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Environmental Protection Technology Series

DESIGN AND OPERATING PARAMETERS FOR EMISSION CONTROL STUDIES:
Kennecott, Hurley, Copper Smelter

Industrial Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

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DESIGN AND OPERATING PARAMETERS FOR EMISSION CONTROL STUDIES: KENNECOTT, HURLEY, COPPER SMELTER

by

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Washington, DC 20460

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A. INTRODUCTION AND SUMMARY

The purpose of this report is to present background design data on the Kennecott Copper Corporation, Chino Mines Division Smelter at Hurley, New Mexico in sufficient detail to allow air pollution control system engineering studies to be conducted. These studies are primarily concerned with lean SO_2 streams that are currently not being captured.

Physical layout of the smelter and surrounding area along with existing smelter and control equipment is presented. Ductwork that would be considered for future system tie-in is defined. Emissions from operating equipment, gas flow rates, temperatures, sulfur balance and process flow sheet are included. Utilities, stack dimensions, footing requirements, and solid waste handling are defined. Available area for new control equipment, gas characteristic variation and potential new control equipment installation problems are discussed.

The major uncontrolled source of SO_2 and particulate at this smelter is the reverberatory furnace with approximately 88,330 tons per year of SO_2 and 6,833 tons per year of particulate emitted (Ref.1). There appears to be sufficient space and utility availability to install additional control equipment.

B. PLANT LOCATION, ACCESS AND OVERALL GENERAL ARRANGEMENT

The Kennecott Copper Corporation Smelter is located adjacent to the town of Hurley, New Mexico. A portion of the USGS map, showing land contours of the immediate area, is presented in Figure 1. Design altitude for the plan is 5,700 ft. with latitude 32°41' and longitude 108°07'

Overall plant and smelter general arrangement are shown in the drawings, Figures 2 and 3. The primary particulate emission sources are the crushing and screening operations and the reverberatory furnaces and converters. The primary sources of sulfur dioxide are the reverberatory furnaces and the converters. Ore source is from the local Kennecott open pit mine and is primarily in sulfide form.


Hurley
Hurley
SMELTER
Hurley Airport
Hurley Cem
Water Tank
Tanks
Whitewater Creek
Quarries
Cameron
SANTA FE
BM 5511
SCALE
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER
260
26
25
30
30
29
28
35
36
31
31
32
33
2
1
6
6
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4
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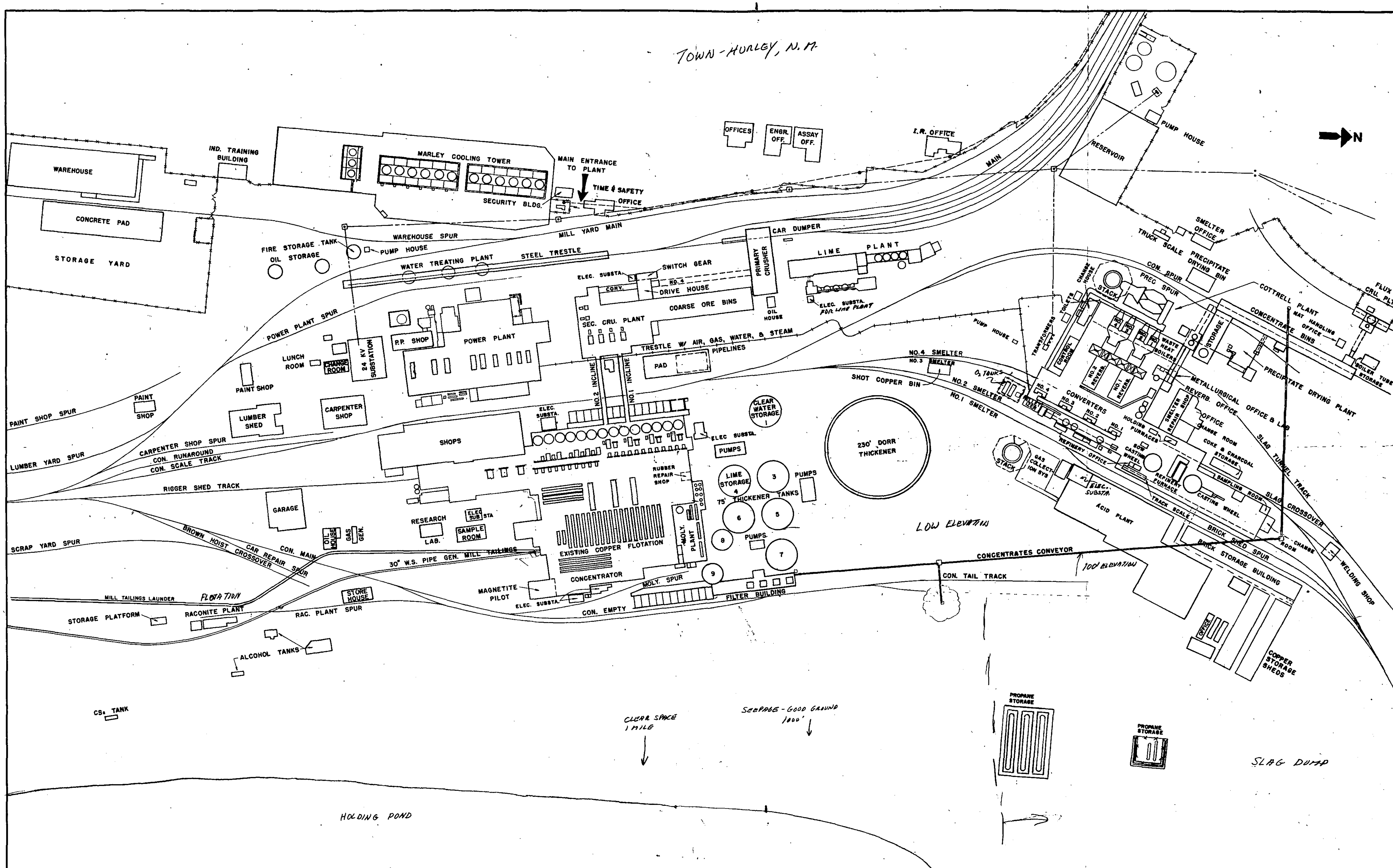
Figure 1.



