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Woodworking: Addressing the Safety and Health Hazards

Hazards of woodworking machinery

Machines used in woodworking are dangerous, particularly when used improperly or without proper safeguards. Workers can suffer injuries from minor lacerations to amputations and blindness. In addition, wood dust and the chemicals used in finishing are health hazards and can cause skin and respiratory diseases.

The principal hazards of woodworking can be classified as either safety or health hazards. Employers should train employees how to identify all types of hazards related to their assigned job tasks.

Safety hazards

Safety hazards can cause immediate injury to a worker, such as cuts and lacerations. The primary safety hazards of woodworking machinery include:

- Machine hazards (point of operation, rotating and reciprocating movements, and in-running nip points)
- Kickbacks
- Flying chips or other material
- Tool projection
- Fire and explosion hazards
- Electrical hazards

Health hazards

Health hazards are associated with exposure to certain substances, excessive noise, or vibrations. Certain types of wood dust, for example, can cause allergic reactions. Health hazards can cause both immediate (acute) and long-term (chronic) health effects. The primary health hazards from woodworking include:

- Wood dust
- Noise
- Vibration
- Chemical hazards (such as coatings, adhesives, and solvent vapors)

Safety hazards

Woodworking machinery can cause injury from improper operation or from poor maintenance. Individual machines must be evaluated for specific operating hazards. An understanding of the safety concerns is necessary to address them with engineering and administrative controls. Most likely, personal protective equipment will also be necessary. Woodworking shops may also present hazards from faulty electrical systems, poor maintenance, and the possibility of fires or explosions.

Machine hazards

Machine hazards are usually overcome by using guards. The different ways that machines operate require a variety of guards, and understanding the hazard is essential to providing protection.

Point of operation

The point of operation is the place where work is performed on the material. This is where the stock is cut, shaped, bored, or formed. Most woodworking machines use a cutting or shearing action. Injuries can occur at the point of operation when:

- Employees hands get too close to the blade, especially when stock unexpectedly moves or when a worker's hand slips.
- Stock gets stuck in a blade and pulls the operator's hands into the machine.
- The machine or its guard is not properly adjusted or maintained.
- The equipment is accidentally started.
- Lockout/tagout procedures are not followed during servicing, maintenance, and repairs.
- An employee reaches in to clean a saw or remove stock after the saw has been turned off, but is still coasting. Saw blades often move so fast that it can be difficult to determine if they are moving.

Rotating and reciprocating movements

Rotating action is hazardous regardless of the speed, size, or surface of the moving part. Rotating parts and shafts can catch hair or clothing and draw the operator in. Rotating parts and stock can also force an arm or hand into a dangerous position, breaking a bone, lacerating, or severing a limb. Bolts, projecting keys, or screws on rotating parts increase the danger of getting caught by the rotary part. Operators also can be struck by a projecting bolt or key.

Reciprocating movement is back-and-forth or up-and-down motion. Operators can be caught and crushed by reciprocating movement when the moving part approaches or crosses a fixed part of the machine.

In-running nip points

In-running nip points (or pinch points) are a special danger of rotating or reciprocating parts. They occur wherever machine parts move toward each other or when one part moves past a stationary object. Parts of the body may be caught between or drawn into the nip point and crushed, mangled, or severed.

Kickbacks

Kickbacks can happen when the stock twists and binds against the blade or is caught in the teeth. A blade that is not sharpened, or is set at an incorrect height, can cause kickbacks. Poor-quality lumber (such as frozen lumber or lumber with many knots or foreign objects such as nails) can also result in kickbacks. Kickbacks are most likely in the absence of safeguards, such as spreaders, anti-kickback fingers, and gauge or rip fences. Kickbacks occur more often when cutting parallel to the wood grain (ripping) than when cross-cutting.

Flying chips

Employees may be exposed to splinters and chips flung by the cutting action of woodworking equipment. Smaller particles, such as sawdust, present more of a health hazard than a threat of injury.

