AN INDUSTRIAL HYGIENE SURVEY

OF THE KENNECOTT COPPER COMPANY (CHINO DIVISION)

MINE, MILL AND SMELTER

AT

SANTA RITA AND HURLEY, NEW MEXICO

JULY 16, 17 and 18, 1963

BY

OFFICE OF THE STATE MINE INSPECTOR

AND

OCCUPATIONAL HEALTH SECTION
NEW MEXICO DEPARTMENT OF PUBLIC HEALTH

AND

OCCUPATIONAL HEALTH FIELD STATION
U. S. PUBLIC HEALTH SERVICE

September 1963

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INTRODUCTION

The survey was made by the Office of the State Mine Inspector and the New Mexico Department of Public Health with the assistance of personnel from the U.S. Public Health Service Occupational Health Field Station. The assistance of the Public Health Service was obtained through a request made by the New Mexico Department of Public Health.

Participants in the survey were Mr. Hugh Colman, Deputy Mine Inspector, Mr. Bob Craft and Mr. Warren Norris of the Field Station, and Mr. Carl R. Jensen, Chief of the Occupational Health Section of the New Mexico Department of Public Health.

The purpose of the survey was to evaluate the health hazards associated with mining, concentrating and smelting of copper ore.

Mr. John Knudsen, Mr. Howard Snell and Mr. Arnold Acosta acted as observers and representatives for the company during the survey. Mr. Acosta collected a number of impinger samples for particle counts, which should tend to duplicate samples collected by the survey team.

DESCRIPTION OF MINING AND REFINING OPERATIONS

The Chino Mine is at the town of Santa Rita, about twelve miles from the mine at Hurley. The mine is an open pit operation. Ore is loosened by blasting and loaded into trucks which transport it to the skip. The equipment used in the mine includes jumbo drills, power shovels and ore trucks. From the skip, the ore is transported to the mill in railroad cars.

In the mill the ore passes through primary and secondary crushers to the coarse ore bins. From the coarse ore bins, the ore is conveyed to cone crushers, and on to the fine ore bins. The ore is conveyed from the fine ore bins to the ball mills where it is mixed with water. From this point all processes are wet until the concentrate enters the smelter. Copper and molybdenum, a by-product, are concentrated by flotation. The molybdenum is placed in drums for shipping, while copper is transported to the smelter for further refining.

In the smelter the copper concentrate is roasted in reverberatory furnaces, where impurities are either burned off or removed as slag. The final product, blister copper, is cast into ingots.

POINTS OF HEALTH INTEREST

The roadways through the open pit mine are of graded clay and gravel, and although they are sprinkled, some dust was apparent. However, it seems unlikely that exposure more hazardous than driving on dusty country roads would be encountered. Drilling, loading and dumping operations, however, would be expected to create silica dust levels which might be of health concern. All workers engaged in these operations work in enclosures, i.e., drill, shovel and truck cabs.

Crushing, pulverizing and conveying operations could cause dust conditions which might be hazardous. Packing of dry molybdenum concentrate into drums might result in significant levels of airborne molybdenum.

The exposures of concern in the smelter were to dust created in the rebuilding of the furnaces, and gases escaping into the building's atmosphere from the furnaces, and from slag.

Thus the following sampling stations were decided upon for particle counts:

1. Drill Cabs
2. Truck Cabs
3. Shovel Cabs
4. Cabs, Skip Loading Station
5. Primary Crusher
6. Primary Screen
7. Under Coarse Ore Bins
8. Roll Crusher Control Board
9. Roll Crusher Floor
10. Tower Screen
11. Top of Fine Ore Bins
12. Operator's Booth, Top of Fine Ore Bins
13. Primary Ball Mill Section
14. Classifier Section
15. Cab of High Crane (Ball Mill Section)

A high volume sample for free silica determination was collected at the Top of the Fine Ore Bins.

Two samples, one at the Molybdenum Packaging Operation, and another in the Molybdenum Area were collected for molybdenum determination.

Samples were collected in the Converter Area for the determination of selenium, arsenic and lead.

On August 13 and 14 samples for sulfur dioxide determination were collected in the smelter.

A sample of the parting compound used in the ingot molds was submitted for free silica determination.

