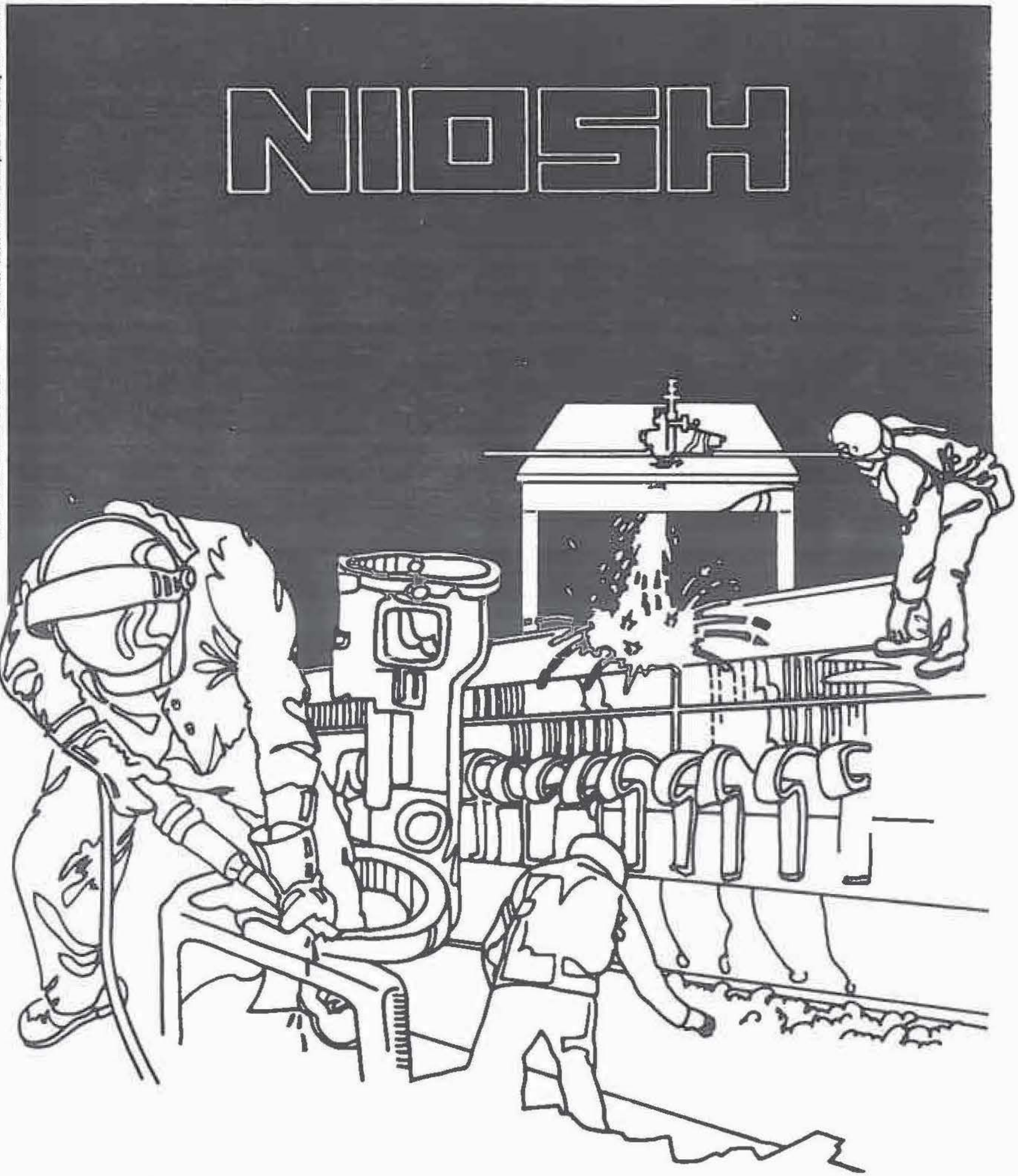
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 81-039-1104
MODINE MANUFACTURING COMPANY
BLOOMINGTON, ILLINOIS

HETA 81-039-1104
MAY 1982
MODINE MANUFACTURING COMPANY
BLOOMINGTON, ILLINOIS

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I. SUMMARY

On October 31, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Association of Machinists and Aerospace Workers Union, Local Lodge #1000, for a health hazard evaluation at Modine Manufacturing Company, Bloomington, Illinois. The request concerned potential exposures to lead and other chemicals used in the production of heavy-duty radiators. The request noted that high blood lead levels had been found in workers and their families.

NIOSH conducted an initial survey at the Bloomington facility on December 16-17, 1980, and a follow-up field survey on October 5-7, 1981.