Tool projection

Some woodworking equipment has rotating cutter heads with multiple knives. Cutter heads that are not properly adjusted, are poorly mounted, or have broken knives, can become unbalanced. Balance is critical for keeping knives secured to a rapidly moving cutter head. An unbalanced cutter head can fling the knives from the tool and severely or fatally injure the operator or others nearby.

Controlling machine hazards

The preferred way to control machine hazards is through engineering or work practice controls. When these controls are not possible or do not provide adequate protection, personal protective equipment (PPE) must be provided. Employers must use all feasible engineering and work practice controls to reduce or eliminate hazards before using PPE.

Engineering controls involve physically changing the machine or work environment to prevent employee exposure to the potential hazard. Examples are using a guard on a machine and using local exhaust ventilation to remove dust at the source.

Work practice controls involve removing employees from exposure to the potential hazard by changing the way they do their jobs. For example, workers should always use push sticks to guide short or narrow pieces of stock through saws. This allows saw operators to keep their hands at a safe distance from the saw blades.

PPE encompasses a wide variety of devices and garments to protect workers from injuries. Examples include respirators, goggles, face shields, hard hats, gloves, earmuffs, and earplugs.

Engineering controls

Although guards are now standard equipment on most woodworking machines, machine guarding violations still make the list of citations issued during OSHA inspections. All moving machine parts that may cause injury must be safeguarded. This includes the point of operation, the power transmission apparatus, and rotary or reciprocating parts.

If a machine does not come equipped with a guard, install one. Contact the manufacturer to see if appropriate guards are available. If not, determine the appropriate guard to install. Guards should always be designed and installed by qualified persons. In addition, have the manufacturer review proposed guard designs to ensure that the guard will adequately protect employees and allow safe equipment operation.

A guard should prevent employees from contacting the dangerous parts of the machines, and it should be secure. This is not always possible, as in the case of the radial arm saw. Regardless, workers should not be able to easily bypass, remove, or otherwise tamper with the guard. However, the guard must not create additional hazards, nor prevent the worker from performing the job.

Guards must have adequate strength to resist blows and strains and should protect operators from flying splinters and machine parts such as broken saw teeth, cutting heads, and tools.

Another engineering control is the placement of operating controls. The controls should be recessed or positioned so that an operator cannot accidentally turn on the machine. However, the emergency stop should be within easy reach of the normal operating position.

Procedural and administrative controls

Procedural and administrative controls involve using safe work practices and ensuring that equipment is used properly or in a manner that minimizes hazards.
These include:

- Using good work practices
- Training operators to safely use the machines
- Properly maintaining the equipment
- Following good housekeeping procedures

Work practices

A worker should not operate equipment if the guard or any other safety device is not functioning properly. Good work practices mean:

- Using appropriate equipment for the job
- Using machines only for work within the rated capacity specified by the manufacturer
- Using the correct tools on a given machine

For example, when using a circular saw, use the correct blade for the required cutting action. Similarly, only mount blades, cutter heads, or collars on machine arbors that have been accurately sized and shaped to fit these parts.

Examples of good work practices include:

- Using push sticks or other hand tools to keep employees' hands away from the point of operation when they work on small pieces of stock.
- Using a brush or stick to clean sawdust and scrap from a machine. Never allow employees to clean a saw with their hands or while the machine is running.
- Never leaving a machine unattended in the "on" position. Make sure workers do not walk away from a machine that has been turned off but is still coasting.
- Never sawing freehand. Always hold the stock against a gauge or fence. Freehand sawing increases the likelihood of an operator's hands coming in contact with the blade.

Training

Allow only trained and authorized workers to operate and maintain equipment. Workers should understand the purpose and function of all controls, know how to stop the equipment in an emergency, and be able to follow the safety procedures for special set-ups.

Operator training should cover:

- Hazards of the machine
- How the safeguards protect the worker

- Under what circumstances the guard may be removed (usually just for maintenance)
- What to do if the guard is damaged or not functioning properly

Employees should demonstrate their ability to run the machine with all safety precautions and mechanisms in place.

