the corporation considered, and the macroeconomic impact on the lead industry has not been considered at all.

Cost per product; effect on market?

2.2 Cost Estimate Results

Given that methodology, the results of the survey are presented in Table 1. Costs are presented in thousands of dollars for three scenarios. The first is the costs to achieve the present 1.5 $\mu g/m^3$ ambient standard, and the latter two columns present the incremental increase in control costs to achieve the alternative standards. Costs are divided by industrial sector as in the body of this study. In addition, they have been extrapolated to the entire industry using the number of facilities existing in each sector (The first line in each sector is reported costs with number of facilities in parentheses while total industry values are on the second line).

The costs provided in Table 1 must be considered as substantial underestimates of actual costs to be expected. Since the estimates were made in 1985 it has become clear that EPA will force substantially greater control costs to meet 1.5$\mu g/m^3$, especially at the primary smelters. While these estimates were made on the premise of meeting the standard at the nearest monitoring site or nearest exposed children, EPA now requires meeting the standard at the fenceline. Additionally, it has become clear that enclosure of the smelting operations (see Section 3) is unavoidable if a 0.5 $\mu g/m^3$ standard is to be met. The doubt registered by plant level engineers, especially in the primary industry, was well founded. Therefore, the costs presented in Table 1 must be viewed as a preliminary industry ~~guess~~ estimate based upon ~~hopefulness~~ about what might be required and concern about what the industry could afford.

2.2.1 Present Costs

The column listed "present costs" reflects the air pollution control equipment placed in service recent years or to be placed in service to meet present SIP objectives. The primary objective is meeting the 1.5 $\mu g/m^3$ NAAQS for lead. Some facilities, most notably battery plants (12 out of 49 responding) do meet that standard at the nearest monitor without requiring additional controls. In a few cases the expenses recorded will result in overachieving the 1.5 $\mu g/m^3$ standard. This occurs where public pressure has forced substantially tighter controls, e.g. Dallas, Texas. In all likelihood, the measured fenceline concentrations are now or will be less than 1.5 $\mu g/m^3$ when the SIP controls are in place.

The timing of the costs cited under "present costs" varies substantially for the facilities. Since some of the capital costs were incurred as long ago as 1980 and some of the capital costs are not to be incurred until 1988, the cost basis varies. The operations and maintenance (O+M) costs more likely reflect current 1985 dollars. SIP requirements have become substantially more

TABLE 1

LEAD INDUSTRY CONTROL COSTS*

(Thousands of 1985 Dollars)

Industrial Sector (# of Facilities)		Present Costs		Additional Costs Costs to Meet 1.0		Additional Costs to Meet 0.5	
		Capital	O&M	Capital	O&M	Capital	O&M
Primary	(3)	19,825	3,207	14,203	900	30,766	1,725
	(5)	33,042	5,345	23,672	1,500	51,277	2,875
Refinery	(1)	7,416	717	2,250	110	4750	140
Tetraethyl	(1)	7,000	3,000	*	*	3,000	500
Secondary	(11)	24,889	5,414	8,611**	696**	17,502***	1,499***
	(23)	52,691	11,320	18,084	2,034	36,755	3,079
Battery	(49)	26,659****	4,903	359*****	1,600	14,335******	3,402
	(98)	53,318	9,806	718	3,200	28,670	6,804
Total Reporting Industry		85,789	17,241	25,423	3,579	70,353	7,266
		153,467	30,188	44,724	6,844	124,452	13,398

* Believes the plant could meet this standard
** 3 facilities believe they could meet this standard
*** 3 facilities believe they would be forced to close
**** 12 meet without controls
***** 18 could meet, 6 would close
****** 3 could meet, 2 more would close

*It is demonstrable that these costs are substantial underestimates, especially for the primary industry. They were generated in 1985 and represent, on the whole, what industry could afford rather whan what would be actually needed to meet the various standards.

rigorous since these estimates were made and it is clear the greater expenses will be required, especially in the primary industry, than anticipated by this 1985 estimate. The resulting total outlay for the industry to attempt to meet the 1.5 $\mu g/m^3$ standard or other airborne lead requirements will be substantially higher than the $150 million in capital costs spread over eight years and $30 million per year in operations and maintenance costs reflected in Table 1.

