A Guide to
Occupational Exposure to Wood,
Wood Dust and Combustible Dust Hazards

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Acknowledgments

A Guide to Wood Dust was originally prepared by Health and Hygiene Inc., whose president, Harold Imbus, M.D., Sc.D., conducted studies about how wood dust affects workers. Dr. Imbus’s studies were cited by OSHA in its final rule regarding wood dust. This edition was revised and updated June 2005, incorporating material from several additional sources referenced within the guide.

This guide is intended to be consistent with all existing OSHA standards; therefore, if an area is considered by the reader to be inconsistent with a standard, then the OSHA standard should be followed.

To obtain additional copies of this book, or if you have questions about N.C. occupational safety and health standards or rules, please contact:

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Phone: (919) 807-2875 or 1-800-NC-LABOR (1-800-625-2267)

Additional sources of information are listed on the inside back cover of this book.

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## Contents

<table>
<thead>
<tr>
<th>Part</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Foreword</td>
<td>v</td>
</tr>
<tr>
<td>1</td>
<td>OSHA Wood Dust Standard</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Exposure to and Measurement of Wood Dust</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>The Health Effects of Wood Dust</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Safe Work Practices and Medical Alerts</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>References/Notes</td>
<td>22</td>
</tr>
</tbody>
</table>
Foreword

Wood is one of our most useful commercial products. People have always worked with wood. As this guide points out, North Carolina has a large number of people who work with wood and who are exposed to hazards associated with it. Most people have considered wood and wood dust to be relatively harmless, but they are not. Knowing some of the health problems that may occur and taking appropriate precautions will help to protect the health of North Carolina woodworkers.

In North Carolina, state inspectors enforce the federal laws through a state plan. The N.C. Department of Labor is charged with this mission. NCDOL enforces these safety standards. It offers many educational programs to the public and produces publications, including this guide, to help inform people about their rights and responsibilities.

As you look through this guide, please remember our mission is greater than just enforcement. An equally important goal is to help citizens find ways to create safe workplaces. Everyone profits from working together for safety. *A Guide to Occupational Exposure to Wood, Wood Dust and Combustible Dust Hazards* will help you form effective occupational safety and health practices in your work.

Cherie K. Berry
Commissioner of Labor
OSHA Wood Dust Standard

Introduction
The federal Occupational Safety and Health Administration (OSHA) was created to establish and enforce standards to protect the safety and health of workers. North Carolina has a state occupational safety and health plan that meets or exceeds the requirements of the federal plan. Authority for all matters related to occupational safety and health rests with the N.C. Department of Labor, Division of Occupational Safety and Health. In most instances, the standards promulgated by federal OSHA are adopted and enforced by the N.C. Department of Labor.

On Jan. 19, 1989, OSHA published an air contaminants standard (29 CFR 1910.1000) that included new wood dust exposure limits (1).* The standard was developed under the OSHA PEL (permissible exposure limits) project and does not include any provisions for medical or environmental monitoring as are included in more comprehensive standards. The standard established the following permissible exposure levels for wood dust:

1. 5 mg/m³ time-weighted average for 8 hours for hardwood and softwood dust, except for Western red cedar.
2. Short term exposure limits (STEL) of 10 mg/m³ for all hardwood and softwood dust, except for Western red cedar.
3. 2.5 mg/m³ 8-hour time-weighted average for Western red cedar.

Wood Dust—What Is It?

Wood Dust
Wood dust is wood particles generated by the processing or handling of wood. Wood dust is a byproduct of wood processing.

Hardwood
Sources of hardwoods include trees that have broad leaves and shed their leaves in the wintertime. Examples of hardwoods are oak, maple and cherry.

Softwood
Sources of softwoods include trees that do not shed their leaves in the winter (evergreens), such as pines, spruce and fir.

Actually the terms hardwood and softwood are somewhat misleading in that some of the hardwoods may be soft and some of the softwoods may be relatively hard.

Other Dust Associated With Wood
When discussing health effects, it is important to distinguish between wood dust and living organisms that may contaminate the wood dust.

Molds and fungi may grow on the wood, especially on the bark of the wood. When the wood is processed, the organisms may be released into the air as dust and cause health problems.

Chemicals
Wood itself contains many different chemicals, and these are included in discussion of the health effects of wood dust. In addition to those chemicals that are a part of the wood, other chemicals may be added to wood, usually as preservatives, binders or glues. Common wood additive chemicals are:

- Arsenic
- Chromium

*Numbers in parentheses refer to entries in References/Notes at the end of this publication.
Many wood products may have wood chips or strands bound together with synthetic chemical products called binders. These often consist of urea-formaldehyde or phenol-formaldehyde resins. Wood products such as plywood may appear as sheets of wood glued together, often with these same types of resins.

A Note About Woods

Wood comes from many different species of trees. Each species has its own chemistry and other characteristics. Just as poison ivy is quite different from a tomato plant, the dust from different trees can have different chemical and health characteristics. For example, one type of wood dust may be very irritating to the respiratory membranes or skin, while another type may have a relative non-irritating effect. Some woods can cause allergies resulting in skin rash or asthma. Others are relatively harmless. Therefore, it is important to remember that the health effects of wood dust are very much dependent on the type of species. We will try to point out some of these differences. However, in the case of rare and imported woods, there may be a peculiar set of characteristics about which further information is needed to evaluate their health effects.

For some time it was thought there were major differences in health effects from hardwoods and softwoods. This was because nasal cancer occurred in the British furniture industry where hardwoods were used. More recent studies have reported that differences in health effects from wood may be owed to the characteristics of the species rather than to whether wood is hardwood or softwood.

Combustible Dust Poses a Dangerous, Explosive Threat in the Workplace

In North Carolina, an explosion of fine plastic powder used in the manufacture of polyethylene products killed six people and injured 38. Wood dust in a particleboard manufacturing plant explosion killed three and injured 10 in Pennsylvania. In Mississippi, rubber dust exploded in a rubber manufacturing plant, killing five and injuring 11. And in Kansas, a series of wheat-dust explosions in a large grain storage facility resulted in the deaths of seven people. Accident investigators in each of these facilities, although different industries, found similar conditions that resulted in a massive, tragic dust explosions. They are quite different one from another. In the stories mentioned above, however, they all met the five conditions necessary for a dust explosion: oxygen, fuel, ignition source, dispersion of dust and confinement.

Dust Is a Hazard

Dusts pose a range of hazards from simple nuisance to explosion hazards. Minor hazards may include reduced visibility and slippery surface conditions. Some dusts such as asbestos and silica pose serious respiratory hazards and long-term health effects such as pneumoconiosis. Many different dusts are recognized as a combustion and explosion hazard. The variety of combustible dusts creates difficulty for a brief discussion. Industries with this hazard are classified as a Class II locations. This classification is based on the National Electrical Code article “Class II Locations,” those that are hazardous because of the presence of combustible dust. North Carolina is home to many industries where the hazard of combustible and explosive dust can be commonly found such as the following:
Wood processing and storage
- Grain elevators, bins and silos
- Flour and feed mills
- Manufacture or storage of metal powders such as magnesium and aluminum
- Chemical production
- Plastic production
- Starch or candy producers
- Spice, sugar and cocoa production or storage
- Coal handling or processing areas
- Pharmaceutical plants
- Dust collection bins or bags
- Shelves, nooks, crannies, inside of equipment and above false ceilings in all facilities

Hazard Assessment

A thorough hazard assessment is essential in identifying and eliminating factors contributing to an explosion. Dusts are generated in various parts of any production process. Explosions can occur within any process where a combustible dust accumulates, is produced or stored, is airborne, and can be triggered by a variety of energy sources. The severity of the resulting explosions is related to the heat released in the combustion of these materials. Only a couple of these dust types spontaneously ignite in air; the majority of them need another source of ignition. Possible ignition sources include:

- Open flames (welding, cutting, matches, etc.)
- Hot surfaces (dryers, bearings, heaters, etc.)
- Heat from mechanical impacts
- Electrical discharges (switch and outlet activation)
- Electrostatic discharges
- Smoldering or burning dust
- Cigars, pipes and cigarettes

Look for the hazard in your facility and try to eliminate it. Ask yourself questions such as the following when considering your facility or process:

- Is vacuuming used whenever possible rather than blowing or sweeping combustible dust?
- Do you have electrical installations in hazardous dust or vapor areas? If so, do they meet the National Electrical Code (NEC) Chapter 5 for hazardous locations?
- Are accumulations of combustible dust routinely removed from elevated surfaces including the overhead structure of buildings, false ceiling, shelves, etc.?
- Is metallic or conductive dust prevented from entering or accumulating on or around electrical enclosures or equipment?
- Where may dust accumulate that we have not considered in this production process?
- Wood dusts can decay and create their own heat as a possible source of ignition. Has this possibility been addressed?

