IN-DEPTH SURVEY REPORT

CONTROL TECHNOLOGY FOR SMALL BUSINESS

EVALUATION OF A VENTILATED BOOTH FOR RADIATOR REPAIR

at

Sims Radiator
Chamblee, Georgia

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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
Division of Physical Sciences and Engineering
Engineering Control Technology Branch
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PLANT SURVEYED	Sims Radiator 2429 Chamblee - Tucker Road Chamblee, Georgia 30341
SIC CODE	7539
SURVEY DATE	July 17-19, 1990
SURVEY CONDUCTED BY	John W Sheehy Thomas C Cooper Charlie Sanders
EMPLOYER REPRESENTATIVE CONTACTED	Mr Alan Sims, Owner 223 Weekes Street Decatur, Georgia 30030
EMPLOYEE REPRESENTATIVE CONTACTED	No Union
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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) was established by the Occupational Safety and Health Act of 1970 Among the numerous responsibilities assigned to the Institute by this Act are the identification of occupational safety and health hazards, evaluation of these hazards, and recommendation of standards to regulatory agencies to control the hazards Located in the Department of Health and Human Services (formerly Department of Health, Education, and Welfare), NIOSH conducts research separate from the standard setting and enforcement functions conducted by the Occupational Safety and Health Administration (OSHA) in the Department of Labor An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering (DPSE) has been given the lead within NIOSH to study the engineering aspects relevant to the control of these hazards in the workplace

NIOSH has been instrumental in the development of recommendations for safeguarding workers' safety and health from exposure to occupational hazards Since 1976, ECTB has conducted assessments of health hazard control technology on the basis of industry, common industrial process, or specific control techniques The objective of each of these studies has been to document and evaluate control techniques and to determine their effectiveness in reducing potential health hazards in an industry or at specific processes These data will create a greater awareness of the need for or availability of an effective system of hazard control measures

A research study of control technology for radiator repair shops by ECTB was prompted by the dangers of potential lead contamination in the workplace and by the need to provide control technology information concerning the prevention of occupational disease to small businesses that may not have access to current technology In the United States, radiator repair shops employ an estimated 40,000 workers These shops are generally small, employing an average of four workers [1-2] State occupational health programs have identified radiator repair shops as a high-risk small business Several states have reported a high incidence of violations for overexposure to lead, airborne lead concentrations in some shops have been as high as 500 $\mu g/m^3$, and blood lead levels in workers were often over 60 micrograms per deciliter ($\mu g/dl$) Before an effective control was installed at some installations, personal breathing zone samples at the workstation averaged 453 $\mu g/m^3$--45 times higher than after the installation of the control [3-4] Although numerous publications deal with the exposure problem, few describe methods to reduce lead levels

NIOSH researchers conducted a control technology study of radiator shops during 1989-90 The goal of this research study is to provide control technology information for the prevention of disease from exposure to lead during radiator repair This report describes a cost-effective ventilation control booth that enclosed two workstations at one worksite Before installation of the control booth, this shop had a potential for high exposures to lead because of the large volume of work and ineffective general room ventilation

The primary objective of this plant study was to evaluate and document the effectiveness of this local exhaust ventilation (LEV) booth to control exposure to airborne lead during radiator repair operations Secondary objectives were to assess the effectiveness of the LEV system during the busiest season for radiator repair (June, July, and August), to determine factors which account for the differences in lead exposures between the two radiator repair mechanics, and to assess the relative effectiveness of the LEV system for the repair of automobile/small truck radiators

This evaluation was accomplished by determining the exposure of radiator repair mechanics to airborne concentrations of lead while using the control system and comparing these levels to the OSHA Permissible Exposure Limit (PEL) for lead Also, before the ventilation control was installed, lead levels had been measured at this site in 1989 during a NIOSH Health Hazard Evaluation (HHE) [5] The availability of these records permitted further documentation of the effectiveness of this control system by determining the reduction in lead exposure based on "before" and "after" results

This in-depth survey report will be used as a basis for making control recommendations and for preparing technical reports and journal articles on the effectiveness of designs and techniques for controlling hazards This information will be part of a database available to health professionals, equipment manufacturers, and others to assist in the development of effective control measures in the workplace

PLANT AND PROCESS DESCRIPTION

FACILITY DESCRIPTION

This radiator shop began operation in 1988 in a facility formerly used as a muffler shop The shop now repairs automotive and small truck radiators Figure 1 shows the building layout and the workstations In July 1990, Sims moved the two radiator repair workstations to the south wall of the shop and built a ventilated booth to enclose them Figures 2 and 3 show sketches of the ventilated booth for the two workstations Each station was equipped with a water bath, compressed air/propane torch, and the right (west) station had a hydraulic lift At the time of the survey, the shop employed five workers one shop manager, two mechanics, and two delivery employees Radiator repair operations were performed by the shop manager and one mechanic The second mechanic repaired air-conditioners, water pumps, and removed radiators from cars

PROCESS DESCRIPTION

Small or medium size radiators are pulled from a car or light truck or brought to the shop The radiator is soaked in an alkaline bath (sodium hydroxide) for approximately 30 minutes to remove corrosion, rinsed with fresh water, and

