Industry Guide 19

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

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Acknowledgments

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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 guide, or if you have questions about N.C. occupational safety and health standards or rules, please contact:

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

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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, the N.C. Department of Labor enforces the federal Occupational Safety and Health Act through a state plan approved by the U.S. Department of Labor. NCDOL offers many educational programs to the public and produces publications to help inform people about their rights and responsibilities regarding occupational safety and health.

When reading this guide, please remember the mission of the N.C. Department of Labor is greater than just regulatory enforcement. An equally important goal is to help citizens find ways to create safe workplaces. Everyone profits when managers and employees work together for safety. This booklet, like the other educational materials produced by the N.C. Department of Labor, can help.

Cherie Berry
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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, Occupational Safety and Health Division. In most instances, the standards promulgated by federal OSHA are adopted and enforced by the N.C. Department of Labor.

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
- Copper
- Creosote
- Pentachlorophenol
- Urea-formaldehyde resins
- Phenol-formaldehyde resins

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. The stories mentioned above are quite different one from another; however, they all met the five conditions necessary for a dust explosion: oxygen, fuel, ignition source, dispersion of dust and confinement.

Be aware of the dangers; dust in your facility may present the same hazard!

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?

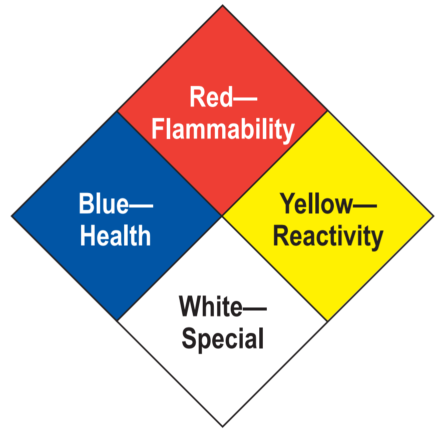
Prevention

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 production 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 hazard 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 safety data sheet (SDS) for each chemical. Each chemical must be labeled. The SDS contains important information on the chemical. Every manufacturer of chemicals does not follow the same SDS format, but every SDS must contain particular information. This information includes:

- Identification of the substance or mixture and of the supplier
- Hazards identification
- Composition/information on ingredients
- First-aid measures
- Fire-fighting measures
- Accidental release measures
- Handling and storage
- Exposure controls/personal protection
- Physical and chemical properties
- Stability and reactivity
- Toxicological information
- *Ecological information (non-mandatory)*
- *Disposal considerations (non-mandatory)*
- *Transport information (non-mandatory)*
- *Regulatory information (non-mandatory)*
- Other information, including date of preparation or last revision

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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. In 2008. North Carolina employed more than 25,000 people in the wood products industry (1). Examples of industries with exposure inclued the following:

- Furniture manufacturing
- Logging and lumber manufacturing
- Construction
- Paper manufacturing

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 respirable limit of 5 mg/m^3 means that no more than 5 milligrams of respirable dust may be present in a cubic meter of air. (The time-weighted average for an 8-hour work shift allows fluctuations above and below the 5 mg/m^3 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. 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/m^3 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 chemical which is classified as a physical hazard or a health hazard, a simple asphyxiant, combustible dust, pyrophoric gas, or hazard not otherwise classified."

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.

**Numbers in parentheses refer to entries in References/Notes at the end of this publication.*

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.

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 SDS for that product. Under paragraph (d)(4), if a chemicals 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 SDS within six 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 SDS 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(d)(4). SDSs for softwood species (not mixed with hardwoods) do not have to be identified as being carcinogenic.

A single SDS may be used for similar mixtures with essentially the same hazards and contents. This is very common with laboratory chemical mixtures. Copies of SDSs must be readily accessible during work hours. When purchasing any hazardous materials, such as paints, solvents, pesticides, etching agents, through local vendors, request an SDS as necessary.

The responsibilities of a retail distributor under the 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 SDSs are available and to provide an SDS to a customer only upon request. Under the standard, a distributor is not obligated to provide a copy of the SDS 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 SDSs to employers whose employees may be exposed to these inhalation hazards.

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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 (2). 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, mansonia 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 (3). 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 (4). 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.

Mucous Flow in the Nose

Table 1

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

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

*From: International Agency for Research on Cancer (IARC). *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans; Wood Leather and Some Associated Industries.* Volume 25, February 1981.

Table 2

Composition of Adhesives Used in the Furniture Industry*

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

*From: International Agency for Research on Cancer (IARC). *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans; Wood Leather and Some Associated Industries.* Volume 25, February 1981.