The environmental evaluation consisted of personal and area airborne monitoring to characterize employee exposures to inorganic lead, sodium hydroxide, sulfuric acid, and triorthocresyl phosphate. Local exhaust ventilation hoods were also evaluated. Airborne concentrations of inorganic lead for personal samples during the follow-up survey ranged from 7.4 micrograms per cubic meter (ug/m^3) to 113.1 ug/m^3. The highest concentrations were obtained on samples worn by core prep personnel. Eleven of the 25 personal samples collected were above the Occupational Safety and Health Administration's (OSHA) action level of 30 ug/m^3, and six of the 11 exceeded the OSHA permissible exposure limit (PEL) of 50 ug/m^3. Airborne concentrations for sodium hydroxide, sulfuric acid, and triorthocresyl phosphate were below the limit of detection, except for one sample that showed a sodium hydroxide concentration of 0.008 mg/m^3. By comparison, the OSHA PEL is 2 mg/m^3. Local exhaust ventilation equipment was found to be in need of repair and/or adjustments.

The medical evaluation consisted of a questionnaire survey of 27 workers and blood lead analysis of 65 workers in the plant. In addition, results of blood lead analyses and clothing lead analyses performed previously by the McClean County Health Department and the company were reviewed.

Blood lead analysis on 57 workers, performed in 1980 by the McClean County Health Department, revealed six workers (one in core bake, one on the tinning line, two in header dip, one in tank assembly, one material handler, and one other) with blood lead results greater than 40 ug/dl (the upper normal limit among non-occupationally exposed persons). Company results showed one worker from core prep with a blood lead level greater than 40 ug/dl. NIOSH testing in 1981 found one worker whose blood lead was greater than 40 ug/dl. A decline in mean blood lead levels was noted between the McClean County Health Department survey in 1980 and the NIOSH evaluation in 1981.

Based on these results, NIOSH has determined that a health hazard existed from employee exposure to inorganic lead in the core prep and test deck area. Recommendations are made in this report concerning employee use of personal protective equipment, employee blood lead tests, initiation of an employee education program, and repair of ventilation equipment

KEYWORDS: SIC 3714 (Motor Vehicle Parts and Accessories), blood lead, inorganic lead, sodium hydroxide, sulfuric acid, triorthocresyl phosphate.

II. INTRODUCTION

On October 31, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Association of Machinists and Aerospace Workers Union, Local Lodge #1000, for a health hazard evaluation of the Modine Manufacturing Company, Bloomington, Illinois. The request concerned potential employee exposure to hazardous concentrations of lead and other chemicals used in the production of heavy-duty radiators. The request cited high blood lead levels in employees and their families as a primary concern.

NIOSH distributed Interim Report No. 1 for this investigation on May 13, 1981, following the initial visit to the plant. On February 5, 1982, NIOSH distributed Interim Report No. 2, following the second visit to the plant.

III. BACKGROUND

The Bloomington facility, which employs approximately 150 employees, began production in 1966. There have been two expansions to the facility, but the process has remained basically unchanged. Local exhaust hoods and general area ventilation equipment were installed in 1966.

Raw materials include brass, copper, and steel. Brass and steel go to separate cleaning lines, where solutions containing sulfuric acid, sodium hydroxide, and other chemicals are used to clean the metals. One employee operates both metal cleaning lines. Subsequently, brass and copper go to one of two tinning lines where they are coated with lead/tin solder. Each tinning line is operated by one employee. From the tinning lines, solder-coated brass is sent to fin presses which form the fins (through which radiator tubes are inserted). There are two fin presses, each operated by one employee. Solder-coated copper meanwhile is sent to the tube-forming area, where it is formed into radiator tubes. There are two tube-forming stations requiring one employee for each station. Subsequently, fins and tubes are sent to the core assembly area and combined manually to form a radiator core. There are 15 core assembly stations, but usually only five to seven stations, requiring one employee each, are operating. Next, the cores go to the bake oven area where they are initially squared up (an operation which straightens the core) and then the cores are dipped in a flux tank and baked in an oven for approximately 3 minutes. There are two bake ovens. Each oven requires one to two employees. Triorthocresyl phosphate is a component of the hydraulic oil used in the hydraulic system of the core bake ovens. The cores are then squared up again and allowed to cool. The cooling action imparts a rigid structure to the radiator cores. Next, the cores are sent to header dip, where headers are added to the core and then the cores are placed into frames and subsequently dipped into tanks of molten lead/tin solder. This action coats the tube-header joints with solder which bonds the header and tubes together. There are three header dip lines. Each line requires two employees. The frames are then removed and the units go to core prep, where solder is manually added as needed using torches and coil solder. In addition, excess solder is removed using hand-held grinders. Five operators work in the core prep area per shift. From core prep, cores are sent to the test deck area where each unit is submerged in a tank containing a soap-water mixture. Air is forced into the radiator tubes under pressure. Leaks will appear as bubbles on the surface of the solution. Any leaks which are found are repaired using flux and lead/tin solder. Seven employees work in the test deck area. Some process areas (cleaning and tinning lines) operate during the first shift (0700-1530) only. Several process areas operate on both the first and second (1530-2400) shifts, and depending on production needs, some process areas may operate during three shifts. The resultant products are radiator components, and complete radiators which will be used in heavy-duty equipment.

