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GIBSON FLATIRON,
ERICA SHELL MANUFACTURING
BOZEMAN, MONTANA

I. SUMMARY

On July 7, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Montana State Health Department to conduct a health hazard evaluation (HHE) at the Gibson Flatiron/Erica Shell Manufacturing Companies in Bozeman, Montana. The State Health Department had received a request from the Fire Marshall in Bozeman to investigate exposures to wood dust and lacquer vapors. The Gibson Flatiron Company crafted mandolins and banjos while the Erica Shell Manufacturing Company made inlay designs from sea shells.

On October 8, an environmental evaluation of the two companies was conducted. The survey consisted of an inspection of the various work areas, interviews with employer representatives and employees, and personal breathing zone and area environmental air monitoring for total dust and various organic compounds.

Short-term wood dust levels ranged from 0.8 to 32 mg/M^3, with 8-hr time-weighted average (TWA) concentrations ranging from 1.2 to 30 mg/M^3. Two of the TWA exposures were above the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for wood dust of 5 mg/M^3. These jobs were involved in rib construction and assembly (15 mg/M^3) and planing bulk ebony wood (30 mg/M^3). All five of the TWA samples were above the NIOSH recommended exposure limit (REL) for wood dust of 1 mg/M^3.

Application of dyes and finishes resulted in low exposures to acetone, toluene, xylene, and butyl acetate. No solvent air concentrations were greater than 10% of their respective PELs.

Based on the environmental monitoring results, the NIOSH investigator concluded that a health hazard existed from overexposure to wood dust. Despite the fact that most employees wore respiratory protection, few wore proper dust filters. Recommendations are made in Section VII to help establish a respiratory protection program, a hearing conservation program, and to correct other identified problems.

KEYWORDS: SIC 3931 (Musical Instruments), wood dust, acetone, toluene, xylene, butyl acetate, noise, mandolin, banjo.

II. INTRODUCTION

On July 7, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Montana State Health Department to conduct a health hazard evaluation (HHE) at the Gibson Flatiron/Erica Shell Manufacturing Companies in Bozeman, Montana. The State Health Department had received a request from the Fire Marshall in Bozeman to investigate exposures to wood dust and lacquer vapors. The Fire Marshall was also concerned about storage of flammable liquids and proper egress from one of the buildings at Gibson Flatiron.

On October 8, an environmental evaluation of the two companies was conducted. The survey consisted of an inspection of the various work areas, interviews with employer representatives and employees, and personal breathing zone and area environmental air monitoring for total dust and various organic compounds.

III. BACKGROUND

The Flatiron company originally built mandolins before it was purchased by the Gibson Guitar company. The main Gibson Guitar Company is located just outside Bozeman. The Gibson Flatiron company represented the Mandolin Division of Gibson. The primary Gibson Flatiron building consisted of a main work area where layup and detail work was done on mandolins. The layup building housed the vast majority of the workers and contained a woodworking shop and offices. This building also had an old spray booth which was used until the summer of 1991. A new spray booth was built in an adjacent building which also housed the finishing department, wood storage, large woodworking machines, and the banjo manufacturing.

The woods used in construction of the mandolins include maple for the body, ebony and rosewood for neck plates, mahogany for the necks, birch for the sides, and spruce for the front. A variety of other woods are also used, but only in small quantities. Many of these same woods are used in the production of banjos.

The Erica Shell Manufacturing site is located several blocks from the Flatiron buildings. The structure is a two-room building, with one small office and the main shell working area. Abalone and other sea shells are received in bulk then cut and ground into small pieces. Designs and logos are then cut from this material by a computer controlled, high speed cutting machine. The shell pieces are inlayed into the mandolins and banjos. Shell parts are sold and shipped to other customers.

IV. MATERIALS AND METHODS

The NIOSH evaluation consisted of interviews with representatives from management and employees, and an environmental survey. The specific measurements and types of samples collected in the environmental survey are detailed below.

A. Personal breathing-zone total dust samples (for wood dust) were collected on mixed cellulose ester membrane filters at a flow rate of 2.0 liters per minute (Lpm) using Gilian Model HFS 513S personal sampling pumps. The filters were analyzed gravimetrically according to NIOSH method 0500.[1]

B. Air samples for organic solvents were collected on 150-milligram charcoal tubes at 80-200 cubic centimeters per minute (cc/min) using Gilian low flow personal sampling pumps. These samples were analyzed for toluene, xylene, butyl acetate, and acetone by gas chromatography according to NIOSH analytical methods #1300, 1450, and 1501.[1]

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week, for a working lifetime without experiencing adverse health effects. It is, 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 preexisting medical condition, and/or a hypersensitivity (allergy).