2.2.2 Meeting a 1.0 $\mu g/m^3$ Standard

Projected incremental costs to attempt to meet a 1.0 $\mu g/m^3$ standard are presented on Table 1 in the second column. These totals for the industry are about $45 million in capital costs and $7 million per year in operation and maintenance costs. It is assumed that these costs represent 1985 dollars. These costs are lower than otherwise might be expected because a substantial number of facilities feel probably inappropriately that they can meet the standard with present or proposed controls listed under "present costs". A total of 22 reporting facilities ~~feel~~ believe they can meet 1.0 $\mu g/m^3$ without further controls. This ~~feeling~~ conclusion comes from either measured fenceline data after installation of controls reflected in "present costs" or model projections that after "present cost" controls the 1.0 $\mu g/m^3$ would be achieved. Six battery plants are apparently marginal ~~enough that they~~ and would be forced to close if 1.0 $\mu g/m^3$ were required.

In extrapolating to the totals for each industrial sector, costs were scaled without including the percentage of facilities which feel these could meet the standard. For example, out of 49 battery plants reporting, 24 would not incur costs so the ratio $\frac{49-24}{49}$ was applied to the 98 plants in the total industry, i.e., multiply costs by about two.

The costs of attempting to meet a 1.0 $\mu g/m^3$ standard would apparently fall most heavily on the primary and secondary industries. But since the actual SIP process often results in overcontrol and since a monthly average standard may be adopted, these costs are grossly underestimated and the entire industry would bear much larger costs.

2.2.3 Meeting a 0.5 $\mu g/m^3$ Standard

Projected incremental costs to attempt to meet a 0.5 $\mu g/m^3$ quarterly average standard are presented in the third column of Table 1. These totals for the industry are $125 million in capital costs and $14 million per year in operation and maintenance costs. This column reflects costs of going from 1.5 to 0.5 $\mu g/m^3$ rather than just from 1.0 to 0.5 $\mu g/m^3$. The plant-level engineering approach reports that at least 3 secondary and 8 battery plants would be forced to close with a 0.5 $\mu g/m^3$ standard. As mentioned before, this evaluation of closing does not truly reflect plant margins, corporate decisions or lead market reasons which might force closing ~~of additional~~ plants. It also reflects ~~a feeling of~~ Views On what the industry could afford rather than what it will actually take. In addition it does not consider non-air control costs which may force closure. Only 3 battery plants out of all the facilities in the industry feel that they could meet a 0.5 standard without additional controls.

These projected costs are seriously underestimated because of the proximity of 0.5 $\mu g/m^3$ to background or non-stationary source concentrations. GCA[9] has estimated that, by the year 1995, concentrations of lead due to automotive sources would average 0.02 but could go as high as 0.13 $\mu g/m^3$. In addition, reentrainment of soil dust lead accounts for some reasonable fraction of measured lead concentrations. Practical experience with comparisons of modeled versus measured concentrations suggests

? Does this suggest we can afford this?

that reentrainment accounts for 10-20% of maximum measured concentrations at stationary source locations. These other sources of lead suggest strongly that the emissions from stationary sources will have to be reduced substantially more than dividing by 3 to demonstrate attainment of a 0.5 $\mu g/m^3$ standard. If the averaging time is monthly rather than quarterly, it may be infeasible to meet the standard short of shutting down the facility. ~~However,~~ Finally

P facility closure does not terminate all contributions to ambient air. For example, ambient concentrations at Bunker Hill exceed monthly averages of 0.5 $\mu g/m^3$ even though the smelter has been shut-down since 1981. The total cost impact on the industry are certainly not reflected in these results.

vague

3.0 BUREAU OF MINES COST ESTIMATES

The U.S. Bureau of Mines[2] chose a different methodology to estimate costs of controlling lead emissions. BOM limited their study to the four operating primary smelters; Buick, Glover, Herculaneum and East Helena. El Paso was not considered because it is temporarily closed. As of this date Buick is also temporarily closed.

