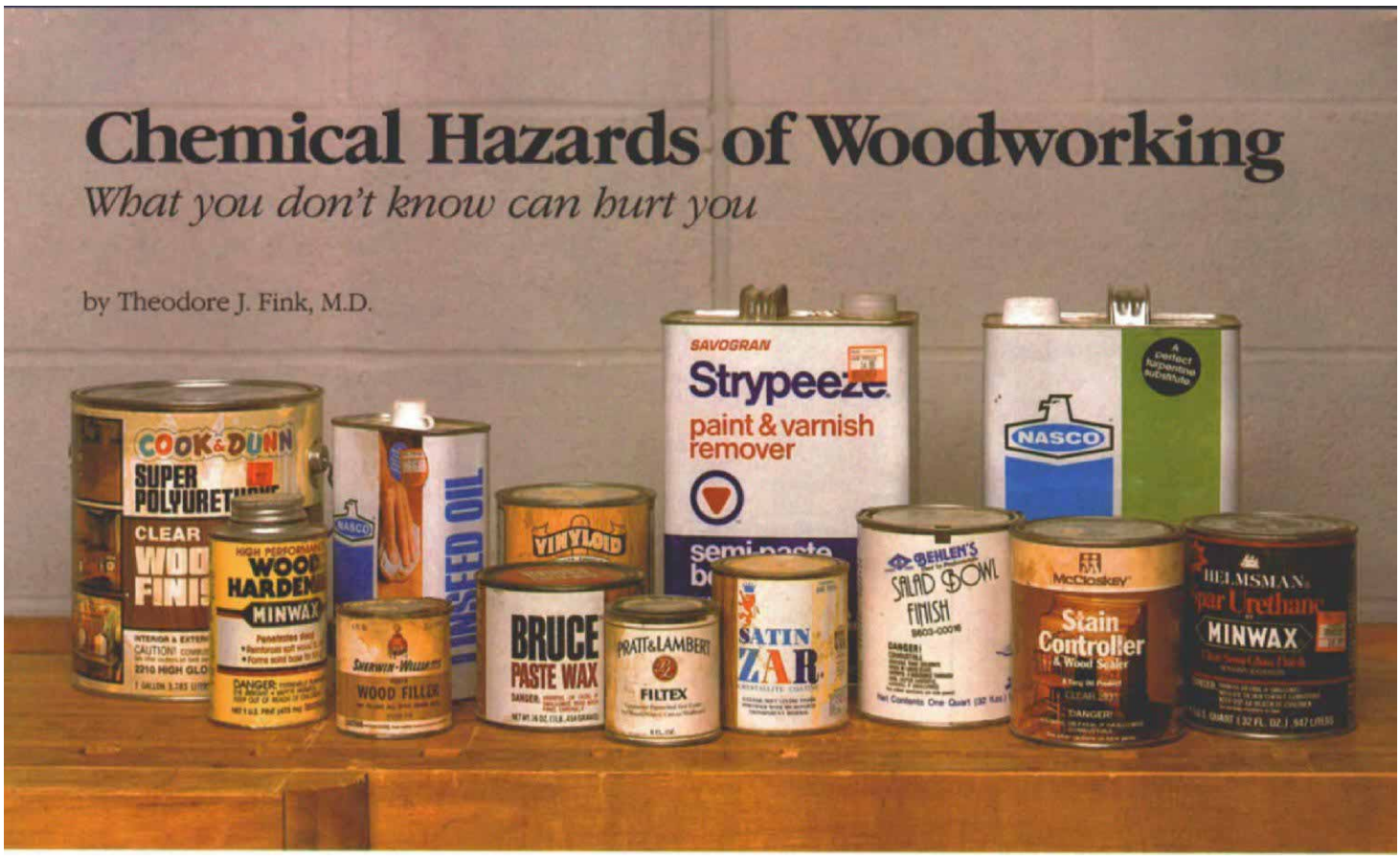
Chemical Hazards of Woodworking

What you don't know can hurt you

by Theodore J. Fink, M.D.



These products, representative of those found in many woodworkers' shops, all contain hazardous substances. While they all have warning labels of potential dangers, many reveal the contents only as petroleum distillates, which can include a number of dangerous solvents.

All too often woodworkers are needlessly exposed to toxic levels of various chemicals. Sometimes this happens because workers ignore warning labels, but frequently it's because they just don't know enough about the chemical products they use to appreciate the risks involved and take adequate precautions. Toxic chemicals are found in a variety of woodshop supplies, including adhesives, paints and varnishes. By presenting an overview of the basic principles of chemical toxicity, I hope to drive home the single most important lesson for woodworkers; protect yourself—it is infinitely better to prevent an illness or injury than it is to treat it after it occurs.

