NIOSH HEALTH HAZARD EVALUATION REPORT:

HETA # 2001-0537-2897
Sunset Strip Furniture Stripping
Huntington Beach, California

April 2003

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

Preface

The Hazard Evaluations 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 employer 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.

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Acknowledgments and Availability of Report

This report was prepared by Ronald M. Hall of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Bradley King. Analytical support was provided by Datachem Laboratories, Inc., Salt Lake City, Utah. Desktop publishing was performed by Robin Smith. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Elements and Wood Dust at Sunset Strip Furniture Stripping

On September 4, 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from a management official at Sunset Strip Furniture Stripping Company, Huntington Beach, California. The request concerned worker exposures to lead and other metal exposures that may result from stripping and refinishing furniture.

What NIOSH Did

- We gathered air samples for metals and wood dust.
- We gathered surface dust and bulk samples for metals.
- We gathered qualitative wipe samples for lead.

What NIOSH Found

- All air samples for metals indicated low concentrations below occupational criteria.
- Bulk samples of dust indicated the presence of metals.
- Qualitative wipe samples indicated the presence of lead at locations on the work table (where sanding was done) and on a chair (before sanding).
- Personal breathing zone samples for wood dust indicated exposures exceeding the NIOSH and ACGIH® criteria.

What Sunset Strip Furniture Stripping Managers Can Do

- Install engineering controls on the hand sander or install an exhaust hood (e.g., downdraft hood) to control dust during sanding.
- Provide respirators until controls are installed and shown to be effective.
- Begin a respiratory protection program with the use of respirators.
- Maintain a policy of no eating, drinking, or smoking in the shop.
- Encourage workers to change out of contaminated clothing and wash thoroughly before eating, drinking, smoking, or leaving work.

What the Sunset Strip Furniture Stripping Employees Can Do

- Use engineering controls as instructed.
- Use respirators as instructed.
- Do not eat, drink, or smoke in the shop.
- Change out of contaminated clothing and wash thoroughly prior to eating, drinking, smoking, or leaving work.

CDC Workplace Safety and Health

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HETA Report # 2001-0537-2897

National Institute for Occupational Safety and Health NIOSH

Health Hazard Evaluation Report 2001-0537-2897
Sunset Strip Furniture Stripping
April 2003

Ronald M. Hall, MS, CIH

SUMMARY

On September 4, 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from a management official at Sunset Strip Furniture Stripping Company, Huntington Beach, California. The request concerned worker exposures to lead and other metals that may result from stripping and refinishing furniture. A site visit at Sunset Strip Furniture Stripping Company was conducted on September 4-5, 2002. This survey was conducted to evaluate worker exposures in the furniture stripping shop for lead and other elements during typical shop operations. Wood dust was also evaluated during this HHE because operations in the shop included sanding on hard woods.

Personal breathing zone (PBZ) air samples were collected on both workers in the shop for lead and other elements (i.e., silver, aluminum, arsenic, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lithium, magnesium, manganese, molybdenum, sodium, nickel, phosphorus, platinum, selenium, tellurium, thallium, titanium, vanadium, yttrium, zinc, and zirconium) and total dust during stripping, rinsing, sanding, and refinishing operations throughout the 2-day sampling period. In addition, area air samples for elements (including lead) and inhalable dust were collected at two locations near sanding operations. Qualitative wipe samples for lead and bulk samples for elements were also collected.

All air samples (both area and PBZ samples) for lead and other elements indicated concentrations well below applicable occupational exposure criteria. Bulk samples of dust material in the shop and stripping solution from the paint stripping operation indicated the presence of lead and other elements. Therefore, care should be taken to improve hygiene practices within the shop to reduce the possibility of ingestion or secondary exposures during cleaning activities. PBZ wood dust air samples indicated exposures exceeding the NIOSH REL (1 milligram per cubic meter [mg/m^3]) for soft or hard wood) and ACGIH® TLV® (1 mg/m^3 for hard wood). The adverse health effects that have been associated with exposure to wood dust upon which evaluation criteria are based include dermatitis, allergic respiratory effects, mucosal and nonallergenic respiratory effects, and cancer.

Engineering controls should be used to reduce worker exposures to wood dust. Personal protective equipment (PPE) (i.e., respirators) are designed to protect workers from airborne exposures while engineering controls are being implemented or when engineering controls are not feasible or effective in reducing air contaminants to acceptable levels. Recommendations for controls, respirators, and hygiene practices (shop cleaning and personal hygiene) are provided.

