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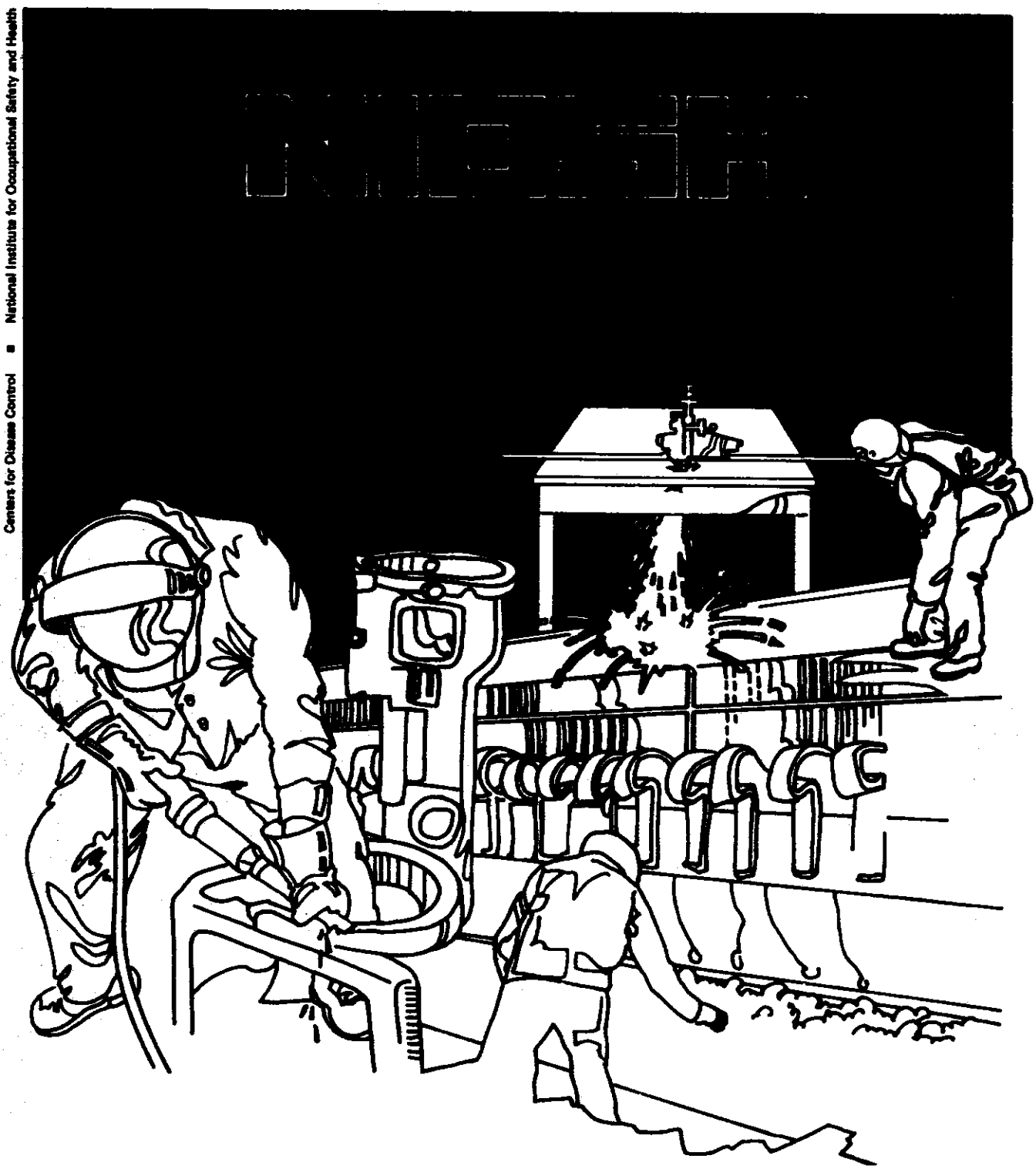

Health Hazard Evaluation Report

HETA 89-231-2016
SIMS RADIATOR SHOP
CONYERS, GEORGIA

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.

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HETA 89-231-2016
FEBRUARY 1990
SIMS RADIATOR SHOP
CONYERS, GEORGIA

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I. SUMMARY

In May 1989, the National Institute for Occupational Safety and Health (NIOSH) received a request from Sims Radiator Shop located in Conyers, Georgia to: 1) evaluate occupational exposures to lead during the cleaning and repair of automobile and commercial radiators, and 2) assist with the design and implementation of a complete environmental and medical monitoring program meeting the Occupational Safety and Health Administration's (OSHA's) lead standard.