The chart in figure 1 on pp. 60-61 should help you identify the products containing potentially harmful chemicals, clarify the risks associated with the most common toxins and choose safer alternatives. The following discussion of chemical hazards and how toxins are absorbed into the body will also help you understand the information presented in the chart.

Hazards of organic solvents—Toxicity refers to a chemical's, or solvent's, ability to produce a harmful effect on a biological system, in this case, your body. These harmful chemicals, called toxins, often target specific tissues. Benzene, for example, attacks the blood-forming elements in bone marrow. Any chemical can produce a toxic effect. Some do so with a single, brief contact, often called an acute exposure; others require chronic exposure: repeated or prolonged contact. The crucial point is that there are no harmless chemicals, only relatively safe ways of using them.

All chemicals can produce both acute and chronic effects. Acute effects generally happen quickly and the illness lasts only a short time. If exposure is low enough, the effects are reversible. More intense acute exposures can cause permanent damage, even death. Chronic effects, on the other hand, may not be apparent until after weeks, months or even years of repeated exposures, and they are usually permanent and irreversible. Some people do not realize that they are being harmed because early symptoms of these effects can vary greatly depending on the type of substance, exposure level and individual sensitivity.

Both acute and chronic effects may be localized or affect the entire system. A local reaction would be something like redness or blistering of the skin at the point of contact. A systemic reaction occurs when the chemical is absorbed into the bloodstream. Harmful effects may occur anywhere in the body, but the toxins in solvents most often affect the central nervous system (CNS). Generally, the chemicals depress the CNS, but some substances, like xylene, may produce agitated hyperactive behavior. Symptoms of depression of the CNS can include dizziness, headache, nausea, confusion, sleepiness, incoordination or irrational behavior.

In the workshop, these symptoms not only decrease productivity, but also lead to higher injury rates. However, the damage can be more far-reaching. The brain has very limited regenerative capacity, so once any neurologic deficit is established, it usually becomes permanent. Very high chronic exposure to solvents can cause dementia, resulting in impairments of judgment, insight, orientation and memory. This raises a question that is currently being studied: Can repetitive, low-level exposures cause premature aging and reduce mental and physical abilities? Until there is an answer, it is wise to minimize exposure to solvents.

How chemicals get into the body—Chemical toxins can be absorbed into the blood system through the respiratory and digestive tracts as well as through the skin. Many solvents are very volatile and quickly transform into vapors, so inhalation is the main method of absorption. The lung tissue exposed to vapors during inhalation is enormous, totaling about two acres of surface area in the

lungs' air sacs. Relative volatility of various solvents, determined by measuring the vapor pressure (VP) of the evaporating liquid in millimeters of mercury (mm Hg), is shown in the chart on the following two pages. The more volatile a solvent, the higher the VP, and the more quickly it will fill a room with vapors. Bear in mind that the VP measurements shown were made at 68°F; any increase in temperature will also increase the volatility.

On the body, a thick outer layer of skin generally forms an effective barrier to most materials. Despite this, many of the organic solvents in wood finishing products, such as methylene chloride or isopropyl alcohol, can penetrate the skin and cause dermatitis and exacerbate the absorption. Also, chemicals are absorbed quickly through cuts and abrasions or areas inflamed by eczema or psoriasis.

Workshop chemicals, like those shown in the photo on the facing page, gain entry to the digestive system in two ways. Consumption of food, drink or cigarettes brought into the shop and contaminated by chemicals is the most common process. A not-so-obvious method involves the lungs. The inner walls of the respiratory tract are protected by a thin fluid layer, which is moved upward by small, constantly moving hairs (cilia). Once the inhaled particles reach the throat, they are swallowed, and then any chemicals in the particles are absorbed by the stomach and intestines. This situation can easily develop when you don't wear a dust mask while sanding out finishes.

Chemical classifications—Organic solvents can be combined into groups of similar chemical structures and solvent characteristics, which simply means you can generally use a solvent within a group as a substitute for another solvent from that same group. The groups of solvents that woodworkers encounter most frequently include aliphatic hydrocarbons, chlorinated hydrocarbons, aromatic hydrocarbons, alcohols and ketones, as outlined in figure 1.