DISCUSSION OF FINDINGS

The Threshold Limit Values adopted by the American Conference of Governmental Industrial Hygienists are used as guides in the control of health hazards, and are not regarded as fine lines between safe and dangerous concentrations. The Threshold Limit for dusts containing free silica is determined by the following equation:

$$\frac{250}{\%SiO_2 + 5}$$

Analysis of the high volume samples collected at the Top of the Fine Ore Bins showed that the air borne dust contained 16.4 percent free silica. Thus:

$$\frac{250}{16.4 + 5} = 11.7$$

The Threshold Limit Value for this dust is 11.7 million particles per cubic foot. Comparing this Threshold Limit Value with the Summary of Particle Count Results, it is found that in only four areas did the counts exceed the Threshold Limit.

One sample out of three taken in the Tower Screen Area, and one of two in the Roll Crusher Floor, exceeded 11.7 million particles per cubic foot. Two out of three samples collected at the Top of the Fine Ore Bins exceeded the Threshold, and one of three from the Primary Ball Mill Section exceeded.

The excessive counts encountered on July 17 on the Roll Crusher Floor and the Tower Screen Area can be explained by the fact that during the sampling period the roteclones stopped operating, and for some unexplained reason the covers were removed from the Tower Screens. On July 16 and 18, when the exhaust system was operating and the screen covers were in place, the dust levels were found to be well below the Threshold.

On the other hand, the excessive dust levels on Top of the Fine Ore Bins seem to be the usual condition, and it appears that dust leaking from this area probably accounts for 90 percent of the dust in the Ball Mill and Classifier Areas.

The Threshold Limit Value for molybdenum is 5 milligrams per cubic meter for soluble compounds and 15 mg/m^3 for insoluble compounds. Assuming that the concentrate being packaged in the Kennecott Mill is composed of insoluble compounds, it can be seen that neither of the two samples collected for molybdenum determination exceeded the Threshold. The relatively high level, 13.2 mg/m^3 in the Packaging Area can be explained by the broken gaskets in the tubing connecting the molybdenum hopper to the drums during filling.

The Threshold Limit Value for selenium is 0.1 mg/m^3, for arsenic 0.5 mg/m^3 and for lead 0.2 mg/m^3. The samples collected in the smelter were all well below this Limit.

The sample of parting compound collected for free silica determination contained only 0.3 percent free silica.

The Threshold Limit Value for sulfur dioxide is 5 parts per million cubic feet. Thus, with one exception, samples collected on the Top of the Reverberatory Furnaces and Converter Aisle were in excess of the Threshold.

RECOMMENDATIONS

1. Every effort should be made to reduce the level of the dust at the Top of the Fine Ore Bins, below the Threshold, or to make this a remote control operation.

2. The walls separating the Top of the Fine Ore Bins from the Ball Mill Area should be made dust tight to prevent contaminating operations which are relatively free of dust.

3. Although the survey indicated that the molybdenum level in the vicinity of the Molybdenum Packaging Operation probably does not exceed the Threshold Limit, this level can easily be reduced by simple repairs of the gaskets and rubber tubing used to convey the molybdenum to the drum being filled.

4. As non-potable water is used in the industrial processes, it is recommended that all piping carrying this industrial water be painted a distinctive color.

5. If possible, steps should be taken to reduce the level of sulfur dioxide in the Reverberatory Furnaces and Converter Areas. If this cannot be done, every effort should be made to assure that each worker in these areas is equipped with properly designed and maintained respiratory protective equipment.

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The participants in this survey sincerely appreciate the cooperation and assistance which was freely given by all of the company's representatives. We are especially grateful to Mr. Howard Snell, Mr. Arnold Acosta , and to the Company for making it possible for Mr. John Knutsen to come from Salt Lake City to assist in the survey.

