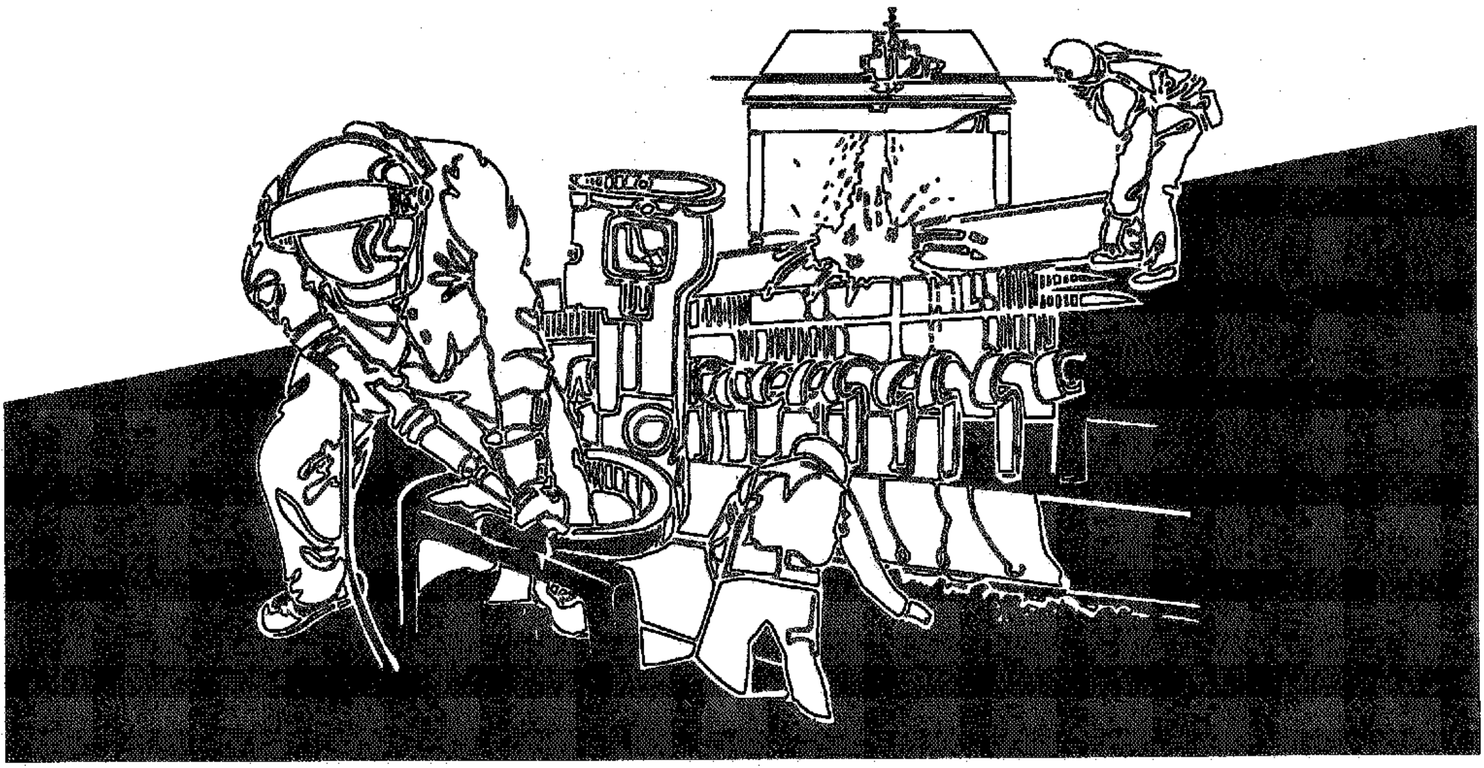
CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

NIOSH HEALTH HAZARD EVALUATION REPORT

HETA 93-0955-2390
UNITED SEAL COMPANY
COLUMBUS, OHIO



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer and authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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I. SUMMARY

On June 9, 1993, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Columbus Childhood Lead Poisoning Prevention Program in Columbus, Ohio, to investigate a case of chronic lead poisoning in a local seal manufacturing company. The patient, as well as the patient's children, sought treatment at a local hospital. The company was also referred to OSHA. On July 8, NIOSH conducted an evaluation of employees of the United Seal Company consisting of interviews of workers, personal and environmental sampling for lead, and medical monitoring for effects of lead exposure.