BOM took an engineering approach to the problem of reducing lead emissions from these four primary smelters. They reviewed the present controls either in place or required by the SIP's which seek to meet the 1.5 $\mu g/m^3$ standard. They concluded that they would focus their efforts on process fugitive lead emissions rather than point sources or open fugitives. Point sources were not considered because stack emissions are controlled to meet Best Available Control Technology (BACT). Open fugitives were not considered because wind-blown dust from stockpiles, soils and roadways have been a subject of major control in most SIP's and engineering of further controls is not only difficult but of unknown efficiency. In short, BOM focused on the following engineering control alternatives to develop costs:

"• Closing existing openings on process-related buildings presently emanating lead-bearing fugitive dust.

• Enclosing open concentrate, sinter, and storage areas that are sources of dusts containing lead.

• Installing new baghouses and adding fans for positive ventilation.

• Adding selective local controls."

The need for the latter two items is because building enclosure has been shown to increase employee exposures to airborne lead, usually well in excess of OSHA standards therefore necessitating localized controls.

3.1 Bureau of Mines Results

The results, in terms of cost, were presented by BOM[2] in Table 6 which is reproduced here as Table 2 for completeness. They chose to provide an alternative cost for a new technology, continuous drossing, which would require more capital but, BOM claimed, lower operating costs. Although there was a qualitative conclusion that the alternative might result in less emissions, no quantitative estimate was made.

The costs are further refined in the Appendix of the BOM report to delineate the costs for each of the four smelters evaluated. They are separated as follows for the conventional technology:

	Costs ($1,000)	
	Capital	O+M
Buick	55,174	3,517
Glover	97,029	7,796
Herculaneum	60,190	4,517
East Helena	37,627	2,677
	250,020	18,507

BOM did not attempt to provide ambient air quality modeling of the emissions after controls. It is difficult, therefore, to discern whether the proposed controls would provide reductions in ambient air quality concentrations to the 1.0 or 0.5 $\mu g/m^3$ proposed NAAQS. BOM did provide a "theoretical emission reduction" in pounds per day (lb/d) which might be achieved at maximum efficiency of control operation (most baghouse efficiencies would have to increase to 99+% control). BOM did not cost the reductions from point sources or open fugitives that are inherent in the "theoretical emission reduction". The results of the reductions are shown in Table 3. Table 3 shows that the "theoretical emissions reduction" from the enclosure of process fugitives ranges from a 6% reduction at Herculaneum to 39% reduction at Buick (see Process Control Effect line).

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TABLE 2

TABLE 6*. - Capital and operating cost summary for ambient air environmental controls for Buick, Herculaneum, Glover, and East Helena

Category	Cost Summary
Conventional Drossing Process Technology	
Capital Costs	
Existing building closure	$ 5,217,500
Baghouse	161,933,600
New building	31,243,200
Local control	51,619,800
TOTAL CAPITAL COST	$250,014,100
Operating Costs	
Baghouse	13,960,700
New building	638,400
Local control	3,908,700
TOTAL OPERATING COST	$ 18,507,800
Continuous Drossing Process Technology	
Capital Costs	
Existing building closure	$ 5,217,500
Baghouse	161,933,600
New building	31,243,100
Local control	59,950,500
TOTAL CAPITAL COST	$258,344,800
Operating costs	
Baghouse	13,960,700
New building	638,400
Local control	1,505,600
TOTAL OPERATING COST	$ 16,104,700

* Reproduced directly from BOM report[2].

TABLE 3

LEAD EMISSION REDUCTIONS*

	Glover	Buick	Herculaneum
Current Lead Emissions**(lb/d)	882	1,181	1,780
Theoretical Reductions from Point and Open Fugitives (lb/d)	393	286	1,243
Theoretical Reduction from:			
Process Fugitives (lb/d)	160	465	101
Percent Control Attained (%)	92.0	60.3	52.3
Total Theoretical Reduction (lb/d)	553	527	1,344
After Controls (lb/d)	329	654	436
Process Control Effect (% of Current Emissions)	81.9	60.6	94.3
Total Control Effect (% of Current Emissions)	37.3	55.4	24.5

* Data from BOM study[2]

** Assumed to be equivalent to sufficient to meet 1.5 $\mu g/m^3$ NAAQS

Because East Helena has used a chemical mass balance method of quantifying emissions, the results of controlling process emissions are presented in terms of ambient air quality. Out of a total of 5.29 $\mu g/m^3$, process emissions account for 3.33 $\mu g/m^3$ or 62.9%. It is difficult to judge how much reduction might be attained from control of these process fugitives. At the other smelters BOM projected control efficiencies from 53.2 to 92% (Table 3, Percent Control Attained) for the proposed building enclosures and evacuations. This might imply a similar range of reductions at East Helena, i.e., 1.77 to 3.06 $\mu g/m^3$ reductions, if the same control range could be attained and the effect on air quality were proportional.

