

ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF ENFORCEMENT

PHELPS DODGE

AJO

NATIONAL ENFORCEMENT INVESTIGATIONS CENTER

DENVER, COLORADO



STATE IMPLEMENTATION PLAN
INSPECTION OF
PHELPS DODGE CORPORATION
NEW CORNELIA BRANCH SMELTER
AJO, ARIZONA

MAY 1976

ENVIRONMENTAL PROTECTION AGENCY

NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
Denver

OFFICE OF AIR QUALITY PLANNING AND STANDARDS
Durham

REGION IX
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CONTENTS

INTRODUCTION	1
PROCESS DESCRIPTION	2
EMISSION SOURCES AND RELATED CONTROL EQUIPMENT	7
EMISSIONS DATA	11
BIBLIOGRAPHY	16

TABLES

1	Smelter Process Equipment and Operating Data	4
2	Smelter Air Pollution Control Equipment and Operating Data	9
3	Particulate Matter Emissions Test Results	14

FIGURES

1	Phelps Dodge, Ajo Process Flow Diagram	3
2	Phelps Dodge, Ajo Plant Layout, Process Exhaust Flow and Air Pollution Control Systems	8

APPENDICES

A	NEIC Information Request Letter to Phelps Dodge	18
B	Phelps Dodge Response to NEIC Information Request	29
C	SIP Regulation Applicable to Phelps Dodge	51
D	Example Calculations of Gas Flow Rates	53

PHELPS DODGE
AJO, ARIZONA

SUMMARY AND CONCLUSIONS

Phelps Dodge Corporation operates a mine, concentrator, and smelter in Ajo, Arizona. An inspection to acquire data with which to evaluate the design and operation of existing particulate matter air pollution control equipment at the smelter and to survey the suitability of the smelter to be emission tested was conducted by Federal and State personnel on January 15, 1976. Substantial amounts of process, control equipment, and stack sampling information were requested of, and received from, Phelps Dodge.

The following conclusions are based on the inspection and a review of the information obtained:

1. The two reverberatory furnace ESP's do not appear to have sufficient capacity to handle the gas volumes coming to them. Calculations from data provided show that the ESP's may be trying to handle gas volumes perhaps 10% greater than they were designed to handle - $2,200 \text{ m}^3/\text{min}$ (77,900 scfm) as compared to $2,000 \text{ m}^3/\text{min}$ (70,400 scfm).
2. The DMA SO_2 absorption plant was not in operation and had not been for considerable time. Since this control system treats half of the reverberatory furnace ESP exhaust gas volume, adequate particulate matter and SO_2 control depends on its operation. If problems with the DMA plant's operation continue, consideration should be given to using the gas cleaning system preceding the DMA plant as an additional particulate matter control system.

3. Phelps Dodge has concluded it must conduct specific process operations in harmony with its air pollution control system. For example, only one converter is operated at a time at the Ajo smelter. Although the converter ESP's can handle larger gas volumes, the acid plant and the preceding gas cleaning system cannot.

4. Three source tests have been conducted at the Ajo smelter, two by Engineers Testing Laboratories, Phoenix, and one by Stearns-Roger, Denver. With the possible exception of the latter test, procedural errors were made to invalidate the test results. However, all three tests indicate that the smelter is not in compliance with the applicable process weight regulation. None of the source test reports contain an adequate description of methods and procedures employed by the test teams.

5. Sufficient process data was not acquired by the source test teams to compare process occurrences with source test results. Because of the complexity of smelter process operations, specific process data must be logged simultaneously with data acquired during source testing. Conclusions such as data comparability, equivalency, precision, and accuracy cannot be made without both data sets.

INSPECTION OF
PHELPS DODGE CORPORATION
NEW CORNELIA BRANCH
Ajo, Arizona
January 15, 1976
602/387-7451

INTRODUCTION

The Phelps Dodge Corporation, New Cornelia Branch, operates a mine, concentrator, and smelter at Ajo, Arizona, to produce anode copper from a chalcopyrite (copper-iron sulfide) concentrate. Average anode copper production during 1975 was 165 m. tons (185 tons)/day.

On December 16, 1975, the manager of the New Cornelia Branch was requested by letter to provide process and air pollution control information on the New Cornelia operation and informed of a planned plant inspection [Appendix A]. On January 15, 1976, the following EPA and State personnel conducted a process inspection: Mr. Meade Stirland, Arizona Department of Health; Mr. Lloyd Kostow, USEPA, Region IX; Mr. Reid Iversen, USEPA, ESED; Mr. Gary D. Young, USEPA, NEIC; Mr. Jim V. Rouse, USEPA, NEIC. The requested data were not available at the time of the inspection, but were subsequently furnished by letter dated February 2, 1976 [Appendix B].

The purpose of the inspection was to acquire data with which to evaluate the design and operation of existing particulate matter air pollution control equipment and to survey the suitability of the smelter to be emission tested. The inspection focused primarily on the smelter, although the mine and concentrator were both inspected. Also examined

were the process equipment, the particulate matter emission sources, and the air pollution control equipment. The inspection team surveyed the existing smelter source testing facilities and locations for accessibility and capability to be source tested.

Company personnel were cooperative throughout the inspection. All the information requested was supplied during the inspection, the exit interview, or by subsequent letter or telephone call. Company personnel participating included: Mr. David H. Orr, Plant Manager; Mr. Forrest R. Rickard, Smelter Superintendent; Mr. James E. Foard, Metallurgist, Phelps Dodge Western Corporate Office.

The applicable regulation contained in the Arizona State Implementation Plan (SIP) of specific interest for this inspection was the process weight regulation [Appendix C]. This regulation was promulgated as 40 CFR §52.126 on May 14, 1973, to replace the State's process weight regulation, which was determined by EPA to be not sufficiently stringent. The regulation provides for an allowable emission rate for each process unit based upon the production feed rate to the unit.

PROCESS DESCRIPTION

Figure 1 is a simplified process flow diagram for the smelter. Table 1 is a list of the smelter process equipment and operating data. Concentrate is delivered from the New Cornelia concentrator to the smelter by a 61 cm (24 in) belt conveyor. Along the way, concentrate is dried in a rotary drier, which is fired by either natural gas, when available, or diesel fuel.

Upon entering the smelter building, the belt-delivered concentrate is mixed with limestone flux in predetermined proportions and bedded.

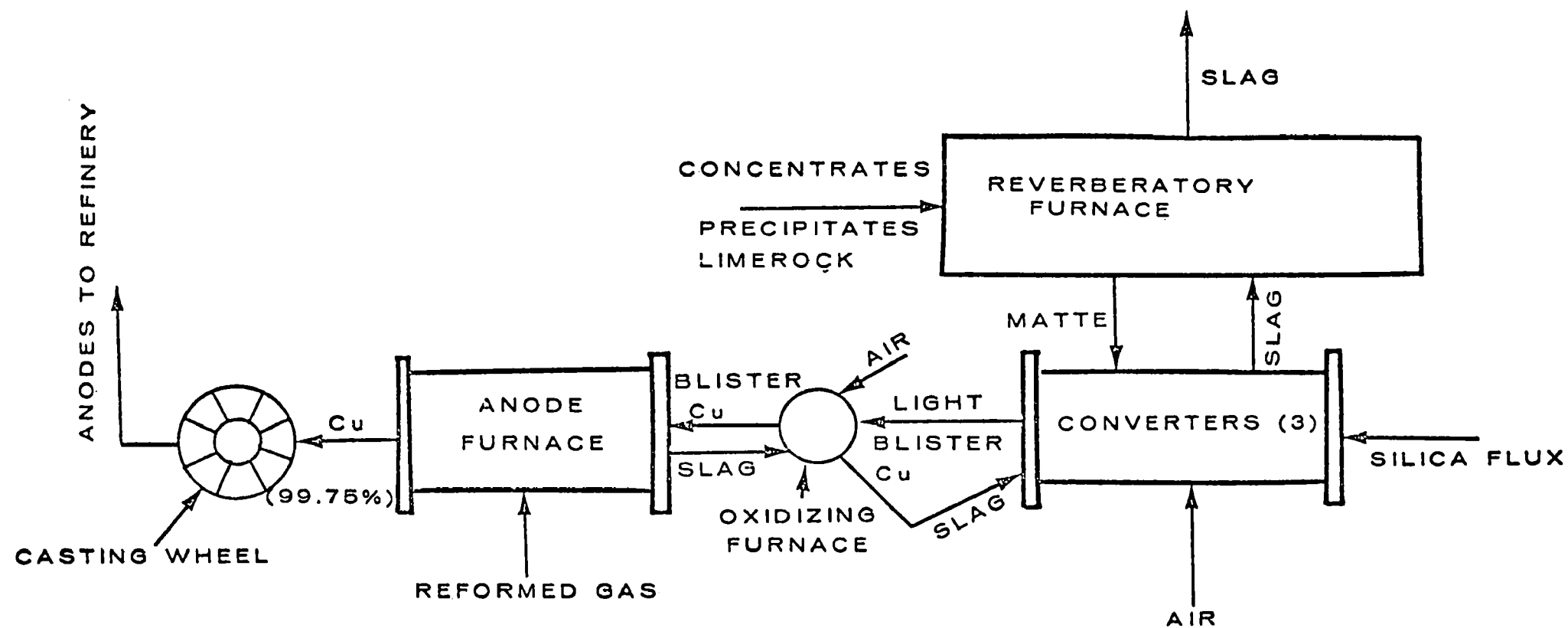


Figure 1. Phelps Dodge, Ajo Process Flow Diagram

Table 1
SMELTER PROCESS EQUIPMENT AND OPERATING DATA
PHELPS DODGE CORPORATION
Ajo, Arizona

Parameter	Reverberatory Furnace		Converters	
No. of Units	1		3	
Feed Constituents [†]	C,P,R,L,CS		M,F,R	
Feed Rate	(m. tons/day)	(tons/day)	(m. tons/day)	(tons/day)
C,P,R,L	613	676	725	799
CS	<u>431</u>	<u>475</u>		
Total	1,044	1,151		
Size of Unit	(meters)	(feet)	(meters)	(feet)
width	9	30	diameter	4 13
length	30	100	length	9 30
height	3	11		
Hours of Operation/month	624		522	
Gas Volume Generated	(m ³ /min)	(scfm)	(m ³ /min)	(scfm)
	2,200	77,900	1,100	39,500
Exit Gas Temperature ^{††}	(°C)	(°F)	(°C)	(°F)
	309*	588*	340**	650**

† Concentrates, Precipitates, Reverts, Limestone, Matte, Converter Slag, Flux (siliceous)

†† Recordings* or estimate** following waste heat boilers

As available, dusts from dust collection facilities are also added to the concentrate and crushed limestone. Concentrates from other copper concentrators -- notably Tyrone, Baghdad, and Bruce, together with copper precipitates from the Phelps Dodge Tyrone operation -- are also bedded as available.

