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SEVILLE CENTRIFUGAL BRONZE INC.
SEVILLE, OHIO

NIOSH INVESTIGATORS:
Nancy J. Clark
Paul A. Jensen

I. SUMMARY

In January 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Ohio Department of Health (ODH) for technical assistance in evaluating employee lead exposures at the Seville Centrifugal Bronze Inc. facility in Seville, Ohio.

On February 28, 1991, NIOSH and ODH representatives conducted an industrial hygiene survey. Personal breathing zone samples for lead and trace elements were collected for the nine employees at the foundry; direct reading measurements using a Realtime Aerosol Monitor (RAM-1) were made throughout the facility; and dust samples from the floor were collected for analysis of lead, quartz, and cristobalite content.

Workplace lead concentrations ranged from 98 to 230 micrograms per cubic meter (ug/m^3), as time-weighted averages. All of the personal breathing zone samples exceeded the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for workplace exposure to airborne lead of 50 ug/m^3 as an 8-hour time-weighted average (TWA). All employees were required to wear half mask respirators with high efficiency particulate air filters (HEPA) in the production area. The personal breathing zone air concentrations for the trace elements, aluminum, copper, iron, magnesium, nickel, tin, and zinc, were below existing guidelines and standards established by NIOSH and OSHA. Cadmium, which has been classified as a suspected human carcinogen, exceeded the NIOSH Recommended Exposure Limit (REL) of lowest feasible exposure level. The lead content, percent quartz, and percent cristobalite were 2000 micrograms per gram sample (ug/g), 15%, and 2.8%, respectively for the first bulk sample and 1900 ug/g, 12% and 2.1% for the second sample. Approximately 70% of the particles in the two bulk dust samples were less than 10 micrometers (um) in size. Respirable dust concentrations in the foundry ranged from 0.5 milligrams per cubic meter (mg/$m^{3)}$ near the functioning local exhaust hoods of the induction furnaces to 20 mg/m^3 during pouring in the centrifugal molding area. There were no local ventilation controls for the pouring area.

The industrial hygiene sampling data indicate that the lead levels at this facility do constitute a health hazard to the employees. Several recommendations are offered to improve working conditions, such as providing additional local exhaust ventilation during pouring and removal of the slag, the use of a vacuum cleaner with high efficiency particulate air filters (HEPA) filters for cleaning up dust, substitution of a less hazardous mold wash, and separating the eating area from the machining and grinding area.

KEYWORDS: SIC 3366 (copper foundries), lead, quartz, cristobalite

II. INTRODUCTION

On February 28, 1991, National Institute for Occupational Safety and Health (NIOSH) representatives, along with representatives from the Ohio Department of Health, conducted an initial site visit to Seville Centrifugal Bronze Inc., in Seville, Ohio. The visit was made in response to a request for technical assistance from the Ohio Department of Health to evaluate worker exposure to lead at the facility. The facility was identified through the physician occupational disease reporting system for the State of Ohio.

III. BACKGROUND

The Seville Centrifugal Bronze Inc. manufactures bronze bushings and bearings. The one-story building housing the foundry was built around 1955. The company uses approximately 25 different alloys, with lead content ranging from 0.5-8% lead. At the time of the site visit, the majority of the alloy used contained 0.5-1.5% lead and had a high zinc content. The facility had three electric induction furnaces, equipped with local exhaust ventilation hoods. The average production was about 1700 pounds per day. Pouring was done in an open area using mobile and stationary molds. A small hand-controlled crane was used to carry the ladle. The pouring temperature of the alloy was between 2000 - 2200^{o}F. The centrifugal molds used a mold wash that contained quartz and cristobalite according the Material Safety Data Sheet (MSDS). The bag-house used at the facility to collect dust was self-cleaning. The collected dust was sold for reclamation. The machining area, located in another building, used turret lathes to shape the metal to customer specifications.

At the time of the site visit, there were eight production workers and one foreman at the foundry. Approximately half of the workforce had started working for the company in the six months prior to the site visit.

The company required 3-M half-mask respirators with high efficiency particulate air filters (HEPA) to be worn in the foundry production area. Uniforms were provided as well as safety glasses, gloves, shoes, and protective clothing.