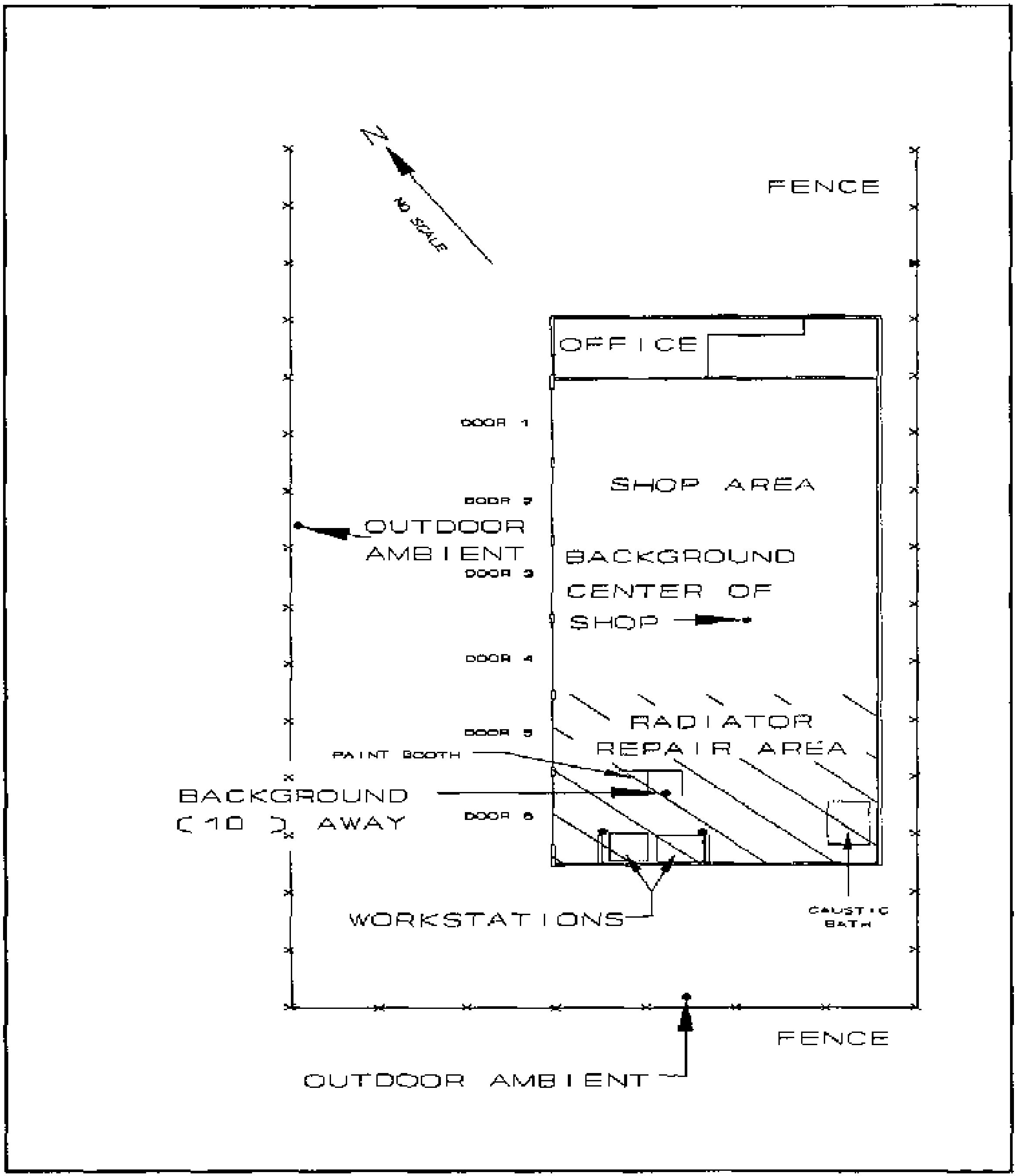

Figure 1. Layout of (35' x 95') building and location of area samples.

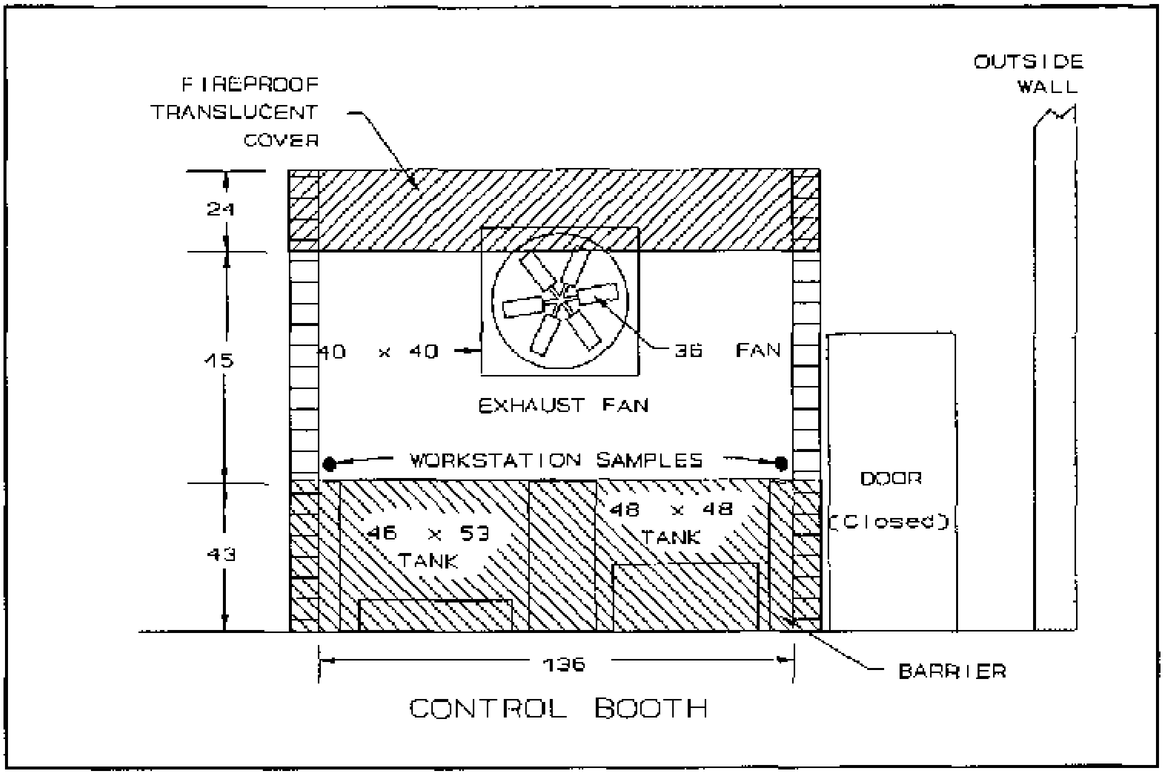

Figure 2. Front view of the ventilated booth.

