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LAKEWOOD RADIATOR SHOP
DENVER, COLORADO

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I. Summary

In September l988, the National Institute for Occupational Safety and Health (NIOSH) received a request from the owners of three radiator repair shops in the Denver, Colorado metropolitan area to evaluate occupational exposures to lead in the repair and cleaning of radiators.

On October 4, l988, an environmental and medical evaluation was conducted by NIOSH and the Colorado State Health Department personnel. The environmental evaluation consisted of measuring breathing zone and general room air concentrations of lead, and, in two of the facilities, evaluating the ventilation systems. (The third facility only had general dilution ventilation.) Eight breathing zone air samples and two general room air samples were collected and analyzed. Six of the eight breathing zone samples and both of the general room air samples had lead concentrations that exceeded the evaluation criterion of 0.05 mg/M^3. The highest concentration was 0.29 mg/M^3 and the lowest concentration was 0.0l, with an average of 0.l6 mg/M^3.

Medical monitoring and evaluation consisted of blood lead (PbB) and zinc protoporphyrin (ZPP) determinations on all 10 radiator shop workers from the three area shops. Of the 10 workers tested, three had blood lead (PbB) levels at or above the OSHA action level of 40 ug/dl (but under the OSHA medical removal level of 50 ug/dl). Four employees had ZPP levels above 60 ug/dl, the laboratory's upper limit of normal. One employee had elevated levels of both PbB and ZPP.

On the basis of the environmental and medical data, the investigators determined that a health hazard existed from over-exposures to lead during the routine cleaning and repairing of automobile radiators. Recommendations are provided in section VIII of this report that may assist in eliminating this hazard.

Keywords: SIC 3714 - (motor vehicle parts and accessories), blood lead, lead, inorganic lead, zinc protoporphyrin, radiator shops

II. Introduction

The National Institute for Occupational Safety and Health (NIOSH) received a request in September l988, from the owners of three radiator repair shops in Lakewood, Arvada, and Aurora, Colorado to evaluate lead exposures among workers who were repairing automobile radiators. This request was prompted by the owner's concern about a worker's elevated blood lead level.

The owner was telephoned upon receipt of the medical and environmental results, and copies of personal blood test results were mailed to each worker in November l988.

III. Background

The Lakewood, Arvada, and Aurora radiator repair shops each employ three radiator mechanics. All mechanics may not work at the same time, and since the shops are owned by the same two individuals, workers may work in different shops, depending on the work load at each shop.

All types of radiators are repaired and cleaned. Most are from automobiles. The radiators are taken apart using an oxygen acetylene torch to melt the top and bottom parts off the radiator. The top and bottom of the radiator are attached to the radiator core with a lead-based solder. When the solder is melted with an oxygen acetylene torch the lead is heated to temperatures that are hot enough to produce lead fumes. This procedure is where most of the workers' exposure occurs. Other lead exposures occur from brushing and skin contact with the oxidized lead. Ingesting some of the lead may be a small contributing factor. There is some lead exposure when the radiator is assembled due to the melting and vaporization of the lead-based soldering wire.

The ventilation was not effective in any of the three facilities. The Aurora shop had good general ventilation but no local exhaust to exhaust the lead fumes at the source of generation. The Lakewood shop had minimum general ventilation and no local exhaust ventilation. The Arvada shop did not have a designated ventilation system.

IV. Evaluation Design and Methods

A. Environmental

Eight breathing zone and two general room air samples were collected on mixed cellulose ester filters (AA) using vacuum pumps operated at 2.0 liters per minute. The samples were analyzed for lead according to NIOSH P&CAM l73.[1]

V. Evaluation Criteria

A. Environmental

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. It is, however, important to note that 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, and/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 (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's 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 or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

B. Toxicology and Medical Criteria

Inhalation (breathing) of lead dust and fume is the major route of lead exposure in industrial setting. 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 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 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. There is some evidence that lead can also impair fertility in occupationally exposed men.[2]

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 exposed to lead at work usually have a blood lead concentration less than 30 ug/dl; the average is less than 15 ug/dl.[3,4] In 1985, the Centers for Disease Control (CDC) recommended 25 ug/dl as the highest acceptable blood level for young children.[5] 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 lead level be below 25 ug/dl.[5] Recent evidence suggests that the fetus may be adversely affected at blood lead concentrations well below 25 ug/dl.[6] Furthermore, there is evidence to suggest that levels as low as 10.4 ug/dl affect the performance of children on educational attainment tests, and that there is a dose-response relationship with no evidence of threshold or safe level.[7] 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-l00 ug/dl represent unacceptable elevations which may cause serious adverse health effects. Levels over l00 ug/dl are considered to be extremely dangerous and often require hospitalization and medical treatment.