IV. METHODS AND MATERIALS

NIOSH conducted initial and follow-up environmental/medical surveys at the Bloomington facility on December 16-17, 1980, and October 5-7, 1981, respectively.

A. Initial Survey

The visit consisted of an opening conference and subsequent initial walk-through and a one-day environmental/medical survey. NIOSH personnel interviewed management and union representatives and 27 employees.

1. Medical

A stratified random sample of 27 workers was selected from a list of 118 employees by department to participate in the medical survey. Each worker was requested to respond to a questionnaire concerning past medical history (including treatment for lead poisoning), symptoms commonly associated with lead poisoning, social history, history of exposures to lead other than occupational, and a complete occupational history. In addition, workers were asked for results of prior blood lead determinations, if any.

2. Environmental

Environmental air sampling was conducted on December 17, 1980. Four general area airborne samples for organics and four general area airborne samples for inorganic metals were collected. Organic samples were collected using charcoal tubes attached via flexible tubing to battery-operated pumps calibrated at 0.2 liters per minute (LPM). Inorganic metal samples were collected using mixed cellulose ester filters loaded into two-piece cassettes. The filters were attached via flexible tubing to a battery-operated pump calibrated at 1.5 LPM. Following collection, all samples were returned to NIOSH laboratories for analysis. Charcoal tubes were desorbed in 1.0 milliliter carbon disulfide and analyzed by gas chromatography equipped with a flame ionization detector. Identities of analytes were confirmed by mass spectrometry. Filters were ashed in nitric and perchloric acids, and the residues dissolved in dilute acid. The resulting solutions were analyzed for trace metal content. Smoke tube kits were used to spot-check ventilation hoods by determining the airflow characteristics.

Employee work practices were observed, OSHA injury reports and material safety data sheets were reviewed. Management was interviewed concerning existing respiratory, audiology, and medical surveillance programs.

B. Follow-up Survey

1. Medical

All 152 current employees were asked to participate in the follow-up survey consisting of a blood test for lead. In addition, results were obtained for the blood lead screening program performed by the McClean County Health Department in 1980, using the laboratory of the Illinois State Department of Health. Results of company screening tests for blood lead, performed at a local pathology laboratory in Bloomington, were also obtained.

2. Environmental

Personal and area airborne monitoring was conducted to characterize employee exposures to inorganic lead, sodium hydroxide, sulfuric acid, and triorthocresyl phosphate. The majority of area samples were collected to assist the laboratory in the analysis of personal samples. A few area samples were collected to evaluate airborne contaminants in specific areas of the plant.

Inorganic lead samples were collected on mixed cellulose ester filters loaded into 2-piece cassettes. The filters were attached via flexible tubing to a battery-operated pump calibrated at 1.5 liters per minute (LPM). Sodium hydroxide samples are collected on teflon filters loaded into 3-piece cassettes. The filters were attached via flexible tubing to a battery-operated pump calibrated at 1.5 LPM. Sulfuric acid samples were collected on washed silica gel tubes attached via flexible tubing to battery-operated pumps calibrated at .2 LPM. Triorthocresyl phosphate samples were collected on cellulose ester filters loaded into 3-piece cassettes. The filters were attached via flexible tubing to battery-operated pumps calibrated at 1.5 LPM. Following collection in the field, all samples were returned to NIOSH laboratories for analysis.

Inorganic lead samples were analyzed by atomic absorption spectroscopy according to NIOSH Method P&CAM No. S-341.[1] Sodium hydroxide samples were analyzed by atomic emission spectrophotometry according to NIOSH Method P&CAM No. 173.[2] Sulfuric acid samples were analyzed using ion chromatography according to NIOSH Method P&CAM No. 339.[3] Triorthocresyl phosphate samples were analyzed using a gas chromatograph equipped with a flame photometric detector according to NIOSH Method P&CAM No. S-209.[1]

Local exhaust ventilation hoods on two cleaning lines and at two header dip stations were evaluated using smoke tubes and a velometer. Velometer readings are reported in linear feet per minute (LFPM).

Employee activities were observed during two shifts. Particular attention was given to employees who cleaned dross (dead solder) from the header dip tanks each morning.

V. EVALUATION CRITERIA

A. Lead

1. Toxicological

Inhalation (breathing) of lead dust and fume is the major route of lead exposure in industry. A secondary source of exposure may be from ingestion (swallowing) of lead dust deposited on food, cigarettes, or other objects. Once absorbed, lead is excreted from the body very slowly. 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 ug/deciliter whole blood are considered to be normal levels which may result from daily environmental exposure.[4] However, fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/deciliter. Lead levels between 40-60 ug/deciliter in lead-exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60-100 ug/deciliter represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/deciliter are considered dangerous and often require hospitalization and medical treatment.