Table 3

Woods Causing Dermatitis*

Botanical Name	Common Name**
• Apocynaceae	
Aspidosperma spp.	Peroba rosa
• Betulaceae	
Alnus spp.***	Alder
• Bignociaceae	
Peratecoma peroba	Peroba de Campos, peroba branca, peroba amarella
Tabebuia spp.	Lapacho, suayacan, ipe, mayflower
• Burseraceae	
Aucommea klaineana	Gaboon, okoume
• Hernandiaceae	
Hernandia sonora	Topolite
• Lauraceae	
Nectandra rodiaei	Antilles greenheart
Phoebe porosa	Brazilian walnut, imbuia
Ocotea spp.	Louro, jigua, pisie
• Leguminosae	
Andira inermis	Partridge wood
Brya ebenus	Cocus wood
Cassia simame	Tagayasan
Dalbergia cearensis	Kingswood, violet wood
Dalbergia granadillo	Costa Rican rosewood
Dalbergia latifolia	East Indian rosewood, Bombay blackwood, sissoo
Dalbergia melanoxylon	African blackwood
Dalbergia nigra	Brazilian rosewood, riopalisander, grenadilla
Dalbergia retusa	Cocobolo
Dalbergia stevensonii	Honduras rosewood
Distemonanthus benthamianus	Ayan, Nigerian satinwood
Gossweilerodendron balsamiferum	Agba, tola branca
*Prosopis juliflora****	Mesquite
Machaerium scleroxylon	African mahogany
• Meliaceae	
Guarea thompsonii	Guarea
Khaya anthotheca	African mahogany
• Moraceae	
Chlorophora excelsa	African iroko, kambala, African teak
• Pinaceae	
Abies spp.***	Fir
*Juniperus virginiana****	Eastern red cedar
*Libocedrus decurrens****	Incense cedar
Picea spp.*	Spruce
Pinus spp.*	Pine
*Pseudotsuga menziesii****	Douglas fir
*Thuja occidentalis****	Northern white cedar
*Thuja plicata****	Western red cedar
Tsuga spp.	Hemlock
• Rutaceae	
Chloroxylon swietenia	East Indian satinwood
Fagara flava (=Zanthoxylum) flavum	West Indian satinwood
Fagara macrophylla	Olon
• Sapotaceae	
Bassia latifolia	Moah, mahwa
Mimusops heckelii	Mackore, baku
• Taxaceae	
Taxus baccata	Yew
• Triplochitonaceae	
Mansonia altissima	Mansonia, African black walnut
• Ulmaceae	
Ulmus spp.***	Elm
• Verbenaceae	
Tectona grandis	Teak

*Adapted from McCord (1958), Fregert and Hjorth (1968), and Gamble (1979).
**Health Effects of Exposure to Wood Dust: A Summary of the Literature.* U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Division of Standards Development and Technology Transfer, June 1987.
**There is no accepted international nomenclature.
***North American species.

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.

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 (5-16). The higher the exposure levels of WRC dust, the greater the number of workers having asthma. In one study (5), 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 win continue to have asthma for indefinite periods.

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 an 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*) (9, 17)
- Western red cedar (*Thuja plicata*) (18, 19, 20)
- Oak (Species *unk*) (21)

Non-Native Species
- Abachi or Obeche (*Triplochiton scleroxylon*) (22)
- Abiruana (*Pouteria* sp) (23)
- Boxwood (*Buxus sempervirens*) (24)
- Cedar of Lebanon (*Cedra libani*) (25)
- Cocobolo (*Dalbergia retusa*) (26)
- Iroko or Kamballa (*Chlosophora excelsa*) (19, 27)
- Kejaat or Muninga (*Pterocarpus anagolensis*) (18)
- Limba (*Terminalia superba*) (22)
- Mahogany (21)
- Mansonia (*Mansonia altissima*) (28)
- Mulberry (*Morus* sp)* (29)
- Pine (Species *unk*)* (30)
- Ramin (*Gonystylus bancanus*) (31)
- Teak (*Tectona grandis*) (22, 27)
- Ukola (*Dumoria africana*) (32)
- Zebrawood (*Microberlinia* sp) (33)
  (*Tanganyeka aningre*) (34)

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 (35-37), while others have been unable to find them (38).

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), and other countries.

In the United States, several studies relevant to the issue have been conducted. 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." (48)

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 more than 89,000 workers in 1990 before declining in recent years. 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 and fall in employment in the furniture industry in North Carolina.