4.0 ADDITIONAL CONTROL REQUIREMENTS

4.1 Review of Available Modeling Information

Given that the Bureau of Mines did not deal with either point or area source of lead emissions, it is necessary to check whether these sources would also require controls to meet a 0.5μg/m^3 standard. Significant modeling efforts have been undertaken in revising the State Implementation Plans for Lead. In each of these efforts, controls were imposed until the modeled concentrations plus background concentrations from other sources were equal to or less than 1.5 μg/m^3. A review of these studies has been conducted to discover the percentage of remaining ambient concentrations due to the various source groups.

4.1.1 Glover

In analyzing the situation at Glover, an April 1984 modeling study by Region VII EPA has been used. This study reviewed the contribution of major source categories to the maximum predicted concentrations prior to controls to meet the 1.5 μg/m^3 standard. It indicates that the following source categories can contribute up to the stated percentage of the maximum concentrations:

Sinter Building Fugitives	<22.5%
Blast Furnace Fugitives	<31.6%
Dross Building Fugitives	<35.3%
Defining Building Fugitives	<8.3%
Point Sources	<8.5%
Area Sources	<55.9%

These maximum percentages occur at different receptors and times (the total is not 100%). Although there has been considerable debate about which receptors in the modeling represent "ambient air quality", one was selected for the following breakdown:

Sinter Building Fugitives	20.65%
Blast Furnace Fugitives	31.52%
Dross Building Fugitives	35.28%
Defining Building Fugitives	7.61%
Point Sources	3.43%
Area Sources	1.25%

It is immediately apparent that at this maximum concentration receptor the process fugitives dominated the pre-SIP modeling result. The point sources do not affect this receptor much because of its close proximity (stack emissions have their maximum impact much further downwind). Area sources do not effect those receptors much but are very important at other receptors.

The final SIP to meet 1.5 $\mu g/m^3$ has yet to be approved and the post SIP modeling is not yet finished. The basic plan is for substantial controls on process fugitives, i.e., partial building enclosure and ventilation with construction of new baghouse capacity to process the ventilation. Additionally there are area source controls primarily to reduce impact at a different receptor.

Recognizing that the area and point sources could individually exceed a 0.5 $\mu g/m^3$ standard, it is probable that electrostatic precipitation (at $1 million) on the main stacks and more area source controls (at $250,000) would be necessary. If we estimate those costs at $1,250,000 capital and $225,000/year O+M, the result for Glover would be $98,283,000 capital and $8,021,000/year O+M when added to the BOM estimate of $97 million to control process emissions.

4.1.2 East Helena

No air quality dispersion modeling has been performed for the current status of the East Helena smelter since reliance has been placed on the chemical mass balance (CMB) technique. The CMB results presented in the BOM report[2] indicate 1.80 $\mu g/m^3$ from non-ASARCO sources, which makes attainment of a 0.5 $\mu g/m^3$ standard problematical. CMB also assigns 0.16 $\mu g/m^3$ to open fugitives and nothing to point sources.

It appears, therefore, that the maximum possible effort would be required from the smelter on process fugitives. The BOM report[2] concluded process emission controls would cost $37.6 million. It is expected that more area source controls would be necessary and should add $500,000 in capital costs and $50,000/year in O+M costs. The total for East Helena would therefore come to $38,100,000 capital and $2,727,000/year O+M.

