NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2000-0308-2981
Ikens Hardwood Floor Services
Madison, Wisconsin

September 2005

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluation and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (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 (OSHA) 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 employers or 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.

HETAB also provides, upon request, technical and consultative assistance 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. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Aaron Sussell, Perianan Periakaruppan, and Gregory Burr of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Gregory Piacitelli, DSHEFS. Analytical support was provided by Data Chem Laboratories, Salt Lake City, Utah. Desktop publishing was performed by Shawna Watts and Robin Smith. Editorial assistance was provided by Ellen Galloway.

Copies of this report have been sent to management representatives at Ikens Hardwood Floor Services and the OSHA Regional Office. The report may be viewed and printed from the following internet address: http://www.cdc.gov/niosh/hhe. Copies may be purchased from the National Technical Information Service (NTIS) at 5825 Port Royal Road, Springfield, Virginia 22161.

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.

Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Lead and Wood Dust Exposure during Sanding and Refinishing Hardwood Floors

NIOSH received a health hazard evaluation (HHE) request from Ikens Hardwood Floor Services to evaluate lead and wood dust exposures produced during sanding and refinishing of hardwood floors. A site survey was conducted at a residential floor refinishing job during which NIOSH investigators collected surface and air samples for lead and wood dust.

What NIOSH Did

- We measured lead and wood dust in the air during floor refinishing.
- We measured the lead content of varnish on floor surfaces.
- We sampled for lead in settled dust on surfaces during floor refinishing.

What NIOSH Found

- Workers are exposed to lead dust during floor refinishing activities. However, these concentrations do not exceed occupational exposure limits.
- Workers are exposed to wood dust in excess of the NIOSH Recommended Exposure Limit during sanding and buffing tasks.
- The settled dust on floors during refinishing contains lead.

What Ikens Hardwood Floor Services Managers Can Do

- Use engineering controls to reduce wood dust from sanding equipment.
- Use NIOSH-approved N95 particulate filtering respirators during sanding and buffing until engineering controls or work practice changes can reduce exposures to wood dust.
- Start a respiratory protection program based on OSHA general industry standard, 29, Code of Federal Regulations 1910.134.
- Use cleanup methods which reduce dust, such as vacuuming and wet cleaning. If vacuums are used, they should be equipped with high-efficiency particulate air (HEPA) filters.

What the Ikens Hardwood Floor Services Employees Can Do

- Wear a NIOSH-approved N95 dust filtering respirator during sanding and buffing activities.
- Replace these respirators when they become dirty or damaged.
- Wash your hands before eating and drinking.
- Use cleaning methods which do not create dust, such as HEPA vacuuming or wet sweeping.

CDC Workplace Safety and Health

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2000-0308-2981

NIOSH

Health Hazard Evaluation Report 2000-0308-2981
Ikens Hardwood Floor Services
Madison, Wisconsin
September 2005

Aaron Sussell, MPH, CIH
Perianan Periakaruppan, BS
Gregory Burr, CIH

SUMMARY

In May 2000, the National Institute for Occupational Safety and Health received a health hazard evaluation (HHE) request from management at Ikens Hardwood Floor Services, Madison, Wisconsin. The request concerned potential lead and wood dust exposures during wood floor refinishing. The floor service company had previously evaluated 41various floor finishes for lead content; among these, 15% exceeded the federal action level for lead-based paint (0.5% lead by weight). NIOSH investigators conducted a site visit in June 2000 at a single-family home in Madison, Wisconsin, where Ikens Hardwood Floor Services was refinishing hardwood floors. General area and personal breathing-zone (PBZ) air samples were collected for lead and wood dust during floor refinishing, and settled dust samples were measured for lead content. Four in situ (in place) surface measurements were taken to measure the lead content in the varnish on floors.

Results from the short-term task-based PBZ air samples ranged from 1.5 to 25 micrograms per cubic meter ($\mu g/m^3$) and were below the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for lead of 50 $\mu g/m^3$. However, worker exposures during buffing approached the OSHA Action Limit for lead of 30 $\mu g/m^3$, assuming that buffing would be performed over an 8-hour work day. Tasks with the greatest potential to produce lead exposures were buffing and final sanding combined with buffing. All of the wood dust exposures measured during rough sanding, rough edging, final sanding/buffing, and buffing tasks exceeded the NIOSH Recommended Exposure Limit (REL) of 1 milligram per cubic meter (mg/m^3) for wood dust, if extrapolated to full shift. All of the settled dust collected on the floors of rooms during refinishing, but prior to final finishing, had lead concentrations exceeding U.S. Housing and Urban Development (HUD) federal clearance guidelines for residential floor areas (0.43 milligrams per square meter [mg/m^2]).