Keywords: SIC Code: 7641 (Reupholstery and Furniture Repair), wood dust, lead, elements, sanding

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Introduction

On September 4, 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from a management official at Sunset Strip Furniture Stripping Company, Huntington Beach, California. The request concerned worker exposures to lead and other metal exposures that may result from stripping and refinishing furniture.

A site visit at Sunset Strip Furniture Stripping Company was conducted on September 4-5, 2002. This survey was conducted to evaluate worker exposures in the furniture stripping shop for lead, other metals, and wood dust during typical wood stripping and refinishing operations.

Background

Sunset Strip Furniture Stripping Company employed two full-time men, including the owner. During the time of our evaluation the workers performed typical operations in the shop such as wood stripping, sanding, and refinishing operations. The company performed the wood stripping and refinishing operations in a leased space of an industrial building.

Furniture stripping and refinishing workers have been identified as a group which may have potential for over exposures to lead.[1] Over-exposure to lead was identified in one study among developmentally disabled workers engaged in furniture refinishing.[1] In this study it was determined that blood lead levels (BLLs) among sanders and helpers averaged 60 micrograms per deciliter of blood (µg/dl) at one location, and at another location 6 individuals had BLLs greater than 25 µg/dl. Hand sanding of chemically stripped wood that was previously coated with lead-based paint was determined to be the exposure source.[1] The Occupational Safety and Health Administration (OSHA) has established a permissible exposure limit (PEL) for lead in air of 50 micrograms per cubic meter (µg/m^3) as an 8-hour time weighted average (TWA), which is intended to maintain worker BLLs below 40 µg/dL.[2, 3]

Methods

On September 4-5, 2002, area air samples for elements (including lead) and inhalable dust were collected at two area locations (see Figure 1): (1) the right side of the work bench (location A1), and (2) the left side of the work bench (location A2). Personal breathing zone (PBZ) air samples were collected on both workers in the shop for elements and total dust during stripping, rinsing, sanding, and refinishing operations throughout the 2-day sampling period. Particle sizing data were also collected at Location A1 with an optical particle analyzer. In addition to air samples, qualitative surface wipe samples for lead and bulk samples for elements were collected.

Elements

Air samples for elements were collected on 37–mm diameter (0.8 µm pore–size) cellulose ester membrane filters, using sampling pumps calibrated at 3 liters per minute (Lpm). Air samples for elements were quantitatively analyzed for silver, aluminum, arsenic, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lithium, magnesium, manganese, molybdenum, sodium, nickel, phosphorus, lead, platinum, selenium, tellurium, thallium, titanium, vanadium, yttrium, zinc, and zirconium using a Perkin Elmer Optima 3000 DV inductively coupled plasma spectrometer according to NIOSH Method 7300.[4]

Total Dust and Inhalable Dust

Air samples for total dust were collected on a tared 37–mm diameter, (5 µm pore–size) polyvinyl chloride (PVC) filter at a calibrated flow rate of 2 Lpm. The filter was gravimetrically analyzed (filter weight) according to NIOSH Method 0500.[4] Air samples for inhalable dust were collected with a tared 25–mm diameter 5 µm PVC filter in conjunction with an IOM inhalable sampler at a calibrated flow rate of 2 Lpm. The filters were gravimetrically analyzed according to NIOSH Method 0500.[4]

Particle Size Analysis

Particle size data were collected with a real-time light scattering aerosol spectrometer (Grimm Model 1105 dust monitor, Labortechnik GmbH & CoKG, Ainring, Germany). The aerosol spectrometer measures the size distribution of particles in 8 different size ranges. The 1105 model measures particles between 0.5 µm and 15 µm in diameter. Particles are sized based upon the amount of light scattered by individual particles. The aerosol spectrometer operates at a flow rate of 1.2 Lpm.[5] The data collected with the aerosol spectrometer was downloaded to an Excel® spreadsheet (Microsoft® Corporation, Redmond, Washington). Because the calibration of the aerosol spectrometer varies with aerosol properties, the output of the instrument is viewed as a measure of relative concentration. Samples for total particulate were collected near the aerosol spectrometer sampling probe. The samples were used for calibration purposes. The calibration sample and aerosol spectrometer data were used to obtain a conversion factor. The conversion factor was obtained by taking the total particulate sample result and dividing it by the integrated aerosol spectrometer concentration result. The conversion factors were then used to adjust the concentration values.

