IN-DEPTH SURVEY REPORT

CONTROL TECHNOLOGY FOR SMALL BUSINESS

EVALUATION OF FLEXIBLE DUCT-LARGE HOOD VENTILATION FOR RADIATOR REPAIR

AT

Hensley's Radiator Service, Inc
Charlottesville, Virginia

REPORT WRITTEN BY
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SIC CODE	7539
SURVEY DATE	September 5-6, 1990
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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 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 State occupational health programs have identified radiator repair shops as a high-risk small business In 1988, 83 cases of elevated blood lead levels in automotive repair workers were reported by seven state health departments (California, Colorado, Maryland, New Jersey, New York, Texas, Wisconsin), and within the automotive repair industry (SIC 7359) the primary cause of lead exposure was from radiator repair work (unpublished data, NIOSH, 1990) Along with many cases of high blood lead levels, airborne lead levels as high as 500 $\mu g/m^3$, 10 times the OSHA Permissible Exposure Limit (PEL) of 50 $\mu g/m^3$, have been reported in some of these shops [1-2] Radiator repair shops in the United States employ an estimated 40,000 workers These shops are generally small, employing an average of four workers each [3-4] Practical and proven engineering control solutions in this industry do not appear in the literature

Typically, engineering controls in these radiator repair shops consist of propeller fans in the building walls or roof for general ventilation or electrostatic precipitators suspended from the ceiling to remove particulate from the air [5] Both methods are ineffective in reducing worker lead exposures to below the OSHA PEL To meet the need for cost-effective engineering controls in radiator repair shops, NIOSH researchers have been conducting a control technology research study of radiator shops since 1989 This research study has as its goal to provide control technology information for the prevention of disease from exposure to lead during radiator repair

This report describes a control technique that researchers at NIOSH have demonstrated to be effective in controlling lead exposures in radiator repair shops Air sampling results from an earlier compliance inspection by the Virginia Occupational Safety and Health Department (VOSH) indicated that this control system, consisting of a canopy-shaped exhaust hood connected to a flexible duct, reduced lead exposures to levels well below the OSHA PEL However, because the compliance inspection involved only limited lead air sampling, NIOSH researchers concluded that a follow-up sampling survey was needed to confirm the effectiveness of the control technique

The objective of this plant study was to evaluate and document the effectiveness of the control system in reducing exposure to airborne lead during radiator repair operations This 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 PEL for lead Also, a VOSH compliance inspector collected personal samples for lead prior to installation of the control system at this shop The availability of these data permitted further documentation about the effectiveness of the control by determining the reduction in lead exposure based on "before" and "after" results A final aim of this plant evaluation was to assess the effectiveness of the local exhaust ventilation (LEV) control system during the peak season (summer) for radiator repair

The report from this in-depth survey 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

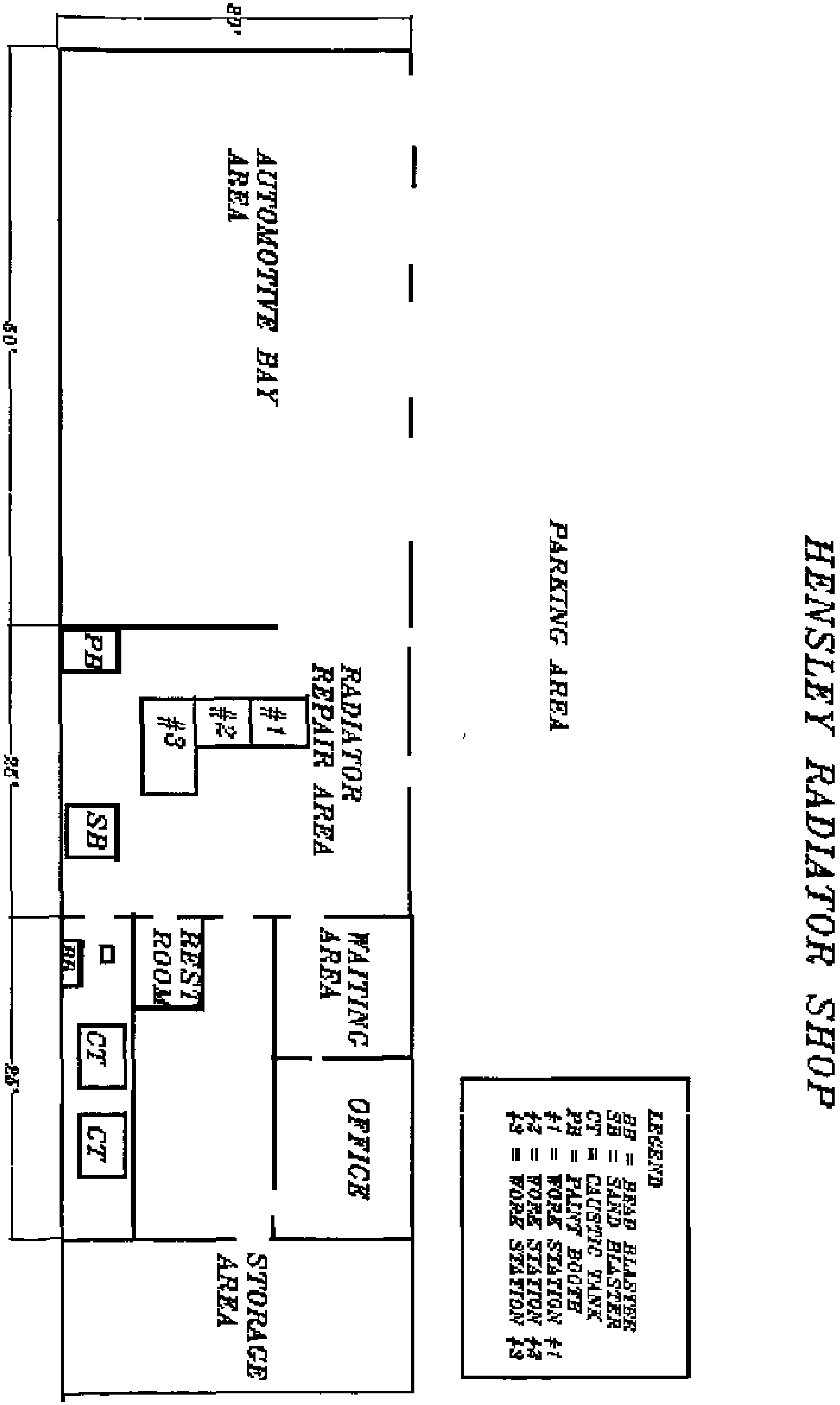
PLANT AND PROCESS DESCRIPTION

FACILITY DESCRIPTION

Hensley Radiator has been in operation since 1957 and has operated at the present location since 1973 The shop repairs automobile gas tanks, heaters, and water pumps, however, the majority of business is radiator repair The shop repairs radiators from both automobiles and small trucks The floor plan of the 4,500-square foot building is shown in Figure 1 The building includes four drive-in bays for automobiles and small trucks, a radiator repair area, office, and a storage room At the time of our study, 8 workers (6 production and 2 office workers) were employed at this facility According to the shop manager, this is the largest radiator repair shop within 60 miles

Each of the shop's three radiator repair stations includes a water bath, a work table (or bench), and two compressed air/natural gas torches for burning and soldering The two torches have different tip sizes the torch with the

Figure 1


BUILDING LAYOUT
HENSLEY RADIATOR SHOP
80'
40'
25'
25'
AUTOMOTIVE BAY AREA
PARKING AREA
RADIATOR REPAIR AREA
PB
#1
#2
#3
SB
BB
REST ROOM
WAITING AREA
OFFICE
CT
CT
STORAGE AREA
LEGEND
BB = BEAD BLASTER
SB = SAND BLASTER
CT = CAUSTIC TANK
PB = PAINT BOOTH
#1 = WORK STATION #1
#2 = WORK STATION #2
#3 = WORK STATION #3

larger 1-inch diameter tip burns much hotter than the torch with the smaller tip which is used for delicate work The shop also contains two caustic cleaning vats, an enclosed sand blaster with gloves for manipulating parts, and a glass bead blaster The sand blaster is used primarily for cleaning radiator headers and the glass bead blaster is used for tanks and other large radiator parts A combination cleaning and paint booth has waterfall downdraft local exhaust ventilation operated from a one-third horsepower motor The booth opening was 4 feet high by 2 8 feet wide

On average, between 8 and 10 radiators are repaired each day, however, during the peak season, predominately the summer months, up to 15 radiators are repaired per day

PROCESS DESCRIPTION

Radiators are pulled from the car or truck or brought to the shop The radiator is cleaned in one of two vats containing a caustic solution and then flushed out with water in the combination cleaning and paint booth Next, the radiator is immersed in a water bath containing green dye, pressurized with air and checked for leaks and overall integrity For minor repairs, radiators are patched with 40-60 tin-lead solder For big jobs, the top and bottom (or side) tanks are separated from the radiator core by melting the lead-based solder with a compressed air/natural gas torch The leaks are patched with 40-60 tin-lead solder and the tanks are reattached to the core by soldering with tin-lead solder A zinc chloride flux is used to prepare the radiator surface for soldering application All burning or soldering is done by the mechanic on the bench next to the water tank Finally, the radiator is placed in the water bath and checked for leaks, if it passes the final leak test, it is painted black in the combination cleaning/spray paint booth This shop occasionally repairs plastic radiators, which does not require soldering with lead