The various materials to be smelted are put into 9 m. tons (10 tons) "cans," which are large cylindrical containers used in charging the reverberatory furnace. The filled can is moved by an overhead crane either to storage or to one of six furnace charging stations for the single reverberatory furnace.

The reverberatory furnace is 30 m (100 ft) long and 9 m (30 ft) wide, inside dimensions, mounted on a heavily reinforced concrete foundation. The reverberatory furnace is fired with natural gas, or with fuel oil if natural gas delivery is interrupted.

The reverberatory furnace walls are made of silica brick, with an interior protective surface of basic brick and, in the area of the crucible, a mixture of tamped periclase and firebrick. The walls also include 51 cm (20 in) high copper water jackets immediately above the crucible. The reverberatory furnace roof is a sprung arch constructed of silica brick. The furnace walls and arch are maintained by hot patching with silica slurry.

The reverberatory furnace is charged by positioning a can of concentrate at one of the six charging stations. A door covering the charge port is opened and a short feeder conveyor, located under the charge hopper, is started. The bottom gates of the can are then opened and the charge falls into a small feed hopper of the charging machine immediately below the can. The charging machine, referred to as a "slinger," is a short, high-speed, portable belt conveyor pivoted on a vertical shaft to permit lateral swinging. The concentrate falls from the feed hopper onto the rapidly moving belt; as the concentrate moves

over the belt head pulley, it is discharged into the furnace. The usual charge is 1.8 to 3.6 m. tons (2 to 4 tons) at an average rate of approximately 0.9 m. ton (1 ton)/min.

The normal molten material depth in the reverberatory furnace is approximately 120 cm (46 in), of which 66 to 76 cm (26 to 30 in) is matte. Slag is tapped through the side wall and flows through a launder into slag pots which are hauled by rail to the slag dump. Matte is tapped as required by the converter or reverberatory furnace conditions into ladles resting on electric-powered trucks which can be moved into the converter aisle.

The matte ladles are picked up by overhead crane and are charged to one of three Pierce-Smith 4 x 9 m (13 x 30 ft) converters. An initial charge to a converter normally consists of four 14 m. ton (16 ton) ladles of matte. Air through tuyeres is blown into the charge, flux is added to the charge, and slag produced is skimmed into a ladle. The converter slag is then returned to the reverberatory furnace by the overhead crane. Additional matte is added to the converter to produce a total of approximately 50 m. tons (55 tons) of light blister copper.

The light blister copper is poured into ladles and carried by overhead crane to the 4 m (12 ft) diameter Great Falls converter which has been modified to serve as an oxidizing furnace. The charge in the oxidizing furnace is blown with air through tuyeres to complete the sulfur removal. This use of the holding furnace for the final oxidation is considered necessary to prolong brick life in the converters and anode furnace.

Following completion of oxidation in the Great Falls converter, the copper is transferred to the anode furnace, which is 9 m (30 ft) long and 4 m (13 ft) in diameter. Reformed natural gas (cracked methane) is

introduced through tuyeres for final copper reduction. The anode-grade molten copper is cast into 330 kg (720 lb) anodes on a 22-mold casting wheel. Anodes are cooled, inspected, and loaded on railroad flat cars for shipment to the Phelps Dodge refinery in El Paso, Texas.

EMISSION SOURCES AND RELATED CONTROL EQUIPMENT

The primary particulate matter sources at the Ajo smelter are the reverberatory furnace and the converters. The majority of the exhaust gas volumes produced by these sources is treated by control systems which are discussed below. However, fugitive emissions from feeding concentrates, skimming converter slag, or returning converter slag are neither collected, nor treated, but are exhausted directly to the atmosphere. The reverberatory furnace matte and slag tap areas are hooded, and collected gases containing particulate matter are exhausted untreated directly to the smelter main stack. Similarly, converter "smoke" not collected by the primary hood system, is collected by a secondary hood system and exhausted untreated directly to the smelter main stack. The oxidizing and anode furnaces also emit some untreated particulate matter directly to the atmosphere above the converter aisle; the former probably emits the greater amount, however, the concentrations are indeterminate.

Figure 2 is a diagram of the Ajo plant layout, the air pollution control systems, and the exhaust gas flow. Table 2 summarizes certain design and operating data for the individual air pollution control systems. Appendix A contains more specific information on each control system.

Reverberatory Furnace Control System

The principal reverberatory furnace exhaust gases pass through a pair of waste heat boilers which partially cool the gases and then enter

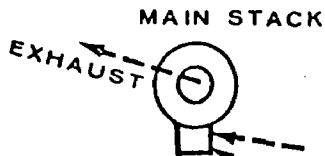


Figure 2. Phelps Dodge, Ajo Plant Layout, Process Exhaust Flow, and Air Pollution Control Systems

Table 2
SMELTER AIR POLLUTION CONTROL EQUIPMENT AND OPERATING DATA
PHELPS DODGE CORPORATION
Ajo, Arizona

Control Device	Manufacturer	Date of Installation/ Modification	No. of Units	Gas Flow Rate		Operating Temperature		Pressure Drop		Collection Area		Velocity		Retention Time
				m ³ /min	scfm	°C	°F	cm H ₂ O	in	m ²	ft ²	m/sec	ft/sec	sec
Reverberatory Furnace														
ESP	Western Precipitator (Type R)	8/73	2 (with 2 stages)	2,200	77,900	309	588	1.3	0.5	1,927	20,738	0.9	3.0	6.6
						inlet								
						230	450							
						outlet								
Scrubbers ^{a b}		1/75	1	700-1,200	25,000-43,000	200-290	400-550	3.8	1.5	NA ^c		NA		NA
						inlet								
						52-66	125-150							
						outlet								
Liquid SO ₂ plant ^d		7/74	1	1,100	38,500	32	90	Unknown		NA		NA		NA
Converter														
ESP	Western Precipitator (Type R)	1972	2 (with 3 stages)	1,100	39,500 ^e	340	650	1.3	0.5	2,890	31,104	1.3	4.2	7.1
						inlet								
						230	450							
						outlet								
Scrubbers ^{f b}		1/75	1	700-1,200	25,000-43,000	200-290	400-550	3.8	1.5	NA		NA		NA
						inlet								
						52-66	125-150							
						outlet								
Acid Plant ^g		7/74	1	990-1,200	35,000-42,000	39	102	Unknown		NA		NA		NA
						inlet								

^a Only includes humidifying tower, not the cooling tower, preceding DMA plant

^b Design and construction by Stearns-Roger in collaboration with Monsanto; no special type or model number designated

^c NA = Not applicable

^d DMA process developed by ASARCO; engineering and construction by Stearns-Roger

^e With one converter in operation

^f Only includes humidifying tower, not the cooling tower, preceding the acid plant

^g Design by Monsanto; no model number

(Should double to account for infiltration air)

a common plenum chamber for the two independent, parallel, electrostatic precipitators (ESP's). The two ESP's were designed to handle $4,200 \text{ m}^3/\text{min}$ (150,000 acfm) at 315°C (600°F) and 1.0 kg/cm^2 (13.8 psia) [$1,990 \text{ m}^3/\text{min}$ (70,400 scfm)]. [See Appendix D for example calculations of gas flow rates.] However, the typical gas flow is $4,640 \text{ m}^3/\text{min}$ (164,000 acfm) at about 309°C (588°F) [$2,200 \text{ m}^3/\text{min}$ (77,900 scfm)]. Each ESP consists of two stages with a total collection area of $1,930 \text{ m}^2$ (20,700 ft^2). Gas treatment retention time is less than 7 seconds with an average gas velocity of 0.9 m (3 ft)/sec. The pressure drop across the unit is 1.3 cm (0.5 in) of water maximum.

About 50% [$1,100 \text{ m}^3/\text{min}$ (38,500 scfm)] of the gas stream can be directed through gas cleaning equipment prior to the DMA (dimethyl-aniline) SO_2 absorption plant. The other part of the gas stream is exhausted to and discharged from the 110 m (360 ft) smelter main stack. The gas stream directed to the DMA plant first enters a humidifying tower where the gases are evaporatively cooled by a weak acid solution and some of the remaining particulate matter is removed. The gases then enter a cooling tower in which a weak acid solution percolating down through packing cools the ascending gases and removes more of the remaining particulate matter. The gases then enter the mist precipitator in which any acid mist or remaining dust particles are removed. The clean gas stream then enters the DMA absorption tower in which SO_2 is removed. Any acid mist formed is removed in the acid scrubbing section of the DMA absorption tower before the gas stream is discharged to the atmosphere through a 15 m (50 ft) stack atop the tower.