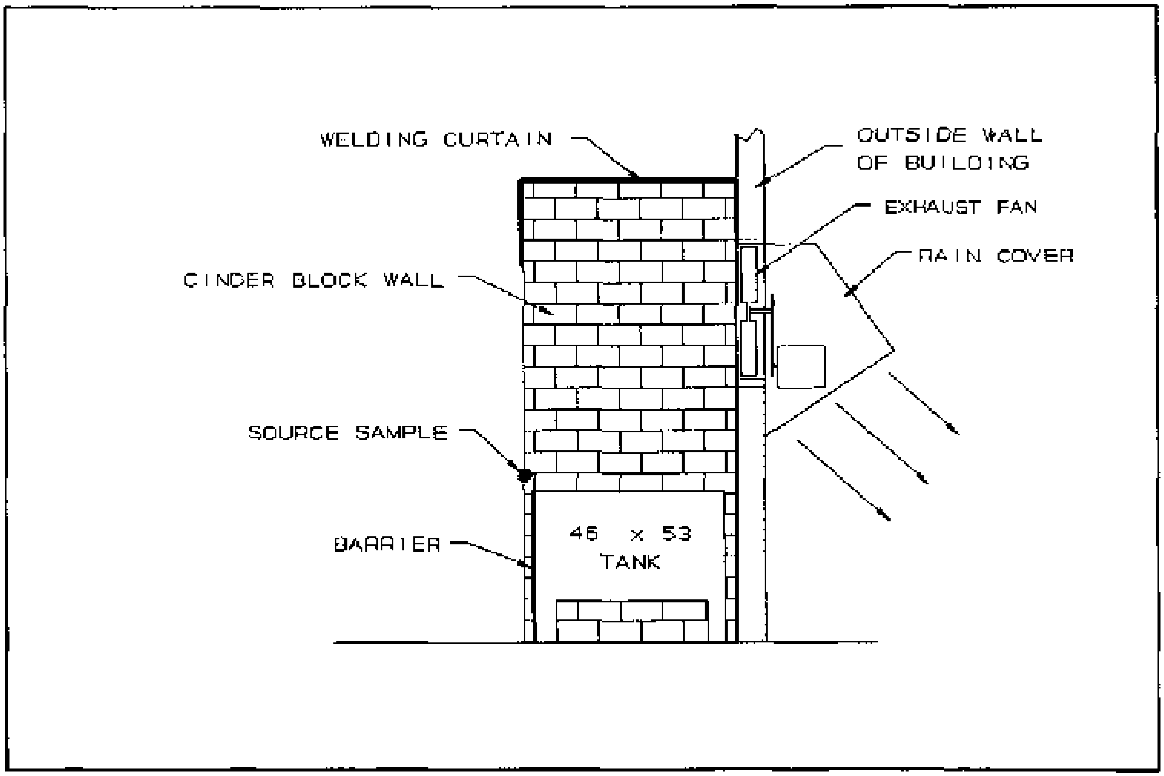

Figure 3. Side view of the ventilated booth.

checked for leaks (using pressurized water), flow restrictions, and overall integrity For minor repairs, the radiators are patched with 65-35 lead-tin (65% lead, 35% tin) solder The solder is melted with a gas torch For major repairs, the inlet and outlet tanks are separated from the core of the radiator by melting the old lead-based solder with a torch Leaks are patched and the tanks reattached to the core by soldering with 65-35 lead-tin solder The radiator is submerged in the water bath and pressurized with shop air to check for leaks Shop air is used to blow the water off and out of the radiator, and then a torch is used to dry the exterior of the radiator If needed, the radiator tanks are abrasive blasted with glass beads, before being painted black in a ventilated spray paint booth During the survey, the shop repaired 25 to 35 automobile and light truck radiators each day, of these, 15 to 20 required soldering

Rinse water and waste water from the tanks are discharged into the community sewer system Sludge from the caustic tank is sent to another Sims facility for disposal Antifreeze drained from the radiators is recycled Air is exhausted from the booth through the south wall into the outside air

VENTILATION SYSTEM

Prior to this study, this Sims facility used only general dilution ventilation consisting of a large exhaust fan located in the corner of the building Make-up air entered through one or more open garage doors (According to the shop staff, when the doors were shut during the colder months of December-February, fumes from the radiator repair operations usually became unpleasant within 30 minutes)