In addition to the index case, the investigation found that two of the seven workers tested had a blood lead level greater than 25 μg/dl. None had other biochemical evidence of lead toxicity, such as an elevated zinc protoporphyrin (ZPP) level, or elevated serum levels of creatinine, uric acid, or blood urea nitrogen (BUN). Results of the questionnaire survey revealed that the employees had not received proper education about the hazards of lead exposure and its prevention; appropriate personal hygiene practices were not regularly followed by many workers. Wipe sampling indicated that workers' hands were contaminated with lead, even after washing with soap and water prior to leaving the worksite at the end of the shift. Surface lead concentrations were quite high in workers' automobiles, particularly on the seat and floor areas.

An investigation was conducted at the United Seal Company in Columbus, Ohio. Two of the seven workers tested had modest elevated blood lead levels. Adequate education on lead exposure was not provided to the workers, and proper personal hygiene practices are not regularly followed by many workers. Hand wipe samples and samples taken from workers' automobiles showed high levels of lead contamination. Recommendations designed to reduce exposure to lead at work and minimize the amount of lead taken home are included in this report.

KEY WORDS: SIC 3679 (Electronic Components, not elsewhere classified), lead, blood lead levels, ZPP

II. INTRODUCTION

On June 9, 1993, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Columbus Childhood Lead Poisoning Prevention Program in Columbus, Ohio, to evaluate lead exposure at a local lead seal manufacturing plant following the referral from a local hospital of a case of lead poisoning. The patient was found to have a blood lead level (BLL) above 40 µg/dl by a local physician and sought treatment at the hospital. At the time of the request, the patient's children were also being treated for lead poisoning by the same hospital. The request was made with a special concern about young children of workers. The United Seal Company, where the patient worked, was also referred to the Occupational Safety and Health Administration (OSHA) for investigation by the Columbus Health Department.

An investigation had been initiated by OSHA before the request was made to NIOSH. OSHA sampling results indicated that personal exposures to airborne lead were quite low. Two of the three air samples were below the limit of detection (detection limit= 2.5 µg); the other sample was less than one-tenth of the OSHA Permissible Exposure Limit (PEL) for lead (50 $\mu g/m^3$). Wipe sampling indicated lead particulate to be on machinery throughout the work areas. Lead contamination was also found in the lunchroom (refrigerator/freezer, floor, table, and door), men's bathroom (door, toilet handle, towel dispenser, bench, and faucet of water cooler), and on the hands of all four employees sampled. The OSHA results indicated the potential for lead ingestion via hand to mouth (eating, drinking, smoking, or chewing).

The NIOSH team visited the seal company on July 8. The site visit by NIOSH was delayed because of difficulties in finding and scheduling a Cambodian interpreter to help conduct questionnaire interviews with some of the workers, who were not fluent in English. An opening conference was held with the owner and the first-shift manufacturing workers in the morning to explain the purpose of the evaluation, describe the survey methods, and answer questions. Another similar conference was held with the owner and the second-shift workers in the afternoon. A walk-through inspection of the facilities was conducted before the afternoon conference.

Each worker participating in blood tests was informed of the test results individually by mail. In addition, a summary of test results was mailed to the employer, and a list of the employees who had children living in the same household was mailed to the Columbus Childhood Lead Poisoning Prevention Program for follow-up studies.

III. BACKGROUND

A. General Description of Lead Seal Manufacturing

Wire from an outside contractor is received on large spools. This wire is combined and twisted to specifications of the client using machines which can run independent of supervision. The wire is independently cut to the desired length (again based upon the clients' specifications), and this too is automated.

The lead seals are formed and applied simultaneously to one end of the wire by two processes. The first and slower process is by hand. The wire is placed into guides on the machine, clamped in place, and a mold is lowered over the end. Molten lead is ladled by hand from a nearby pool, into the mold. The lead is allowed to cool momentarily before the mold is lifted and the wire/seal combination is removed by hand and placed into a holding box. The excess lead in the mold is removed by banging the mold on the machine apron. This lead is eventually recycled into the pool by lowering the long bars by hand into the molten lead.