NIOSH investigators conclude that a health hazard exists during buffing and sanding hardwood floors. Workers are exposed to wood dust above the NIOSH REL, and lead exposures approach the OSHA Action Level for lead. Surface dust samples contained levels of lead which exceed federal clearance standards for residential areas. This suggests a potential health hazard to small children in the home during refinishing, and after if the floors are not cleaned. Recommendations for using engineering and administrative controls and wearing respiratory protection during refinishing activities are included in the Recommendations section of this report.

Keywords: NAICS 238330 (Wood floor finishing), lead, wood dust, varnish, hardwood floors, sanding, resurfacing, refinishing, respirators

Table of Contents

INTRODUCTION

In May 2000, NIOSH received a management request from Ikens Hardwood Floor Services (Ikens), Madison, Wisconsin, to evaluate hazards of traditional floor refinishing techniques. Specifically this HHE concerned possible health hazards associated with lead and wood dust exposures produced during sanding and refinishing of hardwood floors. In response to this request, NIOSH investigators conducted a site visit in June 2000 at a single-family home in Madison, Wisconsin, where Ikens Hardwood Floor Services had been hired by the homeowner to refinish hardwood floors. Area and personal breathing zone (PBZ) air samples were collected for lead and wood dust in the room where refinishing was conducted. Sampling was also performed in surrounding rooms. Four samples of settled dust and two bulk samples of dust were measured for lead content and four in situ (in place) measurements were made of the varnish on floors using a portable X-ray fluorescence (XRF) spectrum analyzer (NITON XL®). Initial results of direct-reading sampling for lead were reported to the company during the site visit, and the laboratory results for lead in air (PbA), wood dust, lead in paint, and lead in settled dust (PbS) were reported to the company in an interim letter dated May 2, 2001.

BACKGROUND

Ikens has been refinishing wood floors, primarily in single-family residences, since 1983. Prior to requesting this HHE, the company had collected 41 samples of floor finishes (primarily old varnishes) at various work sites and submitted them for analysis of lead content. The analytical laboratory (Wisconsin Occupational Health Laboratory, University of Wisconsin, Madison) found that six (15%) of these samples exceeded the federal action limit of 0.5% lead by weight, qualifying them to be considered lead-containing paint. Based on these results, there was concern within the company about potential worker exposures during wood floor refinishing and questions about whether hazardous levels of lead in settled dust would occur as a result of sanding and refinishing existing lead-containing finishes, including varnish.

On June 6-7, 2000, NIOSH industrial hygienists conducted a site visit at a single-family home in Madison, Wisconsin, where Ikens had been hired to refinish the hardwood floors. The residence, built circa 1930, was a 3-bedroom, 2-story house. As reported by Ikens, the upstairs bedrooms and hallways had Douglas fir flooring and the living room downstairs had maple hardwood flooring. According to the analytical laboratory used by Ikens, the average lead concentration in all varnish samples collected throughout the residence was 0.22% by weight.

METHODS

Task-based PBZ air samples were collected on 2 consecutive days to measure PbA and wood dust exposures. For each PBZ sample, one to three paired area PbA samples were collected in the same room or adjacent rooms in areas that would represent potential exposures for bystanders or occupants during the tasks. An air flow rate of 4 liters per minute (Lpm) was used for both PBZ and area air samples. Once collected, these PbA samples were analyzed on site using NIOSH Manual of Analytical Methods (NMAM) Method 7702 (field portable XRF). This direct-reading technique has an estimated LOD for lead of 6 micrograms (µg)/sample. After on site analysis by NIOSH Method 7702 the PbA samples (37 millimeter [mm] diameter mixed cellulose-ester filters in Mylar sleeves) were submitted to a NIOSH contract laboratory and analyzed for lead and other elements using the more sensitive NIOSH Method 7300 (inductively coupled plasma atomic emission spectroscopy [ICP-AES]), modified for microwave digestion.[1] The LOD and LOQ for lead in PbA samples by NIOSH Method 7300 were 0.5 µg/sample and 2 µg/sample, respectively.

