HETA 93-0511-2391
FEBRUARY 1994
STATE OF RHODE ISLAND
DEPARTMENT OF EMPLOYMENT
AND TRAINING
PROVIDENCE, RHODE ISLAND

NIOSH INVESTIGATORS:
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I. SUMMARY

On January 7, 1993, the National Institute for Occupational Safety and health (NIOSH) received a request for a Health Hazard Evaluation (HHE) to assess potential lead contamination within the Rhode Island Department of Employment and Training (DET), Providence, Rhode Island. The request concerned potential lead exposure among DET employees following extensive abrasive blasting to remove lead-based paint from the interior surfaces of the facility.

NIOSH investigators performed environmental monitoring for lead on January 12-13, 1993. This was approximately 18 months after completion of the lead abatement activity. No lead was detected in any of the twelve general area samples obtained for airborne lead. Two bulk samples of residue abrasive blasting any paint chips material contained 3,300 and 120,000 µg-lead/gram of material. Forty wipe samples obtained from surfaces in the office ranged between 9 and 200,000 µgl ead/ft^2. These results are consistent with previous samples collected by the Rhode Island Department of Health.

Surface wipe samples indicate a potential health hazard due to the presence of lead-contaminated dust in the Rhode Island Department of Employment & Training. Manual cleaning and vacuuming of these areas using a high-efficiency particulate air (HEPA) filtering system is recommended. Additional recommendations and precautions are presented in Section IX of this report to reduce the potential for lead exposure.

KEYWORDS: SIC 9441 (State Governmental Facility), Lead, Abrasive Blasting, IAQ, Indoor Environmental Quality, (IEQ) Lead Abatement

II. INTRODUCTION

On January 7, 1993, NIOSH received a request for a Health Hazard Evaluation (HHE) from the management of the Rhode Island Department of Employment and Training (DET), Providence, Rhode Island. The request concerned potential exposures to lead following abrasive blasting to remove lead-based paint from interior surfaces of the facility, prior to occupancy.

NIOSH investigators conducted site visits on January 12-13, 1993, and performed environmental sampling to assess worker exposures to lead and to evaluate exposure control measures.

An opening conference was held with management and union representatives where NIOSH procedures and objectives were discussed. Following the opening conference, a walk-through survey was conducted which included a review of the physical characteristics of the building, observation of employee work areas, and examination of the mechanical ventilation equipment. Area air sampling and surface wipe sampling for lead was conducted throughout the office. Two bulk samples of surface dust were obtained and analyzed for lead.

III. BACKGROUND

(A) Historical

The building occupied by the Department of Employment and Training (DET) served as a jewelry manufacturing establishment during the preceding 100 years. DET first began to occupy the building in 1990. During the renovation of this building, which took place several years ago, all exposed woodwork was sandblasted to remove paint and other surface coatings. Other renovations included painting, installing partitions to create individual offices, carpeting and other interior cosmetic additions. There have been no major renovations of this building since 1990. DET rents the entire building from .....

There are approximately 350 individuals working for DET with
50 to 100 employees on four floors of the five-story building. The fifth floor, which is used partly for storage, is unoccupied and has never been renovated. Each occupied floor has an area of approximately 23,000 square feet (ft^2). Ceilings are 16 feet in height. Although this is an open-space office setting, there are many areas where moveable fabric-covered partitions are used. These partitions are either five feet or seven feet in height. There are individual perimeter offices for supervisors and managers. Windows cannot be opened, and are equipped with mini-blinds.

The local union representative stated that employees have complained of dust on desks and furniture for several years. The union representative also stated that employees working in many areas of the building, and in particular on the first floor, frequently witnessed debris and dust falling from the ceiling onto their desks. They stated that vibration from people walking on the upper floors causes dust to dislodge and settle onto DET work areas. The floors in many office areas are carpeted; the carpeting contains dust dislodged from the ceiling. In some areas of the facility, especially on the first floor, remnants of unremoved paint are still visible on the ceiling.

(B) Ventilation System

Supply and return duct work is visible throughout the building as there is no suspended ceiling. Supply ventilation is furnished by a hybrid system controlled by wall-mounted thermostatic

control units. Centrally located supply ductwork provides ventilation to the central areas of the building on all four floors. From main supply ducts, branches extend outward to the perimeter of the building. The side branches deliver air to perimeter offices and other peripheral employee work areas. There are four thermostats on each floor which regulate air supply to perimeter locations. Four units (one per floor) control supply air to the center of the building. In addition, perimeter offices have convection hot-water heating coils. These convection units are controlled by thermostats located in the individual offices.

