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Ergonomics

An Assessment of Occupational Safety and Health Hazards in Selected Small Businesses Manufacturing Wood Pallets—Part 1. Noise and Physical Hazards

Researchers from the National Institute for Occupational Safety and Health (NIOSH) investigated occupational safety and health concerns in the small business wood pallet manufacturing industry. The investigation consisted of interviews with employees and managers and walkthrough tours of seven wood pallet manufacturing companies while taking measurements at several of them. The purpose of the project was to assess and characterize occupational safety and health hazards in the industry and to offer suggestions as to how exposure to the hazards might be mitigated. Noise level measurements and ergonomic observations were made at each facility. This column describes the assessments and suggestions to minimize ergonomic and noise exposures from the occupational risk factors at the facilities. (A companion paper will address the respiratory hazards evaluated during the investigation: i.e., Part 2—airborne particulate and chemical hazards.) The main findings are as follows:

1. Short-term (<8 hours) noise measurements associated with certain machines and procedures at all sites produced noise levels greater than 90 dBA, which is the Occupational Safety and Health Administration permissible noise exposure limit⁽¹⁾ based on an 8-hour time-weighted average (TWA).
2. Ergonomics-related deficiencies noted in pallet manufacturing included stretching to assemble pallets, bending to retrieve wood, lifting loads that were too heavy, and twisting and turning while lifting those loads.

INTRODUCTION

Small business entrepreneurship is a vital component of the U.S. economy. Of the approximately 6.9 million private industry establishments operating in the United States in 1998, approximately 6.0 million (86%) employ fewer than 20 employees, including about three-fourths (72%) of all domestic wood pallet and container manufacturing firms.⁽²⁾ Prevention of occupational injury and illness is often difficult for small business establishments because they generally have few safety and health resources, do not hire staff devoted to safety and health activities, and often lack the ability to identify occupational hazards and conduct surveillance.

NIOSH examined the wood pallet manufacturing industry because of its high rate of injury. Analysis of Bureau of Labor Statistics data showed that the incidence rate (2000) for nonfatal injuries involving days away from work in the wood pallet and skid manufacturing industry was 226% greater than that for general industry.⁽³⁾

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The rates of particular injuries sustained at wood pallet manufacturers in 1998 were higher than those in general industry (sprains and strains were 194% higher and back pain was 177% higher).⁽⁴⁾ In 2000, the wood pallet and skid industry (SIC code 2448) employed 46,500 workers and approximately 5600 of these workers had an injury on the job that year.⁽⁵⁾

This column provides an overview of occupational risks found in the wood pallet manufacturing industry related to ergonomics and noise and offers suggestions to the industry to ameliorate those risks, in particular, noise exposure and those risks associated with the development of musculoskeletal disorders will be addressed.

METHODS

Four Midwest wood pallet manufacturing small businesses were visited to take noise measurements and to observe working activities to assess ergonomic conditions and potential musculoskeletal stressors. The methods used to make the measurements were as follows:

- Equivalent continuous A-weighted sound pressure (L_{eq}), was measured using a Model 824 (Larson Davis, Provo, Utah) sound level meter (SLM). For each L_{eq} measurement of an operating tool or process, the SLM was mounted on a tripod and the microphone was positioned approximately 1 m from the noise source. More detailed task-based noise measures, dosimetry measures, and measurements of noise hazard at the operator's ear were collected during follow-up visits and will be presented in a subsequent report.
- Work processes were observed and evaluated using standard exposure assessment techniques by the NIOSH investigators. Biomechanical analyses were performed on select work postures using the 3-Dimensional Static Strength Prediction Program from the University of Michigan.

RESULTS

The following measurements were made during the site visits and relate only to conditions at each pallet manufacturer on the day of the visit. The results of these measurements are not necessarily representative of the conditions at other times or at other manufacturers.

Noise

Workers at pallet manufacturers are exposed to noise from equipment, including forklifts, saws, air compressors, pallet stackers, and nail guns. At the sites visited, equipment noise levels were measured at levels up to 104 dBA on a notcher and impulsive noise levels up to 136 dBA on nail guns. Noise monitoring data from the surveys are presented in Table I.