The workers' major source of exposure during radiator repair operations is the lead fumes generated during burning and soldering

VENTILATION SYSTEM

Each of the three radiator repair stations is equipped with local exhaust ventilation (LEV) consisting of a canopy-shaped exhaust hood connected to an 8-inch diameter flexible duct that permits the hood to be moved directly to the work and source of lead fume generation The canopy-shaped exhaust hood at workstation #1 is shown in Figures 2 and 3 The hood is made of fire-retardant fiberglass The 24- by 36-inch opening of the canopy-shaped hood, which is at a 45° angle to the work bench, is large enough so that most size radiators fit inside the hood The hood slides up and down on a vertical carriage over a 4-foot maximum range In addition, the hood is equipped with extension arms that allow it to turn in an arc or move 2 feet in the horizontal plane The hood is counterbalanced so it can be moved close to the work or up and out of the way of the work with little physical effort

Figure 2

Ventilation hood and workstation for radiator repair

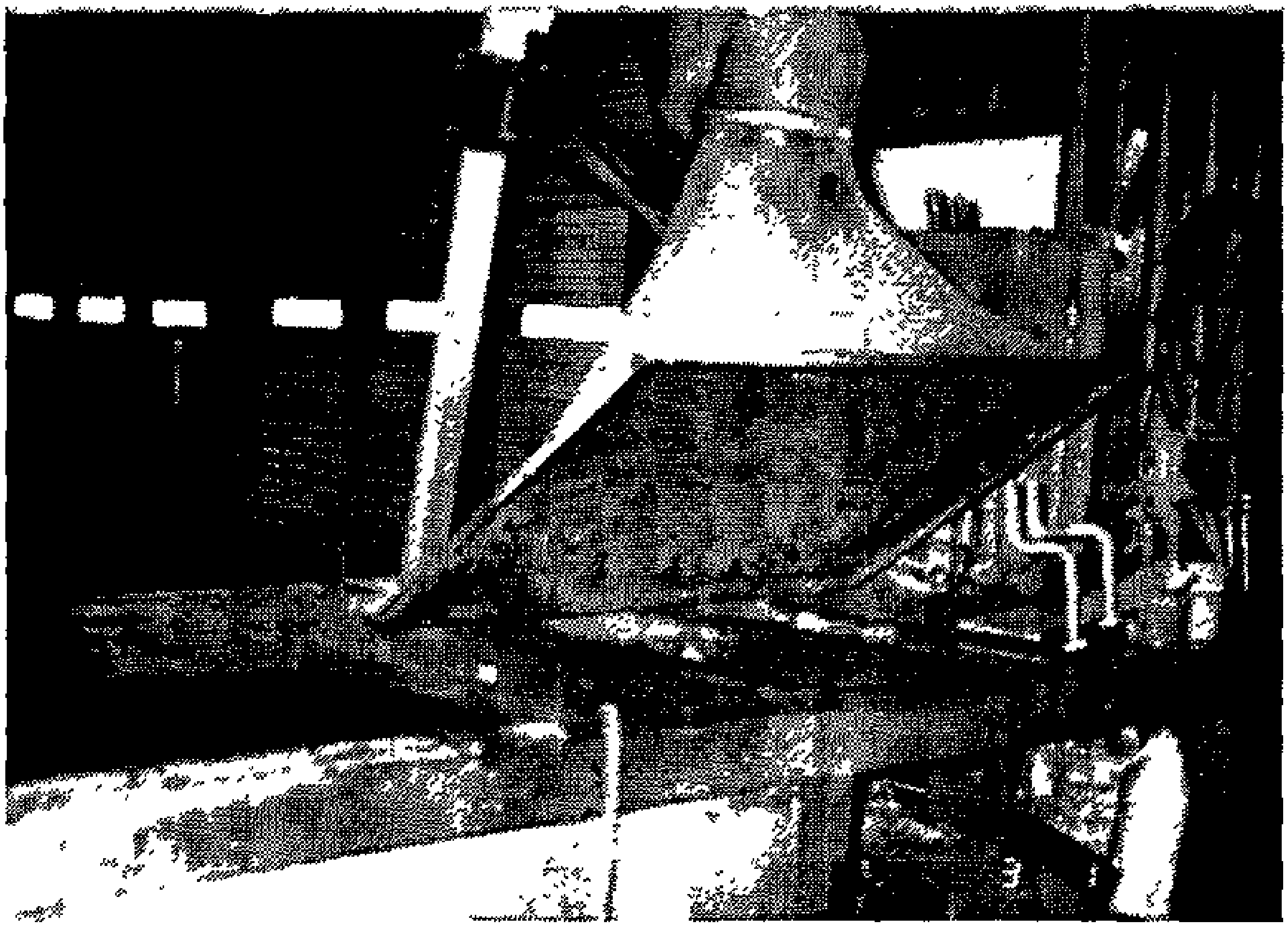
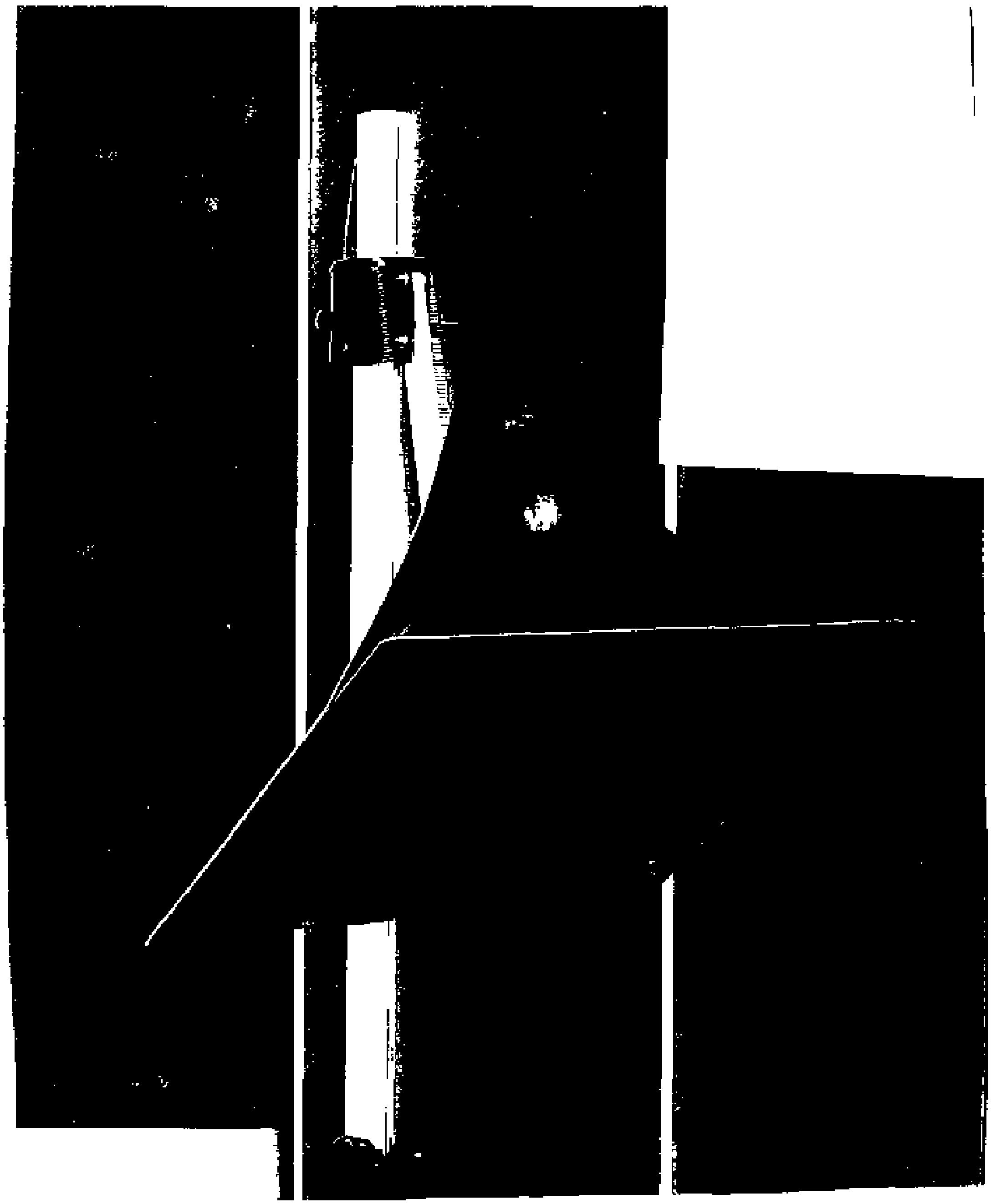


Figure 3

Canopy-shaped hood and vertical carriage to ventilation control
(Courtesy, United Air Specialists, used with permission)



