U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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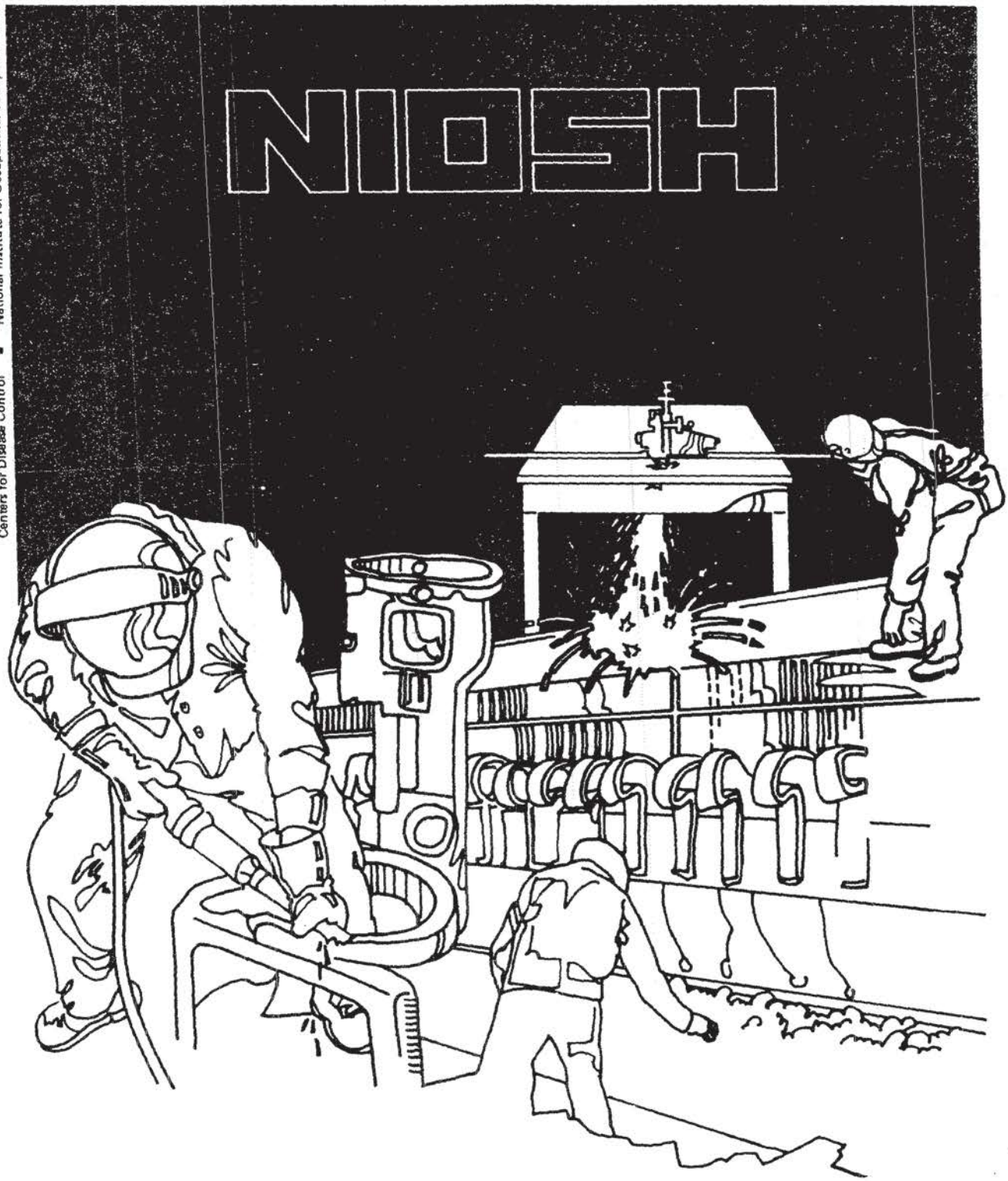
NIOSH



Health Hazard Evaluation Report

HETA 79-157-1212
CRANE COMPANY
ROGERS, ARKANSAS

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HHE 79-157-1212
OCTOBER 1982
CRANE COMPANY
ROGERS, ARKANSAS

NIOSH INVESTIGATORS:
Harry L. Markel, Jr.
Donald L. Slovin, M.D.