4.1.3 Buick

Because Buick and Herculaneum have chosen a SIP which relies on monitoring as opposed to modeling, little modeling has been performed. For Buick, only the monitoring plan[4] contains some hints about relative impact of process versus other sources. It projects that, at the maximum location, 95% of the concentration is due to "all fugitive sources" and 5% is due to the stacks. Again, the predominance of the process fugitives seems evident. While there is substantial disagreement about the absolute value of the modeled ambient air quality, it is probable that the point sources or area sources could also exceed a 0.5 $\mu g/m^3$ standard by themselves. It is therefore again appropriate to add point and area source control costs of $5,255,000 to the BOM costs for process fugitives. This results in a total for Buick of $60,429,000 in capital costs and $4,043,000/year in O+M costs (assumes 10% of capital cost per year to operate the point and area sources controls.)

4.1.4 Herculaneum

The only modeling available for Herculaneum[5] is for the point sources only. This indicates that control of point sources would be necessary to attain a 0.5 $\mu g/m^3$ standard even if process sources and area sources were controlled to the maximum possible. If we use the same costs as Buick for point and area source control, this would result in a total of $65,445,000 capital and $5,043,000/year O+M costs.

4.1.5 El Paso

BOM did not investigate the situation at El Paso because the lead plant is presently not operating. Despite this idling of the plant, ASARCO has pursued a final SIP and it is reasonable to assume that the plant may reopen if market conditions allow. The final modeling for post-SIP compliance yields a maximum quarterly concentration of 0.87 μg/m³. At those two maximum concentration locations, the contributions by source category are as follows:

	RECEPTOR 5		RECEPTOR 24	
	%	μg/m³	%	μg/m³
Points	35.6	.31	53.0	.46
Process Fugitives	63.2	.55	40.8	.36
Area Sources	1.1	.01	6.2	.05

As can be seen, the process fugitives are still the largest source category but in order to meet a 0.5 μg/m³ standard with room to spare for other sources, some control of point and area sources would be needed. A somewhat confusing factor at El Paso is that the copper smelting plant contributes 0.12 μg/m³ of the above total. It seems that for El Paso to attempt to meet a 0.5 μg/m³ standard it too would have to enclose the lead process a la BOM and provide some point source controls. It is therefore reasonable that the average cost at the other facilities might be needed; i.e., $65,570,000 of capital costs and $4,959,000 for annual O+M.

4.2 Consolidated Estimate

It is possible with the above information to estimate the total cost to the primary industry of controls to attempt to meet an ambient air quality standard of 0.5 $\mu g/m^3$. Table 4 provides this estimate. The BCM estimates for control of process emissions are probably higher than possible, given the industries problems, but contain necessary costs that would assure compliance. The presence of background concentrations, the possibility of a monthly average rather than quarterly average standard and the potential for continuous rather than every six-day sampling mean that the combined costs presented in Table 4 are in all likelyhood, and underestimate.

Table 5 presents a consolidated estimate of the control costs expected across the entire industry for all the potential standards. It is already known that costs for controlling to meet the present standard (first column) are going to be considerably higher than these estimates based on 1985 data. This is because of considerable tightening of the definition of ambient air quality being used now by EPA. These additional costs would not necessarily allow for easier compliance with a lower standard since EPA would retain the same definition.

The costs to meet a 1.0$\mu g/m^3$ standard as presented in Table 5 are expected to be a severe underestimate especially when compared to the requirements to meet a 0.5$\mu g/m^3$. A more logical conclusion would be that half the costs needed to meet 0.5$\mu g/m^3$ would be needed to meet 1.0$\mu g/m^3$.

TABLE 4

CONTROL COSTS TO MEET 0.5 $\mu g/m^3$
PRIMARY LEAD SMELTING INDUSTRY

($1,000)

Smelter	Process Fugitives (BOM)		Points and Areas	
	Capital	O+M	Capital	O+M
Buick	55,174	3,517	5,255	526
Glover	97,029	7,796	1,250	225
Herculaneum	60,190	4,517	5,255	526
East Helena	37,627	2,677	500	50
El Paso	62,505	4,627	3,065	332
Total Process	312,525	23,134		
Total Points and Areas			15,325	1,659
Total All	327,850	24,793		

Table 5

Consolidated Estimate
(Thousands of 1985 Dollars)