On June 2, 1989, NIOSH conducted an environmental and medical evaluation. The environmental evaluation consisted of: 1) collecting personal breathing zone (PBZ) air samples to determine the concentrations of airborne lead among 2 employees repairing radiators, 2) collecting 1 general air sample, 3) observing work practices, and 4) observing the overall room ventilation. The medical evaluation consisted of a self-administered questionnaire, a medical and occupational history, a limited physical examination, and a blood lead level and free erythrocyte protoporphyrin (FEP) concentration.

The PBZ concentrations of lead for the 2 radiator mechanics were 80 and 60 micrograms per cubic meter (ug/M^3). Although sampling was limited to approximately 4 of the 8 hours of the workshift, the concentrations measured should closely approximate 8-hour time weighted average (TWA) exposures based on the uniformity of work activities performed over the shift. Both of these concentrations are at or above OSHA's Permissible Exposure Limit (PEL) of 50 ug/M^3 as an 8-hour TWA. The inefficient general room ventilation, and the lack of any local ventilation appeared to be responsible for the elevated PBZ lead concentrations.

These two shop employees (both mechanics) participated in the medical evaluation. Their blood lead levels were 30 and 37 micrograms per deciliter (ug/dl), which is below the OSHA threshold (40 ug/dl) for requiring bimonthly testing. Their FEP levels were also within the normal range. Neither mechanic reported symptoms or had physical findings suggestive of lead poisoning.

This shop was conducting medical surveillance (blood lead levels) as required by OSHA's lead standard, but not other activities specified by the standard (exposure monitoring, respiratory protection, housekeeping, hygiene practices, providing clothing, and a written compliance program).

On the basis of the environmental data, a potential health hazard existed from over-exposures to lead during the routine cleaning and repairing of radiators. Recommendations are provided in Section VIII of this report that will assist in eliminating this hazard.

Keywords: SIC 3714 (motor vehicle parts and accessories), radiator shops, lead, inorganic lead, blood lead, free erythrocyte protoporphyrin, FEP.

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request in May 1989 from Sims Radiator Shop located in Conyers, Georgia to evaluate occupational exposures to lead during the cleaning and repair of automobile and commercial radiators. In addition to evaluating employees' lead exposure, the owner requested assistance in developing an environmental and medical program in order to comply with the Occupational Safety and Health Administration's (OSHA's) lead standard.[1]

The facility owner was informed of the environmental results by telephone in June, 1989. Results and interpretation of individual blood lead tests were mailed to participating employees in June, 1989.

III. BACKGROUND

A. Process Description

This shop cleans and repairs automobile and truck radiators. Delivery employees drop off radiators needing repair to the shop, which are then soaked in an alkaline bath (sodium hydroxide) for approximately 30 minutes to remove corrosion. After removal from the bath, the radiators are checked for "cooling flow" by forcing air through the coils at high pressure while they are submerged in water. If "cooling flow" is restricted, the radiator's top is removed and the internal coils are individually purged. The radiator's top is removed using a gas torch which melts the lead-based solder holding the top to the radiator's metal casing. This torch (compressed air and propane) heats the solder (65% lead, 35% tin) to approximately 1500°F; this produces lead fume. Once the internal coils are cleaned, the radiator's top is once again soldered to its metal casing. Only radiators needing this cleaning procedure (purging the internal coils to allow adequate "cooling flow") result in potential airborne lead exposure. This shop processes approximately 20 radiators per day, with approximately 10 requiring internal coil purging.

Some newer car models, particularly the foreign imports, utilize plastic radiators. Removing the top portion of plastic radiators does not require the melting or application of solder; therefore the potential for lead exposure does not exist. Of the 20 radiators this shop processes per day, approximately 5 or 6 are made of plastic.

B. Workforce

At the time of this evaluation Sims Radiator Shop in Conyers, Georgia employed 3 people: 2 radiator mechanics and 1 delivery employee. The shop manager arranged for the 2 radiator mechanics to have their blood analyzed for lead in April, 1989. The results were 31 and 36 ug/dl, both of which were below OSHA's threshold for bimonthly testing.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

Two breathing zone air samples and 1 general area sample were collected using mixed cellulose ester filters (AA) and vacuum pumps operated at 2.0 liters per minute. The samples were analyzed for lead according to NIOSH Physical and Chemical Analytic Methods (P&CAM 173).[2]

B. Medical

The 2 radiator mechanics were available to participate in the medical survey. The survey consisted of: 1) a medical and occupational history, 2) an examination of the gums for the presence of a "lead line", 3) blood analysis for lead and free erythrocyte protoporphyrin (FEP), and 4) a self-administered questionnaire. The questionnaire was designed to gather demographic information and identify symptoms associated with lead poisoning. The blood was analyzed in one of the OSHA approved laboratories for blood lead analysis based on proficiency testing.[3] Blood lead was analyzed by anodic stripping voltimetry, and FEP was determined by photofluorometric techniques.[4]

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. However, not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH criteria documents and recommendations, (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and (3) the U.S. Department of Labor (OSHA) occupational safety and health standards. Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures. For the purposes of this evaluation, NIOSH has selected the most stringent exposure limits as our evaluation criteria.