Table 5

Employment in Furniture Industry in North Carolina 1919-2009*

1919	8,667
1927	15,652
1929	16,648
1939	18,388
1947	27,858
1954	29,807
1963	48,000
1967	58,500
1972	70,300
1977	78,900
1990	89,100
1994	80,500
1998	77,800
2002	66,200
2004	58,900
2008	44,800
2009	34,800

*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." (48) OSHA also points out, however, "Smoking may have been a confounding factor in these results." (48)

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." (48)

4

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 Respiratory Protection 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 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 maybe 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 (**A**merican **C**onference of **G**overnmental **I**ndustrial **H**ygienists)

- Publishes TLVs for chemical and physical agents
- TWA, STEL, C
- Not an official government agency
- Membership limited to government agencies or educational institutions

TLV (**T**hreshold **L**imit **V**alue)

- 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 (**P**ermissible **E**xposure **L**imit)

- OSHA’s legally allowed concentrations in the workplace

REL (**R**ecommended **E**xposure **L**imit)

- 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 (**W**orkplace **E**nvironmental **E**xposure **L**evel)

- 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 (**T**ime **W**eighted **A**verage)

- Airborne concentrations of substances averaged with regard to their duration

$$TWA = \frac{C1T1 + C2T2 + \ldots CnTn}{T1 + T2 + \ldots Tn}$$

Where: C = Concentration
T = Time

TWA Example

- An air contaminant has a PEL of 100 ppm
- 3 air samples are collected: Sample 1—4 hours/170 ppm
  Sample 2—3 hours/60 ppm
  Sample 3—1 hour/100 ppm

$$8\text{ hr TWA} = \frac{(170\text{ ppm} \times 4\text{ hrs}) + (60\text{ ppm} \times 3\text{ hrs}) + (100\text{ ppm} \times 1\text{ hr})}{8\text{ hours}}$$

8 hr TWA = 120 ppm

STEL (**S**hort **T**erm **E**xposure **L**imit)

- 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 (**C**eiling)

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

P (**P**eak)

- Refers to acceptable maximum concentrations above acceptable ceiling concentrations for an 8-hour shift
- Never to be exceeded

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)

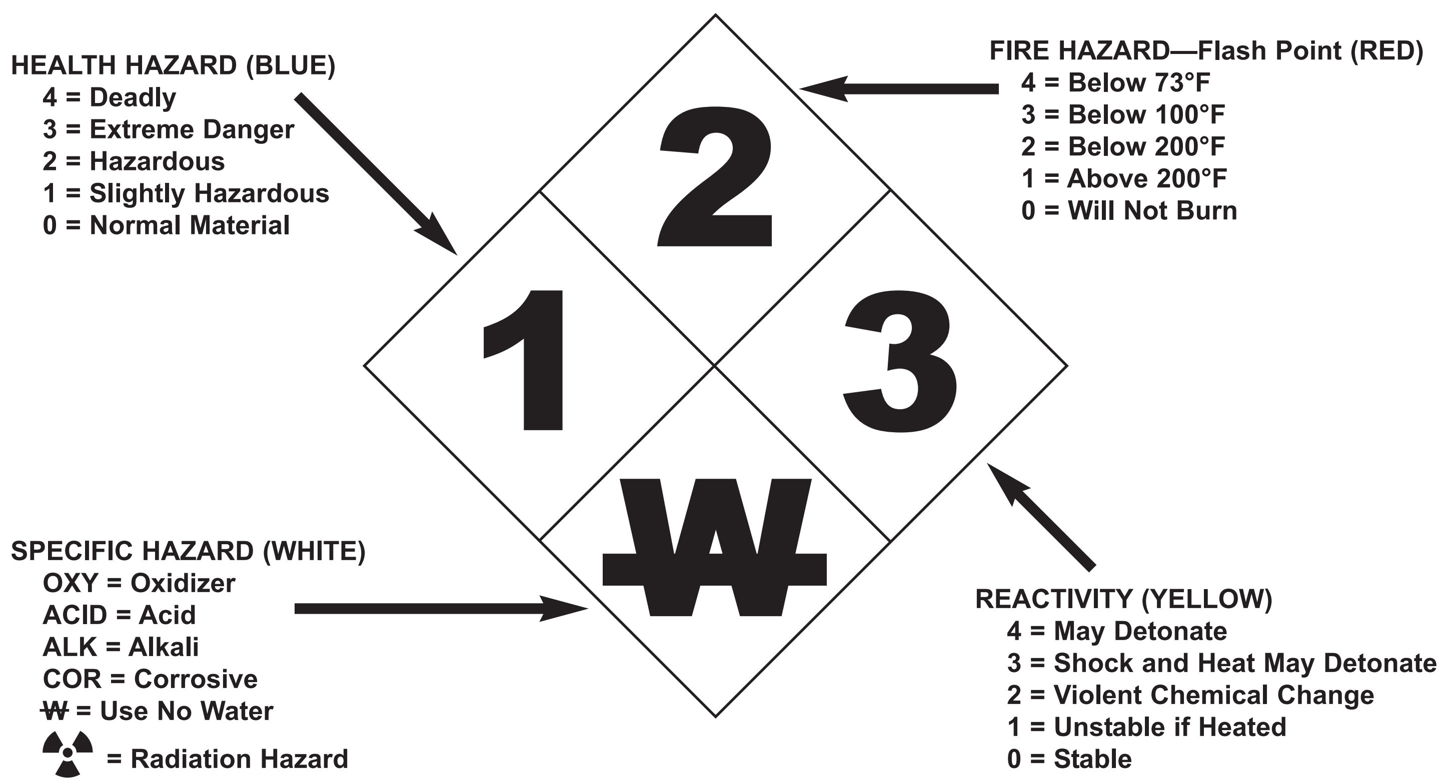
The quadrant includes information on specific characteristics of the material (e.g., reactivity with water, tendency to oxidize).

