Preventing Injuries Among Workers in the Wood Pallet Industry

by

Robert Malkin, Dr.PH
Thomas Lentz, Ph.D.
Jenifer Tomiller, M.S.
Stephen Huddock, Ph.D.
Charles Hayden, M.S.

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

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INTRODUCTION

Workers manufacturing wood pallets are exposed to a multitude of potentially hazardous exposures and operations including noise, saws, nail guns, forklifts, heat chambers, and poor ergonomics. The end result is that these workers have greater workplace injury. Workers in NAICS code 32192, which includes wood container and pallet manufacturing, have an injury rate that is 193% greater than the rate for all private industry; amputations among pallet workers are 922% greater.

This educational manual discusses those hazards and offers potential solutions to safety problems. This is not intended to be a training manual, nor is it a definitive safety manual. The manual does touch on all aspects of pallet manufacturing in a way that will be useful to employees and employers and may result in lower injuries for workers in the wood pallet manufacturing industry.

CDC
Workplace Safety and Health

PALLETS

CHAPTER 1

Understanding Hazards in the Workplace

NIOSH

Chapter 1

Understanding Hazards in the Workplace

Can your business survive an injury?

Occupational injuries may result in higher Workers' Compensation rates.

- In Ohio, injuries that cause a business to be dismissed from an insurance group can result in workers' compensation rates that are five times the rates charged by insurance groups.
- Pallet manufacturing is an industry classification with a high workers' compensation rate (see Figure 1).
- The average cost to the Bureau of Workers' Compensation for a lost-work-time claim is $38,000. However, this amount includes only what the insurance company pays for the claim—the direct costs. A business must also consider the indirect costs for such a claim.

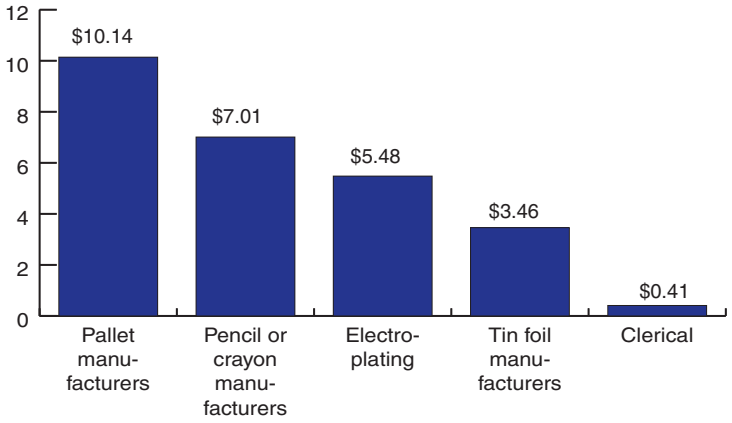

Figure 1. Workers' compensation base rates per $100 payroll in different industries, 2001.

Direct costs	Indirect costs
▪ Medical ▪ Lost-time ▪ Reserve*	▪ Morale ▪ New-worker training ▪ New-worker supervision ▪ Reputation of company ▪ Damage to equipment ▪ Decreased production (difficult to work when your neighbor is severely injured)

*The amount an insurance company must put aside to pay for future claims.

Worker stretching over a large table, possibly resulting in ergonomic injury.

Estimates indicate that for every $1 spent on direct costs of a lost-work-time claim, $4 is spent on indirect costs. Therefore, the real cost of a $38,000 claim is $190,000—not including the increased insurance cost resulting from the injury.

Could your company survive that?

The easiest way to deal with an injury is to prevent it!

Example: A pallet business, that grosses $1 million and nets 5% will net $50,000 per year. Thus if the owner must pay for an injury costing $190,000, the business will have nearly 4 years with NO PROFIT!

Controlling Hazards

No single control is effective for all workplace hazards. The three principles of hazard control are listed below in order of their effectiveness. Removing hazards is the most effective control. Apply the principles in sequence until you find a workable solution.

Remove hazards—Replace hazardous materials, equipment, and processes with safer alternatives.

Reduce exposures—Develop policies and procedures that minimize exposures to hazards; encourage safe work practices; train workers to recognize and report hazards.

Use Safeguards—Provide protective equipment to workers (hearing protection, safety glasses, and goggles, for example).

Communicating Hazards

As a business owner, you play a major role in creating a safe workplace. Promoting safety will help you maintain a productive workforce and protect your company's interests.

- Establish policies that demonstrate that you are concerned with your workers' safety and want them to remain free of injury.
- Involve workers in identifying hazards and equipment that needs repair or maintenance.
- Provide training and education for workers:
  - — Provide information about the potential health effects of their exposures at work.
  - — Train workers to use safe work practices and good personal hygiene measures.
  - — Teach workers how to use and maintain appropriate protective equipment and safety devices.
  - — Provide copies of material safety data sheets (MSDSs) for all hazardous materials at the workplace.

Two workers nailing pallets on a horizontal table.Note earplugs.

Creating a Safe Workplace

To protect your workers and reduce costs, follow these steps:

Identify injuries—Determine which injuries are the most frequent and severe in your industry.

Measure costs—Analyze your costs to determine which injuries cost the most in workers' compensation, health care, and absenteeism.

Control Hazards—Remove or minimize hazards.

Band saw used for recycling pallets.

Worker using a nail gun to assemble a pallet.


Poor Ventilation
Wood dust
Carbon monoxide
Mold
Physical
Noise
Vibration
Occupational Hazards of the Wood Pallet Industry
Traumatic injury
Falls
Forklift and other motor vehicle crashes
Amputations
Lacerations
Broken bones
Eye injuries
Puncture wounds
Ergonomic
Lifting
Materials handling
Poor workstation design
Improper use of power tools
Repetitive motion injuries from hand tool use

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PLANETS

CHAPTER 2

Developing a Safety and Health Program

NIOSH

Chapter 2

Developing a Safety and Health Program

Occupational Illness and Injury

Each day in the United States on average

- 9,000 workers sustain disabling injuries on the job,
- 17 workers die from workplace injuries, and
- 137 workers die from work-related diseases.

The total cost of occupational illness and injury is $171 billion annually—greater than the cost of AIDS, Alzheimer's disease, or cardiovascular diseases. Safety and health programs are clearly needed in workplaces throughout the country.

