HETA 91-391-2174
JANUARY 1992
NEW ENGLAND LEAD BURNING CO.
EATON METALS
SALT LAKE CITY, UTAH

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I. SUMMARY

On July 5, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Director of the Department of Safety and Health, United Association of the Plumbing and Pipe Fitting Industry, to conduct a health hazard evaluation (HHE) at the New England Lead Burning Company, Inc. (NELCO) project in Salt Lake City, Utah. The requestor was concerned about lead exposure among members of Lead Burners Local 153 working at the NELCO contract site in Utah. That HHE was completed in August, 1991.[1]

On August 29, 1991, the union requested that NIOSH conduct a follow-up HHE at the Salt Lake City NELCO site to determine if worker exposures had been reduced as a result of the changes made from the initial HHE. On September 26, 1991, a follow-up site visit was conducted. During this survey personal breathing zone samples for lead were collected, reported changes in the workplace sine July 1991 were observed, and blood samples were collected from 22 workers to determine blood lead levels (BLL), zinc protoporphyrin levels (ZPP), and to estimate employee kidney function using blood urea nitrogen (BUN) and creatinine (CR). In addition, employees had their blood pressure measured.

All 22 of the employees working the day and evening shifts on September 26, 1991, provided a blood specimen. The mean BLL was 23 micrograms (ug)/100 grams whole blood (range 4 to 38). No employees had BLLs over 40 ug/100 grams whole blood, the level at which Utah Occupational Safety and Health regulations require bimonthly testing for employees working in areas where lead exceeds 30 ug/m^3. The mean ZPP level was 52 ug/deciliter (dl) (range 15-222). Six employees (27%) had ZPP levels above the laboratory's reference range of 50 ug/dl. Ten of the 22 workers were present during both NIOSH surveys. The BLL of these 10 employees dropped a mean of 8 ug/100 grams whole blood (p-value=0.01).

No employees had CR above the normal range ($\leq$1.3 mg/dl), while two employees (9%) had BUN above the normal range ($\leq$23 mg/dl). Estimates of creatinine clearance (CrCl) revealed a mean CrCl of 85 (normal 80-120 l/min). Five employees (23%) had CrCl below normal. Six employees (27%) had elevated systolic and diastolic blood pressures (systolic >140 mm hg, diastolic >90 mm hg), and two other employees (9%) had elevated systolic blood pressures.

Time-weighted average exposures for airborne lead ranged from 23 to 1790 micrograms of lead per cubic meter of air (ug/m^3). All but one of these concentrations were above the Utah OSHA Permissible Exposure Limit (PEL) of 50 ug/m^3 as an 8-hour TWA. The short-term lead concentrations for the various jobs ranged from 53 to 450 ug/m^3

during lead burning, 390 to 1970 ug/m^3 during nozzle bonding, 105 to 511 ug/m^3 during clean-up work outside of the tank, and from 16 to 29 ug/m^3 during welding. The employees were wearing respiratory protection; therefore, the actual exposures may have been less than these values, provided that the respirators were properly fitted and maintained. Wipe sampling revealed the presence of lead contamination on table surfaces in the lunch room, on workers' clothes and shoes, in the workers' cars, and on the floor of the change room.

Personal breathing zone lead levels remained above the state-enforced PEL, and wipe sampling revealed persistent lead contamination both inside and outside the work site. Despite these shortcomings, employee BLLs were reduced and none were above the level requiring medical removal or bimonthly BLL testing. The drop in employee BLLs followed changes made by the company as a result of the prior NIOSH survey. The major changes included the addition of air-supplied hood respirators, an onsite trailer with showers and change rooms, daily uniform changes, and a general improvement in hygiene practices.