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

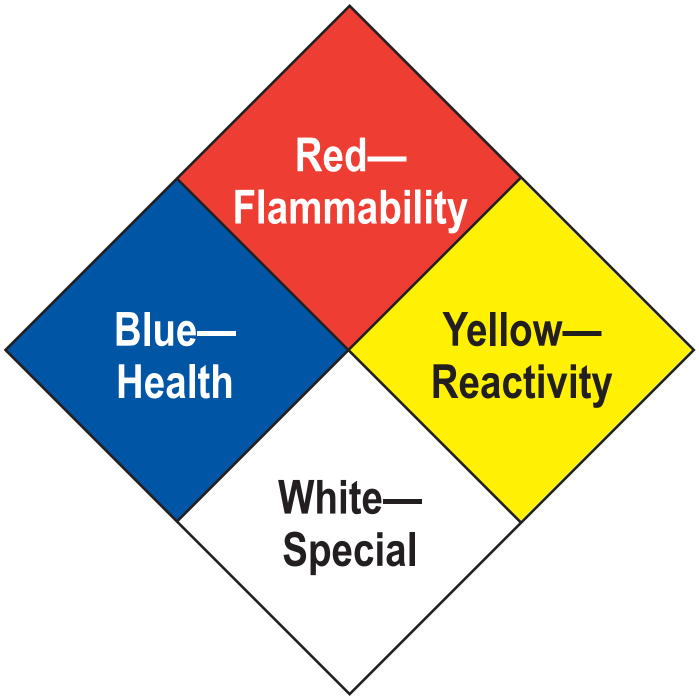
NFPA Hazard Signal Arrangement



Source: http://safety.und.edu/policy/manual/chemhaz/chemhaz.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.

The NFPA Diamond



The National Paint & Coatings Association, Inc. (NPCA) developed the Hazardous Materials Identification System (HMIS®) to aid employers in the implementation of an effective Hazard Communication Program. The Third version of this system, HMIS® III, offers comprehensive resources covering hazard assessment, hazard communication, and employee training.

Types of Information Used to Produce HMIS® Ratings

• Chronic health hazards:	Clear evidence of health effects from repeated overexposure, including carcinogenicity, reproductive effects, and injury to specific (target) organs
• Acute health data:	Information on immediate health effects; acute toxicity data (oral/dermal LD50s, inhalation LC50); potential for eye/skin irritation
• Flammability:	Flash point and boiling point
• Physical Hazard:	Material may contain any of the following properties: water reactive, organic peroxide, explosive, compressed gas, pyrophoric, oxidizer, unstable reactive.

[Extracts taken from: http://www.paint.org/hmis/index.cfm; http://www.ilpi.com/msds/ref/hmis.html]

The 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.