The mass gain, mass fraction (MF), cumulative mass fraction (CMF), CMF less than indicated size, concentration, average respirable fraction, and respirable MF were calculated for each size range. The total percentage of particles in the respirable size range was also calculated as well as the total and respirable concentration values. The aerodynamic mass median diameter (AMMD) and the geometric standard deviation (GSD) were determined from a log-probability plot of the particle size data. The particle size data were used to determine if the majority of the particles generated during sanding operations were in the large particle size range which are likely to impact the walls of the nasal cavity.

Lead

Qualitative lead wipe samples (i.e., to determine the presence of lead, not the amount) were collected using LeadCheck® Swabs on various surfaces. The LeadCheck® Swab turns pink or red in color if lead is present in the dust on the surfaces tested. LeadCheck® Swabs reproducibly detect lead in paints at 0.5%, and may indicate lead in some paint films as low as 0.2%.[6] Refer to Figure 1 for wipe sample locations.

Bulk Samples

Bulk samples of stripping solution from the stripping tank and samples of wood dust (collected in the shop near sanding operations) were analyzed for elements using a Fisons ACCURIS inductively coupled plasma emission spectrometer controlled by a Micron Millennia LXA personal computer in accordance with NIOSH Method 7300 for bulk samples.[4]

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 increases 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),[7] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values

(TLVs®),[8] and (3) the U.S. Department of Labor, OSHA PELs.[9] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

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.

Wood Dust

Wood dust exposure may cause eye and skin irritation, respiratory effects and hard wood nasal cancer.[10] Loggers and persons (involved in initial wood processing) exposed to irritant chemicals typically found in the bark or the sap in the outer part of the tree, are most affected by primary irritant dermatitis which consists of erythema and blistering.[10] Workers involved in secondary wood processing (i.e., carpenters, sawyers, and furniture makers) are more often affected by chemicals causing sensitization. Allergic dermatitis arising from exposure to wood substances is characterized by redness, scaling, and itching, which may progress to vesicular dermatitis after repeated exposures.[10] The adverse health effects that have been associated with exposure to wood dust upon which evaluation criteria are based include dermatitis, allergic respiratory effects, mucosal and non-allergenic respiratory effects, and cancer.

NIOSH recommended that wood dust be considered a potential occupational carcinogen and that exposures be reduced to the lowest feasible level, not to exceed the REL of 1 milligram of wood dust per cubic meter of air (mg/m^3) for both soft and hard woods.[7] ACGIH currently has a TLV of 1 mg/m^3 for hard woods such as beech and oak, and a TLV of 5 mg/m^3 for soft woods.[8] The ACGIH TLV of 1 mg/m^3 for hard woods was principally based on prevention of impaired nasal mucociliary function reported to be important in the development of nasal adenocarcinoma in the furniture industry because of the prolonged retention of wood dust in the nasal cavity.[11] ACGIH also recommends a STEL of 10 mg/m^3 for soft wood averaged over a 15-min period which should not be exceeded at any time during the work day even if the 8-hour TWA exposure value is within the TLV.[8] There is currently no specific OSHA PEL for wood dust. The OSHA PEL for total particulate not otherwise regulated (PNOR) is 15.0 mg/m^3 and 5.0 mg/m^3 for the respirable fraction, determined as 8-hour averages.[9]

RESULTS

Elements

Bulk samples of dust material and the bulk sample of stripping solution indicated the presence of lead and other elements (i.e., aluminum, calcium, cadmium, cobalt, chromium, copper, iron, lithium, magnesium, manganese, molybdenum, sodium, nickel, phosphorus compounds, titanium, vanadium, yttrium, zinc, and zirconium). Area air samples (obtained near the sanding operations) and PBZ air samples (obtained during stripping, rinsing, sanding, and refinishing operations) collected throughout the 2-day sampling period indicated that concentrations of lead and other elements were well below applicable occupational exposure criteria.