Maintenance

Regularly clean and maintain woodworking equipment and guards. Make sure that knives and cutting heads are kept sharp, properly adjusted, and secured. Remove any cracked or damaged blades from service. Remove dull, badly set, improperly filed, or improperly tensioned saws from service, and immediately clean saws to which gum has adhered.

Frequently inspect equipment and guards. Ensure that:

- The operator and machine have the safety accessories suitable for the job hazards
- The machine and safety equipment are in proper working condition
- The machine operator is properly trained
- Document the inspections and keep the records. Documentation should identify the machine, inspection date, problems noted, and corrective action taken. Noting problems helps to ensure that:
    - Corrective action will be taken
    - Operators on all shifts will be made aware of any potential danger
    - Any pattern of repeat problems on a particular machine can be detected and resolved as early as possible.

Housekeeping

Administrative controls include good housekeeping procedures. Keep floors and aisles in good repair and free from debris, dust, protruding nails, or other tripping hazards. If possible, provide a non-slip floor or traction mats in affected areas.

Do not use compressed air to blow away chips and debris because this increases employee exposure. Sweeping or vacuuming is better, though sweeping can also create airborne dust. Vacuums also can be used for removing dust from employees' clothing.

Personal protective equipment (PPE)

PPE is the last line of defense against safety hazards. Use appropriate PPE where hazards cannot be eliminated by other means. The use of PPE should not create additional hazards. In woodworking, PPE is most likely to be used against health hazards such as exposure to wood, dust, noise, or injuries from flying chips.

Clothing such as coveralls can also serve as PPE to protect against skin contact with wood dust. Do not allow workers to wear loose clothing or have long hair that could be caught up in rotating parts. Loose clothing should be secured under coveralls or taped down, and long hair should be tied back and tucked under clothing or caps.

Other safety hazards

Other safety issues associated with woodworking equipment include electrical hazards, fire and explosion hazards, and maintenance hazards.

Electrical hazards

The National Electrical Code (NEC) defines hazardous locations as areas “where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings.” The dust need not be suspended in the air, but can collect around machinery or on lighting fixtures where heat, sparks, or hot metal can ignite them. Hazardous locations can include plants that shape, pulverize, or cut wood and create sawdust or flyings.

A substantial part of the NEC is devoted to hazardous locations because electrical equipment can become a source of ignition in these areas. There are three ways in which electrical equipment can become a source of ignition.

Arcs and sparks produced by the normal operation of equipment (like motor starters, contactors, and switches) can ignite a hazardous location atmosphere.

The high temperatures of some heat-producing equipment, such as lamps and lighting fixtures, can ignite flammable atmospheres if they exceed the ignition temperature of the hazardous material. Electrical equipment failure can also set off an explosion. A burn out of a lamp socket or shorting of a terminal could spark a disaster in a hazardous location.

An OSHA Letter of Interpretation dated August 22, 2003, titled, “Use of portable vacuum cleaners for cleaning up aluminum and wood dust” noted that certain dusts can be combustible and require equipment that is approved for the hazards of the location. Specifically, the letter states:

“Wood dust can cause an area to be classified as a Class II or Class III hazardous location, depending on the particular conditions present. Therefore, any equipment used to clean up dust in that area would need to be approved for use in that hazardous location. It is the employer's responsibility to evaluate the area, determine, if necessary, the appropriate hazardous location classification, and ensure that only equipment approved for that location classification is used in that area.”