The noise from the nail gun was impulsive noise. The sound level would rapidly rise when the gun was fired and then fall to baseline. Workers using the nail guns, however, were often

TABLE I. Machinery Noise Levels

Machinery	Task Noise Level (dBA)
Skid stacking machine	99.1 dB
Compressor	84-in front of wood sound barrier; 93-behind sound barrier, next to compressor
Assembly station (includes pneumatic air gun)	93.1, 98.8
Notcher	104; 126 peak
Band re-saw	93.5
Pallet stripping band saw	99
Nail gun (impulsive noise)	136
Table saw	92.8
Chop saw (small)	99; 120.8 peak
Chop saw (big)	97; 118.9 peak
Fork lift	83-moving slowly; 91-moving fast outside; 91-backup beeper

near other workers using the same guns and, in general, a nail gun would be fired every few seconds.

All visited facilities provided workers with earplugs having noise reduction ratings (NRRs) from 20 to 30 dB, but none gave instruction as to their proper use, conducted fit testing, or monitored their use. Earplugs were to be worn when using nail guns or sawing wood but they were not required. There were no written hearing conservation plans or audiometric testing in any of the firms that were visited.

Ergonomics

A number of ergonomics-related hazards became apparent over the course of this study. These included: (1) manual materials handling of raw material and finished product, (2) the extensive use of power tools, (3) improper height of work surfaces, and (4) extreme forward reaching of workers.

Raw material, such as squared timbers or cants, may weigh over 100 lbs and may be positioned by hand to be cut into usable materials. Workers were observed stacking finished pallets, weighing up to 60 lbs, directly on the shop floor until the stack was above shoulder height. Biomechanical analysis of lifting 60-lb pallets reveals possible back compression forces equal to or greater than the NIOSH recommended maximum disc compression force of 770 lbs, the point above which individuals would be at increased risk of back injury.⁽⁶⁾

Many workers use pneumatic nail guns to attach the deckboards to the stringers of the pallet. These tools weigh about 8.5 lbs and are rarely suspended or counter-balanced to support the weight of the tool. The use of pneumatic tools in conjunction with reaching to fasten the far side of the pallet can result in high loads on the lower back and shoulders. Repetitive use of triggers and prolonged exposure to vibration may result in injury to the soft tissue structures in the hand.



FIGURE 1. Slanted surface of assembly table

Pallets are often assembled on working surfaces that are approximately waist height. Depending on the anthropometrics of the workforce and the details of the work process, the working surface may be either too high or too low for individual workers to use comfortably. Working height and forward reach are primary concerns in pallet assembly. A biomechanical analysis of a typical posture associated with this job determined that nearly all males are capable of performing this job without undue stresses; however, shoulder strength becomes a limiting factor for some females who may perform this task. Only about three-fourths of the 50th percentile female workers would have sufficient shoulder strength to perform this task.

When the workstation is angled or vertical instead of horizontal, reach is a critical consideration. When pallet assembly occurs on a slanted surface, forward reach to the uppermost deckboard is the primary consideration. Figure 1 illustrates a worker nailing the deckboard onto the stringer loaded into the slanted front of an assembly table. It is questionable whether workers of shorter stature can reach the topmost corner of the pallet in such a configuration. A biomechanical analysis of this posture determined that while the shoulder and back are stressed in this posture, it is the strength of the worker's ankle and knee that are the limiting factors. Approximately 50% of 50th percentile female workers and 80% of 50th percentile male workers have sufficient ankle and knee strength to perform this task.

DISCUSSION AND SUGGESTIONS

Noise

Noise exposure at wood pallet manufacturing facilities can be reduced by a combination of engineering controls, administrative controls, and personal protective equipment (PPE). Noise-producing workstations can be acoustically shielded from nearby workers, or noise dampening acoustic treatments may be applied to the walls and ceilings of the manufacturing sheds when feasible. Air compressors can be set up

and operated outside the assembly building or in a separate enclosure within the building, not in the work area. At one site, separating the compressor from the workplace with a wooden barrier lowered the noise exposure from 93 to 84 dBA. Power tools and machinery should be operated and maintained in accordance with manufacturers' instructions. For example, dull and worn cutting blades can increase noise emissions. Proper lubrication of equipment gears and bearings on machinery can both reduce noise emissions and lengthen the life of the machinery.