I. SUMMARY

In September 1979, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Steelworkers of America, Local 7178, to evaluate employee exposures to lead, iron oxide, zinc oxide, silica and other dust at the Crane Company in Rogers, Arkansas.

On November 7, 1979, a preliminary walk-through survey was conducted by NIOSH investigators, information gathered on all substances used in the production areas, and five employees from various sections of the foundry interviewed.

At the joint request of management and the Union, because of pending engineering alterations at the facility, the follow-up environmental/medical evaluation was not conducted until January 19-21, 1981. Results of 69 personal breathing-zone/general area air samples were as follows: Lead [14 air samples ranging from 0.02-0.33 milligrams per cubic meter of air sampled (mg/M^3]; Iron/Iron oxide [14 air samples ranging from 0.02-0.24 mg/M^3]; Zinc/Zinc oxide [14 air samples ranging from 0.16-4.48 mg/M^3]; Particular matter -- total [10 air samples ranging from 0.7-5.7 mg/M^3]; Particular matter -- respirable [11 air samples ranging from 0.4-3.0 mg/M^3]; and Silica [6 air samples, 3 of which were below the lower limit of detection (LOD) of the analytical method -- the remaining 3 samples ranging from 2.1-5.0 mg/M^3]. Twelve of the 14 personal breathing-zone lead samples (86 per cent) exceeded the OSHA standard of 0.05 mg/M^3. One of 6 respirable air samples (17 per cent) exceeded the allowable free silica concentration when using the OSHA criteria and 2 of 6 samples (33 per cent exceeded the NIOSH recommended standard of 0.05 mg/M^3. All other results were within acceptable exposure limits.

A questionnaire, with questions related to symptoms of lead toxicity, and respiratory, mucous membrane, and skin irritation, was administered to 42 foundry employees. Results of blood lead testing performed by the company were reviewed. While the mean lead level was 35 micrograms per deciliter (ug/dl), and none exceeded 60 ug/dl, 30 of 92 tests (33 per cent) exceeded 40 ug/dl. Core/cleaning workers reported more frequent problems with skin irritation, cough, tiredness and headache than did other workers. These symptoms are consistent with exposure to formaldehyde, which was subsequently identified as being present in some of the products used. Mold workers had a higher prevalence of dry, cracked hands than did other workers -- a result consistent with their solvent usage.

Based on results of the environmental/medical evaluation, NIOSH determined that a potential health hazard exists for production area employees from exposures to lead and silica; for core/cleaning workers from formaldehyde; and, for mold workers from skin contact with solvents. No evidence of a hazard from exposure to iron oxide, zinc oxide and particulate matter (total/respirable) was found.

Recommendations relating to this evaluation are presented in Section VIII of this report.

KEYWORDS: SIC 3362 (Brass, Bronze, Copper Base Alloy Foundries); Lead; Iron oxide; Zinc oxide; Silica; Mold release agents.

II. INTRODUCTION

On September 19, 1979, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Steelworkers of America, Local 7178, to evaluate employee exposures to lead, iron oxide, zinc oxide, silica, and total/respirable dust at the Crane Company in Rogers, Arkansas.

III. BACKGROUND

This plant manufactures brass castings/valves, and utilizes approximately 100 "exposed" employees in the annex, core/melt/mold/cleaning departments. Molds and cores are produced in a central area, using a resin-treated sand. The casting itself is performed in the main furnace area and the annex. A barrier wall isolates the melt furnaces and automatic floor furnaces from the remainder of the foundry.

After metal pouring, the castings harden, cool, and are separated from the molds in the shakeout area. Broken molds are crushed and the sand returned to the coremaking area for re-use.

IV. EVALUATION DESIGN AND PROCEDURES

A. Environmental

An initial walk-through survey was performed at the facility on November 7, 1979. Information was gathered on the characterization of all substances used in the production areas (core/melt/mold/cleaning departments and annex), as well as the conditions of their use.