KEY WORDS: SIC 3443 (Fabricated Plate Work), Tank Construction, Inorganic Lead, Lead Lining, Lead Burning, Lead Burners, Blood Lead, Zinc Protoporphyrin

II. INTRODUCTION

NIOSH received an HHE request on July 5, 1991, from the Director of the Department of Safety and Health, United Association of the Plumbing and Pipe Fitting Industry, to determine lead exposure among members of the Lead Burners Local 153 working at the NELCO site in Salt Lake City Utah. That HHE was completed and the final report distributed in August, 1991.[1]

On August 29, 1991, the union requested that NIOSH conduct a follow-up HHE at the Salt Lake City NELCO site to determine if worker exposures had been reduced as a result of the changes made from the initial HHE. On September 26, 1991 a follow up site visit was conducted. During this survey personal environmental air samples for lead were collected, a review of the changes made since the last site visit was conducted, and blood samples were collected from 22 workers to determine blood lead levels (BLL), zinc protoporphyrin levels (ZPP), and to estimate renal function. All workers were notified by letter of their medical results on October 29, 1991.

III. BACKGROUND

A. General Description of NELCO Operations

The New England Lead Burning Company, Inc. (NELCO) contracts for jobs throughout the United States that involve the use of lead. The NELCO job at Eaton Metals involved the lining of two 85-foot long, 14-1/2 foot diameter steel tanks with lead sheets. The tanks had been constructed by Eaton Metals and the lining of the tanks had been subcontracted to an engineering firm which contracted with NELCO to complete the task. The job was scheduled to be completed in 14 weeks.

B. Workforce

The NELCO employees working at the Salt Lake City location are members of Lead Burners Local 153, headquartered in North Carolina. Members of the local, about 100, travel across the country to various jobs which may last a week to several months. There are two main employers who hire members of the local, although other companies may also employ them.

C. Description of Company Operations

The tanks being lined were to be used for the processing of gold ores where acids are used to extract the metal from the ore. The purpose of the lead lining in the tanks was to provide an acid-resistant coating. Lead sheeting (18 inches by 48 inches by 5/16-inch) was bonded to the steel tank, and the 1/2-inch wide seams between the sheets were filled with lead to the same depth. Areas around the intakes to the tanks (nozzles) and nozzles protruding from the tank required homogeneous lead linings. The job of lining a tank with lead involved three steps: grinding, tinning, and bonding/burning.

1. <u>Grinding</u>
The entire inside surfaces of the nozzles, 8-inches around the nozzle openings into the tank, and the outline of the lead sheets (1/2-inch seams) were ground until completely shiny. These areas were then quickly soldered avoid reoxidation of the steel.

2. <u>Tinning</u>
The term "tinning" is derived from the solder used on the newly ground surfaces, which contains an 85% mixture of lead and tin. The remaining 15% consists of zinc chloride, ammonium chloride and ethylene glycol ether. The solder was diluted in a crucible with muriatic acid (20% hydrochloric acid) before application. The surface to be soldered was first heated with gas fired torches. These torches were placed under the tank, around the area to be tinned and allowed to heat the surface for about 30 minutes. The tinning process required 2 to 3 workers: one to operate the torch, one to apply the solder, and one to wipe the newly tinned surface. As the solder was applied, the torch operator would heat the solder until it was bonded. Once he removed the torch, the other worker would quickly wipe the newly soldered surface to insure that the surface was well covered. The torch operator would then apply the torch again, followed again by wiping until the job was complete. Two workers could do the job if the one wiping also applied the solder. The process required substantial heat for proper application of the solder. If the areas were not completely soldered, the lead sheets would not be effectively bonded to the tank.

3. <u>Bonding/Burning</u>
Once the outline for the lead sheets had been tinned, they were laid in place and bonded to the seam. This was accomplished by simply melting the edge of the lead sheet to the soldered area. The seam left between the juncture of two sheets was filled to a

uniform depth with lead material. Lead rods were melted by torches to fill in these gaps. This was referred to as lead burning. Those areas which required homogeneous linings with lead (e.g., around each nozzle) were completely filled in by lead burning.