Among the many provisions in the OSHA electrical standards are the following requirements:

- All of the metal framework on electrically driven machines must be grounded, including the motor, motor casing, legs, and frame. This includes other equipment such as lights that may be mounted on the machine.
- All circuit breakers and fuse boxes must be labeled to indicate their purpose—that is, what area of the plant they power or protect. Use appropriately rated fuses and cover all unused holes in electric boxes.
- Electrical cords, cables, and plugs must be kept in good repair. Flexible cords and cables must be fastened so that there is no direct pull on joints or terminal screws. Cords and cables must be free of splices and must not run through windows, doorways, or holes in the wall.
- Junction boxes, outlets, switches, and fittings must be covered.
- All electrical components must be approved by a Nationally Recognized Testing Laboratory for the specific location where the equipment will be used.
- All machines must have a main power disconnect for lockout/tagout.
- In addition, all machines should have the following:
    - A magnetic switch or other device to prevent automatic restarting of the machine

after a power failure. Such an unexpected start-up could expose the worker to moving parts.
    - An emergency stop device within reach of operators working in the normal operating position.
    - Clearly marked controls that are within easy reach of the operator and away from the hazard area.

Maintenance hazards

Each year, hundreds of workers are killed or injured while repairing or maintaining machines. To prevent accidental energizing of machines during maintenance, follow OSHA's Lockout/Tagout standard at 29 CFR 1910.147. Lockout/tagout refers to the process of shutting down and locking out machines before maintenance to prevent accidental start-up during maintenance, cleaning, or other similar operations.

Locking out equipment provides a physical means (i.e., a lock) to ensure that power will not be restored to the machine and that the machine will not be started until work has been completed. All power sources—electrical, mechanical, pneumatic, hydraulic—must be shut off and locked out during machine maintenance. Tagging the equipment warns others that someone is working on the machine and that power must not be restored until the work is completed and the person performing the work removes the tag.

Prepare a written lockout/tagout plan for each machine that describes all power sources and the correct procedure for shutting down, testing, and re-energizing the equipment. The plan should describe how employees will be notified when lockout/tagout is necessary, and must require employees to always lock out or tag out equipment using the appropriate procedures before performing work on the equipment.

Fire and explosion

Woodworking facilities are inherently prone to fires and explosions because:

- They contain large quantities of fuel in the form of wood, sawdust, and flammable materials such as paints, oil finishes, adhesives, and solvents. Sawdust will ignite and burn far more easily than lumber. Sanders, routers, and shapers produce large amounts of fine dust. Very fine wood dust can accumulate on rafters and other unexpected spots far from the point of generation.
- They contain ignition sources such as potentially faulty electrical wiring, cutting and welding operations, sparking tools, propellant-actuated tools, and employee smoking.

The electrical hazards were discussed in the previous section. The following engineering and work practice controls focus on controlling dust and separating flammable materials.

Engineering and work practice controls

Preventing dust buildup is one of the key means for controlling fire and explosion hazards. The principal engineering control for dust is exhaust ventilation, and the primary work practice control is good housekeeping.

Dust collection is best accomplished at the source—at the point of operation, if feasible. Well-designed ducts and vacuum hoods can collect most dust generated before it reaches the operator. Very fine dust that escapes point-of-source collection can be captured from above by

general exhaust points along the ceiling. These controls are effective for most equipment, except machines that produce the finest dust or large quantities of dust.

Provide continuous local exhaust ventilation on all woodworking machines. The local exhaust systems must have a suitable collector. Dust collection systems must be located outside the building, unless the exceptions described in NFPA standards are met. Never permit blow-down of accumulated dust with compressed air. Blowing dust creates a dust cloud that presents an explosion hazard.

Good housekeeping extends to periodic hand cleaning of the entire facility, as some dust will escape from even the best exhaust system and will eventually accumulate on rafters and other out-of-the-way spots. Also, inspect and clean the exhaust ventilation system on a regular basis to maintain maximum efficiency.