Prevention

Investigators at the accidents mentioned determined that the explosions, like most accidents, resulted from a chain of events or factors. Training employees to recognize the hazard as an unsafe condition and doing something about it can break a link in the chain of events that could lead to an explosion, thereby preventing it.

In simple terms, a dust explosion is a very rapid combustion or burning. Reducing any one of the five factors necessary to sustain the explosion can prevent it. The primary method for prevention is reducing or eliminating the fuel load with good housekeeping. Good housekeeping in this context is essential for explosion prevention. Dust removal can be accomplished
by good ventilation, extraction and removal systems, dust collection systems, and manual housekeeping where automated
collection systems cannot reach. In dusty environments, vacuums and other electrical equipment will need to be spark and
explosion proof. Compressed air blowers should never be used for the removal of dust. Minor but steady leaks in any pro-
duction system must be addressed, as these can cause large amounts of dust to accumulate over a period of time, especially if
the process runs at a slightly elevated pressure. Small amounts of dust can create large clouds. Dust will always be present in
some processes. The best way to avoid dust accumulation is to be constantly aware of the surroundings. Respect for the haz-
ard and a good housekeeping program are essential in eliminating the explosion hazard. Thorough employee training is also
crucial. Training should include information on the hazards of dust. It is also vital to address the specific characteristics of
the dust with which the employees work.

Consider characteristics of the hazard(s) as applicable:

- **Toxicity:** It has an LD50 or LC50 of less than 200 mg/Kg body weight
  and/or fails the “Toxicity Characteristic Leaching Procedure” (TCLP) lab
test for any one of 40 TCLP parameters.
- **Ignitability:** It has a flash point of less than 200°F;
- **Corrosivity:** It has a pH less than or equal to 2.0, or greater than or equal to 12.5;
- **Reactivity:** It reacts violently, forms explosive mixture, generates toxic
gases, or contains cyanides or sulfides that are released when exposed to
acid or alkaline materials, or is explosive when mixed with water.

**Identification and Essential Information Source**

Vendors or manufacturers must provide a material safety data sheet (MSDS) for each chemical. Each chemical must be
labeled. The MSDS contains important information on the chemical. Every manufacturer of chemicals does not follow
the same MSDS format, but every MSDS must contain particular information. This information includes:

- Identity: chemical name, manufacturer’s name and address
- Hazardous ingredients: hazardous components, exposure limits
- Physical/chemical characteristics: boiling/melting point, specific gravity, etc.
- Fire and explosion hazard data: flashpoint, flammable limits
- Reactivity data: concerns for reactivity
- Health hazard data: routes of entry, acute/chronic exposure, emergency/first aid procedures
- Safe handling and use: correct handling, storing procedures
- Control measures: personal protective equipment, hygiene practices prior to breaks, meals and departing from chem-
  ical handling areas
Exposure to and Measurement of Wood Dust

Exposure to Wood Dust

Exposure to wood dust is common in the workplace since a wide variety of commercial and home products are made of wood.

Furniture Manufacturing

In the United States, North Carolina is the leading manufacturer of furniture. North Carolina industries employ over half of all furniture manufacture employees in the United States. Approximately 86,700 people were employed in furniture manufacturing in North Carolina as of April 1989 (2). Most of these employees are exposed to wood products and/or wood dust.

Logging and Lumber Manufacturing

Employees in North Carolina cut and saw a variety of timber. Approximately 36,500 people are employed in this manufacture (2).

Construction

The construction of residential and commercial buildings involves the sawing and handling of wood. Carpenters and cabinetmakers are also frequently exposed to wood dust.

Paper Manufacturing

North Carolina has a number of large paper mills, employing approximately 21,500 people (2). Large logs are brought to the mill where they are converted to chips for making paper.

Home Hobbies

Almost everyone at sometime has sawed or used wood for various home projects. A variety of tools, including drills and saws, are used at home on wood. Most of these activities do not expose people to wood dust on a steady basis, nor do OSHA standards apply to the home.

How Do We Measure Wood Dust in Air?

Air measurements are required to determine the extent of occupational wood dust exposure. Air measurements are made by specially trained personnel, such as industrial hygienists. To make the measurements, a personal sampling pump (suction pump) is placed upon the worker whose exposure is being monitored or in the workroom. At the end of the suction pump is a pre-weighted filter, which catches dust particles sucked onto it by the pump. By knowing how fast the air is pumped and the length of time for pumping, we can measure the amount of air that is sucked through the filter. The filter is reweighed after the suction, and by calculating the increase in weight of the filter, one is able to determine how much wood dust is in the air.

The OSHA standard of 5 mg/m³ means that no more than 5 milligrams of dust may be present in a cubic meter of air. (The standard is a time-weighted average for an 8-hour work shift, which accounts for fluctuations above and below the 5 mg/m³ limit.) A cubic meter of air is the amount of air that would be present in a box that measured 1 meter on each of its sides. (A meter is approximately 3.37 inches longer than 1 yard.) Another way to think about a cubic meter of air is that it is about twice the inside volume of a typical home refrigerator or about 25 times the inside volume of an average microwave oven.

Five milligrams is the weight of 25 grains of salt. If wood dust were salt, 5 mg/m³ would be the equivalent of one grain of salt in a microwave oven or 12 to 13 grains of salt in an average size refrigerator.
OSHA’s Definition of a Hazardous Chemical

OSHA’s hazard-communication standard, 1910.1200, defines a hazardous chemical as “any element, chemical compound, or mixture that is a physical hazard or a health hazard.”

Chemicals That Are Physical Hazards

Chemicals that are physical hazards are unstable and, when handled improperly, can cause fires or explosions. A chemical that is a physical hazard has one of the following characteristics:

- It is a combustible liquid.
- It is a compressed gas.
- It is explosive.
- It is flammable.
- It is water-reactive.
- It starts or promotes combustion in other materials.
- It can ignite spontaneously in air.

Chemicals That Are Health Hazards

Chemicals that are health hazards can damage an exposed person’s tissue, vital organs or internal systems. Generally, the higher the chemical’s toxicity, the lower the amount or dose necessary for it to have harmful effects. The effects vary from person to person, ranging from temporary discomfort to permanent damage, depending on the dose, the toxicity and the duration of exposure to the chemical. Health effects range from short-duration symptoms that often appear immediately (acute effects) to persistent symptoms that usually appear after longer exposures (chronic effects). Health effects can be classified by how they affect tissue, vital organs or internal systems:

- Agents that damage the lungs, skin, eyes or mucous membranes.
- Carcinogens cause cancer.
- Corrosives damage living tissue.
- Hematopoietic agents affect the blood system.
- Hepatotoxins cause liver damage.
- Irritants cause inflammation of living tissue.
- Nephrotoxins damage cells or tissues of the kidneys.
- Neurotoxins damage tissues of the nervous system.
- Reproductive toxins damage reproductive systems, endocrine systems or a developing fetus.
- Sensitizers cause allergic reactions.

The U.S. Department of Transportation is responsible for determining what constitutes a flammable material and has offered the following definitions for ignitable materials:

- **Combustible Liquid**—Any liquid having a flash point above 100°F and below 200°F.
- **Flammable Liquid**—Any liquid having a flash point below 100°F.
- **Flammable Gas**—A compressed gas that satisfies the criteria for flame projection, lower flammability limit and flammability range.
- **Flammable Solid**—A non-explosive material that is capable of producing fire as a result of friction, heat retained from production or which, if ignited, produces a serious transportation hazard.

These definitions are based on the flammability characteristics of the material, specifically the flash point. **Flash point** is the minimum temperature at which a liquid gives off vapor in sufficient concentrations to allow the substance to ignite.