Converter Control System

The principal converter particulate matter-laden exhaust gases are produced when air is blown into the converter through the tuyeres to

oxidize the iron and copper sulfides. Approximately 100% additional air infiltrates around the primary hoods. This additional air becomes a part of the converter exhaust gas stream ducted to a waste heat boiler which further cools the gas stream. The gases then enter a common balloon flue and are carried to two independent, parallel ESP's. The two ESP's were designed to handle a total of $5,900 \text{ m}^3/\text{min}$ (210,000 acfm) at 340°C (650°F) and 1.0 kg/cm^2 (13.8 psia) [$2,660 \text{ m}^3/\text{min}$ (94,100 scfm)]. Phelps Dodge normally only operates one converter which, with infiltration air, produces a total gas volume of $1,120 \text{ m}^3/\text{min}$ (39,500 scfm). Each ESP consists of three stages with a total collection area of $2,890 \text{ m}^2$ (31,100 ft^2). Gas treatment retention time is about 7 seconds with an average gas velocity of just over 1.2 m/sec (4 ft/sec). The pressure drop across the unit is 1.3 cm (0.5 in) of water maximum.

The gas stream is then directed through gas cleaning equipment prior to the single-contact acid plant. Following the ESP's, the gas stream enters a humidifying tower, a cooling tower, and a pair of mist precipitators which are designed and function identically to the gas cleaning system preceding the DMA SO_2 absorption plant. The clean gas stream then enters the acid plant where it is dried, the SO_2 converted into SO_3 , and the SO_3 absorbed in acid to form stronger acid. Between 180 and 380 m. ton (200 to 425 tons) of 92 to 97% strength acid is produced daily. The exit gas from the absorption tower passes through a mist eliminator before it enters a duct which carries the exhaust gases to the smelter main stack.

EMISSIONS DATA

Three separate source tests were conducted at the Phelps Dodge, Ajo smelter during 1975. The first two were performed by the Engineers

Testing Laboratories (ETL), Phoenix, in April and September; the third was performed by Stearns-Roger (S-R), Denver, in November. All of the tests were conducted at the 39 m (127 ft) elevation of the smelter main stack where the stack diameter is 6.4 m (20 ft 10 in). Each test was attempted as a compliance test following the prescribed methods (Methods 1-5) in the regulation [Appendix C]. The stack has four sampling parts, however, only two are at 90° angles. During the source tests ETL used the two at 90° angles, while S-R used three ports. The sampling ports are located approximately four stack diameters downstream from the point at which the exhausts enter the smelter main stack, requiring a minimum of 36 traverse points.

Individual hourly process weights were determined by dividing the daily tonnage fed to each process unit by 24. The allowable emissions were calculated as the sum of the allowable emissions for the reverberatory furnace and converters, taken as separate processes as prescribed by the applicable process weight regulation. The sampling results were then compared with the allowable emissions; in every case the measured emission exceeded the allowable emission.

Following is a summary of each test, containing comments regarding the methods, procedures, and results of each test.

ETL: April 22-24, 1975

Sample points were calculated for 12 points on each of the two diameters, instead of for 18 points as Method 1 prescribes for a sampling station four duct diameters downstream from a flow disturbance. In addition, a 2.4 m (8 ft) probe was used because of the apparent limitation of the support monorail. Therefore, only the first 5 traverse points

could be sampled on each diameter. In fact, only traverse points #1 and #2 were used in the first run and only traverse points #3, #4, and #5 in the second and third run. The sampling train used was a Method 5 configuration with 10% hydrogen peroxide in the impingers. Stack moisture was obtained by impinger weight gain corrected for sulfur compounds. The DMA SO₂ absorption plant was not in operation during this test. The results of the three runs are presented in Table 3.

ETL: September 17-19, 1975

Sample points were calculated for 32 points for each diameter. However, during each of the three runs only traverse points #4 through #16 were used on each of the two diameters. Traverse points #1 through #3 could not be reached because the monorail support was too short for the probe length they were using. The sampling train and the method of moisture determination were the same as those used in the April test. All the particulate matter control equipment was in operation during each of the runs. The third run was abruptly terminated when the reverberatory furnace arch collapsed, but not before a sample volume had been collected which meets the minimum requirements for the test procedure. Isokinetic variation was within prescribed Method 5 tolerances. The results of the three runs are presented in Table 3.

S-R: November 10-13, 1975

Three of the four sampling ports were used for this test -- the two at 90° and the third which is about 135° from the other two. Twelve traverse points were calculated and used on each of the three radii. A Method 5 sampling train was used with 80% isopropanol in the first and second impingers, nothing in the third impinger, and 5% hydrogen peroxide

Table 3
PARTICULATE MATTER EMISSIONS TEST RESULTS
PHELPS DODGE CORPORATION
Ajo, Arizona

Test Run	Date	Stack Temperature		Gas Volume		Moisture Content	Actual Emissions		Allowable Emissions	
		°F	°C	acfm	m ³ /min		%	lb/hr	kg/hr	lb/hr
ETL										
1	4-22-75	254	123	390,000	11,000	4.0	214	97	61	28
2	4-23-75	252	122	443,000	12,500	4.1	173	78	61	28
3	4-24-75	255	124	473,000	13,400	4.0	207	94	59	27
12	9-17-75	213	101	337,000	9,540	3.5	280	127	63	29
13	9-18-75	212	100	309,000	8,750	3.2	151	68	61	28
14	9-19-75	212	100	348,000	9,850	2.6	164	74	61	28
S-R										
1	11-10-75	205	96	311,800	8,830	2.3	295	134	ND [†]	
2	11-12-75	215	102	350,200	9,920	2.5	647	293	ND	
3	11-13-75	212	100	335,800	9,510	3.5	409	186	ND	

25 7

† Not Determined

in the fourth impinger. Moisture content was acquired simultaneously with each particulate run by a separate train run according to Method 4 in the fourth sampling port. Stack gas pressure and Orsat samples were obtained at the same sampling port. The results of the three runs are presented in Table 3.

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4. SO₂ Absorption Plant at the New Cornelia Branch of Phelps Dodge Corporation, Ajo, Arizona. W. J. Chen, Gas Treatment Plant Foreman, Apr. 26, 1974.
5. Engineering Drawing AS-09-1-02, Revision 4. Gas Systems Modifications, General Plot Plan. Stearns-Roger Corporation, Denver, Jan. 2, 1975.
6. Compilation and Analysis of Design and Operating Parameters of the Phelps Dodge Corporation New Cornelia Branch Smelter, Ajo, Arizona for Emission Control Studies. Pacific Environmental Services, Inc., Santa Monica Jan. 1976.
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9. Ajo Copper Smelter Tests for Particulate Emission, Phelps Dodge Corporation, New Cornelia Branch, November 10-13, 1975. Stearns-Roger Incorporated, Denver, Dec. 1, 1975.
10. Letter from James E. Foard, Metallurgist for Western Operations, Phelps Dodge Corporation to Gary D. Young, EPA-NEIC, Denver, Apr. 6, 1976.

APPENDICES

- A NEIC Information Request
Letter to Phelps Dodge
- B Phelps Dodge Response to
NEIC Information Request
- C SIP Regulation Applicable to
Phelps Dodge
- D Example Calculations of Gas
Flow Rates

Appendix A
NEIC Information Request
Letter to Phelps Dodge

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT
NATIONAL FIELD INVESTIGATIONS CENTER— DENVER
BUILDING 53, BOX 25227, DENVER FEDERAL CENTER
DENVER, COLORADO 80225
December 17, 1975

19

D. H. Orr
Manager
New Cornelia Branch
Phelps-Dodge Corporation
Ajo, Arizona 85231

Dear Mr. Orr:

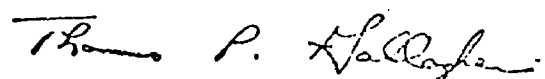
The Environmental Protection Agency has undertaken a program to evaluate the performance characteristics of particulate control facilities at the copper smelters in Arizona and Nevada. Representatives of EPA will observe each smelter's process operations and air pollution control facilities, review source test data, examine appropriate records, etc., during a site inspection of each smelter.

In anticipation of such a site inspection of your smelter, we have prepared the attached list of detailed information needs which we intend to use as a discussion outline during our inspection. We would appreciate it if you could inform the appropriate company personnel about the attached list and the forthcoming inspection of your facility so that the necessary information will be readily available and the inspections can be expedited.

We are conducting these inspections under the authority of Section 114(a)(ii) of the Clean Air Act, which authorizes representatives of EPA to enter facilities for the purpose of determining whether the facility is in violation of any requirement of a state implementation plan. At your facility, we anticipate that EPA or a contractor hired by EPA will be conducting an emissions source test for particulate matter within the next few months. Therefore, EPA will make a source test pre-survey, either separately or in conjunction with our site inspections, prior to performing such a source test.

If you have any questions concerning the purpose of these site inspections, please feel free to contact Mr. Gary D. Young of my staff (303/234-4658) or Mr. Larry Bowerman, EPA Region IX (415/556-6150). Mr. Young will be in contact with you within the next few weeks concerning a site inspection of your smelter during January or early February.