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SUMMARY OF PARTICLE COUNT RESULTS

KENNECOTT COPPER COMPANY, CHINO DIVISION, SANTA RITA AND HURLEY, NEW MEXICO

Station No.	Sample No.	Air Volume Cf	Sample Location	Comments	7/16/63 mppcf	7/17/63 mppcf	7/18/63 mppcf
1	1 HC 8 HC		7/16/63 7/17/63 Cab #25 Drill, and Cab #22 Drill		0.4	3.3	---
2	2 HC 4 HC 7 HC		7/16/63 7/17/63 Cabs, Trucks No. 34, 5, and 16		0.2 0.6	0.5	---
3	5 HC 6 HC		Cab, Shovel #17		0.5	3.2	---
4	3 HC		Cab, Skip Loading Station		0.5	---	---
5	5 BC 5 CJ	1.5 1.0	Primary Crusher	Operator's Control Booth	0.8	1.0	---
6	6 WN 11 WN	1.0 1.0	Primary Crusher Screen	General Air	2.3	4.1	---
7	5 WN 10 WN	1.0 1.0	Under Coarse Ore Bins	Between Belts 2 & 3	2.2	7.2	---
8	4 BC 4 CJ	1.0 1.0	Roll Crusher Control Board	General Air	0.8	8.3	---
9	3 BC 3 CJ	1.0 1.0	Roll Crusher Floor	General Air	2.1	12.1	---
10	4 WN 9 WN 14 WN	1.0 1.0 1.0	Tower Screen	General Air	2.5	25.5	4.5
11	1 WN 7 WN 12 WN	0.5 0.5 0.5	Top of Fine Ore Bins	General Air	11.0	22.8	29.3
12	1 BC 1 CJ	1.5 1.0	Operator's Booth Top of Fine Ore Bins		0.5	1.0	---
13	2 BC 2WN 13 WN	0.5 0.5 0.5	Primary Ball Mill Sec.	General Air	3.1	11.8	3.4
14	2 BC 2 CJ	1.0 1.0	Classifier Section	Operator's Rounds	0.8	3.2	---
15	3 WN	1.0	Cab of High Crane	General Air	2.0	---	---

FIELD SAMPLE SUMMARY

Plant Kennecott Copper Co., Hurley, New Mexico Date 7/16/63

Sample Media H_2O Rate 0.1 cfm

Field Sample No.	Air Vol. cfm	Time t_o / Δt	Sample Location	Comments	mppcf
WM-1	0.5	0920 / 5	Top of Fine Ore Bins	One man - General Air	11.0
WM-2	0.5	0930 / 5	Primary Ball Mill Section	General Air	3.1
WM-3	1.0	0950 / 10	Cab of High Crane	General Air over Ball Mill Area	2.0
WM-4	1.0	1005 / 10	Tower Screen	General Air	2.5
WM-5	1.0	1020 / 10	Under Coarse Ore Bins	General Air between Belts 2 & 3	2.2
WM-6	1.0	1045 / 10	Primary Screen	General Air	[illegible]
BFC-1	1.5	0910 / 15	Operator's Booth Top of Fine Ore Bins	Air Conditioning in Booth	0.5
BFC-2	1.0	0935 / 10	Classifier Section	General Air, Operator's Rounds	0.8
BFC-3	1.0	1010 / 10	Roll Crusher Floor	General Air	2.1
BFC-4	1.0	1020 / 10	Roll Plant Operator Control Board	General Air, Two Men Working	0.6
BFC-5	1.5	1040 / 15	Primary Crusher	Operator Control Booth	0.8

FIELD SAMPLE SURVEY

Plant Kennecott Copper Co., Hurley, New Mexico Date 7/17/63

Sample Media H_2O Rate 0.1 cfm

Field Sample No.	Air Vol. cfm	Time t_o / t	Sample Location	Comments	mppcf
WM-7	0.5	0920 / 5	Top of Fine Ore Bins	General Air	22.8
WM-8	0.5	0945 / 5	Primary Ball Mill	General Air on Walking Floor	11.8
WM-9	1.0	1010 / 10	Tower Screen	General Air All rotoclones went down	25.5
WM-10	1.0	1030 / 10	Under Coarse Ore Bin	Between Belts 2 and 3	7.2
WM-11	1.0	1100 / 10	Primary Screen	General Air	4.1
CJ-1	1.5	0920 / 15	Top of Fine Ore Bin Operator's Booth	Air conditioned	1.0
CJ-2	1.0	0940 / 10	Classifier Section	Operator's Rounds	3.2
CJ-3	1.0	1015 / 10	Roll Crusher Floor	Rotoclones failed	12.1
CJ-4	1.0	1030 / 10	Roll Plant Operator	Control Board	8.3
CJ-5	1.0	1050 / 10	Primary Crusher	Operator's Control Booth	1.0