The National Fire Protection Association has further broken flammable and combustible materials into storage categories based on the flash point of the material. The result is that ignitable materials are subdivided into three categories of flammable materials and two categories of combustible materials.
A single MSDS may be used for similar mixtures with essentially the same hazards and contents. This is very common with laboratory chemical mixtures. Copies of MSDSs must be readily accessible during work hours. When purchasing any hazardous materials, such as paints, solvents, pesticides, etching agents, through local vendors, request an MSDS as necessary.

### Hazard Communication Standard, Reference 1910.1200

Paragraph (g)(2)(vii) of the Hazard Communication Standard requires that the carcinogenicity of hazardous chemicals be identified or reflected on the MSDS for that product. Under paragraph (g)(2)(vii), if a chemical has been identified on either the National Toxicology Program (NTP)—Annual Report on Carcinogens (latest edition), the International Agency for Research on Cancer (IARC) Monographs (latest editions), or by the Occupational Safety and Health Administration (OSHA) as a carcinogen, it must be identified on the MSDS within three months.

The IARC Monograph on Wood Dust (Volume 25, 1995; pages 35–215) has identified hardwood dust as a Group 1 carcinogen. The 1995 Monograph found a clear association between adenocarcinoma of the nasal cavities and paranasal sinuses and occupational exposure to hardwood dust. The report also indicated that there were too few studies to sufficiently evaluate the cancer risk attributable to the workplace exposure to softwood species. In the few studies that have been completed, the risk of cancer from exposure to soft woods appears to be elevated; however, there is not enough evidence to make a final determination.

Consequently, the MSDS for hardwood species and those sheets for mixed species of hardwoods and soft woods must be identified as a carcinogen as required under 29 CFR 1910.1200(g)(2)(vii). MSDSs for softwood species (not mixed with hardwoods) do not have to be identified as being carcinogenic.

Retail distributors express concern over the burden associated with providing MSDSs for wood products to customers. Their responsibilities as a retail distributor under the amended Hazard Communication Standard (HCS) are limited. Specifically, section 1910.1200(g)(7)(iii) requires a retail distributor to post a sign or otherwise inform their customers that MSDSs are available and to provide an MSDS to a customer only upon request. Under the standard, a distributor is not obligated to provide a copy of the MSDS to each customer unless requested by the customer to do so.

The amendments to the standard with respect to wood products reflect a clarification of the original intent in OSHA’s standard. The amended standard does not impose new or additional requirements. Wood and wood products are still exempted from the Hazard Communication Standard if the only hazard presented from use of the product is flammability or combustibility. These hazards are well-known among users of wood products. However, it may not be generally known among users that inhalation of certain types of wood dust or chemicals used to treat wood can present a serious lung disease hazard. For this reason, OSHA has always required under the Hazard Communication Standard that distributors of wood products provide MSDSs to employers whose employees may be exposed to these inhalation hazards.

### Air Contaminants, Reference 1910.1000 (North Carolina State-Specific Requirements)

An employee’s exposure to any substance listed in Tables Z-1, Z-2, or Z-3 of this section shall be limited in accordance with the requirements of the following paragraphs of this section.

(a) Table Z-1.

(1) Substances with limits preceded by “C”—Ceiling Values. An employee’s exposure to any substance in Table Z-1, the exposure limit of which is preceded by a “C,” shall at no time exceed the exposure limit given for that substance. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute time weighted average exposure which shall not be exceeded at any time during the working day.
(2) Other substances—8-hour Time Weighted Averages. An employee’s exposure to any substance in Table Z-1, the exposure limit of which is not preceded by a “C,” shall not exceed the 8-hour Time Weighted Average given for that substance any 8-hour work shift of a 40-hour work week.

The following example is extracted from Table Z-1 to illustrate the requirement for wood dust established by NCDOL:

\[ \text{Source: 13 NCAC 07F.0101; http://www.nclabor.com/title13.pdf} \]
The Health Effects of Wood Dust

Anyone who has sawed a board has been exposed to wood dust. We do not generally think of this as harmful, and in fact, large numbers of people are exposed to substantial amounts of wood dust without any apparent health concerns. However, a number of health problems have been linked to exposure to wood and wood dust. Some of the health problems appear to be associated with certain types of woods or certain manufacturing processes. It is helpful to be aware of these potential health hazards. The health effects that have been reported most often are skin rash (dermatitis), eye and respiratory irritation, allergic respiratory problems (asthma and hay fever like symptom), nasal cancer, and possibly some other types of cancer.

Skin Rash (Dermatitis)

For many years, it has been known that skin rash or dermatitis can result from contact with some woods and their dusts. Wood and wood dust can cause skin rash in several ways.

Mechanical Irritation

Splinters or tiny particles of wood can get under the skin and cause painful irritation and in some cases infection. If this happens in many places on the skin, multiple areas of irritation, soreness or infection may result and cause a skin rash. Nicks and abrasions can also cause irritation. Harsh soaps, chemicals and further rubbing can cause additional irritation and skin rash. Particles can get between the folds of the skin, for example, at the skin crease at the elbow and sweat and rubbing can result in inflammation.

The following measures can protect the woodworker from skin rash from mechanical irritation:

- Promptly remove any embedded splinters.
- Protect exposed areas of the skin from abrasion or scraping. In some cases, gloves or long sleeves maybe needed for protection.
- Frequently wash the skin with mild soap and water to keep skin free from particles and dirt. Never use chemical solvents or harsh, abrasive soaps to clean the skin.
- Promptly report any skin rash to your supervisor, company nurse or company doctor.

Irritant Chemicals

Some woods may contain irritant chemicals that can cause dermatitis. Most of these chemicals are in the sap, bark or cracks in the wood. These chemicals are mostly on the outer part of the tree around the bark area, therefore, they are more likely to cause skin problems to forest workers or those working around unprocessed logs (3). Most of the woods containing these strong irritant chemicals are not North American species. Teak is an example of a foreign wood that can cause dermatitis. Symptoms of this type of dermatitis will result in redness and blistering, sometimes with open sores. The eyes may also become irritated.

Similar dermatitis appears to be experienced infrequently by those who work with North American species. However, those working with exotic foreign species, such as teak, mansonina and radiata pine, should be alert to the possible hazard.

The measures outlined above for mechanical irritation should be used to protect against this type of chemical irritant dermatitis.

Sensitization From Wood (Versus Irritation)

Not everyone acquires a skin rash from poison ivy. Those who do have become sensitized, or allergic, to it. One will not become sensitized on the first exposure, but only after additional exposures while the body develops an allergy to the plant. Once one does become sensitized, even very small amounts of poison ivy can cause dermatitis to occur. Some have developed skin rash after merely touching an animal or some other object that has been in contact with poison ivy.

In contrast to allergic sensitization, strong irritant chemicals such as acids or alkalis will cause any exposed skin to be irritated and generally cause it within a very short period of exposure. Dermatitis can result from this irritation, especially if exposure is frequent and if harsh soaps or solvents are also used.
Some woods can cause allergic sensitization. Again, most of these are foreign woods such as teak and African mahogany. Researchers have reported that up to 1 percent of workers can develop skin sensitization to sawdust of native American woods (4). Some of the North American woods that have been associated with dermatitis due to sensitization are Douglas fir, Western red cedar and poplar.

In contrast to irritant chemicals, the sensitizing chemicals are usually in the core or deep in the wood. Therefore, workers who are sawing or cutting the wood are more likely to be affected. Once a worker becomes sensitized to a particular wood, he or she may have difficulty working with that wood again.

To protect against dermatitis from sensitization, the measures described above for mechanical irritation should be observed. However, sensitization is more difficult to diagnose. It is important to identify the specific wood causing the problem so that woodworkers can avoid or protect against it. That way, it will not be necessary to avoid all types of wood. A physician experienced with this type of problem may perform a patch test to determine if there is sensitization. Small amounts of finely ground sawdust from suspected woods are placed on tape patches and left on the skin for approximately 48 hours. The wood to which the person is sensitized will usually cause a rash under the patch, while other types of wood will not.

**Dermatitis Associated With Chemicals on Wood**

Wood products such as particleboard, fiberboard and plywood have chemical resins, usually phenol-formaldehyde or urea-formaldehyde, as part of their binders. Formaldehyde can cause skin sensitization. Usually formaldehyde is not present in free form to any great extent in the resin. Pentachlorophenol, creosote, chromium, copper and arsenic are chemicals used as wood preservatives that can potentially produce irritation and/or sensitization. Tables 1 and 2 present a list of particular chemicals and adhesives that may be used in or with woods.