Aliphatic hydrocarbons are often petroleum derivatives, such as naphthas, paraffins, mineral spirits, n-hexane and kerosene. From the chart, you can see that n-hexane, found in adhesives, varnishes and seed-oil extracts, is not only extremely flammable, but can cause peripheral nerve damage resulting in weakness of hands and feet. One of the safest solvents for woodworkers is odorless paint thinner, which is mineral spirits or VM&P (varnish maker's and painter's) naphtha with the aromatic hydrocarbons removed.

Chlorinated hydrocarbons are identified by the "chloro" or "chloride" in their names. These are good solvents for many paints and varnishes because they are nonflammable, but most are now known to be very toxic, cause damage to the liver and contain carcinogens. For example, methylene chloride, a common ingredient in paint strippers, not only forms carbon monoxide in the body, but it was recently shown to cause cancer. As a result, the government banned its use in cosmetics and further restrictions are expected soon.

Aromatic hydrocarbons show up in a variety of products, from lacquer thinners and strippers to adhesives and tung oils, and present special hazards as a class. The most toxic, benzene, causes destruction of the blood-forming elements and may wipe out these cells, causing aplastic anemia (bone marrow destruction), or result in leukemia. You are not likely to encounter benzene due to current governmental restrictions; however, some of the older products on the back of your shelf may contain this solvent, and these should be disposed of properly through your local environmental agencies. Toluene and xylene have been widely used as benzene substitutes, and although not as hazardous as benzene, they can still cause serious toxic effects, as shown in the chart.

Among the safest and most important classes of solvents are alcohols, which are found in many types of finishes and other products. Methanol or wood alcohol, which is by far the most toxic of this group, can damage the optic nerve and cause blindness. Ethanol, or grain alcohol, is the least toxic alcohol and has about half the depressant effect on the brain and spinal cord as isopropanol (isopropyl or rubbing alcohol).

Ketones are commonly used in quick-drying finishes and have become more widespread with the increased popularity of vinyl resin finishes. Of the many ketones, three commonly cited on labels are acetone, methyl ethyl ketone and methyl isobutyl ketone. Methyl n-butyl ketone, which you might find in an old product, has generally been banned because it can cause severe nerve damage, the symptoms of which appear gradually over weeks or months and consist of numbness, tingling and weakness in hands and feet. The safest solvent of the ketone group is acetone; however, it is extremely flammable and a real fire or explosion hazard.

Other hazardous materials—Adhesives represent another large group of potentially hazardous materials, as illustrated in figure 2 on p. 62, and should be treated with caution. Some are dangerous because of the flammability of their solvents, such as nitro cellulose cement with 39% acetone and contact cements with various volatile hydrocarbons, Other common adhesives that have lower toxicity are white glue, also known as polyvinyl acetate (PVA), yellow glue (modified PVA/aliphatic resins), hide glue, hot-melt glue (hydrocarbon resin: 50%, ethylene vinyl or acetate copolymer: 45%, wax: 5%) and wet casein glue. These may, however, cause skin irritation or skin allergies. And casein dust, from mixing dry powders, may irritate the upper respiratory tract.

Limiting toxic exposure—Always choose the least-toxic solvent that will get the job done, and always follow the manufacturer's recommendations for safe use. Product labels are now more detailed than ever and should always be your first source of toxicity information. All warnings on labels, such as "use in well-ventilated

(continued on p. 62)

Further reading

Artist Beware **by Michael McCann. Watson-Guptil Publications, New York, NY; 1979.**

A large variety of good information is available from the Center for Safety in the Arts, 5 Beekman St., New York, NY 10038.

Chemical Hazards of the Workplace **by Nick Proctor and James Hughes. J. B. Lippincott Co., Philadelphia, PA; 1978.**

Handbook of Organic Industrial Solvents **(LC-TG-07-683) by Alliance of American Insurers, 1501 Woodfield Rd., Suite 400 W., Schaumburg, IL 60173; 1987.**

Industrial Toxicology **by Phillip Williams and James Burson. Van Nostrand Remhold Co., New York, NY; 1985.**

"A Distinct Pattern of Personality Disturbance Following Exposure to Mixtures of Organic Solvents," ***Journal of Occupational Medicine,*** **Vol. 31, No. 9, (Sept. 1989), by Lisa Morrow, Ph.D., et al.**

"Neurobehavioral Effects of Solvents," ***Journal of Occupational Medicine,*** **Vol. 30, No. 2, (Feb. 1988), by Edward L. Baker, M.D., et al.**

Occupational Diseases **by U.S. Department of Health, Education and Welfare, U.S. Government Printing Office, Washington, DC; 1977.**