Total Dust and Inhalable Dust

PBZ air samples for total dust were collected on both workers at the facility during shop activities (i.e., stripping, rinsing, sanding, and refinishing operations) over the 2-day sampling period. The shop typically works on hard woods (i.e., oak, mahogany, walnut, and beech). On September 4, 2002, sanding operations were reported as being light and lasted for approximately 2 ½ hours. The two full-shift PBZ samples collected for total dust on this day indicated concentrations of 0.6 mg/m^3 (worker #1 listed on Table 1) and 1.5 mg/m^3 (worker #2 listed on Table 1). On September 5, 2002, PBZ total dust full-shift samples on the two workers in the shop indicated concentrations of 0.4 mg/m^3 (worker #1) and 1.5 mg/m^3 (worker #2). Worker #2 performed the majority of sanding operations and had the highest total dust exposure on both sampling days.

Area air samples for inhalable dust were collected at two locations: (1) the right side of the work bench (location A1), and (2) the left side of the work bench (which was closer to the majority of sanding operations [location A2]). On September 4, the inhalable samples collected at locations A1 and A2 indicated concentrations of 1 mg/m^3 and 1.4 mg/m^3, respectively (see Table 1). On September 5, inhalable samples collected at locations A1 and A2 indicated concentrations of 0.7 mg/m^3 and 1.5 mg/m^3, respectively (see Table 1).

Particle Size Analysis

The results of the particle size data indicated that the total and respirable particle concentrations in an area near the sanding operations (Location A1) were 0.82 and 0.05 mg/m^3, respectively. The log-probability plot indicated an AMMD of 14.9 µm and a GSD of 2.1. The mass gain, MF, CMF, CMF less than indicated size, concentration, average respirable fraction, and respirable MF are presented in Table 2.

Lead Qualitative Wipe Samples

One location on the work table and a wipe sample collected on a chair (after stripping operations and prior to sanding) indicated the presence of lead. All other wipe samples did not indicate the presence of lead compounds (above the detection limits of the swabs [see Figure 1]).

DISCUSSION

During the time of our evaluation, air sampling results (both PBZ and area) indicated that concentrations of lead and other elements were well below applicable occupational exposure criteria and did not indicate an airborne hazard. However, bulk sample results indicated the presence of elements (including lead) in the stripping solution and dust in the shop. In addition, qualitative lead wipe samples indicated the presence of lead compounds on the work table and on a chair that was being processed at the facility. Furniture stripping and refinishing workers have been identified as a group which may have potential for over exposures to lead.[1] Therefore, care should be taken to improve hygiene practices within the shop to reduce the possibility of ingestion or secondary exposures during cleaning activities (see Recommendations).

Workers in the shop primarily work on hard wood furniture (i.e., oak, beech, mahogany, and walnut). Therefore, wood dust exposures are compared to occupational criteria for hard wood. Full-shift PBZ wood dust air samples indicated exposures exceeding the NIOSH REL (1 mg/m^3 for soft or hard wood) and ACGIH TLV (1 mg/m^3 for hard wood). ACGIH has listed wood dust criteria in the "notice of intended changes" section of the TLV booklet.[8] The changes listed include evaluating wood dust exposure with the inhalable fraction and proposed TLV's of 2 mg/m^3 for nonallergenic and noncarcinogenic wood dust, 0.5 mg/m^3 for western red cedar wood dust, and 1 mg/m^3 for other respiratory allergenic wood dust, birch, mahogany, teak, walnut, oak, and beech.[8] Area inhalable samples indicated concentrations exceeding the wood dust criteria in the "notice of intended changes" for hard wood dust. Sanding operations at the time of our evaluation were reported as being light. Operations involving heavy sanding throughout the workday are likely to result in higher wood dust concentrations.

The ACGIH TLV for hard woods was recommended principally based on prevention of impaired nasal mucociliary function reported to be important in the development of nasal adenocarcinoma in the furniture industry because of the prolonged retention of wood dust in the nasal cavity.[11] Particulate size is the main factor that influences deposition in the respiratory system. Large particulate (> 5 µm in diameter) are likely to impact on the walls of the nasal cavity or pharynx during inspiration; medium particles (1 to 5 µm in diameter) are likely to settle out in the trachea, bronchi, or bronchioles as the air velocity decreases in the smaller passage ways; and small particles (< 1 µm in diameter) typically move by diffusion into the alveoli.[12] The particle size data collected with a real-time light scattering aerosol spectrometer indicated a AMMD of 14.9 µm. These data indicate that the majority of the particles generated in the shop during sanding activities are in the large particulate size range (> 5 µm in diameter) and are likely to impact the walls of the nasal cavity or pharynx.