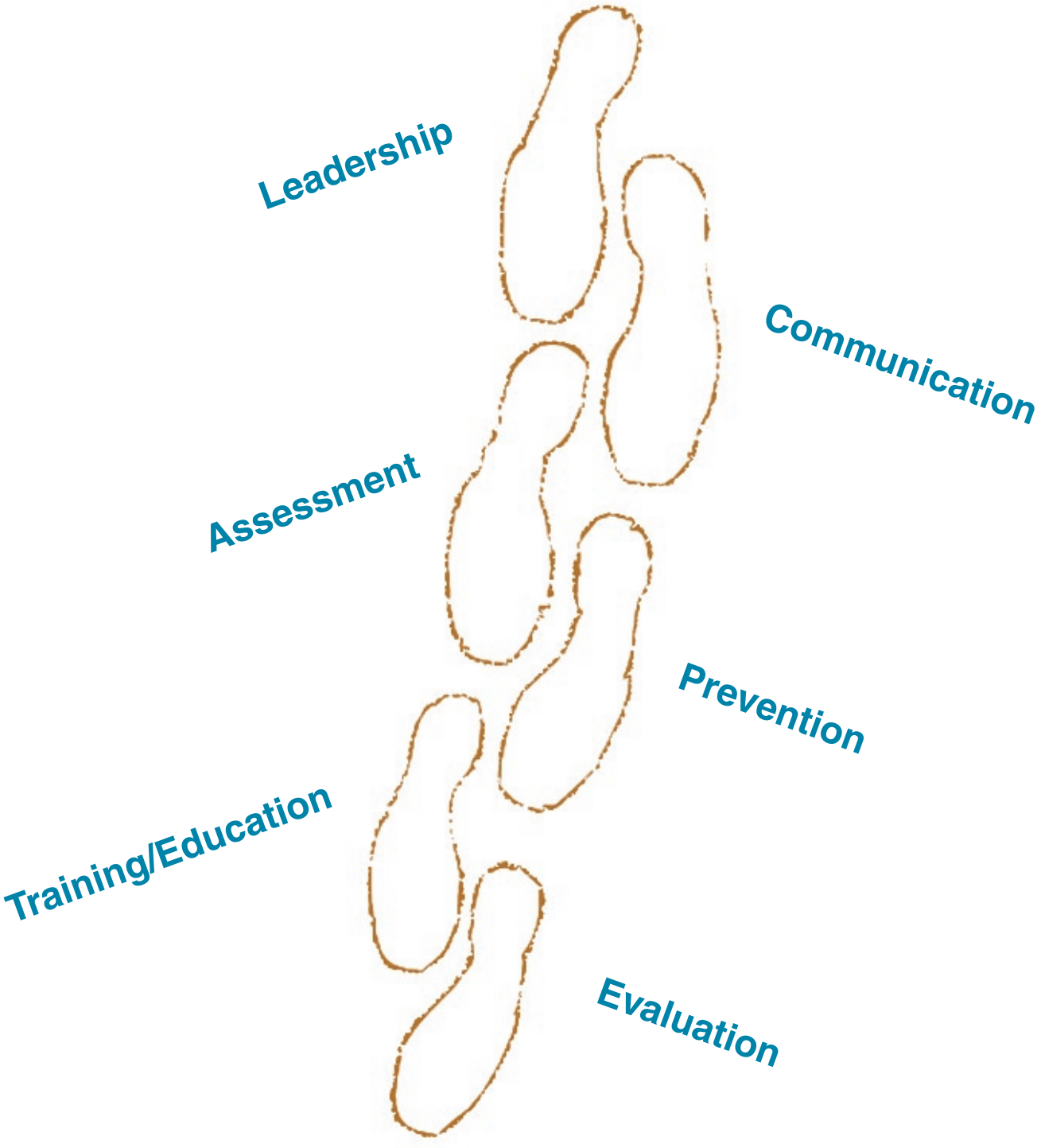
Developing a Safety and Health Program

Like any other aspect of your business, safety must be managed. Following the law is important, but compliance alone is not enough to ensure a safe workplace.

Prevention efforts are most effective when they are part of an overall written safety and health program. Such programs promote a culture of cooperation, awareness, and shared responsibility for safety and health.

Many business owners have the same question about developing a program: Where do we begin? The following guidelines will help you get started on the right track.

The steps outlined in each of these guidelines are components that constitute an effective safety and health program.



Be a Leader

- Establish workers' responsibilities with regard to safety and health in the workplace. Put these responsibilities in writing and make sure all workers understand them.
- Provide workers with information they need to carry out their safety and health responsibilities
- Respond promptly to reports about safety and health conditions and take corrective action if needed.
- Delegate authority over safety and health issues to qualified workers.

Involve Workers

- Encourage workers to participate in all aspects of the program.
- Solicit safety and health recommendations on a continual basis.
- Maintain constructive dialogue throughout the company.
- Establish procedures for reporting hazards.

Identify and Assess Hazards

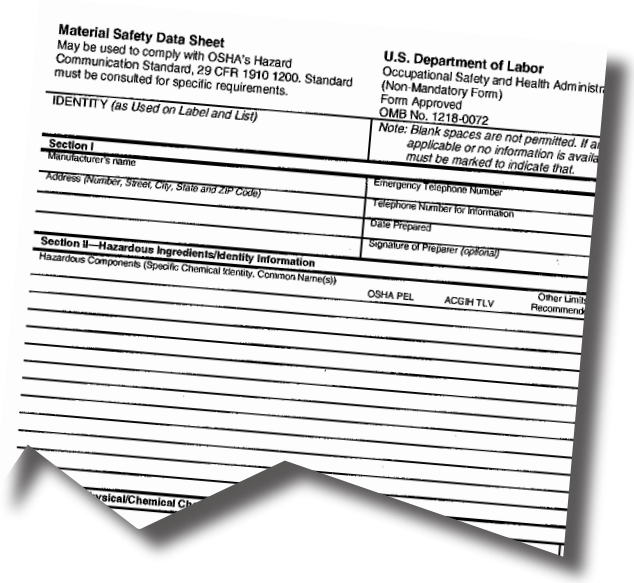
- Inspect the workplace for hazards at least a year—and any time a change in working conditions could lead to additional hazards.
- Evaluate the safety of new equipment, materials, and processes before they are used in the workplace.
- Assess the severity of hazards and set priorities for controlling them accordingly.

Prevent and Control Hazards

- Replace hazardous equipment, materials, and processes with safer alternatives.
- Develop policies and procedures that minimize exposure to hazards.
- Provide workers with appropriate personal protective equipment (such as safety glasses).

Provide Training

- Train workers on the following topics:
  - — Recognizing hazards on the job
  - — Using hazard control measures in the workplace
  - — Taking steps to protect themselves from exposure to hazards
- Provide initial training to all new workers and periodic refresher training thereafter. (Refresher training is necessary for all workers whenever a work process or exposure changes.)
- Distribute Material Safety Data Sheets (MSDSs) for all hazardous materials at the job site.
- Ask experienced workers to serve as instructors.
- Maintain safety and health communication through bulletin boards, signs, posters, and announcements.


Material Safety Data Sheet
May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910 1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administr
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY (as Used on Label and List)

Note: Blank spaces are not permitted. If a applicable or no information is availa must be marked to indicate that.

Section I
Manufacturer's name
Address (Number, Street, City, State and ZIP Code)
Emergency Telephone Number
Telephone Number for Information
Date Prepared
Signature of Preparer (optional)

Section II—Hazardous Ingredients/Identity Information
Hazardous Components (Specific Chemical Identity, Common Name(s))
OSHA PEL
ACGIH TLV
Other Limit Recommend

Evaluate the Program

- Regularly evaluate the program's effectiveness using surveys, interviews, and personal observations. Examples of useful data to collect are listed below:
  - — Types and frequency of unsafe behavior
  - — Attendance at safety meetings
  - — Number of reported "near misses"
  - — Changes in the use of safe work practices (such as lock-out/tag-out)
  - — Level of employee involvement in the program
  - — Number of "safe days" without an incident
- Establish a database to track safety and health information such as injury and illness rates, workers' compensation claims, absenteeism, and incident reports.

For More Information

BWC [1999]. 10-step business plan. Columbus, OH: Ohio Bureau of Workers' Compensation.

OSHA [2001]. Safety and health programs [http://www.osha-slc.gov/SLTC/safetyhealth/index.html]. Washington, D.C.: U.S. Department of Labor, Occupational Safety and Health Administration. Date accessed: July 21, 2005.

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PAWETS

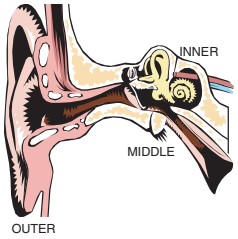
CHAPTER 3

Issues Related to Noise Exposure

NIOSH

Pallet making is very noisy!
Loud noise will hurt your hearing.

Question 1: What is noise-induced hearing loss?



Answer: Noise induced hearing loss is a loss of hearing caused when the nerves in your ears are damaged by loud sounds. Too much noise kills the tiny hair cells inside your inner ear. As more cells die off, hearing gets worse. This damage to your ears is permanent and cannot be cured or repaired.

Question 2: What other health effects are related to noise exposure?

Answer: Noise may cause injuries and deaths when workers cannot hear instructions or warnings from coworkers or cannot hear back-up signals from heavy equipment such as forklifts. Noise can also cause psychological stress, anxiety, increased heart rate, and increased blood pressure.