**Dermatitis Due to Other Living Organisms Not Part of Wood**

Since trees are plants, as they grow they can contact many living organisms. These may be other plants, such as poison ivy or plants that grow upon the bark of the tree, such as different types of fungi. In addition to plants, insects such as caterpillars can get on the wood and can be irritating and sometimes cause dermatitis. Table 3 lists woods that can cause dermatitis.

**Respiratory Problems**

Respiratory problems from exposure to wood dust may be due to irritation or to allergy. The preceding differentiation between irritation and allergy with regard to dermatitis also applies to respiratory problems. If one breathes the vapor of a strong chemical such as ammonia, irritation of the nose and perhaps coughing and sneezing will be experienced. In contrast, consider that some individuals develop hay fever or seasonal asthma from exposure to pollen such as ragweed in the fall of the year. (Though a majority are not similarly affected.) This is allergy. As with the skin problems previously discussed, it takes time to develop an allergy, usually several exposures.

**Irritant Effects of Wood Dust on the Eyes and Respiratory Tract**

Wood dust consists of very fine particles. Any particle, since it is a foreign material, can cause irritation to the eyes and mucous membranes. If the particle does not have any inherently irritating properties, it is called inert. Most domestic species of wood dust have some irritating qualities. For example, wood dust has been found to be almost four times as irritating as plastic dust in the same concentration (5). However, there is wide variation in the irritating nature of various types of wood dust. Some of the foreign species are quite irritating and account for many of the respiratory irritant phenomena described by medical literature.

Nasal irritation may appear as continued colds, nose bleeds, sneezing and sinus inflammation. These conditions are common in the general population, and determining whether they are caused by wood dust requires careful medical examination and evaluation. Similarly, the eyes maybe irritated, resulting in redness and tearing. Large particles of wood dust are foreign bodies that may necessitate removal.
Table 1

Partial List of Active Fungicidal and Insecticidal Products Used Alone or in Commercial Wood Preservatives*

<table>
<thead>
<tr>
<th>Compound</th>
<th>Purpose</th>
<th>Mode of Application</th>
</tr>
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<tbody>
<tr>
<td>Arsenicals (alone or mixed)</td>
<td>insecticides</td>
<td>low-pressure injection, osmosis, by pressure</td>
</tr>
<tr>
<td>Borates, polyborates, boric acid (alone or mixed)</td>
<td>fungicides, insecticides, flame retardants</td>
<td>soaking, low-pressure injection, by pressure</td>
</tr>
<tr>
<td>Alkaline chromates and dichromates (alone or mixed)</td>
<td>fungicide, insecticide</td>
<td>soaking, low-pressure injection, by pressure</td>
</tr>
<tr>
<td>Copper sulphate</td>
<td>insecticide</td>
<td>low-pressure injection</td>
</tr>
<tr>
<td>Alkali fluorides, complex fluorides, fluorosilicates (alone or mixed)</td>
<td>insecticide</td>
<td>by brush, spraying, soaking</td>
</tr>
<tr>
<td>Mercury dichloride</td>
<td>fungicide, insecticide</td>
<td>soaking</td>
</tr>
<tr>
<td>Chlorinated cresols</td>
<td>fungicide</td>
<td>by brush, spraying, soaking</td>
</tr>
<tr>
<td>Dinitrophenols (in mixtures)</td>
<td>fungicide</td>
<td>by brush, spraying, soaking, injection under pressure</td>
</tr>
<tr>
<td>Alkali pentachlorophenate s</td>
<td>fungicide, insecticide</td>
<td>by brush, spraying, soaking</td>
</tr>
<tr>
<td>Alkali phosphates (alone or mixed)</td>
<td>fungicide, insecticide, flame retardant</td>
<td>by brush, spraying, soaking</td>
</tr>
<tr>
<td>Zinc chloride</td>
<td>fungicide, insecticide</td>
<td>by brush, spraying, soaking</td>
</tr>
<tr>
<td>Aldrin (in mixtures)</td>
<td>insecticide</td>
<td>by brush, spraying, soaking, under pressure, in retorts</td>
</tr>
<tr>
<td>Phenol</td>
<td>fungicide, insecticide</td>
<td>by brush, soaking</td>
</tr>
<tr>
<td>Chlorobenzones (in mixtures)</td>
<td>insecticide</td>
<td>by brush, soaking, under pressure, in retorts</td>
</tr>
<tr>
<td>Creosote (from coal tar)</td>
<td>fungicide</td>
<td>by brush, soaking, injection under pressure, in retorts</td>
</tr>
<tr>
<td>DDT (in mixtures)</td>
<td>insecticide</td>
<td>by brush, spraying, soaking</td>
</tr>
<tr>
<td>Dieldrin (in mixtures)</td>
<td>insecticide</td>
<td>by brush, spraying, soaking</td>
</tr>
<tr>
<td>Hexachlorocyclohexane or lindane (in mixtures)</td>
<td>insecticide</td>
<td>by brush, spraying, soaking, injection under pressure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Glue</th>
<th>Composition</th>
<th>Mode of Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium silicate</td>
<td>dry matter: sodium silicate; solvent: water</td>
<td>cold, in aqueous solution</td>
</tr>
<tr>
<td>Amylased glue</td>
<td>dry matter: starch foodstuffs (manioc, potatoes, etc.), flours (wheat, maize, bean, vetch, etc.); solvent: water; bactericide: chlorocresol; fluidifier: sodium hydroxide</td>
<td>cold, in aqueous solution</td>
</tr>
<tr>
<td>Vegetable glues</td>
<td>dry matter: soya flour; solvent: water; adjuvants: sodium hydroxide, lime, sodium silicate; antiseptics: pentachlorophenol, orthophenylphenol</td>
<td>hot or cold, in aqueous solution</td>
</tr>
<tr>
<td>Gelatine glues</td>
<td>dry matter: gelatine; solvent: water; bactericides: sodium trichlorophenates, formaldehyde; adjuvants: tannins, aluminum sulfate, alkali dichromates</td>
<td>cold, in aqueous solution</td>
</tr>
<tr>
<td>Blood glues</td>
<td>dry matter: powdered blood; solvent: water; solubilizer: lime, sodium or ammonium hydroxide; bactericide: formaldehyde</td>
<td>hot or cold, in aqueous solution</td>
</tr>
<tr>
<td>Fish glues</td>
<td>dry matter: fish gelatine; solvent: water</td>
<td>cold, in aqueous solution</td>
</tr>
<tr>
<td>Casein glues</td>
<td>dry matter: milk casein; solvent: water; solubilizer: lime or sodium hydroxide; bactericide: formaldehyde; adjuvants: copper chloride, sodium fluoride, sodium silicate; retarders: alkali fluorides</td>
<td>hot or cold, in aqueous solution</td>
</tr>
<tr>
<td>Urea-formaldehyde</td>
<td>dry matter: urea and formaldehyde resins, partially condensed; solvent: water; fillers: leguminous or cereal flours, casein, lime sulfate, colloid clay, diatomite, etc.; hardeners: hydrochloric acid, phosphoric acid, ammonia</td>
<td>hot or cold, in aqueous solution</td>
</tr>
<tr>
<td>Melamine-formaldehyde</td>
<td>dry matter: melamine and formaldehyde resins, partially condensed; solvent: water; fillers: bean, soya, rye flours, starch, kaolin, gypsum, asbestos, barium sulfate; hardeners: salts of ammonia, organic acids (acetic acid)</td>
<td>hot or cold, in aqueous solution</td>
</tr>
<tr>
<td>Resorcinol-formaldehyde</td>
<td>dry matter: resorcinol and formaldehyde resins, partially condensed; solvents: water, alcohol; fillers: phenolic resins, flours; hardeners: formaldehyde, paraformaldehyde; catalyst: formaldehyde</td>
<td>hot or cold, in aqueous solution</td>
</tr>
<tr>
<td>Vinylic glues</td>
<td>dry matter: polyvinyl acetate and butyrate; solvent: water</td>
<td>cold, in aqueous emulsion</td>
</tr>
<tr>
<td>Cellulose glues</td>
<td>dry matter: cellulose acetate; solvents: amyl acetate, ethyl acetate, etc.</td>
<td>cold, in organic solvents</td>
</tr>
<tr>
<td>Chlorinated rubber glues</td>
<td>dry matter: chlorinated rubber; solvents: toluene, xylene, etc.; softening agents: chloronaphthalenes</td>
<td>cold, in organic solvents</td>
</tr>
<tr>
<td>Neoprene glues</td>
<td>dry matter: neoprene; solvents: toluene, xylene, acetone, methyl ethyl ketone, cyclohexanone, dichloromethane, methanol, ethanol, etc.</td>
<td>cold, in organic solvents</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>dry matter: phenolic and formaldehyde resins, partially condensed; solvents: water, methanol; fillers: wood flour, nutshell flour, crushed bark, blood albumin; hardeners: acids or bases</td>
<td>hot or cold water, alcohol or aqueous alcohol solution</td>
</tr>
<tr>
<td>Formol cresol</td>
<td>dry matter: cresol and formaldehyde resins, partially condensed; solvents: water, methanol, ethanol; fillers: wood flour, nutshell flour, crushed bark, blood albumin; hardeners: acids or bases</td>
<td>hot or cold water, alcohol or aqueous alcohol solution</td>
</tr>
</tbody>
</table>