Organic Solvent Neurotoxicity **(Publication No. 87-104); March 31, 1987 and** ***Pocket Guide to Chemical Hazards*** **(Publication No. 85-114); September, 1985, by U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH), 4676 Columbia Parkway, Cincinnati, OH 45226.**

Solvents in Museum Conservation Labs **by Center tor Safety in the Arts, 5 Beekman St., New York, NY 10038; 1985.**

Threshold Limit Values and Biological Exposure Indices for 1987-88 **by American Conference of Governmental Industrial Hygienists (ACGIH), 6500 Glenway Ave., Building D-7, Cincinnati, OH 45211; 1987.**

FIG. 1: HAZARDOUS CHEMICALS USED IN WOODWORKING

Solvent (synonym)	Where Used	Toxicity [1] * TLV (Threshold Limit Value) in PPM	Flammability [2] * Combustability FP (Flash Point) in Degrees F	Volatility * Vapor Pressure in mm Hg
Aliphatic Hydrocarbons				
n-Hexane (Skellysolve-B)	Spray adhesives and fixatives, fast-drying cements, rubber and contact cements, inks, varnishes, seed-oil extracts, diluent	50	-7	124
Petroleum naphtha	Plastic wood filler, wax, lacquer thinner, petroleum distillates	100	-50	40
VM&P naphtha (varnish maker's and painter's)	Quick-drying thinner, degreaser, varnish, lacquer thinner, petroleum distillates	300	20-55	2-20
Mineral spirits	General-purpose thinner, degreaser, brush cleaner, petroleum distillates, plastic wood filler, varnish, tung oils	200	86-105	0.8
Kerosene	Petroleum distillates, solvents, thinners	None	100-165	Varies
Chlorinated Hydrocarbons				
Methylene chloride (dichloromethane, methylene dichloride)	Paint and varnish removers, furniture refinishers, contact cement, aerosols, urethane foam, adhesives, paint	50**	None [3]	350
Aromatic Hydrocarbons				
Benzene (benzol, cyclohexatriene)	Paint stripper, petroleum distillates, lacquer thinner	10	12	75
Toluene (toluol, methyl benzene)	Petroleum distillates, polyurethane lacquer thinners, inks, adhesives, spray products, modified tung oil, furniture refinishers, strippers, plastic wood putty	100	40	22
Xylene (xylol, dimethyl-benzene)	Petroleum distillates, dewaxer, degreaser, substitute for benzene	100	81	9
Alcohols				
Ethanol (denatured, ethyl or grain alcohol)	Shellac, spirit stain, resorcinol	1000	55	43
Methanol (wood or methyl alcohol, wood spirit)	Paints, varnishes, lacquers, dyes, furniture refinishers, strippers, wood hardener	200	52	97
Isopropanol (isopropyl or rubbing alcohol)	Plastic wood fillers, lacquer thinner, surface cleaner	400	53	33
Ketones				
Acetone (dimethyl ketone, 2-propanone, ketone propane)	Strippers, wood fillers, lacquer thinner, wood hardener, diluent for epoxy and polyester resins and plastic cements, cleaner	750	1.4	266
Methyl ethyl ketone (MEK, 2-butanone)	Lacquer thinner, plastic wood filler, plastic cements, spray can products	200	21	70
Methyl n-butyl ketone (MBK, 2-hexanone)	Fast-drying finishes, plastic wood fillers, aerosols, lacquers, nitrocellulose, resins, oils, waxes, varnish and lacquer removers	5	77	3
Methyl isobutyl ketone (MIBK, hexone)	Plastic wood fillers, spray can products, plastic cements	50	73	15
Others				
Gum turpentine/wood turpentine	Waxes, finishes, tung oils, general-purpose thinner, brush cleaner, degreaser	100	95	5
Methyl cellosolve*** (Glycol ether, 2-methoxy ethanol, many others	Degreasers, cleaners (water based), lacquer thinners, dyestuffs, some latex paints, spray products, epoxies	5	107	6
Diglycidyl ether*** (DGE, 2-epoxypropyl ether)	Epoxies (especially liquid), some other plastic resin systems	0.1	147	.09

1. Toxicity—highly toxic: less than 101 PPM; moderately toxic: 101 to 500 PPM; slightly toxic: more than 500 PPM
2. Flammability—extremely flammable: less than 21°F; flammable: 21°F to 99°F; combustible: 100°F to 150°F
3. No FP, but flammable when vapors reach 14% to 22% by volume of air at 77°F.