The company used qualitative fit-testing with irritant smoke. Each employee had their own respirator and was responsible for cleaning it. The general manager inspected the respirators. Hearing protection was not required by the company but was available at employee request. Physical exams were required annually and pre-employment physicals were given. Air sampling and biological monitoring for lead were done on a routine basis. A lunch area and showers were provided. Employees showered before leaving the facility and the company provided a laundry service. There was a no smoking policy in the foundry production area.

IV. EVALUATION CRITERIA AND TOXICOLOGY

In order to assess the hazards posed by workplace exposures, industrial hygienists use a variety of environmental evaluation criteria. These criteria propose exposure levels to which most employees may be exposed for a normal working lifetime without adverse health effects. These levels do not take into consideration individual susceptibility such as pre-exiting medical conditions or possible interactions with other agents or environmental conditions. Evaluation criteria change over time with the availability of new toxicologic data.

There are three primary sources of environmental evaluation criteria for the workplace: 1) NIOSH Recommended Exposure Limits (RELs), 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs^{R}), and 3) the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs). The OSHA PELs may include the feasibility of controlling exposure in various industries where the agents are used; the NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted while reviewing this report that industries are legally required to meet those levels specified by an OSHA standard.

A. Lead

Inhalation of lead dust and fumes is the major route of exposure in industrial environments. A secondary source of exposure may be from ingestion of lead deposited on food, cigarettes, or other objects. Absorbed lead interferes with red blood cell production and can damage the kidneys, peripheral and central nervous systems, and bone marrow. Symptoms that have been associated with high lead exposures include fatigue, weakness, irritability, mental deficiencies, digestive disturbances, high blood pressure, kidney damage, and slow reaction times. Chronic lead exposures have been associated with infertility among both sexes and with fetal damage in pregnant women.[1,2] The developing systems of young children may be damaged by Blood Lead Levels (BLLs) as low as 10 micrograms per deciliter (ug/dl).

The OSHA PEL for lead in air is 50 micrograms lead per cubic meter of air (ug/m^3) calculated as an 8-hour time-weighted average (TWA) for daily exposure. This regulation also requires semi-annual blood lead monitoring of workers exposed to air concentrations of 30 ug/m^3 or greater of lead. Employees whose BLL is 40 ug/dl or greater must be retested every two months and be removed from a lead-exposed job if their average BLL is 50 ug/dl or more over a 6-month period. A BLL of 60 ug/dl or greater, confirmed by retesting within 2 weeks, is an indication for immediate medical removal. Workers on medical removal should not be returned to a lead-exposed job until their BLL is confirmed to be below 40 ug/dl. Removed workers in the U.S. have protection for wage, benefits, and seniority for up to 18 months until their blood levels are below 40 ug/dl and they can be returned to lead exposure areas.[3] The NIOSH REL for lead is less than 100 ug/m^3 (air levels to be maintained so that the worker's BLL remains below 60 ug/100 gm of whole blood.[4] The ACGIH TLV for airborne lead is 150 ug/m^3.[5]

B. Silica

Crystalline silica (quartz) and cristobalite have been associated with silicosis, a pulmonary fibrosis of the lung caused by the deposition of fine particles of crystalline silica in the lungs. Symptoms usually develop insidiously, with cough, shortness of breath, chest pain, weakness, wheezing, and non-specific chest illnesses. Silicosis usually occurs after years of exposure, but may appear in a shorter period of time if exposure concentrations are very high. The NIOSH RELs for respirable quartz and cristobalite are 50 ug/m^3, as time- weighted averages. NIOSH considers quartz and cristobalite to be potential human carcinogens. The OSHA PELs and the ACGIH TLVs are 100 and 50 ug/m^3 for respirable quartz and cristobalite, respectively.

C. Trace Elements

The potential health effects associated with the trace elements of major toxicologic importance are shown in Table 1. These elements include aluminum, cadmium, copper, iron, magnesium, nickel, tin, and zinc. The NIOSH RELs, the OSHA PELs, and the ACGIH TLVs are also given for each element.[3,4,5,6,7]

V. METHODS

Nine personal breathing zone air samples were collected on mixed-cellulose ester filters (37 millimeter diameter, 0.8 um pore size) using a flowrate of 2.0 liters per minute. Samples were collected for a period as near as possible to an entire workshift.