Sincerely,



Thomas P. Gallagher
Director

Attachment

cc: Richard O'Connell
Bruce Scott

COPPER SMELTER INFORMATION NEEDS

A. GENERAL

1. Plant location
2. Person to contact regarding plant survey information needs, his telephone number and address
3. Simple block flow diagram showing smelter process equipment, air pollution control devices, and stack configuration

B. PROCESS

1. General

- a. Detailed description of the process, including flow diagrams, unique features, and how the process operates
- b. Definition of normal operation
- c. Actual production rate (lbs blister copper/hr and percent Cu)
- d. Type and quantity of fuel consumed

Oil - i. Heating value (BTU's/gal)
ii. Percent sulfur (by weight)
iii. Percent ash (by weight)
iv. Specific gravity
v. Consumption (gals or bbls/yr)

Gas - i. Type of gas (constituents in percent by weight)
ii. Density (lbs/SCF)
iii. Heating value (BTU's/SCF)
iv. Percent sulfur (by volume and grains/SCF)
v. Consumption (SCF/yr)

Coal - i. Heating value (BTU's/T)
ii. Percent sulfur (by weight)
iii. Percent ash (by weight)
iv. Consumption (lbs/unit/hr)

- e. Ore composition, including a typical percent and range of percentages for each chemical constituent
- f. Flux composition, including a typical percent and range of percentages for each chemical constituent
- g. Standard conditions - pressure (psi) and temperature (°F). - used to calculate SCFM

2. Concentrators

- a. Design process feed rate (lbs raw ore/hr)
- b. Actual process feed rate (lbs raw ore/hr), including method and estimated accuracy of measurement
- c. Average number of hours of operation per month
- d. Process instrumentation used, including data for a typical reading and range of readings
- e. Description of where and how samples of process material can be collected
- f. Description of typical types of process fluctuations and/or malfunctions, including frequency of occurrence and anticipated emission results
- g. Expected life of process equipment (years)
- h. Plans to modify or expand process production rate

3. Roasters

- a. Design process feed rate (lbs concentrate/hr)
- b. Actual process feed rate (lbs concentrate/hr), including method and estimated accuracy of measurement
- c. Design process gas volumes (SCFM)
- d. Actual process gas volumes (SCFM), including method of determination, calculation, or measurement
- e. Actual process temperature (°F)
- f. Average number of hours of operation per month
- g. Process instrumentation used, including data for a typical reading and range of readings
- h. Description of where and how samples of process material can be collected
- i. Description of typical types of process fluctuations and/or malfunctions, including frequency of occurrence and anticipated emission results

- j. Expected life of process equipment (years)
- k. Plans to modify or expand process production rate

4. Reverberatory furnaces

- a. Design process feed rate (lbs calcine/hr + lbs flux/hr + lbs converter slag/hr)
- b. Actual process feed rate (lbs calcine/hr + lbs flux/hr + lbs converter slag/hr), including method and estimated accuracy of measurement
- c. Design process gas volumes (SCFM)
- d. Actual process gas volumes (SCFM), including method of determination, calculation, or measurement
- e. Actual process temperature (°F)
- f. Average number of hours of operation per month
- g. Process instrumentation used, including data for a typical reading and range of readings
- h. Description of where and how samples of process material can be collected
- i. Description of typical types of process fluctuations and/or malfunctions, including frequency of occurrence and anticipated emission results
- j. Expected life of process equipment (years)
- k. Plans to modify or expand process production rate

5. Converters

- a. Design process feed rate (lbs matte/hr + lbs slag/hr + lbs flux/hr)
- b. Actual process feed rate (lbs matte/hr + lbs slag/hr + lbs flux/hr), including method and estimated accuracy of measurement
- c. Design process gas volumes (SCFM)
- d. Actual process gas volumes (SCFM), including method of determination, calculation, or measurement
- e. Actual process temperature (°F)

- f. Average number of hours of operation per month
 - g. Process instrumentation used, including data for a typical reading and range of readings
 - h. Description of where and how samples of process material can be collected
 - i. Description of typical types of process fluctuations and/or malfunctions, including frequency of occurrence and anticipated emission results
 - j. Expected life of process equipment (years)
 - k. Plans to modify or expand process production rate
6. Refining Furnaces
- a. Design process feed rate (lbs blister copper/hr)
 - b. Actual process feed rate (lbs blister copper/hr), including method and estimated accuracy of measurement
 - c. Design process gas volumes (SCFM)
 - d. Actual process gas volumes (SCFM), including method of determination, calculation, or measurement
 - e. Actual process temperature (°F)
 - f. Average number of hours of operation per month
 - g. Process instrumentation used, including data for a typical reading and range of readings
 - h. Description of where and how samples of process material can be collected
 - i. Description of typical types of process fluctuations and/or malfunctions, including frequency of occurrence and anticipated emission results
 - j. Expected life of process equipment (years)
 - k. Plans to modify or expand process production rate

C. EMISSIONS

1. List of sources of particulate emissions in the plant (including fugitive emissions)
2. Level of uncontrolled particulate emissions by source (lbs/hr or T/yr)
3. Existing source test data employed for particulates by stack, process unit, or control device, including:
 - a. Test method
 - b. Data acquired
 - c. Operating process weight rate
 - d. Calculations
 - e. Test results
4. Particle size and chemical composition of uncontrolled particulate emissions, including method of determination
5. Level of uncontrolled visible emissions by source (percent opacity) and method of determination
6. Extent of and reason for variance of particulate emissions with:
 - a. Process design parameters
 - b. Process operating parameters
 - c. Raw material composition or type
 - d. Product specifications or composition
 - e. Production rate
 - f. Season or climate
 - g. Sulfur dioxide control

D. CONTROL SYSTEMS

1. Detailed description of the particulate and sulfur dioxide emissions control systems, including:
 - a. Process treated

- b. Type of fuel consumed per unit
- c. Quantity of fuel consumed per unit
- d. Method of determination of design parameters
- e. Engineering drawings or block flow diagrams
- f. Expected life of control system
- g. Plans to upgrade existing system

2. Electrostatic precipitators

- a. Manufacturer, type, model number
- b. Manufacturer's guarantees, if any
- c. Date of installation or last modification and a detailed description of the nature and extent of the modification
- d. Description of cleaning and maintenance practices, including frequency and method
- e. Design and actual values for the following variables:
 - i. Current (amperes)
 - ii. Voltage
 - iii. Rapping frequency (times/hr)
 - iv. Number of banks
 - v. Number of stages
 - vi. Particulate resistivity (ohm-centimeters)
 - vii. Quantity of ammonia injected (lbs/hr)
 - viii. Water injection flow rate (gals/min)
 - ix. Gas flow rate (SCFM)
 - x. Operating temperature (°F)
 - xi. Inlet particulate concentration (lbs/hr or grains/SCFM)
 - xii. Outlet particulate concentration (lbs/hr or grains/SCFM)
 - xiii. Pressure drop (inches of water)

3. Fabric filters

- a. Manufacturer, type, model number
- b. Manufacturer's guarantees, if any
- c. Date of installation or last modification and a detailed description of the nature and extent of the modification

- d. Description of cleaning and maintenance practices, including frequency and method
- e. Filter material
- f. Filter weave
- g. Bag replacement frequency
- h. Forced or induced draft
- i. Design and actual values for the following variables:
 - i. Bag area (ft²)
 - ii. Bag spacing (inches)
 - iii. Number of bags
 - iv. Gas flow rate (SCFM)
 - v. Operating temperature (°F)
 - vi. Inlet particulate concentration (lbs/hr or grains/SCF)
 - vii. Outlet particulate concentration (lbs/hr or grains/SCF)
 - viii. Pressure drop (inches of water)

4. Scrubbers

- a. Manufacturer, type, model number
- b. Manufacturer's guarantees, if any
- c. Date of installation of last modification and a detailed description of the nature and extent of the modification
- d. Description of cleaning and maintenance practices, including frequency and method
- e. Scrubbing media
- f. Design and actual values for the following variables:
 - i. Scrubbing media flow rate (gals/min)
 - ii. Pressure of scrubbing media (psi)
 - iii. Gas flow rate (SCFM)
 - iv. Operating temperature (°F)
 - v. Inlet particulate concentration (lbs/hr or grains/SCF)
 - vi. Outlet particulate concentration (lbs/hr or grains/SCF)
 - vii. Pressure drop (inches of water)

5. Sulfuric acid plants

- a. Manufacturer, type, model number

- b. Manufacturer's guarantees, if any
- c. Date of installation or last modification and a detailed description of the nature and extent of the modification
- d. Description of cleaning and maintenance practices, including frequency and method
- e. Frequency of catalyst screening
- f. Type of demister
- g. Design and actual values for the following variables:
 - i. Production (T of acid/day)
 - ii. Conversion rate (percent)
 - iii. Acid strength (percent H_2SO_4)
 - iv. Number of catalyst beds
 - v. Gas flow rate (SCFM)
 - vi. Operating temperature ($^{\circ}\text{F}$)
 - vii. Inlet SO_2 concentration (ppm)
 - viii. Outlet SO_2 concentration (ppm)
 - ix. Acid mist (lbs H_2SO_4 /T of acid)
 - x. Blower pressure (psi)

6. Liquid SO_2 plants

- a. Manufacturer, type, model number
- b. Manufacturer's guarantees, if any
- c. Date of installation or last modification and a detailed description of the nature and extent of the modification
- d. Description of cleaning and maintenance practices, including frequency and method
- e. Absorbing media
- f. Design and actual values for the following variables
 - i. Production (T of SO_2 /day)
 - ii. Conversion rate (percent)
 - iii. Gas flow rate (SCFM)
 - iv. Operating temperature ($^{\circ}\text{F}$)
 - v. Inlet SO_2 concentration (ppm)
 - vi. Outlet SO_2 concentration (ppm)
 - vii. Acid mist (lbs H_2SO_4 /T of SO_2)