Other measures to minimize fire and explosion hazards include the following:

- Ensure the proper use and storage of flammable materials, such as paints, finishes, adhesives, and solvents. Segregate combustible and flammable materials such as lumber stock and chemical solvents from each other and from ignition sources.
- Segregate tasks particularly prone to fire and explosion hazards, such as spray painting, welding, and use of powder-actuated nail guns.
- Train employees to recognize, avoid, and correct potentially hazardous conditions and behaviors. Train employees on the special equipment and aspects of building design related to fires and explosions.
- Control ignition sources. Use electrical systems rated for the projected use and protected by appropriate circuit breakers, ground all equipment prone to accumulating static electrical charges, and restrict smoking in and around the workplace. Consult Subpart S of OSHA's General Industry Standards for information on electrical design requirements.

Heath hazards

The three main health hazards in woodworking are exposure to wood dust, excessive noise, and equipment vibration.

Exposure to wood dust can cause a variety of health problems, including skin conditions, respiratory effects (such as asthma and chronic bronchitis), and cancer.

Excessive noise can damage hearing and may lead to stress-related disorders such as nervousness, chronic fatigue, increased blood pressure, and impaired concentration and mental function.

Exposure to excessive vibration can cause problems with worker's hands, including "white fingers" disease in which the blood vessels in the fingers are damaged.

These health hazards are discussed in detail below.

Wood dust

Short-term exposure to wood dusts can result in eye and skin irritation, asthma, blistering, redness, scaling, and itching. Long-term exposure can result in dermatitis reactions, asthma, coughing, wheezing, fever, and the other signs and symptoms associated with chronic

bronchitis. Other common symptoms of wood dust exposure include eye irritation, nasal dryness and obstruction, prolonged colds, and frequent headaches.

Sensitization to wood dust can also be a problem. When a worker becomes sensitized, he or she can suffer a severe allergic reaction (such as asthma) after repeated exposure or exposure to lower concentrations. Both the skin and respiratory system can become sensitized to wood dust.

Certain species of hardwood—such as oak, mahogany, beech, walnut, birch, elm, and ash—have been reported to cause nasal cancer in wood-workers, particularly when exposures are high. At this time, OSHA regulates wood dust as a nuisance dust. However, OSHA strongly encourages employers to keep exposures to a minimum. The maximum Permissible Exposure Limit for nuisance dust is 15 mg/m3, total dust (5 mg/m3, respirable fraction).

Because of these hazards, employers should consider providing employee medical evaluations. Employers should also protect workers from wood dust through a combination of engineering and work practice controls. Where necessary, provide PPE as a supplement to these controls.

Pre-placement medical evaluation

A pre-placement medical evaluation is recommended to assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to wood dust at or below the prescribed exposure limit.

Before a worker is placed in a job with a potential for wood dust exposure, a licensed health care professional should evaluate and document the worker's baseline health status with:

- Thorough medical, environmental, and occupational histories
- A physical examination
- Physiologic and laboratory tests appropriate for the anticipated occupational risks

These evaluations should concentrate on the function and integrity of the skin and respiratory system. The health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Medical surveillance for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society.

Periodic medical evaluations

Occupational health interviews and physical examinations should be performed at regular intervals during employment. Where the hazard is minimal, evaluations should be conducted every 3 to 5 years or as recommended by an occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to wood dust exposure. The interviews, examinations, and tests should focus on identifying the adverse effects of wood dust on the skin or respiratory system. Current health status should be compared with the baseline health status of the individual or with expected values for a suitable reference population.

Termination medical evaluations

The history interviews, physical examination, and tests that were conducted at the time of placement should be repeated at the time of job transfer or termination to determine the

worker's medical status at the end of employment. Any changes in the worker's health status should be compared with those expected for a suitable reference population. Because occupational exposure to wood dust may cause diseases with prolonged latent periods, the need for medical surveillance may extend well beyond the termination of employment.

Engineering controls

Each employer is responsible for installing engineering controls which adequately reduce employee exposure to wood dust. Engineering controls typically include a ventilation system with collectors where dust is produced. Respirators may be worn when engineering controls do not reduce exposure to acceptable levels.

OSHA will typically review an employer's engineering controls if the airborne wood dust exceeds the Permissible Exposure Limit (PEL). If OSHA determines that an employer has not instituted feasible engineering controls for preventing or reducing employee overexposure to wood dust, a citation would be issued.