Description of Ventilated Booth

The two existing radiator repair benches, originally located near the center of the shop opposite Doors 5 and 6, were relocated by the owner against an outside wall A ventilated control booth enclosing the two workstations was then constructed by a contractor The booth measures 4 feet deep by 11 3 feet wide by 9 3 feet high Cement-block walls made from 8-inch cinder block form the sides, and a fireproof, translucent welding curtain formed the top of the booth and extended 2 feet down the front of the booth This resulted in an opening in the front of the booth 11 3 feet wide by 7 3 feet high that extends from the bottom of the welding curtain to the floor This opening in the front of the booth permits the mechanics to repair radiators within the enclosure The back of the booth was formed by the outside wall of the building (Figure 3) A 6-blade, 36-inch diameter axial belt-driven fan with a one-horsepower motor rated at 17,600 m^3/hr (10,200 cfm) of free air at 1/8 inch static pressure was installed in the outside wall The fan produced an average airflow of 1 3 m/sec (250 fpm) through the enclosure opening Air is exhausted from the booth directly to the outside, there are no air cleaning devices on the exhaust stream (During our survey, air samples for lead were taken outside near the exhaust to assess a possible increase in outdoor lead concentrations) ECTB provided guidance for the design and installation of this control

Booth Modification during the Survey

During the survey, NIOSH researchers modified the booth by placing a sheet of plastic across the bottom 3 6 feet of the front opening This reduced the height of the opening to 3 75 feet (decreasing the area of the opening by about 50%) and increased the face velocity through the opening by about 75 fpm (40%) to 260 fpm (During the survey, the effectiveness of the booth was tested under both conditions with the larger opening of 7 3 feet by 11 3 feet and the smaller opening of 3 75 feet by 11 3 feet)

The control booth was completed on July 16, 1990 The cost of the entire ventilation system was about $2,200 (1990 dollars), i e an average of $1,100 per workstation The total cost included the fan, motor, two high intensity lights ($250), welding curtain, building material (cinder block, cement, and sheet metal), and labor for construction of the booth and electrical installation

POTENTIAL HEALTH HAZARDS AND EVALUATION CRITERIA

The important routes of lead adsorption by man are inhalation and ingestion Man absorbs small amounts of lead in his food and from the air which normally does not cause poisoning Lead absorbed from occupational sources, such as soldering operations in radiator repair shops, are in addition to this "normal" body burden of lead [6]

HEALTH EFFECTS OF LEAD

Lead adversely affects a number of organs and systems The four major target organs and systems are the central nervous system, the peripheral nervous system, kidney, and hematopoietic (blood-forming) system [7] Inhalation or ingestion of inorganic lead has caused loss of appetite, metallic taste in the mouth, constipation, nausea, pallor, blue line on the gum, malaise, weakness, insomnia, headache, muscle and joint pains, nervous irritability, fine tremors, encephalopathy, and colic Lead exposure can result in a weakness in the muscles known as "wrist drop," anemia (due to lower red blood cell life and interference with the heme synthesis), proximal kidney tubule damage, and chronic kidney disease [6,8] Elevated blood pressure has been positively related to blood lead levels [9,10] Lead can concentrate in the soft tissue and bones, particularly in the liver and kidney, and elimination is slow Finally, exposure is associated with fetal damage in pregnant women [7,8]

EVALUATION CRITERIA

The occupational exposure criterion for inorganic lead is the current OSHA permissible exposure limit (PEL) of 50 $\mu g/m^3$, the OSHA action level for lead is 30 $\mu g/m^3$ [11] (These are 8-hour time-weighted averages (TWA))

METHODOLOGY

BACKGROUND

A NIOSH health hazard evaluation[5], conducted at Sims Radiator Shop in May 1989, showed excess blood lead levels and lead exposures up to four times the OSHA PEL of 50 $\mu g/m^3$ of lead. Three of the four mechanics repairing radiators had breathing zone lead levels exceeding the OSHA PEL. The highest concentration was 220 $\mu g/m^3$. Medical evaluation revealed an elevated blood level in one of the mechanics. In the spring of 1990, at the behest of the shop owner, DPSE/ECTB researchers provided recommendations for the design of a ventilation control system. The owner then followed up by designing a ventilation booth and hiring a contractor to build it. This ventilation control system was installed in July 1990.

AIR SAMPLING AND ANALYSIS

Three full-shift personal samples, 29 short-term personal samples and 27 area samples for airborne lead were collected. Short-term samples were collected over a 1 to 2 hour period, one sample for each major radiator repair operation or for several radiators undergoing minor or no repairs. ("Major repairs" involved extensive melting of solder to remove the inlet and outlet tanks from the core, to make repairs, and to reattach the tanks. "Minor repairs" involved the melting of a lesser amount of solder, primarily to patch small leaks. "No repairs" involved no soldering.) Four to six short-term personal samples were taken each day on each mechanic. All the airborne lead samples were collected on 37-mm diameter cellulose ester, 0.8-μm pore-size filters using SKC (model #224) pumps at 2.0 liters per minute (Lpm). Samples for lead were analyzed by inductively coupled plasma-atomic emission spectrometry (ICP) in accordance with NIOSH Method 7300.[12] The limit of detection (LOD) for lead was 2.0 μg/filter.

During the sampling survey, work practices and use of personal protective equipment were documented. Ventilation measurements were taken using a Kurz (model #1440) digital and a TSI (model #1650) analog hot-wire anemometers. Turbulent airflow was qualitatively evaluated with smoke tubes. The capacity and dimensions of the local exhaust ventilation system were also recorded.