Fumes from soldering and burning are drawn into the hood through a flexible duct to a plenum that connects directly to a Smokeeter® electronic ionizer air cleaner that is hung from the ceiling One electronic air cleaner serves workstations #1 and #2 and a second one serves workstation #3 The air cleaner unit includes a belt-driven squirrel cage fan with a 1725 RPM, 1/2 HP motor The air cleaner has a warning light to indicate when the ionizer is not ready We observed the exhaust hood and the flexible ducts to the LEV control were in very good condition after more than 3 years of operation The average cost per workstation for the control system consisting of the exhaust hood, flexible duct, extension arms, and vertical carriage, but excluding the electronic ionizer air cleaner, was $900 (1987 dollars)

Before installation of the canopy-shaped hood LEV control in February 1987, some ventilation was provided in the shop by several electronic air cleaners hung from the ceiling above the workstations [6] However, ventilation measurements taken by the VOSH industrial hygienist showed air velocities in the mechanic's breathing zone of only 25 to 50 feet per minute (fpm) Since these air cleaning units were 4 or more feet from the workers breathing zone, air velocities measured in the worker's breathing zone were more likely due to general room air currents than from ventilation provided by the electronic air cleaners

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 [7]

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 [8] Inhalation or ingestion of inorganic lead can cause 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 [7,9] Lead exposure is associated with fetal damage in pregnant women [8,9] Lastly, elevated blood pressure has been positively related to blood lead levels [10,11]

EVALUATION CRITERIA

The occupational exposure criterion for inorganic lead in air is the current OSHA permissible exposure limit (PEL) of 50 $\mu g/m^3$, the OSHA action level is 30 $\mu g/m^3$ [12] In addition, workers with blood lead concentrations higher than 60 micrograms per deciliter ($\mu g/dl$) of whole blood must be immediately removed from the work environment In cases where the blood lead concentration exceeds 40 $\mu g/dl$, blood leads and protoporphyrin levels must be monitored every 2 months The occupational exposure criteria for carbon monoxide are the OSHA PEL of 50 ppm and the NIOSH REL of 35 ppm [13,14]

EXPOSURES TO AIRBORNE LEAD

Many cases of overexposure to lead during radiator repair activity (in addition to those previously cited) are documented in the literature Goldman et al ,[5] investigated 27 radiator repair shops in the Boston area in the mid-1980's The shops were poorly ventilated and workers often ate and smoked in the work area, there were one to four radiator repair benches per shop The primary source of lead exposure came from inhalation of lead fumes during soldering and burning Blood leads were drawn from 56 radiator repair mechanics 80% of the mechanics had blood lead levels above 30 $\mu g/dl$, 39% were above 40 $\mu g/dl$, and 7% were above 60 $\mu g/dl$ This contrasts with the results from the Second National Health and Nutrition Evaluation Survey, where only 6% of male workers with potential occupational lead exposure had blood lead concentrations above 30 $\mu g/dl$ [5]

Researchers at the Minnesota Health Department[1] surveyed 30 radiator repair shops in the Minneapolis-St Paul area and obtained blood leads from 53 workers 32% of the mechanics had blood lead levels above 40 $\mu g/dl$ Personal air samples for lead, collected at 16 of these shops, showed the average lead exposure to be 113 $\mu g/m^3$, more than twice the OSHA PEL The shops in the Minnesota study were small, with an average of two radiator repair mechanics per shop, few shops had local exhaust ventilation

In addition, NIOSH Health Hazard Evaluation reports for radiator shops[2,15-21] describe excess air and blood lead concentrations and recommend improved control technology for radiator repair shops

Air sampling results contained in reports[15,16,22] of surveys at radiator repair shops show that concentrations of hazardous substances, other than for lead, were below their respective OSHA PELs

Radiator repair mechanics can also ingest lead on the job Exposure by this route can be controlled by good personal hygiene such as not eating, drinking, smoking, or chewing tobacco in the radiator repair area and hand washing before eating or smoking

METHODOLOGY

As part of the Virginia State-initiated special emphasis program to reduce occupational exposures to lead in radiator repair shops, a VOSH industrial hygienist conducted environmental evaluations at Hensley Radiator in November 1986 and January 1987 Personal sampling data collected by VOSH during the evaluations at this shop showed time-weighted average (TWA) lead exposures[6] for workers as high as 193 $\mu g/m^3$, i e , four times the OSHA PEL for lead, despite the use of electronic air cleaning devices hung from the ceiling above the workstations

After consultation with the Smokeeter® representative, the shop owner had the existing electronic air cleaning devices modified by adding a flexible duct and a canopy-shaped hood to control lead emissions at the source Subsequent personal sampling at the shop by the VOSH industrial hygienist showed that the modified ventilation system greatly reduced lead exposures However, because the VOSH sampling results were for only one day, NIOSH researchers concluded that further sampling should be conducted during the busy season to confirm the performance and effectiveness of the modified ventilation control system

AIR SAMPLING AND ANALYSIS

Personal and area samples for lead were collected on 37-mm diameter cellulose ester, 0 8-μm pore size filters using SKC (model #224) pumps at 2 0 to 3 5 liters per minute (Lpm) Pump flow rates were checked every 2 hours using a mini-Buck calibrator Samples were analyzed for lead by graphite furnace atomic absorption spectroscopy using NIOSH Method 7105 [23] The limit of detection (LOD) for lead was 0 02 μg/filter

Both full-shift samples and short-term samples for the duration of a single radiator repair operation (one to two hours) were performed Personal breathing zone samples were taken on one mechanic repairing radiators full time and on a second mechanic who repaired automobile water pumps and performed other tasks, but did no lead soldering or burning In addition, indoor background samples for lead were taken in the shop at locations away from radiator repair operations and in the shop office, outdoor ambient samples were collected at two locations on opposite sides of the building within 5 feet of the building

Area samples for carbon monoxide were taken using Draeger indicator tubes

Ventilation measurements were made using the Kurz (model #1440-4) digital and the TSI (model #1650) analog hot-wire anemometers A smoke tube was used to qualitatively evaluate air movement in front of and in the enclosure The capacity and dimensions of the local exhaust ventilation control were obtained

During the sampling survey, work practices and use of personal protective equipment were documented Personal hygiene practices, such as furnishing clean uniforms, were also observed and documented

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 the appendices to this report

Short-Term Personal Samples

Short-term sample exposures for lead obtained in the breathing zone of the principal radiator repair mechanic are presented in Table 1 This worker performs the majority of radiator repair work for this shop and performed all radiator repair work during our survey Sample time, sample duration, which ranged from 67 to 125 minutes, and the level of radiator repair activity associated with each short-term personal sample are shown in Table 1 The level of repair activity is categorized as light, moderate, or heavy Light repairs included patching leaks without removing the radiator tanks, heavy activity consisted of burning and melting old solder to remove the radiator tanks, reattaching the tanks with solder, and patching leaks, and moderate activity represents repair work that falls between light and heavy activity

The overall arithmetic mean lead concentration for the short-term samples in Table 1 was 19 $\mu g/m^3$, and the geometric mean lead concentration was 11 $\mu g/m^3$ The arithmetic mean lead exposure for the radiator mechanic was 29 and 8 6 $\mu g/m^3$ on the first and second days of the survey, respectively

Analyses of the short-term lead exposures from our survey reveal a bi-modal distribution with a large difference between the two levels of lead exposure One group includes two high exposures of 56 and 59 $\mu g/m^3$ and the other group includes all the other short-term sample exposures ranging from 3 to 22 $\mu g/m^3$ These results are displayed graphically in Figure 4 Three factors, when taken together, appear to explain the major difference between the two levels of lead exposures First, at the start of our survey, particularly during the first day, the radiator mechanic used a wire brush to clean lead solder from the header This not only generated a large amount of lead dust, but caused the worker to lean over the header and place his face and breathing zone right in the dust plume The mechanic ceased brushing off the headers toward the end of the first day, and did no wire brushing during the second day of the survey Instead, he cleaned the header by blowing the lead containing dust into the exhaust hood with compressed air Wire brushing of the header coincided with the two highest lead exposures above 50 $\mu g/m^3$, but was not done on the second day of the survey when lead exposures averaged 8 6 $\mu g/m^3$ This implicates the use of the wire brushing as a primary source of lead exposure and points out that wire brushing of any lead contaminated parts should be avoided (We were unable to determine with certainty whether the wire brush was used to clean the header during the last two sample periods of the first day)

