



## Case Studies

### Lead Contamination in Radiator Repair Shops

Dawn Tharr Column Editor

To cite this article: Dawn Tharr Column Editor (1993) Case Studies, Applied Occupational and Environmental Hygiene, 8:5, 434-438, DOI: [10.1080/1047322X.1993.10388135](https://doi.org/10.1080/1047322X.1993.10388135)

To link to this article: <https://doi.org/10.1080/1047322X.1993.10388135>



Published online: 24 Feb 2011.



Submit your article to this journal [↗](#)



Article views: 10



View related articles [↗](#)



Citing articles: 2 View citing articles [↗](#)

---

## Lead Contamination in Radiator Repair Shops

Dawn Tharr, Column Editor

Reported by Greg M. Piacitelli and Carol Rice

### Introduction

During July to August 1991, the National Institute for Occupational Safety and Health (NIOSH) evaluated employee exposures to lead in three radiator repair shops in the Cincinnati area. These surveys were prompted by previous reports which had described excessive lead poisoning in the radiator repair industry and suggested the need for more complete exposure information. This study included measurements of airborne and surface lead concentrations in these shops to estimate the personal airborne lead exposures for eight radiator mechanics. The results of these investigations are reported below.

### Background

While lead poisoning is one of the oldest recognized occupational diseases, exposure to lead continues to occur in many industries. Recent studies suggest that the use of solder for the assembly and repair of automotive radiators is a common source of exposure to lead that has received little public recognition.<sup>(1-3)</sup>

There are an estimated 10,000 radiator repair shops in the United States, employing an average of four workers each.<sup>(4)</sup> Exposure to inorganic lead during radiator repair is by the inhalation of lead fumes and lead oxide dusts generated by soldering, burning, grinding, and brushing activities; accidental ingestion may also result from lead contamination of work surfaces, food, and a worker's hands, face, and clothing. Airborne lead (PbA) levels as high as 500  $\mu\text{g}/\text{m}^3$  [10 times greater than the Occupational Safety and Health Administration (OSHA) permissible

exposure limit (PEL) of 50  $\mu\text{g}/\text{m}^3$ ] have been reported in radiator shops.<sup>(5,6)</sup> Evaluations by NIOSH from 1979 to 1990 in radiator shops indicated that 68 percent of the workers sampled had airborne lead exposures exceeding the OSHA standard.<sup>(3)</sup> Past studies also indicate that blood lead levels (BLLs) of shop employees are substantial. For example, among 56 radiator repair mechanics in the Boston area, 80 percent had BLLs greater than 30  $\mu\text{g}/\text{dL}$ , and 16 percent had BLLs greater than 50  $\mu\text{g}/\text{dL}$ .<sup>(2)</sup> OSHA requires that any worker with a BLL exceeding 60  $\mu\text{g}/\text{dL}$  or an average (of three tests) BLL greater than 50  $\mu\text{g}/\text{dL}$  be removed from lead exposure until the BLL drops below 40  $\mu\text{g}/\text{dL}$ .

Inhalation is considered the major route of entry of lead in the work environment; therefore, measurement of airborne lead concentrations is the primary procedure for assessing worker exposures and employer compliance with the OSHA PEL. However, some researchers have also recognized that surface contamination and poor personal hygiene habits of industrial workers can contribute to lead exposure through unintentional ingestion.<sup>(7-9)</sup> Contaminated food, tobacco products, skin, and clothing may be potential contributors of lead absorption through ingestion. While the OSHA Lead Standard<sup>(6)</sup> includes administrative and work practice controls intended to reduce lead uptake by ingestion, the measurement and evaluation of the potential sources of ingestion or dermal contact from work surfaces and personal contamination generally have been ignored.

### Study Design

Twenty of the 40 radiator repair companies listed in a 1991 Cincinnati telephone directory were chosen by

random selection and contacted to request information about solder usage, repair volume, number of workers, and engineering controls. Three shops were then selected for field surveys based on the following criteria: highest estimated work volume; greatest number of full-time repair mechanics; and level of engineering controls.

Of the three shops surveyed, only Shop C could be described as "small, dirty, and poorly ventilated," a description previously used to characterize many radiator shops in other studies.<sup>(2)</sup> The other two shops were spacious, clean, and orderly, with effective and well-maintained ventilation systems. Shop C, the newest of the three shops, was 4 years old, whereas the other two shops were at least 12 years old.