Wood dust air samples were collected on 37 mm diameter tared polyvinyl chloride filters using calibrated air sampling pumps and a flow rate of

2.0 Lpm. Samples were analyzed using NIOSH Method 0500 (total particulates not otherwise regulated). PbA and wood dust results are reported in micrograms per cubic meter ($\mu g/m^3$) and milligrams per cubic meter (mg/m^3), respectively. The LOD for wood dust (as total dust) was 0.02 milligrams (mg)/sample.

Task-based PbS samples were collected concurrently with some of the air samples on both days of the project. These PbS samples were collected inside and outside the room where the refinishing task was in progress. PbS samples were collected on pre-moistened 5.5-inch by 8.0-inch (0.029 square meter [m^2]) towelettes (Wash'n Dri®, Softsoap Enterprises, Inc, Chaksa, Minnesota). These towelettes have been found to be suitable for PbS sampling.[2] To collect a sample, a clean towelette was unfolded and placed flat in a clean 6-inch by 9-inch plastic storage tray (EKCO® Consumer Plastic Inc., model No. 514-1). At the end of each 30-minute work period, the towelette was folded inward upon itself to contain any dust adhering to it, and placed in 50-milliliter (mL) centrifuge tube for shipment to the NIOSH contract laboratory. The samples were analyzed for lead according to NIOSH Method 7300, with a LOD and LOQ of 0.4 and 1 µg/sample, respectively. Surface concentrations were reported in mg/m^2.

Lead content of the varnish on floor surfaces undergoing refinishing was measured using a NITON 700 Series XL® portable XRF spectrum analyzer, calibrated according to the manufacturer's directions. Bulk samples of the varnish were also collected according to the American Society for Testing and Materials (ASTM) Method E1729-99.[3] The varnish was removed by cold scraping with a stainless steel utility knife. Two bulk samples of wood dust after sanding were also collected. A 0.5 gram (g) portion of each bulk sample (or all of sample if < 0.5 g) was weighed out and analyzed by NIOSH Method 7300. Results were reported as percent lead by weight. The limit of detection (LOD) for lead was 0.001% and the limit of quantitation (LOQ) was 0.004%.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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 even though 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 health effects even if the occupational exposures are controlled at the level set by the 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, 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 become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[4] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[5] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[6] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Lead Exposure

Occupational exposure occurs via inhalation of lead-containing dust and fume and ingestion from contact with lead-contaminated surfaces. Symptoms of lead poisoning include weakness, excessive tiredness, irritability, constipation, anorexia, abdominal discomfort (colic), fine tremors, and "wrist drop."[7,8,9] Overexposure to lead may also result kidney damage, anemia, high blood pressure, infertility and reduced sex drive in both sexes, and impotence. An individual's blood lead level (BLL) is used as the best indication of recent exposure to, and current absorption of, lead.[10] Measurement of zinc protoporphyrin (ZPP) levels in blood can be a good indicator of the toxic effect of lead on heme synthesis in red blood cells. Elevated ZPP levels due to lead exposure, which may remain months after the exposure, are an indicator of chronic lead intoxication. Persons without occupational exposure to lead usually have a ZPP level of less than 40 micrograms per deciliter (µg/dL).[11] Because other factors, such as iron deficiency, can cause an elevated ZPP level, the BLL is a more specific test in the evaluation of occupational exposure to lead.

In the OSHA lead standards for general industry and construction, the PEL and Action Level for PbA is 50 and 30 µg/m^3 (both 8-hour TWAs), respectively. These limits are intended to maintain worker BLLs below 40 µg/dL; medical removal is required when an employee's BLL reaches 50 µg/dL.[12,13] NIOSH has concluded that its 1978 REL of 100 µg/m^3 as an 8-hour TWA did not sufficiently protect workers from the adverse affects of exposure to inorganic lead [14] and has adopted the OSHA PEL. However, NIOSH has conducted a literature review of the health effects data on inorganic lead exposure and finds evidence that some of the adverse effects on the adult reproductive, cardiovascular, and hematologic systems, and on the development of children of exposed workers can occur at BLLs as low as 10 µg/dL.[15] At BLLs below 40 µg/dL, many of the health effects would not necessarily be evident by routine physical examinations, but represent early stages in the development of disease. In recognition of this, voluntary standards and public health goals have established lower BLL exposure limits to protect workers and their children. The ACGIH TLV® for PbA is 50 µg/m^3 as an 8-hour TWA, with worker BLLs to be controlled to ≤30 µg/dL. A national health goal is to eliminate all occupational exposures which result in BLLs greater than 25 µg/dL.[16]