The second and much more efficient process is automated. The wire is spun, cut and fed onto a rotating plate which contains the molds for the seals. This plate rotates slowly and the molds are filled with lead, one by one. By the end of the revolution the lead has cooled enough to remove the wire/seal combination. These machines are supervised by an operator, whose responsibilities include filling the lead pool as the level drops by placing a solid lead bar into the pool.

Seals are also formed without application to the wires. This is performed by two machines which simply fill molds on a rotating plate. The seals are removed from the molds before the end of the revolution and dumped into a collection device. These machines run with minimal supervision, such that the plant superintendent can operate these machines. The sole function of the supervisor of this equipment is to refill the molten lead pools by placing a solid lead bar into the pool as the level drops.

The seals and seal/wire combinations are made to order. There appeared to be very little surplus lead.

B. Workers

The main plant has been located at its present location since 1962. Currently, it has 19 employees excluding the owner; 17 (11 males and 6 females) of them are involved in the manufacturing process. Besides lead seals, they also manufacture plastic locks. The various jobs are divided by task. Job rotation does occur such that everyone does almost everything, with the exception of the manual lead seal casting, which is performed only by men. The 17 manufacturing workers work on a three-shift schedule. Both of the two night (third) shift workers refused to participate in the survey, and on the day of the site visit, one worker was on vacation, and another one was on sick leave. The work shifts are extremely flexible; workers may come and go as they please within certain guidelines, provided they complete their work. Among the workers, there are seven Cambodians, one Laotian, and one Filipino. Many of the immigrant workers had poor fluency in English.

IV. EVALUATION METHODS

A. Industrial Hygiene

Before the NIOSH team arrived, OSHA had conducted air sampling and did not find lead exposure above its PEL. On July 8, 1993, surface sampling was conducted to investigate possible routes by which lead might be taken from the workplace. Samples for surface lead were collected from the hands and the automobiles of willing participants and from the work areas. Sampling and analytical methods used in this evaluation are summarized below. The NIOSH analytical methods referenced are described in the NIOSH Manual of Analytical Methods, Third Edition.[1]

Hands: Hand wipe samples were collected from workers after their normal end-of-shift hygiene practices. Each worker was instructed to thoroughly wipe both hands for approximately 30 seconds using a pre-moistened towelette (Wash'n Dri®, Softsoap Enterprises, Chaksa, MN); the wiping was then repeated using two additional wipes. All three wipes were then composited as one sample per worker and stored in a single plastic vial prior to analysis. Samples were analyzed for inorganic lead by NIOSH Method 7082 (flame atomic absorption spectrometry). Lead contamination per pair of hands was calculated as "micrograms of lead per square meter" ($\mu g/m^2$); the surface area per pair of hands was estimated to be 0.082 m^2.[2]

Automobiles: Surface lead concentrations on the driver's floor and seat were determined by vacuuming these surfaces using a collection nozzle attached by Tygon® tubing to a closed-face cassette containing a pre-weighed polyvinyl chloride filter (37-mm diameter, 5-μm pore size) and a personal air monitoring pump calibrated at 2.0 Lpm. The collection nozzle was a 5 cm long tube of stainless steel (1 cm i.d.) with the sampling end molded to form an opening of approximately 12 mm by 2 mm.[3] Both the seat and floor areas of each automobile were sampled using the same cassette; these areas were marked off using a disposable 7x7-inch template. Samples were analyzed for total weight (NIOSH Method 0500) and for lead (NIOSH Method 7082).

Surface lead levels on the driver's arm rest, the gas pedal, and the steering wheel were determined by wipe sampling with towelettes (described above). The dimensions of these parts were measured to help estimate the area sampled. Samples were analyzed for lead by NIOSH Method 7082.

Work Areas: Two area wipe samples were taken using 7x7-inch templates: one on the lunchroom table and one on the door between the office and the workshop. Samples were analyzed by NIOSH Method 7082. Note: More area wipe samples were not done because OSHA had recently performed area wipe sampling throughout the workshop.