## Table 3

**Woods Causing Dermatitis***

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Common Name**</th>
<th>Botanical Name</th>
<th>Common Name**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apocynaceae</td>
<td></td>
<td>Meliaceae</td>
<td></td>
</tr>
<tr>
<td><em>Apocynosperma</em></td>
<td><em>Peroba rosa</em></td>
<td><em>Guarea thompsonii</em></td>
<td></td>
</tr>
<tr>
<td><em>Aldus spp.</em></td>
<td><em>Alder</em></td>
<td><em>Khaya anthotheca</em></td>
<td></td>
</tr>
<tr>
<td>Bignoniaceae</td>
<td></td>
<td><em>Moraceae</em></td>
<td></td>
</tr>
<tr>
<td><em>Peratecoma peroba</em></td>
<td></td>
<td><em>Chlorophora excelsa</em></td>
<td></td>
</tr>
<tr>
<td>Tabebuia spp.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burseraceae</td>
<td></td>
<td><em>Pinaceae</em></td>
<td></td>
</tr>
<tr>
<td><em>Aucommea klaineana</em></td>
<td></td>
<td><em>Abies spp.</em></td>
<td></td>
</tr>
<tr>
<td>Hernandiaceae</td>
<td></td>
<td><em>Juniperus virginiana</em></td>
<td></td>
</tr>
<tr>
<td><em>Hernandia sonora</em></td>
<td></td>
<td><em>Libocedrus decurrens</em></td>
<td></td>
</tr>
<tr>
<td>Lauraceae</td>
<td></td>
<td><em>Picea spp.</em></td>
<td></td>
</tr>
<tr>
<td><em>Nectandra rodiae</em></td>
<td></td>
<td><em>Pinus spp.</em></td>
<td></td>
</tr>
<tr>
<td>Phoebe porosa</td>
<td></td>
<td><em>Pseudotsuga menziesii</em></td>
<td></td>
</tr>
<tr>
<td>Ocotea spp.</td>
<td></td>
<td><em>Thuja occidentalis</em></td>
<td></td>
</tr>
<tr>
<td>Leguminosae</td>
<td></td>
<td><em>Thuja plicata</em></td>
<td></td>
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<tr>
<td><em>Andira inermis</em></td>
<td></td>
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</tr>
<tr>
<td><em>Brya ebenus</em></td>
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<tr>
<td><em>Cassia simame</em></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dalbergia cearensis</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dalbergia grandadillo</td>
<td></td>
<td></td>
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<tr>
<td>Dalbergia latifolia</td>
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<td></td>
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<tr>
<td>Dalbergia melanoxylon</td>
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<td></td>
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<tr>
<td><em>Dalberbia nigra</em></td>
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<tr>
<td>Dalbergia retusa</td>
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<td></td>
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</tr>
<tr>
<td>Dalbergia stevensonii</td>
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<tr>
<td><em>Distemonanthus</em></td>
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<tr>
<td><em>benthamianus</em></td>
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<td></td>
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<tr>
<td><em>Gossweilerodendron</em></td>
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<td></td>
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<tr>
<td><em>balsamiferum</em></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><em>Prosopis julifora</em>**</td>
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<td></td>
</tr>
<tr>
<td><em>Machaerium scleroxylon</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meliaceae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Guarea thompsonii</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Khaya anthotheca</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moraceae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Chlorophora excelsa</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pinaceae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Abies spp.</em>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Juniperus virginiana</em>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Libocedrus decurrens</em>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Picea spp.</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pinus spp.</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pseudotsuga menziesii</em>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Thuja occidentalis</em>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Thuja plicata</em>**</td>
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<td></td>
</tr>
<tr>
<td><em>Tsuga spp.</em></td>
<td></td>
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<tr>
<td>Rutaceae</td>
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<tr>
<td><em>Chloroxylon swietenia</em></td>
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</tr>
<tr>
<td><em>Fagara flavum</em> (Zanthoxylum) flavum</td>
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</tr>
<tr>
<td><em>Fagara macrophylla</em></td>
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<tr>
<td>Sapotaceae</td>
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<tr>
<td><em>Bassia latifolia</em></td>
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<tr>
<td><em>Mimusops heckelii</em></td>
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<tr>
<td>Taxaceae</td>
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<tr>
<td><em>Taxus baccata</em></td>
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<td>Triplochitonaceae</td>
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<tr>
<td><em>Mansonia altissima</em></td>
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<tr>
<td>Ulmaceae</td>
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<tr>
<td><em>Ulmus spp.</em>**</td>
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<tr>
<td>Verbenaceae</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><em>Tectona grandis</em></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Adapted from McCord (1958), Fregert and Hjorth (1968), and Gamble (1979).


**There is no accepted international nomenclature.

***North American species.

### Mucous Flow in the Nose

Our nose protects our lungs from inhaling large particles of dust. The nose secretes mucous, which helps catch wood particles and acts as a cleansing agent. A runny nose from a cold or from having breathed irritating materials is the body’s attempt to cleanse itself. The mucous runs backwards in the nose toward the throat and provides a means for particles to be expelled or swallowed. In some situations, workers exposed to wood dust have been noted to experience a slowing of this mucous flow. This creates the potential to make individuals more susceptible to infection and other problems.
The above effects are dependent upon the type of wood and the quantity of dust in the air. The government cannot set a different standard for every type of wood, so standards are set upon the basis of average domestic woods. Most cases of significant irritation have occurred where exposures are above the present standard of 5 mg/m³ of air. OSHA has stated that some of these symptoms have occurred at exposure levels as low as 2 mg/m³. Health evidence, however, clearly indicates that exposure to wood dust poses a significant risk at 10 mg/m³ and that establishing a permissible exposure limit of 5 mg/m³ will substantially reduce the risk.

**Respiratory Allergy Problems**

A number of types of wood dust are capable of causing respiratory allergy problems. Just as with skin problems, these allergies can be caused by chemicals in the wood dust itself or by organisms that grow on the wood. Allergy symptoms are similar to hay fever, including nasal irritation, excessive runny nose, sneezing, and congested or stuffed-up nose.

Asthma is a more serious problem that can develop from wood dust allergies. Asthma is a condition characterized by coughing, wheezing, and shortness of breath that will improve quickly on its own or with medication. Asthma is caused by a spasm of the muscle surrounding the bronchial tubes and swelling and mucous secretions of the mucous membrane lining of the bronchial tubes. One can think of asthma as similar to a stuffy, runny nose, but in the bronchial tubes.

**Allergies Due to Wood Dust**

The domestic wood most frequently associated with respiratory tract allergy problems is Western red cedar (WRC). This wood is grown in the northwestern U.S. and western Canada. The effects of this wood have been carefully studied (6-17). The higher the exposure levels of WRC dust, the greater the number of workers having asthma. In one study (6), 5 to 24 percent of those working with WRC had asthma. It generally takes from weeks to a number of years of exposure to develop symptoms. Often at first there may be just nasal irritation, sneezing, coughing and then wheezing. Symptoms may tend to be worse at night, and relief occurs over the weekend. However, with continued exposure, signs such as fits of coughing and wheezing become progressively worse, occurring in the afternoon or evening and, in some cases, immediately after exposure. If exposure continues, symptoms continue during weekends so that they resemble chronic asthma or bronchitis. Though asthma tends to improve after exposure has ceased, some individuals will continue to have asthma for indefinite periods.