Lead in Surface Dust and Soil

Lead contamination in dust and soil, which is commonly found in the U.S. due to the past use of lead in gasoline and paints, and also from industrial emissions, is a risk to children. Lead-contaminated surfaces may also be a source of occupational exposure for workers. Lead exposure may occur either by direct hand-to-mouth contact, or indirectly through contamination of hands, cigarettes, cosmetics, or food.

Generally there is little or no correlation between surface lead levels and employee PBZ exposures in the workplace. The amount of lead ingested in contaminated work areas depends on the effectiveness of administrative controls, personal hygiene practices, and available facilities for maintaining personal hygiene.

There is no federal standard which provides an occupational exposure limit for surface lead contamination. The U.S. Department of Housing and Urban Development (HUD) has established the following dust lead standards for clearance after residential lead-based paint hazard reduction activities in federally owned or assisted housing: (1) floors, 0.43 mg/m^2; (2) interior window sills, 2.7 mg/m^2; and window troughs, 8.6 mg/m^2.[17]

There are no federal standards for soil lead contamination in the workplace. The Environmental Protection Agency has proposed standards for residential soil-lead levels, expressed as the average total lead by weight in drip-line and mid-yard composite soil samples: 400 ppm as a level of concern which should trigger appropriate risk reduction activities, and ≥ 2000 ppm as a trigger for permanent abatement of soil lead hazards.[18]

Wood Dust (as Total Dust)

Wood dust is a potential health hazard when wood particles from processes such as sanding and buffing become airborne. Wood dust may be inhaled and deposited in the nose and throat region, the upper bronchial region, or the lung, depending on the particle aerodynamic size.

Workers exposed to wood dust have experienced a variety of adverse health effects including eye and skin irritation, allergy, reduced lung function, asthma, and nasal cancer.[19,20,21] Obstructive respiratory effects, development of lung fibrosis, and impairment of the mucociliary clearance mechanism in the respiratory system have also been reported.[22,23] As a general rule, hard woods are more hazardous to human health than soft woods. One exception is western red cedar, a soft wood which has been identified as one of the most hazardous to human health. The health effects are believed related to the concentration of tannin and similar compounds in the wood.[24]

The OSHA PEL for wood dust (as total dust) is 15 mg/m^3 as an 8-hour TWA. The ACGIH TLVs for softwood and hardwood dust are 5 mg/m^3 and 1 mg/m^3, respectively; both as 8-hour TWAs for total dust. In addition, ACGIH recommends a STEL of 10 mg/m^3 for soft wood dust. In 2005, ACGIH adopted TLVs for wood dust ranging from 0.5 mg/m^3 (for western red cedar) to 1 mg/m^3 (for nonallergenic wood species).[5] In addition, ACGIH has designated oak and beech wood dust as confirmed human carcinogens, and birch, mahogany, teak, and walnut as confirmed animal carcinogens, with all other wood dusts not classifiable as human carcinogens.[5] NIOSH has designated wood dust as a potential occupational carcinogen and has established a REL of 1 mg/m^3. NIOSH also recommends that exposures for potential occupational carcinogens be reduced to the lowest feasible concentration. NIOSH has indicated that it does not agree that soft wood dust should be considered separately from hard wood dust; the agency's REL applies to all types of wood dusts.[25]

RESULTS

Of the four *in situ* measurements of the lead content in varnish on floors made by the portable XRF analyzer (two bedrooms, stairs, first floor living room), three indicated very low but detectable concentrations of lead (0.01 to 0.03 mg/square centimeter [cm^2]). No lead was detected in the fourth sample. The federal criterion to be considered a lead-containing finish is 1.0 mg/cm^2.

Five bulk samples of varnish were collected from floors in a bedroom, the main stairs, living room, and stair landing. The average lead concentration in these varnishes was 0.21% (range: 0.16% - 0.24%), consistent with the reported average lead concentration (0.22%) among varnish samples previously collected by the contractor. A single sample of varnish dust collected immediately after sanding contained 0.25% lead by weight. A bulk sample of wood dust from the collection bag of the floor sander after rough sanding contained 0.018% lead by weight. Like the surface samples of varnish, none of these samples exceeded the federal action level for lead-based paint (0.5% lead by weight).