RESULTS/DISCUSSION

PRINCIPLES OF CONTROL

Occupational exposures can be controlled by the application of a number of well-known principles including engineering measures, work practices, and personal protection. Engineering measures are the preferred and most effective means of control. These include material substitution, process and equipment modification, isolation or automation, and local and general ventilation. Control measures also may include good work practices and personal hygiene, housekeeping, administrative controls, and personal protective equipment such as respirators, gloves, and aprons. These principles all apply to the control of lead in radiator repair shops, but substitution and local exhaust ventilation appear to be the most realistic control approaches for reducing lead exposures in these shops In particular, affordable control methods are needed in small businesses such as radiator repair shops

LEAD AIR SAMPLING RESULTS

All individual sample results are shown in Table A-1, Appendix A

TWA Lead Exposures

TWA lead exposures obtained in the breathing zones of the two radiator repair mechanics are presented in Table 1[1] The overall average TWA lead exposure was 13 $\mu g/m^3$ or one-fourth the OSHA PEL of 50 $\mu g/m^3$ while using the ventilation control TWA lead exposures for worker "A" averaged 20 $\mu g/m^3$ and for worker "B" averaged 6 $\mu g/m^3$ During the first day of the survey, before the ventilated booth was modified by adding the plastic sheet along the bottom of the booth, the TWA lead exposures averaged 22 $\mu g/m^3$ For worker "A", the TWA lead level was 41 $\mu g/m^3$, approaching the OSHA PEL

On the first day of the survey the lead exposures for worker "B" were much lower than for worker "A" because worker "B" was not as busy as worker "A" More importantly, worker "B" (at the left workstation) was not adversely affected by eddies and turbulent airflow at the right side of the ventilation booth at worker "A's" workstation The eddies and turbulent airflow were quantitatively evaluated using the hot-air anemometer and qualitatively measured using smoke tubes

Table 1 Time-Weighted-Average (TWA) Exposures to Inorganic Lead

Worker	Work Station	TWA Lead Exposures in ($\mu g/m^3$)			Average ($\mu g/m^3$)
		7/17/90	7/18/90	7/19/90	
A	Right	41*	13	5	20
B	Left	3	8	8	6
Average		22	11	6	13
OSHA PEL			50 $\mu g/m^3$		
OSHA Action Level			30 $\mu g/m^3$		

* One outlier sample excluded

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[1] TWA lead exposures in Table 1 were calculated by integrating the short-term personal sample results (descriptive statistics for short-term sample results are shown in Table 2)

Closing off the bottom 3 6 feet of the booth increased the face velocity into the booth produced a more uniform face velocity and a reduction in airflow eddies and turbulence This resulted in a 78% reduction in the TWA lead exposure for worker "A" from 41 µg/m^3 on the July 17 to an average of 9 µg/m^3 for the July 18 and 19

Short-Term Personal Samples

Short-Term sampling results for airborne lead for the two radiator repair mechanics are presented in Table 2 Daily arithmetic mean lead concentrations ranged from 6 to 22 µg/m^3 for worker "A" (These data exclude one short-term sample which was shown by the Grubb's Test[13] to be an outlier The Grubb's test is a statistical test for identifying values that are outliers) For worker "B", daily arithmetic mean ranged from 3 to 10 µg/m^3 Daily geometric mean lead concentrations ranged from 5 to 13 µg/m^3 (worker "A") and 3 to 7 µg/m^3 (worker "B") The short-term samples averaged 76 minutes in duration

Table 2 Short-Term Lead Exposures for Radiator Repair Mechanics

Worker	Date	No of Samples	Avg Sample Duration (min)	Arith Mean (µg/m^3)	Geom Mean (µg/m^3)	Range (µg/m^3)
A	7/17	4	100	22	13	4-57
A	7/18	5	72	13	10	4-34
A	7/19	6	63	6	5	3-11
B	7/17	4	61	3	3	2-4
B	7/18	4	100	10	7	2-24
B	7/19	5	62	6	4	<3-17

OSHA PEL - 50 µg/m^3
OSHA Action Level - 30 µg/m^3

Before adding the plastic sheet along the bottom of the booth, the ventilation booth provided adequate control of lead fumes as demonstrated by the radiator mechanics' average lead exposure on 7/17/90 of 22 µg/m^3, about half the OSHA PEL of 50 µg/m^3 However, after the control was modified, the average short-term lead exposure was 8 µg/m^3 or less than one-sixth the OSHA PEL indicating that the ventilation booth provided excellent control of lead fumes Of 20 individual (short-term) personal samples taken on the two mechanics after the booth was modified, only one lead level exceeded 25 µg/m^3

Comparison to Lead Exposures from Earlier Studies

Sampling results for airborne lead from the 1989 NIOSH HHE at this shop are presented in Table 3 The TWA lead exposures for four radiator repairmen averaged 98 $\mu g/m^3$ and ranged from 30 to 220 $\mu g/m^3$ Three of the four personal samples exceeded the OSHA PEL for lead of 50 $\mu g/m^3$ and one was more than four times the OSHA PEL These high lead exposures were recorded during normal work activities When these exposures were measured, ventilation in the shop consisted of a large exhaust fan located in the corner of the building According to the NIOSH investigators, this fan did not provide adequate ventilation at the source of the lead fume generation [5]

Table 3 Lead Exposure Results from Previous (5/31/89) Survey[5]

Worker	Sampling Time (min)	Concentration ($\mu g/m^3$
1	455	220
2	413	90
3	435	50
4	255	30

In July 1990, after the local exhaust ventilation booth was installed, the average TWA lead exposures were reduced to 22 $\mu g/m^3$ (Table 1), an 81% reduction from the 1989 levels Following modification of this ventilated booth with the addition of the plastic sheet, the average TWA lead exposures for the radiator repair mechanics was further reduced to 8 $\mu g/m^3$, a 92% decrease from the 1989 levels The production levels during the HHE survey (before the booth was installed) and during this survey were similar

Statistical analysis of the TWA lead exposure data using a log-transformed pooled t-test showed that the reduction in lead levels between no-control and the control after modification (with the plastic sheet) was significant ($p<0\ 005$)