D. Personal Protection and Engineering Controls

Personal protective equipment worn by the workers included a full-face piece respirator with a combination cartridge that included a high efficiency particulate filter and organic vapors/acid gases cartridges, or a Type C air-supplied hood respirator. Most workers involved in lead burning wore the air-supplied respirators while workers involved in activities outside the tanks (e.g., cleanup or welding) wore full-face piece respirators. All workers wore disposable Tyvek coveralls, work uniforms, work boots, safety glasses, and gloves. Hearing protection (ear plugs) were used for all jobs in the tanks. Several changes in personal protection equipment had been made by the company as a result of the first NIOSH survey. This included the addition of air-supplied respirators, company-provided uniforms, and more uniform wearing of hearing protection.

Several fans were used to ventilate each tank. Four 1500-2000 cubic feet per minute (CFM) supply fans were used on each tank to provide general dilution ventilation. Each tank had four local exhaust fans which were used at the point where workers were burning lead. Most of the available inlets to the tanks, minus one or two for worker access, were utilized for ventilation.

Since the initial visit, the company had installed a change trailer complete with showers, respirator storage bins, closets for clean uniforms, and bins for used clothing. The workers went to the trailer as they arrived at work, changed into work uniforms and boots, put on a Tyvek suit, and then went to the worksite. At the end of the shift, they were to remove the soiled Tyvek suit and uniform, place the used items in appropriate bins, take a shower, and put on their street clothes. The trailer was equipped with wash basins for cleaning before breaks, lunch, etc.

The trailer also had wooden bins for respirator storage between shifts. Plastic bags were made available for storage of respirators when not in use. Pegs were available outside the trailer to store the respirators during breaks. Additional training had been provided to the workers regarding the hazards associated with lead, the clothes change policy, and respirator use and storage. The air supplied hood respirators were also new since the first visit.

E. Environmental and Medical Monitoring Program

Air and blood monitoring of the employees for lead levels was performed through a local occupational health consultant. The job was expected to last 14 weeks, and many of the workers had been monitored prior to this job for blood lead. In addition to the first NIOSH HHE, air monitoring had been conducted twice since the job started. Since many of the workers had been employed by NELCO for their last job, which was also in Salt Lake City, blood lead results were available for these workers for the last four to five months. No lab reports were available at the site, only results that had been recorded by the job superintendent. Blood lead levels (BLL) from June 21, 1991 ranged from 21 to 58 micrograms per 100 grams of whole blood (ug/100 g), with an average of 35 ug/100 g. BLLs from the July 10, 1991, NIOSH survey ranged from 11 to 77 ug/100 g with an average of 34 ug/100 g.

IV. MATERIALS AND METHODS

A. Environmental

On September 26, 1991, a follow-up environmental and medical survey was conducted to determine employee exposures to lead. During this survey, personal breathing zone (PBZ) air samples were collected near the workers' breathing zone for lead and trace metals. Samples were obtained using Gilian model HSF 513A battery-powered sampling pumps operating at 2.0 liters of air per minute. The pumps were attached by Tygon tubing to the collection medium (37-millimeter (mm), 0.8 micron pore size, mixed-cellulose ester membrane filters contained in 2-piece plastic cassettes). The sampling media for the personal samples were replaced after lunch during the work shift. Wipe samples were collected with a baby wipe (Scott Paper Company Wash a-bye Baby) which had been tested by other NIOSH personnel and shown to contain very low levels of background lead contamination.

The air and wipe samples were analyzed for lead by atomic absorption spectroscopy according to NIOSH method 7082.[2] In addition, the samples collected during welding and outside cleanup operations were analyzed for 30 trace metals using inductively coupled plasma - atomic emission spectroscopy in accordance with NIOSH Method 7300.[2]

B. Medical

Employees working the day and evening shift were offered the opportunity to have 1) their blood pressure taken, 2) their blood drawn and analyzed for lead and ZPP levels, and 3) their kidney function assessed using blood levels of urea nitrogen (BUN) and creatinine (CR). The blood CR was used to estimate creatinine clearance (CrCl) for men based on their age, weight, and height.[3] All 22 employees (including the two job superintendents) participated in the survey.