Two analytical methods were used for the analyses. Six personal breathing zone samples were analyzed according to NIOSH Method 7082.[8] The samples were wet ashed using nitric acid and hydrogen peroxide. After heating, the sample solutions were allowed to cool, brought up to volume using deionized water, and then analyzed for lead using atomic absorption spectroscopy. The limit of detection (LOD) was 3 micrograms per filter. The limit of quantification (LOQ) was 10 micrograms per filter.

Three personal breathing zone samples were analyzed for trace elements according to NIOSH Method 7300.[9] In the laboratory, the samples were wet-ashed with concentrated nitric and perchloric acids and the residues were dissolved in a dilute solution of the same acids. The resulting sample solutions were analyzed by inductively coupled plasma-atomic (ICP) emission spectrometry.

Two samples of bulk dust were collected from the foundry floor. They were analyzed for quartz and cristobalite content using x-ray diffraction (NIOSH Method 7500)[10], lead content by atomic absorption spectroscopy (NIOSH Method 7082), and particle size using polarized light microscopy.

Aerosol measurements were made at the facility using a Realtime Aerosol Monitor (RAM-1, MIE, Inc., Bedford, MA) to identify potential sources of exposure to foundry dusts. This instrument samples the workplace air and measures the concentration of airborne dusts and mists by analyzing the amount of light scattered by these materials. The optical characteristics of the RAM are such that it is most sensitive to respirable aerosols (dusts and mists below 10 micrometers in diameter). The instrument is calibrated using Arizona road dust at an estimated 2.4 milligrams per cubic meter (mg/m^3).

VI. RESULTS

Employee exposure to lead fume and dust were monitored throughout the production area. Workplace lead concentrations ranged from 98 to 230 ug/m^3, as time-weighted averages. All of the personal breathing zone samples exceeded the OSHA PEL for workplace exposure to airborne lead. The lead sampling results analyzed using atomic absorption are shown in Table 2. The lead concentrations in the air samples were similar to what had been found by the company during their environmental sampling. Blood lead levels were similar to those found in employees of similar facilities.

Table 3 presents the results for trace elements with potential health hazards, including lead, which were analyzed using inductively coupled plasma-atomic emission spectrometry. The personal breathing zone air concentrations for aluminum, copper, iron, magnesium, nickel, tin, and zinc were below existing guidelines and standards established by NIOSH and OSHA. Cadmium, which has been classified as a suspected human carcinogen, exceeded the NIOSH REL of lowest feasible exposure concentration.

The lead, quartz and cristobalite content of the two bulk dust samples are listed in Table 4. The lead content, percent quartz, and percent cristobalite were 2000 microgram per gram sample (ug/g), 15%, and 2.8%, respectively for the first sample and 1900 ug/g, 12% and 2.1% for the second sample. Approximately 70% of the particles in the two bulk dust samples were less than 10 microns in size.

Results for the respirable dust monitoring are presented in Table 5. The dust concentrations were lower near the functioning local exhaust hoods of the induction furnaces and highest during pouring operations.

VII. DISCUSSION AND CONCLUSIONS

The airborne lead concentrations exceeded the OSHA PEL, thus constituting a health hazard to the employees of this foundry. High concentrations of lead, quartz and cristobalite were found in the dust samples suggest an additional hazard from the floor area, especially during clean-up procedures. Cadmium, a suspected human carcinogen, was detected in the three air samples analyzed for trace elements.

VIII. RECOMMENDATIONS

1. Slagging and pouring operations should be continued with the existing local exhaust system to control the fumes. The hoods on the induction furnaces were effective during melting, but did not control the fumes during metal transference into the ladles or slagging operations. No controls were used when transferring from one ladle to another. One suggestion is a movable local exhaust device that could be added in the vicinity of the transfer location to collect the fume.

2. Large amounts of respirable dust containing lead, quartz, and cristobalite were found in samples taken from the floor. Workers were also observed sweeping the floor with a broom which reentrains dust into their breathing zone. A vacuum cleaner, with HEPA filters, would be a less hazardous method of cleaning the dust from the floor of the facility. An area approximately 3 feet wide and 30 feet long was observed to contain a few inches of dust from where the bulk samples were obtained. This area should be cleared of all dust and the floor repaired as necessary.

