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Safety Guide for Art Studios

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Many of us have handled and worked with materials associated with the arts since childhood, and it is difficult to believe that these creative efforts could be hazardous to our health. However, research has shown that an artist's craft has the potential to adversely affect his/her health. If not properly used, art materials and processes can cause physical injury or illness or initiate fires.

It is essential for artists to understand studio hazards and how to protect themselves and those working around them. This safety guide provides an overview of the hazards associated with the arts and is intended to help instructors safely orient their students to those hazards. Labor and environmental laws extensively regulate many of these areas. This guide is not intended to replace the safety standards and training required of institutions and their employees. Specific resources pertaining to applicable workplace standards are listed in the reference section at the end of this guide.

While conducting a safety orientation for art students is a good first step, United Educators encourages art instructors to go further:

- Serve as a role model of good safety practices.
- Supervise the studios and enforce compliance with the school's safety policies and legal requirements.
- Take the initiative to identify and manage risks that may not be addressed in this guide.
- Document your diligence in creating a safe environment for students.

A special thanks goes out to all who reviewed this document. We particularly appreciate the efforts of two reviewers. Monona Rossol, President of Arts, Crafts and Theater Safety (ACTS) and author of several resources listed in the reference section, offered invaluable technical and compliance feedback in the development of this document. Debbie Fanning, Executive Vice President of Art & Creative Materials Institute (ACMI), provided thoughtful comments and compliance information.

Safety in the Studio: The Potential Hazards

Chemical Hazards Associated with Art Materials

It is imperative that you and your students understand the hazards inherent in the art materials you use such as toxicity, flammability, and reactivity, and the appropriate precautions to protect against illness or injury. Materials that are highly toxic, flammable, or reactive can be handled safely if the proper precautions are followed. However, even materials of low toxicity that are normally considered to be "safe" can lead to accidents and toxic exposures if students ignore appropriate procedures and precautions.

Find Out About the Hazards of the Materials You Are Using

Two good, immediately available sources of health and safety information are: a product's label and its Material Safety Data Sheet (MSDS). As an instructor, you need to be able to teach your students about using these two resources.

Product Labels

Two federal labeling standards apply to art products: the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard and Labeling of Hazardous Art Materials Act (LHAMA).

Under the OSHA Hazard Communication Standard, hazardous art materials, like other chemical products, must be labeled with: (1) the common name of the chemical or product; (2) the name, address, and emergency phone number of the company that manufactured the product; and (3) an appropriate hazard warning which may include words such as DANGER, WARNING, or CAUTION. DANGER is reserved for products that have serious health or safety hazards associated with them, such as being highly toxic, corrosive, or flammable. WARNING and CAUTION are used on less hazardous substances. Most labels provide additional safety information including a list of specific potential hazards associated with the material, protective measures to be used when handling the material, personal protective equipment or clothing that should be worn, first aid instructions, storage information, and procedures to follow in the event of a fire, leak, or spill.

LHAMA amends the Federal Hazardous Substances Act which required manufacturers to evaluate and label consumer products only for acute hazards. LHAMA requires that information about chronic or long-term hazards be present as well on the label of art and craft materials. Manufacturers must evaluate their products' ability to cause chronic illness and use label information to warn consumers about those hazards. The law, which encodes existing voluntary standards, was needed because art and craft materials were exempt from consumer lead laws, although they could contain lead and other hazardous substances such as mercury and cadmium not usually allowed in consumer products.

Under LHAMA, all art material labels must include: (1) a statement that the product and its labeling conform to ASTM D-4236. This does not mean that the product is safe, only that following the label's advice should enable the consumer to use the product safely; (2) a list of all potentially hazardous ingredients and signal words such as Caution or Danger (Note: manufacturers may consider some ingredients to be proprietary and therefore are not required to list those specific ingredients even if they are hazardous); (3) chronic hazard statements which inform the user of the kind of harm the product might cause such as, "Cancer Agent," or "Exposure may cause allergic reaction"; (4) precautionary statements which tell the user what actions they must take in order to use the product safely; (5) a manufacturer's telephone number; and (6) a statement that the product is not appropriate for use by children.