7. Detailed description of how the particulate and sulfur dioxide emission control systems operate
8. Description of instrumentation (flow meters, continuous monitors, opacity meters, etc.) used, including manufacturer and model number, data for typical and range of readings, and identification of location by process unit, control system unit, or by stack
9. Description of typical types of control system malfunctions, including frequency of occurrence and anticipated emission results

E. STACKS

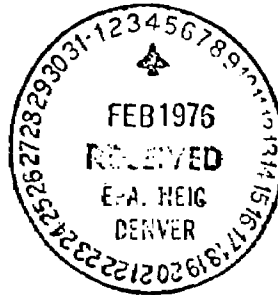
1. Detailed description of stack configuration, including process and/or control system units exhausted
2. Identification by stack of:
 - a. Heights (ft above terrain)
 - b. Elevation of discharge points (ft above sea level)
 - c. Inside diameters (ft)
 - d. Exit gas temperatures (°F)
 - e. Exit gas velocities (ft/sec)

Appendix B
Phelps Dodge Response
To NEIC Information Request



Phelps Dodge Corporation New Cornelia Branch, Ajo, Arizona 85321

February 2, 1976



Mr. Thomas P. Gallagher, Director
Environmental Protection Agency
Office of Enforcement
National Field Investigations Center
Building 53, Box 25227,
Denver Federal Center
Denver, Colorado 80225

Dear Mr. Gallagher:

As promised at the time of the on-site inspection of the New Cornelia Branch Smelter on January 15, attached is the response to the questionnaire that accompanied your letter to me dated December 17, 1975.

The information requested in paragraph A(3) of the questionnaire was given to your Mr. Gary D. Young during the Ajo visit and is not included in this packet.

Very truly yours,

D. H. Orr,
Manager

DHO:tjp

cc: W/O A(3) information and test data

FRR

JMS

MPS

JHD

JFB

Nils I. Larson

COPPER SMELTER INFORMATION NEEDS

Phelps Dodge Ajo Smelter

A. General

1. Phelps Dodge Corporation.
New Cornelia Branch
Ajo, Arizona 85321

See Stearns-Roger Drawing No. AS 09-1-02

2. David H. Orr, Manager
P. O. Drawer 9
Ajo, Arizona 85321
(602) 387-7451

3. See following papers and drawings:

- i) "Operations at New Cornelia Copper Smelter of Phelps Dodge Corporation"
- ii) Drawing AS 09-1-02
- iii) "Gas Treatment Facilities at the New Cornelia Branch of Phelps Dodge Corporation"
- iv) "Use of the Gas Coolers (Waste Heat Boilers) in the Converter Department at the New Cornelia Branch of the Phelps Dodge Corporation".
- v) "SO₂ Absorption Plant at the New Cornelia Branch of Phelps Dodge Corporation"

B. Process

1. General

- a) See Item (3i) above.
- b) Operations are normal whenever process units scheduled for use achieve their nominal daily level of performance or availability.

c) Copper Production

- i) Anode Copper (99.75% Cu)
- ii) Range : 125-210 tpd
- iii) Average (1975) : 185 tpd.

d) Fuels

See Attachment 1 - Fuel Summary
Coal - None

e) See Attachment 2 - Composition of Materials Treated.

f) See Attachment 2 - Composition of Materials Treated.

g) Standard conditions*

14.7 psi (29.92 inches mercury)
70° F

* Except as noted.

2. Concentrators

(a) - (c)

	<u>Feed Rate</u> <u>(tpd)</u>	<u>Operation</u> <u>(Hr./Mo.)</u>	<u>Weightometer</u> <u>Accuracy (%)</u>
Design	32,000	NA	
Actual	32,300	625	+ 1.5

- d) Weightometers are used to measure the ore into the plant. The weightometers have limits of 0-200 T/hr. No other instrumentation is used for accounting purposes. Grinding circuits are instrumented to indicate conditions in each individual grinding circuit and to control the feed rate, i.e. ... classifier load, classifier overflow density, section feed rate.
- e) Process samples are taken automatically during the operating period at various control points in the Concentrator - Feed, Rougher Concentrate, Cleaner Tail, Final Concentrate, and Tails.
- f) Fluctuations in process may occur when the ore delivering from the mine is interrupted or when hardness varies. The feed rate to the ball mills will be varied accordingly. The hardness of the ore can change daily. Emissions are not affected as there are none.

g) Many years - no firm figure.

h) None

3. Roasters

None

4. Reverberatory Furnaces

(a) - (d)

	<u>Feed Rate Solid chg. (tpd) *</u>	<u>Converter Slag (tpd)</u>	<u>Reverb Gas Volume (ACFM)</u>
Design	700	NA	150,000 @ 600°F
Actual	676	475	164,000 @ 588°F
Maximum	863	NA	NA

* Includes flux, concentrates, precipitates, dusts

Solid charge weighed in feed containers on platform scales. Accuracy $\pm 3.0\%$.

Converter slag is unweighed and is estimated on basis of number ladles (each estimated to hold 14.5 tons of slag when full) returned to the furnace. Accuracy $\pm 10\%$.

Gas volumes obtained from pitot traverse of flue.

e)	<u>°F</u>
Furnace smelting zone	2650
Waste heat boiler outlet	580-620

f) Monthly operation - 624 hours (1975)

g) <u>Instrumentation</u>	<u>Readings</u>	
	<u>Range</u>	<u>Typical</u>
Furnace draft gauge	0.0-pos. 0.1" wc	+ .03
Fuel flow meters		
Oil	228-1140 gph	1140
Gas	55000-177,000 cfm	177,000
Temperature recorder		
Boiler Outlet	580-620	600

h)

<u>Material</u>	<u>Sampling Location</u>	<u>Sampling Method</u>
Reverb slag	Skim hole	Grab sample in steel cup
Matte	Matte launder	Grab sample in steel cup
Ajo concentrates	Ahead & after filters	Automatic samplers
	At dryer discharge	Grab sample from belt
Custom conc.	In railroad cars	Slit pipe driven thru material
Limerock	At crushing plant	Automatic samplers

i)

<u>Cause of Fluctuation</u>	<u>Frequency</u>	<u>Emission Effect</u>
Charging cycle	Every 15 min.	Peak emissions during charging
Change in character of feed	Twice a week	Reduced smelting rate reduces emissions
Power outage	Once a year	Reduces emissions
Misc. mechanical failures	Twice a week	Reduces emissions

j) Indefinite

k) None

5. Converters

(a) - (f)

	<u>Feed Rate (tpd)</u>	<u>Gas Vol. (scfm)**</u>	<u>Converter Temp. (°F)</u>	<u>Operating Time (hr./mo.)</u>
Design	NA	39500	NA	NA
Actual	799*	35-42,000	1900-2250	522

* Includes matte, flux, and reverts.

** One converter operation.

Matte to converter is estimated by number of ladles (each containing approximately 15.75 tons). Accuracy $\pm 10\%$. Flux and reverts estimated on assumed weight per container added. Accuracy $\pm 10\%$.

Gas volumes calculated from pitot tube traverse of exit duct to acid plant.

g)

<u>Instrumentation</u>	<u>Readings</u>	
	<u>Range</u>	<u>Typical</u>
Blast air flow meter	15-35000 scfm	20,000
Temperature Recorder	1900-2250°F	2150
SO ₂ Recorder	0.0-13.0%	3-9

h)

<u>Material</u>	<u>Sampling Location</u>	<u>Sampling Method</u>
Matte	At reverb furnace	As previously described
Slag	At converter	Rod sample during skim
Flux	At crushing plant	Automatic
Reverts	Not sampled	--
Blister Copper	Not sampled	--

i)

<u>Cause of Fluctuation</u>	<u>Frequency</u>	<u>Emission Effect</u>
Changing matte grade	Twice a week	Low grade prolongs blowing, increases emissions
Changing air blasts	Continually	Directly related
Matte shortage	Twice a week	Curtailment reduces emissions
Mechanical failure	Once a month	Emissions may drop to zero

j) Indefinite - no firm figure.

k) None

6. Refining Furnaces

(a) - (d)

	<u>Feed Rate (tpd)</u>	<u>Gas Volumes (scfm)</u>	
		<u>Oxidizing</u>	<u>Reducing</u>
Design	250	NA	1500
Actual	185	NA	1200-1300

Anode product is weighed on platform scales. Error is negligible.

e) Process temperatures are not measured.

f) Refining time - 580 hours per month.

g) None

h)

<u>Material</u>	<u>Sampling Location</u>	<u>Sampling Method</u>
Refined copper	Casting wheel	Grab sample caught in steel spoon during copper pour.

- i) No fluctuations affecting emissions.
- j) Indefinite
- k) None.

C. Emissions

(1) - (3)

Emission Sources	Particulate Loading (lb./hr)		Source of Test Data
	To Control System	From Control System	
Crushing Plant	NA	NA	None
Reverberatory Process Gas			
i) Portion not treated in DMA plant. Vented to main stack	350.6	34.2	(a)
ii) Portion treated in DMA plant.	Nil	Nil	Assumed
Converter Process Gas			
i) Portion not treated in acid plant. Vented to main stack.	NA	108	(b)
	NA	6.13	(c)
ii) Portion treated in acid plant. Vented to main stack.	Nil	Nil	Assumed
Fugitive Gas			
i) Portion captured by launder and converter hoods. Vented to main stack.	NA	*	None
ii) Portion escaping hoods	NA	*	None

* Vented fugitive gas does not pass through control systems.

(a) Western Precipitation Inc. precipitator efficiency tests, 10/24-11/2/72. WP Method 50 test method used, measuring hard particulates only.