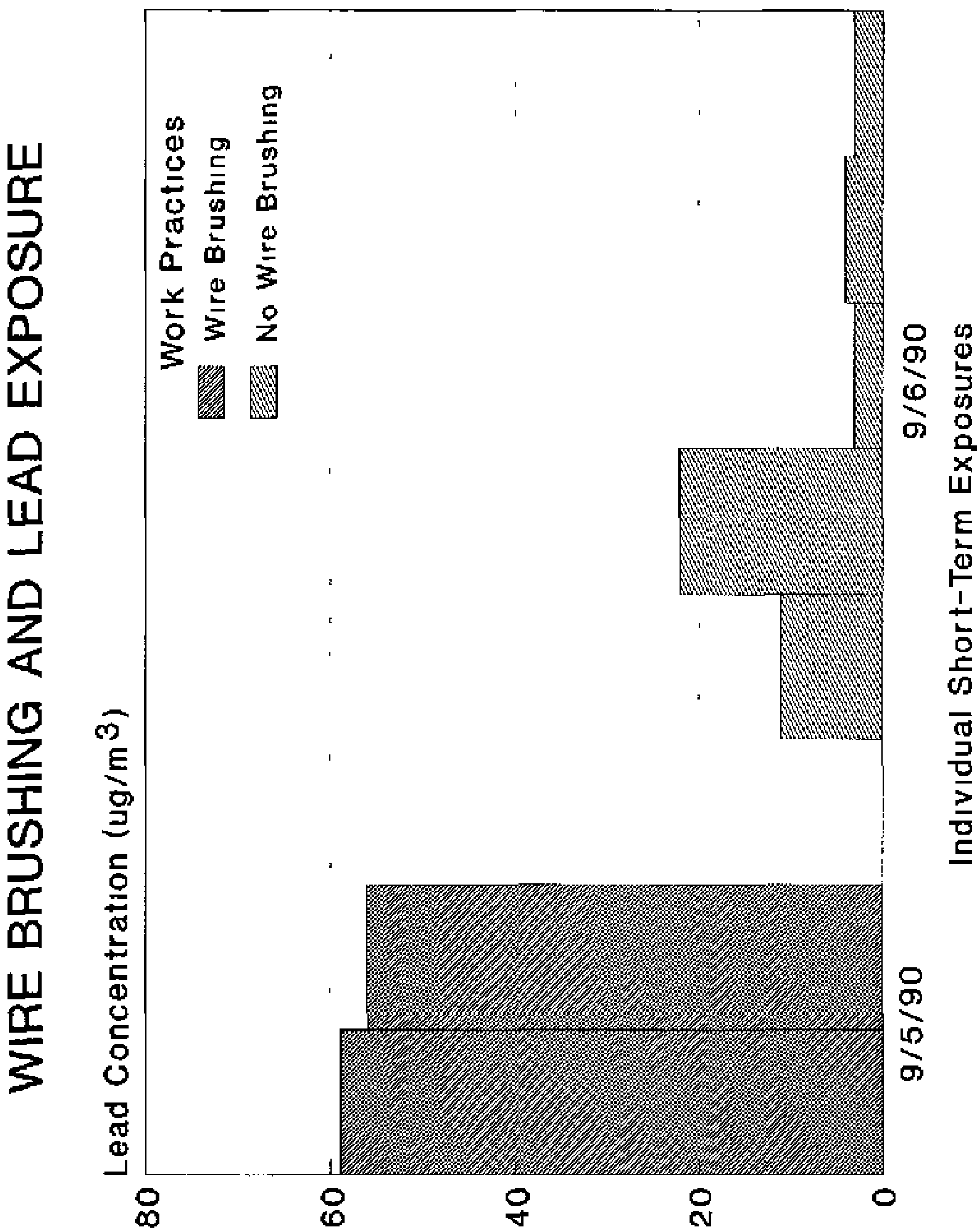
Table 1
Short-term Inorganic Lead Exposures
for Radiator Repair Mechanic

Date	Sample Period Start Time	Sample Duration (min)	Level of Radiator Repair Activity	Lead Concentration ($\mu g/m^3$)
9/5/90	7 49	67	heavy	59
	8 56	125	light	8
	11 01	92	heavy	56
	12 33	94	heavy	10
	14 52	94	moderate	11
9/6/90	7 36	78	heavy	11
	8 55	100	heavy	22
	10 35	100	heavy	3
	12 15	97	moderate	4
	14 53	79	moderate	3
OSHA PEL		50 $\mu g/m^3$		
OSHA Action Level		30 $\mu g/m^3$		

The second factor associated with higher lead exposures is the level of radiator repair activity (Table 1) the three highest short-term lead exposures were measured during heavy radiator repair activity On the other hand, heavy repair activity on the second day did not cause high exposures as illustrated by short-term lead exposures as low as 3 $\mu g/m^3$ during heavy repair activity

Third, the face velocity of the exhaust hood at workstation #1 increased from 75 to 100 feet per minute (fpm), after the mechanic cleaned out the collectors to the electronic ionizer The collectors were cleaned at 9 00 a m on 9/5 While only one short-term personal sample was collected at a face velocity of 75 fpm, this sample showed the highest lead exposure for any sample (59 $\mu g/m^3$) After the face velocity was increased to 100 fpm only one of the short-term personal samples for lead was above 22 $\mu g/m^3$ In summary, if wire brushing is avoided and a face velocity of 100 fpm into the exhaust hood is

Figure 4


WIRE BRUSHING AND LEAD EXPOSURE
Lead Concentration (ug/m3)
80
60
40
20
0
Work Practices
Wire Brushing
No Wire Brushing
9/5/90
9/6/90
Individual Short-Term Exposures

maintained, short-term lead exposures should be controlled below the OSHA action level of 30 $\mu g/m^3$, even during heavy radiator repair activity

TWA Lead Exposures

TWA inorganic lead exposures shown in Table 2† were 25 $\mu g/m^3$ or half the OSHA PEL on the first day of the survey, and 8 8 $\mu g/m^3$ or about one-sixth the OSHA PEL on the second day The TWA lead exposures also were below the OSHA action level while using the ventilation control The OSHA PEL for inorganic lead is 50 $\mu g/m^3$ and the OSHA action level (requiring medical surveillance and environmental monitoring to be instituted) is 30 $\mu g/m^3$ (TWA exposures represent the worker's exposure for the entire shift of 7+ hours)

Table 2 Time-weighted Average Lead Concentrations

Worker	Operation	Date	Sample Time (min)	Lead Concentration ($\mu g/m^3$)
A	Radiator Repair	9/05/90	472	25
B	Shop Mechanic	9/05/90	422	3 8
A	Radiator Repair	9/06/90	454	8 8
A	Radiator Repair	3/12/87	420	<1 0*
OSHA PEL		50 $\mu g/m^3$		
OSHA Action Level		30 $\mu g/m^3$		

* TWA personal sample collected by VOSH following installation of the canopy-shaped exhaust hood

A personal sample collected by the VOSH industrial hygienist in 1987 after the ventilation control was installed showed a TWA lead exposure of less than 1 $\mu g/m^3$ (Table 2) This sample was collected on the same radiator repair mechanic we sampled Thus, the average TWA lead exposure from the VOSH survey and our survey was 12 $\mu g/m^3$

The TWA lead exposure for a shop mechanic servicing automobiles but not soldering radiators was 3 8 $\mu g/m^3$ This mechanic worked occasionally in the radiator repair area, but spent the majority of his time in the automobile service bays This result indicates almost no migration of lead from the radiator repair operation into the other areas of the shop

† The TWA lead exposures in Table 2 and the short-term lead exposures sample in Table 1 were calculated from the same measurements

Comparison With Lead Exposures Before Installation of Control

Personal sampling data, collected by the Virginia Occupational Safety and Health Department *before* the canopy-shaped exhaust hoods were installed showed TWA lead exposures for workers as high as 193 $\mu g/m^3$.[6] VOSH conducted two separate evaluations at this shop before the exhaust hoods were installed. During the first survey on November 6, 1986, the TWA lead exposure was 50 $\mu g/m^3$ for the principal radiator repair mechanic. On the second survey, January 6, 1987, the principal radiator repair mechanic had a TWA lead exposure of 193 $\mu g/m^3$. TWA lead exposures from before and after installation of the ventilation control are compared in Figure 5 for the busiest radiator repair mechanic on that day. Overall, use of the ventilation control reduced lead exposures by 90%. (Radiator repair activity by the other mechanics was highly variable so that comparing their lead exposures from survey to survey is not meaningful.) No major process changes have taken place at Hensley Radiator since the initial survey in November of 1986.