Temperature on the first floor is controlled by programmable thermostats. Temperature on floors two through four is controlled by a remote sensor system which uses the return air temperature to establish set-points for cooling or heating supply air. Supply air to the main heating, ventilating and air-conditioning (HVAC) duct work is maintained at 55°F.

There are 20 air handling units located on the roof of the facility. Maintenance personnel reported that the minimum stop on these units was set at 5%.

(C) Previous Environmental Surveys

On January 22, 1991, an inspection of DET was performed by the Rhode Island Department of Labor, Division of Occupation Safety. Fifteen alleged safety and health violations were recorded, and including: (1) means of egress, (2) poor housekeeping, (3) lack of adequate first aid facilities, (4) lack of caution signs to warn against potential unsafe practices, and (5) inappropriately used and guarded electrical equipment.

During a previous NIOSH evaluation (June 30, 1992), health hazard evaluation (HHE) 92-168) bulk samples of ceiling paint chips and residues found on and in ventilation duct work were found to contain 56 mg/g lead (i.e., the sample was comprised of 5.6% inorganic lead by weight). At the time of this investigation, the potential for employee exposure to lead was reported, and subsequent air and surface monitoring for lead was recommended.

On December 8, 1992, the Rhode Island Department of Health conducted air sampling on floors one through four, as well as area wipe samples for lead contamination. Area air sampling, as well as personal breathing zone sampling, indicated less than 0.002 milligrams of lead per cubic meter of air (mg/m^3). These levels are well below the OSHA Permissible Exposure Limit of 0.05 mg/M^3 as well as the OSHA action level of 0.03 mg/M^3. The conclusion of the Rhode Island Department of Health evaluation was that the lead-containing dust on the "I" beams and in the air intakes on the fourth floor needed to be properly cleaned to prevent further exacerbation of the potential exposure.

IV. EVALUATION DESIGN AND METHODS

(A) SAMPLING PROCEDURES

(1) Area Air Samples

Twelve area samples for airborne lead were collected from various areas throughout DET at a flow rate of 2.0 liter per minute (l/min) through 37-millimeter (mm), 0.8-micron (µm) pore size, cellulose ester membrane filters in closed-face cassettes connected to Gillian Hi Flow...; Analysis of lead samples was performed by atomic absorption spectroscopy (AAS) with flame ionization, NIOSH Method 7082[(1)].

A minimum of two field blanks (sample media carried into the field, and handled like the other media, with the exception that they were not used to collect samples), representing at least 10% of samples, were prepared and submitted with each sample set.

(2) Surface Lead:

(a) Bulk Samples

Two bulk samples of abrasive material and paint were collected by transferring between one and ten grams of material into clean 20 milliliter (ml) glass vials. Bulk samples were analyzed by flame AAS NIOSH Method 7082, modified for the sample type.

(b) Surface Dust - Wipe Sampling

Forty surface wipe samples plus ten blanks were collected using commercial pre-moistened handwipes (Wash'n Dri®) and employing a modification of the Department of Housing and Urban Development (HUD) "Laboratory Testing for Lead in Dust" procedure[12]. Surface dust samples were collected by: (a) measuring and marking a flat surface of about 10 cm x 10 cm (approximately 4 inches x
4 inches); (b) donning disposable gloves; (c) taking a wipe from the container (the first wipe each day was discarded); (d) folding the wipe in half and wiping the entire marked area with a series of horizontal strokes in an "S"-pattern (the wipe is not lifted); (e) refolding the wipe with the dust side in and wiping the area in an "S"-pattern a second time at a 90° angle to the first pattern; (f) placing the folded baby wipe in a new sealable plastic bag. To reduce possible cross-contamination, the disposable gloves were changed after each sample was collected. Care was taken to use the same technique and wiping pressure for each sample to reduce variation in collection efficiency.

The wipes were wet-ashed with concentrated nitric and perchloric acids. Since a significant amount of unashable material remained after wet-ashing, these samples were leached overnight in dilute solutions of the same acids, then centrifuged. The supernatant solutions were used for analysis. The solutions were analyzed for lead by AAS with flame according to NIOSH Method 7082, modified for the sample type.