(b) Engineering Testing Laboratories tests, 5/19-29/75. EPA Method 5 used, measuring hard particulates plus acid mist and metallic sulfates.

(c) Stearns-Roger test (1975), using WP method 50. Hard particulates only.

Main Stack

- 1) Collects all vented gas except DMA plant gas.
- 2) Test results by Method 5 have shown particulate loadings of stack discharge to range between 151 and 647 lbs./hr., and higher, if post filter catchments are included.
- 3) See Attachments (3), (4), (5) for test methods, test data, etc.

4. No definitive testwork has been carried out.
5. See Attachment 6 - opacity readings.
6. Variances have been due to the following factors:
 - a) Expected performance of particulate control equipment was based on the ability of this equipment to collect hard particulates only, as determined by ASTM approved methods of measurement. EPA's prescribed Method 5, when applied to most smelter gas streams, will collect sulfuric acid mist and other sulfates as well, which are weighed as particulate matter.
 - b) Stack temperatures on SO₂ controlled gas streams are generally lower than on untreated streams, which aggravates the sulfate condensation problem. Intentions to re-heat these gases have been thwarted by energy restrictions and burner problems.
 - c) The process weight tables used to determine compliance are inappropriate for application to the Ajo smelter.
 - d) The fluctuating nature of normal smelter operation, plus the ups and downs in the SO₂ control trains, is hard on electrostatic precipitators and tends to reduce their efficiency and accelerate their deterioration.

There have been no deviations from design specifications or changes in operating parameters which would significantly contribute to the variances which have been experienced.

D. Control Systems

1. Descriptions

a) Process treated.

i) Reverberatory furnace gas

The gas stream is first treated for particulate removal in an electrostatic precipitator (see following section).

At present, approximately 50% of this gas can be further treated for removal of particulate matter in the scrubbing section of the DMA (dimethylaniline) absorption plant for SO₂ removal. This equipment consists of a spray chamber, a packed cooling tower, and an acid mist precipitator. Very efficient particulate removal is obtained. Tests indicate excellent SO₂ removal as well (165 ppm output).

Many problems have been encountered in running this plant. We are still gathering data to determine the plant's shortcomings

D. 1. a) i) Cont'd

Meanwhile, equipment breakdowns are costly and are preventing operation, thereby removing part of the particulate control and all of the SO₂ control from the reverberatory furnace gases.

ii) Copper converter off gases.

Treated for particulate removal by an electrostatic precipitator described in a following section.

The gas is scrubbed for further particulate removal and cooling. A spray chamber (humidifying tower) washes and cools the gas. A packed cooling tower condenses moisture and removes any residual solids. Electrostatic mist precipitators are utilized to remove acid mist droplets. Essentially all of the particulate material is removed before the gas enters the acid plant for SO₂ removal.

SO₂ control of the converter gases is achieved with varying success as the SO₂ percentage in the gas varies.

(b) - (c)

<u>Unit</u>	<u>Fuel Type</u>	<u>Fuel Quantity</u>
Acid Plant	Natural gas or No.2 Diesel Oil	600m cfd natural gas or equivalent - Oil (160-170 gph).

Although equipped with burners which can burn either natural gas or No. 2 diesel oil, the electrostatic precipitators are not consuming any fuel because of fuel restrictions and mechanical difficulties in the burners themselves.

- d) Design parameters (such as the volume, chemical content, and particulate loading of various process gas streams) were for the most part established theoretically, although backed up by actual measurement and experience in some cases. The newly adopted control processes introduced many new parameters, for which actual advance measurement would have been impossible.
- e) See references in paragraph A (3) above.
- f) Normal life of about 20 years will probably be reduced because of accelerated deterioration due to many process upsets.
- g) None.

2. Electrostatic Precipitators

Electrostatic Precipitators	Reverberatory	Converter
a. Manufacturer, type and model number	Western Precipitation, Div. Joy Manufactureing Company Type R - No model number.	Western Precipitation Div. Joy Manufacturing Company Type R - No model number.
b. Manufacturer's guarantees, if any	96.83% of entering particulate subject to following: <ol style="list-style-type: none"> 1. At the option of the Company, an outlet loading of 40 #/hr. will satisfy the guarantee. 2. The determination of collection efficiency will be by the Company's standard procedure as described in Bulletin WP-50. 3. Maximum inlet grain loading of 2.25 grains per scf (32°F & 14.7 psia). 	<u>Converter Cases</u> 97.5% and 41#/hr. under same statements as for reverb electrostatic precipitator. Maximum inlet grain loading of 2.10 grains/scf.
c. Date of installation or last modification and a detailed description of the nature and extent of the modification:	Last modification was addition of Transformer-Rectifier unit, Aug. 23, 1973. Original precipitator had two T-R units, full wave 45 KV, 1100 MA, voltage primary: 400. Additional T-R unit added was 87.5 KVA with 440V and 210 maximum amperage (1400 MA T-R). The original installation consisted of two, one-chamber-wide, two-field-deep precipitators in parallel. The inlet field of each precipitator was energized by a common 1100 MA T-R which energized the inlet fields of both precipitators was replaced with a 1400 MA T-R. The 1100 MA T-R originally energizing the inlet fields was installed above the outlet field of one precipitator and the other 1100 MA T-R unit that energized both outlets was reconnected to energize one outlet field.	No modifications since installed in 1972.

2. Electrostatic Precipitators

Electrostatic Precipitators	Reverberatory	Converter
<p>d. Description of cleaning and maintenance practices, including frequency and method.</p>	<p>Removal of dust is done by screw conveyor which operates with an electric timer set at 30 minutes on and 30 minutes off throughout the 24 hours.</p> <p>The collecting plates, discharge electrodes, and gas distribution plates use MD 850A electric rappers. The hoppers have been equipped with air vibrators - hand operated during the day to eliminate build-ups that may cause shorts in the electrodes. During shut down period, (about once per month) the hoppers are inspected and cleaned out, if necessary.</p> <p>Broken insulators are changed immediately upon being detected. Broken wire electrodes require more time since the chamber must be isolated and cooled off so that men may go inside. However, most often, wire electrodes break and fall clear and do not cause shorts.</p>	<p>Removal of dust by screw conveyors continuously. The collecting plates, discharge electrodes, and gas distribution plates use MD-850A electric rappers; the hoppers have been equipped with air vibrators which are manually operated to avoid dust build ups.</p> <p>Hoppers are inspected and cleaned once per month. Broken insulators are changed immediately. Broken wire electrodes require more time since chamber must be isolated and allowed to cool. However, wire electrode breaks are infrequent, most of the time these fall clear.</p>
<p>e. Design and actual values for the following variables: Current - (amperes)</p> <p>Voltage -</p> <p>Rapping frequency (times/hr.)</p>	<ol style="list-style-type: none"> Two T-R sets rated 45 kv-400 volts, 1100 MA One T-R sets rated 87.5 kva-400 volts, 1400 MA 440 volts primary-maximum; actual 256 volts primary. Intermittent rapping with 28 electric rappers complete 15 cycles per hour. 	<ol style="list-style-type: none"> Three T-R sets rated 45 kv-400 volts, 1100 MA Actual amperes: 53 average 440 volts, 3 phase; actual 228 volts primary Intermittent rapping with 40 electric rappers complete 12 cycles per hour.

2. Electrostatic Precipitators

Electrostatic Precipitators	Reverberatory	Converter
(Continued)		
Number of banks.	4. Two	4. Two
Number of stages	5. Two	5. Three
Particulate resistivity (ohm-centimeters)	6. We do not have this information.	6. We do not have this information.
Quantity of ammonia injected (lbs/hr)	7. No ammonia is injected.	7. No ammonia is injected.
Water injection flow rate (gals/min)	8. No water is injected.	8. No water is injected.
Gas flow rate (scfm)-3.02 ft/sec.	9. Design: 150,000 acfm @ 600°F. Actual: 164,000 acfm @ 588°F.	9. Design: 210,000 acfm @ 650°F. Actual: 39,500 scfm (1 converter)
Operating temperature (°F)	10. Design: 600°F maximum Actual: 450-550°F	10. Design: 650°F Actual: 450-650°F
Inlet particulate concentration (lbs/hr or grains/scfm)	11. Design: 2.25 grains max. scf (32°F and 14.7 psia) Actual: 421 lbs. per hr.*	11. Design: 1,079 lbs/hr. Actual: 246 lbs/hr.***
Outlet particulate concentration (lbs/hr or grains/scfm)	12. Design: 0.063 particulate concentration Actual: 47 lbs. per hour (1975)**	12. Design: 41 lbs/hr. Actual: 6.13 lbs/hr.***
Pressure drop (inches of water)	13. 0.5 inches of water	13. 0.5 inches of water negative

* 1975 Tests by Engineering Testing Laboratories, using WP Method 50. Hard particulates only.

** 1975 Tests by Engineering Testing Laboratories, using EPA Method 5 with sulfates deducted.

***1975 Tests by Stearns-Roger, using WP Method. Hard particulates only.

3. Fabric Filters

None

4. Scrubbers

Scrubbers are installed after the reverberatory and converter electrostatic precipitators as further steps in cleaning the gases before their entry into the DMA and acid plants. Scrubbers of two types are used in series: an open-type spray chamber (humidifying tower), followed by a packed tower (cooling tower). Since the cooling tower performs a very minor role in particulate removal, information on the humidifying tower only is reported.