Tools and abrasives used in this floor refinishing project are presented in Table 1. Results from task-based PBZ PbA, area PbA, and surface wood dust sampling are presented in Table 2. Among six task-based PBZ air samples collected over 20 to 106 minutes, PbA exposures (measured by ICP-AES) ranged from 4.7 to 25 $\mu g/m^3$. The highest personal PbA exposure occurred during buffing, with the next highest, 11 $\mu g/m^3$, when both final sanding and buffing was performed. All of the other personal PbA exposures were below the minimum detectable concentration (MDC) of 4 $\mu g/m^3$. Among nine area air samples collected concurrently, PbA concentrations ranged from none detected (<1.3 $\mu g/m^3$) for rough sanding outside the refinished room to 25 $\mu g/m^3$ for buffing inside the refinished room.

The ICP-AES analyses revealed that the lead collected on the 15 sample filters averaged 1.2 µg (range: none detected [<0.5 µg] - 3.1 µg). All of the lead loadings were below the estimated LOD for the portable XRF method (6 µg/sample). Thus, when four of these 15 sample filters were analyzed by portable XRF, three had none detected results. The fourth sample contained a detectable result of 5.6 ± 3.7 µg/sample (which is equivalent to an air concentration of 40 ± 26 $\mu g/m^3$). This sample result, however, was obtained by extending the XRF reading for an unusually long analysis time (592 source seconds, about 10 real-time minutes). This XRF result was higher than the corresponding result obtained with ICP-AES (0.6 µg/sample), but the laboratory result was also semi-quantitative because it was between the LOD and LOQ.

Task-based PBZ air samples for wood dust ranged from 2.9 mg/m^3 (during rough sanding) to 60 mg/m^3 (during final sanding and buffing). Area wood dust samples ranged from 1.9 mg/m^3 (during rough sanding) to 83 mg/m^3 (during final sanding and buffing). No wood dust sample was obtained for the buffing task alone. PbS sampling results ranged from 2.4 to 16.8 mg/m^2 (within the room where the floor refinishing was occurring) and from 0.23 to 0.34 mg/m^2 (in the adjacent rooms).

DISCUSSION

This hazard assessment of traditional wood floor finishing techniques was limited in scope because only a single worker at one job site was available during the site visit. A further limitation was that the air sampling was done over relatively brief periods of the day, with individual task times ranging from 20 to about 100 minutes. The contractor reported that these task times are typical for refinishing single residential rooms. The contractor's other daily activities (set up, cleaning, and commuting to job site) have less potential exposure to lead and wood dust than the tasks evaluated. Therefore, extrapolating these short-term task-based TWA results to 8 hours overestimates full-shift exposures.

While none of the varnish finishes NIOSH sampled had lead concentrations exceeding the federal action level for lead-based paint (1.0 mg/cm^2 or 0.5% lead by weight), detectable amounts of lead were still detected in both airborne and settled dust samples during floor refinishing. Thus, while these finishes would technically be considered "not lead containing" by federal guidelines, the small amount of lead in these surface coatings and dust may still represent a potential health hazard for the renovation contractor.

The measurements made by portable XRF were relatively lower with respect to the federal action limit for lead in paint than the laboratory measurements. This is not surprising, since varnishes are applied in thin films and the lead loading per unit surface area is thus reduced compared to paint. Therefore, a portable XRF may not have sufficient analytical sensitivity to be useful in this situation.

None of the task-based personal lead exposures measured (if extrapolated to full shift) exceeded the OSHA PEL or NIOSH REL. The personal exposure during buffing did approach the OSHA Action Limit of 30 $\mu g/m^3$. Tasks with the greatest potential to produce hazardous worker lead exposures were buffing and final sanding combined with buffing. These activities were done without engineering controls and appeared to generate a considerable amount of fine dust. Air sampling results revealed that a portable XRF field method was not useful for quantifying lead in task-based samples with low lead loading.