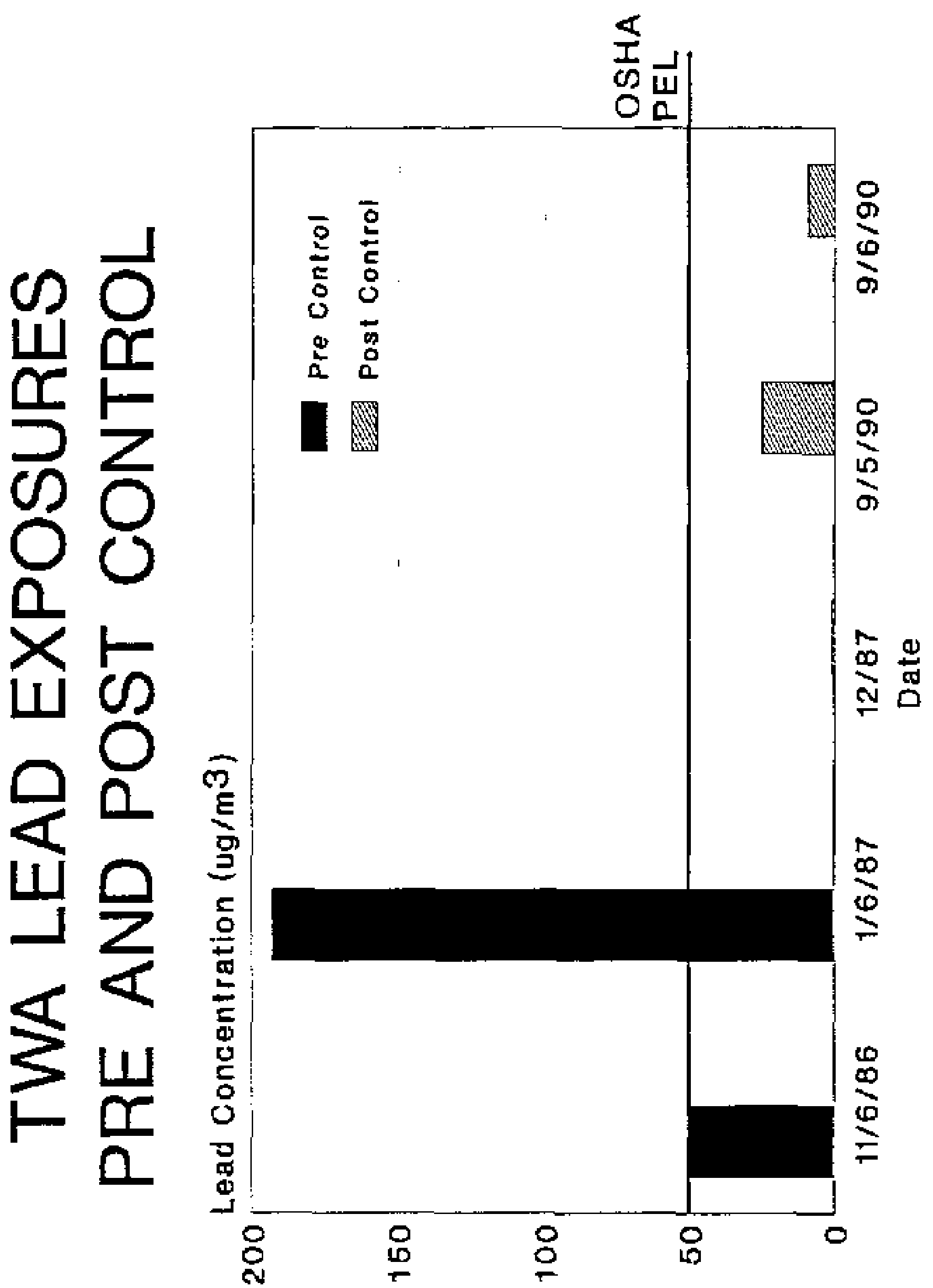
The surveys before installation of the ventilation control were conducted during November and January when production activity is generally slower. On the other hand, our September 1990 survey was conducted during hot weather (temperatures above 90°F) with radiator repair activity near peak levels. Because radiator repair production was greater during the September survey (after installation of the control) than during the surveys conducted before installation of the control, the reduction in lead exposures using the canopy-shaped exhaust hood may actually be better than the 90% demonstrated here.

Area and Background Samples

Area and background (ambient) lead concentrations measured during our survey are presented in Table 3. A sample taken at the edge of the water bath of workstation #1, about 3 feet from the soldering operation, showed an average lead concentration of 9 $\mu g/m^3$. The lead concentration at this site was virtually the same on both days of the survey: 8.7 and 9.4 $\mu g/m^3$, for days one and two, respectively, whereas the mechanic's breathing zone lead exposure was 3 times higher on the first day than on the second day. These area sample lead concentrations are indicative of the amount of lead fumes from soldering that escaped capture by the exhaust hood, therefore, the 3-fold higher lead exposure for the radiator repair mechanic on day one was most likely due to factors other than soldering such as work practices. And the major difference in work practices, noted earlier, was use of a wire brush to clean lead from the radiator header which occurred only on day one.

Indoor (background) sample lead concentrations collected inside the shop approximately 12 feet from the soldering operation at workstation #1 ranged from 1.4 to 1.8 $\mu g/m^3$. These indoor ambient lead concentrations indicate little build-up of lead in the shop either directly from soldering or from lead exhausted by the electronic ionizers, and that the potential for lead exposure among workers during operations other than radiator repair is almost nil. The average ambient lead level (1.6 $\mu g/m^3$) inside the shop represents less than one-tenth the radiator repair mechanic's overall lead exposure during our evaluation.

Figure 5



TWA LEAD EXPOSURES
PRE AND POST CONTROL
Lead Concentration (ug/m3)
200
150
100
50
0
11/6/86
1/6/87
12/87
9/5/90
9/6/90
Date
Pre Control
Post Control
OSHA PEL

Table 3

Area Sample Lead Concentrations

Sample Location	Average Sample Time (min)	Lead Concentration ($\mu g/m^3$)	
		9/5/90	9/6/90
Workstation #1 on Side of Water Bath	496	8 7	9 4
Ambient Inside Shop	494	1 8	1 4
Shop Office	493	3 6	0 8
Ambient Outside - East	490	0 11	0 04
Ambient Outside - SW	486	0 14	0 14

The average lead concentration in the shop office was 2 2 $\mu g/m^3$ Although this level is far below the OSHA PEL, it is actually above the ambient lead concentration inside the shop and indicates possible cross-contamination between the shop and the office Since the door between the office and the shop was kept closed during the our survey, the source of lead in the office may be due to a slow build-up of lead from inadequate ventilation in the office The quality of the air in the office could be improved by bringing additional outside air into this area

Outdoor ambient lead concentrations averaged 0 1 $\mu g/m^3$ Full-shift (8-hour) outdoor ambient samples were collected both days of the survey at two locations East and Southwest of the building These data indicate that lead emissions generated during radiator repair operations and released through doors, roof vents and other shop openings did not have a material effect on the immediate environment, and that outdoor lead levels near the plant were not a source of lead concentrations for workers in the shop

Exhaust From Electronic Ionizer

Area samples for lead were placed at the face of the discharge side of the electronic ionizer serving workstations #1 and #2 to determine the amount of lead that might pass through the ionizer The average lead concentration measured at the discharge face of the ionizer was 1 3 $\mu g/m^3$ (Table 4) This is marginally less than indoor ambient lead concentrations

Normally, recirculation is not recommended in order to prevent the discharge of any lead back into the shop However, the lead concentration in the discharge stream from the ionizer was low, and moreover, ambient indoor lead concentrations at this shop were lower than at other controlled radiator repair shops we have surveyed

Table 4

Lead Levels in Exhaust of Electronic Ionizer

Area Sample Location	9/5		9/6	
	No of Samples	Lead Concentration ($\mu g/m^3$)	No of Samples	Lead Concentration ($\mu g/m^3$)
Exhaust from Electronic Ionizer	1	0 4	2	2 2
Indoor Ambient	1	1 8	1	1 4

Sand Blaster and Bead Blaster

The sand blaster is essentially an enclosed glove box During his initial survey at Hensley the VOSH industrial hygienist concluded that potential lead exposures from the bead and sand blasters were negligible Our personal and area sampling results also indicate that the sand and bead blasters were not a significant lead exposure source, since lead fumes at the radiator repair workstation appear to account for nearly all the radiator repair mechanic's lead exposure

Field Blank Results

The results of field blanks analyzed for lead are shown in Table A-1 Small amounts of lead were found on all the field blanks because of the high sensitivity of the analytical method and the corresponding low limit of detection (LOD) Therefore, a quantity of 0 09 μg of lead was subtracted from the mass of each sample

VENTILATION

Local Exhaust Ventilation

The face velocity and exhaust air volumes for the canopy-shaped hood at workstation #1 are shown in Table 5 (During our survey all radiator repair work was done at workstation #1) Ventilation measurements were taken twice each day The average face velocity into the hood was 76 fpm before the collectors to the electronic ionizer were cleaned and averaged 100 fpm after the collectors were cleaned The exhaust air volume into the 6 square feet opening of the hood was 460 cubic feet per minute (cfm) prior to the collectors being cleaned and ranged from 560 to 620 cfm after the collectors were cleaned

Table 5

Ventilation Measurements at Workstation #1 Hood

When Measurements Taken		Average Face Velocity (fpm)	Exhaust Volume (cfm)
Date	Time		
9/5	8 50 am	76(*)	460(*)
9/5	9 50 am	104	620
9/6	12 50 pm	92	560
9/6	1 30 pm	98	590

(*) Before electronic ionizer collectors were cleaned

Air velocity measurements taken in the plane 12 inches from the face of hood opening ranged from 10-35 fpm Although this is a low capture velocity, in combination with the large size hood opening it was sufficient to capture fumes that would escape from other LEV systems with such a low capture velocity

Dilution Ventilation

Dilution (or general) ventilation provided by open garage doors helped control lead exposures in this shop by diminishing lead emissions that may have escaped capture by the LEV control The movement and direction of air flow in the shop was in and out through the large garage doors with some movement toward the radiator repair area