Reference DWG. NO.	DESCRIPTION	Reference DWG. NO.	DESCRIPTION	NO.	DATE	REVISIONS	BY	NO.	DATE	REVISIONS	BY
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Designed
Checked
Job No.

KENNECOTT COPPER CORPORATION
METAL MINING DIVISION
CHINO MINES DIVISION
HURLEY, NEW MEXICO 88043

Figure 2

Scale 1" = 100'
Dept.
Drawing No. G-
Rev.

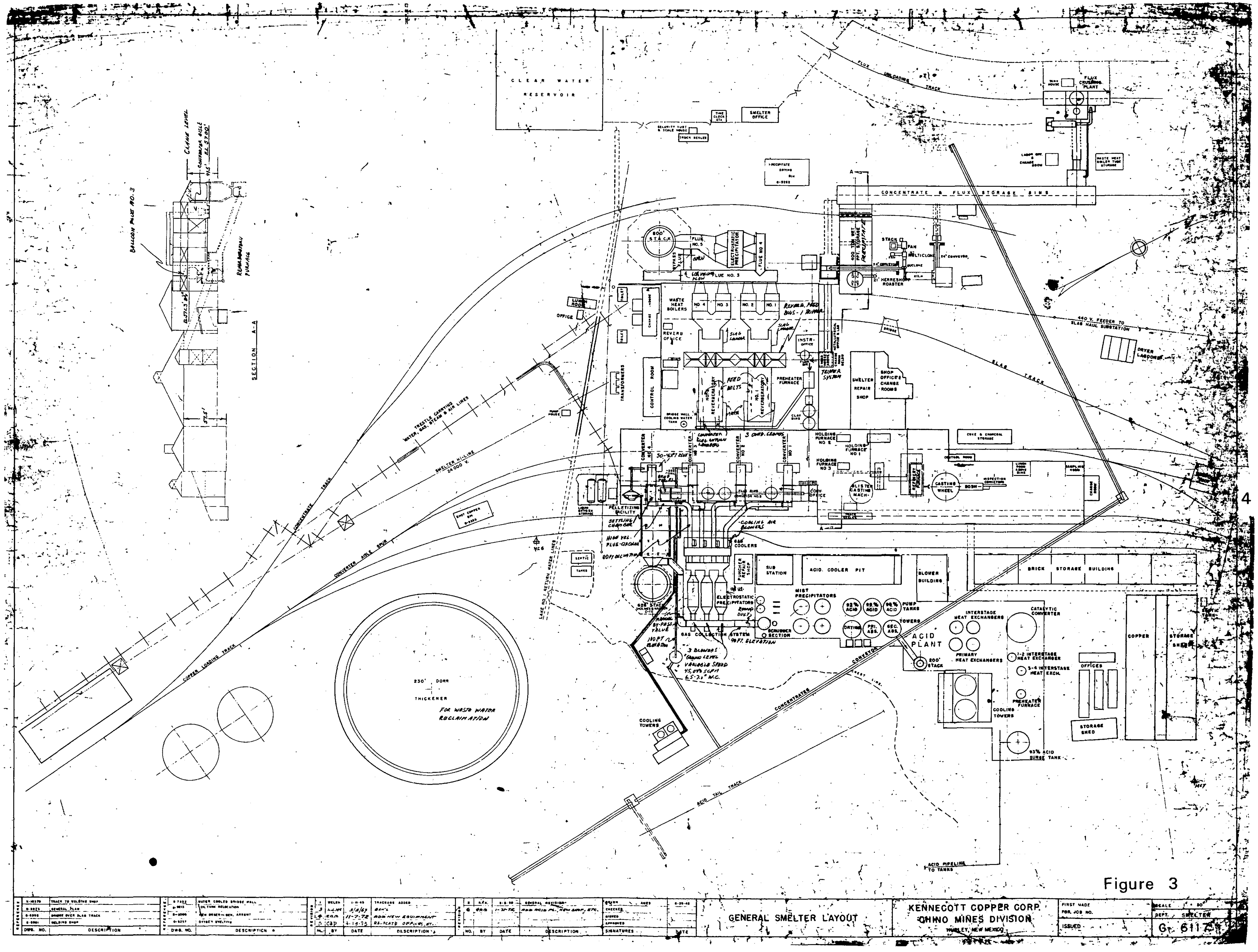

CLEAR WATER RESERVOIR
SMELTER OFFICE
CONCENTRATE & FLUX STORAGE BINS
FLUX UNLOADING TRACK
FLUX CRUSHING PLANT
WASTE HEAT BOILERS
REVERB OFFICE
CONTROL ROOM
TRANSFORMERS
PREHEATER FURNACE
SMELTER REPAIR SHOP
SHOP OFFICE & CHANGE ROOMS
HOLDING FURNACE NO 1
HOLDING FURNACE NO 2
HOLDING FURNACE NO 3
CASTING WHEEL
BLISTER CASTING MACH.
COKE & CHARCOAL STORAGE
440 V. FEEDER TO SLAG HAUL SUBSTATION
SLAG TRACK
DRYER LAGOONS
21' HERRESHOFF ROASTER
TRESTLE CARRYING WATER, GAS, STEAM & AIR LINES
SMELTER HI-LINE 24,000 V.
CONCENTRATE TRACK
CONVERTER AISLE SPUR
COPPER LOADING TRACK
SECTION A-A
SUB STATION
ACID. COOLER PIT
BLOWER BUILDING
BRICK STORAGE BUILDING
MIST PRECIPITATORS
ELECTROSTATIC PRECIPITATORS
GAS COLLECTION SYSTEM
SCRUBBER SECTION
PUMP TANKS
TOWERS
ACID PLANT
INTERSTAGE HEAT EXCHANGERS
PRIMARY HEAT EXCHANGERS
CATALYTIC CONVERTER
PREHEATER FURNACE
COOLING TOWERS
93% ACID SURGE TANK
OFFICES
STORAGE SHED
COPPER STORAGE SHED
230' DORR THICKENER
FOR WASTE WATER RECLAMATION
CONCENTRATES CONVEYOR
ACID TAIL TRACK
ACID PIPELINE TO TANKS
GENERAL SMELTER LAYOUT
KENNECOTT COPPER CORP.
CHINO MINES DIVISION
HURLEY, NEW MEXICO

Figure 3

4

The smelter portion of the plant consists of the initial ore handling and mixing equipment, rotary dryer, two reverberatory furnaces, four Peirce-Smith converters, a fire refining furnace, a rotary lime kiln, and three holding furnaces.