*See further discussion of these values in sidebar on p. 63.
**Indicated for change based on its cancer status.
***First in a large class of chemicals that have similar uses and hazards.

Usual Route of Absorption L = Lung S = Skin	Comments	Organs Affected	Symptoms
L, S	Can damage PNS and cause CNS depression.	Skin, URT, CNS, PNS	Irr., peripheral neuropathy, numbness and weakness of hands and feet, headache, nausea, loss of balance, weight loss, fatigue
L, S	Mixture of aliphatic hydrocarbons may contain benzene.	Eyes, skin, URT, CNS, lungs	Irr., narcosis, derm.
L, S	One of the least toxic.	Skin, CNS, lungs	Irr., derm., narcosis
L, S	Try to use odorless paint thinner or mineral spirits with reduced aromatics.	Skin, CNS, lungs, eyes	Irr., derm., narcosis
S	–	Skin, lungs, URT, CNS	Irr., narcosis, lung hemorrhage, chemical pneumonia
	Try to avoid as a class. May produce phosgene gas and other toxins when heated or exposed to ultraviolet radiation. Most are suspected carcinogens.		
L, S	Forms carbon monoxide in blood and stresses heart. Reaches maximum levels 3 to 4 hours after exposure. Organic vapor cartridge not approved for use with methylene chloride. Suspected carcinogen. Often used with methanol, which increases toxicity.	Skin, URT, CNS, CVS, liver	Irr., narcosis, numbness of limbs, heart palpitations, headache, shortness of breath, angina, heart attack
	Try to avoid as a class.		
L, S	Do not use: Carcinogen, absorbed through skin.	Skin, CNS, blood, chromosomes, liver, kidneys	Derm., narcosis, leukemia, aplastic anemia
L, S	Recently identified by EPA as top air pollutant and is targeted for regulation.	CNS, liver, URT, kidneys, skin, eyes	Irr., derm., narcosis, muscular weakness, liver and kidney damage
L, S	May cause CNS excitation.	Skin, URT, CNS, liver, GI, blood	Irr., narcosis, derm., stomach pain, incoordination, staggering gait
	One of the safer classes.		
L	Least toxic in class.	Eyes, nose, skin, CNS	Irr., headache, drowsiness, fatigue
L, S	Use ethanol when possible. Toxic effects due to the metabolic products formaldehyde and formic acid, occurring primarily from ingestion or repeated high-level exposure. No approved filtering medium.	Eyes, skin, CNS	Blurred or double vision, loss of peripheral vision, optic nerve damage, blindness, narcosis
L, S	One of least toxic in class.	Eyes, skin, CNS	Irr., headache, drowsiness
L	Least toxic in class. Principal hazard is fire and explosion.	Skin, URT, CNS, eyes	Irr., narcosis, derm.
L	–	Skin, URT, CNS	Irr., narcosis, derm.
L, S	Can cause PNS damage after 4 to 8 weeks' exposure.	Skin, URT, CNS, PNS	Numbness and weakness of hands and feet, narcosis
L	–	Skin, URT, CNS	Irr., narcosis, derm.
L, S	Use mineral spirits or odorless paint thinner when possible.	Skin, eyes, URT, lungs, CNS, kidneys, bladder	Irr., derm., sensitization, pulmonary edema, narcosis, convulsions, kidney and bladder damage, fever
L, S	Do not use: Absorbed rapidly through skin, causes birth defects in animals, penetrates many gloves. Check with manufacturer for appropriate protection.	Skin, eyes, URT, CNS, kidneys, liver, reproductive system, blood	Headache, irr., narcosis, renal failure, pulmonary edema, fatigue, anemia
L, S	Do not use: Absorbed rapidly through skin, causes birth defects in animals, affects bone marrow, penetrates many gloves. Check with manufacturer for appropriate protection.	Skin, eyes, CNS, reproductive system	Irr., allergies

Abbreviations:
CNS–central nervous system
CVS–cardiovascular system
derm.–dermatitis
GI–gastrointestinal system
Irr.–irritating to eyes, skin and/or URT
PNS–peripheral nervous system
URT–upper respiratory tract