Because of the tendency to develop allergy problems with Western red cedar, OSHA has set for it the different standard of 2.5 mg/m³ of air, which is one-half the standard for other wood dusts.

Other wood dusts have been associated with respiratory allergy, including oak, redwood, spruce, fir and pine, but allergies from such woods appear to be much rarer and are only occasionally reported in medical literature. A number of foreign species, such as African zebra wood, mahogany, teak and African maple have been associated with respiratory allergy.

**Allergies Due to Molds and Fungi Growing on Wood**

There are a number of molds and fungi that can grow on wood, especially around the bark. These can cause respiratory allergy problems and may result in asthma or other respiratory conditions. Exposure commonly produces inflammation in the lungs and may be accompanied by an achy feeling, sweating, chills, fever, tightness in the chest and shortness of breath. These conditions have been described as maple bark disease, from working with maple bark; wood pulp workers disease; sequoiosis caused by inhalation of redwood; and suberosis from inhalation of cork. Table 4 lists woods known to cause respiratory allergy reactions.
Table 4

*Woods Causing Respiratory Allergy Reactions As Demonstrated by Skin or Bronchial Provocation Tests*

**Native American Species**
- Redwood (*Sequoia sempervirens*) (10, 18)
- Western red cedar (*Thuja plicata*) (19, 20, 21)
- Oak (Species *unk*) (22)

**Non-Native Species**
- Abachi or Obeche (*Triplochiton scleroxylon*) (23)
- Abiruana (*Pouteria* sp) (24)
- Boxwood (*Buxus sempervirens*) (25)
- Cedar of Lebanon (*Cedra libani*) (26)
- Cocobolo (*Dalbergia retusa*) (27)
- Iroko or Kamballa (*Chlosophora excelsa*) (20, 28)
- Keajaat or Muninga (*Pterocarpus anagolensis*) (19)
- Limba (*Terminalia superba*) (23)
- Mahogany (22)
- Mansonia (*Mansonia altissima*) (29)
- Mulberry (*Morus* sp)* (30)
- Pine (Species *unk*)* (31)
- Ramin (*Gonystylus bancanu*) (32)
- Teak (*Tectona grandis*) (23, 28)
- Ukola (*Dumoria africana*) (33)
- Zebrseud (*Microberlinia* sp) (34)
  (*Tanganyeka aningre*) (35)

*Note 1—Numerous other species have been reported to cause respiratory sensitization without confirmation testing. These include orangewood (*Citrus aurantium*) and nara (*Pterocarpus indicus*).*

*Note 2—Species shown with asterisk (*) may have native American counterparts.*

**Other Lung Diseases**

Whether wood dust causes lung disease other than those listed above is still being studied. Certainly high levels of small dust particles that penetrate into the bronchial tubes or smaller airways of the lungs might produce irritation and bronchitis. Whether these produce any permanent changes is not currently known. Some studies report permanent changes (36-38), while others have been unable to find them (39).

**Nasal Cancer**

Nasal cancer is a very rare disease. A particularly rare type of nasal cancer is called adenocarcinoma. In the 1960s in the English furniture industry a much larger number of people than expected were getting this type of cancer. Though the cause was unknown, wood dust was the suspected cause (40-44). Since, the phenomenon has also been identified in France (45), Australia (46), Finland (47), Italy (48, 49), Holland (50), and Denmark (51).

In the United States, several studies relevant to the issue have been conducted (52-55). Some have shown that workers in woodworking industries do experience more of this rare type of nasal cancer, though the problem is not nearly that noted in England. In addition, studies in the United States generally have not revealed any overall excess of nasal cancer in furniture workers, when an types of cancer are considered. “OSHA agrees ... that the incidence of nasal cancer seen in the United States is substantially lower than that seen in other countries, particularly in Great Britain. However, the agency does not agree that excesses in nasal cancers and particularly in adenocarcinomas have not been observed in American woodworkers. (1)
In England, the incidence of nasal cancer among furniture workers seems to have diminished since World War II. In the United States, especially in North Carolina, the furniture industry has grown from 182 employees working in six factories in 1890 to almost 87,000 workers in 1989. However, at the time this guide was published, there was no evidence of increasing mortality from nasal cancer among North Carolina furniture workers. Table 5 depicts the rise in employment in the furniture industry in North Carolina.

Table 5

<table>
<thead>
<tr>
<th>Year</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1919</td>
<td>8,667</td>
</tr>
<tr>
<td>1927</td>
<td>15,652</td>
</tr>
<tr>
<td>1929</td>
<td>16,648</td>
</tr>
<tr>
<td>1939</td>
<td>18,388</td>
</tr>
<tr>
<td>1947</td>
<td>27,858</td>
</tr>
<tr>
<td>1954</td>
<td>29,807</td>
</tr>
<tr>
<td>1963</td>
<td>48,000</td>
</tr>
<tr>
<td>1967</td>
<td>58,500</td>
</tr>
<tr>
<td>1972</td>
<td>70,300</td>
</tr>
<tr>
<td>1977</td>
<td>78,900</td>
</tr>
<tr>
<td>1989</td>
<td>86,700</td>
</tr>
</tbody>
</table>

*Data from U.S. Department of Commerce, Bureau of Census, Census of Manufacturers, and N.C. Security Commission

No one is sure why the risk of nasal cancer appears to be less in the United States and also less in England since World War II. Different types of manufacturing processes, different species of wood, or different sizes of the particles of dust may be responsible.

Other Types of Cancer

Some have expressed concern about other types of cancers, including lung cancer, that may be associated with exposure to wood dust. Few studies have shown any conclusive evidence that lung cancer is associated with wood dust exposure. According to OSHA, “the association between lung cancer and occupational wood dust exposure is inconclusive, although several epidemiological studies have reported increases in lung cancer among wood dust exposed workers.” (1) OSHA also points out, however, “Smoking may have been a confounding factor in these results.” (1)

An increased incidence of another type of cancer, Hodgkin’s disease, has been observed among some types of woodworkers; however, many believe that this is due to other chemicals or factors other than wood itself. OSHA has stated that, “although the data are conflicting, several ... studies of U.S. workers do report increases in the incidence of Hodgkin’s disease among woodworkers. This excess is particularly apparent among carpenters.” (1)
Safe Work Practices and Medical Alerts

Work Practices

Local exhaust ventilation and good work practices are important means of controlling wood dust exposure and protecting against health hazards from it. Many factories are already using good local exhaust ventilation. In a typical furniture factory, dust control is essential to worker health and a quality product as well.

Good practices for work involving wood dust include the following:

1. Avoid unnecessary breathing of dust. If certain operations are especially dusty, a dust respirator should be used. (When a dust respirator is used, all provisions of the respirator standard (29 CFR 1910.134) must be met.)
2. Good personal hygiene is important to avoid skin problems. Wash frequently with a mild non-irritating soap. Use gloves where skin abrasion or splinters are likely. In some cases, long sleeves should be worn.
3. Avoid unnecessary blowing or stirring of dust during cleaning operations. Vacuum or suction collection devices are always preferable to blowing.
4. Keep cutting tools sharp and in good repair so as to avoid excess friction and burning of the wood.
5. Know the chemicals in your workplace. Under the Hazard Communication Standard, workers must be provided with material safety data sheets for hazardous chemicals and must receive training on chemical hazards and safeguards.

Wood dust (a byproduct rather than a product of wood) is not exempt from the Hazard Communication Standard, as are wood and wood products. Wood dust is considered a hazardous chemical subject to the standard and requires material data safety sheets and employee training. (See 52 Federal Register 31863, Aug. 24, 1987.)
6. Know the species of wood with which you are working. If it is an allergenic, for example, Western red cedar, be especially alert for possible allergenic problems.

Medical Alert

1. Report any skin rashes promptly and seek medical attention if they persist.
2. Report any signs of allergy, hay fever or asthma. These symptoms may be caused by a variety of things in the home, environment or workplace, and qualified medical opinion is necessary to differentiate the potential source and cause.