To check for excessive airborne wood dust, look for dust collecting on equipment, clothes, employees' faces, or hair (which indicates dust around the workers' breathing zone). A clean work area during operation can indicate that wood dust levels are below OSHA's PEL. However, the only way to be certain is by air sampling to document compliance. Air samples should be collected by a qualified person to ensure correct sampling procedures and reliable results.

The primary method of controlling wood dust is with local exhaust ventilation (LEV), which removes dust at or near its source. LEV systems can often be integrated with machine guards. Exhaust hoods should be located as close as possible to the emission source, either on the woodworking machinery itself or near the machine. The local exhaust systems should have an efficient air cleaning device.

LEV recommendations for individual machines

Circular saws

- Exhaust the saw through the bottom of the table under the blade slot. To decrease the open area between the table and the lower hood, attach a strip of flexible material to the machinery that will cover this area when the hood operates.
- For increased dust control, add a local exhaust hood above the top of the saw blade. The hood should be integrated with the guard on the upper part of the blade.

Band saws

- Provide LEV under the blade slot. To increase the collection area of the hood, add holes (1/8 inch in diameter) in the table around the slot area.
- To collect wood dust from the saw teeth, place a suction nozzle above the table at the rear of the saw blade.

Jointers

- Place a hood underneath the machine head.

Shapers

- Control each head with an open-faced hood on the table behind the head. For additional protection, use a combination of fixed and adjustable hoods. A fixed open-faced hood

can be attached to the rear of the table between the shaper heads. Movable open-faced hoods also can be used on the table.

Planers/Molders

- Place open-faced hoods above the spinning heads of planers. Each head can be ventilated separately, or one hood can be used to control several heads.
- Place open-faced hoods around the spinning components of molders. Each head should be separately controlled.
- For increased dust control, add a small open-faced hood along the side of the molder between the main head and the worker.

Lathes

- Place an open-faced hood attached to a movable mechanical arm at the point of operation.

Routers

- Place two open-faced hoods behind the heads of the router table. Connect the hoods to the exhaust ductwork via a flexible hose.
- Locate an open-faced or slot hood at the rear end of the router table.

Sanders produce considerable dust that is difficult to control with conventional methods. Some possibilities include the following:

- Enclose disc sanders with an exhaust hood installed below the table; cover the back of the sanding disc at points above the worktable. Some systems supply pressurized air to the disc inside the hood. The jet of high speed air blows dust particles out of the disc air layer so the dust can be captured by the exhaust hood.
- On random orbital sanders, use an aspirator in combination with a perforated sanding pad. The aspirator creates a vacuum that draws wood dust up through the holes of the sanding pad. Some dust control systems use additional exhaust and a slotted sanding pad.
- Enclose horizontal belt sanders with exhaust hoods covering each end of the belt. These hoods control the dust carried by the belt. To further control dust emissions, install an additional hood above the area where the wood is processed. To increase the effectiveness of this system, add a narrow hood and a stripper.

For LEV systems to provide maximum protection, they should be properly maintained. Check and clean ducts and dust collectors at regular intervals. Inspect ducts to ensure that they are not loose, broken, or damaged. Check the V-belts on the drive units of belt-driven exhaust fans for slippage or breakage. Make sure the duct velocity is maintained per the equipment manufacturer's instructions, such as a minimum of 2,500 to 4,000 feet per minute, to effectively remove light, dry saw dust, heavy wood chips, and green shavings, and to prevent these from plugging the system.

To maintain peak operating efficiency, temporarily close ducts to equipment not in operation. This will increase the air flow to the rest of the hoods or vacuum devices. Adding a stronger fan also can improve dust removal, and modifying existing systems is generally less expensive than installing a new system.

Personal protective equipment (PPE)

Appropriate PPE must be carefully selected, used, and maintained to be effective in preventing

skin contact with wood dust. The selection of PPE should be based on the extent of the worker's potential exposure to wood dust.