B. Medical

On July 8, 1993, a personal questionnaire interview was conducted with employees working in the manufacturing area. The questionnaire asked information about general demographic characteristics, work history, medical history, work practices, personal habits, non-occupational exposure to lead, and job training. If the interviewee was not fluent in English, the questions were translated by the interpreter. After the interviews, blood samples were drawn from the participants to test for blood lead level (BLL), zinc protoporphyrin (ZPP), blood urea nitrogen (BUN), creatinine, and uric acid. The participation was voluntary, and a consent form was signed by all the participants which also authorized releasing information to the Columbus Health Department for follow-up study on the participants' children. All 13 manufacturing workers who were present during our visit accepted the interview; 7 of them consented to give the blood samples; however, one of the 7 blood sample providers refused to give enough amount of blood for all the tests. As a result, BLL and ZPP were tested for seven employees, but BUN, creatinine, and uric acid were tested for only six employees.

V. EVALUATION CRITERIA

The major route of occupational lead exposure is through inhaling lead dust and fumes. A secondary route of exposure may be from ingestion of lead dust deposited on hand, food, cigarettes, or clothing. Once absorbed, lead is excreted from the body very slowly. Absorbed lead can damage the kidney, peripheral and central nervous systems, and bone marrow. The symptoms and signs of lead intoxication include weakness, tiredness, irritability, anxiety, constipation, anorexia, abdominal pain, high blood pressure, kidney damage, fine tremors, "wrist drop," or slow reaction times. Chronic lead exposure is associated with infertility in both men and women and with fetal damage in pregnant women.[4-6]

Lead is a trace element in foods and beverages. Adults consume approximately 300 μg of lead each day, of which only approximately 10% is absorbed, while children absorb nearly 50% of ingested lead. The daily respiratory intake for adults living in the United States around the 1980's was 20 μg.[4-5] Although an effective barrier to inorganic lead, the skin may allow for substantial absorption of fat soluble organic lead such as tetraethyl lead found in formerly used in gasoline, and may allow absorption of inorganic lead if broken secondary to disruption from trauma or dermatitis.

The U.S. OSHA permissible exposure limit (PEL) for lead in air is 50 $\mu g/m^3$ calculated as an 8-hour time weighted average (TWA) for daily exposure.[7] Employees whose blood lead level (BLL) is 40 μg/dl or more must be retested every two months, and be removed from a lead-exposed job if their average BLL is 50 μg/dl or more over a 6-month period.

A BLL of 60 μg/dl or greater, confirmed by retesting within two weeks, is an indication for immediate medical removal. Workers on medical removal should not be returned to a lead exposed job until their BLL is confirmed to be below 40 μg/dl.[7] Removed workers in the U.S. have protection for wage, benefits, and seniority for up to 18 months until their BLL decline to below 40 μg/dl and they can return to lead exposure areas. This provides an incentive for employers to correct excessive exposures and avoids a disincentive for employee participation.

The BLL is a measure of the amount of lead in the body and is the best available measure of recent lead absorption. Adults not exposed to lead at work usually have a BLL well around 16 μg/dl[8], and with the implementation of lead-free gasoline and reduced lead in food, the average BLL of U.S. men may be below 9 μg/dl[9-10]. BLL's higher than 10 to 15 μg/dl have harmful effects on the mental development of young children. Since the BLL of a fetus is similar to that of its mother, and since the fetus's brain is presumed to be at least as sensitive to the effects of lead as a child's, the Centers for Disease Control and Prevention (CDC) advises that a pregnant women's BLL be below 10-15 μg/dl.[10]

Previous studies reported that overt symptoms of lead poisoning in adults generally begin at BLL's between 60 and 120 μg/dl.[4] Lead-acid battery workers, who may be heavily exposed to lead, have been shown to be at higher risk of dying from cerebrovascular and renal diseases.[4-5] Neurologic, hematologic, and reproductive effects, however, may be detectable at much lower levels, and the World Health Organization (WHO) has recommended an upper limit of 40 μg/dl for adult males.[11] Recent studies suggest that exposure of the developing fetus to BLL's far below these occupational exposure limit is associated with subtle neurologic impairment in early life and that there may not be a safe threshold for this effect.[12-13]

One of the earliest adverse health effects of lead is interference with the production of hemoglobin, the oxygen carrying molecule in red blood cells (RBCs). Heme synthetase, the last enzyme in heme synthesis, may be blocked by lead and cause ZPP to accumulate in RBCs before they are released from the bone marrow, where they are made, into the blood. Initially after lead exposure begins, affected RBCs will be in the minority, but with continued lead exposure the proportion of RBCs with increased amount of ZPP increases. RBCs containing elevated amounts of ZPP can still be circulating 3-4 months after lead has exerted its adverse effects on them. Therefore, BLL and ZPP levels will not rise and fall at the same time or rate.[14]