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

The primary sources of air contamination criteria generally consulted include: (1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs), (2) the American Conference of Governmental Industrial Hygienist's (ACGIH) Threshold Limit Values (TLVs),[2] and (3) the U.S.

Department of Labor (OSHA) federal occupational health standards, permissible exposure limits (PEL).[3] These sources provide environmental limits based on airborne concentrations of substances to which workers may be occupationally exposed in the workplace environment for 8 to 10 hours per day, 40 hours per week for a working lifetime without adverse health effects.

The industrial criteria for the substances evaluated in this survey are presented in Table 1. 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 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. A discussion of the substances evaluated in this survey is presented below.

A. Wood Dust

Some woods, both domestic and exotic, are know to cause contact dermatitis. Respiratory diseases associated with wood dust include hypersensitivity, asthma, acute airway obstruction, and allergic disorders of the upper respiratory tract.[4] An increased incidence of adenocarcinoma of the nasal cavity and ethmoid sinus has been demonstrated in woodworkers in the furniture industry of England, Belgium, France, and Denmark. The most frequent complaints of workers exposed to wood dust include dryness in nose, eye irritation, nasal obstruction, prolonged colds, and frequent headaches.[4] The current OSHA permissible exposure limit (PEL) is 5 milligrams per cubic meter of air (mg/M^3) measured as total wood dust for all types of woods, except for Western Red Cedar which has a PEL of 2.5 mg/M^3. OSHA also has a short-term exposure limit (STEL) of 10 mg/M^3 over 15-minutes. The ACGIH has a TLV of 1 mg/M^3 for total hard wood dusts and 5 mg/M^3 for total soft wood dust. ACGIH further recommends a STEL for soft woods of 10 mg/M^3 as total dust. NIOSH recommends an 8-hr TWA of 1 mg/M^3 for all types of wood.

B. Acetone

Acetone has been considered to be a low hazard to health, since few adverse effects have been reported, despite widespread use for many years. Awareness of mild eye irritation occurs at airborne concentrations of about 1000 ppm. Very high concentrations (12,000 ppm) depress the central nervous system, causing headache, drowsiness, weakness, and nausea. Repeated direct skin contact with the liquid may cause redness and dryness of the skin. However, at least 6 studies have been reported in the literature documenting possible adverse effects on humans at exposures below 1000 ppm. Furthermore, the available evidence indicates that

occupational exposure to acetone may lead to its accumulation in the body. NIOSH has therefore recommended lowering the current exposure limit from 1000 ppm to 250 ppm.[5] The current OSHA permissible exposure limit is 750 ppm and the STEL is 1000 ppm.

C. Toluene

Toluene may cause irritation of the eyes, respiratory tract, and skin. It may also cause fatigue, weakness, confusion, headache and dizziness. Long-term effects may include drying and cracking of the skin.[6] The current OSHA permissible exposure limit is 100 ppm and the STEL is 150 ppm. NIOSH recommends the same TWA and STEL limits as OSHA.

D. Xylene

Xylene vapor may cause irritation of the eyes, nose, and throat. Repeated or prolonged skin contact with xylene may cause drying and defatting of the skin which may lead to dermatitis. Liquid xylene is irritating to the eyes and mucous membranes, and aspiration of a few milliliters may cause chemical pneumonitis, pulmonary edema, and hemorrhage. Repeated exposure to the eyes to high concentrations of xylene vapor may cause central nervous system depression and minor reversible effects upon liver and kidneys. At high concentrations xylene vapor may cause dizziness, staggering, drowsiness, and unconsciousness.[7] Workers exposed to concentrations above 200 ppm complain of loss of appetite, nausea, vomiting, and abdominal pain. Brief exposure of humans to 200 ppm has caused irritation of the eyes, nose, and throat.[6]

The current OSHA standard for xylene is 100 ppm averaged over an 8-hour work shift with a STEL of 150 ppm. NIOSH has recommended that the permissible exposure limit be changed to 100 ppm, averaged over a work shift of up to 10 hours per day, 40 hours per week, with a STEL of 150 ppm.[6] The ACGIH TLV first adopted in 1967, is retained with a STEL of 150 ppm for a 15-minute exposure.[4]

E. Butyl Acetate

Overexposure to butyl acetate may cause irritation of the eyes, nose, and throat. Severe overexposure may cause weakness, drowsiness, and unconsciousness. Prolonged exposure may result in irritation of the skin. Since butyl acetate is a mild defatting agent and can cause dermatitis on prolonged exposure, persons with pre-existing skin disorders may be more susceptible to this effect.[6] The current OSHA PEL and NIOSH REL is 150 ppm with 200 ppm as a short-term exposure limit.