FIG. 2: ADHESIVES

	Hazardous Solvents or Materials	Comments	Organs Affected	Symptoms
Nitro cellulose cement	Acetone (39%)	See figure 1.	–	–
Casein (dry powder)	Strong alkalis	Irritating dust possible when mixing powders.	URT, lungs, eyes	Irr.
Plastic resin glues (urea-formaldehyde) and resorcinol	Formaldehyde	Out-gases formaldehyde, a suspected carcinogen. Avoid breathing powder and fumes. Wear appropriate gloves. Fumes may arise from machining plywood. Formaldehyde has a TLV of 1 PPM.	Skin, eyes, URT	Irr., bronchospasm, pulmonary irr., derm., nausea, vomiting
Epoxy hardeners and resins	Aliphatic amine, diglycidyl ethers	Main toxicity is due to extremely alkaline amine curing agents, which are highly caustic. Uncured liquid resins are irritants and sensitizers. See figure 1.	Skin, URT, eyes	Irr., burns, allergies
Instant glues and accelerators	Cyanoacrylate, freon	Bonds skin, which requires solvent (acetone) to separate.	Skin, URT	Irr., pulmonary edema, headaches
Acrylic plastic glues	Methyl methacrylate	TLV is 100 PPM.	Skin, URT, eyes	Irr., mucous membrane irr.
Contact cements	Aliphatic and chlorinated hydrocarbons	All are toxic, solvent based and most are highly flammable. See figure 1. Nonflammable cements contain 1-1-1 trichloroethane (methyl chloroform).	Skin, CNS, CVS, eyes, liver	Headache, irr., derm., CNS depression, narcosis, more. See figure 1.

area," should not be taken lightly. For more detailed information on the safe use and storage of a particular product, request a material safety data sheet (MSDS), which is outlined on the facing page. The new United States and Canadian right-to-know laws require employers make MSDSs available to employees working with potentially hazardous materials. MSDSs are also available from either the product manufacturer or the local distributor.

Since chemical toxicities usually occur through inhalation and skin contact, it is important that such exposures be minimized to prevent injury. Provide adequate ventilation by exhausting fumes away from you to the outdoors with a source of fresh replacement air. This can be facilitated by placing a fan to your side, blowing across the work area toward the means of exhaust. A fan blowing from behind can actually create a low-pressure area directly in front of your body, drawing the toxic fumes toward you.

In addition to ventilation, most manufacturers recommend using a respirator, which is available in a variety of styles from a low-cost disposable mask to a full-coverage self-contained breathing apparatus that has numerous filtering media designed to handle specific toxins and concentrations. Consult the package, MSDS or manufacturer for the protection appropriate for your situation. Many solvents can be effectively filtered through activated charcoal. However, check with manufacturers first, because there are no approved filters or cartridges for certain solvents, such as methanol and methylene chloride. There also aren't any that will protect you from very high concentrations of chemicals, such as from a spill, which cause cartridges to saturate quickly. Even when exposed to low concentrations of contaminants, activated cartridges have a limited life span, Again, consult the manufacturers for the cartridges' life span, keep track of the time you wear them and seal them in a plastic bag when not in use because exposure to air decreases their useful life span.

Effective function of a respirator depends on proper fit, which can be checked by placing your hands over the cartridges, sucking in and holding your breath. If there is an air leak, the mask will return to its original shape, The Occupational Safety and Health Administration (OSHA) requires more formal fit tests and employers should check with their respirator supplier for more details. Because beards prevent masks from sealing tightly to the face, OSHA usually requires bearded employees to wear an "air-powered" respirator, which supplies filtered air under pressure to a mask or hood. Home or self-employed bearded users can try smearing their beards with petroleum jelly for a tighter seal. If the chemical you use is also an eye irritant, use a full-face respirator that covers the eyes.

To prevent direct skin contact, wear gloves specified by the chemical manufacturer. This is important even when using a nontoxic finish because it may require using a solvent, such as mineral spirits, to remove the finish from your hands. Barrier creams, also a skin protection method, are less effective and should only be used to resist occasional splashes rather than direct contact. Try to avoid using solvents to clean your hands and be sure to wash with plenty of soap and water after handling any solvents.

All of these precautions are meant for healthy adults. You may need to take extra precautions if you have heart disease, lung problems, chronic illnesses or disabilities, or take medication. For example, methylene chloride is known to cause heart attacks and should be particularly avoided by someone with coronary heart disease, Children and the elderly also are at greater risk from solvents and chemicals. Children under 13 should not work with solvent-containing materials. At greatest risk is the fetus, From before conception through cessation of breast feeding, women should avoid exposure to all chemicals. Also, chemical exposures should be avoided by men prior to conception to reduce the risk of genetic abnormalities.