Engineering controls should be used to reduce worker exposures to wood dust. Administrative controls and personal protective equipment (PPE) (i.e., respirators) are designed to protect workers from airborne exposures while engineering controls are being implemented or when engineering controls are not feasible or effective in reducing air contaminants to acceptable levels.

Respirators may be used to reduce worker exposure to wood dust until engineering controls are implemented and shown to be effective in reducing exposures to acceptable levels. For respirators to be worn by employees, an appropriate respiratory protection program must be utilized by the company and be in accordance with OSHA regulation 29 CFR 1910.134.[13]

NIOSH respirator recommendations are governed by the following selection criterion:

Assigned protection factor (APF) > (workplace airborne concentration/NIOSH REL)

This selection criteria only applies to respirators used in a proper respirator program under the supervision of a properly trained respirator program administrator. Respirators used without such a program with all its essential elements can not be relied upon to protect workers.[14]

Each worker required to wear a respirator must be medically evaluated and cleared by a physician to wear the specific respirator before performing assigned tasks. For respirators to be effective and protect workers from harmful exposures they must be selected, inspected, and maintained properly. Respirators should be inspected by the worker prior to and after each use for any defects. Respiratory protective equipment should also be cleaned and disinfected after each use. Respiratory protective devices should never be worn when a satisfactory face seal can not be obtained. Many conditions may prevent a good seal between the worker's face and the respirator. Some of these conditions include facial hair, glasses, or an unusually structured face. All workers required to wear a respirator must be properly trained on the selection, use, limitations, and maintenance of the respirator and also be fit–tested to assure a proper seal between the workers face and the respirator prior to performing work tasks in a contaminated area. A recent article [Campbell, D.L. et al. 2001], recommends to purchase only respirators with good fitting characteristics (h ≥ 0.95) and then carefully conduct fit-test on individual workers.[15] All workers should receive annual fit–testing with a quantitative testing device. When not in use, respirators must be stored in a clean environment located away from any source of contamination.

CONCLUSIONS

Engineering controls should be used to reduce worker exposures to wood dust. PPE (i.e., respirators) are designed to protect workers from airborne exposures while engineering controls are being implemented or when engineering controls are not feasible or effective in reducing air contaminants to acceptable levels.

During the two days of our evaluation, it was observed that the majority of wood dust exposures occurred during sanding activities with a 6-inch random orbital sander. The sander was not equipped with any control devices to limit the amount of wood dust generated. NIOSH researchers designed and tested a new control system for hand sanders that significantly reduced dust emissions.[16] During this research study a dust control plenum with a series of exhaust slots along the edges was designed to fit between the sanding pad and the sander body. An exhaust connection on the top of the sander pad connects the plenum with a vacuum source. Laboratory tests indicated that the plenum reduced wood dust emissions by approximately 90 percent.[16] Gary N. Carlton, et.al., recently published an article on the effectiveness of handheld ventilated sanders.[17] This study evaluated two sanders (a DCM sander [DCM Clean-Air Products, Inc., Fort Worth Texas], and a Dynabrade sander [Dynabrade, Clarence, NY]) in a laboratory glove box.[17] Within the experimental guidelines of this evaluation, both sanders were found to be effective in controlling inhalable dust generated during simulated aircraft surface abrasion, with the DCM sander reducing mass concentrations by 93% and the Dynabrade sander reducing mass concentrations by 98%.[17]

Another option for controlling wood dust exposures in the shop is a local exhaust ventilation system such as a downdraft table. If a downdraft table is utilized, good work practices are essential when working with the ventilation system. Care must be taken to manipulate the piece of wood (i.e., furniture) in a manner to avoid blocking the air flow into the hood, for example, placing the piece of furniture on its side on top of the downdraft table to allow the air and particulate to flow freely into the hood versus laying it flat on the downdraft table and blocking the air flow. If a local exhaust ventilation system is utilized it should be designed to have a capture velocity (minimum hood-induced air velocity necessary to capture and convey the contaminant into the hood) of approximately 200 feet per minute (fpm), and a duct velocity of approximately 3500–4000 fpm (recommended duct velocities for average industrial dust) to avoid plugging the duct work with material.[18] The system must also be designed to meet fire, safety, or environmental codes that apply to this facility and operations.