The new Occupational Safety and Health Administration (OSHA) standard for lead in air is 50 ug/m^3 calculated as an 8-hour time-weighted average for daily exposure.[4] The standard also dictates that workers with blood lead levels greater than 60 ug/deciliter must be immediately removed from further lead exposure and, in some circumstances, workers with lead levels of less than 60 ug/deciliter must also be removed. Removed workers have protection for wage, benefits, and seniority for up to 18 months until their blood levels decline to below 50 ug/deciliter and they can return to lead exposure areas.

The OSHA standard also has an action level of 30 ug/m^3 based on an 8.0-hour TWA. The action level initiates several requirements, including environmental monitoring, medical surveillance, and training and education.[4]

2. Chronic Renal Toxicity

Lead has been shown in previous studies[5] to cause chronic kidney disease (nephropathy) in persons with long-time occupational exposure. The process is gradual and dose related. Persons who experience the greatest lifetime risk of manifesting lead-induced kidney disease are those who have experienced the most lead absorption over their working career. The initial signs of lead nephropathy are subtle. Affected workers will usually have no symptoms in the early stages. Their renal function test values may still be within the broad range of normal, although their test results will tend over time to move toward the high end of the normal range.

Because the kidney has an enormous reserve capacity, results of the usual renal function tests--blood urea nitrogen (BUN), serum creatinine, and serum uric acid--will not become frankly abnormal until one-third to one-half of kidney function has been destroyed.[6] For that reason, more sensitive screening tests of renal function have been sought. These include serum measurement of 1,25-dihydroxy vitamin D, which may be decreased in persons with kidney damage caused by lead.[7] Other abnormalities which may also be noted in chronic lead nephropathy include aminoaciduria, renal glycosuria, and hypercalcuria. Gout is a particularly noteworthy manifestation of lead nephropathy;[8] the elevated serum uric acid concentrations which may occur in lead nephropathy have been associated with the development of gouty arthritis.

B. Sodium Hydroxide

Sodium hydroxide is a severe irritant of the eyes, mucous membranes, and skin. Inhalation of sodium hydroxide is usually of secondary importance in industrial exposures, but the effects vary from mild irritation of the nose at 2.0 milligrams per meter of air (mg/m^3) to severe pneumonitis, depending upon the severity of exposure.[9] The OSHA PEL for sodium hydroxide is 2.0 mg/m^3 based on an 8-hour time-weighted average (TWA). The NIOSH recommended standard is 2.0 mg/m^3 as a ceiling value, not to exceed 15 minutes.[4,10]

C. Sulfuric Acid

Sulfuric acid is a severe irritant to the eyes, respiratory tract, and the skin. Concentrated sulfuric acid destroys tissue as a result of its severe dehydrating action, whereas the dilute form acts as a milder irritant due to acid properties.[9] The OSHA PEL for airborne sulfuric acid is 1.0 mg/m^3 based on an 8-hour TWA. The NIOSH recommended standard is 1.0 mg/m^3 for up to a 10-hour TWA.[4,10]

D. Triorthocresyl Phosphate

Triorthocresyl phosphate is used as a plasticizer in lacquers and varnishes and in the production of heat stable lubricating oils. Triorthocresyl phosphate causes peripheral neuropathy with flaccid paralysis of the distal muscles of the upper and lower extremities, followed in some cases by spastic paralysis.[9] The OSHA PEL for airborne vapors of triorthocresyl phosphate is 0.1 mg/m^3 based on an 8.0-hour TWA.[4] NIOSH currently has no recommended standard for this substance.

VI. RESULTS

A. Initial Survey (December 16-17, 1980)

The 27 workers selected from the departmental employment roster all agreed to participate in the medical questionnaire survey.

Symptoms frequencies are reported in Table I. The most prevalent symptoms were muscle or bone aches in 20 workers (74%) and headaches (37%).

The primary purpose of the area samples was to identify the major organics and metals present in the general work environment. Results of charcoal tube analysis revealed low airborne concentrations of four organics (toluene, perchloroethylene, xylene, and kerosene) ranging from 0.02 parts per million parts of air (ppm) to 0.17 ppm. Analysis of AA filters for metals revealed highest airborne concentrations for lead (9 to 47 ug/m^3), iron (10.0 to 29 ug/m^3), tin (4.0 to 16 ug/m^3), and zinc (0.9 to 22 ug/m^3). A second group of metals ranged from 1.0 to 11 ug/m^3 (aluminum, calcium, cobalt, copper, magnesium, manganese, sodium), while a third group consisting of 18 metals were found to be below the limit of quantitation.