F. Total Dust

Particulate aerosols which do not show a marked toxic effect and are not otherwise classified are grouped into a category of nuisance dusts. These dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. Excessive exposures to nuisance dusts in the workplace may reduce visibility, may cause unpleasant deposits in the eyes, ears, and nasal passages, or cause injury to the skin or mucous membranes. The current OSHA PEL for Particulates Not Otherwise Classified (PNOC) is 15 milligrams per cubic meter of air (mg/M^3) measured as total dust. The ACGIH has a TLV of 10 mg/M^3 for PNOC measured as total dust.

VI. RESULTS AND DISCUSSION

A summary of the air sampling results for total dust is presented in Table 2. The time-weighted averages ranged from 1.2 to 30 mg/M^3, with short-term levels ranging from 0.8 to 32 mg/M^3. Shell cutting and grinding averaged 1.3 mg/M^3, while other assembly jobs on banjos and mandolins averaged from 1.2 to 14.7 mg/M^3. The highest TWA exposure, 30 mg/M^3, was measured during planing of ebony. Although this specific job of planing ebony is only done 4-5 times per year, the exposures measured are indicative of the job of planing, regardless of the wood type. Several workers commented that they found ebony to be a very irritating wood.

The air sample results for organic solvents are summarized in Table 3. All sample results were low, substantially below any of the evaluation criteria. The highest exposures were measured in the spray booth after spraying a lacquer finish; these levels were only 10% of any solvent PEL.

VII. CONCLUSIONS

Exposures to wood dust were above both the OSHA 8-hr TWA and the 15-minute STEL during planing operations and rib assembly. Other similar assembly jobs were probably at similar exposure levels. All employees were wearing half-face air purifying respirators equipped with a variety of filters. All respirators had organic vapor cartridges and a few were equipped with an adapter for dust. At least one of the adapters for dust was noted as being incorrectly installed, resulting in leakage around the dust filter. In general, the employees knew little about their respirators and had never been fit tested. Similarly, most employees wore ear muffs which had been modified by the

employees to put the earpiece from a cassette player/radio inside the muff. Noise levels were not measured so it is hard to determine if hearing protection is needed. However, the ear muffs used would not be considered as certified equipment due to the modifications.

VIII. RECOMMENDATIONS

1) Develop a comprehensive respirator program. The exposures to wood dust warrant adequate respiratory protection. Included is a copy of an OSHA document on the requirements of a good respirator program.[3] This includes fit testing of employees, the use of certified respirators, training for employees on use and maintenance of respirators, medical testing for the ability to wear respirators, and having a written respirator policy. It would appear that air-purifying respirators (cartridge-type with dust filters) will be sufficient for controlling exposures to wood dust, solvent vapors, and shell dust. However, certified dust filters, properly installed, need to be used. Likewise, employees will not be able to wear beards with half or full-face respirators. If air-supplied respirators are used, then the compressed air source needs to contain filters for water and oil plus a carbon monoxide alarm.

2) Measure noise levels to determine if a hearing conservation program is needed. If a hearing conservation program is needed, several items will have to be addressed. Included is a NIOSH document titled, "A Practical Guide to Effective Hearing Conservation Programs in the Workplace". Elements include annual audiograms for all affected employees, appropriate hearing protection, a written program, etc. This recommendation includes the Erica Shell Manufacturing site. The employee-modified ear muffs currently being used are not acceptable if a hearing conservation program is required.

3) The main layup building contained many connecting rooms without any exit signs. Egress routes should be clearly marked from all parts of the buildings.

4) Finishing dye vapors and overspray in the finishing department where coloring is applied to the completed instruments was not being adequately controlled by the spray booth ventilation. If a slot were installed above the area where the dyes are stored and sprayed, then the spray booth exhaust would control the overspray.

5) Flammable liquid storage should comply with OSHA regulation CFR 1910.106.[3] The bulk solvents container stored in the Erica Shell location should, at a minimum, be grounded.

IX. REFERENCES

1. NIOSH [1986]. NIOSH Manual of Analytical Methods. 3rd ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-100.

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7. NIOSH [1977]. Occupational diseases, a guide to their recognition, revised edition. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-181.