B. Toxicology and Medical Criteria

Inhalation (breathing) of lead dust and fume is the major route of lead exposure in the industrial setting. A secondary source of lead 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 interferes with red blood cell production and can damage the kidneys, peripheral and central nervous systems, and the blood forming organs (bone marrow). These effects may be manifested 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. There is some evidence that lead can also impair fertility in occupationally exposed men.[5]

The blood lead test is one measure of the amount of lead in the body and is the best available measure of recent lead absorption. Adults not occupationally exposed usually have a blood lead concentration less than 30 ug/dl; the average is less than 15 ug/dl.[6,7] In 1985, the Centers for Disease Control (CDC) recommended 25 ug/dl as the highest acceptable blood level for young children.[8] Since the blood lead concentration of a fetus is similar to that of its mother, and since the fetus's brain is presumed to be at least as sensitive to the effect of lead as a child's, the CDC advised that a pregnant woman's blood level be below 25 ug/dl.[8] Recent evidence suggests that the fetus may be

adversely affected at blood lead concentrations well below 25 ug/dl.[9] Furthermore, there is evidence to suggest that levels as low as 10.4 ug/dl affect the performance of children on educational attainment test, and that there is a dose-response relationship with no evidence of a threshold or safe level. [10-12] 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 60-100 ug/dl represent unacceptable elevations which may cause serious adverse health effects (Table 1). Levels over 100 ug/dl are considered to be extremely dangerous and often require hospitalization and medical treatment.

The OSHA standard for lead in air is 50 ug/M^3 calculated as an 8-hour time weighted average for daily exposure.[1] Blood lead and zinc protoporphyrin levels must be monitored at least every 6 months for workers exposed to air lead levels above 30 ug/M^3 for more than 30 days per year, and at least every 2 months if the workers' last blood lead was at or exceeded 40 ug/dl whole blood. The standard also dictates that workers with blood lead levels greater that 60 ug/dl whole blood must be immediately removed from further lead exposure if confirmed by a follow-up test. Workers with average lead levels of 50 ug/dl or greater must be removed. Removal is also possible on medical grounds. Removed workers have protection for wage, benefits, and seniority for up to 18 months or until they can return to lead exposure areas.[1]

The free erythrocyte protoporphyrin (FEP) and zinc protoporphyrin (ZPP) levels are measures of interference with hemoglobin production at the time the red cells are made. Although some diseases and iron deficiency anemia can cause a rise in FEP or ZPP, in a healthy individual working with lead, lead absorption is the most likely cause for such an increase. Further, the FEP or ZPP levels increase abruptly when blood lead levels reach about 40 ug/dl, and they tend to stay elevated for 3-4 months (the average life span of a red blood cell). Normal values are below 50 ug/dl.[13]

The OSHA lead standard requires air monitoring for lead every 6 months if the initial air monitoring is above the action level (30 ug/M^3), and every 3 months if the initial air monitoring is above the PEL (50 ug/M^3). In addition, the OSHA lead standard requires blood monitoring for lead every 6 months if an employee is exposed to airborne lead above the action level for more than 30 days per year. If the blood lead level is above 40 ug/dl, a blood lead test needs to be performed every 2 months. If a blood lead concentration averages 50 ug/dl or more, the affected employee must be removed from further exposure and monthly blood lead tests performed until the level drops below 40 ug/dl.

VI. RESULTS AND DISCUSSION

A. Environmental

1. Air Samples

Results of the environmental samples for inorganic lead are presented in Table 2. Although sampling was limited to approximately 4 of the 8 hours of the workshift, the concentration measured should closely approximate 8-hour time weighted average (TWA) exposures based on the uniformity of work activities performed over the shift. Therefore, both radiator mechanics had lead exposures above OSHA's PEL of 50 ug/M^3 as an 8-hour TWA. The one general area sample was below OSHA's PEL of 50 ug/M^3 as an 8-hour TWA.

2. Ventilation

This shop's ventilation consisted of one large exhaust fan located in the corner of the building. Although ventilation was not measured in a quantitative manner, it was apparent that this fan did not offer local exhaust ventilation at the point of lead generation. During NIOSH's survey the shop's doors were kept open, providing fresh air; however, these doors were reportedly closed during the winter months.

3. Hygiene and Housekeeping

Lead ingestion could also be occurring from poor workplace hygiene (drinking and eating in the work area), both of which were noted during NIOSH's survey.