The pollution control equipment consists of multi-cyclones, rotoclones and cyclones for the crushing and screening operations and the lime kiln. Part (40%) of the gases leaving the reverberatory furnace pass through a precipitator for particulate control. The gases from the converters are passed to a double contact sulfuric acid plant to control the SO_2 and are conditioned before entering this plant by passing through precipitators and scrubbers for particulate and temperature control.

Figure 2, showing overall plant site, indicates space for new control equipment could be found adjacent to the acid plant on the slag dump. Considerable additional area is available to the east of the smelter.

C. PROCESS DESCRIPTION

The smelter flow sheet diagram is shown in Figure 4. The feed in the form of precipitates, concentrate, lime and flue dust is fed to a rotary dryer which removes a major portion of the moisture to minimize excess pressures in the reverberatory furnace. The partly dried material is then passed to one of two reverberatory furnaces where it is processed to matte. The reverberatory furnace uses preheated air, flux and fuel to produce slag and matte.

The matte is then taken to the four converter lines where normally three operate at any one time. The converters produce blister copper which is then placed in a holding furnace and is further refined in the refining furnace and cast into ingots. This is one of two smelters in the United States that does not make copper anodes.

Gases from the rotary dryer pass through a cyclone and scrubber and then out the stack. Gases from the reverberatory furnace pass through a waste heat boiler, a precipitator and out the stack. Gases from the converters pass to a gas cleaning system which consists of settling chambers, air to