- a) The humidifying towers were designed and constructed by Stearns-Roger, Inc. in collaboration with Monsanto Enviro-Chem Systems, Inc. No special type designation or model number were specified.
- b) Dust collection efficiency of 98% is guaranteed under the specified operating conditions.
- c) The revisions to the towers were completed the week of January 22, 1975 and included: the complete removal of the tray portions of the towers on the upper dome, the replacement of the stainless steel upper dome with a carbon steel shell lined with lead and acid brick; and a complete new spray system with plastic fog spray nozzles.
- d) Units are inspected annually. The build-up of scrubbing liquid (weak acid solution) is purged along with the concentrator tailings to the tailings dam. Repairs to fiberglass weak acid piping and the Worthington pumps are made as required during operations. As inspections indicate, plans are made for internal repairs during scheduled shut down periods.
- e) Scrubbing medium: Weak sulfuric acid at about 125° F and 0.7% H₂SO₄.

f)	Design	Actual
i) Scrubbing media flow rate (gpm)	1,400	NA
ii) Scrubbing media pressure (psi)	30	45-50
iii) Gas flow rate (scfm)	39,800	25-43,000
iv) Operating temperature (°F)		
Inlet	600-700	400-550
Outlet	150	125-150
v) Inlet particulate loading (lb/hr)	NA	6.13
vi) Outlet particulate loading (lb/hr)	NA	NA
vii) Pressure drop (" WC)	0.27	1.5

D. Control Systems - Continued

5. Sulfuric acid plant

- a) Plant designed by Monsanto Enviro-Chem Systems, Inc. Single contact plant. No model number.
- b) Guaranteed to produce 740 short tons of H_2SO_4 (100% equivalent) when supplied with adequate volume of 9.8% SO_2 .

Effluent gas not to exceed 2500 ppm SO_2 when operating at designed condition.

- c) One significant modification has previously been covered in the description of the changes to the humidifying towers (scrubbers).

It was determined soon after startup that one mist precipitator was insufficient for removal of acid mist from the process gas. The two mist precipitators in the two gas cleaning systems were connected in series for use in the acid plant gas cleaning train. This gave the acid plant adequate mist elimination and required the construction of two additional mist precipitators for the SO_2 plant gas cleaning train. Modification to the acid plant was completed in early July 1974.

- d) The plant was originally intended to have a preventative maintenance program in force at all times. For the most part this has never materialized. As the acid plant is an integral part of the entire Ajo operation, major or minor repairs requiring skilled tradesmen must be scheduled.

There is a crew of two full time repairmen that repair and maintain spare equipment and work on faulty operating equipment as the plant operations permit.

Three full time instrument men are also employed to keep essential instrumentation in proper repair.

Each year the entire operation is shut down for major repairs. A previously arranged private contract is carried out with plant supervision to complete a list of repairs and inspections. This repair period lasts three weeks, normally.

Depending on the smelter operating schedule, the acid plant may experience two to four shut down days per month. The repairmen and, if required, tradesmen are scheduled to work on these days to correct problems or potential problems. Also, there are emergency shut downs for maintenance.

D. Control Systems - Continued

5. Sulfuric acid plant

- e) Catalyst screening should be carried out when needed. Due to problems in operation which fouled the catalyst, screening has been done during the annual shut down each of the past three years.
- f) York demister pads are used in the absorption tower.

g)	<u>Design</u>	<u>Actual</u>
Production (tpd)	740	200-425
Conversion (%)	97-98	96-97
Acid strength (%)	93	92-97
Catalyst beds (No.)	4	4
Gas flow rate (scfm)	39,800	35-42,000
Inlet gas temp. (°F) *	102	102
Inlet SO ₂ (%)	6.8-9.8	0-13
Outlet SO ₂ (ppm)	2500	2400
Acid mist (lb./ton acid)	NA	6.46
Blower pressure ("WC)	100 Max.	60-80

* From cooling tower.

6. Liquid SO₂

- a) Absorption of SO₂ by dimethylaniline (DMA) process as developed by ASARCO. Engineering and construction by Stearns-Roger Corporation.
- b) None
- c) The addition of a stand-by compressor for SO₂ gas was completed in April of 1975. This spare compressor was intended to reduce down time due to frequent required repairs of the compressor in service.

Previous modifications entailed the addition of another two mist precipitators and the rebuilding of the top of the humidifying (scrubber) tower. Both of these changes have already been covered.

Construction of the plant was initially completed in November of 1972.

- d) There has not been enough operation of the plant to establish definite practices. When in operation, the plant is washed down as often as needed to prevent excessive buildup from acid spills or dimethylaniline spills.

D. Control Systems - Continued

6.-d) Cont'd.

Periodic equipment inspection and instrument readings give indications of possible problems or needed repairs. Repairs that can be delayed until scheduled shut downs are completed at these times; otherwise, the plant is shut down when problems occur and the required personnel are brought in to do the repairs.

A certain amount of preventative maintenance is carried out by two repairmen who serve both the SO₂ and acid plants.

e) Dimethylaniline (DMA) .

f)	<u>Design</u>	<u>Actual</u>
Production (tpd)	60-90	Uncertain
Gas flow rate (scfm)	41,000	NA
Operating temperature*	90	90
Inlet SO ₂ concentration	1-10	0.5-4.5
Outlet SO ₂ concentration	500	165 ppm
Acid mist (lbs.H ₂ SO ₄) /ton SO ₂ **	Nil	Nil

* From cooling tower.

**Assumed.

7. Refer to references in paragraph A (3) .

8. Instrumentation

a) Acid Plant

Inlet: i) DuPont SO₂ Analyzer Model 460 B.
 0-15% SO₂ (instrument range)
 3-6% SO₂ (typical matte blow)
 5-9% SO₂ (typical copper blow)
 Location: On converter precipitator discharge.

ii) Leeds & Northrup SO₂ Analyzer
 Model 7802-D-A2
 0-15% SO₂ (instrument range)
 Typical range: as above
 Location: discharge of acid plant blower.

Outlet: DuPont SO₂ Analyzer Model 400
 0-0.5% SO₂ (instrument range)
 0-2-0.3% SO₂ (typical)
 Location: Tail gas duct about 100' from absorbing tower.

8. Instrumentation (Cont'd)

b) SO₂ Plant

Inlet: i) Served by same DuPont instrument as inlet acid plant whenever converter gas is diverted to SO₂ plant.

- ii) DuPont SO₂ Analyzer Model 460B
0-15% SO₂ (instrument range)
1.5-2.5% SO₂ (typical)
Location: Discharge of SO₂ plant blower.

Outlet: DuPont SO₂ DMA Analyzer Model 461 C
0-2000 ppm SO₂ instrument range
0-50 ppm DMA instrument range
150-200 ppm SO₂ (typical)
15-20 ppm DMA (typical)
Location: Top of SO₂ plant absorption tower.

c) Main Stack

Outlet (Located 127' up on 360' stack)

- i) DuPont SO₂ Analyzer Model 460
0-10% SO₂ (instrument range)
1-1.5% SO₂ (typical)
- ii) Lear Siegler Optical Transmitter,
Model #20-200
0-100% opacity (instrument range)
100% (typical)

9. Acid Plant

- a) Possible flame out in heating unit for acid plant catalyst chamber. If there is insufficient feed gas for autothermal operation (continuous supply-39,000 scfm of 6.5% SO₂ gas), the plant operating heat will be lost and a period of time is required to refire the heater and build up the plant heat. During this time any converter gases will have no SO₂ control and reduced particulate control. This may occur at any time, but is infrequent.
- b) Insufficient heat exchanger capacity to cool the amount of acid being produced will cause a reduction in production. This will require some of the converter gas to be released to the atmosphere, giving slightly less SO₂ and particulate control. This is a frequent occurrence.
- c) One of the acid circulation pumps could fail. This causes a shut down of the acid plant and SO₂ plant as well. No SO₂ control will be achieved until a crane can be scheduled to install the spare pump. This has occurred approximately five times in three years.

D. Control System - Continued

9. Acid Plant (Cont'd)

- d) If one of the two primary gas blowers should fail for any reason, production would be reduced to about one-third of normal. The process gas emitted from the smelter converters would be higher in SO_2 and particulate matter until the problem was corrected. On several occasions this mishap has occurred.
- e) Electrical shorts could negate the particulate recovery from the electrostatic precipitators serving the acid plant. This could cause a reduction in acid production or even a complete stoppage if the problem were serious enough. Shorts have been frequent but have never caused the plant to be shut down.
- f) A leak in any one of the many acid lines would cause an immediate halt or curtailment in production. Reduced SO_2 control and reduced particulate control would be the result until the leak could be fixed. This problem has been bad at times and non-existent at others. The problem may occur as frequently as once a week.

SO_2 Absorption Plant

The plant could shut down for any of the following reasons:

- a) Blower failure
- b) Critical pump failure (8 pumps are critical)
- c) Compressor failure, unless the spare is available.
- d) Loss of steam.
- e) Leaks in the acid, DMA, soda ash, water, or SO_2 gas or liquid lines.

All of these have been troublesome. The most frequent are compressor failure and acid leaks which may happen once or twice a week. The effect of these problems is to reduce the SO_2 and particulate control.

E. Stacks

- 1. The 360-foot concrete stack is of tapered reinforced concrete construction. It is lined with acid-resisting brick laid in acid-proof mortar and has 2-inches of fiber glass insulation between the concrete and the brick lining.

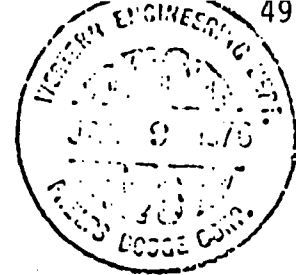
Units exhausted through the stack are: non-treated reverberatory furnace gases, non-treated converter gases, acid plant tail gases, smoke hood (hoods over three converter hoods) exhaust system and the exhaust system for the matte launders, matte ladle tunnel and reverb slag launder.