The ZPP level is a measure of lead interference with hemoglobin production. People who have been exposed to different levels of lead for different periods of time may have different "body burdens" of lead stored in their bones and other tissues; this can affect their ZPP levels.[15-16] Certain medical conditions can also affect protoporphyrin metabolism; iron deficiency is the most common cause of an elevated ZPP in people without occupational lead exposure. Although some disease and iron deficiency anemia can cause a rise in ZPP, in a healthy individual working with lead, lead absorption is the most likely cause for such an increase. ZPP levels begin to increase as BLL reach 14-17 µg/dl and tend to stay elevated for 3-4 months, which is the same duration of the average life span of a RBC. The BLL at which ZPP becomes elevated varies from person to person. At a BLL of 35-40 µg/dl, about one half of adult males will have an elevated ZPP; at BLL of 25-30 µg/dl, about one half of adult females will have an elevated ZPP.[7] Normal values are below 50 µg/dl.

The OSHA lead standard requires exposed workers to have periodic ZPP determinations, but it specifies no level at which any action should be taken. A WHO study group recognized that in countries where blood lead monitoring is impractical, it may be necessary to use ZPP to assess lead exposure. The group recommended that if ZPP is used for this purpose, a worker's ZPP should not exceed the upper limit of the laboratory's "normal" range by more than 50%.[7] Several other laboratory measures of the renal (kidney) effects oflead are reported, including BUN, creatinine, and uric acid.

Lead dust may be carried home on clothing, skin, and hair, and in automobiles of workers occupationally exposed to lead. Presently, there are no federal standards addressing the level of lead in surface dust in either occupational or non-occupational (i.e., residential) settings. However, lead-contaminated surface dust represents a potential exposure to lead through ingestion, especially by children. This may occur either by direct hand-to-mouth contact with the dust, or indirectly from hand-to-mouth contact via clothing, food, and other objects that are contaminated by lead dust. In non-residential environments, such as workplaces and automobiles, the length of exposure, the potential for contact with surface contamination, and the frequency of hand-to-mouth contact may be much less than in the residential setting. The U.S. Department of Housing and Urban Development (HUD) has recommended the following final clearance standards for lead in house dust on specific interior surfaces following lead abatement: 2,150 micrograms lead per square meter ($\mu g/m^2$) on floors; 5,380 $\mu g/m^2$ (window sills); and 8,610 $\mu g/m^2$ (window wells).[19] While comparison between workplace sampling results and the HUD criteria may not be directly applicable, they should provide some reference for assessing the degree of lead contamination and may be useful until they are refined or replaced through additional research.

VI. RESULTS AND DISCUSSION

A. Industrial Hygiene

The surface lead concentrations measured on workers' hands and in their automobiles are summarized in Table 1. Hand wipes were collected from three workers and lead concentrations ranged from 1,000 - 3,024 $\mu g/m^2$ (mean = 1,943 $\mu g/m^2$). To most accurately measure the contamination on hands as the workers leave for home, these samples were obtained after the workers washed their hands with soap and water. Sampling in automobiles of seven workers indicated gross lead contamination on the floor and seat areas (mean = 150,000 $\mu g/m^2$ [floor & seat surface] and mean = 177,964 $\mu g/m^2$ [gas pedal]). On surfaces more likely to be touched by hands, such as the steering wheel and driver's armrest, lead contamination was considerably less (mean = 1,071 and 1,911 $\mu g/m^2$, respectively). The variability of all sampling results was quite high, with relative standard deviations (RSDs) ranging from 52-109%. In addition to differences in lead concentrations, other factors may have contributed to the observed sample variability including type of surface (e.g., cloth versus vinyl), and individual variation in sampling technique. Two wipe samples were also collected in the workplace. A sample collected from the door (above the knob) between the shop and office areas indicated a lead concentration of 3,797 $\mu g/m^2$. Of more immediate concern is the measured surface lead contamination of 24,367 $\mu g/m^2$ on a tabletop in the lunch area, where it could contaminate food, utensils, or hands and then be ingested.