The open garage doors during the survey also supplied make-up air required for the combination cleaning and paint booth LEV system Shop doors are generally open except during the months of January, February, and part of December Even when the garage doors are closed there appears to be no need for a mechanical make-up air supply since there is considerable leakage into the building (according to shop personnel), and garage doors have to be opened periodically for customer vehicles to be driven in and out There was minimal air circulation in the office The quality of the air in the office area would benefit from additional outside air

During our survey, the air temperature inside the shop was 87°F and the relative humidity was 60% The outside temperature was 92°F and the relative humidity was 50% These temperature and humidity measurements were taken around 11 00 a m on September 6

Paint Spray Booth

The total exhaust air volume for the combination cleaning and paint spray booth, which had an opening 4 feet high by 2 8 feet wide, was 1,400 cfm and the average face velocity was 125 fpm Exhaust air was discharged outside above the roof Radiators were painted in the ventilated booth with a black-oil based acrylic paint that does not contain lead The ventilation was turned on before painting was started

WORK PRACTICES

Advantages and Disadvantages of LEV Control

To be effective, flexible duct ventilation hoods, such as the one evaluated in this shop, must be positioned near the soldering operation by the radiator repair mechanic With straight duct "elephant trunk" type ventilation hoods, such as those observed at another radiator repair shop[22], the mechanic must constantly move the hood as he maneuvers around the radiator melting and soldering In addition, a fair amount of strength is required to move the hood each time The canopy-shaped hood used at this shop has several advantages over the straight duct LEV hood First, the 6 feet-square opening of the canopy-shaped hood is large enough to enclose most radiators so that the mechanic does not have to constantly reposition the hood as he solders around the radiator, secondly, the large hood can capture fumes from a much larger area or zone whereas straight duct hoods are more vulnerable to cross-currents, lastly the hood is counterbalanced and easily moved toward the soldering operation or moved up or down This ergonomic consideration is critical since workers will often stop using the control if awkward movements or a lot of extra time is required to position the hood

Individual Work Practices

During this survey the radiator repair mechanic conscientiously moved the hood close to the lead fume source where it would be most effective Using the canopy-shaped hood LEV control in combination with these work practices resulted in a TWA lead exposure for the mechanic of 9 $\mu g/m^3$ during peak day radiator repair activity (the second day of our survey) This TWA lead exposure is less than one-fifth the OSHA PEL On the other hand, if poor work practices are used such as standing between the radiator and the hood, failing to pull the hood down over the radiator, or failing to turn on the ventilation, much higher lead exposures, well above the OSHA PEL, are possible

The one problematic work practice (as discussed earlier) that apparently increased the lead exposure for the radiator repair mechanic was using a wire brush to remove lead from the header

Removing, cleaning, and reinstalling the collectors to the electronic ionizer did not appear to increase the radiator mechanic's lead exposure His lead exposure during this operation which also included some minor radiator repairs was only 8 $\mu g/m^3$ (Table 1)

OTHER AIR SAMPLING RESULTS

A sample for carbon monoxide collected with Draeger tubes in the radiator repair area was less than 5 parts per million (ppm) The OSHA PEL for carbon monoxide is 50 ppm and the NIOSH REL is 35 ppm [13,14]

During their initial survey at Hensley radiator in November 1986 before the canopy-shaped exhaust hood was installed, VOSH collected personal samples for zinc chloride on three workers [6] TWA zinc chloride concentrations for the three workers averaged 0 13 mg/m^3 and ranged from 0 09 to 0 17 mg/m^3 Even without the LEV control these levels were well below the NIOSH REL and OSHA PEL[23] for zinc chloride of 1 mg/m^3 A material safety data sheet for zinc chloride is included in Appendix B

A bulk sample of dust was obtained from the electronic ionizer collectors and analyzed for 30 minerals and metals and by qualitative GC/MS The percentage of each of the 30 elements in the bulk sample is summarized in Table A-2 The major mineral/metal constituents in the bulk sample were lead (1 8%), aluminum (15%), iron (14%), zinc (3 3%), copper (0 4%), and manganese (0 2%) Most of the remainder of the bulk sample consisted of a complex mixture of hydrocarbons

PERSONAL PROTECTIVE EQUIPMENT, HYGIENE, MONITORING, AND TRAINING

The radiator repair mechanic wore safety glasses and steel-toed shoes when working on radiators Employees are required to wear goggles when they use the caustic cleaning vats, this area also has an eye wash unit Because of low lead exposures for this shop, respirators are not required and were not worn The mechanics are provided a set of coveralls every two days The dirty coveralls are laundered by a cleaning service

No smoking or eating is permitted in the radiator repair area while repairing radiators, however, smoking and eating is allowed in the rest of the shop and in the radiator repair area when there is no repair activity

Employees have undergone blood-lead monitoring Employees are given an orientation on the hazards of lead and are provided up-to-date MSDS (Examples of two MSDS from Hensley are in Appendix B)

CONCLUSIONS AND RECOMMENDATIONS

1 The ventilation control evaluated at this shop effectively controlled lead emissions during hot weather with radiator repair activity near peak levels Personal lead concentrations for the radiator repair mechanic during our study averaged one-third the OSHA PEL of 50 μg/m^3 when using the control (*When the results from an earlier Virginia Occupational* Safety and Health Department survey and this survey are combined, the lead exposure for the radiator repair mechanic averaged only one-fourth the OSHA PEL when using the control)

2 Personal sampling data collected at this shop prior to installation of the exhaust hood showed TWA lead exposures for the radiator repair mechanics as high as 193 $\mu g/m^3$ In comparison, the highest TWA lead level after installation of the control was 25 $\mu g/m^3$, representing an 87% reduction in lead exposures

3 During the survey, the radiator repair mechanic was diligent in keeping the exhaust hood near the source of lead fume generation In general the effectiveness of "flexible duct" or "elephant trunk" LEV systems is more dependent on work practices than are "back draft" exhaust booths However, because of its large opening the canopy-shaped hood at Hensley's has a wide zone of effectiveness and is less vulnerable to poor work practices than are "flexible duct" LEV systems with round straight hoods which must be constantly moved to ensure fume capture Furthermore, the canopy-shaped hood slides easily up and down on a vertical rail and is counterbalanced for easy positioning, while most "flexible duct" systems require greater physical effort to reposition

4 Wire brushing to clean the radiator header or any other parts contaminated with lead should be avoided It appears that using the wire brush to clean lead from the header may have increased the radiator mechanic's lead exposure by as much as 150%

5 The canopy-shaped exhaust hood and the flexible ducts to the LEV control at Hensley's were in good condition after more than 3 years of operation The primary disadvantage in the use of the control system is the need to frequently clean the electronic ionizer collectors

6 The electronic ionizer effectively captured the lead in the exhaust stream generated during radiator repair operations, lead levels in the discharge from the ionizer were similar to ambient indoor lead concentrations measured during the survey Moreover ambient indoor lead levels at this shop were lower than at other radiator repair shops we have surveyed Since the ionizer is working well at this shop, there is no need to relocate the exhaust discharge from the ionizer to the outside, however, locating the discharge from the ventilation control inside the shop (even if the LEV system is equipped with an electronic ionizer or filtration system) is normally not recommended, because of the potential problems with the recirculation of a hazardous material such as lead Exhaust air discharged to the outside should be handled in accordance with state and federal regulations

7 The collectors to the electronic ionizers should be cleaned frequently to maintain sufficient air flow into the exhaust hood The frequency of cleaning depends upon the level of radiator repair activity and the buildup on the collectors

8 Smoking and eating near the radiator repair workstations should not be permitted even during downtime Workers should shower and change from work clothes to street clothes after their tour of duty

9 The flexible duct canopy-shaped exhaust hood control used at this shop requires less exhaust air volume--thus, less make-up air must be heated during cold weather--than typical "back draft" ventilation booths and many "flexible duct" LEV systems with round straight hoods For example, the exhaust air volume per workstation for the canopy-shaped hood was 600 cfm, for "back draft" booths it is 2000-6000 cfm, and for "flexible duct" (or "elephant trunk") systems it is 700 - 1500 cfm

10 This affordable ventilation control system can be utilized by most radiator repair shops Not only is the cost of the control system (excluding the air ionizer) inexpensive, but the volume of air that must be exhausted is relatively low so that less make-up air must be heated in the winter months which saves on fuel costs

11 The face velocity of the canopy-shaped exhaust hood should be checked every two weeks The face velocity into the exhaust hood can be determined quickly and relatively inexpensively using a velometer [24] A reliable velometer can be obtained for about $200 For radiator repair shops that do not have electronic ionizers, the ventilation system may not have to checked this often