BLL, ZPP, BUN, and CR were analyzed by a laboratory approved for blood lead analysis by the Occupational Safety and Health Administration based on proficiency testing.[4] The blood leads were determined utilizing anodic stripping voltimetry, and ZPPs were determined by photofluormetric techniques.[5] The laboratory reported the blood lead levels as microgram (ug) per deciliter (dl). These values were converted to ug per 100 grams whole blood (units used in the OSHA lead standard), using 1.052 as the specific gravity of blood.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week, for a working lifetime, without experiencing adverse health effects. It is important, however, to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a preexisting medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects often are not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes and, thus, potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards [Permissible Exposure Limits (PELs)]. Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that the company is required by the Occupational Safety and Health Administration to meet those levels specified in an OSHA standard. A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday.

A brief discussion of the toxicity and evaluation criteria for inorganic lead follows.

1. <u>Toxicity</u>

Inhalation (breathing) of lead dust and fume is the major route of lead exposure in the industrial setting. A secondary source of exposure may be from ingestion (swallowing) of lead dust deposited on food, cigarettes, or other objects. Once absorbed, lead is excreted from the body very slowly. Absorbed lead can damage the peripheral and central nervous systems, gastrointestinal system, kidneys, reproductive system, hematopoietic system (blood forming organs), and virtually all other systems of the body.[6] The acute effects may manifest as weakness, tiredness, irritability, reduced intelligence, slowed reaction times, abdominal pain, or high blood pressure.[7] Chronic lead exposure can cause infertility, kidney damage, and, in pregnant women, fetal damage manifested as prematurity, reduced birth weight, reduced red blood cell production, and reduced intelligence.[8-12] The blood lead test is one measure of the amount of lead in the body and is the best available measure of recent lead absorption. The mean serum lead level for US men between 1976 and 1980 was 16 ug/dl;[13,14] however, with the implementation of lead-free gasoline and reduced lead in food, the 1991 average serum lead level of U.S. men will probably drop below 9 ug/dl.[6] A summary of the lowest observable effect levels of lead are listed in Table 1.

2. Medical Exposure Criteria

The OSHA lead standard requires annual blood lead testing for employees exposed to lead above the action level (30 ug/m^3).[15] If an employee's blood lead level is at or above 40 ug/100 grams of whole blood, the employee must have his blood lead checked every 2 months. If an employee's blood lead level averages 50 ug/100 grams of whole blood or more, he must be removed from areas containing more than 30 ug/m^3 airborne lead, and have monthly blood lead tests.[15] For employees removed from lead exposure, the OSHA lead standard requires the employer to maintain the earnings, seniority, and other employment rights and benefits as though the employee had not been removed. For an employee to return to work in the area with excessive lead exposure, their blood lead level must be below 40 ug/100 grams of whole blood on two consecutive tests if the original blood lead was between 50-60, or drop at least 20 ug/100 grams of whole blood on two consecutive tests if the original blood lead was greater than 60.[15] The blood samples must be analyzed by a laboratory that has been approved by OSHA.[4]

Zinc protoporphyrin (ZPP) levels measure the effect of lead on the red blood cell enzyme ferrochelatase, the last enzyme involved in the process of heme synthesis. In men, ZPP levels increase abruptly when blood lead levels rise above 35 ug/dl, and they tend to stay elevated for several months.[15] In women, ZPP level rise at a BLL of 25 ug/dl. The upper limit of normal for ZPP is 50 ug/dl; in the absence of lead exposure, the most common cause of an elevated ZPP is iron deficiency.[17]