At the request of management and the union, the environmental/medical evaluation was delayed pending the completion of planned engineering alterations within the facility. The follow-up evalation was conducted on January 20-21, 1981. During that period, 67 personal breathing-zone and two general area air samples were collected to evaluate employee exposure to lead, iron oxide, zinc oxide, silica, and total/respirable dust. Samples were collected by using both 0.8 and 5.0 micron pore size filters, depending on the prescribed sampling/analytical method. Analytical methods utilized were inductively coupled plasma/atomic emissions spectroscopy (ICP-AES), x-ray diffraction and gravimetric analysis.

At the time of the evaluation, the potential for formaldehyde exposure had not been identified because of incomplete information provided by management on trade-name products.

B. Medical

During the November 7, 1979 initial walk-through survey, five (5) employees were interviewed at various sections of the foundry. On the basis of these interviews, a questionnaire was designed and administered during the January 19-21, 1981, follow-up study. Questions were included for demographic information, smoking history, occupational history, and for occurrence -- both during the preceding two days and preceding six months -- of symptoms such as tiredness, burning eyes,

dizziness, headache, muscle weakness, tremors, poor appetite, cough, chills, fever, runny nose, abdominal cramps, and skin problems. Other questions included the use of shower facilities, hand washing before eating and smoking, and possible exposure to lead outside the workplace.

All employees in the melt area were interviewed. For other foundry areas, a systematic sample was generated by using an employment list. The number of employees interviewed versus the total number performing duties within each department were as follows: core department (22 of 33); grinding department (2 of 12); annex (6 of 13); auto forge (2 of 2); and melt department (5 of 5).

Results of lead screening tests previously performed by the company on employees in the more exposed areas of the plant, and on maintenance workers and grinders, were also reviewed. After July, 1980, these samples were analyzed by Smith Kline Laboratories, Creve Coeur, Missouri. Only those tests from July-December 1980 are included in this report.

V. EVALUATIONS CRITERIA

A. Environmental

Environmental standards and criteria considered applicable to this evaluation are shown below.

Substance	NIOSH, 8-10 hr. TWA Recommendation mg/M^3*	ACGIH, TLV Committee, 8-hr. TWA (mg/M^3*	OSHA, 8-hr. TWA Standard (mg/M^3*)
Lead	0.05	0.15	0.05
Iron	**	5.0	5.0
Zinc	5.0	5.0	5.0
Nuisance particulate (Respirable)	**	5.0	5.0
Nuisance particulate (Total)	**	10.0	15.0
Crystalline silica	50 micrograms/M^3	30 mg/M^3 % SiO_2	(total) 30 mg/M^3 % SiO_{2+2} (respirable) 10 mg/M^3 %SiO_{2+2}
1,1,1-Trichloroethane	1910 (10 min. ceiling)	1900	1900
Formaldehyde	***	***	3.6

* Eight or ten-hour, time-weighted-average (TWA) concentrations in milligrams of substance per cubic meter of air sampled.

** No recommendation available

*** Suspected carcinogen -- lowest feasible limit

ACGIH - American Conference of Governmental Industrial Hygienists, Threshold Limit Value Committee; OSHA - Occupational Safety and Health Administration.

B. Toxic Effects

Lead[1,2]

Inhalation of lead dust and fumes is the major route of lead exposure in industry. A secondary source of exposure may be from ingestion of lead dust contamination on food, cigarettes, or other objects. Once absorbed, lead is excreated from the body very slowly. The absorbed lead can damage the kidneys, peripheral and central nervous systems, and the blood forming organs (bone marrow). These effects may be felt as weakness, tiredness, irritability, digestive disturbances, high blood pressure, kidney damage, mental deficiency, or slowed reaction times. Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.

Blood lead levels below 40 micrograms per deciliter (ug/dl) whole blood are considered to be normal levels which may result from daily environmental exposure. However, fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/dl. Lead levels between 40-60 ug/dl in lead exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60 to 100 ug/dl represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/dl are considered dangerous and often require hospitalization and medical treatment.

The most recent OSHA standard for lead in air is 0.05 milligrams per cubic meter of air sampled (mg/M^3) based on an 8-hour time-weighted average for daily exposure. The standard also dictates that in four years, workers with blood lead levels greater than 50 ug/dl must be immediately removed from further lead exposure, and in some circumstances, workers with lead levels less than 50 ug/dl must also be removed. At present, medical removal of workers is necessary at blood lead levels of 70 ug/dl or greater. Removed workers have protection for wage, benefits, and seniority for up to eighteen months until their blood levels adequately decline and they can return to lead exposure areas.