During the study, the average number of radiators repaired daily ranged from 5 to 15 in the three shops selected. Shops A and B each employed two full-time and one part-time radiator mechanics while Shop C employed two full-time mechanics. The three repair stations at Shop A were equipped with local exhaust ventilation (LEV) consisting of a canopy-shaped exhaust hood connected to a flexible duct and a ceiling-mounted exhaust blower. In addition, an electronic precipitator was positioned above two of the repair stations. Two of the three repair stations at Shop B were equipped with LEV consisting of a nonflanged hood connected to a flexible duct and exhaust blower; a wall fan was positioned between these stations. The third station at Shop B was a ventilated enclosure, resembling a laboratory hood, with a wall-mounted propeller fan at the top of the enclosure. There was no LEV system used at Shop C; a single wall fan was located 15 feet opposite from the two repair stations and a ceiling-

mounted exhaust fan was 10 feet above each station.

Employee BLLs in Shop A ranged from 24 to 35  $\mu\text{g}/\text{dL}$  and from 17 to 23  $\mu\text{g}/\text{dL}$  in Shop B when last tested in 1990. Employee blood-lead testing had never been conducted in Shop C. None of the radiator shop operators had ever monitored employee exposures to airborne lead. While all three company owners stated that they were aware of the OSHA Lead Standard, none knew of its specific requirements or had a copy available.

### Evaluation Methods

Surveys lasting 4 days each were conducted at Shops A and B, while sampling was stopped after only 3 days at Shop C due to lack of repair activity; all three shops operated only one shift per day. All eight radiator mechanics from these three shops agreed to wear air samplers and to allow skin and facial wipe sampling.

Personal breathing zone and area air samples for lead were collected following NIOSH Sampling and Analytical Method 7105 (flameless atomic absorption spectroscopy). Wipe samples were collected using a commercial "wet-wipe" (Wash-a-Bye Baby™ Moist Towelettes) and analyzed by Method 7105.

### Results and Discussion

#### Air Sampling

A total of 129 air samples were collected and analyzed for PbA. Ninety percent of the individual sample concentrations were below 20  $\mu\text{g}/\text{m}^3$ ; however, the remaining 10 percent were at or above 94  $\mu\text{g}/\text{m}^3$ . The LEV systems used in Shops A and B were effective in controlling PbA concentrations; the highest concentration measured during a brief period of continuous soldering (a worst-case situation) was only 7.1  $\mu\text{g}/\text{m}^3$ . However, the results were considerably different at Shop C, where no LEV was used. The 13 personal samples in this shop averaged 209  $\mu\text{g}/\text{m}^3$ ; a maximum value of 810  $\mu\text{g}/\text{m}^3$  was measured for a 56-minute sample worn while tearing down and

# 25 DECIBELS. 45 DECIBELS. 65 DECIBELS. 80 DECIBELS.

---

# 85 DECIBELS. 90 DECIBELS. 100 DECIBELS. 115 DECIBELS. 140 DECIBELS. LOSS OF HEARING.



Call 1-800-245-0779 For More Information  
510 South Worthington St. • Oconomowoc, WI 53066  
414-567-9157 • FAX: 414-567-4047

**To Manage Your Noise Measurement And Hearing Conservation Challenges, A New Line Of Quest Dosimeters.**

To meet industrial safety regulations, accurate worker and workplace noise exposure readings are a must. The answer? Quest's new dosimeters are added to a full line of noise-monitoring devices.

Featuring bigger, more informative displays. Easy-to-program rubberized key pads. Optional computer interface for data management. Plus battery change with no memory loss.

All, built to last with sturdy aluminum cases and surface-mount technology.



**Circle reader action no. 117**

resoldering a single radiator.

Similarly, all but one of the 8-hour time-weighted average (TWA<sub>8</sub>) personal exposures in Shops A and B were below 10  $\mu\text{g}/\text{m}^3$  (the other was 17  $\mu\text{g}/\text{m}^3$ ). The five exposures measured at Shop C all exceeded the Action Level (AL) of 40  $\mu\text{g}/\text{m}^3$ , with two also greater than the PEL.