All woodworkers should consult their physicians anytime they experience any of the previously mentioned symptoms. Always be prepared to help physicians make a diagnosis by telling them the chemicals you use and that you are exposed to wood dust. And even if you have no symptoms, have regular checkups. □

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Reading a manufacturer's safety sheet

by Charley Robinson

A material safety data sheet (MSDS) provides helpful information for working safely with potentially hazardous chemicals. Employers must have an MSDS for products that contain hazardous ingredients, but you should be able to obtain one from chemical suppliers or a manufacturer's technical or customer service department. Some companies are now including an 800 hot-line number on the product label that you can call for additional information.

All MSDSs must contain certain information. OSHA has suggested a format, as shown below, but many manufacturers develop their own style. Generally, information is organized in sections and is self-explanatory. The following terms and information will help you further understand the MSDS.

Identity: The product trade name, chemical name and usual synonyms.

Section II—Hazardous ingredients: Each hazardous ingredient comprising more than 1% of the total, or more than 0.1% if carcinogenic, must be listed, except those ingredients the manufacturer claims are a trade secret. Any known health hazards of secret ingredients must be disclosed in a later section. Many ingredients, especially trade secrets, have never been studied, so their risks are unknown. Ingredients, such as formaldehyde, that can produce toxic effects at levels less than 0.1% must be indicated. This section indicates OSHA-permissible exposure levels (PEL) and short-term exposure limits (STEL), which are OSHA-enforced. Also, the threshold limit values (TLVs), updated annually by the American Conference of Governmental Industrial Hygienists (ACGIH), are included. All of these values are expressed in parts per million (PPM). The PEL and TLV numbers indicate the airborne contaminant levels that most healthy, adult workers may be repeatedly exposed to for 8 hours a day, 40 hours a week without adverse effect. The STEL number is the maximum concentration of contaminant that a worker should be exposed to for a specified time, usually 15 minutes.

Section III—Physical data: An essential piece of information is the vapor pressure (VP), which indicates the force exerted by the evaporated vapors on the atmosphere directly above the liquid, usually in millimeters of mercury (mm Hg). The greater the vapor pressure, the more volatile the liquid.

Section IV—fire and explosion hazards: The flash point (FP) is the lowest temperature at which vapors above a volatile combustible substance ignite in air when exposed to flame. Materials with a FP below 100°F are dangerous because a spark or static electricity can cause a fire or explosion. No FP means the material is nonflammable. The appropriate fire extinguisher and special fire hazards, such as spontaneous combustion from linseed oil-soaked rags, should also be specified here.

Section V—Reactivity data: A chemical's stability, its likelihood of reacting with other materials and all special cautions to be taken, as shown on the form, are revealed here. Don't mix chemicals without reading this section.

Section VI Health hazard data: This section usually specifies how chemicals normally enter the body, the acute effects of exposure, signs and symptoms of exposure, and emergency and first-aid procedures. A manufacturer must identify all ingredients classified as a carcinogen by OSHA, the International Agency for Research on Cancer (IARC) or the National Toxicology Program (NTP).

Section VIII—Control measures: Because of manufacturers' concerns for liability, protective measures are often geared to the worst possible circumstances, such as a large spill. A manufacturer might suggest, for example, using a self-contained breathing apparatus when any approved respirator would suffice for limited exposure. □

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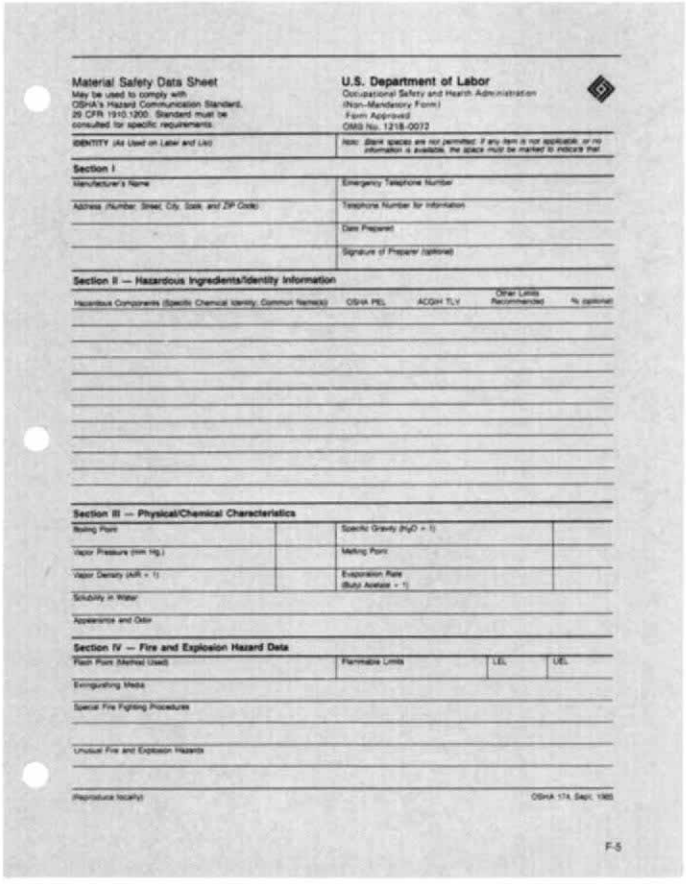