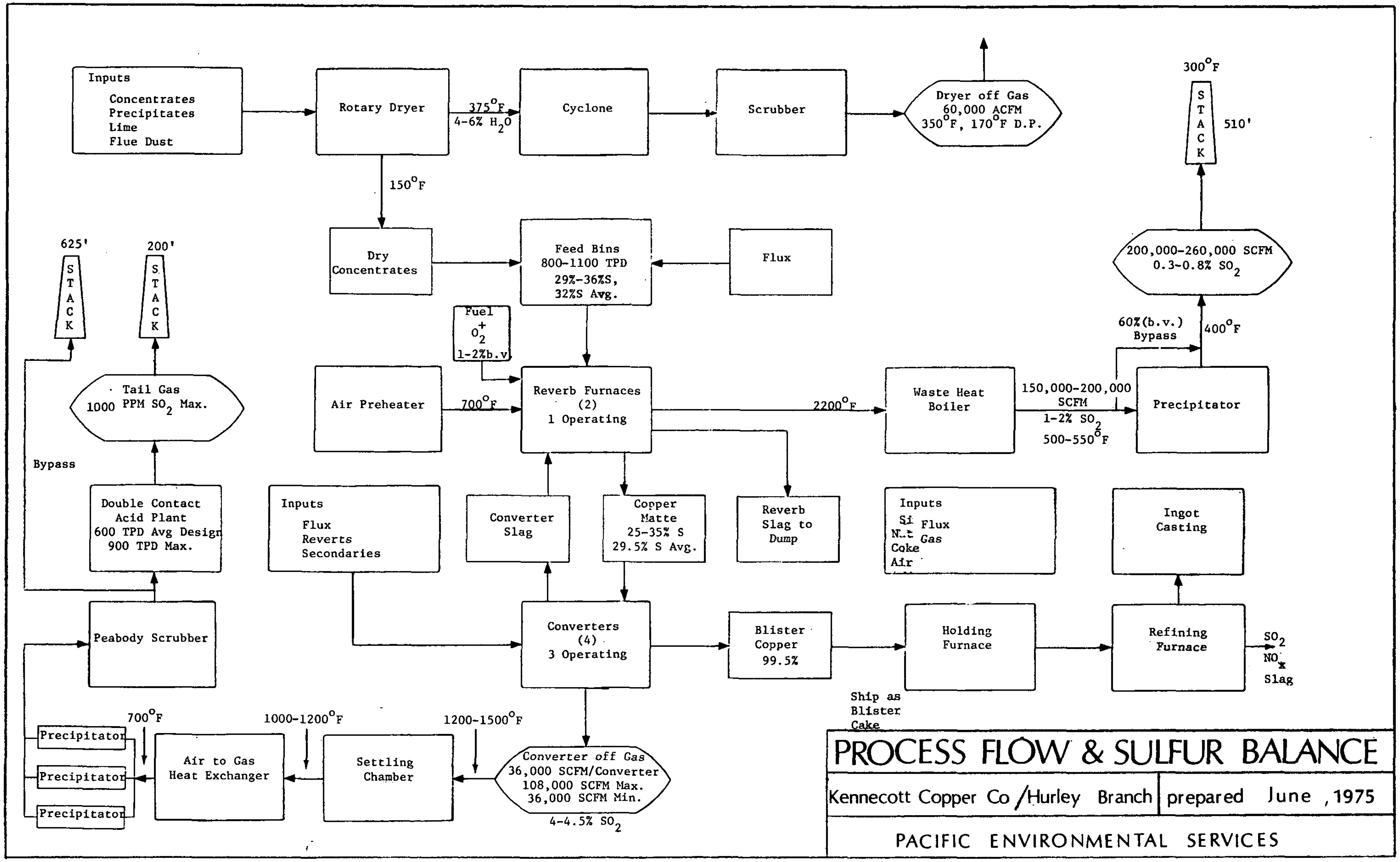

Inputs
Concentrates
Precipitates
Lime
Flue Dust
Rotary Dryer
375°F
4-6% H2O
Cyclone
Scrubber
Dryer off Gas
60,000 ACFM
350°F, 170°F D.P.
150°F
Dry Concentrates
Feed Bins
800-1100 TPD
29%-36%S,
32%S Avg.
Flux
300°F
STACK
510'
200,000-260,000 SCFM
0.3-0.8% SO2
625'
STACK
200'
STACK
Fuel
O2
1-2%b.v.
60%(b.v.)
Bypass
400°F
Tail Gas
1000 PPM SO2 Max.
Air Preheater
700°F
Reverb Furnaces
(2)
1 Operating
2200°F
Waste Heat
Boiler
150,000-200,000
SCFM
1-2% SO2
500-550°F
Precipitator
Bypass
Double Contact
Acid Plant
600 TPD Avg Design
900 TPD Max.
Inputs
Flux
Reverts
Secondaries
Converter
Slag
Copper
Matte
25-35% S
29.5% S Avg.
Reverb
Slag to
Dump
Inputs
Si Flux
Coke
Air
Ingot
Casting
Peabody Scrubber
Converters
(4)
3 Operating
Blister
Copper
99.5%
Holding
Furnace
Refining
Furnace
SO2
NOx
Slag
Ship as
Blister
Cake
700°F
1000-1200°F
1200-1500°F
Precipitator
Precipitator
Precipitator
Air to Gas
Heat Exchanger
Settling
Chamber
Converter off Gas
36,000 SCFM/Converter
108,000 SCFM Max.
36,000 SCFM Min.
4-4.5% SO2
PROCESS FLOW & SULFUR BALANCE
Kennecott Copper Co /Hurley Branch
prepared June ,1975
PACIFIC ENVIRONMENTAL SERVICES

Figure 4

gas heat exchangers, precipitators, and scrubbers. The cleaned gases then pass to a double contact sulfuric acid plant and then to the acid plant stack.

Temperatures, volume flows, and SO_2 percentages are shown on the flow sheet.

D. EMITTING EQUIPMENT

a. Reverberatory Furnaces

Two reverberatory furnaces are installed. Dimensions are 125 feet long by 35 feet wide by 25 feet high. The draft for the furnace is generated entirely by the stack. A top charge tripper system feeds the furnace which takes a side-wall charge. Only one reverberatory furnace is operated at a time. A suspended arch roof is used to facilitate repair during operation. Oxygen quantities of 1 to 2 percent total gas volume are used for burner combustion.

One reverberatory furnace is now down for refurbishing. This takes approximately 8 months. If a long campaign is planned, the system must be designed to handle maximum leakage on the last day of operation. Launders will be covered completely with hooding in the new, reworked reverberatory furnace.

Table I summarizes reverberatory furnace design data from Reference 3.

b. Converters

There are four Peirce-Smith converters 13 feet in diameter by 33 feet long. Normally only three of these converters are active at one time with the fourth being repaired. Each converter has a close-fitting water-cooled hood with a sliding front door to aid in sealing when the converter is rolled in. Only shut-off dampers are used for each hood system.

TABLE I: REVERBERATORY FURNACE DATA (Reference 3)

FURNACE DIMENSIONS	
Length, Inside	121 Ft. 10 in.
Width, Inside Firing End	28 ft. 8 in.
Flue End	28 ft. 8 in.
Height Inside Firing End	11 ft. 5 in.
Flue End	11 ft. 5 in.
Side Wall Thickness at Slag Line	4 ft. 3 in.
Side Wall Thickness above Slag Line	20 in.
Roof Thickness	20 in.
Area Gas Uptake	146 sq. ft.
FIRING DATA	
Kind of Fuel	Natural gas
Number, Type and Size of Burners	8 multiple jet - 84 jets per burner
Amount of Fuel per Day	5,056,000
Fuel per Ton of Solid Charge	5,998
Fuel per Ton of Total Charge	--
Temp. Exit Gases	2408°F
Per Cent Calories Recovered in Steam	51.54
Is Automatic Draft Control used?	No
Type Waste Heat Boilers	Stirling, three pass and one pass
PRODUCT DATA	
Depth Molten Charge	33 in.
Tons Slag per 24 Hours	539
Method Slag Disposal	Dumped hot
Tons Matte per 24 Hours	621
Vol. Gas per 24-Hour Standard Condition	63,800,000 cu. ft.
Per Cent Cu in Matte	34.85

REFRACTORY DATA	
Kind of Brick, Roof	Silica
Side Walls	Silica
Heatth Material	Crushed Quartzite slag cover
Type and Location of Water Cooling	None
CHARGE DATA PER 24 HOURS	
Wt. Hot Calcine	None
Wt. Raw Concentrate	689 tons (dry)
Av. Moisture in Raw Conc. Pct.	8.74
Wt. Crushed Ore	None
Wt. Flue Dust	9 tons
Wt. and Nature of Flux	38 tons limerock
Wt. Liquid Converter Slag	449 tons
Wt. and Nature of Other Material	77 tons copper precipitates
Where and How is Furnace Charged	Vibrator conveyors 70 ft. along sidewalls
Wt. and Nature of Fettling Material	30 tons mine ore 70 pct. SiO_2

c. Other Emitting Equipment

Material handling in the feed preparation area during crushing and screening operations generates particulate.

The refining furnace generates small quantities of SO_2, NO_x and particulate.

Leaks in ducts and at other pieces of equipment can release SO_2 and particulate.

Ladles holding matte and slag produce visible fugitive emissions.

The rotary dryer for processing the reverberatory furnace feed produces particulate.

E. EXISTING CONTROL EQUIPMENT

The existing electrostatic precipitator installed to control the particulate from the reverberatory furnace is considerably under capacity. It was designed originally for 80,000 SCFM and there is over 200,000 SCFM currently generated by the furnace. It is an American Standard unit (company not now in business).

Dimensions of the reverberatory furnace precipitator are 43 feet high, 50 feet in length, and 22 feet wide. It is stub-nosed against the reverberatory furnace and connected with very little duct work. The inlet duct to outlet duct dimension is 17 feet.