Area and Background Samples

Area and background (ambient) lead concentrations measured during our survey are shown in Table 4 Average lead concentrations at the edge of the water bath of the right workstation was 41 $\mu g/m^3$ On the first day of the survey, before the ventilated booth was modified, the area lead concentration at the right workstation was 84 $\mu g/m^3$ After the booth was modified, the average lead concentrations at this location decreased to 20 $\mu g/m^3$ This is further evidence that before the modification the LEV control did not properly draw the lead fume away from the soldering operation It appears the turbulence

Table 4   Area and Background Inorganic Lead Concentrations

Sample Location	No of Samples	Average Sample Duration (min)	Mean Concentration ($\mu g/m^3$)		Range ($\mu g/m^3$)
			Arith	Geom	
Right Workstation (before)[a]	2	269	84	50	16-151
Right Workstation (after)[a]	4	254	16	9	<3-40
Left Workstation (after)[a]	4	254	9	4	<2-22
Background (10' from Booth)	4	328	3	3	2-5
Background (Center of Shop)	4	318	1 0	1 0	<1-1 4
Office	3	430	2 3	2 3	1 7-2 8
Outdoor Ambient 26' from Exhaust Fan (South)	3	444	1 2	1 1	<1-2 0
Outdoor Ambient 75' from Exhaust Fan (West)	3	367	<1	<1	<1

[a] "Before" and "after" the ventilated booth was modified with the addition of the plastic sheet

from air flowing under the water baths was disrupting the movement of exhaust air and causing higher airborne lead levels at the right workstation, which in turn contributed to the higher lead exposures of worker "A" on the first day of the survey These results also show that the major reduction in the lead exposures for worker "A" was undoubtedly effected by the modification of the ventilation system (closing off the opening in front of the water baths) rather than from changes in the work practices of worker "A"

Lead concentration measured at the edge of the water bath for the left workstation after the booth was modified averaged 9 $\mu g/m^3$ (Samples were not collected in this area before the booth was modified) The area lead concentrations on the left side of the ventilated booth were about half the area lead levels on the right side Interestingly, area lead concentrations on the left side were the same as the personal lead exposures (Table 1)

Indoor (background) lead concentrations collected inside the shop, approximately 10 feet from the front opening of the ventilated booth, averaged 3 $\mu g/m^3$ while background lead levels in the center of the shop, about 40 feet from the ventilated booth, averaged less than 1 $\mu g/m^3$ These indoor ambient lead concentrations indicate little build-up of lead in the shop directly from soldering and that the potential for lead exposure among workers during operations other than radiator repair is almost nil A slightly higher lead concentration (3 $\mu g/m^3$) at the location 10 feet from the ventilated booth compared to 40 feet from the booth might be expected because radiator repair operations are the only source of lead emissions in the shop Lead levels in the office area averaged 2 $\mu g/m^3$

Outdoor ambient lead levels averaged less than 1 $\mu g/m^3$ Outdoor samples taken at a location south of the building, 26 feet from the discharge of the exhaust fan and in line with the exhaust airflow, averaged 1 $\mu g/m^3$ All the samples taken west of the building were below the LOD, which averaged 0 6 $\mu g/m^3$ These results indicate that lead exhausted from the shop had no material effect on the immediate environment and that the outdoor lead levels near the facility contributed little to the lead exposure of workers in the shop

Field Blank Results

The results of field blanks (Table A-1, Appendix A) analyzed for lead were below the LOD Therefore, no blank corrections were made to the analytical results of the lead samples

VENTILATION

Exhaust air volumes, average velocities at the face of the booth, and air velocities in the vertical plane 12 inches from the face of the booth, are presented in Table 5 Before the booth was modified with the addition of the plastic sheet, the average face velocity at the booth opening was 185 fpm

However, due to turbulent airflow individual face velocity readings varied from 0 to 250 fpm and air velocity readings near worker "A"s breathing zone approached 0 fpm After modifying the enclosure by blocking the airflow passing under the water baths and reducing the booth opening by nearly 40%, the face velocities were more uniform, varying from 200 fpm to 320 fpm, averaging 260 fpm Face velocities above 260 fpm reduced the heat from the torches making it more difficult to melt the solder Also, the flames from the torches not being used flickered and were almost blown out

In the vertical plane 12 inches from the opening of the booth, the average velocity after the booth was modified was 150 fpm and ranged from 110 to 175 fpm Cross-currents were minimal in the room and airflow was uniformly distributed into the hood Smoke tube tests showed the booth captured smoke up to 4 feet from the opening

With four (10 feet by 12 feet) garage doors open, approximately 9600 cfm of air at 20 fpm enters the building, resulting in good dilution ventilation throughout the building This is also more than adequate replacement air for the ventilation system

All the doors were briefly closed during the survey to assess the effect this might have on the performance of the ventilation system and simulate winter conditions when doors are normally closed With the doors closed the face velocity through the opening of the ventilated booth decreased by an average of 10 fpm, from 260 to 250 fpm. The total exhaust volume was reduced by less than 10% Because of leakage through openings in the roof and the walls,

Table 5 Ventilation Measurements for July 17-19, 1990

Six Garage Doors each (10' x 12')	Capture Velocity (fpm)		Exhaust Volume (cfm)
	At Face	12" from Face	
4 Doors Open[a]	185	-	8,900
4 Doors Open[b]	260	150	10,600
All Doors Closed[b]	250	-	10,200

a) Before modification of ventilation booth
b) After modification of ventilation booth

adequate replacement air to maintain the effectiveness of the ventilation with the present exhaust system would be provided with the doors closed