3. Occupational Exposure Criteria

The work performed by NELCO was classified as construction, which in the past would have exempted it from most elements of the OSHA general industry lead standard. The State of Utah, however, passed legislation which eliminated the construction exemption from their state lead standard (effective July 15, 1991). Therefore, the company must comply with all elements of the OSHA general industry lead standard. The current OSHA PEL for airborne lead is 50 ug/m^3 calculated as an 8-hour TWA for daily exposure. The standard also specifies that if more than 8 hours are worked in any work day, the PEL should be adjusted accordingly, e.g., the PEL for a 10-hr work day is 40 ug/m^3.[15] In addition, the OSHA lead standard establishes an "action level" of 30 ug/m^3 TWA which initiates several requirements of the standard, including periodic exposure monitoring, medical surveillance, and training and education.[15] If the initial determination shows that any employee's 8-hr TWA PBZ results are above 30 ug/m^3, air monitoring must be performed every six months until the results show two consecutive levels of less than 30 ug/m^3 (measured at least seven days apart).

VI. RESULTS

A. Air Samples

The results of the air samples for lead are contained in Table 2. Time-weighted average exposures for lead ranged from 23 to 1790 micrograms of lead per cubic meters of air (ug/M^3). All but one of these samples exceeded the OSHA Permissible Exposure Limit (PEL) of 50 ug/M^3 as an 8-hour TWA. In addition, the shift lasted for 10 hours which effectively lowers the PEL to 40 ug/M^3. The short-term lead concentrations for the various jobs ranged from 53 to 450 ug/M^3 during lead burning, 390 to 1970 ug/M^3 during nozzle bonding, 105 to 511 ug/M^3 during clean up work outside of the tank, and from 16 to 29 ug/M^3 for welding (also outside the tanks). Most of the workers involved in lead burning and bonding of nozzles were wearing air-supplied hood respirators so their actual exposure would be expected to be substantially lower than the measured values, provided that the respirators were operating properly.

The wipe sample results are summarized in Table 3. The samples indicate lead contamination on all surfaces tested: lunch room table, water cooler, door handles, change room floor, work and street clothes, and in the workers' clothes. Many of these levels are as high as or higher than was measured during the first site visit.

B. Medical

1. Blood Lead Levels (BLL) and Zinc Protoporphyrin Levels (ZPP)

The mean BLL was 23 micrograms (ug)/100 grams whole blood (range 4 to 38). No employees had BLL over 40 ug/100 grams whole blood, the level requiring bimonthly testing for employees working in areas where lead exceeds 30 ug/m^3. The mean ZPP level was 52 ug/deciliter (dl) (range 15-222). Six employees (27%) had ZPP levels above 50 ug/dl. Ten of the total 2 workers were employed at the site during both NIOSH investigations. The BLL of these 10 employees dropped a mean of 8 ug/100 grams whole blood (p value=0.01). Nine of these 10 employees' BLLs dropped; the other went from 25 to 27, a difference within the acceptable range of analytical variability.

2. Blood Urea Nitrogen (BUN) and Creatinine (CR) and Creatinine Clearance

No employees had CR above the normal range ($\leq$1.3 mg/dl), while two employees (9%) had BUN above the normal range ($\leq$23 mg/dl). Estimates of creatinine clearance (CrCl) revealed a mean CrCl of 85 L/min (normal 80-120 L/min). Five employees (23%) had CrCl below normal, one of which also had the elevated BUN level.

3. Systolic and Diastolic Blood Pressure Measurements

Six employees (27%) had elevated systolic and diastolic blood pressures (systolic >140 mm hg, diastolic >90 mm hg), and two other employees (9%) had elevated systolic blood pressures.

VII. DISCUSSION

A. Environmental

The environmental samples for lead were up to 40 times the OSHA PEL on a TWA basis. Most of the workers were in air-supplied respirators while in the tanks. Also, due to production problems, the company was trying to rapidly complete one of the tanks. This resulted in a large number of workers concentrated in one tank; this probably was responsible for the higher air lead concentrations we observed during the follow-up survey, despite improved tank ventilation.