A Chemico 600-ton-per-day double contact sulfuric acid plant has been installed and was started up in December 1974 to handle all of the gases from the converter collection system. Gas conditioning before the acid plant includes precipitators, scrubbers, drop-out chambers and heat exchangers.

The plant can handle a maximum short term load of 900 tons per day. There were some problems with the preheater, however, the system seems to be operating reasonably well at the present time.

Particulate control in the ore crushing and handling area is accomplished by multiple cyclones and rotoclones. The rotary dryer for reverb feed uses a cyclone and scrubber.

F. GAS SYSTEM DUCTWORK

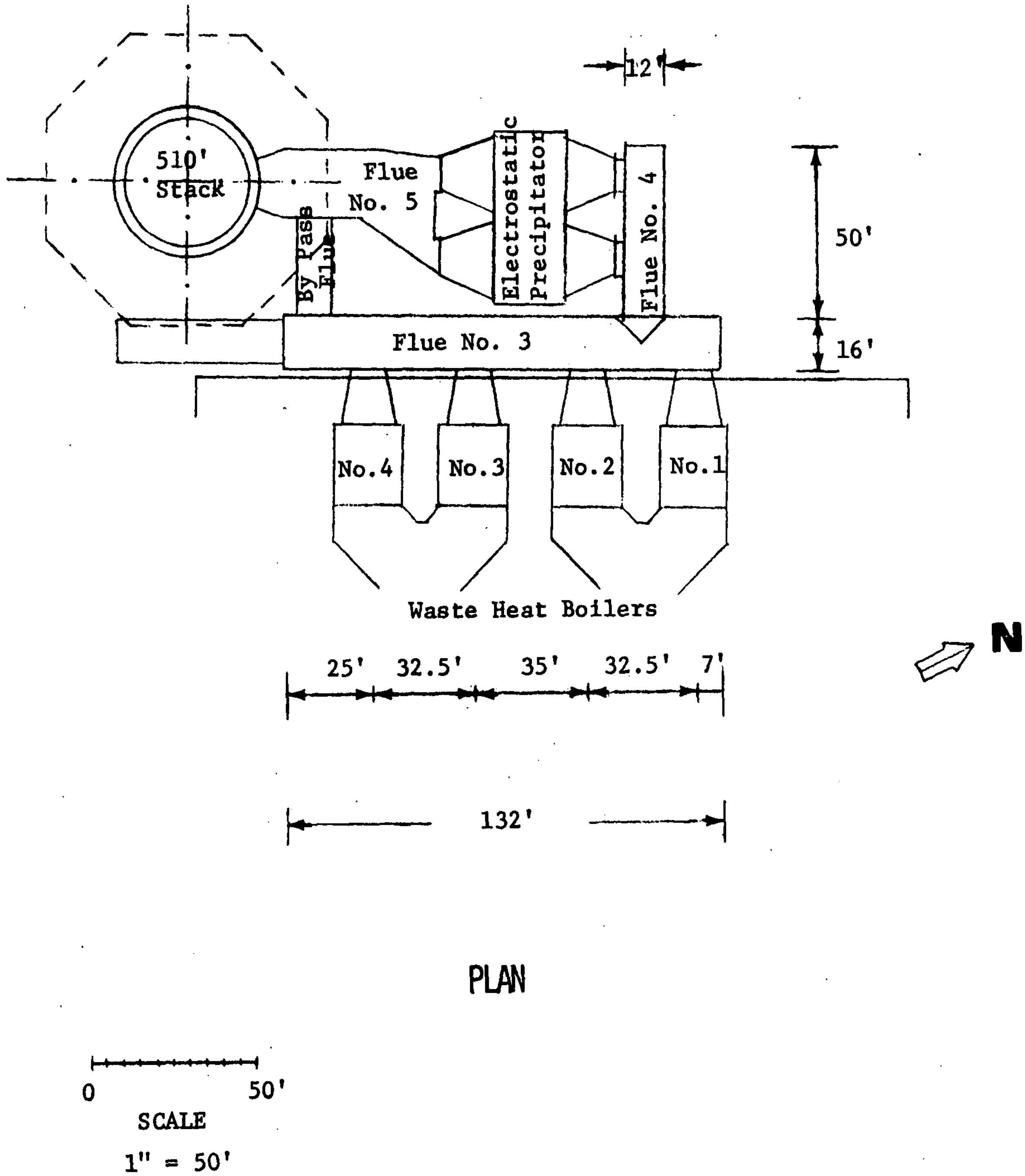
A plan view of the reverberatory furnace gas system ductwork is shown in Figure 5. Flue gases from the four waste heat boilers pass through individual ducts into Flue No. 3. Sixty percent (by volume) of the gas flow goes directly to Flue No. 5 and then to a 510 foot tall stack. The remaining 40% of the gas flow in Flue No. 3 passes through Flue No. 4 and into an electrostatic precipitator. Downstream of the precipitator, the cleaned gas rejoins the bypassed gas in Flue No. 5 before entering the 510-foot stack. As seen in Figure 6, an elevation view, Flue No. 3 is balloon-shaped, approximately 17.5 feet in diameter and 132 feet long. Flue No. 4 is 12 feet wide, 14.5 feet high, and 50 feet long.

Watercooled hoods collect the offgases from the four converters. The converter offgas system ductwork is shown in Figure 7. Larger particles are removed from the gases in a settling chamber. The gases then travel through high velocity circular flues to air-cooled heat exchangers. The cooled gases then pass through three parallel electrostatic precipitators. The dust-free gases travel via round duct, 72 inches in diameter, to a double contact acid plant. A manual bypass valve permits venting the dust-free gases directly to a 625-foot tall stack in the event the acid plant is down.