FIELD SAMPLE SUMMARY

Plant Kennecott Copper Co., Hurley, New Mexico Date 7/18/63

Sample Media H_2O Rate 0.1 cfm =

Field Sample No.	Air Vol. cfm	Time t_2 / t_1	Sample Location	Comments	mppcf
WH-12	0.5	0845 / 5	Top of Fine Ore Bins	General Air	29.8
WH-13	0.5	0900 / 5	Ball Mill Area	General Air	3.4
WH-14	1.0	1040 / 10	Tower Screen Area	General Air	4.5

OCCUPATIONAL HEALTH FIELD STATION, U. S. PUBLIC HEALTH SERVICE
P. O. Box 2539, Ft. Douglas Station
Salt Lake City, Utah

SAMPLE DATA AND LABORATORY REPORT

Name of Plant Kennecott Copper, Hurley Reduction Plant Address Hurley, New Mexico

Analyse for Lead, arsenic, selenium, molybdenum and free silica. Collected by Norris and Craft Date Collected 7/16,17,18/63

Send Report to

Laboratory Number**	Field Number	Type of Sample*	Sample Volume	Description: Location, name, time, collecting medium & volume, etc. Use next two columns if convenient.		Analysis**
6974	No.1(S)	MF	855 L	Back of No. 2 converter - 7/16/63 75 min. @ 11.4 liters/min.=855 l.	(Selenium)	0.04 mg/M^3
6975	No.2(A)	MF	798 L.	Back of No. 2 converter - 7/16/63 70 min. @ 11.4 l/m = 798 l.	(Arsenic)	0.0013 Mg/M^3
6976	No.1(M)	MF	114 L.	Collected in moly area close to drum filler. Gaskets broken. Leakage apparent. 10 min.@ 11.4 l/m-114L		Molybdenum 13.2 Mg/M^3
6977	No.2(M)	MF	342 L.	Collected in moly area, top deck above roaster. One operator covers area-30 min.@11.4 l/m=342 l.		Molybdenum 2.2 Mg/M^3
6978	No.1(L)	MF	2508 L.	Back of converters - 7/18/63 220 min. @ 11.4 min.	(Lead)	0.001 Mg/M^3
6979	No.1(FS)	MS	-	Top of fine ore bin (composite)	(Free silica)	16.4%
6980	No.2(FS)		-	Parting compound (bone ash)	(Free silica)	0.3%

Remarks (Interfering materials possibly present, purpose of samples, unusual circumstances, laboratory comments, etc. Use back for additional space.)

*Bulk; urine; blood; SD - settled dust (only portion passing thru 200 mesh screen will be analyzed); HV - high volume sampler; MF - millipore filter; MS - microsorban filter; FF - filter paper; MI - midget impinger; IMP - impinger; MB - midget fritted bubbler; BB - fritted bubbler; ESP - electrostatic precipitator.

**To be filled out by laboratory. Please submit two copies of form with samples. One copy will be returned with results.

Date Received** 7 /19/63 Date Reported** 8/16/63 Analyst** Dixon and Larsen Russel H. Hendricks **
Chief of Laboratory

OCCUPATIONAL HEALTH FIELD STATION, U. S. PUBLIC HEALTH SERVICE
P. O. Box 2539, Ft. Douglas Station
Salt Lake City, Utah

SAMPLE DATA AND LABORATORY REPORT

Name of Plant Kennecott Copper Company, Smelter Address Hurley, New Mexico

Analyze for Free Silica Collected by Carl R. Jensen Date Collected Sep. 16,17,18, 1963

Send Report to

Laboratory Number**	Field Number	Type of Sample*	Sample Volume	Description: Location, name, time, collecting medium & volume, etc. Use next two columns if convenient.	Analysis**
	1	MB	70.8 liter	Top of Reverberatory Furnace	6.5
	2	"	56.6	Upper areas of Converter Aisle	6.2
	3	"	34.0	Top of Reverberatory Furnace	8.8
	4	"	23.44	Upper areas of Converter Aisle	2.0
	5	"	20.7	Top of Reverberatory Furnace	21.0

Remarks (Interfering materials possibly present, purpose of samples, unusual circumstances, laboratory comments, etc. Use back for additional space.)

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