Paint Spray Booth

The total volume of air exhausted from the paint spray booth (3 7 feet wide by 5 feet high) was 2,750 cfm with an average face velocity of 150 fpm The booth is operated intermittently for a few minutes at a time There is visible leakage of paint mist from the front of the booth during spraying but xylol concentrations (measured using a Draeger tube) were less than 10 ppm during painting

WORK PRACTICES

The main source of lead exposure for the radiator repair mechanics is during the melting of old and new solder The primary strategy to minimize lead exposures is to keep the radiator between the mechanic's breathing zone and the ventilated booth during soldering Since each mechanic propped the radiator on a welded support at the front of the water bath, it was nearly impossible for him to stand between the source of the lead fumes and the exhaust air stream As long as the radiator was within 12 inches of the front of the booth, there was more than enough exhaust airflow to capture lead emissions

The bead blasting table was used infrequently to clean parts of the radiators Even though it was not enclosed, no visible dust was observed at this operation

Analysis of Individual Work Practices

Both mechanics kept the radiators between themselves and the booth and kept their breathing zone out of the visible smoke streams during soldering High personal lead concentrations for worker "A" on the first day of the survey were most likely due to turbulent airflow patterns caused by the ventilation system rather than poor work practices

PERSONAL PROTECTIVE EQUIPMENT, HYGIENE, AND MONITORING

New employees are given a two day training course on safe work practices Mechanics repairing radiators wear water-proof gloves and rubber soled safety boots No other personal protective equipment is required There is no separate lunchroom, but employees use the office area for meals Employees washed their hands before eating No food is allowed in the radiator repair area, however, one mechanic was observed smoking in this area

CONCLUSIONS AND RECOMMENDATIONS

1 The average TWA lead concentration prior to installing the LEV control was 98 $\mu g/m^3$ in 1989 (individual TWA lead levels were as high as 220 $\mu g/m^3$) for the radiator repair mechanics After the LEV control was installed, the average TWA lead concentration was 13 $\mu g/m^3$, an 87% reduction in lead exposures This indicates that the control booth was effective in controlling lead exposures during radiator repair operations

2 Before the ventilated booth was modified by blocking off the bottom 3 6 feet of the booth with a plastic sheet, reducing the opening by nearly 40%, TWA lead exposures averaged 19 $\mu g/m^3$ with one TWA lead exposure above the OSHA action level of 30 $\mu g/m^3$ However, after the ventilated booth was modified, TWA lead exposures averaged 8 $\mu g/m^3$

3 As a result of modifying the booth during the survey, airflow velocities increased, turbulent airflow on the right side became more uniform, and lead exposures for the radiator repair mechanic at the right workstation decreased an additional 78%

4 Based on the results of this evaluation, blocking the airflow under the water baths and maintaining a booth face velocity of 200 to 230 fpm is recommended This reduced airflow would require a smaller fan resulting in lower installation and operating costs

5 The ventilated booth should be effective even with the shop doors closed

6 Airflow velocities above 260 fpm reduced the heat from the torch making it more difficult to melt the solder Also, when the torches were hung up between soldering steps, the torch flames flickered and were almost blown out Because of this, booth face velocities should not exceed 250 fpm (Also, air blowing across workers at high velocities during the colder months may cause discomfort to the workers)

7 This affordable ventilation control system can be utilized by most radiator repair shops However, a considerable volume of air must be exhausted and heating of the make-up air in the winter months in cold

climates could be very expensive Therefore, this ventilation design is recommended for locales where winters are relatively mild

8 The face velocity across the front of the ventilated booth should be checked monthly This would identify irregular flows and areas of low capture velocities The face velocity into the exhaust hood can be determined quickly and relatively inexpensively using a velometer[14] A reliable velometer can be obtained for about $200

9 Training and reinforcement of good work practices and hygiene help to maintain reduced lead exposures Enforcement of no smoking in the radiator repair area is needed

10 Good personal hygiene practices such as washing hands before eating and changing from soiled work clothes before leaving work are encouraged