B. Medical

1. Blood Lead Tests

The blood lead and the FEP levels for the 2 mechanics are listed in Table 3. Both blood lead and FEP levels were in compliance with the OSHA lead standard.

2. Symptoms and Physical Findings

Neither employee reported symptoms suggestive of lead poisoning or had lead lines on their gums.

VII. CONCLUSION

On the basis of the environmental data, a potential health hazard existed from over-exposures to lead during the routine cleaning and repairing of radiators. This shop was providing medical surveillance (blood lead testing) but other activities specified by the OSHA lead standard (exposure monitoring, respiratory protection, housekeeping, hygiene practices, providing clothing, and a written compliance program) needed implementation.

VIII. RECOMMENDATIONS

To ensure that workers are adequately protected from the adverse effects of lead, a comprehensive program of prevention and surveillance is needed. The guidelines for such a program are presented in the OSHA lead standard.[1] In addition to specifying a PEL for airborne lead, the OSHA lead standard also contains specific provisions dealing with mechanical ventilation, respirator usage, protective clothing, housekeeping, hygiene facilities, employee training, and medical monitoring.[1] The implementation of the provisions of this standard will help to ensure that the employees are protected against any potential adverse health effects of lead exposure.

A copy of the OSHA lead standard accompanies this report. To assist the employer in implementing the standard's key provisions, a brief overview as they relate to the findings of this survey follows:

1. This radiator shop should install a local exhaust ventilation system at the source of lead fume generation. Ventilation needs to be installed in the immediate area where the torch is used for melting the top off the radiators. This ventilation would capture the lead fumes before they mix with the general room air.

2. All workers repairing radiators should have their blood drawn and analyzed for lead and ZPP content every 6 months. If the blood lead level is above 40 ug/dl, a blood lead test needs to be performed every 2 months. If a blood lead concentration averages 50 ug/dl or more, the affected employee must be removed from further exposure and monthly blood lead tests performed until the blood lead level drops below 40 ug/dl.

3. There should be no eating, drinking, smoking, or tobacco chewing in the radiator repair area.

4. Workers should shower and change from work clothes to street clothes after their tour of duty.

5. Workers removed from exposure for elevated blood lead or lead-related illness should have protection of wage, benefits, and seniority for up to 18 months or until they can return to lead exposure areas.

6. Given that our environmental monitoring found lead levels above OSHA's PEL, environmental monitoring needs to be conducted quarterly until at least two consecutive measurements, taken seven days apart, are below the PEL.

IX. REFERENCES

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XI. Distribution and Availability of Determination Report

Copies of this Determination Report are temporarily available upon request from NIOSH, Hazard Evaluation and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH publications office at the Cincinnati, address. Copies of this report have been sent to:

A. Sims Radiator Shop, Decatur, Georgia
B. Mr. Alan Sims
C. NIOSH Regional Offices/Divisions
D. U.S. Department of Labor, OSHA-Region 1V.

For the purposes of informing the affected employees, copies of this report must be posted in a prominent place accessible to the employees, for a period of 30 calendar days.

TABLE 1

Lowest Blood Lead Levels Reported To Cause Health Effects In Adults

Blood Lead Level	Health Effect
100-120 ug/dl	Cental Nervous System Toxicity (Encephalopathy)
100 ug/dl	Chronic Renal Damage
80 ug/dl	Low Blood Count (Anemia)
60 ug/dl	Pregnancy Complications
50 ug/dl	Decrease Hemoglobin Production Mild Central Nervous System symptoms
40 ug/dl	Decrease Peripheral Nerve Conduction Pre-term Delivery
30 ug/dl	High Blood Pressure

Table 2

PERSONAL BREATHING ZONE AND GENERAL AREA LEAD CONCENTRATIONS

Sims Radiator, Conyers, Georgia
June 2, 1989

Sample Number	Job/Location	Sampling Time	ug/M3 Lead
1	Radiator Mechanic	10:25-2:35	80
2	Radiator Mechanic	10:25-2:35	60
3	Mechanic Bench (Area)	10:25-2:32	10

Evaluation Criteria 50 ug/M^3
Laboratory Limit of Detection 20 ug/sample
* - Below the laboratory limit of detection

Table 3

Blood Lead* and FEP** Results

Sims Radiator, Conyers, Georgia
June 2, 1989

	Job Title	Blood Lead (ug/dl)*	FEP (ug/dl)**
1.	Mechanic	30	44
2.	Mechanic	37	25

* - Blood lead, reference range for occupational exposure: less than 40 ug/dl.
** -FEP = Free erythrocyte protoporphyrin, normal range: less than 50 ug/dl.