3. Due to the high quartz and cristobalite content of the mold wash used in the centrifugal molds and as evidenced by the large quantities found in the bulk samples of floor dust, the possibility of using a less hazardous substitute mold wash should be investigated. Also, compressed air should not be used to clean the molds as this results in the aerosolization of the quartz and cristobalite particulates.

4. The eating area should be physically separated from the machining and grinding areas to prevent contamination of food and promote good hygiene practices. Smoking should not be allowed where potential contaminants are present.

5. The use of chain falls and forklifts should be continued to limit potential injuries from lifting of heavy loads.

6. Blood lead levels should continue to be monitored every six months and the results reviewed by a physician, preferably with training in occupational medicine.

7. Quartz and cristobalite air monitoring should be conducted on a regular basis to make sure there are no excessive exposures.

IX. REFERENCES

1. Hernberg S, Dodson WN, and Zenz C (1988). Lead and its compounds. In Zenz C. Occupational Medicine: 2nd Ed. Chicago, IL: Year Book Medical Publishers, pp. 547-582.

2. Landrigan PJ, Froines JR, and Mahaffey KR (1985): Body lead burden: Summary of epidemiological data on its relation to environmental sources and toxic effects. Chapter 2. In Mahaffey KR ed. Dietary and environmental lead: Human health effects. Amsterdam: Elsevier Science Publishers.

3. Code of Federal Regulations (1978). OSHA: Occupational exposure to lead - final standard. 29 CFR 1910.1025. Washington, DC: U.S. Governmental Printing Office, Federal Register.

4. CDC (1988). NIOSH recommendations for occupational safety and health standards 1988. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. MMWR 37 (supp. no. S-7).

5. ACGIH (1990). Threshold limit values and biological exposure indices for 1990-91. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

6. Code of Federal Regulations (1989). OSHA Table Z-1. 29 CFR 1910.1000. Washington, DC: U.S. Governmental Printing Office, Federal Register.

7. NIOSH (1986). Occupational respiratory diseases. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 86-102.

8. NIOSH (1984). Lead: method no. 7082. In: Eller PM, ed. NIOSH manual of analytical methods. 3rd rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) publication No. 84-100.

9. NIOSH (1984). Elements (ICP): method no. 7300. In: Eller PM, ed. NIOSH manual of analytical methods. 3rd rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) publication No. 84-100.

10. NIOSH (1989). Silica, crystalline, respirable: method no. 7500 (supplement issued 5/15/89). In: Eller PM, ed. NIOSH manual of analytical methods. 3rd rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) publication No. 84-100.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:
Nancy J. Clark, M.P.H., M.S.
Industrial Hygienist
Industrial Hygiene Section

Paul A. Jensen, P.E.
Industrial Hygiene Engineer
Division of Physical Sciences and Engineering

Field Support:
Lesliann E. Helmus
Nan A. Migliozzi
Ohio Department of Health

Analytical Support:
Data Chem, Inc.
960 West Leroy Drive
Salt Lake City, Utah

Originating Office:
Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies

Report Typed by:
Linda J. Morris
Secretary
Industrial Hygiene Section

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1. Seville Centrifugal Bronze Inc.
2. The Ohio Department of Health
3. OSHA, Region V

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Table 1

Possible Health Effects and Evaluation Criteria for Detected Trace Elements

Element	Health Effects	NIOSH REL (ug/m^3)*	OSHA PEL (ug/m^3)	ACGIH TLV (ug/m^3)
Aluminum	aluminosis, some lung scarring, possible asthma	1000	1500	10000
Cadmium	pulmonary edema; cough; emphysema; renal involvement; mild anemia; respiratory cancer	LFC**	200	50 (10#)
Copper	irritation of upper respiratory tract; metallic taste; nausea; metal fume fever	1000	1000	1000
Iron	siderosis; scarring of the lung with increased quartz content	10000	10000	5000
Magnesium	Eye and nasal irritation; metal fume fever	None	10000	10000
Nickel	Lung and nasal cancer; some pneumoconiosis	15	1000	1000 (50#)
Tin	Tin pneumoconiosis; severe X-ray changes in miners	2000	2000	2000
Zinc	shortness of breath; some minor lung changes; some deaths reported from pneumoconiosis.	5000	10000	10000

* ug/m^3 - microgram per cubic meter as time-weighted average.