Sector	Present Costs Capitol	Present Costs O&M	Costs to Meet 1.0 Capitol	Costs to Meet 1.0 O&M	Costs to meet 0.5 Capitol	Costs to meet 0.5 O&M
Primary Smelting	33,042	5,345	23,672	1,500	327,850*	24,793*
Refining	7,416	717	2,250	110	4,750	2,875
Tetraethyl	7,000	3,000	**	**	3,000	500
Secondary Smelting	52,691	11,320	18,084	2,034	36,755	3,079
Battery	53,318	9,806	718	3,200	28,670	6,804
Industry Total	152,467+	30,188+	44,724++	6,844++	401,025	38,051

* Includes Bureau of Mines estimates.
** Presumed to already meet a 1.0µg/m³ standard.
\+ Expected that this is an underestimate given significant additional SIP requirements imposed since 1985 especially on the primary smelter industry.
++ An apparent underestimate when compared to the costs to meet 0.5µg/m³. It is more likely that $200 million in capitol costs and $20 million in annual O&M costs would be required.

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3. Daye, R.L.: "Air Dispersion MOdeling Results ASARCO Lead Smelter, Glover, MO" memo to Dewayne Durst, June 4, 1984 Region VII EPA, Kansas City, Missouri.

4. AMAX Lead Company of Missouri, "Long Term Monitoring Plan for Lead", submitted to the State of Missouri DNR.

5. C.T. Main, Inc.: "Assessment of Relative Impacts On Ambient Lead Levels of Herculaneum Lead Smelter Emissions Scenarios" Report for St. Joe Minerals Report 3544-4-1, March 1983.

Vacuum Dust

REDACTED

REDACTED

REDACTED

	Ratio	Dust ug/g	Matching Soil ug/g
1	1.5	5170	3360
2	4.0	160	40
3	2.3	230	100
4	.22	880	40
5	5.7	170	30
6	4.1	780	190
7	0.5	1210	2390
8	—	1050	—
9	3.5	210	60
10	1.4	720	520
11	11.3	4290	380
12	1.1	1040	910
13	1.8	2080	1160
14	1.9	1340	690
15	6.7	740	110
16	3.4	650	190
17	1.6	8300	5300
18	1.2	2080	1210
19	1.2	2040	1740
20	33.0	660	20
21	4.7	1610	340
22	2.2	2620	1200
23	0.7	470	640
24	1.0	1910	2010
25	4.6	1600	350
26	19.2	1540	80
27	24.6	1230	50
28	5.2	630	120
29	370 ~~140~~ ~~160~~ 2.6 30	635 Old State Rd., Pevetti	~~[illegible]~~ 160

DR6500928

Soils

REDACTED

REDACTED

REDACTED

REDACTED

REDACTED

REDACTED

*1	120	*30	1740 ✓
2	140	*31	2010 ✓
3	230	32	1360 ✓
*4	140	33	3140 ✓
*5	230	34	530 ✓
6	320	35	7470 ✓
7	180	36	1610 ✓
*8	190	*37	1810 ✓
*9	130	38	340 ✓
10	110	39	3580 ✓
11	330	40	750 ✓
12	140	41	1820 ✓
13	210	*42	50 ✓
*14	110	43	1010 ✓
15	150	44	350 ✓
16	70	45	4720 ✓
*17	60	46	260 ✓
18	110	47	8870 ✓
19	190	48	190
20	80	*49	340
21	1670	50	1180 ✓
22	1680	51	100 ✓
23	3100	52	50 ✓
*24	100	53	870 ✓
*25	40	*54	30 ✓
*26	198	55	990 ✓
27	800	*56	80 ✓
*28	3360	57	80 ✓
29	3600	*58	40 ✓

Soils - cont.