All three surveys of radiator shops described in this report were con-

ducted in summer months during hot weather when radiator repair activity was near peak levels compared to the rest of the year and when doors and windows are commonly left open, according to shop personnel. Therefore, while the results reported here may be considered to represent worst-case exposures, this should be confirmed by winter surveys when repair volume is generally about 25 percent of that seen

# IL1430 UV ACTINIC RADIOMETER SYSTEM

## IL1430

- Hand-held... battery operated
- Six decade auto-range
- Directly coupled or detachable detector with cord available
- Direct reading in effective watts/cm<sup>2</sup> and joules/cm<sup>2</sup> in the UV hazard wavelength ranges (190-400nm)



SEND FOR BULLETIN IL1400



## international light<sup>INC</sup>

Specialists in Light Measurement Since 1965

17 GRAF ROAD NEWBURYPORT, MA 01950 U.S.A.  
 ■ TEL. 508-465-5923 ■ FAX 508-462-0759 ■ TELEX 94-7135

Write for name of sales representative in your area (over 40 countries worldwide)

Circle reader action no. 114

during the summer but when the buildings are not as open.

Two primary factors are probably responsible for the major differences in air lead concentrations between Shop C and the other shops surveyed. First, only the radiator mechanics at Shop C routinely used a wire brush to clean solder from the soldered joints when tearing down radiators. This not only generated a large amount of lead dusts but also shortened the distance between the worker's breathing zone (where the sampler was worn) and the radiator as he leaned over while brushing.

Second, the lack of effective engineering controls in Shop C certainly contributed to excessive PbA exposures. The use of a single wall-mounted and two roof-mounted propeller fans was ineffective in reducing breathing zone lead exposures below the PEL. On the other hand, local exhaust ventilation at Shops A and B, where face ve-

locities of at least 100 fpm were maintained, was found to effectively control PbA exposures to well below the PEL. The adjustable-arm, flexible duct hoods in these shops were large enough that the mechanic did not have to constantly reposition the hood as he worked on a radiator, and yet they were easily movable when necessary. This ergonomic consideration may be important in predicting how frequently the worker will use the exhaust hood and, therefore, how effectively exposures are controlled.

### Wipe Sampling

A total of 126 samples were collected to assess surface lead (PbS) contamination on surfaces likely to be contacted by workers. Of these samples, 29 percent were greater than 10,000  $\mu\text{g}/\text{m}^2$ . While wipe sampling may be considered only semiquantitative, these results do indicate the presence and rela-

tive magnitude of lead on sampled surfaces. The highest PbS concentrations were generally found in the immediate area where radiators were being torn down and resoldered (maximum value over 500,000  $\mu\text{g}/\text{m}^2$ ). This finding is not unexpected because these activities are the primary sources of lead contamination at the radiator shops. Less expected was the lead contamination found to be pervasive throughout the rest of the shop, especially the shop office (up to 84,500  $\mu\text{g}/\text{m}^2$ ). Furthermore, lead was not confined to work surfaces, as indicated by the levels found in the cars of workers (96,000  $\mu\text{g}/\text{m}^2$  maximum) and on mechanics' unwashed hands (78,050  $\mu\text{g}/\text{m}^2$ ) and foreheads (6,000  $\mu\text{g}/\text{m}^2$ ). These findings are particularly disturbing since lead was found in areas where workers frequently eat and smoke and because it indicates that lead is being carried away from the workplace. Therefore, workers, customers, and families are potentially being exposed to lead through skin contact, possibly resulting in their ingestion of lead.

Washing with liquid detergent and water was effective in removing lead from workers' hands, with a significant difference ( $p < .05$ ) between PbS average concentrations before (6788  $\mu\text{g}/\text{m}^2$ ) and after (593  $\mu\text{g}/\text{m}^2$ ) washing. Interestingly, a concentration of 2439  $\mu\text{g}/\text{m}^2$  was found on one worker's hands *after* washing. This suggests that personal hygiene is highly variable and may be difficult to control.

Presently, there are no federal criteria for surface contamination in occupational environments. The U.S. Department of Housing and Urban Development (HUD) recommends the following limits for surface contamination in residential housing following removal of lead-based paint: 200  $\mu\text{g}/\text{ft}^2$  (2160  $\mu\text{g}/\text{m}^2$ ) on floors; 500  $\mu\text{g}/\text{ft}^2$  (5400  $\mu\text{g}/\text{m}^2$ ) on window sills; and 800  $\mu\text{g}/\text{ft}^2$  (8640  $\mu\text{g}/\text{m}^2$ ) in window wells.<sup>(3)</sup> These guidelines were established with the goal of preventing lead poisoning in housing occupants, especially young children. In the residential environment, the length of exposure, the potential for contact with surface contamination, and the frequency of

hand-to-mouth contact is generally considered to be much greater than in the occupational environment. Therefore, direct comparison between our results and the HUD levels may not be pertinent but should provide some reference for assessing the degree of lead contamination. In this context, 64 percent of the wipe samples were less than the least conservative HUD guideline (8,640  $\mu\text{g}/\text{m}^2$ ) and only 37 percent were less than the most stringent limit (2,160  $\mu\text{g}/\text{m}^2$ ).