Health Hazards		
*	Chronic Hazard	Chronic (long-term) health effects may result from repeated overexposure
0	Minimal Hazard	No significant risk to health: > 200 mg/l or > 10,000 ppm
1	Slight Hazard	Irritation or minor reversible injury possible: > 20-200 mg/l or > 1,000-10,000 ppm
2	Moderate Hazard	Temporary or minor injury may occur: > 2-20 mg/l or > 200-1,000 ppm
3	Serious Hazard	Major injury likely unless prompt action is taken and medical treatment is given: > 0.2-2 mg/l or > 20-200 ppm
4	Severe Hazard	Life-threatening, major or permanent damage may result from single or repeated overexposures: < 0.2 mg/l or ≤ 20 ppm
Flammability Rating		
0	Minimal	Material that will not burn
1	Slight Hazard	Materials that must be preheated before ignition will occur. Includes liquids, solids and semi solids having a flash point above 200°F. (Category Liquid—4 / Class IIIB)
2	Moderate Hazard	Materials which must be moderately heated or exposed to high ambient temperatures before ignition will occur. Includes liquids having a flash point at or above 100°F but below 200°F. (Category Liquid—3 FP≥100°F / Class II & IIIA)
3	Serious Hazard	Includes flammable liquids with flash points below 73°F and boiling points above 100°F, as well as liquids with flash points between 73°F and 100°F. (Category Liquid—2; Category Liquid—3 FP<100°F / Classes IB & IC)
4	Severe Hazard	Flammable gases, or very volatile flammable liquids with flash points below 73°F, and boiling points below 100°F. Materials may ignite spontaneously with air. (Category Liquid—1 / Class IA)
Physical Hazard (HMIS III)		
• Reactivity hazard are assessed using the OSHA criterion of physical hazard. Seven such hazard classes are recognized: ○ Water Reactives ○ Organic Peroxides ○ Explosives ○ Compressed gases ○ Pyrophoric materials ○ Oxidizers ○ Unstable Reactives This version replaces the now-obsolete yellow section titled **Reactivity** – see later section for more information.		
0	Minimal Hazard	Materials that are normally stable, even under fire conditions, and will NOT react with water, polymerize, decompose, condense, or self-react. Non-Explosives.
1	Slight Hazard	Materials that are normally stable but can become unstable (self-react) at high temperatures and pressures. Materials may react non-violently with water or undergo hazardous polymerization in the absence of inhibitors.
2	Moderate Hazard	Materials that are unstable and may undergo violent chemical changes at normal temperature and pressure with low risk for explosion. Materials may react violently with water or form peroxides upon exposure to air.

Source: University of Maryland, Center for Environmental Science, Chesapeake Biological Laboratory

3	Serious Hazard	Materials that may form explosive mixtures with water and are capable of detonation or explosive reaction in the presence of a strong initiating source. Materials may polymerize, decompose, self-react, or undergo other chemical change at normal temperature and pressure with moderate risk of explosion
4	Severe Hazard	Materials that are readily capable of explosive water reaction, detonation or explosive decomposition, polymerization, or self-reaction at normal temperature and pressure.
	Reactivity Rating (HMIS I and II – now obsolete)	
	• The criteria used to assign numeric values (0 = low hazard to 4 = high hazard) were identical to those used by NFPA 704. • This version is now obsolete. The yellow section has been replaced with an orange section titled **Physical Hazard**	
0	Minimal Hazard	Materials which are normally stable even under fire conditions, and which will not react with water.
1	Slight Hazard	Materials which are normally stable, but can become unstable at high temperatures and pressures.
2	Moderate Hazard	Materials that undergo violent chemical change at elevated temperatures and pressures. These materials may also react violently with water.
3	Serious Hazard	Materials that are capable of detonation or explosive reaction, but require a strong initiating source, or must be heated under confinement before initiation. Materials which react explosively with water.
4	Severe Hazard	Materials that are readily capable of detonation or explosive decomposition at normal temperatures and pressures.
	Protective Equipment	
	• Noted as largest area of difference between the NFPA and HMIS® systems. In the NFPA system, the white area is used to convey special hazards whereas HMIS® uses the white section to indicate what personal protective equipment (PPE) should be used when working with the material.	
	HMIS Letter	**Required Equipment**
	A	safety glasses
	B	safety glasses and gloves
	C	safety glasses, gloves and an apron
	D	face shield, gloves and an apron
	E	safety glasses, gloves and a dust respirator
	F	safety glasses, gloves, apron and a dust respirator
	G	safety glasses, a vapor respirator
	H	splash goggles, gloves, apron and a vapor respirator
	I	safety glasses, gloves and a dust/vapor respirator
	J	splash goggles, gloves, apron and a dust/vapor respirator
	K	airline hood or mask, gloves, full suit and boots
	L - Z	custom PPE specified by employer

NOTE: See the appropriate HMIS® Implementation Manual for complete descriptions of the rating criteria for each of the various categories.

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