Workers should wear work uniforms, coveralls, or similar full-body coverings that are laundered each day. Employers should provide lockers or other closed areas to store work and street clothing separately, collect work clothing at the end of each work shift, and provide for its laundering. Laundry personnel should be informed about the potential hazards of handling contaminated clothing and instructed about measures to minimize their health risk.

Respirators

Some situations may require respirators to control exposure. Respirators must be worn if the ambient concentration of wood dust exceeds the PELs. The selection of appropriate respirators requires a thorough knowledge of the workplace, the potential contaminants, and their concentrations. The use of respirators also requires a respiratory protection program.

Employers should institute a respiratory protection program that, at a minimum, complies with the requirements of OSHA's Respiratory Protection Standard at 29 CFR 1910.134. Such a program must include:

- Respirator selection
- An evaluation of the worker's ability to perform the work while wearing a respirator
- Regular training of personnel
- Respirator fit testing
- Periodic workplace monitoring
- Regular respirator maintenance, inspection, and cleaning

Implementing an adequate respiratory protection program requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Personal hygiene procedures

If wood dust contacts the skin, workers should wash the affected areas with soap and water. Workers who handle wood dust should thoroughly wash their hands, forearms, and faces with soap and water before eating, using tobacco products, using toilet facilities, applying cosmetics, or taking medication.

Workers should not eat, drink, use tobacco products, apply cosmetics, or take medication in areas where wood dust is handled or processed.

In addition, safety showers and eye wash stations should be located close to operations that involve wood dust.

Noise

Two primary factors act together to make noise hazardous—volume (intensity) and duration. The louder the noise and the longer the exposure, the greater the potential for hearing loss. The risk of hearing impairment is also cumulative over the course of a working day.

Methods to reduce noise levels include source controls, path controls, and hearing protection. Source controls (or engineering controls) provide the most effective protection since they actually reduce the amount of noise generated. For this reason, examine source control options

first before moving on to path controls and, finally, to hearing protection.

Source controls

Source control begins with a thorough analysis of each piece of noise-generating equipment. Identify all noise sources within a given piece of equipment, as well as the ways in which the sound is transmitted (and often amplified by resonance or vibration) to the room. Make every effort to quiet the sources and dampen the vibrations. Noise sources generally include motors, gears, belts and pulleys, points of operation where blades touch wood, and any other moving parts. Resonant transmitters generally include the equipment frames, footings, and housings.

Examples of source control steps include:

- Maintaining motors and all moving parts in top operating condition through lubricating and cleaning, replacing worn parts, maintaining proper belt tensions and bolt torques, and properly balancing pulleys, blades, and other rotating parts
- Reducing the speed of operation to the slowest level consistent with product quantity and quality goals
- Moving power equipment operations out of wooden or steel-frame buildings and into stone, cement, or brick structures, if possible
- Ensuring that equipment frames are as rigid as possible, that equipment is firmly seated on a solid floor (preferably cement), and that no piece of equipment is in contact with any other piece or with walls
- Isolating noisy equipment with rubber footings, springs, or other forms of damping suspension to reduce vibration that transmits and amplifies noise
- Applying vibration-damping materials to all resonating surfaces, and (where possible) constructing sound absorbent hoods around points of operation

Path controls

Effective path controls involve isolating, blocking, diverting, absorbing, or otherwise reducing noise intensity before it reaches employees' ears. In other words, it means controlling the path that sound follows to direct it away from employees.

Examples of path control steps include:

- Move or locate noise-producing equipment away from employees, since noise intensity decreases significantly with distance. Reflective surfaces (such as flat metal surfaces that reflect sound back toward employees) will limit the noise reduction achieved by this method.
- Segregate operations to limit the number of employees exposed to or working near noise producing equipment.
- Enclose equipment within barriers designed to absorb noise and/or reflect it in harmless directions, such as toward ceilings covered with sound absorbent material.