Exposure Limits and Related Terms

ACGIH (American Conference of Governmental Industrial Hygienists)
- Publishes TLVs for chemical and physical agents
- TWA, STEL, C
- Not an official government agency
- Membership limited to government agencies or educational institutions

TLV (Threshold Limit Value)
- Airborne concentrations of substances to which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect
- Guidelines published by ACGIH

PEL (Permissible Exposure Limit)
- OSHA’s legally allowed concentrations in the workplace
REL (Recommended Exposure Limit)
- NIOSH recommended exposure limits for hazardous substances or conditions in the workplace
- Published and transmitted to OSHA and MSHA for use in promulgating legal standards

WEEL (Workplace Environmental Exposure Level)
- Published by the American Industrial Hygiene Association (AIHA)
- Guidelines that represent workplace exposure levels to which it is believed nearly all individuals could be exposed repeatedly without experiencing adverse health effects

TWA (Time Weighted Average)
- Airborne concentrations of substances averaged with regard to their duration
  \[
  \text{TWA} = \frac{C_1 T_1 + C_2 T_2 + \ldots + C_n T_n}{T_1 + T_2 + \ldots + T_n}
  \]
  Where: \( C = \text{Concentration} \) \( T = \text{Time} \)

**TWA Example**
- An air contaminant has a PEL of 100 ppm
- 3 air samples are collected:
  - Sample 1—4 hours/175 ppm
  - Sample 2—3 hours/60 ppm
  - Sample 3—1 hour/100 ppm

\[
8 \text{ hr TWA} = \frac{(175 \text{ ppm} \times 4 \text{ hrs}) + (60 \text{ ppm} \times 3 \text{ hrs}) + (100 \text{ ppm} \times 1 \text{ hr})}{8 \text{ hours}}
\]
8 hr TWA = 120 ppm

STEL (Short Term Exposure Limit)
- A 15-minute TWA exposure that should not be exceeded at any time
- Usually supplements 8-hour TWA limit where there are acute effects from a substance with primarily chronic effects

C (Ceiling)
- Limit given to a substance that is relatively fast acting
- An airborne concentration that is never to be exceeded

P (Peak)
- Refers to acceptable maximum concentrations above acceptable ceiling concentrations for an 8-hour shift
- Never to be exceeded
- Found in 29 CFR 1910.1000, Table Z-2

**Acute toxicity:** The LD50 (Lethal dose for 50 percent of a test population, all exposure routes except inhalation) or LC50 (Lethal concentration for 50 percent of a test population by inhalation) describe how much material is immediately dangerous to life and health (IDLH). This number is not to be confused with permissible exposure limits (PELs) or threshold limit values (TLVs) discussed in earlier section.

**Identification Systems**

National Fire Protection Association 704 System (NFPA 704), What the Diamond Code Means:

The National Fire Protection Association (NFPA) has developed a color-coded system called NFPA 704. The system uses a color coded diamond with four quadrants in which numbers are used in the upper three quadrants to signal the degree of emergency health hazard (blue), fire hazard (red) and reactivity hazard (yellow). The bottom quadrant is used to indicate water reactivity, radioactivity, biohazards or other special hazards. The emergency hazards are signaled on a numerical scale of 0 to 4, with 0 = no unusual hazard, 1 = minor hazard, 2 = moderate hazard, 3 = severe hazard, and 4 = extreme hazard.
Health (Blue)

Health hazards in firefighting generally result from a single exposure, which may vary from a few seconds up to an hour. Only hazards arising out of an inherent property of the material are considered. It should be noted, however, that the physical exertion demanded in firefighting or other emergency conditions tends to intensify the effects of any exposure.

Flammability (Red)

Susceptibility to burning is the basis for assigning risk levels within this category. The method of attacking the fire is influenced by the material’s susceptibility factor.

Reactivity/Stability (Yellow)

The assignment of degrees in the reactivity category is based upon the susceptibility of materials to release energy either by themselves or in combination with water. Fire exposure is one of the factors considered, along with conditions of shock and pressure.

Special Information (White)

The quadrant includes information on specific characteristics of the material (e.g., reactivity with water, tendency to oxidize).

This system is used as a quick reference in emergency situations. It should be readily available to assure that effective and fast control may be achieved during fire incidents. The ratings are always represented within a diamond shaped symbol (see figure 2).

The top position of the diamond shaped symbol indicates the flammability rating, the left position indicates the health hazard rating, and the right position indicates the reactivity rating. The colors used to emphasize each category are blue for health, red for flammability, and yellow for reactivity. The bottom of the symbol is a space used for additional information such as for radioactivity or skin hazards. In figure 2, the letter “W” with a line through the center alerts emergency personnel not to use water as an extinguishing agent for this particular chemical and not to allow the chemical to contact water.

Figure 2

NFPA Hazard Signal Arrangement

Source: http://departments.und.edu/safety/manual/chemhaz/chem.html

Fire Diamond Symbol designed by the NFPA to give a quick number rating for the particular material’s degree of health (blue), flammability (red), reactivity (yellow) and specific (white) hazard.
<table>
<thead>
<tr>
<th>Health (Blue)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4</strong> Danger</td>
<td>May be fatal on short exposure. Specialized protective equipment required</td>
</tr>
<tr>
<td><strong>3</strong> Warning</td>
<td>Corrosive or toxic. Avoid skin contact or inhalation</td>
</tr>
<tr>
<td><strong>2</strong> Warning</td>
<td>May be harmful if inhaled or absorbed</td>
</tr>
<tr>
<td><strong>1</strong> Caution</td>
<td>May be irritating</td>
</tr>
<tr>
<td><strong>0</strong></td>
<td>No unusual hazard</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flammability (Red)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4</strong> Danger</td>
<td>Flammable gas or extremely flammable liquid</td>
</tr>
<tr>
<td><strong>3</strong> Warning</td>
<td>Flammable liquid flash point below 100°F</td>
</tr>
<tr>
<td><strong>2</strong> Caution</td>
<td>Combustible liquid flash point of 100° to 200°F</td>
</tr>
<tr>
<td><strong>1</strong></td>
<td>Combustible if heated</td>
</tr>
<tr>
<td><strong>0</strong></td>
<td>Not combustible</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reactivity (Yellow)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4</strong> Danger</td>
<td>May be explosive if shocked, heated under confinement or mixed with water</td>
</tr>
<tr>
<td><strong>3</strong> Danger</td>
<td>May be explosive if shocked, heated under confinement or mixed with water</td>
</tr>
<tr>
<td><strong>2</strong> Warning</td>
<td>Unstable or may react violently if mixed with water</td>
</tr>
<tr>
<td><strong>1</strong> Caution</td>
<td>May react if heated or mixed with water but not violently</td>
</tr>
<tr>
<td><strong>0</strong> Stable</td>
<td>Not reactive when mixed with water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Special Notice Key (White)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid</td>
<td>pH &lt; 3 pH units</td>
</tr>
<tr>
<td>Alk</td>
<td>pH &gt; 9 pH units</td>
</tr>
<tr>
<td>Corr</td>
<td>Capable of</td>
</tr>
<tr>
<td>Oxy</td>
<td>Oxidizing Agent</td>
</tr>
<tr>
<td>Water Reactive</td>
<td>Water Reactive</td>
</tr>
<tr>
<td>Radiation Hazard</td>
<td>Radiation Hazard</td>
</tr>
</tbody>
</table>

Source: [http://www.cbl.umces.edu/Resources/SafetyWeb/HazComHandout.html#stability](http://www.cbl.umces.edu/Resources/SafetyWeb/HazComHandout.html#stability)
**Hazardous Materials Information System (HMIS):** Lists the hazards of the product under actual use conditions using the same scale as NFPA. The HMIS Hazard Rating: Lists the hazards of the product under the conditions of normal use by severity.

Note: HMIS differs from NFPA in both the health rating and reactivity rating. HMIS considers long term (chronic) health affects while NFPA considers acute affects only; HMIS considers inherent reactivity of the product while NFPA considers its reactivity with fire extinguishing media.