Iron/Iron Oxide[3,4]

Inhalation of iron oxide fume or dust may cause a benign pneumoconiosis (siderosis). Iron oxide alone does not cause fibrosis in the lungs of animals, and it is probable that the same applies to humans. Exposures of six to ten years are usually required before changes recognizible by x-ray occur; the retained dust gives x-ray shadows that may be indistinguishable from fibrotic pneumoconiosis.

Zinc/ZInc Oxide [5,6]

Inhalation of zinc oxide fume can cause an influenza-like illness termed metal fume fever. During human exposure to zinc oxide fume, effects are dryness and irritation of the throat, a sweet or metallic taste, substernal tightness and constriction in the chest, and dry cough.

Several hours following exposure, subjects develop chills, lassitude, malaise, fatigue, frontal headache, low back pain, muscle cramps and occasionally blurred vision, nausea and vomiting. An attack usually subsides after 6-12 hours, but may last up to 24 hours; recovery is usually complete.

Most workers develop an immunity to the attacks, but it is quickly lost; hence, attacks tend to be more severe on the first day of the workweek. Only freshly-formed fume causes the illness, presumably because flocculation occurs rapidily in the air forming larger particles that are deposited in the upper respiratory tract and do not penetrate deeply into the lungs.

Silica[7,8]

Crystalline silica, usually referred to as free silica, is defined as silicon dioxide (SiO_2) molecules arranged in a fixed pattern, as opposed to a nonperiodic, random molecular arrangement defined as amorphous silica. The three most common crystalline forms of free silica encountered in industry are quartz, tridymite, and cristobalite, with quartz being by far the most common of these. NIOSH, in its recommendations for a free silica standard, has proposed that exposures to all forms of free silica be controlled so that no worker is exposed to respirable airborne concentrations greater than 0.05 mg/M^3, as averaged over a 10-hour working day, 40-hour week. This recommendation was designed to protect workers from silicosis, a lung disease caused by the inhalation of dust containing crystalline silica. A worker with silicosis generally first notes the onset of shortness of breath on exertion. This becomes gradually worse and may be accompanied by cough. The silica causes nodules and fibrosis to occur in the lung. The onset of symptoms may be a few months after exposure but, more typically, is several years, depending on the extent of exposure. Silicosis is usually detectable on chest x-ray before symptoms or functional impairment occur. The current federal, or OSHA, standard for respirable free silica exposure is an 8-hour TWA based upon the 1968 ACGIH TLV formulas of 10 mg/M^3 divided by the percent SiO_2 plus 2 ($10\ mg/M^3/\%SiO_2 + 2$) for respirable quartz. One-half this amount was established as the limit for cristobalite and tridymite. As can be seen from the calculation, the OSHA regulation is based on the percentage of free silica contained in the respirable particulate exposure, whereas the NIOSH recommended limit applies directly to the air borne concentrations of respirable free silica.

Nuisance Particulate[9]

Nuisance dusts have little adverse effects on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amounts. However, the lung-tissue reaction caused by inhalation of nuisance dusts have the following characteristics: the architecture of the air spaces remains intact; scar tissue is not formed to a significant extent; and the tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears, and nasal passages, or cause injury to the skin or mucous membranes by chemical/mechanical action per se, or by the rigorous skin cleansing procedures necessary for their removal.

1,1,1-Trichloroethane[10]

1,1,1-trichloroethane, the major ingredient in THIEM SLIC (mold release agent) causes such symptoms as headache, dizziness and drowsiness. Severe exposures may result in liver and kidney damage. It has also been implicated as a carcinogen in animal studies.

Formaldehyde[11]

Repeated exposure to phenol-formaldehyde resin, such as that used in the FASKURE sand and RESEMENE, can cause irritation of the eyes, nose and upper respiratory tract. Repeated exposure may cause dermatitis from irritation or allergy. NIOSH recommends that formaldehyde be considered a potential carcinogen and, therefore, that exposures be reduced to the lowest feasible limit.

Clay

The Bentonite used in the plant is composed of montmorillonite clay. There are no recommended exposue limits for this material, and it is not believed to be toxic.