G. SULFUR BALANCE AND GAS COMPOSITION AT SYSTEM EXIT

Typical Sulfur Balance Data
Based on Data From Smelter Sulfur Balance Report:

	TPD	
Sulfur in		
Reverberatory	324.5	
Secondaries	26.8	
Total	351.3	(maximum estimated at 525 TPD)
Sulfur Fixed		
Reverberatory slag	18.2	
Sulfur that would report to acid plant	196.5	Reference 4
Total	214.7	
Sulfur emitted to atmosphere		
Reverberatory offgas plus fugitives	130.5	
Acid plant emissions	6.1	
Total	136.6	

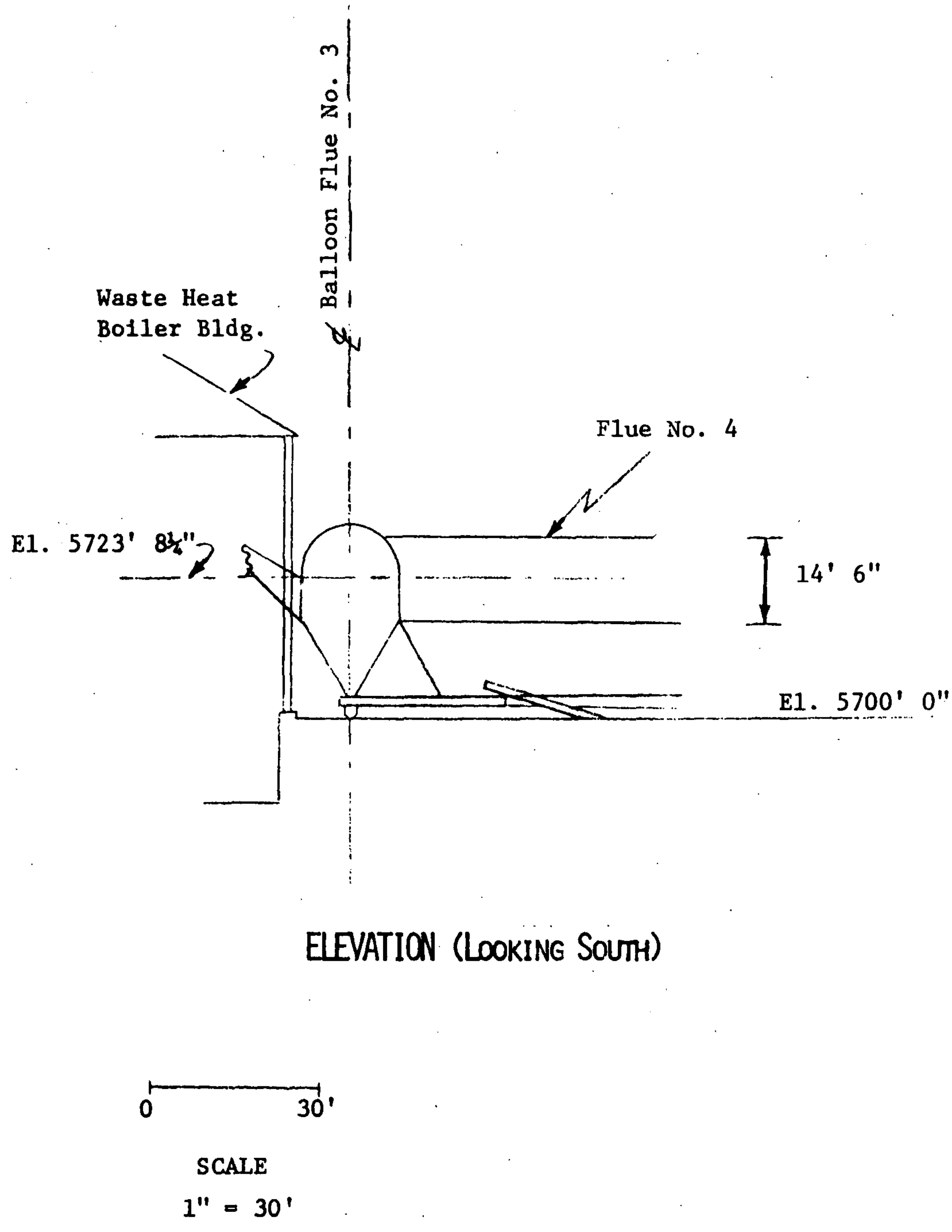


REVERBERATORY FURNACE GAS SYSTEM DUCTWORK

Kennecott/Hurley June, 1975

PACIFIC ENVIRONMENTAL SERVICES

Figure 5



ELEVATION (LOOKING SOUTH)