E. Stacks - Continued

2.

a) Height (feet above terrain)	360
b) Elevation of discharge points (feet above sea level)	2104
c) Inside diameters (ft)	
Bottom	24.27
Top	10.75
d) Exit gas temperatures (°F)	212
e) Exit gas velocities (ft/sec)	25.8-29.1

January 1976



SPECIFICATIONS:

Ajo - No. 2 Fuel

	<u>Range</u>
BTU/Gal :	129,323 - 140,600
% Sulfur:	.23 - .50
% Ash :	-0- - .01
Specific Gravity:	.8155 - .8654
Consumption :	37,039 Bbls.

<u>Typical Average</u>
135,000
.31
.01
.8424

2.1×10^{11} BTUs

DRW - No. 6 Fuel

	<u>Range</u>
BTU/Gal :	152,381 - 153,095
% Sulfur:	.90 - .98
% Ash :	.03 - .05
Specific Gravity:	.9937 - .9951
Consumption :	103,101 Bbls.

<u>Typical Average</u>
153,000
.95
.04
.9946

Morenci - Nos. 4 - 5 - 6 - Kerosene:

	<u>Range</u>
BTU/Gal :	137,038 - 145,693
% Sulfur:	.15 - .77
% Ash :	-0- - .001
Specific Gravity:	.8121 - .9198
Consumption :	285,281 Bbls.

<u>Typical Average</u>
142,000
.42
.001
.8725

GAS SPECIFICATIONS:

Percentage Composition	MOL. %
Helium	.02
Carbon Dioxide	.20
Nitrogen	1.28
Methane C ₁	89.49
Ethane C ₂	7.29
Propane C ₃	1.48
Iso-Butane C ₄	.08
N-Butane n C ₄	.14
Iso-Pentane i C ₅	.01
N-Pentane n C ₅	.01
Total	100.00%

Density:	.047 Lbs./SCF
BTU/CF :	1,064
Percent Sulfur:	0.0006 Grains/SCF
Consumption :	
Ajo :	1,547,865 MSCF
DRW :	3,516,346 "
Morenci :	5,101,069. "

1.6×10^{12} BTUs

Attachment 2

Composition of Materials Treated in the Ajo Smelter

Component	Concentrates				Tyrone Precipitate	Lime- Rock	Mixed Flux
	Ajo	Tyrone	Bagdad	Bruce			
Cu (1)	30.07	19.36	32.5	24.99	74.79	-	-
(2)	27.16-32.56	16.66-23.44	30.10-33.89	23.87-25.99	66.86-81.45	-	-
SiO ₂	8.5	4.8	5.4	1.6	1.7	3.3	79.8
	7.4-9.6	3.1-7.8	3.6-7.1	1.2-2.6	1.1-2.9	2.4-4.2	76.6-81.7
Al ₂ O ₃	3.1	2.2	2.0	0.5	3.0	1.3	8.3
	2.6-3.5	1.8-2.6	1.1-3.0	0.1-0.7	2.0-4.0	0.7-2.2	5.1-9.7
Fe	24.7	30.8	25.9	26.0	6.3	0.5	2.2
	23.2-25.9	27.4-32.2	23.9-27.5	25.3-27.2	3.6-9.6	0.5-0.6	1.6-3.5
S	29.8	40.3	31.7	32.3	-	-	-
	28.9-30.4	37.3-41.7	30.2-32.6	31.5-32.8	-	-	-
CaO	0.9	0.4	0.3	0.2	-	51.9	1.4
	0.8-1.1	0.1-0.6	0.1-0.9	0.1-0.9	-	50.2-55.2	1.0-1.9
Pb	-	-	-	2.8	-	-	-
	-	-	-	1.7-4.0	-	-	-
Zn	-	-	-	8.6	-	-	-
	-	-	-	7.8-9.5	-	-	-
MgO	-	-	-	-	-	0.8	-
	-	-	-	-	-	0.6-1.1	-

(1) Average

(2) Range

Appendix C
SIP Regulation Applicable
To Phelps Dodge

(ii) Process weight is the total weight of all materials and solid fuels introduced into any specific process. Liquid and gaseous fuels and combustion air will not be considered as part of the process weight. For a cyclical or batch operation, the process weight per hour will be derived by dividing the total process weight by the number of hours in one complete operation from the beginning of the given process to the completion thereof, excluding any time during which the equipment is idle. For a continuous operation, the process weight per hour will be derived by dividing the process weight for a given period of time by the number of hours in that period.

(iii) For purposes of this regulation, the total process weight from all similar units employing a similar type process shall be used in determining the maximum allowable emission of particulate matter.

(2) Paragraph (b)(1) of this section shall not apply to incinerators, fuel burning installations, or Portland cement plants having a process weight rate in excess of 250,000 lb/h.

(3) No owner or operator of a Portland cement plant in the Phoenix-Tucson Intrastate Region (§ 81.36 of this chapter) with a process weight rate in excess of 250,000 lb/h shall discharge or cause the discharge of particulate matter into the atmosphere in excess of the amount specified in § 60.62 of this chapter.

(4) Compliance with this paragraph shall be in accordance with the provisions of § 52.134(a).

(5) The test methods and procedures used to determine compliance with this paragraph are set forth below. The methods referenced are contained in the appendix to part 60 of this chapter. Equivalent methods and procedures may be used if approved by the Administrator.

(i) For each sampling repetition, the average concentration of particulate matter shall be determined by using method 5. Traversing during sampling by method 5 shall be according to method 1. The minimum sampling time shall be 2 hours and the minimum sampling volume shall be 60 ft³ (1.70 m³), corrected to standard conditions on a dry basis.

(ii) The volumetric flow rate of the total effluent shall be determined by using method 2 and traversing according to method 1. Gas analysis shall be performed using the integrated sample technique of method 3, and moisture content shall be determined by the condenser technique of method 4.

(iii) All tests shall be conducted while the source is operating at the maximum production or combustion rate at which such source will be operated. During the tests, the source shall burn fuels or combinations of fuels, use raw materials, and maintain process conditions representative of normal operation, and shall operate under such other relevant conditions as the Administrator shall specify.

3. Section 52.129 is amended by adding paragraphs (c) and (d) as follows:

Subpart D—Arizona

§ 52.124 [Revoked]

1. Section 52.124 is revoked.
2. Section 52.126 is amended by adding paragraph (b) as follows:

§ 52.126 Control strategy and regulations: Particulate matter.

(b) *Replacement regulation for Regulation 7-1-3.6 of the Arizona Rules and Regulations for Air Pollution Control, Rule 31(E) of Regulation III of the Maricopa County Air Pollution Control Rules and Regulations, and Rule 2(B) of Regulation II of the Rules and Regulations of Pima County Air Pollution Control District (Phoenix-Tucson Intrastate Region).*—(1) No owner or operator of any stationary process source in the Phoenix-Tucson Intrastate Region (§ 81.36 of this chapter) shall discharge or cause the discharge of particulate matter into the atmosphere in excess of the hourly rate shown in the following table for the process weight rate identified for such source:

Process weight rate (pounds per hour)	Emission rate (pounds per hour)	Process weight rate (pounds per hour)	Emission rate (pounds per hour)
50.....	0.36	60,000	29.60
100.....	0.55	80,000	31.19
500.....	1.53	120,000	33.28
1,000.....	2.25	160,000	34.85
5,000.....	6.34	200,000	36.11
10,000.....	9.73	400,000	40.36
20,000.....	14.99	1,000,000	46.72

(i) Interpolation of the data in the table for process weight rates up to 60,000 lbs/hr shall be accomplished by use of the equation:

$$E=3.59 P^{0.82} \quad P \leq 30 \text{ tons/h}$$

and interpolation and extrapolation of the data for process weight rates in excess of 60,000 lbs/hr shall be accomplished by use of the equation:

$$E=17.31 P^{0.10} \quad P > 30 \text{ tons/h}$$

Where: E=Emissions in pounds per hour
P=Process weight in tons per hour

Appendix D
Example Calculations of
Gas Flow Rates

Flowrate at Standard Conditions

$$\frac{P_i V_i}{T_i} = \frac{P_s V_s}{T_s} \quad \text{or} \quad V_s = \frac{P_i}{P_s} \times \frac{T_s}{T_i} \times V_i$$

where: P_i = given pressure
 V_i = given gas volume
 T_i = given temperature in ° R
 P_s = pressure @ std condns (14.7 psi or 760 mm Hg)
 V_s = gas volume @ std condns (in same units as V_i)
 T_s = temperature @ std condns (530°R)

Reverb ESP Design[†]

$$V_s = \frac{13.8}{14.7} \times \frac{530}{1,060} \times 150,000 \text{ acfm}$$

$$V_s = 70,400 \text{ scfm}$$

Converter ESP Design[†]

$$V_s = \frac{13.8}{14.7} \times \frac{530}{1,110} \times 210,000 \text{ acfm}$$

$$V_s = 94,100 \text{ scfm}$$

Reverb ESP Actual^{††}

$$V_s = \frac{13.8}{14.7} \times \frac{530}{1,048} \times 164,000 \text{ acfm}$$

$$V_s = 77,900 \text{ scfm}$$

Reverb ESP Actual w/o Pressure Correction

$$V_s = \frac{530}{1,048} \times 164,000 \text{ acfm}$$

$$V_s = 82,900 \text{ scfm}$$

DMA Plant Corrected for Pressure^{††}

$$V_s = \frac{13.8}{14.7} \times 41,000 \text{ acfm}$$

$$V_s = 38,500 \text{ scfm}$$

[†] Reference ³
^{††} Reference ¹