Question 3: What type of noise is involved in pallet work?

Answer: Two types of noise are involved in pallet work: impulsive and non-impulsive (continuous) noise. Impulsive noises are sounds like those made by nail guns and hammering (Figure 1). They are characterized by a sharp rise in the sound level followed by a rapid decrease. Continuous noise is fairly constant and is similar to the noise created by saws.

Both types of noise are dangerous at levels over 85 decibels (dB). Continuous and impulsive noises together are synergistic: that is, they interact to cause more hearing damage than either one would cause alone.

Figure 1. Worker wearing ear plugs to protect against impulsive noise while using a nailgun to assemble a pallet.

Question 4: What are the current exposure limits for noise?

Answer: Exposure limits for noise have been established by the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA). They are as follows:

- ***NIOSH recommended exposure limit (REL):*** 85 decibels measured on the A scale (dBA) as an 8-hour time-weighted average (TWA). NIOSH Recommends that personal protective equipment (PPE) be worn with exposure above this level.
- ***OSHA permissible exposure limit (PEL):*** 90 dBA as an 8-hour TWA.
- ***OSHA action level: 85 dBA as an 8-hour TWA:*** the level at which a hearing conservation program must be provided. This program should include monitoring the hearing hazards, engineering and administrative controls, audiometric evaluations, personal hearing protection devices, education and motivation sessions, record keeping, and program evaluation. Further information can be found in the NIOSH publication, *Preventing Occupational Hearing Loss—A Practical Guide*.

An estimated 41% of workers in the lumber and wood products industry are exposed to noise levels at or above the NIOSH REL of 85 dBA.

Question 5: What noise levels are workers and others commonly exposed to?

Answer: Workers and others are often exposed to impulsive noise levels as high as 136 dBA. Exposure to noise above 85 dBA for 8 hours or more may cause permanent hearing loss. Figure 2 lists common noise levels produced by various items and activities.

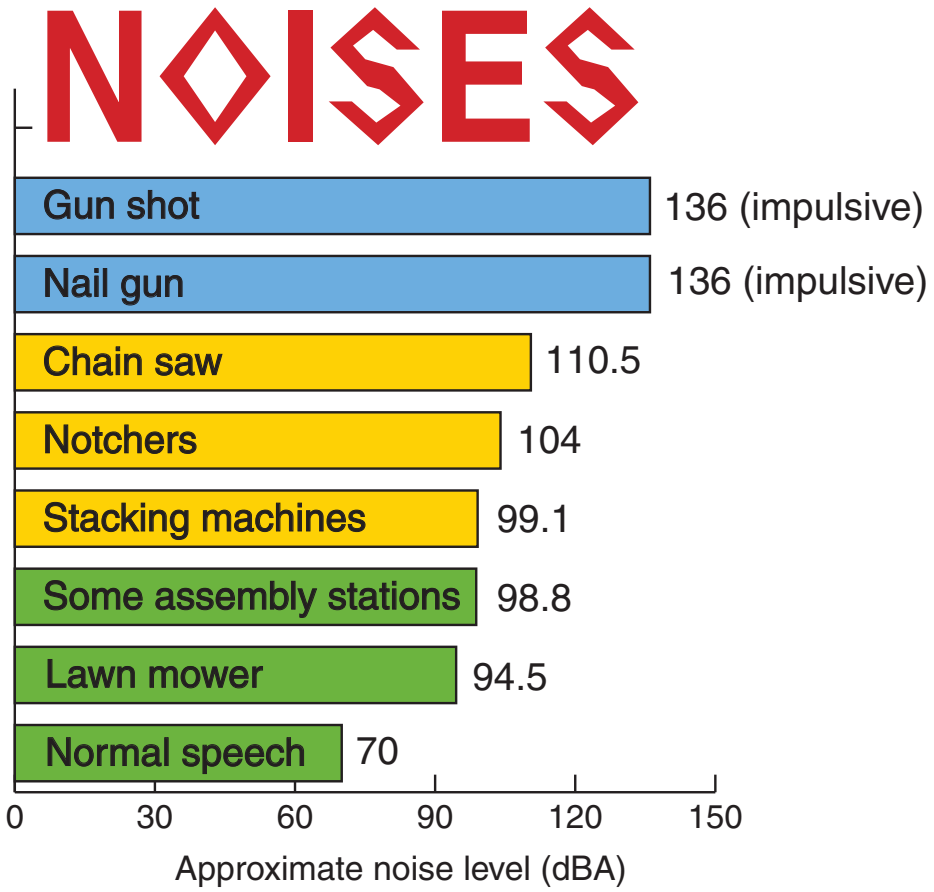


Figure 2. Noise levels produced by common items or activities.

Question 6: How can I control my noise exposure?

Answer: There are three ways to control noise.

- Engineering Controls—buy quieter power tools and maintain equipment properly (keep blades sharp).
- Administrative controls—keep number of people exposed to a minimum
- Hearing protection—this is the LEAST preferred method of noise control

You will need to wear personal protective equipment (PPE) when you are exposed to loud noises that you cannot reduce to a safe level. More than 300 types of hearing protection devices are available, so everyone should be able to find something comfortable. The main types of hearing protection devices include:

- ear plugs
- ear muffs
- canal caps.

Ear plugs: Ear plugs, particularly foam ear plugs, are a simple, effective type of hearing protection that you can wear when you are exposed to loud noises. There are three main types of ear plugs: formable, pre-molded, and custom molded. They are often provided to workers exposed to loud noise. Make sure the plugs are comfortable and fit well. Wear them consistently. *Remember: Ear plugs must be inserted properly, to be effective.*

Method for inserting ear plugs: Ensure hands are clean. Roll up the plug so that half of it will fit into the ear canal. Avoid creases—they will allow noise to enter the ear canal. While holding the ear plug in the ear canal with one hand, pull up and back on the ear lobe with the other hand to straighten the ear canal. Then insert the rolled-up ear plug and hold it in position for 10–20 seconds to give the plug time to expand in the ear canal.

Ear muffs: Ear muffs fit over the ear. One big advantage is that some ear muffs have electronic circuitry that allow speech to pass through the muff while rejecting all loud noises above a certain frequency. Thus workers can be protected from loud noise and still be able to communicate with each other.

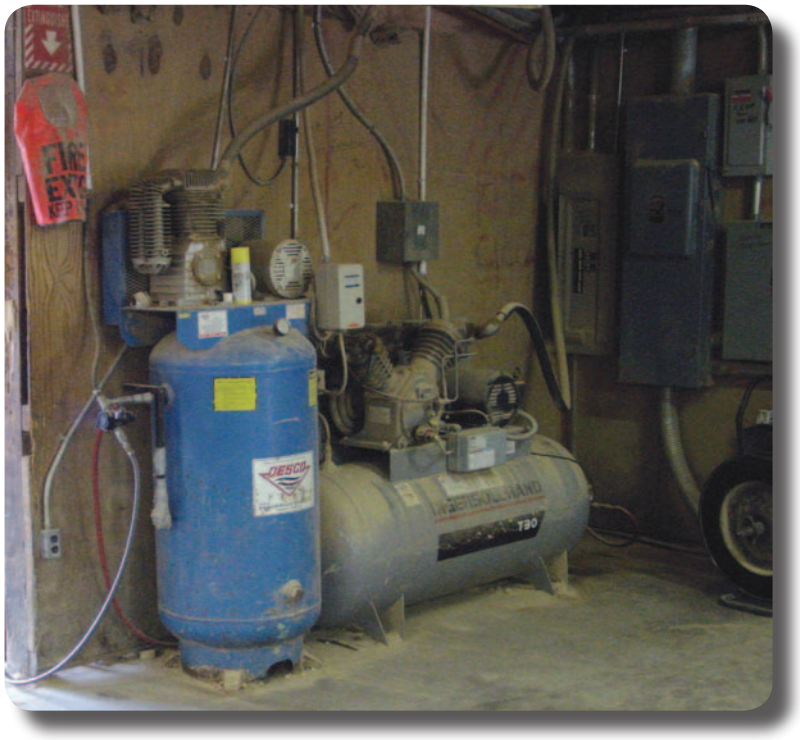
Canal caps: Canal caps often resemble earplugs on a flexible plastic or metal band similar to a headband. Many can be worn over the head, behind the neck, or under the chin. The earplug tips of a canal cap may be a formable or pre-molded material. The main advantage of canal caps is convenience.