RECOMMENDATIONS

1. Engineering controls should be implemented to control wood dust exposures during sanding operations. The engineering control system for orbital hand sanders, described in the conclusion section of this report, may reduce dust emissions to acceptable levels during sanding operations. Other engineering controls, such as a downdraft table, could also be utilized to reduce dust emissions. After engineering controls have been installed, worker exposures should be re-evaluated to determine if controls are effectively reducing wood dust exposures below NIOSH and ACGIH occupational criteria.

2. During sanding operations the workers did not have respiratory protection. NIOSH investigators recommend that the workers utilize respirators during sanding operations until engineering controls can be implemented and shown to be effective in reducing wood dust exposures to concentrations below NIOSH and ACGIH criteria. A properly fitting half-mask respirator (with good fitting characteristics [$h \geq 0.95$][15]) equipped with N-95 filters should be sufficient to protect the workers during sanding operations. In environments where oil aerosols may be present an R-95 or P-95 filter should be used with the selected respirator.[19] An appropriate respiratory protection program must be utilized by the company and be in accordance with OSHA regulation 29 CFR 1910.134.[13] Wood dust may also cause eye irritation. Therefore, goggles or other appropriate eye protection should be worn to avoid wood dust from irritating the eyes. Eye protection may be difficult with half-mask respirators. If this becomes a problem, another option may be full-face respirators. Full-face respirators will protect the eyes and respiratory system.

3. Eating, drinking, or smoking should not be allowed in work areas. These activities should be restricted to designated areas away from contaminants in the shop. In the shop workers wore street clothes (e.g., blue jeans and tee-shirts). Workers should change out of contaminated clothing and wash thoroughly to remove any contaminants prior to eating, drinking, smoking, or leaving work (to prevent any possible contamination of vehicles or homes).

4. Housekeeping practices should be improved to reduce any secondary exposures to wood dust or other possible contaminants.

Dry–sweeping in the shop should be prohibited to prevent dust from becoming airborne which would increase workers' exposures. Only wet clean–up methods (i.e., mopping) or vacuuming with an approved high efficiency particulate air (HEPA) filter vacuum should be allowed during clean–up activities. Wet clean–up methods should not be used in any area where they may cause a potential electrical or safety hazard.

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Table 1. Total Dust and Inhalable Dust Sample Results (HETA 2001-0537)

Sample Type	Date	Total Dust (TD) or Inhalable (IOM)	Sample Time (min)	Sample Concentration (mg/m^3)
PBZ worker #1	9/4/02	TD	422	0.6
PBZ worker #2	9/4/02	TD	423	1.5
PBZ worker #1	9/5/02	TD	455	0.4
PBZ worker #2	9/5/02	TD	475	1.5
Area A1	9/4/02	IOM	427	1
Area A2	9/4/02	IOM	392	1.4
Area A1	9/5/02	IOM	464	0.7
Area A2	9/5/02	IOM	366	1.5