VI. RESULTS AND DISCUSSION

A. Environmental

Results appearing in Table 1 show that airborne concentrations of 14 iron oxide (Range: 0.02 - 0.24 mg/M^3) and 14 zinc oxide (Range: 0.16 - 4.48 mg/M^3) personal breathing-zone air samples were all below NIOSH, ACGIH and OSHA criteria. However, 12 of 14 (86 percent) lead (Range: 0.02 - 0.33 mg/M^3) personal breathing-zone air samples exceeded the current OSHA standard of 0.05 mg/M^3. Employees in the melt, annex and auto forge areas are required to wear respirators.

Similarly, Tables 2 and 3 reveal that airborne concentrations of 10 total dust (Range: 0.7 - 5.7 mg/M^3), and 11 respirable dust (Range: 0.4 - 3.0 mg/M^3) personal breathing-zone air samples were below recommended exposue limits. Table 4 shows that although none of the four personal breathing-zone respirable dust samples for free silica exceeded the OSHA standard, one of the two general area samples (Annex Sand System Area) did exceed the standard. Two of the four personal breathing-zone free silica samples also exceeded the NIOSH recommended exposure limit of 50 micrograms per cubic meter (ug/M^3). The NIOSH recommended level relates directly to the airborne concentrations of free silica, while the current OSHA standard is based on the percentage of free silica contained in the respirable particulate sample.

B. Medical

The blood lead data is summarized in Table V. of the values recorded, 30 of 92 (33 per cent) exceed 40 ug/dl and 8 of 92 (9 per cent) exceeded 50 ug/dl. None of the values were over 59 ug/dl. Employees involved with furnance operations(s) (ladle, furnace repair, furnace utility, etc.) were at the highest risk for lead levels exceeding 40 ug/dl.

Tables VI, VII and VIII summarize the responses to the questionnaire by three major job groupings -- core/cleaning, furnace (including annex and auto forge), and molding. Table VI compares these groups for various characteristics. There are no statistically significant differences between the groups for age, years of employment at the plant, or smoking history. Core/cleaning and molding employ more women than does the furnace area. The vast majority of workers were found to wash their hands before eating/drinking and shower after completing their work shift -- practices that are important in reducing lead ingestion.

Significantly more mold workers than furnace workers report that their hands are often dry and cracked ($p = 0.029$ Fisher's Exact Test).

Table VII lists the number of workers in the three job categories reporting particular symptoms during the two days preceding the study. Workers in core/cleaning reported eye irritation significantly more frequently than did mold workers ($p = 0.037$ Fisher's Exact Test). The other symptoms do not differ significantly between the groups. Nasal stuffiness and cough occurred frequently in furnace and core/cleaning workers, but this effect is diminished when those persons having colds are not included. Other symptoms noted by more than one-half the workers in any category include unusual tiredness, eye irritation, and headache.

Table VII also lists reports of the frequent occurrence of a particular symptom during the six months preceding the study. Core/cleaning workers reported unusual tiredness and headache significantly more frequently than did furnace workers ($p = 0.0019$ and $p = 0.0056$, respectively, Fisher's Exact Test). Other symptoms prominent among core/cleaning workers were cough, eye irritation, skin irritation and loss of sleep -- all of which they reported more frequently than did furnace workers, although not by a statistically significant amount. For furnace workers, only eye irritation and cough were often reported. Mold workers commonly noted only headache and unusual tiredness.

VII. CONCLUSIONS

A. Environmental

Results of environmental sampling indicate that employees were not exposed to iron oxide, zinc oxide, total dust, and respirable dust which exceeded presently recommended limits. However, eighty-six percent of the lead samples exceeded the OSHA standard of 0.05 mg/M^3. Employees in the melt, annex, and auto forge areas are required to wear

respirators. Although exposure to free silica was shown to exceed the NIOSH recommended level (50 ug/M^3) in two of the four personal samples, none exceeded the OSHA standard. Fifty percent of the general area free silica samples exceeded both the NIOSH recommended level and the OSHA standard.

B. Medical

All blood lead levels were below 60 ug/dl. However, the considerable number of employees with levels exceeding 40 ug/dl is consistent with the excessive lead levels found during environmental monitoring. With the exception of the jolt squeeze (annex), all job categories had several test results over 40 ug/dl, including both those requiring respirators (melt, annex, auto forge) and those not requiring respiratory protection (maintenance and grinding). This suggests that respirators alone are insufficient in maintaining acceptable blood lead levels; engineering controls and cleanup measures are also required.