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Copies of this report have been sent to:

1. Manager, Gibson Flatiron, Erica Shell Manufacturing, Bozeman, Montana.
2. Fire Marshall, Bozeman, Montana
3. Industrial Hygienist, Montana Department of Health
4. U.S. Department of Labor/OSHA - Region VIII.
5. NIOSH, Region VIII

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

Table 1
ENVIRONMENTAL CRITERIA FOR SELECTED SUBSTANCES
GIBSON FLATIRON, ERICA SHELL MANUFACTURING
BOZEMAN, MONTANA
OCTOBER 1991
HETA 91-298

SUBSTANCE	OSHA PEL	NIOSH REL	ACGIH TLV
Wood dust, all types, total dust	5 mg/M^3 8-hr TWA 10 mg/M^3 STEL	1 mg/M^3 8-hr TWA	5 mg/M^3 8-hr TWA Soft woods 1 mg/M^3 Hard woods
Particulates Not Otherwise Regulated	15 mg/M^3 Total dust 8-hr TWA	none	10 mg/M^3 Total dust 8-hr TWA
Acetone	750 ppm 8-hr TWA 1000 ppm STEL	250 ppm 8-hr TWA	750 ppm 8-hr TWA 1000 ppm STEL
Toluene	100 ppm 8-hr TWA 150 ppm STEL	100 ppm 8-hr TWA 150 ppm STEL	100 ppm 8-hr TWA 150 ppm STEL
Xylene	100 ppm 8-hr TWA 150 ppm STEL	100 ppm 8-hr TWA 150 ppm STEL	100 ppm 8-hr TWA 150 ppm STEL
n-Butyl Acetate	150 ppm 8-hr TWA 200 ppm STEL	150 ppm 8-hr TWA 200 ppm STEL	150 ppm 8-hr TWA 200 ppm STEL

Abbreviations and Key
TWA - Time-weighted average concentration
ppm - Parts of contaminant per million parts of air
STEL - Short-term exposure limit; 15-minute TWA exposure
mg/M^3 - milligram/cubic meter of air

TABLE 2
SUMMARY OF AIR SAMPLING RESULTS FOR TOTAL DUST
GIBSON FLATIRON, ERICA SHELL MANUFACTURING
BOZEMAN, MONTANA
OCTOBER 8, 1991
HETA 91-298

Sample #	Job/Area Description	TOD	Sample Duration (min)	Sample Volume (liters)	Dust Conc (mg/M^3)
OM-2763	Finishing body of mandolin	AM	299	598	1.6
OM-2759	Finishing, using palm sander	PM	181	362	7.7
			480	TWA	3.9
OM-2770	Rib construction/assembly	AM	297	594	13
OM-2760	"	PM	194	388	18
			491	TWA	15
OM-2769	Make metal screws for banjo	AM	286	572	1.4
OM-2761	Banjo assembly	PM	167	334	0.84
			453	TWA	1.2
OM-2771	Shell cutting, grinding 1.3	AM/PM		339	678
OM-2762	Planing ebony	AM	104	208	32
OM-2773	"	PM	86	172	27
			190	TWA	30

Evaluation Criteria: Wood Dust, all types: TWA - 5 mg/M^3, STEL 10 (OSHA)
Soft Woods - 5 mg/M^3, Hard Woods 1 mg/M^3
(ACGIH) : (NIOSH) - 1 mg/M^3 as 8-hr TWA
Particulates Not Otherwise Regulated: TWA - 15 mg/M^3
as total dust (OSHA); 10 mg/M^3 as total dust (ACGIH).

Abbreviations and Key
min = minute
mg/M^3 = milligrams of dust per cubic meter of air
TOD = time of day

TABLE 3
SUMMARY OF AIR SAMPLING RESULTS FOR ORGANIC SOLVENTS
GIBSON FLATIRON, ERICA SHELL MANUFACTURING
BOZEMAN, MONTANA
OCTOBER 8, 1991
HETA 91-298

Sample #	Job/Area Description	TOD	Sample Vol(L)	Solvent Concentration (ppm) Acetone	Toluene	Xylene	Butyl Acetate
EC-02	Area, center of finish shop	AM	24.1	0.5	3.9	0.7	0.5
EC-07	"	PM	11.9	<0.1	ND	ND	ND
EC-03	Finisher, sanding & applying	AM	60	<0.1	0.8	0.2	0.1
EC-05	finish.	PM	31	0.4	0.9	0.7	0.5
EC-04	Area, inside spray booth	AM	30	0.3	2.0	1.2	0.9
EC-06	"	PM	15	1.9	4.2	9.4	8.7
Evaluation Criteria (ppm):							
	OSHA & NIOSH-TWA			750	100	100	150
	OSHA & NIOSH-STEL			1000	150	150	200

Abbreviations and Key
TWA - time-weighted average
STEL - short-term exposure limit
ND - non-detectable
OSHA - Occupational Safety and Health Administration
NIOSH- National Institute for Occupational Safety and Health