Question 7: How can I reduce the noise from the compressor?

Answer:

1. Move the compressor outside. You must cover the compressor to protect it from the elements, but do not allow heat to build up from lack of ventilation. You can enclose the compressor with a wood barrier, but be sure to leave a place at the top for heat to escape.
2. Erect a barrier for the compressor while leaving the compressor inside. If you can't move the compressor outside, it may be possible to erect a wood barrier inside. At one pallet company, use of a wood barrier lowered noise levels from 93 to 84 dB.

Be careful not to overheat the compressor!



For additional information:

Criteria for a Recommended Standard: Occupational Noise Exposure. Revised Criteria 1998. NIOSH. NIOSH Publication Number 98–126. June 1998.

Preventing Occupational Hearing Loss. NIOSH Publication 96–110. June 1996.

NIOSH Safety and Health Topic: Noise and Hearing Loss Prevention. http://www.cdc.gov/niosh/topics/noise/. Accessed August 15, 2005.

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PAWETS

CHAPTER 4

Wood Dust ▪ Issues Related to Ventilation

NIOSH

Chapter 4

Wood Dust ■ Issues Related to Ventilation

Question 1: What operations generate wood dust?

Answer:

Saws

Nail guns—the exhaust of a nail gun may loosen dust on a board.

Question 2: What are the exposure standards for wood dust?

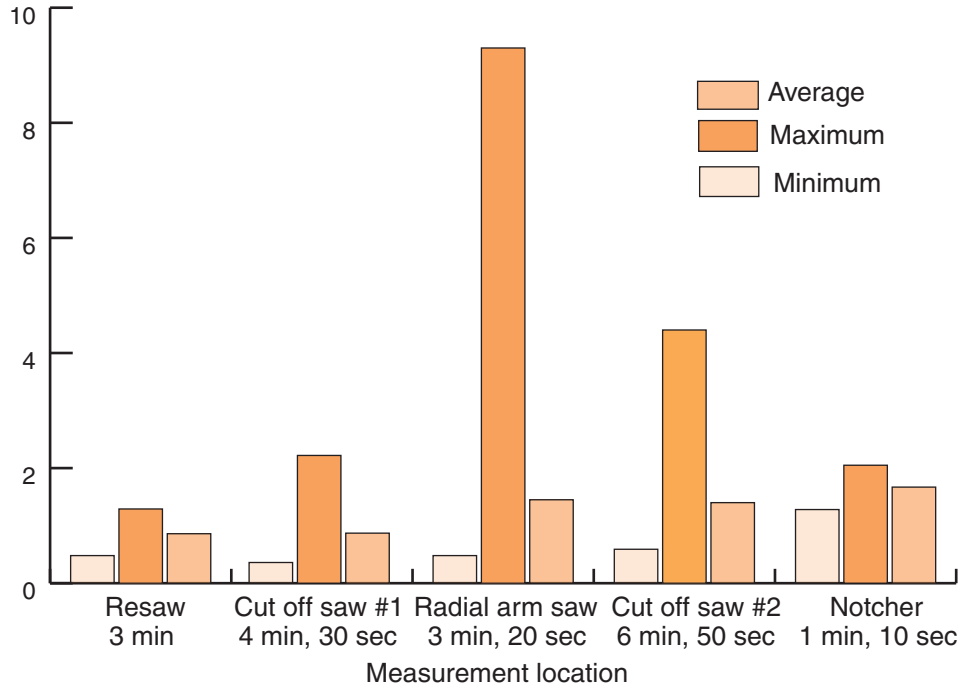
Answer: OSHA has no permissible exposure limit (PEL) for wood dust but regulates it as a particle not otherwise classified (PNOC). The PEL for a PNOC is a time-weighted average (TWA) of 15 miligrams per cubic meter (mg/m^3) for total dust and a TWA of 5 mg/m^3 for the respirable fraction of that dust.

1. The American Conference of Governmental Industrial Hygienists (ACGIH) changed their threshold limit value (TLV) (2005) for all wood dust to a TWA of 1 mg/m^3.
2. NIOSH has a recommended exposure limit (REL) of 1 mg/m^3 for all woods and classifies wood as a potential occupational carcinogen.

Question 3: What were the measurements of wood dust in pallet manufacturing facilities?

Answer: NIOSH researchers conducted spot measurements of hardwood dust and found average levels of 1.67 mg/m^3 around the notcher and 1.45 mg/m^3 around the radial arm saw. These measurements were not for 8-hour periods and it is unlikely, although possible, that these readings would be the same for 8 hours.

Table 1. DataRAM measurements of dust in a pallet plant
Concentration (mg/m^3)



Question 4: What are the effects of wood dust?

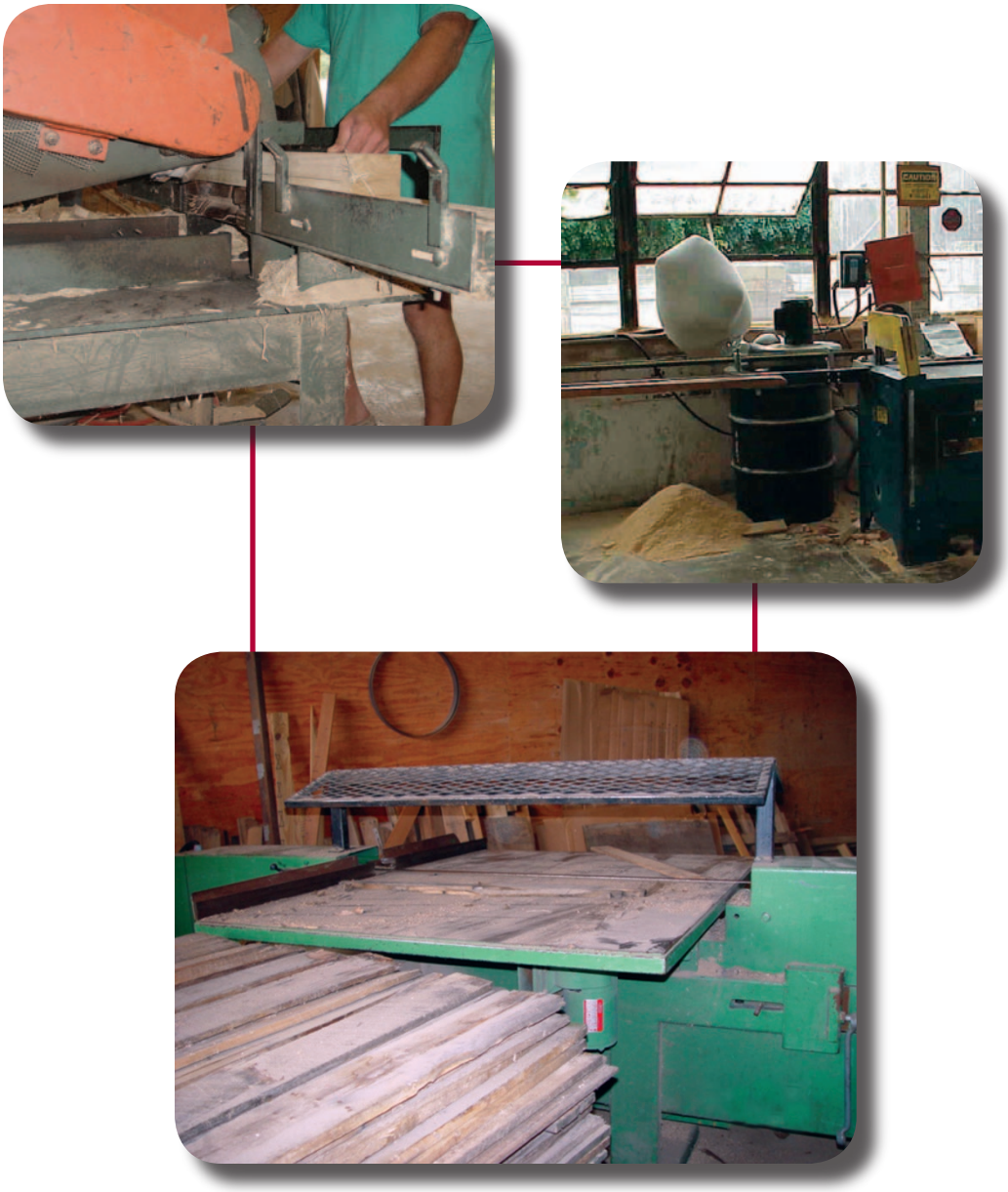
Answer: Respiratory effects. The respiratory effects of wood dust exposure include asthma, eye irritation, nasal dryness and obstruction, prolonged colds, and frequent headaches.