While significant housekeeping improvements have been made since the first NIOSH site visit, wipe sample results indicate more improvements are needed. The floors and tables in the lunch room and change trailer were washed daily. The wipe samples were collected prior to these areas being cleaned. No post clean up sampling was conducted so the immediate efficacy of the clean-up effort is unknown. However, lead contamination was evident despite the prior day's cleaning.

B. Medical

The blood lead levels (BLL) of 9 of the 10 employees had decreased since the last NIOSH visit. Although many of these were small decreases within the acceptable range of analytical variability, the fact that 90% of the values decreased and the mean BLL was lower (p-value=0.01) suggests an effect other than laboratory variability.

All BLLs were below 40 ug/100 grams of whole blood. Several of the ZPP levels were still elevated, indicating higher BLL during the previous two to three months. The elevated ZPP levels were expected given the elevated BLL during the July survey.

Five employees were identified with potential kidney dysfunction. Three of these five had a borderline normal estimated CrCl (67, 69, and 69 ml/min); however, two employees had significantly reduced values of 56 and 57. These reduced values should be interpreted with caution because the method used to estimate the CrCl is not as reliable an indication of kidney function as the CrCL determined using a 24-hour urine collection. Individuals with reduced values should be followed-up by their physicians to evaluate this finding. Although reduced CrCl is not specific for lead poisoning, the relatively high prevalence of employees with abnormal estimated values, suggests the possibility of chronic lead toxicity.

Eight employees (36%) had either elevated systolic, or systolic and diastolic blood pressure measurements. Like CrCl, high blood pressure is not specific for lead poisoning. In some individuals, elevated blood pressure could represent chronic lead toxicity, particularly in the two individuals with both elevated blood pressure and reduced estimated CrCl.

VIII. CONCLUSIONS

The environmental survey revealed airborne lead exposures well above the OSHA PEL. In addition, many areas remained contaminated with lead. No workers had BLL above 40 ug/100 grams of whole blood, and the BLL of employees working at the site during both NIOSH surveys dropped a mean of 8 ug/100 grams whole blood. Despite the high air lead concentrations, and persistent lead contamination, BLLs decreased.

This is probably primarily due to the use of air-supplied respirators. Other contributing factors include the company supplied and laundered uniforms, increased emphasis on reducing lead contamination, and, in general, the prompt implementation of NIOSH recommendations.

IX. RECOMMENDATIONS

1. Additional efforts regarding the clean up of lead contamination should be undertaken. Part of the problem stems from workers tracking the lead around the site. Workers should remove their contaminated footwear and clothing whenever they enter the lunch room or change trailer. Another option might be the use of disposable booties which could be inexpensively discarded whenever workers enter these areas. The change trailer should be divided into clean and dirty areas to avoid cross-contamination. Employees should be required to shower at the end of the shift. No clothing or equipment worn during the shift should be worn home, including shoes and underwear.

2. Respirators were stored with no protection against contamination. This was particularly true of the half-face respirators that were removed and stored on the pegs outside the change trailer during breaks. Respirators should be stored in protective bags. The respirators should be cleaned prior to being placed in the protective bags.

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C. Lead Burners Local 153, Murphy, North Carolina
D. NELCO, Santa Fe Springs, California
E. Occupational Safety and Health Administration - Region VIII
F. Utah Department of Health
G. Utah Occupational Safety and Health
H. NIOSH Regional Offices/Divisions

For the purposes of informing the affected employees, copies of the report should be posted in a prominent place accessible to the employees, for a period of 30 calendar days.