The Occupational Safety and Health Administration (OSHA) standards for lead in air is 50 ug/M^3 calculated as an 8-hour time weighted average for daily exposure.[8] Blood lead and 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 than 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 l8 months or until they can return to lead exposure areas.[8]

The zinc protoporphyrin (ZPP) level is a measure of interference with hemoglobin production at the time the red cells are made affecting heme synthetase, the last enzyme in heme synthesis. Although some diseases and iron deficiency anemia can cause a rise in ZPP, in a healthy individual working with lead, lead absorption is the most likely cause for such an increase. Further, the 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 cell). Normal values are below 50 ug/dl (60 ug/dl at the laboratory used for this study).[9]

VI. Results and Discussion

A. Environmental

Results of the environmental samples for inorganic lead are presented in Table l. Air concentrations ranged from 0.0l to 0.29 mg/M^3. The average concentration for all ten samples was 0.l6 mg/M^3. Six of eight breathing zone air samples and both of the area samples exceeded the evaluation criterion of 0.05 mg/M^3.

The housekeeping in the Lakewood and Aurora shops was good. The housekeeping in the Arvada shop needs to be improved. Eating areas were provided that were free from lead exposure. Good personal hygiene was observed.

B. Medical

Of the 10 workers tested for blood lead (PbB) and zinc protoporphyrin (ZPP), four were within the reference range for both (PbB less than 40 ug/dl, ZPP level less than 60 ug/dl). Of the other six workers, three employees had PbB levels exceeding 40 ug/dl and four employees had elevated ZPP levels. One worker had elevated levels of both PbB and ZPP. Comparison of breathing zone air samples with blood testing revealed no significant statistical association. However, in Table 1, worker's with personal air samples exceeding a TWA of 0.05 mg/M^3 had either PbB or ZPP levels exceeding the reference ranges noted previously.

VII. Conclusions

Based on the high environmental lead levels and the elevated blood lead levels we concluded that a health hazard exists at these radiator shops. Eight of l0 time weighted average (TWA) air samples exceeded the evaluation criterion and six of ten workers had elevated ZPP or blood lead levels. All results indicate that more stringent measures are needed to control workers' exposure to lead.

VIII. Recommendations

1. All three of the radiator shops need to install local exhaust ventilation at the source of the lead fume generation. Ventilation needs to be installed in the immediate area where the acetylene torch is melting the bottom and top off the radiators. This ventilation would capture the lead fumes before they mix with the general room air.

2. All workers must have blood drawn for lead analysis every 6 months if their last blood lead was below 40 ug/dl and every 2 months if it was 40 ug/dl or above. For purposes of compliance with the OSHA lead standard, a blood lead concentration averaging 50 ug/dl or more represents excessive lead exposure, and the affected employee must be removed from further lead exposure until the blood lead concentration is below 40 ug/dl.

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

4. Removed workers should have protection for wage, benefits, and seniority for up to l8 months or until they can return to lead exposure areas.

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

IX. References

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9. Occupational Safety and Health Administration. OSHA Safety and Health Standards. 29 CFR 1910.1025. Lead. Occupational Safety and Health Administration, Revised 1983.

X. Authorship and Acknowledgements

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XI. Distribution and Availability of Determination Report

Copies of this Determination Report are temporarily available upon request from NIOSH, Hazard Evaluations 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. Lakewood Radiator Shop
B. Aurora Radiator Shop
C. Arvada Radiator Shop
D. U. S. Department of Labor, OSHA - Region VIII
E. NIOSH Regional Offices/Divisions

Table 1

Breathing Zone and General Room Air Concentrations of Lead, and Blood lead (PbB) and Zinc protoporphyrin (ZPP) levels
at
The Lakewood, Arvada, and Aurora Radiator Repair Shops
on October 4, 1988

Sample #	Job	Location	Sampling Time	Mg/M^3 Lead	Ug/dL PbB	Ug/dL ZPP
5	Radiator Mechanic	Lakewood	7:55 - 2:17	0.13	42	39
15	Radiator Mechanic	Lakewood	7:57 - 2:22	0.01	20	40
12	Radiator Mechanic	Lakewood	8:00 - 2:00	0.08	41	20
9	All Areas Manager	Lakewood	8:00 - 2:20	0.04	25	51
16	Radiator Mechanic	Arvada	8:35 - 2:50	0.29	8	117
7	Radiator Mechanic	Arvada	8:35 - 2:50	0.23	44	97
10	Area Sample	Arvada	8:40 - 2:50	0.18	---	---
5	Radiator Mechanic	Aurora	9:15 - 3:20	0.21	38	84
3	Radiator Mechanic	Aurora	9:15 - 3:20	0.29	17	108
1	Area Sample	Aurora	9:15 - 3:20	0.09	---	---
Evaluation Criteria				0.05	40	60

Laboratory Limit of Detection 0.002 mg/filter