Cancer. Wood dust is known to be a human carcinogen. Wood dust may be deposited in the nose and the upper and lower airways. According to the National Toxicology Program, "Particles with a diameter larger than 5 micrometers (μm) (***inspirable particles***) are deposited almost completely in the nose, while particles 0.5 to 5 μm in diameter (***respirable particles***) are deposited in the lower airways.

Eye and skin irritation. Contact with the irritant compounds in wood sap can cause dermatitis and other allergic reactions.

Mold exposure. Fine sawdust may also make an excellent medium for mold growth, and exposure to wood dust has long been associated with a variety of adverse health effects from mold, including dermatitis, allergic respiratory effects, and mucosal and nonallergic respiratory effects.

Poor housekeeping in a wood pallet manufacturing facility includes excess wood dust in the air or on walking surfaces. Piles of sawdust on the floor can become trip and fire hazards.



Question 5: How can I improve ventilation?

Answer:

- Add local exhaust to all machines that create dust
- Install a central exhaust system (if possible). Make sure that the wood dust that is collected is protected from rain, snow, and wind.

Outlet for a central exhaust system. The exhausted material is piled too high and is not protected from rain and wind.

- Position exhaust hoods as close to the point of dust generation as possible.
- Perform regular maintenance on the ventilation system or individual dust collectors.
- Consider removing dust deposited on wood that is being cut by a resaw by using a vacuum cleaner with an appropriate filter.
- Make sure there are no leaks in the ventilation system and minimize the use of flexible ducts.

- Make sure the ventilation system is strong enough to capture and transport the dust that is being collected. A transport velocity of 4,000 to 4,500 feet per minute is required for heavy and wet sawdust.
- Make sure exhaust system is turned on and functioning

A gap in the ductwork of an exhaust system

For additional information

American Conference of Governmental Industrial Hygenists [2005]. 2005 TLVs and BEIs.

Dement J [2001]. Wood dust. In: Bingham E, Cohrnssen B, Powell C, eds. Patty's Toxicology.

National Toxicology Program [2005]. 11th Report on carcinogens. Department of Health and Human Services, http://ntp.niehs.gov/ntp/roc/eleventh/profiles/s189wood.pdf.

NIOSH. NIOSH Pocket guide to chemical hazards [Online]. http://www.cdc.gov/niosh/npg/npgd0667.html

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Workplace Safety and Health

PAMETS

CHAPTER 5

Improving Saw and Nail Gun Safety

NIOSH

Chapter 5

Improving Saw and Nail Gun Safety

Things the company should do to improve saw safety:

- Make sure saws have adequate guards and proper ventilation. Always turn on ventilation when using the saw.

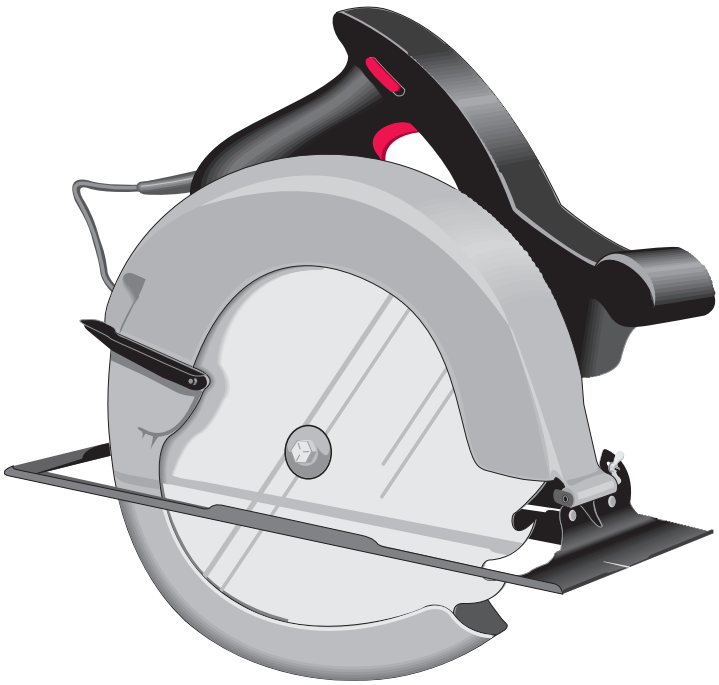
A large chain saw with minimal guarding, no exhaust ventilation, and no barriers to prevent other workers from walking into the saw.

- Ensure all workers are aware of the safety concerns regarding band saws; placing guards for band saws used in recycling is difficult. This photo shows a guard on top of the band saw. A guard of this type will allow access to the blade but prevent a worker from putting his hand on the blade.

Band saw for recycling pallets that has a guard on top.

Band saw for recycling pallets that has no guarding.

- Ensure all electric saws used are double-insulated or have a 3-prong plug in a grounded outlet with a ground-fault circuit interrupter.



Electric saw

Outlet with a ground-fault circuit interrupter

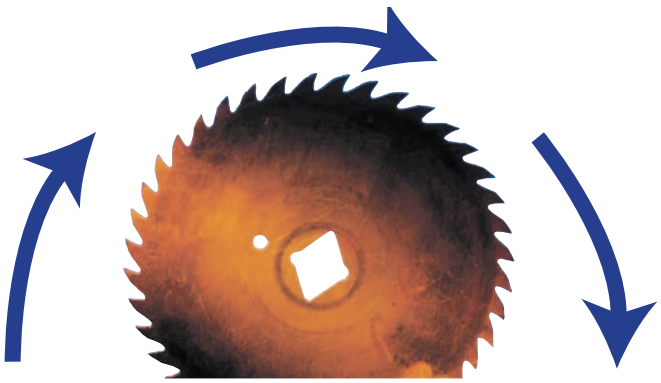
Things a worker must do to improve saw safety:

- Eye (safety glasses) and ear protection (at least ear plugs) are required when saws are used.

- Make sure all guards are in place before operation. Never remove guards or reach in guarded areas while the saw is on.

Chop saw with a guard on top

- Make sure that each saw either has an effective brake to stop rotation immediately when the saw is turned off or a program requiring the saw operator to stay with the saw until it stops rotating.



- Blades can rotate even if the motor is "off." Saw blades are sharp and can cut you even if the machine is "off," and the blade is not rotating.
- Lock out the motor of the saw before cleaning loose pieces of sawdust. OSHA's hazardous energy control, or "lockout/tagout" standard mandates that such machinery be shut down and its power source be physically locked out before workers clean, service, or perform maintenance. The standard requires employers to, among other things, develop and use machine-specific lockout procedures, train workers in the procedures, annually review its lockout program, and ensure that lockout devices are in fact affixed to the power source before workers begin work on the machine.