11 In the near future, lead-free solders may be a viable substituted for lead-containing solders and worth looking into

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APPENDIX A

TABLE A-1 INDIVIDUAL INORGANIC LEAD SAMPLE RESULTS FOR SIMS RADIATOR

DATE	SAMPLE NUMBER	TYPE	CODE	SAMPLE DESCRIPTION LOCATION	SAMPLE TIME (min)	SAMPLE VOLUME (liters)	LEAD DETECTION LIMIT	LEAD MASS (ug)	LEAD CONC (ug/m3)
7/17/90	122	PERS	A	RIGHT WORKSTATION	248	496		41	83 0
7/17/90	116	PERS	A	RIGHT WORKSTATION	257	514		15	29 2
7/17/90	141	PERS ST	A	RIGHT WORKSTATION	70	245		1 0	4 1
7/17/90	136	PERS ST	A	RIGHT WORKSTATION	70	245		74	302 0
7/17/90	107	PERS ST	A	RIGHT WORKSTATION	108	378		7	18 3
7/17/90	139	PERS ST	A	RIGHT WORKSTATION	90	315		2 2	7 0
7/17/90	165	PERS ST	A	RIGHT WORKSTATION	135	476		27	56 7
7/17/90	137	PERS ST	B	LEFT WORKSTATION	58	203		0 5	2 6
7/17/90	121	PERS ST	B	LEFT WORKSTATION	65	228		1 0	4 4
7/17/90	103	PERS ST	B	LEFT WORKSTATION	47	165	ND	<0 5	<3
7/17/90	130	PERS ST	B	LEFT WORKSTATION	75	263		1 0	3 8
7/17/90	105	AREA		RIGHT WORKSTATION	172	344		52	151 2
7/17/90	140	AREA		RIGHT WORKSTATION	366	732		12	16 4
7/17/90	111	AREA		BACKGROUND (10)	183	366		1 0	2 7
7/17/90	104	AREA		BACKGROUND (10')	372	744		1 8	2 4
7/17/90	120	AREA		BACKGROUND (CENTER)	183	366	ND	<0 5	<1
7/17/90	123	AREA		BACKGROUND (CENTER)	339	678	ND	<0 5	<1
7/17/90	118	AREA		OFFICE	515	1030		1 8	1 7
7/17/90	102	AREA		SOUTH OF BUILDING	530	1060		1 0	0 9
7/17/90	117	AREA		WEST OF BUILDING	314	1099	ND	<0 5	<1
7/18/90	195	PERS ST	A	RIGHT WORKSTATION	88	308		2 2	7 1
7/18/90	164	PERS ST	A	RIGHT WORKSTATION	54	189		1 6	8 5
7/18/90	114	PERS ST	A	RIGHT WORKSTATION	76	266		9	34 2
7/18/90	175	PERS ST	A	RIGHT WORKSTATION	74	259		3	9 7
7/18/90	134	PERS ST	A	RIGHT WORKSTATION	68	238		1 0	4 2
7/18/90	197	PERS	B	LEFT WORKSTATION	225	450		4	8 2
7/18/90	157	PERS	B	LEFT WORKSTATION	204	408		3	8 1
7/18/90	174	PERS ST	B	LEFT WORKSTATION	80	280		7	23 6
7/18/90	142	PERS ST	B	LEFT WORKSTATION	118	413		1 9	4 6
7/18/90	131	PERS ST	B	LEFT WORKSTATION	89	312		3	6 0
7/18/90	163	PERS ST	B	LEFT WORKSTATION	116	406		1 0	2 5
7/18/90	181	AREA		RIGHT WORKSTATION	464	928		16	17 2
7/18/90	153	AREA		RIGHT WORKSTATION	199	398		16	40 2
7/18/90	209	AREA		LEFT WORKSTATION	458	916		10	10 9
7/18/90	159	AREA		LEFT WORKSTATION	201	402		4	9 7
7/18/90	177	AREA		BACKGROUND (10)	434	955		5	5 5
7/18/90	208	AREA		BACKGROUND (CENTER)	432	864		1 0	1 2
7/18/90	173	AREA		OFFICE	431	862		2 1	2 4
7/18/90	182	AREA		SOUTH OF BUILDING	444	888		1 8	2 0
7/18/90	201	AREA		WEST OF BUILDING	433	866	ND	<0 5	<1
7/19/90	172	PERS ST	A	RIGHT WORKSTATION	55	193		1 8	9 4
7/19/90	206	PERS ST	A	RIGHT WORKSTATION	45	158		1 8	11 4
7/19/90	187	PERS ST	A	RIGHT WORKSTATION	75	263		0 7	2 7
7/19/90	224	PERS ST	A	RIGHT WORKSTATION	59	207		0 8	3 9
7/19/90	203	PERS ST	A	RIGHT WORKSTATION	58	203		0 8	3 9
7/19/90	154	PERS ST	A	RIGHT WORKSTATION	88	308		1 0	3 2
7/19/90	170	PERS	B	LEFT WORKSTATION	174	348		1 8	5
7/19/90	213	PERS	B	LEFT WORKSTATION	139	278		3	11 9
7/19/90	194	PERS ST	B	LEFT WORKSTATION	68	238		1 6	6 7
7/19/90	188	PERS ST	B	LEFT WORKSTATION	55	193	ND	<0 5	<3
7/19/90	202	PERS ST	B	LEFT WORKSTATION	47	165	ND	<0 5	<3
7/19/90	138	PERS ST	B	LEFT WORKSTATION	76	266		0 8	3 0
7/19/90	200	PERS ST	B	LEFT WORKSTATION	63	221		4	18 1
7/19/90	181	AREA		RIGHT WORKSTATION	178	356		1 0	2 8
7/19/90	189	AREA		RIGHT WORKSTATION	176	352		1 0	2 8

TABLE A-1 INDIVIDUAL INORGANIC LEAD SAMPLE RESULTS FOR SIMS RADIATOR

DATE	SAMPLE NUMBER	TYPE	CODE	SAMPLE DESCRIPTION LOCATION	SAMPLE TIME (min)	SAMPLE VOLUME (liters)	LEAD DETECTION LIMIT	LEAD MASS (ug)	LEAD CONC (ug/m3)
7/19/90	178	AREA		LEFT WORKSTATION	178	356	ND	<0 5	<1 4
7/19/90	219	AREA		LEFT WORKSTATION	179	358		<0 5	<1 4
7/19/90	204	AREA		BACKGROUND (10)	322	644		1 6	2 5
7/19/90	179	AREA		BACKGROUND (CENTER)	319	638	ND	<0 5	<0 8
7/19/90	176	AREA		OFFICE	344	688		1 9	2 8
7/19/90	183	AREA		WEST OF BUILDING	337	674	ND	<0 5	<0 7
7/19/90	221	AREA		SOUTH OF BUILDING	331	666	ND	<0 5	<0 7
7/17/90	126	BLANK				0	ND	<0 5	
7/17/90	108	BLANK				0	ND	<0 5	
7/17/90	143	BLANK				0	ND	<0 5	
7/18/90	180	BLANK				0	ND	<0 5	
7/18/90	193	BLANK				0	ND	<0 5	
7/19/90	222	BLANK				0	ND	<0 5	
7/19/90	186	BLANK				0	ND	<0 5	
7/19/90	149	BLANK				0	ND	<0 5	

ND – NOT DETECTED