Note that materials deemed to be "non-toxic" by the certifying toxicologist only need to have the manufacturer's name and address and an ASTM D4236 conformance statement. Products labeled "nontoxic" may also contain chemicals for which

there are no chronic toxicity data. Use all art products with care.

Material Safety Data Sheet

Product labels are good sources of initial information about the principal hazards associated with a container's contents, but they are brief summaries that are not meant to replace a product's MSDS or other reference material.

An MSDS is a chemical- or product-specific health and safety reference document. It provides detailed information about the hazards associated with a chemical or product and precautions for handling it. The chemical or product manufacturer prepares the MSDS and it is available from the manufacturer, distributor, or importer listed on the product's label. MSDSs must be on file at your institution, and it is advisable to keep current copies in your shop, studio, or work area. Consult an MSDS whenever your students begin working with a new chemical or product and review MSDSs periodically to see if the information has changed. Although the format varies widely, the information found on an MSDS is consistent and includes:

- Manufacturer's name, address, and phone number.
- A list of the product's hazardous ingredients including permissible exposure limits.
- A description of physical and chemical properties, as well as flammability and reactivity data.
- Health hazard information, including short- and long-term exposure effects, symptoms of overexposure, and a description of appropriate first aid and medical treatment to use in case of excessive exposure.
- Precautions for the safe handling, storage, and use of the product.
- A description of how to safely handle the material under normal and emergency situations.
- Control measures including personal protective equipment, ventilation, and work/hygiene practices.

The quality of the information on MSDSs varies widely. Unfortunately some manufacturers use generic statements that are of limited value. In other cases, the health and safety guidelines have been written to address worst-case scenarios that are more typical of industrial settings and would be unusual in an art studio or shop.

Your institution is required to provide training on how to read MSDSs to all employees who use toxic materials. Training will help you learn about the products you and your students use and enable you to answer any questions they may have about the safety of the art materials and processes they will be using. Teach your students how to interpret the available safety data. If after your training you are unsure how to read a particular MSDS, consult one of the references at the end of this document or a safety professional at your institution.

How Can Art Materials Affect Your Health?

Determining whether an art material may cause harm depends not only on the toxicity of the material, but also the dose you receive. In order for an art material to affect your health, it must first enter your body and then reach an area of the body (termed the target organ or system) in a large enough concentration or dose to cause harm. Just as you need to take a sufficient dose of a medicine to have a desired effect, so must you be exposed to a sufficient quantity of a hazardous material to be harmed. Factors such as the length of time you are exposed and how often you are exposed influence the effects.

Toxic materials can exert their harmful effects immediately (acute effects) or after a long period of exposure (chronic effects). Minor acute effects such as nausea, lightheadedness, or irritation are generally brief and reversible, but acute effects can also be as severe as death. Chronic effects such as cancer, fibroses of the lung, or liver damage are generally not reversible. Whenever possible, substitute a less toxic material for a highly or moderately toxic one.

People involved in the arts are most likely to be exposed to toxic materials by either skin contact or inhalation. A few exposures (particularly to metals) may occur through ingestion. Even though the skin is a very effective barrier, certain heavy metals such as mercury and solvents such as toluene, methyl alcohol, and glycol ethers can quickly penetrate it and, once in the body, cause harm. Other materials used in the arts, such as corrosives (acids and alkalis), can attack and destroy the outer layers of the skin, creating serious burns. Skin burns and absorption of

toxic materials through the skin can be avoided by wearing chemically impermeable gloves and other chemical protective equipment and by washing contaminated skin surfaces immediately.