** NIOSH considers cadmium to be a potential human carcinogen; therefore, exposure should be reduced to the lowest feasible concentration.

- Notice of Intended Changes 1990-91.

Table 2

Results of Personal Breathing Zone Samples for Lead
Atomic Absorption Technique

Seville Centrifugal Bronze Inc.
Seville, Ohio
HETA 91-093

February 28, 1991

Job/Location	Sampling Duration	Sample Volume (liters)	Lead Conc. (TWA-ug/m^3)*
Spinner	6:28-14:26	956	125.5
Sheet Man	7:02-12:58 13:00-14:43	918	98
Furnace Operator	6:29-14:31	964	155.6
Lathe Operator	6:56-14:57	962	76.9
Pulling Spinners	6:57-12:30 12:42-14:59	940	117
Foreman	7:05-14:45	920	119.6
OSHA Permissible Exposure Limit:			50
NIOSH Recommended Exposure Limit:			<100

Limit of Detection (LOD): 3 ug/filter (3 ug/m^3)

Limit of Quantitation (LOQ): 10 ug/filter (10 ug/m^3)

* TWA-ug/m^3 - Time-weighted average-micrograms per cubic meter

Table 3

Results of Personal Breathing Zone Samples for Trace Elements
Using Inductively Coupled Plasma Emission Spectroscopy (ICP)

Seville Centrifugal Bronze Inc.
Seville, Ohio
HETA 91-093

February 28, 1991

Job Title	Sampling Time	Sample Volume	Trace Element Concentrations (TWA-ug/m^3)* Al	Cd	Cu	Fe	Mg	Ni	Pb	Sn	Zn
Grinding Chain	7:01-14:59	896	11.2	4.46	42.4	19	5.58	1.12		134	22.3	2009
Furnace Oper.	6:30-14:30	960	20.8	3.13	95.8	29.2	8.33	2.08		198	20.8	813
Pourer	7:00-14:59	958	62.6	4.18	66.8	42.8	20.9	2.09		230	41.8	1983
Limits of Detection (ug/filter)			10	1	1	1	5	1	2	10	l	

* - TWA-ug/m^3 - Time-weighted average micrograms per cubic meter

Elements	OSHA PELs (ug/m^3)	NIOSH RELs (ug/m^3)	ACGIH TLVs (ug/m^3)
Al - Aluminum	1500	1000	10000
Cd - Cadmium	200	LFL**	50
Cu - Copper	1000	1000	1000
Fe - Iron	10000	5000	5000
Mg - Magnesium	10000	None	10000
Ni - Nickel	1000	15	1000
Pb - Lead	50	<100	150
Sn - Tin	2000	2000	2000
Zn - Zinc	10000	5000	10000

** - Lowest Feasible Concentration

Table 4

Lead And Silica Content of Bulk Dust Samples from Foundry Floor

Seville Centrifugal Bronze Inc.
Seville, Ohio
HETA 91-093

February 28, 1991

Sample Number	Lead Concentration (ug/gram)	Quartz Percent	Cristobalite Percent
1	2000	15%	2.8%
2	1900	12%	2.1%
Limit of Detection (LOD)	3	0.75%	0.75%
Limit of Quantitation (LOQ)	11	1.5%	1.5%

Table 5

Respirable Aerosol Monitoring Results

Seville Centrifugal Bronze Inc.
Seville, Ohio
HETA 91-093

February 28, 1991

Location	Concentration (mg/m^3)
<u>Foundry Area</u>	
Furnace Area While Melting - No Recent Metal Transfer	0.5 - 1
Removing Slag from Ladle (No local exhaust ventilation)	5
Centrifugal Mold Area	5 - 8
Centrifugal Mold Area While Pouring	15 - 20
Slag Removal From Furnace	10 - 15
<u>Machine Shop</u>	
Center Area Between Lathes	<1
Along Outside Wall Behind Lathe	1.2 - 1.4