Example of Lockout/tagout used on electrical equipment

- Institute lockout/tagout procedures for saws requiring repair or maintenance.
- Make sure each saw blade is sharp and well maintained. Replace broken or worn blades

Things an employer can do to improve nail gun safety:

A nail gun is potentially a very dangerous tool because it fires a projectile at high velocity like a firearm. Despite the hazards involved, these tools can lead to increased production resulting in lower productions costs. Using a nail gun requires constant awareness for safe operation.

- Make sure all operators review the owner's manual and safety procedures prior to tool operation or maintenance.
- Use only clean, dry compressed air at the manufacturer-recommended pressure, and never use bottled gases or air.
- Suspend the nail gun from the ceiling, or provide a shelf that can be adjusted to the appropriate height for each worker to rest the nail gun on when not in use.
- Make sure that workers have adequate experience using the "bump" trigger method that may increase the risk of traumatic injury but decreases the potential risk of musculoskelatal disorders.

The worker's free hand is very close to the firing end of the nail gun.

- Perform any necessary maintenance on the gun and compressor prior to use.
- Limit the weight of fully loaded nail guns so that the worker's arm does not get overly fatigued.
- Investigate the use of automatic nailing machines to manufacture the pallet.

Things a worker can do to improve nail gun safety:

- Never assume the tool is empty.
- Do not carry the tool by the hose or with a finger on the trigger.
- Never point the gun at anyone even if it is empty or disconnected from the air supply.
- Disconnect the air hose prior to clearing a jam. Next, when you are sure the gun is not pointed at anyone else, depress the gun trigger to ensure that all air is exhausted from the tool.
- Do not fire the tool unless the nose is firmly pressed against a work piece.
- Move forward, not backward when nailing horizontal areas.
- Keep your free hand safely out of the way of the tool.
- Always use safety glasses and hearing protection.

For Additional Information

OR-OSHA [2003]. Use of Pneumatic nail guns. http://www.cbs.state.or.us/external/osha/hazards/nailgun.htm.

Pneumatic nailer injuries: A report on Washington State 1990–1998. http://www.cdc.gov/elcosh/docs/d0400/d000436/d000436.html.

U.S. Department of Labor, Occupational Safety and Health Administration. Machine guarding standards. http://www.osha.gov/sltc/machineguarding/standards.html.

U.S. Department of Labor, Occupational Safety and Health Administration. Machine guarding etool. http://www.cdc.gov/elcosh/d0400/d000436/d000436.html.

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PALLETS

CHAPTER 6

Forklift Safety Problems and Solutions

NIOSH

Chapter 6

Forklift Safety Problems and Solutions

What Managers Can Do to Improve Forklift Safety

In order to prevent injuries and fatalities from forklifts, NIOSH recommends that employers develop, implement, and enforce a comprehensive written safety program that includes worker training and operator licensing.

Case Study

A 58 year-old male textile plant foreman was killed when a second forklift falling off a loading dock struck his forklift truck. The incident occurred as the victim and co-workers were transferring pipes from a forklift located at ground level to a second forklift on the edge of the loading dock. The workers had completed loading the second forklift and were raising the load when the lift's front wheels slipped off the edge of the dock. The forklift fell off the dock, striking the first forklift at ground level and turning it over. The victim, who was operating the first lift, was crushed under the roll cage as it turned over.

Preventive Recommendations for Employers

- Make sure that workers do not operate a forklift unless they have been trained and licensed.
- Ensure that operators always use seatbelts; if the forklift does not have seatbelts, contact the manufacturer as many offer restraint systems that can be retrofitted to older forklifts. Many fatalities resulting from forklift overturn might have been prevented if the operator had been restrained. The overhead guard of the forklift is generally the part that crushes the operator's head or torso after he or she falls or jumps outside of the operator's compartment.

- In the event of a lateral or longitudinal tip-over, operators of sit-down type forklifts should be trained to stay with the truck rather than trying to jump free. The operator should hold on firmly and lean away from the point of impact.
- The employer should develop, implement, and enforce a comprehensive written safety program for forklifts that includes worker training, operator licensure, and a timetable for reviewing and revising the program in compliance with the Code of Federal Regulations [129 CFR 1910.178(1)]. This standard addresses specific training requirments for truck operation, loading, seat belts, overhead protective structures, alarms, and maintenance of industrial trucks. Refresher training is required if the operator is observed operating the truck in an unsafe manner, is involved in an accident or near miss, or is assigned to a different type of truck.
- Employees should be told not use a forklift to elevate workers unless an approved lifting cage is used and always make sure that the platform is secured to the lifting carriage or forks.
- Separate forklift traffic and other workers where possible; limit some aisles to workers on foot only or forklifts only.
- Restrict the use of forklifts near time clocks, break rooms, cafeterias, and main exits, particularly when the flow of workers on foot is at a peak (such as at the end of a shift or during breaks).
- Install physical barriers where practical to ensure that workstations are isolated from aisles traveled by forklifts.

- Evaluate intersections and other blind corners to determine whether overhead dome mirrors could improve the visibility of forklift operators or workers on foot.
- Install workstations, control panels, and equipment away from the aisle when possible. Do not store bins, racks, or other materials at corners, intersections, or other locations that obstruct the view of forklift operators or workers at workstations.
- Make sure forklift operators make every effort to alert workers when a forklift is nearby. Use horns, audible backup alarms, and flashing lights to warn workers and other forklift operators in the area. Flashing lights are especially important in areas with high ambient noise levels.

- Ensure that workplace safety inspections are routinely conducted by a person who can identify hazardous conditions such as obstructions in the aisle, blind corners and intersections, and forklifts that come too close to workers on foot or at their workstation.
- Enforce safe driving practices for forklift operators such as obeying speed limits, stopping at stop signs, and slowing down and sounding the horn at intersections.
- Repair and maintain cracks, crumbling edges, and other defects on loading docks, aisles, and other operating surfaces.
- Check carbon monoxide (CO) emissions at every tune-up.

Case Study

A 19 year-old male warehouse order picker was fatally injured after falling from a pallet that was raised on the forks of a forklift truck. The incident occurred when the victim and a co-worker were getting an order of paper products that had been stored on the top tier of a warehouse storage rack. The victim was raised on the forklift and had retrieved a box of paper when he stepped off the edge of the pallet, falling 12 feet to the concrete floor. The victim died 4 hours after the incident.

Preventive Recommendations for Workers

- Elevate a worker on a platform only when the vehicle is directly below the work area; workers on the platform should use a restraining means such as rails, chains, or a body belt with a lanyard or deceleration device.
- Do not drive to another location with the work platform elevated.
- When a forklift is to be left unattended, the forks are to be lowered, power shut off, brakes set, and key removed.
- Do not enter areas with a forklift that do not have adequate ventilation.
- Do not operate a forklift unless you have been trained and licensed.
- Always wear eye and ear protection.
- The forklift should be thoroughly inspected and findings recorded before each shift. Any problems found with the forklift during the shift should be reported to the supervisor.
- Always use seatbelts if they are available.
- Report to your supervisor any damage or problems that occur to a forklift during your shift.

Case Studies

Fall from Forklift Platform—A 36-year-old furniture warehouse worker was killed after falling from a platform mounted on the forks of an order-picker forklift truck. The incident occurred when the victim and a co-worker were moving boxes of furniture onto a newly installed racking system. The workers had loaded the boxes onto the forklift platform and were raising the lift to place the boxes on the new racks. The victim was standing on the forklift platform with the boxes and fell off when the lift shook as it was being raised. He fell 8 feet 8 inches to the floor, striking his head on a section of steel angle iron lying on the cement. The victim, who only had a few inches of platform to stand on, apparently lost his balance and fell, pulling down a wardrobe he was holding. The forklift operator heard the wardrobe fall and looked down to see the victim on the floor with the box on top of him.