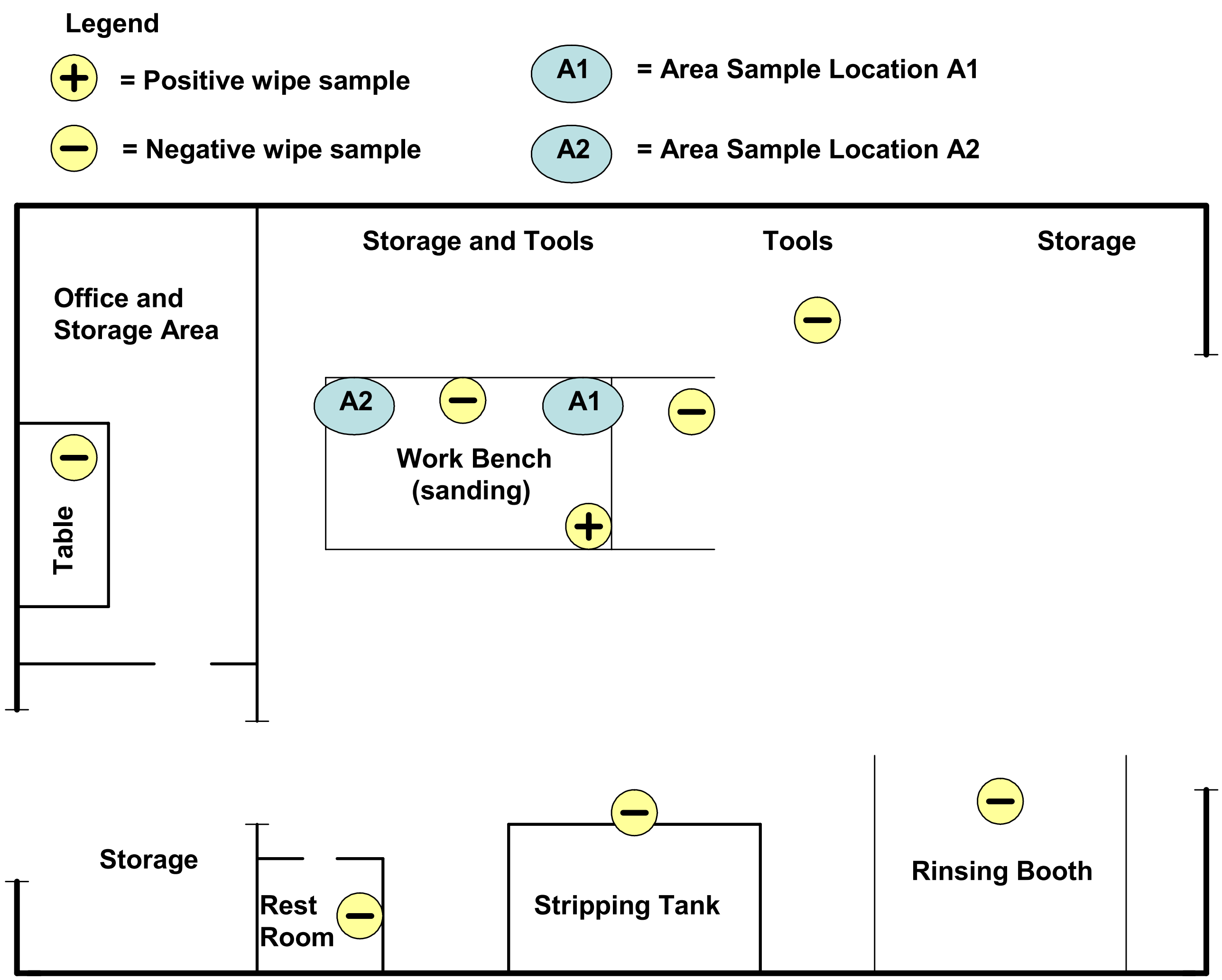
PBZ = Personal Breathing Zone
mg/m^3= milligrams per cubic meter

Table 2. Particle Size Data Results

Stage Number	Effective Cut Diameter	Size Range lower	Size Range upper	Size Interval Dp	Final Weight (mg)	Initial Weight (mg)	Net Gain (mg)	Mass Fraction	CMF	CMF< Indicated Size	Concentration (mg/m^3)	Average Respirable Fraction	Respirable Mass Fraction
1	15	15	>15		0.324	0.000	0.324	0.474	1.000	0.526	0.38680	0	0
2	10	10	15	5	0.494	0.324	0.170	0.248	0.526	0.279	0.20230	0.005	0.00124
3	7.5	7.5	10	2.5	0.575	0.494	0.081	0.118	0.279	0.161	0.09646	0.0425	0.00502
4	5	5	7.5	2.5	0.632	0.575	0.058	0.084	0.161	0.076	0.06892	0.1875	0.01582
5	3.5	3.5	5	1.5	0.667	0.632	0.035	0.051	0.076	0.025	0.04169	0.455	0.02323
6	2	2	3.5	1.5	0.679	0.667	0.012	0.017	0.025	0.008	0.01424	0.775	0.01351
7	1	1	2	1	0.683	0.679	0.004	0.005	0.008	0.002	0.00434	0.97	0.00515
8	0.5	0.5	1	0.5	0.684	0.683	0.002	0.002	0.002	0.000	0.00203	1	0.00249
Totals							0.684				0.82		0.07
Total Aerosol Concentration 0.82 mg/m3													
Respirable Mass Fraction 0.07 or 7%													
Respirable Mass Concentration 0.05 mg/m3													

mg=milligrams
CMF = cumulative mass fraction
mg/m^3= milligrams per cubic meter

Figure 1. Diagram of shop layout



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Centers for Disease Control and Prevention
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