It was noted through observation and limited discussion with the workers that the hygiene practices are lacking. Most, but not all, workers washed only their hands prior to leaving work. Work clothes were worn home by all workers who were interviewed. No facilities for changing into street clothes were observed.

It was also noticed that the workers handling molten lead have insufficient personal protective equipment. The workers were given safety glasses but not gloves or aprons to protect the rest of the body from molten lead. In addition some of the stations where workers were making the seals by hand from molten lead lacked appropriate ventilation hoods. Box fans were used to help keep the worker cool and to blow the fumes away from the worker into the rest of the shop.

B. Medical

Index Case:

An employee of the United Seal Company visited a physician earlier this year and was found to have elevated BLL. Besides the lead exposure at work, lead paint exposure at home was also noted. At the time of the request being made, the patient and the patient's children were treated for lead poisoning by a local hospital in Columbus, Ohio.

Questionnaire Survey:

A total of 13 employees, 7 females and 6 males, were interviewed during the site visit. Their ages ranged from 23 to 72, with a mean of 45; most of them were between 40 and 50. Nine of the interviewees were Asian, three were white, and one was black. Ten of them had high school educations (four graduates); none of them went to college, and three of them had the educations from 1-8 grades. Most of the interviewees are married, and eight of them had children 16 years old or younger living with them; a total of 15 children in that age range were identified. The duration of employment at United Seal among these workers range from one and one half years to 24 and one quarter years, with the mean duration 9 years. Most of the workers had no other working experience before coming to United Seal. All worked 5 days a week, and almost all of them worked 8 hours a day. Ten of the interviewees reported having some medical problems during the past 2 weeks; the most common symptoms were unusual tiredness (six) and poor memory or confusion (four). In addition, three of them were told by doctors that they had high blood pressure.

Most of the interviewees wore safety glasses at work, but only three of them wore gloves. Two of them wore disposable paper "dust masks" at work; no other respiratory protection equipment was used by any of the interviewees. The company did not provide work clothes to the employees, and there were no shower facilities in the plant for workers. None of the interviewees change clothes or shoes before leaving work, and they all take their dirty work clothes home. Most of the interviewed workers always washed their hands before lunch, and all except one of them always washed hands before going home. All the interviewees ate at the factory; 12 of them ate in the lunchroom, and one of them ate at a work station. Two of them smoked cigarettes at work, either in the lunchroom or outside the plant. From the interviews, no obvious occupational exposure to lead from previous or other jobs nor remarkable non-occupational exposure (including possible exposure from folk medicine to lead) were identified.

About half of the interviewees recalled receiving training from the company about the hazards of exposure to lead, but most of the "training" consisted of written materials with no assistance given to interpret them in spite of the fact that many workers had limited comprehension of English. Some of them received such materials years after they had begun to work in the plant.

Blood Tests:

The blood test results are shown in Table 2. Among the seven workers tested, two of them had a BLL higher than the Public Health Service's goal of 25 μg/dl; none exceeded the OSHA action level of 40 μg/dl (Table 2). None of the other test results (ZPP, serum creatinine, uric acid, and BUN) were outside the normal ranges (Table 2). Because one of the seven workers refused to provide sufficient blood, some of the tests were performed on six workers only.

Follow-up Studies on Children:

A list of the interviewed employees who were living with children under 16 was mailed to the Columbus Childhood Lead Poisoning Prevention Program for follow-up studies on children. This list included the name, address, and phone number (if available) of the interviewee and the number of children living with the interviewee. In addition, the age and sex of these children were also listed. The follow-up studies were planed to begin in January of next year.

VII. CONCLUSIONS

1. Wipe sampling indicated that workers' hands are contaminated with lead even after washing with soap and water prior to leaving the worksite at the end of the shift. Surface lead concentrations are quite high in workers' automobiles, particularly on the seat and floor areas.

2. Shower and change facilities are not available and work clothing is normally worn home by all workers. Proper personal hygiene practices are not regularly followed by many workers.

3. Personal protective clothing such as gloves and coveralls are not provided to workers exposed to lead, thereby increasing the possibility of the workers' skin and personal clothing becoming contaminated by lead.

4. In addition to the index case, two of the seven workers test had elevated BLL's indicating excessive exposure to lead.