Forklift Overturn—A 43 year-old male company president/co-owner died as a result of injuries he sustained after a forklift he was operating overturned. The victim and the director of field operations (the witness) were in the process of unloading materials from a tractor trailer when the incident occurred. The victim had completed unloading material from one side of the trailer and drove down and alongside the trailer and while turning the corner to go behind the trailer, the forklift began to tip over and trapped the the victim.

Forklift Crushes Driver—A 16 year-old male part-time cleaner was fatally injured when the forklift he was operating at a seafood processing/retail facility overturned, pinning him and crushing his chest. The victim was moving a wooden pallet loaded with trash. The load was raised approximately 4½ feet when, during a right-hand turn, the forklift overturned. The victim was either thrown or attempted to jump from the forklift as the falling object protective structure (FOPS) attched to the forklift landed on his chest. He died the next morning.

Fall from Forklift—A 21 year-old warehouseman died after being crushed between a forklift and the edge of the floor of a railroad boxcar. The victim was attempting to close the boxcar door using a chain. The victim had parked the forklift on the loading dock without setting

the parking brake or chocking the wheels. The forklift rolled backward falling partially off of the dock, crushing the victim against the edge of the boxcar floor. The victim was not trained or certified to operate a forklift.

For additional information

NIOSH [2001]. NIOSH alert: preventing injuries and deaths of workers who operate or work near forklifts. http://www.cdc.gov/niosh/2001–109.html.

NIOSH [2005]. Fatality and Control Evaluation (FACE) Program. http://www.cdc.gov/niosh/face/

OSHA safety and health topics: powered industrial trucks. http://www.osha.gov/sltc/poweredindustrialtrucks/index.html.

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PALLETS

CHAPTER 7

Carbon Monoxide and Heat Treatment

NIOSH

Chapter 7

Carbon Monoxide and Heat Treatment

Question 1: What is carbon monoxide?

Answer: Carbon monoxide is a lethal gas that is produced when fossil fuels such as gasoline or propane are burned. It is one of many chemicals found in engine exhaust and can rapidly accumulate even in areas that might appear to be well ventilated.

Question 2: What are the health effects of carbon monoxide?

Answer: Because carbon monoxide is colorless, tasteless, oderless, and nonirritating, it can overcome the exposed person without warning. At low concentrations, carbon monoxide can cause fatigue in healthy people and chest pain in people with heart disease. At higher concentrations, it can cause impaired vision and coordination, headaches, dizziness, confusion, and nausea. High exposures can result in death.

Avoid carbon monoxide exposure by making sure the work area is well ventilated when operating a forklift indoors.

Case Study

Two carpenters were overcome by carbon monoxide when they entered a basement area where a gas-powered engine was running. There was no electricity at the site and the gas engine powered an electric generator. It appears that the first worker may have gone into the basement via a ladder to check the generator and was overcome. The second worker may have gone into the basement to assist the downed worker and was also overcome. Both victims were found at the bottom of an opening in the basement wall. One of them had tried to punch out one of the basement windows to provide ventilation. The workers were deceased when they were found.

Question 3: How does carbon monoxide work?

Answer: Carbon monoxide poisons primarily by competing with oxygen for binding sites on hemoglobin. The affinity of carbon monoxide for hemoglobin (forming carboxyhemoglobin) is more than 200 times greater than hemoglobin's affinity for oxygen. Carbon monoxide thus replaces oxygen, and reduces the oxygen-carrying capacity of the blood. Carbon monoxide may also poison by binding to tissues and cells of the human body and interfering with their normal function.

Question 4: Is carbon monoxide exposure regulated?

Answer: Carbon monoxide is regulated by OSHA and the current OSHA PEL for carbon monoxide is 50 parts per million (ppm) as an 8-hour time-weighted average (TWA) The NIOSH recommended exposure limit (REL) for carbon monoxide is 35 ppm as an 8-hour TWA with a ceiling limit (CL)

of 200 ppm that should not be exceeded at any time. NIOSH recognizes the immediately dangerous to life and health (IDLH) concentration for carbon monoxide as 1,200 ppm. The IDLH is the concentration that could result in death or irreversible health effects, or prevent escape from the contaminated environment within 30 minutes. The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted a threshold limit value (TLV) for carbon monoxide of 25 ppm as an 8-hour TWA.

Question 5: What machines produce carbon monoxide?

Answer: In the wood pallet manufacturing industry carbon monoxide was predominantly produced by fork lifts (both gasoline and liquid propane gas [LPG]) operating inside but also by unvented propane powered space heaters.

Case Study

A 15-year-old male camp counselor died of carbon monoxide poisoning when the furnace malfunctioned in the cabin where he was sleeping. The victim had worked as a counselor at the camp for 9 weeks. On the night of the incident, he was the only person assigned to sleep in the building that housed Health Services. The wood frame building had a furnace room that housed a liquid propane (LP) gas-fueled furnace. The furnace was used infrequently and for brief time periods. There were no records to indicate when the furnace had last been inspected or repaired. There were no carbon monoxide detectors in the building. The victim went into the building about 8:30 p.m. and turned on the furnace before he went to bed. He kept the windows and doors closed. When the victim did not show up for breakfast the next morning, a supervisor went to the building and found him motionless in bed. Emergency services were summoned.

Question 6: What types of forklifts make carbon monoxide?

Answer: All forklifts except for those that are electrically powered produce carbon monoxide. Gasoline powered forklifts usually produce the highest amounts of carbon monoxide. Propane powered forklifts may also emit substantial amounts of carbon monoxide, particularly if a forklift was not properly maintained. If a propane powered lift was not properly maintained, some propane engines may generate more carbon monoxide than a gasoline engine. A carbon monoxide emissions test is needed to properly tune up all forklifts.

Question 7: How much carbon monoxide was present in the wood pallet manufacturing industry?

Answer: Carbon monoxide levels were measured for part of the work day at four plants that used either LP or gasoline forklifts. The plant managers that had diesel forklifts did not use them inside their facilities for any extended period of time, and their carbon monoxide measurements were not substantially elevated. Forklifts, however, were used to load pallets on a trailer. High concentrations of carbon monoxide were generated (138 ppm) for a short period of time while a forklift was in a trailer that did not have ventilation.

The results from three of the four plants indicated that both worker and area measurements of carbon monoxide were approximately 10 ppm. Plant number 4 had carbon monoxide concentrations that potentially exceeded both NIOSH and OSHA criteria (109 ppm). That plant used an older LP forklift. The OSHA standard is 50 ppm (8-hour TWA).

A forklift in a trailer.

Question 8: What steps can employers and workers take to protect themselves?

Answer:

Employers

1. Educate workers about the sources and conditions that may result in carbon monoxide poisoning as well as the symptoms and control of carbon monoxide exposure.
2. Develop a program of preventive maintenance that includes a tune up based on exhaust gas measurements.
3. Monitor workers" carbon monoxide exposure to determine the extent of the hazard.
4. Improve ventilation in the plant, particularly in the winter. Carbon monoxide levels in the summer were usually within the standard, and most plants had open doors and windows. In the winter the doors and windows of the plant were closed, and few plants had mechanical ventilation systems. Owners were concerned that heating and adding outside air in the winter would greatly increase heating costs; however, the alternative may be unsafe carbon monoxide levels.
5. Install carbon monoxide monitors. If the carbon monoxide level is too high, it may be necessary to turn off.
6. Do not require workers to enter a trailer for an extended period of time. Our measurements showed carbon monoxide levels rising up to 138 ppm in the trailer when a worker entered on a forklift.
7. It may be necessary to purchase a new forklift if the forklift you have is not reparable. The plant owner with the carbon monoxide of 109 ppm purchased a modern LPG forklift, and carbon monoxide measurements for both the worker and the plant floor declined to approximately 4 ppm in the summer. Besides improving working conditions, the new forklift used less fuel (approximately one tank of propane a week for the new machine as compared to a tank every day for the old) and was more reliable.