## Conclusions

This study helps to emphasize several important public health issues. First, radiator repair work needs to be recognized, particularly by shop owners, employees, and health personnel, as associated with an increased risk of lead poisoning. Educating workers and controlling sources of lead exposure should be a high priority in this industry, considering the toxicity of lead, the potential magnitude of exposures, and the potential to carry exposures away from the workplace.

Second, this study illustrates the dilemma of small businesses concerning health and safety conditions. Frequently, owners may be poorly informed about hazardous conditions in their shops, the applicable health and safety regulations, and the methods to control workplace exposures. Even if they are aware of conditions and requirements, they may lack the information and resources to implement the regulations or correct problems. Industry associations and government agencies should focus on disseminating practical information concerning lead usage and hazards in trade journals, newsletters, and product literature.

Third, ingested lead has received minor attention, compared to inhaled lead, as a major contributor to lead absorption. However, the results from this survey indicate that hand, facial, and work surface lead contamination may be significant sources which potentially contribute to ingestion of lead by radiator mechanics. Further, radiator repair work also presents a poten-

tial risk of lead poisoning to the families of mechanics, as illustrated by the high levels of lead carried home on skin and clothing and in automobiles.

Since inhalation has been considered the primary route of lead entry by most occupational health agencies, most requirements for personal and environmental hygiene are predicated on PbA levels, with relatively minor consideration of PbS contamination. For example, OSHA recognizes wipe sampling results as useful in identifying lead-contaminated areas but has not yet established specific criteria for surface dust levels that can be used for determining the need for any corrective action. The results from this survey emphasize the need for routine wipe sampling and for pertinent comparison criteria that can be used to assess the need for specific actions directed to personal, occupational, and environmental hygiene.

. These survey results are similar to

those found in other studies of radiator shops and confirm the potential for excessive lead exposures of radiator mechanics as well as the success of local ventilation in reducing exposures. Recent research by the NIOSH Division of Physical Sciences and Engineering has resulted in the design of affordable (less than \$1000) and effective ventilation control systems that could be used in all radiator shops, including those where limited resources preclude purchasing expensive, elaborate engineering controls.<sup>(3)</sup> Other actions recommended to eliminate exposures to lead include: the mandatory use of protective equipment, such as respirators (until exposures are below the PEL) and gloves and uniforms which are replaced or cleaned daily; a strict adherence to personal and environmental hygiene; an enforced restriction on eating and smoking in all lead-contaminated areas; the implementation of routine environmental and

## HAZ-DUST™ 10 $\mu\text{m}$ Particulate Monitor

\* INSTANT READINGS OF LUNG DAMAGING PARTICLES AND RESPIRATORY AEROSOLS

\* ELIMINATES FILTER GRAVIMETRIC TESTS

\* FOR AIR QUALITY AND RISK ASSESSMENTS

\* OSHA & EPA RECOMMENDED



\* DIRECT READING

\* INTERNAL ALARM

\* E-Z to USE

\* FIELD PORTABLE

\* DATA LOGGING

*"When Your Employees' Health is on the Line,  
Make Sure HAZ-DUST is on the Job!"*

Environmental Devices Corporation  
88 Essex Street, Haverhill, MA 01830  
Phone: (508) 521-1514

Circle reader action no. 119

**Comprehensive  
Industrial  
Hygiene Preparation  
V5.0**

**Comprehensive  
Safety  
Preparation  
V2.0**

**Certified  
Hazardous  
Materials  
Manager**

**Certification**

**15 DAY  
Money Back Guarantee**

**Training**

CIH, CSP and CHMM are the most sought after certifications today! Datachem has been producing interactive computer learning tools since 1986. Currently, EH&S professionals in 20 countries use our products to improve their skills.