The ventilation equipment appeared to be in need of a thorough evaluation. Hoods at the brass cleaning line and header dip area were not working efficiently. This was determined by observation of escaping particulates, and qualitative airflow tests performed with smoke tubes. Some hoods were damaged and in need of repair. One hood located in the cleaning room had been bent inward, thus potentially altering the original design characteristics.

B. Follow-up Survey (October 5-7, 1981)

1. Environmental

Tables II and III present the air sampling results for airborne inorganic lead. Concentrations ranged from 7.5 micrograms per cubic meter of air (ug/m^3) to 111.3 ug/m^3 on October 6, 1981, and from 7.4 ug/m^3 to 113.1 ug/m^3 on October 7, 1981. The highest concentrations on each day were obtained on samples worn by core prep personnel (41.3 to 111.3 ug/m^3 on October 6, 1981, and 69.1 to 113.1 ug/m^3 on October 7, 1981). Eleven of the 25 personal samples collected were above the Occupational Safety and Health Administration's (OSHA) action level of 30.0 ug/m^3. In addition, six of the 25 personal samples collected were above the OSHA permissible exposure limit (PEL) of 50 ug/m^3.[4]

Table IV presents the air sampling results for airborne sodium hydroxide. Only one of two personal samples was above the limit of detection. This sample had a concentration of .008 mg/m^3, which is well below the OSHA PEL of 2.0 mg/m^3 and the NIOSH recommended standard of 2.0 mg/m^3.[4,10]

Table IV also presents the air sampling results for airborne sulfuric acid. Concentrations of both personal samples were below the limit of detection.

The area sample for airborne triorthocresyl phosphate was below the limit of detection (0.01 milligrams).

Table V presents the ventilation measurements. Capture velocity readings taken at a number of local exhaust ventilation hoods varied considerably. Capture velocity readings were taken at the operator's work station for each hood evaluated. Measurements taken at Tank No. 9 (4 feet wide by 7.5 feet long) on the brass cleaning line were approximately

25 linear feet per minute (LFPM) for six measurements. This tank contained hot water. As a guideline, the ACGIH Industrial Ventilation Manual lists the desired capture velocity for tanks containing hot water as 50 LFPM.[11] Six similar measurements for capture velocity taken at Tank No. 1 (4 feet wide by 7.5 feet long), also at the brass cleaning line, were all in the range of 25 to 50 LFPM. This tank contained a weak alkaline mixture. The ACGIH Industrial Ventilation Manual lists 100 LFPM as a minimum control velocity for this type of metal cleaning tank.[11]

Capture velocity readings were taken at two of three dip pot hoods located in the header dip area. All dip pot contained molten solder. At Dip Pot No. 1, four readings taken at the operator's work station were all approximately 100 FPM. Four similar readings were taken at Dip Pot No. 2, all averaged between 50 and 75 LFPM. The ACGIH Industrial Ventilation Manual has no specific guidelines for the header dip hoods. However, the manual does list ranges of capture velocities by the conditions of dispersion. For contaminants released at low velocities into moderately still air (which approximates the conditions at header dip), the capture velocity range is listed as 100 to 200 LFPM. Considering that inorganic lead is the contaminant of concern, the lower end of the range should be considered as a minimum value.[11]

Capture velocity readings were also taken at three tanks containing weak acid or alkaline solutions located at the steel cleaning line. All three tanks were small (42 by 42 inches) and had four slots in the hood. Three capture velocity readings were taken at the position where the operator stands at each tank. The readings at Tank No. 1 were approximately 20 LFPM, the reading at Tank No. 2 were 50 to 75 LFPM, and the reading at Tank No. 5 were approximately 100 LFPM. As a comparison, the ACGIH Industrial Ventilation Manual lists alkaline and sulfuric acid cleaning tanks as requiring a minimum capture velocity of 100 LFPM.[11]

The employees who were cleaning dead solder (that had accumulated overnight) off the header dip tanks were observed using wooden paddles to accumulate the oxidized material at one corner of the dip pot tank. Then a metal ladle was used to dip out the dead solder and transfer it to a 55-gallon barrel. The cleaning process required approximately 25 minutes per tank. While cleaning, the employees wore face shields, goggles, and gloves. Some employees wore work boots, but at least one wore tennis shoes while transferring the molten material. Molten material was observed dripping from the ladles onto the floor.