Noise measurement surveys should be conducted at the work site. Knowing the amount of noise workers are exposed to will allow the employer to select the proper PPE and also ensure compliance with Occupational Safety and Health Association (OSHA) regulations and NIOSH guidelines. A hearing loss prevention program (HLPP) should be instituted if necessary. NIOSH recommends that an HLPP be implemented for all workers whose unprotected 8-hour time-weighted average exposures (i.e., exposures incurred without the use of hearing protectors) equal or exceed 85 dBA. This program should include, among other things, an assessment of noise exposures, baseline audiometric evaluations, and monitoring of workers' hearing.⁽⁷⁾ Workers should be trained to use earplugs or other hearing protection devices that ensure a correct fit and are comfortable enough to ensure worker acceptance. The NRR assigned to hearing protection devices (HPD) is not necessarily the true protection of the HPD; the NRR is typically lowered by as much as 50% to determine the relative performance of the plug.⁽⁸⁾ For noise levels typically found in this industry most commercially available devices, if properly fit and worn, will provide adequate protection.

Ergonomics

If the pallet assembly area comprises work surfaces that are all of one height, which may not be appropriate for all workers, the company should consider purchasing or designing adjustable tables and placing them at heights that are correct for the expected user. When assembling pallets, the actual work surface is the top of the pallet, where fasteners (nails or staples) are installed to secure the deckboards to the stringers. Since the stringer and deckboards add about 4 inches of height to the work surface, the actual table surface used for pallet assembly may be lower than anticipated, approximately 32–35 inches from the floor. This height allows the average male worker to keep his upper arm nearly vertical and at his side with the elbow flexed at about 90°. Different work surface height adjustments may be required for other workers.

Reaching across the pallet while fastening boards during construction creates a risk of musculoskeletal injury to the shoulder, neck, and back. To lessen this risk, a company might consider using a rotating table or pallet carousel when assembling the pallet. In general, forward functional reach should be kept to within about 17 inches of the front of the body.⁽⁹⁾ Any reach beyond this amount begins to stress the shoulder and the back muscles. The use of a rotating table or carousel would allow a single employee to rotate the pallet to the area that

needs fastening, reducing the reach distance and minimizing the associated risk of injury.

One of the primary activities in small pallet operations is the manual materials handling of either raw materials (cants) or finished product. Each cant is well over the ideal recommended weight limit as suggested by NIOSH (51 lbs).⁽¹⁰⁾ Using hydraulic or spring loaded material handling carts could alleviate strain. Team lifts or mechanical lift assist devices, such as vacuum assist devices, are also suggested when feasible. Many double-sided pallets can weigh 50–60 lbs, and skids 30–40 lbs. Stacking pallets manually involves stacking the pallets from the floor and then lifting the pallet to the top as the stack grows. Using an automated stacker that allows the placement of the pallet onto the stack without lifting the pallet into place would eliminate exposure to this hazard. The worker should also use a pallet jack or a hydraulic lift table to raise the stack of raw material off the floor so the worker does not have to bend as much. Spring-loaded material tables may also be useful for this task.

Many pallet industry workers use pneumatic nail guns to secure the deckboards to the stringers. These tools weigh about 8.5 lbs unloaded. While the weight of the tool is not excessive, the workers must support the full weight of the tool and nails, often extending their reach to secure the deckboards on the far side of the pallet they are assembling. This stretching and static load on the shoulder can result in musculoskeletal injury. By suspending the pneumatic tool on a tool balancer attached to the ceiling or rafters, one can lessen the load that the worker must hold. As long as the pallet assembly is conducted in one primary area, there should be no need to disconnect and reconnect the tool each time the worker moves to a new process.

CONCLUSIONS

Based on measurements, site visits, and interviews, exposure to noise and ergonomic-related hazards was apparent from this study of small business wood pallet manufacturing facilities. These hazards included excessive noise levels (from nail guns and saws) and musculoskeletal injuries from lifting, reaching, and workstation design problems. Suggestions to lessen the number of hazards found in the wood pallet industry are given with the goal of promoting occupational safety and

health in the industry, and decreasing the prevalence of injuries. These suggestions are general and can be implemented without making specific measurements of exposure.

NIOSH is preparing a guidance document for small business owners and managers engaged in the wood pallet manufacturing industry. This document will include more detailed recommendations and workplace solutions as well as recommendations for workforce training.

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