All of the settled dust measurements collected on the floors of rooms during refinishing had lead concentrations exceeding federal clearance standards for residential floor areas (0.43 mg/m^2). While these measurements represent lead levels during the refinishing job and not after cleanup and application of new finish, they do represent a *potential* health hazard to occupants of the home, especially young children present during refinishing who may ingest dust on floors through hand-to-mouth contact. When lead is present in the varnish or paint being removed from the floors, contractors should use proper containment and cleanup techniques, including HEPA vacuuming of all horizontal surfaces, to insure that lead contamination which could endanger children is not dispersed in the house or left at the end of the job. Recommended techniques for safe cleanup of lead during and after renovation work have been published by HUD (available on the Web at http://www.hud.gov/offices/lead/).[26]

Wood dust is a health hazard during the sanding and buffing tasks. All of the wood dust exposures measured during rough sanding, rough sanding (edging), final sanding/buffing, and buffing tasks exceeded the NIOSH REL of 1 mg/m^3 (if extrapolated to a full shift). The exposures during buffing and final sanding/buffing tasks exceeded the ACGIH STEL of 10 mg/m^3. NIOSH recommends limiting wood dust exposures to prevent health problems. Previous studies have found that wood dust created by disc sanders is often not effectively controlled. NIOSH has produced several documents which suggest available control technology, including: (1) Control of Wood Dust From Large Diameter Disc Sanders,[27] (2) Control of Wood Dust From Random Orbital Hand Sanders,[28] and (3) Control of Wood Dust From Orbital Hand Sanders.[29] Without the use of effective engineering controls to eliminate hazardous wood dust exposures during floor refinishing, appropriate respirators should be used for protection.

Since sanding and buffing activities can potentially generate dust levels in excess of the NIOSH REL for wood dust, workers performing buffing, rough sanding, or final sanding should wear a respirator at least as protective as a NIOSH-approved half–mask, N95 air-filtering respirator. The air sampling results also suggest that a more protective respirator may be warranted during buffing (an activity with generated much higher dust concentrations). Examples of respirators in this category would be a full–face, air–purifying respirator or a powered air-purifying respirator with loose fitting hood or helmet. In addition to offering a higher protection factor than a half-mask respirator, both of these have the added benefit of providing eye protection. It should be emphasized that respirators should be used until engineering or administrative controls can feasibly be implemented to eliminate hazardous exposures; respirators are not the preferred means of control. Whenever respirators are required, a respiratory protection program must be established and the employees should be fit–tested and trained in proper use and care of the respirator.[30]

CONCLUSIONS

The greatest occupational exposure to lead occurs during buffing and final sanding combined with buffing. PBZ exposure during these activities, if extrapolated to 8 hours, produces lead exposure levels that approach the OSHA Action Limit. All methods of sanding expose workers to hazardous concentrations of airborne wood dust which are above the NIOSH REL.

Dust generated during removal of lead containing varnish and paint from residential floors poses a potential health hazard to occupants in the home, especially small children, if not properly contained and removed.

Surface lead concentrations measured on floors where refinishing was taking place exceeded the federal clearance standard for residential floor areas.

The portable XRF consistently produced lower in place lead measurements from the varnish floor finish compared to the laboratory measurements of bulk samples of the varnish. This discrepancy may be due to the fact that varnishes are applied in thin films and the lead loading per unit surface area is below the analytical sensitivity of the portable XRF. Therefore, this device may not be a useful tool to quantify lead concentrations in surfaces with low lead loadings.

RECOMMENDATIONS

The following recommendations are based on the findings of this investigation and are offered to improve the safety and health of Ikens Hardwood Floor Services employees.

1. Use engineering controls on sanding equipment to limit wood dust and lead dust exposure. Publications developed by NIOSH provide guidance on controls for sanders. These include the following:
   (1) Control of Wood Dust from Large Diameter Disc Sanders (http://www.cdc.gov/niosh/hc7.html);
   (2) Control of Wood Dust from Orbital Hand Sanders (http://www.cdc.gov/niosh/hc9.html); and
   (3) Control of Wood Dust from Random Orbital Hand Sanders (http://www.cdc.gov/niosh/ hc8.html).

2. Use respirators to reduce worker exposure to wood dust until engineering and/or administrative controls are effective in reducing exposures below the NIOSH REL. As a minimum they should be NIOSH-approved half-mask respirators with an N95 filter designation.

3. Develop a written respiratory program. This program should include the following components: selection of respirators, medical evaluation, fit testing, use of respirators, maintenance and care of respirators, identification of filters, training and information, program evaluation, and recordkeeping.[30]

4. Use cleanup techniques which minimize the generation of dust at the end of the refinishing project, including high efficiency particulate air (HEPA) vacuuming of all horizontal surfaces.