(B) Environmental Lead Assessment

The bulk samples containing chips of paint from the ceiling area of a first floor office were submitted for lead analysis by atomic absorption spectroscopy according to NIOSH Method 7082[1] modified for bulk sample analysis.

The limit of detection (LOD) was 8.0 µg lead (Pb)/gram. The limit of quantitation (LOQ) was 28 µg Pb/gram.

Wipe samples were digested according to NIOSH Method 7082, modified for sample matrix, and analyzed according to NIOSH Method 7082 as per NIOSH draft Method 0700.[2]

The limit of detection (LOD) was 1.0 µg Pb/wipe. The limit of quantitation (LOQ) was 4.4 µg Pb/wipe.

Air filter samples were analyzed for lead by flame atomic absorption spectroscopy according to NIOSH Method 7082[1].

The limit of detection and the limit of quantitation for the samples are 2.0 µg Pb/filter and 7.0 µg Pb/filter, respectively.

V. EVALUATION CRITERIA

(A) General

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, however, important 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 pre-existing 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 adverse health effects, even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes; thus, such contact may contribute to 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[3], (2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values[5] (TLVs), and (3) the United States Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards[4] (Permissible Exposure Limits - PELs). Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the economic feasibility of controlling exposures in various industries where the agents are used; the NIOSH Recommended Exposure Limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease.

In evaluating the exposure levels and the recommendations for reducing these levels, it should be noted that industry is required by the Occupational Safety and Health Act of 1970 (29 CFR 1910) to meet those levels specified by an OSHA standard. A time-weighted average (TWA) exposure refers to the average airborne concentrations of a substance during a normal 8-10 hour workday. Some substances have recommended short-term exposure limits (STELs) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high, short-term exposures.

(B) Lead

Toxicity of Lead - Health Effects

Lead has been found to have profound adverse effects on the health of workers. Inhalation, the most important source of lead intake, and ingestion result in damage to the nervous, urinary and

reproductive systems[6]. The adverse health effects associated with exposure to lead range from acute, relatively mild, reversible stages such as inhibition of enzyme activity, reduction in motor nerve conduction velocity, behavioral changes, and mild central nervous system (CNS) symptoms, to permanent damage to the body and chronic disease.

The signs and symptoms of severe lead intoxication which occur at blood lead levels of 80 micrograms per 100 grams (µg/g) and above are well documented[6-11]. The symptoms of severe lead intoxication include loss of appetite, metallic taste in the mouth, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pains, fine tremors, numbness, dizziness, hyperactivity, and colic.

Evidence accumulated in both adults and children indicates that toxic effects of lead have both central and peripheral nervous system manifestations. The effects of lead on the nervous system range from acute intoxication, coma and cardio-respiratory arrest to mild symptoms, subtle behavioral changes, and electro-physiologic changes associated with lower-level exposure. In fact, these effects can occur at blood lead levels of less than 80 micrograms.

With respect to the renal system, it is apparent that kidney disease from exposure to lead is more prevalent than previously believed. The hazard here is compounded by the fact that routine screening is ineffective in early diagnosis. Renal disease may be detected through routine screening only after about two-thirds of kidney function is lost or when manifestation of symptoms of renal failure are present.

Overexposure to lead has profoundly adverse effects on the course of reproduction in both males and females. In the case of male workers, there is evidence of decreased sexual drive, impotence, decreased ability to produce healthy sperm, and sterility[7].

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 free erythrocyte protoporphyrin (FEP) level is a measure of interference with hemoglobin production at the time the red blood cells are made. Lead affects heme synthetase, the last enzyme in heme synthesis. Although some diseases and iron deficiency anemia can cause a rise in FEP, in a healthy individual working with lead, lead absorption is the most likely cause for such an increase. Further, the FEP level becomes elevated when the blood lead level reaches about 40 µg/dl in men and 30 µg/dl in women, and since the average life span of a red blood cell is 120 days, the FEP reflects the blood lead level over the preceding three to four months. Normal FEP levels are below 50 µg/dl.