The review of the written Respiratory Protection Program revealed that the program covered all requirements of a minimally acceptable program as outlined in the OSHA requirements for respiratory protection (1910.134).[4] However, observation of employees improperly wearing respirators indicated that the training section of the program needs to be improved. In addition, the provision in the company program that respirators be collected, cleaned, and disinfected as frequently as necessary should be changed to provide for cleaning after each use per the OSHA standard.[4]

2. Medical

Sixty-six of 118 workers agreed to participate. Results of blood lead tests are shown on Table VI. The highest number of elevated blood lead results (greater than 39 micrograms per deciliter, ug/dl) were found in Area 30 (test and repair, dip frame, header dip, and core prep) (4 by county test, 1 by company test, and 1 by NIOSH test). The highest single level found in the NIOSH survey was in a Test and Repair worker with a blood lead of 52 ug/dl, in the company survey it was in a core prep worker with blood lead of 43 ug/dl, and in a header dip worker with blood lead of 49 ug/dl in the county survey. Mean blood lead levels declined significantly from 27 in 1980 to 23 in 1981. This may be due to laboratory variation, reduced environmental levels, or improved work practices.

In addition, one employee reported receiving arm burns through his gloves while welding.

VII. DISCUSSIONS AND CONCLUSIONS

Analysis of environmental samples indicate that employees in the core prep area were exposed to airborne concentrations of inorganic lead in excess of the OSHA PEL. In addition, some employees in the header dip and test deck area are exposed to inorganic lead concentrations above the OSHA action level of 30 ug/m^3.[4] Employees in the core prep area were observed wearing 3M-brand respirators (8710) while grinding excess lead solder. These respirators have recently been certified for respiratory protection against dusts having an OSHA PEL not less than 50 $micrograms/m^3$.[12] The core prep employees, in addition to grinding, are involved in soldering activities which expose the employees to fumes of lead. These fumes are as important as dusts emitted during grinding operations. Respirators used in this area should be certified for protection against fumes.[13]

Evaluation of the ventilation equipment using a velometer and smoke tubes indicate that the various hoods are operating over a wide range of effectiveness. The values listed in the Industrial Ventilation Manual can be used as guidelines for comparisons to the values obtained during the survey. Due to the general nature of the manual's guidelines, however, they cannot solely be used to determine the effectiveness of a specific hood. Variations between identical or very similar hoods provide a second indication of the overall effectiveness of a particular hood. A good example concerns the capture velocity readings of the exhaust hoods located at the steel cleaning line. All three tanks were the same size and had identical slot arrangements in the exhaust hoods. Velometer readings taken at the operator's work area at each tank ranged from 20 LFPM at Tank No. 1 to 100 LFPM at Tank No. 5.

Analysis of three separate blood lead testing procedures performed over a period of 1 year on Modine Company employees revealed several workers with increased blood leads. Many workers complained of symptoms which have been associated with lead exposure in the past, including muscle or bone aches, headaches, and sleep disturbances (Table I). However, these symptoms are prevalent in non-lead exposed populations as well. No non-lead exposed control group was readily available to be interviewed making the assignment of these symptoms to lead exposure alone impossible.

The statistically significant decline observed in mean blood lead levels over the course of the past year between county testing program and the NIOSH screening may be due to any of the following:

A. Different laboratories used by each testing program.

B. Improved ventilation, work practices, or respiratory protection during the past year at the plant.

C. Decrease in environmental lead due to other causes, such as tetraethyl lead in gasolines (Centers for Disease Control recently reported a nationwide decline in blood lead levels coincident with declining sales of leaded gasoline).[14]

Analysis of clothing items of Modine Company workers revealed high levels on shirts and shoes of Modine workers and lower levels on other items of clothing and furniture (Table VIII). These findings combined with reports of lead poisoning among children and grandchildren of Modine Company workers suggest that environmental lead contamination may be affecting the community as well.

VIII. RECOMMENDATIONS

1. Provisions of the lead standard (1910.1025) should be followed with particular emphasis on the following points.[4]

   A. Medical Surveillance. Employees blood lead levels should be monitored at least every 6 months for all workers exposed to >30 ug/m^3, and at least every 2 months for each employee whose last blood test showed a blood lead level >40 ug/dl. This frequency should be maintained until two consecutive blood tests show a blood lead concentration <40 ug/dl. Blood lead tests should be performed by a laboratory licensed by the Centers for Disease Control (CDC), which received a satisfactory proficiency rating from CDC in the previous 12 months (Appendix I).

B. Environmental Monitoring. Management should conduct environmental monitoring for airborne lead at least once every 3 months in areas where airborne lead concentrations exceed the OSHA PEL and at least once every 6 months in areas where airborne lead values exceed the OSHA action level.

C. Respiratory Protection. The single-use respirator issued to core prep employees for use during grinding activities should be replaced with respirators certified for use in atmospheres containing lead fumes.[4,12,13] Fumes emitted during soldering activities are as important as airborne lead particulates produced during grinding operations.

D. Employee Information and Training. Management should institute a worker education program for all employees who are subject to exposure to airborne lead at or above the action level or for whom the possibility of skin or eye irritation exists.