Workers

1. Turn off the forklift when it is not in use. Do not leave it idling indoors.
2. Do not remain in unvented areas for an extended period of time. Carbon monoxide levels rise rapidly if there is no fresh air supply.

A new propane powered forklift.

Heat Treatment of Pallets

As of March 31, 2002, heat treatment was required of all nonmanufactured (solid sawn) softwoods and hardwoods used in packaging that are to be exported. This is to prevent the introduction of the pinewood nematode that has caused extensive disease in pines in Japan and China. Heat treatment requires that the pallet be heated to a minimum core temperature of 56°C (132.8°F) for a minimum of 30 minutes.

Heat treatment is usually done in a heat chamber. Suggestions for safe operation of a heat chamber include the following:

- To avoid burn injuries
  - — Do not open the door to the heat chamber until the heat chamber is off. There is no reason for someone to go into a heat chamber or be inside the heat chamber during operation.
  - — Let the heat chamber cool off before entering.

- To avoid explosion injuries
  - — Do not smoke around the heat source for the heat chamber. This is particularly true if the heat chamber uses propane gas to generate heat.
- To avoid toxic vapor exposure
  - — Minimize the amount of time you are in the heat chamber with a forlift, even if the heat chamber is off. Carbon monoxide may build up rapidly when the forklift is operated in the heat chamber.
  - — Do not use direct fire systems because of the possibility of exhaust buildup and of starting a fire. Move the flame out of the heat chamber; make sure that there is sufficient ventilation or use an indirect system. If you have a boiler on the property, consider using steam.
- To avoid running into other workers with a forklift
  - — Only trained operators should run the forklift.
  - — Make sure loads are stable, with the forks as low as possible.

Home-made heat treatment chamber with pallets loaded, and ready to start heat treatment cycle.

Commercially manufactured heat treatment chamber.

For additional information

OSHA [1997]. Carbon monoxide standard. http://www.osha.gov/pls/owadisp.show_document?p_table=STANDARDS&p_id=10366&p_text_version=FALSE.

OSHA Fact sheet: carbon monoxide. http://www.osha.gov/OshDoc/data_General_Facts/carbonmonoxide-factsheet.pdf.

OSHA Health guidelines for carbon monoxide. http://www.osha.gov/SLTC/healthguidelines/carbonmonoxide/

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CHAPTER 8

Ergonomics for Wood Pallet Manufacturers

NIOSH

Chapter 8

Ergonomics for Wood Pallet Manufacturers

Ergonomic Considerations for the Wood Pallet Manufacturing Industry

Within the wood pallet manufacturing industry, three issues should be addressed by the application of ergonomic principles:

- Manual material handling of raw material and finished product
- Use of power tools and exposure to impulse and cyclical vibrations
- Workstation design issues related to awkward positions

Manual Material Handling

The NIOSH recommended weight limit for manual material handling tasks is a maximum of 51 pounds under ideal conditions. (*Applications Manual for the Revised NIOSH Lifting Equation*). The size and weight of the raw material (timber and/or cants) would often exceed this limit, requiring the use of mechanical lifting aids or team lifting to move the material. This requirment helps to minimize low back or upper arm injury, particularly when moving material from storage areas to work areas where saws, nailers, etc. are present. Gravity feed or roller table systems may also be implemented to move heavy objects.

Worker manually positioning wood into saw.

Worker lifting wood from supply pile below knee height.

If possible, keep the supply of raw material, or finished product between the shoulders and the knees. Do not stack above shoulder height or below knee height. Performing such tasks may result in neck, shoulder, and lower back injuries over time. Automatic height adjusting carts (e.g., those which use springs to raise or lower the work surface) adjust the shelf height based on the weight of the material on the cart. Hydraulic-powered elevating carts are also an option.

Worker moving heavy timber into saw.

Worker moving pallet through saw.

Keeping load close to body while moving pallet component.

When manually transferring raw material or product to a different location, keep the load as close to the worker's torso as possible. In the case of pallets, carry vertically close to the body as opposed to horizontally in front of the body, if vision is not obstructed by the load. For example, carrying a 50 pound pallet with hands 20 inches in front of the spine results in 1,000 inch-pounds of force. By carrying the 50-lbs pallet 8 inches in front of the spine results in only 400 inch-pounds of force.

Minimize the distance walked when manually carrying loads. Carrying heavy loads over more than a few feet extracts a physiologic toll from the worker. Prolonged energy expenditure can lead to fatigue, which in turn may result in injuries or accidents.

Use of Power Tools

Exposure to hand-arm or segmental vibration would primarily be from the use of handheld power tools. This exposure can be minimized through proper tool selection, preventive tool maintenance, and the use of anti-vibration gloves where appropriate. Gloves should meet or exceed the requirements of the *International Organization for Standardization* (ISO) [ISO-10819 Mechanical vibration and shock. Hand-arm vibration. Method for the measurement and evaluation of the vibration transmissibility of gloves at the palm of the hand 1997.]

Impact tools, such as pneumatic nailers, should be designed to minimize kickback. The tools may be counterbalanced to alleviate some of the stresses to the worker's wrist and forearm. Pneumatic nailers often weigh over nine pounds when loaded with fasteners. In a dedicated pallet assembly area or workstation the tool can be easily suspended overhead, above the work area. Suspending the tool would eliminate some of the weight of the tool the worker must hold as well as provide a permanent location for the tool for general housekeeping issues.

Worker in awkward posture to use saw.

Worker in stressful awkward posture with twisted torso.

Worktable too high, forcing awkward arm posture.

Worker reaching with tool rather than bringing work closer to body.

Powered handtools that require the use of a single-finger trigger place undue stress on the soft tissues (e.g., tendons) of that finger; usually the index finger, due to the many repetitions over the course of the day. Tools with multiple-finger or strip triggers allow the user to alternate which finger activates the tool while still maintaining control of the tool in the hand. Pressure-activated tools eliminate the need for triggers by starting upon steady pressure on the end of the tool.

Workstation Design

Keeping the worker's arms as close to the body as possible while using a tool is less stressful than using the tool with the arm fully extended. Extreme reach with a tool places additional stress on the arm, shoulder, neck, and spine. Additional stresses occur to the legs as well as shown in the photo on the next page.

Place the raw materials in a jig on a rotating surface so that the pallet (and surface) can be spun in front of the worker to minimize reach with the pneumatic nailer. Turntable tops are relatively inexpensive and can be mounted to many existing work surfaces.

Worker stretching to nail far side of pallet.

Worker in awkward posture due to table height with work on the far side of pallet.

Use jigs, fixtures, and vises versus hands to hold material in place. Simple clamps and fixtures can be used to secure the raw material in place during pallet construction.

One common principle to improve productivity in the workplace is to have a predetermined location for each tool or item needed and to always return that item to that location after each use.

Many facilities are indoors with relatively poor area lighting and little to no task lighting. The elimination of poor lighting is especially important in areas where saws or other power equipment is being used.

Minimize bending, stooping, squatting, lifting and lowering of loads. A variety of lift tables, scissors lifts, pallet tables, etc. can be used that would help minimize worker fatigue over the course of the work shift.

Where possible use workstations with easily adjustable heights that readily accommodate most workers. Pneumatic, hydraulic, or manually adjustable systems are available. Where possible allow both standing and seated workstations which lessens muscle fatigue among the workers.

For More Information

Applied Occupational Ergonomics [1998]. Fernandez JE, Marley RJ.

Cumulative trauma disorders: a manual for musculoskeletal diseases of the upper limbs [1988]. Putz-Anderson V, ed.

Elements of Ergonomics Programs [1997]. NIOSH Publication No. 97–117.