Adults not exposed to lead at work usually have a blood lead concentration less than 30 µg/dl; the average is less than
15 µg/dl[6]. The Centers for Disease Control (CDC) recommended 10-15 µg/dl as the highest acceptable blood level for young children[8]. Since the blood lead concentration 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 effect of lead as a child's, the CDC advised that a pregnant woman's blood lead level be below 25 µg/dl[8]. Recent evidence suggests that the fetus may be adversely affected at blood lead concentrations well below
25 µg/dl[9]. Furthermore, there is evidence to suggest that levels as low as 10.4 µg/dl affect the performance of children on educational attainment tests, and that there is a dose-response relationship with no evidence of threshold or safe level[10,11]. Lead levels between 40 - 60 µg/dl in lead exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60 - 100 µg/dl represent unacceptable elevations which may cause

serious adverse health effects. Levels over 100 µg/dl are considered to be extremely dangerous and often require hospitalization and medical treatment.

(C) Acceptable Clearance Levels

The U.S. Department of Housing and Urban Development (HUD) prepared guidelines for removing lead-based paint which were published in the Federal Register, April 18, 1990, pages 14556-14614[12]. All lead-containing paint should be removed from areas where it is located and these areas repainted with a non-lead containing paint. Contractors, hired to remove the lead paint, should be asked about their qualification, experience removing lead-based paints, and the plans to follow Federal and State lead-paint-removal guidelines.

VI. RESULTS

(A) Bulk Sample Lead:

The quantity of lead identified in the two bulk samples was 3,300 and 120,000 µg/gram of material analyzed.

(B) Surface Lead:

Although there are no surface exposure guidelines for occupational lead exposure, the concentrations found using wipe sampling techniques can be compared to the HUD guidelines for final clearance after lead abatement operations. The clearance guideline with the highest allowable lead surface concentration was that for window wells (800 µg/ft^2). This concentration was established based upon infrequent occupant contact with window wells. The lead surface concentrations of 18 samples were above this guideline.

Forty wipe samples were collected from various surfaces and work areas. All forty samples were collected by wiping specific, measured areas on the various surfaces. This procedure allows surface concentrations to be calculated in micrograms of lead per square foot (µg/ft^2). Table 1 shows the results of the wipe samples collected from various surfaces where lead contamination was suspected. These included desk tops, surfaces of office partitions, tops of HVAC duct work, and the inside of return air grilles. Surface lead contamination on interior wipe-sampled surfaces ranged between 9 and 200,000 µg/ft^2

Of the forty surface wipe samples obtained within DET work areas, eighteen (45%) exceeded the maximum HUD guideline of 800 µg/ft^2, and thirty-two (80%) exceeded the minimum HUD guideline of 200 µg/ft^2.

(C) Airborne Lead:

Airborne lead was not detected in any of the air samples collected over sampling periods ranging between 375 minutes and 383 minutes. The limit of detection and the limit of quantitation for the samples are 2.0 µg Pb/filter and 7.0 µg Pb/filter, respectively. This was as expected: air contamination would be expected only if lead on I-beams, ductwork, etc. were disturbed, causing the lead-containing particles to dislodge.

VII. DISCUSSION

Some areas within DET (i.e., tops of I-beams, tops of HVAC ductwork, etc.) appear to be significantly contaminated with lead. Paint fines, chips, and dust collected in the bulk samples and most of the surfaces wipe-sampled were contaminated with lead. The quantity of lead identified in the two bulk samples was 3,300 and 120,000 µg/gram of material analyzed.

Currently there are no Federal standards governing the concentration of lead in surface dust in either occupational or non-occupational (i.e., residential) settings. However, lead-contaminated surface dust in either setting presents a potential exposure to lead through ingestion, especially by children. In workers, this may occur either by direct hand-to-mouth contact with the dust, or indirectly from hand-to-mouth contact via clothing, cigarettes, or food contaminated by lead dust. Criteria established by HUD as final clearance standards, for lead in house dust after lead abatement, are an indication of what is acceptable, or "clean": floors, 200 micrograms per square foot (µg/ft^2); walls and window sills, 500 µg/ft^2; and window wells, 800 µg/ft^2. HUD also recommends the standard for floors be applied to exterior porches[12]. These criteria were not based on epidemiology, but were empirically established as feasible limits for clearance following final cleaning during residential lead-based paint abatement. HUD recommends the use of these criteria until they are refined or replaced through additional research.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Ingestion is a potential route for employee lead exposure at DET. Lead contaminated paint fines, chips, and dust were identified in breakrooms, lounges and cafeteria areas. Other surface areas which were sampled (surface areas of HVAC ductwork, I-beams, etc.) were also contaminated with relatively high concentrations of lead. Although episodic in nature, inhalation of lead following disturbance of lead-contaminated surfaces is also a concern.