5. Use good hygiene practices, such as washing hands prior to eating or drinking and changing or laundering work clothes before returning home to reduce the possibility of lead and wood dust exposures.

REFERENCES

1. NIOSH [1994]. NIOSH manual of analytical methods, 4th edition. Eller, P and Cassinelli, ME, Eds. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94–113.

2. Millson M, Eller PM, Ashley K [1994]. Evaluation of wipe sampling materials for lead in surface dust. Am Ind Hyg Assoc J *55*:339–342.

3. ASTM [2000]. E1729-99 Standard Practice for Field Collection of Dried Paint Samples for Lead Determination by Atomic Spectrometry Techniques. West Conshohocken, PA: American Society for Testing and Materials.

4. NIOSH [1992]. Recommendations for occupational safety and health: compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.

5. ACGIH [2004]. 2004 TLVs® and BEIs®: threshold limit values for chemical substances and physical agents. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

6. CFR [2003]. 29 CFR 1910.1000. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

7. Hernberg S, et al. [1988]. Lead and its compounds. In: Occupational medicine. 2nd ed. Chicago, IL: Year Book Medical Publishers.

8. Landrigan PJ, et al. [1985]. Body lead burden: summary of epidemiological data on its relation to environmental sources and toxic effects. In: Dietary and environmental lead: human health effects. Amsterdam: Elsevier Science Publishers.

9. Proctor NH, Hughes JP, Fischman ML [1991]. Lead. In: Chemical hazards of the workplace. 3rd ed. Philadelphia, PA: J.B. Lippincott Company, pp 353–357.

10. NIOSH [1978]. Occupational exposure to inorganic lead. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78–158.

11. Lauwerys RR and Hoet P [1993]. Industrial chemical exposure: guidelines for biological monitoring, Second Edition. Ann Arbor, MI: Lewis Publishers, p. 62.

12. CFR. 29 CFR, Part 1910.1025. OSHA lead standard for general industry. Code of Federal regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

13. CFR. 29 CFR, Part 1926.62. OSHA construction industry lead standard. Code of Federal regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

14. 62 Fed. Reg. 206 [1997]. National Institute for Occupational Safety and Health: occupational exposure to inorganic lead: request for comments and information.

15. Sussell A, et al. [1998]. Protecting workers exposed to lead–based paint hazards: a report to Congress. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98–112. January 1998–revised with minor technical changes.

16. DHHS [2000]. Healthy people 2010–conference edition; National health promotion and disease objectives. Washington, DC: U.S. Department of Health and Human Services. Available on the internet at: www.health.gov/healthypeople/Document/default.htm

17. 64 Fed. Reg. 178 [1999]. Department of Housing and Urban Development: requirements for notification, evaluation and reduction of lead-based paint hazards in federally owned residential property and housing receiving federal assistance, September 15, 1999. (To be codified at 24 CFR Part 35, et al.)

18. 63 Fed. Reg. 106 [1998]. Environmental Protection Agency: lead; identification of dangerous levels of lead; proposed rule, June 3, 1998. (To be codified at 40 CFR Part 745.)

19. Chan-Yeung M, Barton GM, MacLean L, et al. [1973]. Occupational asthma and rhinitis due to western red cedar. Amer Rev Resp Dis 108:1094-1102.

20. Whitehead LW, Ashikaga T, Vacek P [1981]. Pulmonary function status of workers exposed to hard wood or pine dust. Amer Ind Hyg Assoc J 42:178-186.

21. Hills JH [1982]. Nasal carcinoma in woodworkers: a review. J Occ Med 24:526-529.

22. Michaels L [1967]. Lung changes in woodworkers. Can Med Assoc J 96:1150-1155.

23. Black A, Evans JC, Hadfield HE, et al. [1974]. Impairment of nasal mucociliary clearance in woodworkers in the furniture industry. Br J Ind Med 31:10-17.

24. OSHA [2001]. Technical links–Health Guidelines–Wood Dust. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration. Web site: www.osha-slc.gov

25. NIOSH [1994]. NIOSH pocket guide to chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94-116.

26. HUD [1999]. Lead paint safety, a field guide for painting, home maintenance and renovation work. Washington, DC: U.S. Department of Housing and Urban Development, Office of Lead Hazard Control. Publication No. HUD 1779-LHC.