FLUE NO. 3

Kennecott/Hurley June, 1975

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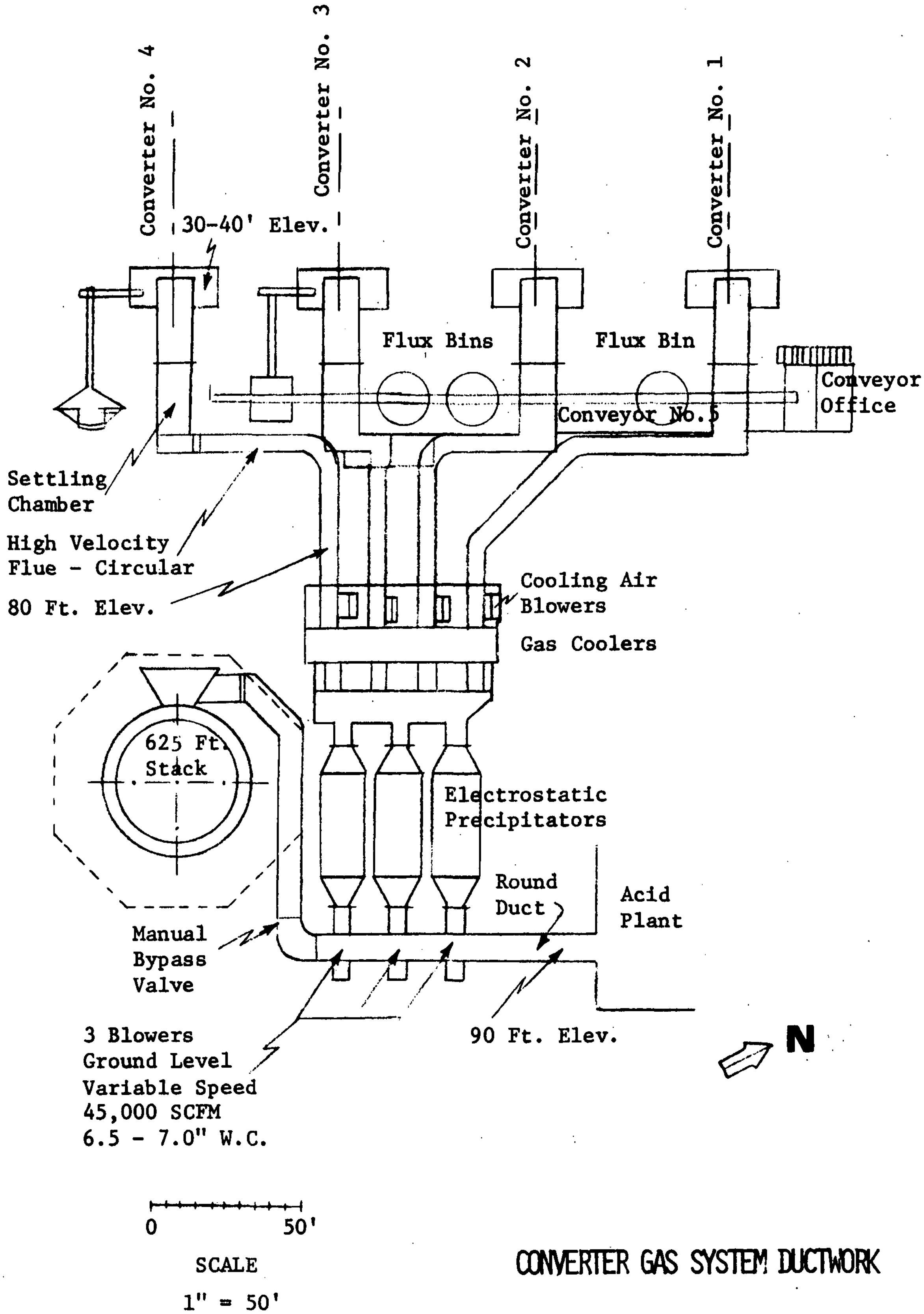
Figure 6



CONVERTER GAS SYSTEM DUCTWORK

Kennecott/Hurley June, 1975

PACIFIC ENVIRONMENTAL SERVICES

Figure 7

Emissions stated in tons per year for the various pieces of equipment studied are shown in Table II. Table III summarizes stack test data. This information taken from Reference 1 is somewhat contradictory to the data obtained and accepted by the smelter; however, it appears to be typical for water, SO_3 and oxygen content.

There is no evidence of chlorine, fluorine, arsenic, or other potentially harmful constituents. Zinc, tin, iron, and copper particulates have been detected and have been lumped into the particulate emission values shown in Table I.

The following is an estimate obtained from smelter personnel of the gas and dust composition from the reverberatory furnace.

GAS			DUST	
CO_2	8.3%		Cu	47.4%
SO_2	3.0%	(High value)	Fe	9.5%
H_2O	19.1%	(High value)	S	9.6%
N_2	67.6%		SiO_2	19.0%
O_2	2.0%		Al_2O_3	2.1%
			CaO	0.4%

Grain loading in the gases leaving one reverberatory furnace ranges from 0.4 to 0.8 grains per ACF (0.9 to 1.7 gr/SCF). For short periods (5-10 min.) 2.5-4.0 gr/SCF has been detected. Another estimate was noted to be 0.97 gr/SCF maximum and 0.45 gr/SCF average. A puff situation occurs which may generate from 0.3 to 1.5 gr/SCF.

TABLE II. EMISSION SOURCE, CONTROL EQUIPMENT, CONTAMINANT AND EMITTED QUANTITY

Type Unit	Type of Control Equipment	Installation Date	Type of Air Contaminant	Quantity Emitted Per Year (tons)
Rotary Dryer Precipitate	Cyclone & Baffle Spray	1965	Particulate	N/A
Reverberatory Furnace	Electrostatic Precipitator	1937	Copper, Zinc, SO_2	SO_2 - 102,000; Particulates - 275
Reverberatory Furnace	Electrostatic Precipitator	1950	Particulate	
Converter	Settling Chamber (Acid Plant)	1938	Tin	
Converter	A/G Heat Exchanger (Acid Plant)	1938	Iron	SO_2 - 145,000 (controlled by acid plant with 2,500 ppm SO_2 emissions)
Converter	Electrostatic Precipitators (Acid Plant)	1940	SO_2	Particulates - 1,000
Converter	Scrubbers (Acid Plant)	1972	Particulate	
Fire Refining Furnace	None	1940	Carbon, SO_2, NO_x, Cu	N/A (Estimated to be very low)
Rotary Lime Kiln	Cyclone	1941	SO_2	N/A (Estimated to be very low)
Holding Furnace	None	1942	SO_2	N/A (Estimated to be very low)
Holding Furnace	None	1943	SO_2	N/A (Estimated to be very low)
Holding Furnace	None	1951	SO_2	N/A (Estimated to be very low)
Primary Crushing & Screening	Multiclone		Particulate	107.9
	Multiclone		Particulate	10.0
	Rotoclone		Particulate	77.6
Secondary Crushing and Screening	Rotoclone		Particulate	1.03
	Rotoclone		Particulate	11.1
			Particulate	34.9
	Rotoclone		Particulate	8.14
Screening	Rotoclone		Particulate	11.0
Screening	Rotoclone		Particulate	12.0
Screening	Rotoclone		Particulate	16.41
Screening	Rotoclone		Particulate	53.34
Screening	Rotoclone		Particulate	0.45

TABLE III. EMISSIONS

REVERBERATORY FURNACE	
Particulate	25.6 TPD
After Precipitator	18.72 TPD
SO_2	242 TPD = 1.07%
SO_3	4.5 TPD
NO_x	3.38 ppm
H_2O	5.5 % b.v.
CO_2	2.0 % b.v.
O_2	17.2 % b.v.
Volume Flow	176,000 SCFM (@ 70°F)
CONVERTERS	
Particulate	8.15 TPD
After Precipitator	5.68 TPD
SO_2	489 TPD
SO_3	1.4 TPD
NO_x	1.96 ppm
H_2O	2.3 % b.v.
CO_2	.5 % b.v.
O_2	19.7 % b.v.
Volume Flow	130,860 SCFM (@ 70°F)
Volume Flow out stack	200,000 SCFM
Dilution	69,000 SCFM

Reference 1.