The data collected here does not suggest that these employees are suffering overt signs of lead poisoning. However, research suggests that lead levels chronically over 40 ug/dl may have subtle neurologic effects. Therefore, blood leads should be held below this level.

Results also suggest some differences in symptom prevalence between the groups. The high rate of skin irritation, eye irritation, and cough among core/cleaning workers is most likely explained by irritation from sand and the phenol-formaldehyde resin used in the sand. This is because formaldehyde is one of the major exposure differences between core and furnace work, and these symptoms are entirely consistent with formaldehyde exposure.

The foundry is relatively new (4 years old at the time of the survey) and silica levels were not extremely high. For both of these reasons, one would not expect to find a silicosis problem at this time. However, the potential for this serious disease in a foundry environment suggests the prudence of testing exposed workers, on a periodic basis, for symptoms and signs of silicosis.

Interviews during the walk-through survey of November 1979, revealed a few cases, in the furnace area, suggestive of metal fume fever. None were found during the January 1981 follow-up evaluation. This suggests that ventilation and other improvements made during the interim had some ameliorative effect.

Many more core/cleaning workers noted unusual tiredness, headache and loss of sleep than did workers in the furnace area. These symptoms are suggestive of the nervous system depression seen with many solvents. Care should be exercised when solvent exposure occurs, as is the case when the mold release agent, THIEM SLIC, is sprayed. Such solvent exposure may also play a role in the high prevalence of cracked, dry hands seen in mold and core workers using the THIEM SLIC product.

VIII. RECOMMENDATIONS

1. Metal agitation produces fumes/vapors. Pouring should be ventilated at both the furnaces and molds. Mobile ladle transfer hoods are effective at capturing fume from alloys containing toxic metals, such as lead, provided no disruptive crossdrafts are present.

2. Improved housekeeping procedures are needed to further reduce lead exposure(s).

3. Solvents, such as the mold release agent, THIEM SLIC, should be used only in areas where ventilation is good.

4. Those workers exposed to the sand, who are having rashes, should consider the use of gloves or a barrier cream.

5. Workers exposed to silica should receive pre-placement and periodic physical examinations, including chest x-rays and pulmonary function tests. Any employee having symptoms of respiratory distress, x-ray evidence of silicosis, or pulmonary function impairment should be fully evaluated by a physician qualified to advise the employee as to whether or not he should continue to work in a dusty trade.

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X. AUTHOSHIP AND ACKNOWLEDGEMENTS

Report Prepared By and Evaluation Conducted By:

Harry L. Markel, Jr.
Regional Industrial Hygienist
HHS/PHS/NIOSH, Region VI.
Dallas, Texas

Donald L. Slovin, M.D.
Medical Officer
HHS/PHS/NIOSH/DSHEFS
Cincinnati, OHio

Originating Office: Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies
HHS/PHS/NIOSH
Cincinnati, Ohio

Laboratory Services: Utah Biomedical Test Laboratory
Salt Lake City, Utah

XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

For the purpose of informing the approximately 100 affected employees, a copy of this report shall be posted in a prominent place, accessible to the employees, for a period of thirty (30 calendar days).

Table 1

Lead, Iron, Zinc Concentrations (Personal Breathing-Zone)