27. NIOSH [1997]. NIOSH Hazard controls: control of wood dust from large diameter disc sanders. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 96-124.

28 NIOSH [1997]. NIOSH Hazard controls: control of wood dust from random orbital hand sanders. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 96-125.

29. NIOSH [1997]. NIOSH Hazard controls: control of wood dust from orbital hand sanders. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 96-126.

30. NIOSH [1987]. Guide to industrial respiratory protection. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-116.

Table 1: Tools and Abrasives Used for Wood Floor Refinishing
Ikens Hardwood Floor Services, Madison, Wisconsin
HETA 2000-0308-2981

Task	Main floor tool	Edging Tool	Abrasive
Rough sanding	220-volt Hummel® type BG-112 8-inch belt sander (Eugen Lägler GMBH, Germany)	110-volt/15 amp Clarke Super 7R® 7-inch orbital sander with nonperforated disk	36 grit sandpaper
Final sanding	220-volt Hummel® type BG-112 8-inch belt sander (Eugen Lägler GMBH, Germany)	110-volt/15 amp Clarke Super 7R® 7-inch orbital sander with nonperforated disk	80 grit (main floor) 100 grit (edging)
Buffing	110-volt/13.5 amp Kent KF-170A® 16-inch disk floor buffer, Kent Company, Elkhart, Indiana		120 grit screen

Table 2: Task-based Lead in Air (PbA) and Lead in Surface Dust (PbS) Results During Wood Floor Refinishing
Ikens Hardwood Floor Services, Madison, Wisconsin, HETA 2000-0308-2981

Sample type	Task[A]	PbA, $\mu g/m^3$			PbS, milligrams/square meter		Wood Dust, mg/m^3	
		Time (min)	XRF	ICP-AES	Inside room	Outside room	Actual	8-hr TWA
PBZ	buffing	20	ND†	25				
PBZ	final sanding and buffing	72		11			60	2.5
PBZ	rough sanding	35	40 ± 26	(4.3)‡	2.4	0.34	6.9	0.50
PBZ	rough sanding	47		5.3‡	16.8		5.7	0.56
PBZ	rough sanding	83		(1.5)‡		0.24	2.9	0.50
PBZ	rough sanding (edging)	106	ND†	4.7	16.5	0.23	4.5	0.99
GA	buffing - inside room	20		25				
GA	buffing - outside room	20		(8.8)‡				
GA	final sanding and buffing - inside room	72		10			83	12.5
GA	rough sanding - inside room	35		ND†			2.7	0.20
GA	rough sanding - inside room	47	ND†	(4.3)‡			1.9	0.19
GA	rough sanding - inside room	83		(1.5)‡			2.4	0.42
GA	rough sanding - outside room	47		ND†				
GA	rough sanding (edging) - inside room	106		(2.4)‡			3.9	0.86
GA	rough sanding (edging) - outside room	106		(2.1)‡				
Minimum Detectable Concentration (MDC), (assuming a 120 liter air sample)				4	Not applicable (N/A)		N/A	
Minimum Quantifiable Concentration (MQC), (assuming a 120 liter air sample)				16	N/A		N/A	
OSHA Permissible Exposure Limit			50		None			15
NIOSH Recommended Exposure Limit			50		None			1
ACGIH Threshold Limit Value (hardwood dust and softwood dust)			50		None			1 and 5

PBZ = personal breathing-zone	GA = general area air sample	[A] work on main floor area unless noted.	$\mu g/m^3$ = micrograms per cubic meter	Actual = time period sampled
‡Trace = between the MDC and MQC	†ND, none detected (less than MDC)	XRF = X-ray diffraction	mg/m^3 = milligrams per cubic meter	TWA = time weighted average

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, OH 45226-1998

OFFICIAL BUSINESS
Penalty for private use $300

National Institute for Occupational Safety and Health
NIOSH

Delivering on the Nation's promise:
Safety and Health at work for all people
through research and prevention

To receive NIOSH documents or information
about occupational safety and health topics
contact NIOSH at:

1-800-35-NIOSH (356-4674)
Fax: 1-513-533-8573
E-mail: pubstaft@cdc.gov
or visit the NIOSH web site at:
http://www.cdc.gov/niosh

SAFER • HEALTHIER • PEOPLE™