Based on the results and observations of this evaluation, the following recommendation is offered to reduce the risk of employee exposure to inorganic lead.

1. Qualified, trained, and experienced lead abatement contractors and/or industrial hygienists should be consulted to perform effective cleaning of all employee work areas where inorganic lead has been detected. Furthermore, air monitoring should be conducted at the completion of the cleaning procedures to assess the efficiency of the cleaning.

   Management can oversee the clean-up and vacuuming of employee work areas within DET where environmental lead has been identified.

   Qualified lead abatement contractors should use high-efficiency particulate air (HEPA) filtering system units during all clean-up procedures in order to prevent contamination of additional areas by inorganic particulate lead. (CAUTION) - clean-up, if not properly conducted, may create a worse exposure situation than currently exists).

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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4. President, Local 401, SEIU/AFL-CIO 1704 Broad Street, Cranston, Rhode Island 02905-2720
5. Health and Safety Manager, Local 401, SEIU/AFL-CIO, 1704 Broad Street, Cranston, Rhode Island 02905-2720

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XI. REFERENCES

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Table 1.
Wipe Samples
January 13, 1993

	Location	Lead ($\mu g/ft^2$)	Comments
1st Floor	Mass. Adjudication	363	Top of Blue HVAC duct
	Mass. Adjudication	272	Desk Behind Computer Terminal
	R.I. Benefits	300	Updating - Top of Blue HVAC duct
	Atrium	900	Brown Water Pipe
	JTPA/JS	154	Top of Blue HVAC
	JPTA/JS	64	Top of Partition
	JPTA/JS	1,364	Above Coffee Pot Area
2nd Floor	Cafeteria	236	Top of Smoke Eater
	Underneath Drip Ceiling	64	Top of Blue HVAC duct above supply outlet
	Cafeteria	200,000	Top of I-Beam
	Cafeteria	173	Top of Cabinet Above Sink in Cafeteria
	Conversion Area	9	Top of Filing Cabinets Near Return Air Duct
	Conversion Area	736	Top of Blue HVAC Duct

Table 1. (continued)

	Location	Lead ($\mu g/ft^2$)	Comments
2nd Floor	Data Entry Area	245	Top of Desk
	Data Entry Area	682	Top of Blue HVAC duct
	Mail Room	136,363	I Beam
	Board of Review - Legal Area	1,036	Legal Area-Top of Brown Pipe
	Central Clerical	1,182	Above Suspended Ceiling
3rd Floor	Break Room	300	Surface Area
	Break Room	46	Top of Soda Machine
	Break Room	5,091	Top of Blue HVAC Duct
	Field Audit/Fraud Unit	4,727	Top of Brown Air Duct
	Field Audit/Fraud Unit	1,545	Above Suspended Ceiling Panel
	Exp. Rating Area	1,273	Top of Blue HVAC Duct
	Information Processing Area	2,455	Top of Blue HVAC Duct
	Technical Support Area	909	Top of Blue HVAC Duct
4th floor	Personnel Snack Area	49,091	I Beam - Top
	Personnel Snack Area	39,091	Top of HVAC Blue Duct
	LMI Computer Section	54,546	I Beam
	LMI Computer Section	209	Top of HVAC Blue Duct

Table 1. (continued)

Location		Lead ($\mu g/ft^2$)	Comments
2nd Floor	Inside Air Return Louvers	12,727	Behind Grille
4th Floor	LMI Computer Section	ND	Desk Top/Partition Top
	Manager Services	2,546	Coat Rack Area Brown Return Duct Top
	Side of Brown Duct	43	Air Leak Dust on Surface
	Top of Supply Diffuser	700	Blue Duct Near File Cabinets
	Lounge	491	Top of Blue Duct - Soda Machine
	Lounge	518	Top of Cabinet Above Sink
	Conference Room	318	Blue HVAC Duct Top
	Work Force 2000	67,273	Top of I-Beam
	Administrative Benefits Area	427	Top of Blue HVAC Duct