Certified Hazardous Materials Manager provides training in areas of environmental health and safety practices. This includes regulatory compliance and policy, science and technology, materials handling, emergency response, and remedial action. Training can take place on site and requires NO PROGRAMMING!!!

**CIH\***

- 2100+ questions w/ detailed explanations
- Toxicology
- Chemistry
- Hazardous waste
- Management
- Air Sampling Methods
- Noise
- Radiation
- Air Pollution
- Ventilation
- Regulations

**CSP\***

- 1400 questions w/ detailed explanations
- Applied Sciences
- Hazardous waste
- Fire Protection
- Management
- Safety Engineering
- Industrial Hygiene
- Regulations
- Environmental Health
- Plant & Physical Safety
- System Safety

**CHMM\***

- 900+ questions w/ detailed explanations
- Hazardous Waste Management
- Air Pollution
- Underground Storage
- CERCLA
- PCB/Asbestos
- Water Pollution (SDW)
- Health and Safety Program
- HAZMAT and DOT

\* These certifications offered by ABIH, BCSP, IHMM.

**DON'T WAIT - ORDER TODAY  
Call 1-800-348-8882**

VISA, MC, PO's, Prepay  
\$8.00 s/h — \$16.00 international  
• **Specify disk size** •  
MA residents add %5 tax

Comp.Ind.Hyg.Pre. ....  
Comp.Saf.Pre. ....  
Cert.Haz.Mat. ....

Indiv. Lic. ....\$299.95/ea.  
Site Lic. ....\$595.00/ea.  
Network Lic. ...\$895.00/ea.

*Datachem Software*

181 Ruggles Street • Westboro, MA 01581

COMPUTER SYSTEM REQUIREMENTS: PC/XT/AT/PS2 or 100% compatible computer running DOS 3.3 or higher, with 512k ram, a monitor and a hard drive with at least 2.6 megabytes free. Software comes in either 5.25" or 3.5" disks with a user manual and can be operated with or without a mouse.

Circle reader action no. 120

medical monitoring programs; and training to increase the awareness of the problems associated with lead use.

**References**

1. Lussenhop, D.; Parker D.L.; Barklind, A.; McJilton, C.: Lead Exposure and Radiator Repair Work. *Am. J. Pub. Health* 79:1558-1560 (1989).
2. Goldman, R.H.; Baker, E.L.; Hannan, M.; Kamerow, D.B.: Lead Poisoning in Automobile Radiator Mechanics. *N. Engl. J. Med.* 317:214-218 (1987).
3. Centers for Disease Control: Control of Excessive Lead Exposure in Radiator Repair Workers. *Morbidity and Mortality Weekly Report* 40:139-141 (1991).
4. Goldfield, J.; Sheehy, J.W.; Gunter, B.J.; Daniels, W.J.: Cost-Effective Radiator Repair Ventilation Control. *Appl. Occup. Environ. Hyg.* 6:959-965 (1991).
5. Gunter, B.J.; Payor, P.D.: Health Hazard Evaluation Report No. HETA 80-089-723, Denver Radiator and Shutter Service, Denver, CO. NTIS Pub. No. PB-81-171-100. National Technical Information Service, Springfield, VA (1980).
6. U.S. Department of Labor, Occupational Safety and Health Administration: 29 CFR Part 1910.102, Occupational Exposure to Lead; Final Standard. USDH/OSHA, Washington, DC (1978).
7. Chavalitnitikul, C.; Levin, L.: A Laboratory Evaluation of Wipe Testing Based on Lead Oxide Surface Contamination. *Am. Ind. Hyg. Assoc. J.* 45:802-808 (1984).
8. Chavalitnitikul, C.; Levin, L.; Chen, L.C.: Study and Models of Total Lead Exposures of Battery Workers. *Am. Ind. Hyg. Assoc. J.* 45:802-808 (1984).
9. Que Hee, S.S.; Peace, B.; Clark, C.S.; et al.: Evolution of Efficient Methods to Sample Lead Sources, Such as House Dust and Hand Dust, in the Homes of Children. *Environ. Res.* 38:77-95 (1985).

*Editorial Note:* Greg Piacitelli is with the Industrywide Studies Branch of NIOSH, and Carol Rice is with the University of Cincinnati Medical Center. More detailed information on this study is contained in IWSB Report 182.5, available through Mr. Piacitelli, NIOSH, Industrywide Studies Branch, Mail Stop R14, 4676 Clumbia Parkway, Cincinnati, OH 45226.