Material Safety Data Sheet
May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

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

IDENTITY (As Used on Label and List)

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

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

Section II — Hazardous Ingredients/Identity Information
Hazardous Components (Specific Chemical Identity; Common Name(s)) | OSHA PEL | ACGIH TLV | Other Limits Recommended | % (optional)

Section III — Physical/Chemical Characteristics
Boiling Point | Specific Gravity (H2O = 1)
Vapor Pressure (mm Hg.) | Melting Point
Vapor Density (AIR = 1) | Evaporation Rate (Butyl Acetate = 1)
Solubility in Water
Appearance and Odor

Section IV — Fire and Explosion Hazard Data
Flash Point (Method Used) | Flammable Limits | LEL | UEL
Extinguishing Media
Special Fire Fighting Procedures
Unusual Fire and Explosion Hazards

(Reproduce locally) OSHA 174, Sept. 1985

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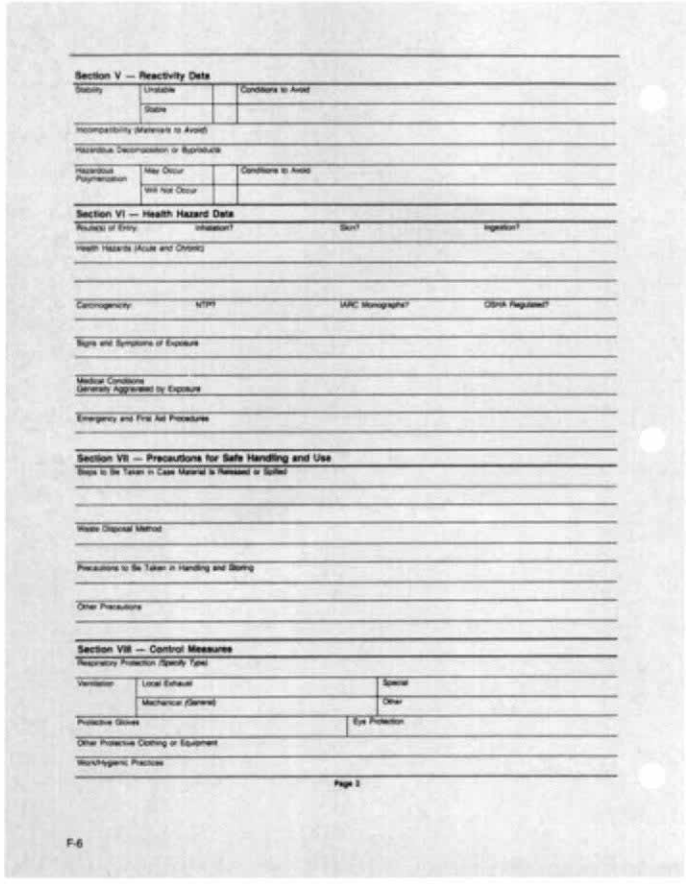

Section V — Reactivity Data
Stability | Unstable | Conditions to Avoid
Stable
Incompatibility (Materials to Avoid)
Hazardous Decomposition or Byproducts
Hazardous Polymerization | May Occur | Conditions to Avoid
Will Not Occur

Section VI — Health Hazard Data
Routes(s) of Entry: Inhalation? Skin? Ingestion?
Health Hazards (Acute and Chronic)
Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?
Signs and Symptoms of Exposure
Medical Conditions Generally Aggravated by Exposure
Emergency and First Aid Procedures

Section VII — Precautions for Safe Handling and Use
Steps to Be Taken in Case Material Is Released or Spilled
Waste Disposal Method
Precautions to Be Taken in Handling and Storing
Other Precautions

Section VIII — Control Measures
Respiratory Protection (Specify Type)
Ventilation | Local Exhaust | Special
Mechanical (General) | Other
Protective Gloves | Eye Protection
Other Protective Clothing or Equipment
Work/Hygienic Practices

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