VIII. RECOMMENDATIONS

In general, the recommendations for engineering controls, personal protective equipment, and personal hygiene practices, and medical surveillance in the NIOSH Alert - Preventing Lead Poisoning in Construction Workers[18] apply to all lead-exposed workers. The following specific recommendations are offered as prudent practices to prevent respiratory and skin exposure to lead.

1. In order to inform workers about the health hazards of lead and prevent excess lead exposure, education and job training should be given before a new worker begins to work in the plant.

2. Education materials and warning signs in the workplace should be translated, at least orally, into other relevant languages to make sure they are fully understood by the workers.

3. The employer should provide any worker potentially exposed to lead with clean protective work clothing and equipment. Appropriate clothing and equipment might include coveralls, gloves, hats, shoes, and NIOSH-approved respirators (any air-purifying respirator equipped with HEPA filters[19]). The workers should be trained to use them properly and their usage strictly enforced.

4. Shower and changing facilities should be made available by the employer. Contaminated clothing and equipment must not be permitted to leave the worksite. Certain mechanisms for cleaning the contaminated clothing, such as a laundry machine in the workplace or a contract laundry, should be made available to the workers. This is a significant step in reducing the transfer of lead from the workplace into a worker's home and provides added protection to employees and their families.

5. Workers should be required to wash their hands and face before eating, drinking, smoking, or applying cosmetics. Such activities should be done away from the work area, and smoking should not permitted indoors except in separately ventilated rooms that are not used for other purposes.

6. Since the work surfaces and workers' cars are highly contaminated with lead, employees should perform proper cleaning with a HEPA-filtered vacuum cleaner and tri-sodium phosphate (TSP) detergent, as recommended by the U.S. Department of Housing and Urban Development[20]. These materials and equipment should be provided by the employer. Wipe sampling should then be performed to assess the success of these cleaning efforts.

7. All surface should be maintained free of accumulations of lead through regular housekeeping and engineering controls. To assess the effectiveness of these measures, regular lead exposure monitoring (including wipe sampling for surface lead contamination) and BLL testing are strongly recommended.

8. For those employees who did not participate in the interview, evaluation of the possible lead exposure to lead among their children is highly recommended, because they might not be covered by the follow-up studies to be conducted by the Columbus Childhood Lead Poisoning Prevention Program in Columbus.

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Copies of this report have been sent to:

1. Columbus Childhood Lead Poisoning Prevention Program, Columbus, Ohio.
2. The United Seal Company, Columbus, Ohio.
3. OSHA, Columbus Ohio.

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

Environmental Sampling Results
United Seal Company
Table 1

Summary of Lead Contamination in Workers' Hands and Automobiles
in micrograms of lead per square meter ($\mu g\ Pb/m^2$)

Worker	Hands[1]	Steering Wheel[2]	Driver's Armrest[2]	Gas Pedal[2]	Driver's Seat & Floor[3]
A	1,000	302	615	7,970	6,171
B	1,805	2,314	2,926	166,389	348,101
C	3,024	2,478	4,098	81,500	268,987
D	-	272	673	80,690	52,215
E	-	426	431	27,812	11,076
F	-	500	1,632	343,438	15,348
G	-	11,202	3,000	537,949	348,101
Mean RSD[4]	1,943 52%	1,071 90%	1,911 75%	177,964 109%	150,000 109%

[1] Calculated using a size of 0.082 m^2 per pair of hands (from EPA)[2]

[2] Wipe sample

[3] Vacuum cassette sample

[4] Relative standard deviation = (standard deviation/mean value) x 100

Blood Test Results
United Seal Company
Table 2

Summary of Other Blood Test Results among Workers

Test (unit)	Participants	Mean	Range	Normal Range	Abnormal
BLL[a] (ug/dl)	7	18.7	9.1-27.3	0-24.9[b]	2 (29%)
ZPP (ug/dl)	7	39.9	27-49	15-50	0 (0%)
Uric Acid (mg/dl)	6[c]	6.3	4.7-7.6	2.2-8.3	0 (0%)
BUN (mg/dl)	6[c]	14.7	11-19	6-23	0 (0%)
Creatinine (mg/dl)	6[c]	0.9	0.8-1.2	0.6-1.3	0 (0%)