Later data than the above supplied by the smelter personnel indicated the following for the furnace emissions:

FURNACE EMISSIONS

Particulate	27 TPD
H_2O	4.0% to 7.0% b.v.
SO_2	7400-8700 PPM
SO_3	220 PPM
CO_2	2.0% b.v.
O_2	17.0%
NO_x	1.0-7.0 PPM
SO_3	550 lbs/hr (sulfuric acid mist)
H_2O	5%-7% b.v.
Cl	none
F_2	none
NO_x	none

Arsenic, Selenium, and Zinc mostly in the form of Sulfides. Lead tied up in the slag.

Particulate size range is currently being investigated and is not available.

PARTICULATE OUT OF REVERBERATORY FURNACE

Element	%b.w.
Cu	1-25
Fe	2-20
Mo	.1 - .5
Pb	.2 - 2.0
Si Approx.	60.0
Al	2.0
As	.01 - .15
Ba	.5
Hg	None
Mg	.2
Mn	.01
Ni	.001 - .02
Sn	.1 - 1.0
W	None
Zn	2.0 - 30

95% thru 200 mesh

SO_x	246 short tons	
SO_2	242	98.4%
SO_3	4	1.6%

Reference 5

H. GAS CHARACTERISTIC VARIATION

It can be expected that SO_2 concentration in the offgas from the reverberatory furnace will vary significantly with time. This results from the variation in time required for decomposition or reaction of the various sulfide ores charged to the furnace. This variation in SO_2 content has been known to vary as much as 10 to 1 within a given charging time cycle. While no data are yet available from this smelter concerning this point, it should be considered for control system design.

SO_2 concentration in the converter offgas will also vary considerably for an entirely different reason. The operation of a converter usually includes three slag blows and one copper blow. Between these blows the converter may be rolled out for slag pouring or material charging. When the converter is not blowing, the hood above the converter is closed off by dampers so that the gases do not pass through the collection system to the acid plant. An attempt is always made to maintain at least one converter blowing gases into the system at any given time. Usually 18,000 to 20,000 SCFM will be introduced to the converter tuyeres. Additionally, 100 to 120% dilution air is added to this gas flow resulting in a total gas flow from each converter in the range of 35,000 to 40,000 SCFM. When a converter is blowing there will usually be approximately 38,000 SCFM with an SO_2 content in the range of 4.0 to 4.5%

Because of the normal fluctuation in converter feed and operation, the SO_2 concentration can vary over a relatively wide range. In addition, the gas volume flow from the converter line to the control system acid plant can usually vary over a wide range from maximum to zero. Operation of the control system must be conducted in a manner to compensate for these fluctuations. Acid plant operation at this smelter appears to be typical providing reasonably satisfactory control. Significant on-time data have not yet been accumulated because of the relatively short time the plant has been in operation.

I. STACK DESCRIPTION

Reverberatory Stack

Height	510 feet
Diameter	26 feet
Draft	24.2" Hg Absolute
Acid brick lined	

Converter Stack

Height	625 feet
Diameter	33 feet
Draft	This stack presently not being used.
Acid brick lined	

Acid Plant Stack

Height	200 feet
Diameter	10 feet
Draft	(forced)
Steel	

J. PRESENT TECHNIQUE FOR SOLID WASTE HANDLING

Slag from the reverberatory furnace is taken to the slag dump. Dust from the precipitator in the converter gas cleaning system is taken by screw conveyor into a pug mill where it is processed to allow handling for feeding to the reverberatory furnace via loaders.

K. FOOTING AND STRUCTURAL REQUIREMENTS

If construction is to be carried out in some areas, footing tests would be required. A major portion of the area adjacent to the smelter is old slag dumps. It will be necessary to conduct footing tests to determine detailed footing requirements. However, if slag is assumed for determining footings, then the most conservative (highest cost) estimate will result. There is also a large amount of consolidated rock in the area.

No local codes apply. Seismic zone 2, 20 PSF wind load and 20 PSF snow load are used for design.

L. EXISTING AND POTENTIALLY AVAILABLE UTILITIES

The smelter produces its own electricity. They have recently added 30 megawatt capacity. This leaves approximately 15 megawatts available above that presently being used.

Water is obtained from wells. There does not appear to be a limitation on availability of water. A new pumping system would be required if a large quantity of additional water is used.

There is no additional gas available for fuel. If additional fuel is required, oil must be used.

Steam generated by the smelter is used for electrical power generation.

M. POTENTIAL NEW CONTROL EQUIPMENT INSTALLATION PROBLEMS

The existing precipitator on the reverberatory furnaces is designed for 80,000 SCFM. Since gas flow is currently in the range of 200,000 SCFM, it will be necessary to add additional particulate collection capability. This could be done by either removing the existing units and replacing with one of larger capacity or adding to these units to match the total gas flow. Since the precipitator is old, it would be advisable to replace it.

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5. Kennecott Copper Corp., Chino Mines Division Data.

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16. ABSTRACT

The report gives background design data for a specific copper smelter. The data is sufficiently detailed to allow air pollution control system engineering studies to be conducted. These studies will be concerned primarily with lean SO2 streams that currently are not being captured. Physical layout of the smelter and the surrounding area is presented, along with existing control equipment. Ductwork that would be considered for future system tie-in is defined. Emissions from operating equipment, gas flow rates, temperatures, sulfur balance, and a process flow sheet are included. Utilities, stack dimensions, footing requirements, and solid waste handling are defined. Available area for new control equipment, gas characteristic variation, and potential new control equipment installation problems are discussed.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution	Air Pollution Control	13B
Copper	Stationary Sources	07B
Smelters	Emission Control	11F
Design	Operating Data	
Sulfur Dioxide	Solid Waste Handling	
Utilities	Wastes	

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