E. Protective Work Clothing and Equipment. In those areas where employees are exposed to airborne lead concentrations exceeding the OSHA PEL, management should provide employees with coveralls or similar full-body work clothing, gloves, hats, shoes or shoe coverlets, and other equipment. This protective clothing should be utilized in conjunction with a change room incorporating shower facilities.

2. Employees who report receiving hand and/or arm burns at their work stations should be issued protective equipment, such as gloves and/or sleeves. The protective equipment should be made of a material suitable for working with hot materials. Employees issued this equipment should be instructed on the importance of wearing the equipment.

3. The ventilation equipment should be evaluated with particular emphasis given to local exhaust equipment located at the header dip area and also at the two cleaning lines.

IX. REFERENCES

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XI. DISTRIBUTION AND AVAILABILITY OF 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:

1. I.A.M. and A.W., Local 1000
2. Modine Manufacturing Company
3. Illinois State Department of Health
4. NIOSH, Region V
5. OSHA, Region V

For the purpose of informing the 150 affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I

Symptom Prevalence in Previous Month

Modine Manufacturing Company
Bloomington, Illinois
HETA 81-039

December 1980

Symptom	Number Reported	Percent (n=27)
Muscle or Bone Ache	20	74
Headaches	10	37
Sleep Disturbance	5	19
Weight Loss	4	15
Unexplained Fatigue	4	15
Nausea/Vomiting	3	11
Loss of Appetite	2	7
Shaking or Tremor	2	7
Chronic Hoarseness	2	7
Abdominal Cramps	2	7
Constipation	1	4
Weakness in Wrists or Ankles	1	4
Hair Loss	1	4

TABLE II

Airborne Concentrations of Inorganic Lead
Personal Samples

Modine Manufacturing Company
Bloomington, Illinois
HETA 81-039

October 6, 1981

Location	Sample Time	Volume (Liters)	Concentration (ug/m^3)
Core Bake[1]	0601 - 1458	805	7.5
Tinning Line	0708 - 1155 1227 - 1505	667	15.0
Tinning Line[3]	0810 - 1155 1235 - 1507	565	15.9
Header Dip[2]	0605 - 1310	637	11.0
Header Dip	0712 - 1445	679	25.0
Header Dip	0713 - 1444	676	19.2
Header Dip	0715 - 1442	670	37.3
Core Prep	0720 - 1443	664	111.3
Core Prep	0721 - 1438	655	59.5
Core Prep	0724 - 1446	678	41.3
Test Deck	0730 - 1448	672	59.5
Test Deck	0732 - 1447	652	24.5
Test Deck	0734 - 1450	654	35.2

1 = Employee wore sample for approximately 2.0 hours, then he asked that pump be removed because it was affecting his work. Sample placed on side of bake oven for remainder of the shift.
2 = Employee left plant early.
3 = This tinning line did not operate until after 0800.

Limit of Detection = 3 ug/filter
Environmental Criteria (ug/m^3): OSHA = 50.0 (based on an 8.0-hour TWA)

TABLE III

Airborne Concentrations of Inorganic Lead
Personal Samples

Modine Manufacturing Company
Bloomington, Illinois
HETA 81-039

October 7, 1981

Location	Sample Time	Volume (Liters)	Concentration (ug/m^3)
Tinning Line	0701 - 1429	672	7.4
Tinning Line	0703 - 1156 1228 - 1450	562	12.4
Header Dip	0600 - 1440	780	23.0
Header Dip	0705 - 1440	682	35.1
Header Dip	0707 - 1442	682	27.8
Header Dip	0709 - 1437	672	17.9
Core Prep	0711 - 1445	681	113.1
Core Prep	0714 - 1438	666	69.1
Core Prep[1]	0719 - 1335	564	83.3
Test Deck	0722 - 1436	651	32.3
Test Deck	0725 - 1406	601	16.6
Test Deck	0727 - 1435	642	26.5

1 = Employee left plant early.

Limit of Detection = 3 ug/filter
Environmental Criteria (ug/m^3): OSHA = 50.0 (based on an 8.0-hour TWA)

TABLE IV

Airborne Concentrations of Sodium Hydroxide and Sulfuric Acid
Personal Samples

Modine Manufacturing Company
Bloomington, Illinois
HETA 81-039

October 6 and 7, 1981

Location	Date	Sample Time	Volume (Liters)	Material Analyzed For	Concentration (mg/m^3)
Cleaning Lines	10-7	0703 - 1455	708	Sodium Hydroxide	LLD
Cleaning Lines	10-6	0730 - 1432	633	Sodium Hydroxide	.008
Cleaning Lines	10-7	0730 - 1432	84	Sulfuric Acid	LLD
Cleaning Lines	10-6	0703 - 1455	90	Sulfuric Acid	LLD

LLD = Below the Limit of Detection (4 ug/filter) for sodium hydroxide, sulfuric acid.