Crane Company
Rogers, Arkansas

January 20-21, 1981

Sample Number	Date of Sample	Location	Sampling Period	(a) Concentration (mg/M^3) Lead	Iron	Zinc
C-1	1-20-81	Annex--Furnace Operationw operator	0736-1448	0.15	0.16	2.71
C-2	1-20-81	Annex--Metal Pourer	0741-1449	0.24	0.18	4.27
C-3	1-20-81	Cleaning Department--Grinder	0748-1456	0.18	0.04	0.16
C-4	1-20-81	Cleaning Department--Saw Operator	0750-1451	0.06	0.03	0.16
C-5	1-20-81	Core Department--Core Cleaning	0807-1500	0.02	0.02	0.18
C-6	1-20-81	Core Department--Shell Core Operator	0814-1501	0.09	0.04	0.92
C-7	1-20-81	Mold Department--Auto. Mold Operator	0827-1508	0.21	0.16	2.10
C-8	1-20-81	Melt Department--Fork Lift Operator	0836-1512	0.12	0.06	1.50
C-9	1-20-81	Melt Department--Furnace Operator	0841-1512	0.21	0.04	2.00
C-10	1-20-81	Melt Department--Metal Pourer	0844-1517	0.28	0.06	4.03
C-11	1-20-81	Melt Department--Utility	0845-1514	0.33	0.09	4.48
C-12	1-21-81	Annex-Jolt Squeezer	0718-1308	0.10	0.15	1.51
C-13	1-21-81	Annex-Shakeout Operator	0720-1307	0.10	0.15	1.51
C-14	1-21-81	Core Department--Core Assembler	0747-1318	0.03	0.02	0.23
U.S. Department of Labor (OSHA), Standard (8-hr. TWA)				0.05	5.0	5.0
NIOSH, 8-10 hr. TWA, Recommendation				0.05	---	5.0
ACGIH, 8-hr. TWA, Recommendation				0.15	5.0	5.0

(a) mg/M^3 - milligrams of substance per cubic meter of air sampled

Table 2

Total Dust Concentrations (Personal Breathing-Zone)

Crane Company
Rogers, ARkansas

January 21, 1981

Sampler Number	Location	Sampling Period	(a) Concentration (mg/M^3)
T-3239	Cleaning Department--Grinder	0728-1214	2.6
T-3237	Cleaning Department--Saw Operator	0729-1312	1.3
T-3236	Core Department--Shell Core operator	7044-1319	2.2
T-3240	Core Department--Core Cleanter	0733-1315	0.7
T-3241	Core Department--Bench Core	0737-1316	0.9
T-3238	Core Department--Blower Core	0740-1318	2.1
T-3245	Mold Department--Auto Mold Operator	0803-1326	5.7
T-3244	Mold Department--Core Setter	0758-1327	4.2
T-3246	Mold Department--Mold Utility	0754-1331	1.4
T-3247	Mold Department--Shakeout	0801-1326	5.3

U.S. Department of Labor (OSHA), Standard (8-hr. TWA) 15.0
NIOSH, 8-10 hr. TWA, Recommendation ..... --
ACGIH, 8-hr. TWA, Recommendation 10.0

(a) mg/M^3 - milligrams of substance per cubic meter of air sampled

Table 3

Respirable Dust Concentrations (Personal Breathing-Zone)

Crane Company
Rogers, Arkansas

January 20, 1981

Sampler Number	Location	Sampling Period	(a) Concentration (mg/M^3)
R-3260	Cleaning Department--Saw Operator	0754-1415	0.4
R-3272	Cleaning Department--Grinder	0758-1453	0.6
R-3254	Core Department--Bench Core	0802-1506	2.1
R-3262	Core Department--Core Cleaner	0804-1457	0.4
R-3251	Core Department--Blower Core	0809-1458	0.7
R-3267	Core Department--Shell Core Operator	0812-1500	1.8
R-3266	Mold Department--Auto. Mold Operator	0820-1508	2.9
R-3268	Mold Department--Core Setter	0825-1506	3.0
R-3273	Mold Department--Mold Utility	0827-1504	1.7
R-3261	Mold Department--Shakeout	0831-1503	1.8
R-3274	Mold Department--Furnace Operator	0855-1516	1.4

U.S. Department of Labor (OSHA), STandard (8-hr. TWA) 5.0
NIOSH, 8-10 hr. TWA, Recommendation ..... --
ACGIH, 8-hr. TWA, Recommendation 5.0

(a) mg/M^3 - milligrams of substance per cubic meter of air sampled

Table 4

Free Silica Concentrations (Respirable)

Crane Company
Rogers, Arkansas

January 21, 1981

Sample Number	(a) Type of Sample	Location	Percent Free Silica	Sampling Period	(b) Acutal Concentration (mg/M^3)	(c) Allowable Concentration (mg/M^3)
3250	P	Annex--Jolt Squeezer	2.3	0715-1311	2.1	2.3
3243	P	Annex--Sand System Attendant	2.4	0723-1312	2.1	2.3
3253	P	Core Department--Sand Mixer	---	0751-1323	*	---
3252	P	Mold Department--Shakeout	---	0818-1329	*	---
3255	GA	Annex--Sand System Area	4.95	0828-1307	5.0	1.4
3248	GA	Core Department--Muller ARea	---	0811-1321	*	---

(a) P - Personal; GA - General Area

(b) Actual concentration of free silica (SiO_2) in milligrams per cubic meter of air sampled.