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A P P E N D I X   A

TABLE A–1 INDIVIDUAL INORGANIC LEAD SAMPLE RESULTS FOR HENSLEY RADIATOR

DATE	SAMPLE NUMBER	TYPE	WORKER	SAMPLE DESCRIPTION/ LOCATION	SAMPLE TIME (min)	SAMPLE VOLUME (liters)	LEAD LOD/LOQ	LEAD MASS (ug)	LEAD* CONC (ug/m3)
09/05/90	476	PERS	A	RADIATOR REPAIR	67	235		14	59 7
09/05/90	428	PERS	A	RADIATOR REPAIR	125	438		3 5	8 0
09/05/90	475	PERS	A	RADIATOR REPAIR	92	322		18	55 9
09/05/90	454	PERS	A	RADIATOR REPAIR	94	329		3 4	10 3
09/05/90	456	PERS	A	RADIATOR REPAIR	94	329		3 6	10 9
09/05/90	429	PERS	B	SHOP MECHANIC	294	588		3 2	5 4
09/05/90	461	PERS	B	SHOP MECHANIC	128	448		0 9	2 0
09/05/90	472	AREA		WORKSTATION#1	481	962		8 5	8 8
09/05/90	439	AREA		AIRCLEANER EXHAUST	301	602		0 2	0 3
09/05/90	477	AREA		AIRCLEANER EXHAUST	124	248		0 3	1 2
09/05/90	414	AREA		BACKGROUND SHOP	487	974		1 8	1 8
09/05/90	440	AREA		OFFICE ON DESK	486	972		3 6	3 7
09/05/90	441	AREA		OUTSIDE EAST	487	974		0 2	0 2
09/05/90	443	AREA		OUTSIDE SW	488	976		0 23	0 2
09/06/90	412	PERS	A	RADIATOR REPAIR	78	273		3 1	11 4
09/06/90	407	PERS	A	RADIATOR REPAIR	100	350		7 9	22 6
09/06/90	445	PERS	A	RADIATOR REPAIR	100	350		1 3	3 7
09/06/90	409	PERS	A	RADIATOR REPAIR	97	340		1 4	4 1
09/06/90	411	PERS	A	RADIATOR REPAIR	79	277		0 79	2 9
09/06/90	415	AREA		WORKSTATION#1	209	418		2 8	6 7
09/06/90	442	AREA		WORKSTATION#1	302	604		7	11 6
09/06/90	413	AREA		AIRCLEANER EXHAUST	173	346		2 2	6 4
09/06/90	421	AREA		AIRCLEANER EXHAUST	332	664		0 91	1 4
09/06/90	458	AREA		AIRCLEANER EXHAUST	156	312		1 1	3 5
09/06/90	433	AREA		AIRCLEANER EXHAUST	331	662		0 47	0 7
09/06/90	425	AREA		BACKGROUND SHOP	600	1000		1 5	1 5
09/06/90	471	AREA		OFFICE ON DESK	500	1000		0 94	0 9
09/06/90	455	AREA		OUTSIDE EAST	492	984		0 13	0 13
09/06/90	469	AREA		OUTSIDE SW	484	968		0 23	0 2
09/05/90	467	BLANK				0	NQ	0 04	
09/05/90	424	BLANK				0		0 1	
09/06/90	473	BLANK				0	NQ	0 03	
09/06/90	420	BLANK				0		0 13	
09/06/90	452	BLANK				0		0 08	
09/06/90	450	BLANK				0		0 05	
09/06/90	453	BLANK				0		0 17	

* not adjusted for field blanks

TABLE A-2

Percentages of Metals and Minerals in Electronic Ionizer Bulk Sample

Analyte	Amount(%)
Aluminum	15 0
Arsenic	0 009
Barium	0 001
Beryllium	<0 001
Calcium	0 039
Cadmium	0 002
Cobalt	<0 001
Chromium	0 007
Copper	0 37
Iron	14 0
Lithium	<0 001
Magnesium	0 068
Manganese	0 230
Molybdenum	<0 001
Nickel	<0 001
Lead	1 80
Phosphorus	0 053
Platinum	<0 001
Selenium	<0 001
Silver	0 002
Sodium	0 130
Tin	0 068
Tellurium	<0 001
Thallium	<0 001
Titanium	0 007
Tungsten	0 008
Vanadium	0 003
Yttrium	<0 001
Zinc	3 30
Zirconium	<0 001

A P P E N D I X   B

Material Safety Data Sheets for tin-lead solder and zinc chloride flux.

Material Safety Data Sheet   Tin/Lead/Antimony/Silver/Bismuth Alloys
Page 1 of 3

Section 01   Identification

Info furnished by	Federated-Fry Metals
Address.	6th Avenue & 41st Street Altoona, PA 16602
Date Effective	2/22/89
Emergency Phone	(814) 946-1611
Chemtrec	800-424-9300
Product or Trade Name	Flowsolder Alloys
Person to Contact	Dan Weaver

Section 02   Constituents

Chem	CAS	%WT	Carcinogen	TLV/TWA
Tin	7440-31-5	0-100	No	2mg/cu m ACGIH 2mg/cu m (inorganic) OSHA 0.1mg/cu m (organic) OSHA
Lead	7439-92-1	0-100	No	0 15mg/cu m ACGIH 0 05mg/cu m OSHA (PEL)
Antimony	7440-36-0	0-15	No	0.5mg/cu m ACGIH/OSHA
Silver	7440-22-4	0-10	No	0 1mg/cu m ACGIH 0 01 mg/cu m OSHA
Bismuth	7440-69-9	0-60	No	Not regulated ACGIH/OSHA

This product contains a chemical subject to SECTION 313 of SARA Title III

Section 03   Physical Data

Melting Point	360-620 degrees depending on composition
Boiling Point	N/A
Vapor Pressure	Not volatile
Vapor Density (air is 1)	Not volatile
Solubility in Water	NIL
Appearance & Color	Silver to grey metal
Specific Gravity	7-11 approx. depending on composition
Odor	None
% Volatile	NIL
pH	N/A
Evaporation Rate(nBuAc=1)	N/A

Section 04   Fire & Explosion Hazard Data

Flash Point/Method Used	Not Flammable
Flammable Limits	N/A
Extinguishing Media	N/A
Fire-fighting equipment	If this metal is present where there is a fire, wear self-contained breathing apparatus in case of poisonous lead fumes.
Special precautions	None

Section 05 Reactivity Data

Stability:	Stable
Conditions to avoid	N/A
Hazardous Polymerization	Will not occur
Conditions to avoid	N/A
Incompatibility	Strong acids, oxidisers, reducing agents, halogens.
Hazardous Decomposition Products	Lead fumes at high temperatures (above 800 degrees F).

Section 06 Spill, Leak and Disposal Procedures

Action to take for Spills/Leaks	Allow to solidify and collect in sealed drums for disposal
Disposal Method:	Return to supplier for reprocessing.

Section 07 Health Hazard Data

Eye.	Dust or fume will be an irritant
Skin Contact.	Not a route of entry into the body.
Skin Absorption:	Not a route of entry into the body.
Ingestion:	Ingestion of dust or fume must be avoided. Lead is toxic and cumulative, affecting the kidneys, reproductive system and nervous system. Symptoms of chronic overexposure include anemia, insomnia, weakness, irritability, constipation and stomach pains. Antimony is toxic and dust or fume can cause nasal septal ulceration and stomach lining irritation. Tin is not regarded as toxic but excessive exposure can cause fever, nausea, stomach cramps or diarrhea Alloyed silver is unlikely to be hazardous. Bismuth is not hazardous.
Inhalation:	Inhalation of dust and fumes must be avoided. Irritation of nose and bronchial tracts may occur as well as effects due to absorption of lead, etc in the blood stream.
Systemic & Other Effects	UNK

Section 08 First Aid Procedures

Eyes:	Flush with water for 15 minutes.
Skin:	Wash thoroughly with soap and water. Remove contaminated clothing.
Ingestion:	Induce vomiting if person is conscious. Get medical attention.
Inhalation	Remove to fresh air Get medical attention.
Note to Physician	N/A

Section 09 Special Handling Information

Ventilation	If fume or dust is being generated, mechanical ventilation must be provided to maintain exposure levels below TLV's.
Respiratory Protection	Only required if TLV's are exceeded Use a NIOSH/MSHA approved respirator for toxic dust and/or fume. Note: See 29CFR1910 1025 Subpart (f) of OSHA's Lead Standard
Eye Protection:	Wear safety glasses during soldering operations.
Skin Protection:	Not normally needed.
Other	N/A

Section 10 Special Precautions & Additional Information

Storage.	Store in dry conditions
Handling Information	Lead use is regulated under OSHA 29CFR 1910.1025. No food or drink should be allowed in areas where these products are handled. Personnel must wash thoroughly after handling the metal before drinking, eating or smoking.

Section 11 Transportation

Proper Shipping Name	Not regulated.
UN Number:	N/A
NA Number:	N/A
Dot Exemption No :	N/A
Hazard Classes	N/A

The information is given in good faith, but no warranty, express or implied, is made.