Environmental Criteria (mg/m^3):

Sodium Hydroxide: OSHA = 2.0 (based on an 8.0-hour TWA)
NIOSH = 2.0 (as a ceiling value, not to exceed 15 minutes)

Sulfuric Acid: OSHA = 1.0 (based on an 8.0-hour TWA)
NIOSH = 1.0 (for up to a 10-hour TWA)

TABLE V

Measurements of Local Exhaust Ventilation Hoods

Modine Manufacturing Company
Bloomington, Illinois
HETA 81-039

October 6-7, 1981

Location of Hood	Number Of Hood	Number of Capture Velocity Readings Taken	Range of Readings (LFPM)	Recommended Levels*
Brass Cleaning Line	1	6	25-50	100
Brass Cleaning Line	9	6	25	50
Steel Cleaning Line	1	3	20	100
Steel Cleaning Line	3	3	50-75	100
Steel Cleaning Line	5	3	100	100
Header Dip	1	4	100	100-200**
Header Dip	2	4	50-75	100-200**

* Recommended capture velocities values from ACGIH Industrial Ventilation Manual.
** For contaminants released at low velocities into moderately still air.

TABLE VI

Blood Lead, By Area

Modine Manufacturing Company
Bloomington, Illinois
HETA 81-039

Area	Job Titles	Blood Lead, ug/dl COUNTY (10-11/80)	COMPANY (8/81)	NIOSH (10/81)
06	Inspectors	23	-	16
		26	-	18
	AVERAGE	24.5	-	17
10	Brite Dip, Press Operator, Spot Welder	15	-	-
		17	-	16
		19	-	16
		15	-	13
		25	-	18
	AVERAGE	23	-	15
20	Fin Press, Core Assembly, Tinning Machine, Core Bake, Press Set Up, Material Handler, Tube Machine	-	-	15
		36	-	33
		37	-	36
		-	-	24
		35	-	27
		19	-	-
		59*	-	-
		23	-	-
		23	-	-
		19	-	18
		33	-	22
		20	-	15
		-	-	21
		23	-	18
		40*	-	31
		-	-	32
		-	-	18
		16	-	18
		19	-	23
		-	-	18
		16	-	-
		42*	-	-
	AVERAGE	29	-	23

(continued)

TABLE VI (continued)

Area	Job Titles	Blood Lead, ug/dl COUNTY (10-11/80)	COMPANY (8/81)	NIOSH (10/81)
30	Test and Repair, Dip Frame, Header Dip (HD), Bolted, Tank Assembly, Material Handler, Core Prep	24	-	-
		25	-	19
		33	-	28
		25	-	23
		-	-	52*
		24	-	24
		29	-	22
		26	-	19
		-	-	18
		49*	-	-
		32	-	31
		-	-	26
		34	-	32
		-	-	27
		27	-	29
		-	-	26
		-	-	23
		-	-	21
		-	-	27
		-	-	18
		46*	-	-
		-	-	34
		32	-	21
		18	-	14
		42*	-	29
		20	-	20
		41*	-	28
		28	-	28
		33	31	24
		18	20	20
		22	20	16
		29	18	26
		25	22	23
		35	28	-
		-	29	32
		-	-	24
		-	43*	-
		17	28	-
		-	18	-
	AVERAGE	29	26	21

(continued)

TABLE VI (continued)

Area	Job Titles	Blood Lead, ug/dl		
		COUNTY (10-11/80)	COMPANY (8/81)	NIOSH (10/81)
40	Welder, Drill Press	-	-	24
		38	-	36
		20	-	16
		18	-	16
		18	-	11
	AVERAGE	24	-	20
65	Packaging Department	18	-	14
		15	-	15
	AVERAGE	17	-	15
70	Painting Department	14	-	13
		31	-	-
	AVERAGE	23	-	13
72	Maintenance Department	30	-	26
	AVERAGE	30	-	26
OVERALL AVERAGE**		27	26	23

*Blood lead >39 ug/dl.
**T=2.589, df=118, p<0.01

TABLE VII

Results of Clothing Analysis

Modine Manufacturing Company
Bloomington, Illinois
HETA 81-039

Item Analyzed	Date	Lead (ppm)
Workers A Shirt*	10/3/80	804.31
Chair A*	10/3/80	24.91
Chair B*	10/3/80	8.34
Carpet*	10/3/80	8.29
Workers Shoes*	10/3/80	673.61
Shoes of Modine Worker B**	1981 (***)	2613.6
Shirt of Modine Worker B**	1981 (***)	229.8
Pants of Modine Worker B**	1981 (***)	251.1
Forearm of Modine Worker B**	1981 (***)	49.96
Shoes of Modine Worker C**	1981 (***)	578.1

* Reported by H.B. Ehrhard, Chief Public Health Microbiologist.
** Reported by Union Local 1000 representative of values obtained by workers who had wipe samples taken by McClean County Health Department.
*** Month and day unknown.