<table>
<thead>
<tr>
<th>Health</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 IDLH; Severe</td>
<td>Severe Hazard. Life threatening, major or permanent damage may result from single or repeated exposures. Probable oral lethal dose for humans: &lt; 0.2 mg/l or &lt; 20 ppm</td>
</tr>
<tr>
<td>3 Serious</td>
<td>Serious Hazard. Major injury likely unless prompt action is taken and medical treatment is given. Probable oral lethal dose for humans: &gt; 0.2-2 mg/l or &gt; 20-200 ppm</td>
</tr>
<tr>
<td>2 Moderate</td>
<td>Moderate Hazard. Temporary or minor injury may occur. Probable oral lethal dose for humans: &gt; 2-20 mg/l or &gt; 200-2,000 ppm</td>
</tr>
<tr>
<td>1 Slight</td>
<td>Slight Hazard. Irritation or minor reversible injury possible. Probable oral lethal dose for humans: &gt; 20-200 mg/l or &gt; 2,000-10,000 ppm</td>
</tr>
<tr>
<td>0 Minimal risk</td>
<td>Minimal Hazard. No significant risk to health Probable oral lethal dose for humans: &gt; 200 mg/l or &gt; 10,000 ppm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flammability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Extremely Flammable</td>
<td>Severe Hazard. Very flammable gases or very volatile flammable liquids with flash points below 73ºF and boiling points below 100ºF.</td>
</tr>
<tr>
<td>3 Highly Flammable</td>
<td>Serious Hazard. Materials capable of ignition under almost all normal temperature conditions Flammable liquids in this category have flash points below 73ºF and boiling points above 100ºF as well as liquids with a flash point between 73ºF and 100ºF.</td>
</tr>
<tr>
<td>2 Flammable</td>
<td>Moderate Hazard. Materials that must be moderately heated before ignition will occur. Flammable liquids in this category have flash points at or above 100ºF and below 200ºF.</td>
</tr>
<tr>
<td>1 Ignitable Combustible</td>
<td>Slight Hazard. Materials that must be preheated before ignition will occur. Flammable liquids in this category have flash points at or above 200ºF.</td>
</tr>
<tr>
<td>0 Non-Flammable</td>
<td>Minimal Hazard. Materials that are normally stable and will not burn unless heated.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reactivity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Extremely Unstable</td>
<td>Severe Hazard. Materials that are readily capable of detonation or explosive decomposition at normal temperatures and pressures.</td>
</tr>
<tr>
<td>3 Unstable</td>
<td>Serious Hazard. Materials that are capable of detonation or explosive reaction, but which require a strong initiating source or which must be heated under confinement before initiation; or materials that react explosively with water.</td>
</tr>
<tr>
<td>2 Stable</td>
<td>Moderate Hazard. Materials that, in themselves, are normally unstable and that readily undergo violent chemical change, but will not detonate. These materials may also react violently with water.</td>
</tr>
<tr>
<td>1 Stable</td>
<td>Slight Hazard. Materials that are normally stable, but can become unstable at high temperatures and pressures. These materials may react with water, but they will not release energy violently.</td>
</tr>
<tr>
<td>0 Stable</td>
<td>Minimal Hazard. Materials that are normally stable, even under fire conditions, and will not react with water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protective Equipment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Severe</td>
<td>*This section will list necessary PPE required to protect employees from the specific contact hazards.</td>
</tr>
<tr>
<td>3 Serious</td>
<td>*This section will list necessary PPE required to protect employees from the specific contact hazards.</td>
</tr>
<tr>
<td>2 Moderate</td>
<td>*This section will list necessary PPE required to protect employees from the specific contact hazards.</td>
</tr>
<tr>
<td>1 Slight</td>
<td>*This section will list necessary PPE required to protect employees from the specific contact hazards.</td>
</tr>
<tr>
<td>0 Minimal</td>
<td>*This section will list necessary PPE required to protect employees from the specific contact hazards.</td>
</tr>
</tbody>
</table>

*PPE: Safety glasses; Face shield; Gloves; Self-Contained Breathing Apparatus; Respirator; Special clothing*
References/Notes

The following industry guides are available from the N.C. Department of Labor’s Division of Occupational Safety and Health:

1. A Guide to Safety in Confined Spaces
5. A Guide for Persons Employed in Cotton Dust Environments
6. A Guide to Lead Exposure in the Construction Industry
7. A Guide to Bloodborne Pathogens in the Workplace
8. A Guide to Voluntary Training and Training Requirements in OSHA Standards
10. A Guide to Farm Safety and Health
15. A Guide to Developing and Maintaining an Effective Hearing Conservation Program
17. A Guide to Electrical Safety
18. A Guide to Occupational Exposure to Wood and Wood Dust
19. A Guide to Crane Safety
22. A Guide to Personal Protective Equipment
25. A Guide to Eye Wash and Safety Shower Facilities
26. A Guide to Safety and Health in Feed and Grain Mills
27. A Guide to Working With Corrosive Substances
28. A Guide to Formaldehyde
29. A Guide to Fall Prevention in Industry
30. A Guide to Office Safety and Health
31. A Guide to Safety and Health in the Poultry Industry
32. A Guide to Preventing Heat Stress
33. A Guide to the Safe Use of Escalators and Elevators
34. A Guide to Boilers and Pressure Vessels
35. A Guide to Safe Scaffolding
38. A Guide to OSHA for Small Businesses in North Carolina
Occupational Safety and Health (OSH)

Sources of Information

You may call 1-800-NC-LABOR (1-800-625-2267) to reach any division of the N.C. Department of Labor; or visit the NCDOL home page on the World Wide Web, Internet Web site address: http://www.nclabor.com.

N.C. Division of Occupational Safety and Health

Mailing Address: 1101 Mail Service Center, Raleigh, NC 27699-1101

Physical Location: Old Revenue Building, 3rd Floor

Local Telephone: (919) 807-2900  Fax: (919) 807-2856

For information concerning education, training and interpretations of occupational safety and health standards contact:

Bureau of Education, Training and Technical Assistance

Mailing Address: 1101 Mail Service Center, Raleigh, NC 27699-1101

Physical Location: Old Revenue Building, 4th Floor

Telephone: (919) 807-2875  Fax: (919) 807-2876

For information concerning occupational safety and health consultative services and safety awards programs contact:

Bureau of Consultative Services

Mailing Address: 1101 Mail Service Center, Raleigh, NC 27699-1101

Physical Location: Old Revenue Building, 3rd Floor

Telephone: (919) 807-2899  Fax: (919) 807-2902

For information concerning migrant housing inspections and other related activities contact:

Agricultural Safety and Health Bureau

Mailing Address: 1101 Mail Service Center, Raleigh, NC 27699-1101

Physical Location: Old Revenue Building, 2nd Floor

Telephone: (919) 807-2923  Fax: (919) 807-2924

For information concerning occupational safety and health compliance contact:

Safety and Health Compliance District Offices

Raleigh District Office (313 Chapanoke Road, Raleigh, NC 27603)

Telephone: Safety (919) 662-4597  Fax: (919) 662-4709

Health (919) 662-4711

Asheville District Office (204 Charlotte Highway, Suite B, Asheville, NC 28803-8681)

Telephone: (828) 299-8232  Fax: (828) 299-8266

Charlotte District Office (901 Blairhill Road, Suite 200, Charlotte, NC 28217-1578)

Telephone: (704) 342-6163  Fax: (704) 342-5919

Winston-Salem District Office (4964 University Parkway, Suite 202, Winston-Salem, NC 27106-2800)

Telephone: (336) 776-4420  Fax: (336) 776-4422

Wilmington District Office (1200 N. 23rd St., Suite 205, Wilmington, NC 28405-1824)

Telephone: (910) 251-2678  Fax: (910) 251-2654

***To make an OSHA Complaint, OSH Complaint Desk: (919) 807-2796***

For statistical information concerning program activities contact:

Planning, Statistics and Information Management

Mailing Address: 1101 Mail Service Center, Raleigh, NC 27699-1101

Physical Location: Old Revenue Building, 2nd Floor

Telephone: (919) 807-2950  Fax: (919) 807-2951

For information about books, periodicals, vertical files, videos, films, audio/slide sets and computer databases contact:

N.C. Department of Labor Library

Mailing Address: 1101 Mail Service Center, Raleigh, NC 27699-1101

Physical Location: Old Revenue Building, 5th Floor

Telephone: (919) 807-2848  Fax: (919) 807-2849

N.C. Department of Labor (Other than OSH)

1101 Mail Service Center

Raleigh, NC 27699-1101

Telephone: (919) 733-7166  Fax: (919) 733-6197