MATERIAL SAFETY DATA SHEET

GANDO FAST TINNING COMPOUND

CHEMICAL FAMILY: INORGANIC FLUX – METAL HALIDE   LAST REVISED: 9/27/89
PHYSICAL HAZARD: REACTIVE   GANDO No. 714;714-1;718;718-1;724;724-1
HEALTH HAZARD: TOXIC, CORROSIVE, EYE HAZARD

DAMON CHEMICAL COMPANY, INC
BOX 2120, ALLIANCE, OH 44601

PHONES: (800) 362-9850 IN OHIO
(800) 321-9757 OTHER USA
(216) 821-5310 OUTSIDE USA

HAZARD RATINGS: HEALTH: 3
FLAMMABILITY: 0
REACTIVITY: 1

0 = Insignificant 3 = Serious
1 = Slight 4 = Severe
2 = Moderate

D.O.T. HAZARD CLASS: CORROSIVE MATERIAL

--- SECTION 2 – HAZARDOUS INGREDIENTS ---

INGREDIENT	CAS NO	PERCENT	TWA	STEL	CEILING
AMMONIUM CHLORIDE FUME	12125-02-9	2 – 10%	10 mg/m3	20 mg/m3	-
LEAD	7439-92-1	10 – 20%	–	.05 mg/m3	-
TIN	7440-31-5	1 – 10%	2 mg/m3	-	-
ZINC CHLORIDE FUME	7646-85-71	> 60%	1 mg/m3	2 mg/m3	-

THE BALANCE OF INGREDIENTS ARE NOT CONSIDERED HAZARDOUS UNDER CFR 29 1910 1200

------- SECTION 3 – PHYSICAL DATA -------

BOILING POINT: 300° F.
VAPOR PRESSURE: NOT APPLICABLE
VAPOR DENSITY: LESS THAN 1
SOLUBILITY IN WATER: ALL BUT SOLDER IS SOLUBLE
SPECIFIC GRAVITY: 2 64
PERCENT VOLATILES: 3%
EVAPORATION RATE: 1 (WATER=1)
pH: 0 0 ± 0 5
APPEARANCE AND ODOR: GRAY HEAVY PASTE WITH ACID ODOR.

-- SECTION 4 – FIRE AND EXPLOSION DATA --

FLASH POINT: NONE
LOWER EXPLOSIVE LIMIT: NOT APPLICABLE
UPPER EXPLOSIVE LIMIT: NOT APPLICABLE

EXTINGUISHING MEDIA. NOT APPLICABLE
SPECIAL FIRE FIGHTING PROCEDURES: NONE
UNUSUAL FIRE AND EXPLOSION HAZARDS: MAY RELEASE HYDROGEN CHLORIDE, AMMONIA, ZINC OXIDE, ETC IF INVOLVED IN FIRE

------- SECTION 5 – REACTIVITY DATA -------

STABILITY: STABLE
INCOMPATIBILITY: STRONG ALKALIS, OXIDIZERS.
HAZARDOUS DECOMPOSITION PRODUCTS: HYDROGEN CHLORIDE, AMMONIA, ZINC OXIDE
HAZARDOUS POLYMERIZATION: WILL NOT OCCUR.

----- SECTION 6 – HEALTH HAZARD DATA -----

THRESHOLD LIMIT VALUE (TLV) NONE KNOWN (SEE INDIVIDUAL INGREDIENTS)

PRIMARY ROUTES OF ENTRY. X THROUGH SKIN X INHALATION X INGESTION

EFFECTS OF OVEREXPOSURE:
BREATHING – FUMES FROM SOLDERING CONTAIN AMMONIUM CHLORIDE, ZINC CHLORIDE AND POSSIBLY SMALL AMOUNTS OF TIN AND LEAD FUMES CAUSE RESPIRATORY IRRITATION. PROLONGED EXCESSIVE ABSORPTION OF INORGANIC LEAD BY INHALATION OF DUST AND FUMES IS CHARACTERIZED BY ABDOMINAL PAIN OR WHAT IS SOMETIMES REFERRED TO AS "LEAD COLIC", METALLIC TASTE IN MOUTH, LOSS OF WEIGHT, PAIN IN MUSCLES AND MUSCULAR WEAKNESS. THE SIMILARITY OF SYMPTOMS WITH THOSE OF OTHER ILLNESSES REQUIRES BLOOD TESTS FOR DIAGNOSIS

EYES - CAUSES IRRITATION, REDNESS AND MAY CAUSE EYE DAMAGE.

SKIN - CAUSES IRRITATION, REDDENING, DERMATITIS, POSSIBLE SENSITIZATION. PROLONGED CONTACT CAN CAUSE SKIN DAMAGE.

SWALLOWING - MAY RESULT IN SEVERE DAMAGE TO MUCOUS MEMBRANES. PROLONGED INGESTION MAY CAUSE LEAD POISONING. SEE BREATHING ABOVE FOR SYMPTOMS.

FIRST AID PROCEDURES:

EYE CONTACT: IMMEDIATELY FLUSH WITH LARGE AMOUNTS OF WATER FOR AT LEAST 15 MINUTES, LIFTING UPPER AND LOWER LIDS OCCASIONALLY. GET MEDICAL ATTENTION

SKIN CONTACT: IMMEDIATELY FLUSH EXPOSED AREA WITH WATER FOR AT LEAST 15 MINUTES IF IRRITATION PERSISTS, GET MEDICAL ATTENTION. REMOVE CONTAMINATED CLOTHING AND LAUNDER BEFORE RE-USE.

INGESTION: GIVE TWO GLASSES OF WATER TO DRINK. INDUCE VOMITING IMMEDIATELY BY STICKING FINGER DOWN THROAT OR BY GIVING AN EMETIC SUCH AS IPECAC. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON. TREAT FOR SHOCK BY KEEPING WARM AND QUIET. GET MEDICAL ATTENTION IMMEDIATELY

INHALATION. IF AFFECTED, REMOVE INDIVIDUAL TO FRESH AIR. IF BREATHING IS DIFFICULT, ADMINISTER OXYGEN. IF BREATHING HAS STOPPED GIVE ARTIFICIAL RESPIRATION KEEP PERSON WARM AND GET MEDICAL ATTENTION.

——— SECTION 7 - SPECIAL PRECAUTIONS AND SPILL/LEAK PROCEDURES ———

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE.

EMPTY CONTAINERS RETAIN PRODUCT RESIDUE AND MAY BE HAZARDOUS OBSERVE ALL PRECAUTIONS GIVEN IN THIS DATA SHEET

DO NOT EAT OR SMOKE IN AREAS WHERE PRODUCT IS USED CHANGE CLOTHING BEFORE LEAVING WORK CONTAMINATED CLOTHING MAY CARRY LEAD HOME TO AFFECT OTHER FAMILY MEMBERS

CONTACT THE NATIONAL AUTOMOTIVE RADIATOR SERVICE ASSOC (NARSA) FOR MORE INFORMATION ON LEAD POISONING AND MONITORING OF BLOOD LEAD LEVELS. NARSA, P O BOX 267, HARLEYSVILLE, PA 19438 - (215) 368-6766

OSHA REGULATIONS MAY REQUIRE YOU TO PROVIDE BLOOD LEAD TESTING OF EMPLOYEES AND MONITOR AIRBORNE LEAD LEVELS

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: SCOOP UP MATERIAL INTO CLEAN CONTAINER. WASH RESIDUE TO SEWER WITH PLENTY OF WATER. IN SOME LOCALITIES EVEN SMALL AMOUNT OF LEAD ARE PROHIBITED FROM ENTERING SEWERS COMPLY WITH ALL LOCAL, STATE AND FEDERAL REGULATIONS

WASTE DISPOSAL METHOD. IF PRODUCT CAN NOT BE USED, DISPOSE OF AT A CHEMICAL LANDFILL IN COMPLIANCE WITH LOCAL, STATE AND FEDERAL REGULATIONS

——— SECTION 8 - PROTECTIVE EQUIPMENT ———

RESPIRATORY PROTECTION: IF FUMES EXCEED OSHA LIMITS FOR ANY INGREDIENT, AN OSHA APPROVED BREATHING APPARATUS OR RESPIRATOR SHOULD BE USED

VENTILATION: PROVIDE SUFFICIENT MECHANICAL (GENERAL) AND/OR LOCAL EXHAUST TO MAINTAIN EXPOSURE TO FUMES BELOW OSHA LIMITS IT IS HIGHLY RECOMMENDED THAT AN ELECTROSTATIC PRECIPITATOR AND/OR LOCAL EXHAUST BE USED TO REMOVE AIRBORNE LEAD AND ZINC.

PROTECTIVE GLOVES WEAR RESISTANT GLOVES SUCH AS: NEOPRENE.

EYE PROTECTION: SAFETY GLASSES, OR CHEMICAL GOGGLES IN COMPLIANCE WITH OSHA REGULATIONS.

OTHER PROTECTIVE EQUIPMENT. IMPERVIOUS CLOTHING OR APRON, BOOTS.

THE INFORMATION ACCUMULATED HEREIN IS BELIEVED TO BE ACCURATE BUT IS NOT WARRANTED TO BE RECIPIENTS ARE ADVISED TO CONFIRM IN ADVANCE THAT THE INFORMATION IS CURRENT, APPLICABLE, AND SUITABLE TO THEIR CIRCUMSTANCES

——— SECTION 313 SUPPLIER NOTIFICATION ———

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of CFR 372:

CHEMICAL NAME	CAS#	% BY WEIGHT
ZINC CHLORIDE	7646-85-71	61%
LEAD	7439-92-1	16%

This information must be included in all MSDSs that are copied and distributed for this product.

GANDOPASTTIN 2