√ 59	REDACTED	110	88	REDACTED	70
+? 60		320	89		10
√ 61		520	90		80
√ 62		380			53
√ 63		1400			
√ 64		130			
√ 65		410			
√ 66		200			
√ 67		640			
√ 68		350			
√ 69		1450			
√ 70	REDACTED	910			
√ 71		690			
√ 72		1160			
√ 73		1440			
74		9250			
√ 75		1200			
√ 76		870			
√ 77		5300			
√ 78		1970			
√ 79	REDACTED	1190			
√ 80		2390			
√ 81		410			
√ 82		360			
√ 83		20			
√ 84		1160			
√ 85		50			
√ 86		350			

V-FS-EP

11 false neg 22%　%41 false pos 46%　17.12-10.00 1984-16.52 2.36

Herculaneum (Re-Test)

REDACTED

REDACTED

REDACTED

REDACTED

REDACTED

√1.	34-40 29·–	√30.	15-18 35·+			
√2.	33-49 163·	√31.	15-17 17·			
√3.	30-46 140·	√32.	14-22 43·+			
√4.	28-41 44·	√33.	13-23 20·			
√5.	26-19 *35·	√34.	13-22 29·			
√6.	26-28 46·	√35.	13-18 46·+			
√7.	26-28 43·	√36.	11-15 35·+			
√8.	25-17 *26·–	√37.	10-23 52·+			
√9.	25-17 *55·	√38.	10-26 28·			
√10	24-34 33·	√39.	9-32 35·+			
√11.	24-43 28·	√40.	9-36 29·			
√12	24-36 15·	√41.	9-30 32·			
√13.	23-40 32·	√42.	8-43 19·			
√14.	22-31 37·+	√43.	8-38 37·+			
√15.	22-28 37·+	√44.	8-33 28·			
√16.	20-45 37·+	√45.	7-23 37·+			
√17.	18-39 34·	√46.	7-25 39·+			
√18.	17-35 23·	√47.	6-17 40·+			
√19.	17-18 32·	√48.	5-20 32·			
√20	17-17 46·+	√49.	5-18 35·+			
√21.	17-27 40·+	√50.	10-37 19·			
√22	16-21 28·	√51.	8 20			
√23	16-43 158·+	√52	5 37			
√24	16-32 33·			V+2	FS	Δ
√25	15-31 19·	$\bar{x}$ =	16.52	(16.13)	29.38	12.86 43.77%↓
√26	15-34 70·+	sd =	7.495	(7.606)	9.727	
√27	15-47 37·+	var =	55.05	(56.73)	92.716	
√28	15-24 32·	Σ =	826	(839)	1469	
√29	15-21 30·	n =	50	(52)	50	

V-FS-EP

TEI 14 false neg 22%   7/41 false pos 46%

17.12-10.00
1984-16.52
2.36

Herculaneum (Re-Test)

REDACTED

REDACTED

REDACTED

REDACTED

√1.	34-40 29.–	√30.	15-18 35 · +
√2.	33-49 163·	√31.	15-17 17·
√3.	30-46 140·	√32.	14-22 43 · +
√4.	28-41 44·	√33.	13-23 20·
√5.	26-19 * 35·	√34.	13-22 29·
√6.	26-28 46·	√35.	13-18 46 · +
√7.	26-28 43·	√36.	11-15 35 · +
√8.	25-17 * 26.–	√37.	10-23 52 · +
√9.	25-17 * 55·	√38.	10-26 28·
√10	24-34 33·	√39.	9-32 35 · +
√11.	24-43 28·	√40.	9-36 29·
√12	24-36 15·	√41.	9-30 32·
√13.	23-40 32·	√42.	8-43 19·
√14.	22-31 37·+	√43.	8-38 37 · +
√15.	22-28 37·+	√44.	8-33 28·
√16.	20-45 37·+	√45.	7-23 37 · +
√17.	18-39 34·	√46.	7-25 39 · +
√18.	17-35 23·	√47.	6-17 40 · +
√19.	17-18 32·	√48.	5-20 32·
√20.	17-17 46·+	√49.	5-18 35 · +
√21.	17-27 40·+	√50.	10-37 19·
√22.	16-21 28·	√51.	8 20
√23.	16-43 158·+	√52.	5 37

			V	V+2	FS	Δ
√24.	16-32 33·					
25.	15-31 19·	$\bar{x}$ =	16.52	(16.13)	29.38	12.86
26.	15-34 70·+	sd =	7.495	(7.606)	9.727	43.777↓
27.	15-47 37·+	var =	55.05	(56.73)	92.716	
28.	15-24 32·	Σ =	826	(839)	1469	
29.	15-21 30·	n =	50	(52)	50	

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