TABLE 1
Summary of Lowest Observed Effect Levels for
Key Lead-Induced Health Effects in Adults and Children[@]

BLL* (ug/dl)		HEALTH EFFECT
>100	Adults:	Encephopathic signs and symptoms
>80	Adults:	Anemia
	Children:	Encephopathic signs and symptoms
		Chronic nephropathy (aminoaciduria, etc)
>70	Adults:	Clinically evident peripheral neuropathy
	Children:	Colic and other Gastro-Intestinal (GI) symptoms
>60	Adults:	Female reproductive effects
		CNS symptoms:sleep disturbances, mood changes, memory and concentration problems, headache.
>50	Adults:	Decrease hemoglobin production
		Decreased performance on neurobehavioral tests
		Altered testicular function
		GI symptoms: abdominal pain, constipation, diarrhea, nausea, anorexia
	Children:	Peripheral neuropathy
>40	Adults:	Decrease peripheral nerve conduction
		Elevated blood pressure (white males, 40-59 yr old)
		Chronic nephropathy
	Children:	Reduced hemoglobin synthesis
>25	Adults	Elevated erythrocyte protoporphyrin levels in males
15-25	Adults	Elevated erythrocyte protoporphyrin levels in females
	Children:	Decreased IQ and Growth
>10**	Fetus:	Pre-term Delivery
		Impaired Learning
		Reduced Birth Weight
		Impaired Mental Ability

@ Adopted from ATSDR[7], and Goldman et al.[18].
* Blood lead level (BLL) in micrograms per deciliter (ug/dl).
** "Safe" blood lead levels have not been determined for fetuses.

TABLE 2
SUMMARY OF WORKER EXPOSURES TO LEAD
NELCO
SALT LAKE CITY, UTAH
SEPTEMBER 26, 1991

Sample #	Job Description	TOD	Duration (min)	Volume (liters)	Concentration (ug/M3)
NL-16	Lead Burning	AM	239	478	110
NL-29	"	PM	273	546	310
			512	TWA	220
NL-21	Lead Burning	AM	283	556	230
NL-25	"	PM	279	558	250
			562	TWA	240
NL-15	Bonding Nozzles	AM	279	558	390
NL-35	"	PM	277	554	450
			558	TWA	420
NL-14	Lead Burning	AM	283	566	58
NL-36	"	PM	278	556	110
			561	TWA	84
NL-11	Lead Burning	AM	174	348	140
NL-26	"	PM	310	620	230
			484	TWA	200
NL-17	Bonding Nozzles	AM	271	542	1600
NL-23	"	PM	279	558	1970
			550	TWA	1790
NL-20	Lead Burning	AM	274	548	120
NL-33	"	PM	278	556	290
			552	TWA	210
NL-12	Lead Burning	AM	209	418	53
NL-22	"	PM	279	558	320
			488	TWA	210
NL-13	Clean up	AM	273	546	105
NL-27	"	PM	152	304	109
			425	TWA	106
NL-19	Cleanup	AM	274	548	511
NL-34	"	PM	226	452	288
NL-31	"	PM	56	112	ND*
			556	TWA	370
NL-10	Welding, grinding	AM	262	524	29
NL-30	outside	PM	276	562	16
			528	TWA	23

Environmental Criteria: Inorganic Lead - OSHA - 50 ug/M^3, 8-hour TWA.
TWA - Time-weighted average: ug/M^3 - micrograms per cubic meter of air
*ND - none detected

TABLE 3
SUMMARY OF WIPE SAMPLES FOR LEAD
NELCO
SALT LAKE CITY, UTAH
SEPTEMBER 26, 1991

Sample #	Location/Description	Amount (ug Pb)	Conc (ug/cm^2)	Conc (ug/ft^2)
NLW-101	Lunch room table	28	0.28	260
NLW-102	Around base of water cooler	150	1.5	1400
NLW-103	Small table in center of lunch room	200	2.0	1860
NLW-104	Door handle of change trailer	82	1.6	1490
NLW-105	Bottom of tennis shoe (street shoe)	430	5.7	5300
NLW-106	Top of wooden bench in change room	370	3.7	3400
NLW-107	Worker's truck, floor mat, driver's side	390	3.9	3600
NLW-108	Floor of change room trailer	500	5.0	4650
NLW-109	Bottom of old work boot	38,000	380	350,000
NLW-110	Worker's truck, floor, driver's side	320	3.2	2970