Hearing protection

Hearing protection devices isolate the ear from harmful noises. Employees should wear them as the final line of defense against noise hazards. Hearing protection can be effective and, compared to source and path control efforts, relatively inexpensive. However, the use of hearing protection demands ongoing effort and commitment.

Given the nature of woodworking operations, production floor employees will almost certainly require hearing protection. Where required, develop and implement a hearing protection program according to 29 CFR 1910.95.

Vibration

Both hand-held and stationary tools that transmit vibration can cause vibration “white fingers” or hand arm vibration syndrome (HAVS).

White fingers, or Raynaud’s Syndrome, is a disease of the hands in which the blood vessels in the fingers collapse due to repeated exposure to vibration.

HAVS is a more advanced condition, and the entire hand or arm may be affected. Early signs of HAVS are infrequent feelings of numbness and/or tingling in the fingers, hands, or arms, or numbness and whiteness in the tip of the finger when exposed to cold. As the disease progresses, workers experience more frequent attacks of numbness, tingling, and pain, and find it difficult to use their hands. Workers with advanced HAVS may be disabled for a long time.

Engineering controls

The two most effective engineering controls for vibration are using vibration isolators on the equipment and using damping techniques. Isolate machine vibrations from the surface if the machine is mounted, or use vibration isolation mounts.

Control vibrating panels of machine housings and guards by applying damping materials to the panels. Determining the correct type and quantity of damping material for a particular machine is a complicated process and should be left to a knowledgeable person. The frequency emitted by the machine, the noise reduction desired, and the weight and size of the machine are factors to consider. Generally, the damping layer should be the same thickness as the surfaces being treated.

Work practice controls

As noted previously, work practice controls include such things as machine maintenance and worker technique. The following work practice controls can help reduce the health hazards of vibration:

- Maintain machines in proper working order. Unbalanced rotating parts or unsharpened cutting tools can create excessive vibration.
- Arrange work tasks so that vibrating and non-vibrating tools can be used alternately.
- Restrict the number of hours a worker uses a vibrating tool during each shift. Allow employees to take 10 to 15 minute breaks from the source of the vibration every hour.
- Train workers about the hazards of working with vibrating tools. Instruction should include the sources of vibration exposure, early signs and symptoms of hand-arm vibration syndrome, and work practices for minimizing vibration exposure.
- Instruct workers to keep their hands warm and dry, and not to grip a vibrating tool too tightly.
- Workers should allow the tool or machine to do the work.

Hazard communication

Woodworking shops may have solvents, paints, and other chemicals that require a hazard communication program under 29 CFR 1910.1200. However, the wood itself can also trigger certain provisions of the hazard communication standard.

Wood and wood products are exempted from the hazard communication standard if the only hazard presented from use is flammability or combustibility. However, inhalation of certain types of wood dust or chemicals used to treat wood can present serious health hazards. For this reason, OSHA has always required that distributors of wood products provide a Safety Data Sheet (SDS) to employers whose employees may be exposed to these inhalation hazards.

The hazard communication standard requires that the carcinogenicity of hazardous chemicals be identified on the SDS for that product. The International Agency for Research on Cancer has found a clear association between nasal cancer and occupational exposure to hardwood dust.

Hazardous waste management

EPA considers a waste to be hazardous if it exhibits any of the following characteristics as defined in 40 CFR 261.21-261.24: ignitability, corrosivity, reactivity, or toxicity. Under the Resource Conservation and Recovery Act (RCRA), EPA has specifically listed many chemical wastes as hazardous. Although wood dust is not specifically listed under RCRA, EPA requires employers to treat waste as hazardous if it exhibits any of the four characteristics.

The U.S. Department of Transportation, EPA, and state and local regulations should be followed to ensure that removal, transport, and disposal of wood dust are conducted in accordance with existing regulations. To be certain that waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346. In addition, contact relevant state and local authorities for information on any requirements they may have for the waste removal and disposal.