(c) Allowable concentration of free silica (SiO_2) in milligrams per cubic meter of air sampled by use of OSHA formula: $\frac{10\ mg/M^3}{\%SiO_2+2}$

* Below lower limit of detection for analytical method

Table 5

Blood Leads

Crane Company
Rogers, Arkansas

July - December 1980

Job	Number of Test[1]	Mean Lead ug/dl[2]	Range ug/dl	Number over 40 ug/dl	Number over 50 ug/dl
Furnace	19	41	(20-53)	10	4
Grinder	21	34	(13-59)	7	2
Jolt Squeeze	8	34	(19-39)	0	0
Maintenance	30	32	(16-56)	7	1
Melt and Metal Pour	7	38	(15-59)	3	1
Shakeout	7	37	(22-46)	3	0
Total	92	35	(15-59)	30	8

[1]Some employees were tested more than once.
[2]ug/dl - micrograms of lead per deciliter of whole blood.

Table 6

Comparison Between Job Categories

Crane Company
Rogers, Arkansas

January 1981

	Job		
	Core and Cleaning (24 workers)	Furnace (13 workers)	Mold (5 workers)
Mean Age (Years)	32	30	33
Males	14 (58%)	13 (100%)	2 (40%)
Mean Seniority (Years)	2	3	2
Smokers	17 (71%)	9 (69%)	3 (60%)
Wash before eating and drinking?	22 (92%)	12 (100%)	4 (80%)
Do you usually shower after work?	23 (96%)	13 (100%)	5 (100%)
Hands often dry, cracked?	14 (58%)	4 (31%)	4 (80%)

Table 7

Workers Reporting Symptoms During the Two Days Preceding Survey

Crane Company
Rogers, Arkansas

January 1981

Symptoms	JOB: Core and Cleaning (24 workers)	Furnace (13 workers)	Mold (5 workers)
Unusual Tiredness	16 (67%)	6 (46%)	2 (40%)
Eye Irritation	13 (54%)[1]	5 (38%)	0 (0%)
Headache	12 (50%	3 (23%)	3 (60%)
Tremors	4 (17%)	0 (0%)	0 (0%)
Poor Appetite	5 (21%)	2 (15%)	0 (0%)
Cough	10 (42%)	5 (38%)	1 (20%)
Chills	1 (4%)	1 (8%)	1 (20%)
Nasal Stuffiness	19 (79%)	8 (62%)	4 (80%)
A Cold	8 (33%)	4 (31%)	2 (40%)
Skin RAsh	7 (29%)	3 (23%)	2 (40%)

[1] $p = 0.048$ Fisher's Exact Test, two-tailed, when compared to mold group.

Table 8

Symptoms Reported By Workers For Preceding Six Months

Crane Company
Rogers, Arkansas

January 1981

Symptoms	JOB: Core and Cleaning (24 workers)	JOB: Furnace (13 workers)	JOB: Mold (5 workers)
Unusual Tiredness	15 (62%)[a]	1 (8%)	1 (20%)
Eye Irritation	10 (42%)	3 (23%)	0 (0%)
Headache	10 (42%)[b]	0 (0%)	2 (40%)
Tremors	1 (4%)	0 (0%)	0 (0%)
Poor Appetite	5 (21%)	0 (0%)	0 (0%)
Cough	11 (46%)	3 (23%)	1 (20%)
Skin Irritation	7 (29%)	2 (15%)	0 (0%)
Abdominal Cramps	3 (12%)	0 (0%)	0 (0%)
Poor Memory	1 (4%)	0 (0%)	0 (0%)
Trouble Sleeping	7 (29%)	1 (8%)	0 (0%)

[a] $p = 0.0016$, Fisher's Exact Test, two-tailed, when compared to furnace group.

[b] $p = 0.0067$, Fisher's Exact Test, two-tailed, when compared to furnace group.