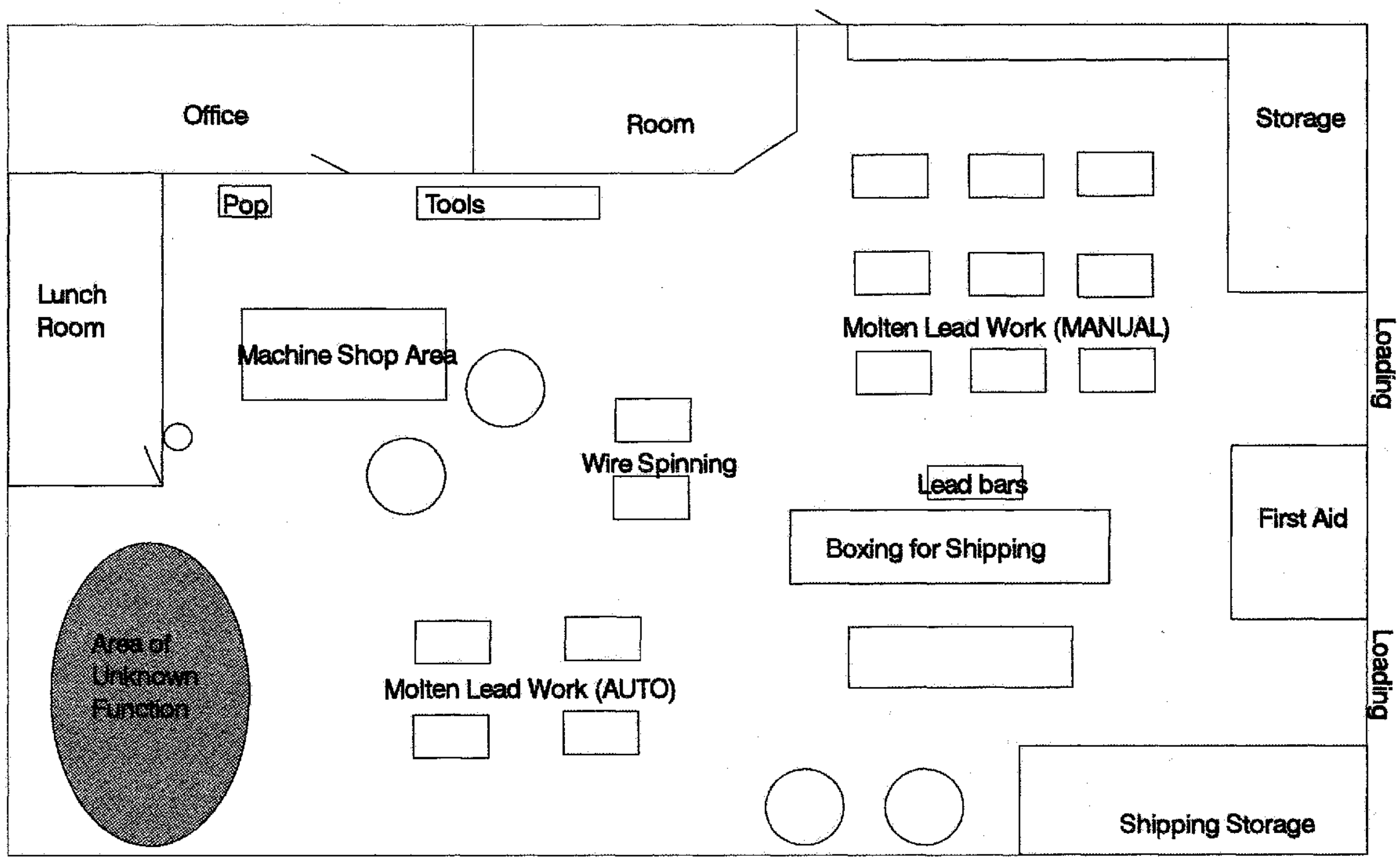
[a]All workers tested had detectable blood lead levels.

[b]The 25 ug/dl is a Public Health Service goal for occupationally exposed adults; the OSHA action level is 40 ug/dl. Most non-occupationally exposed adults have a BLL less than 20 ug/dl, with an average less than 10 ug/dl.

[c]One of the participants refused to provide sample for these tests.

The United Seal Company

Very General Floor Plan-- May not be exact



Delivering on the Nation's promise:

Safety and health at work
For all people
Through prevention

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