Many substances enter the body through inhalation of vapors, gases, fumes, mists, or dusts. For example, the solvent components of paints and inks evaporate after being applied to surfaces and may then be inhaled. Airborne contaminants in art studios can also include irritant gases and vapors emitted from photographic development solutions, polyester, epoxy, or urethane resins, as well as fumes from welding, wood dusts from woodworking, and gaseous emissions from kilns. Work that may generate airborne contaminants must be adequately ventilated to maintain safe levels. If ventilation alone can not maintain safe levels, a respirator may have to be worn.

Ingestion may occur when hands, food, a cigarette, or anything else that has become contaminated comes in contact with the mouth. Ingestion is frequently the route of exposure to metals when working with painting pigments, ceramic glazes, or welding. You and your students should NEVER point the tip of your paintbrush with your lips or hold the dirty handle of your brush in your teeth! Exposure though ingestion can be avoided by frequently washing your hands, not eating or smoking in the studio, and keeping all objects out of your mouth. Prohibit eating and smoking in the art classroom or studio. Consider adopting a policy about alcohol consumption and drug use (both prescription and illegal) during studio time and beforehand.

What is a Safe Level of Exposure to Toxic Materials Used in the Arts?

A number of governmental organizations and professional associations publish exposure standards or guidelines for airborne concentrations at levels that nearly all healthy adults are believed to be able to tolerate without adverse health effects. Exposure limits for a product's hazardous or toxic components are listed on the product's MSDS. Some people (such as young children, pregnant or nursing mothers, and individuals with health conditions such as asthma) are at higher risk of exposure to art materials. If you have concerns about how a hazardous material may affect a student due to a special health condition, you should talk with a medical or safety professional and with the student.

The lower the exposure limits are, the more toxic the substance is.

In your classroom, as a rule of thumb, try to use solvents with exposure standards above 100 ppm whenever possible. For example, replace mineral spirits (100 ppm) with odorless paint thinner (300 ppm), or eliminate old rubber cements containing n-hexane (50 ppm) and use new ones which contain heptane (400 ppm).

All solvents should be used with ventilation which is discussed in more detail later in this guide. The more toxic the solvent, the more solvent used, and the more quickly it evaporates (or vaporizes into the surrounding air), the greater the volume of dilution air (ventilation rate) should be.

Fire Hazards Associated with Chemicals Used in the Arts

The fire hazards associated with artist's materials are often overlooked, yet fire may be the greatest risk artists face. Common art materials that may cause a fire include flammable or combustible solvents, oily rags, chemical oxidizers, and compressed welding gases.

Improper use of solvents causes most art-related fires. Artists must be aware of a solvent's flashpoint and volatility, the two primary properties that influence a solvent's ability to initiate a fire.

The flashpoint, the single most important factor, is the temperature at which a solvent gives off enough vapor to form an ignitable mixture with air and can ignite in the presence of an ignition source such as a flame or electrical spark. The lower the flashpoint, particularly when it is at or below room temperature, the more hazardous the material.

A substance's volatility determines how much of it will evaporate and mix with air. In order for a solvent to catch fire, it must evaporate and its vapors must mix with air to form the right fuel/air ratio (typically 1-3 percent). The more volatile the solvent, the more readily it will evaporate and the more likely it will create an ignitable fuel/air mixture. Acetone is extremely volatile and if spilled, it will evaporate almost instantly. Mineral spirits, which has a much lower volatility than acetone, will evaporate much more slowly if spilled.

To control the risk of a fire, always choose a solvent with the highest possible flashpoint and the lowest possible volatility. Ventilate the area to keep the

solvent concentration from reaching an ignitable air/fuel mixture. Remove ignition sources such as open flames and electrical equipment that may generate sparks. Vapors from flammable solvents are heavier than air. They can travel some distance to an ignition source and then flash back to the solvent source. When dispensing flammable solvents from large metal containers, ground both containers to dissipate static electrical charges.

To prevent fires, store rags soiled with setting oils (tung oil, linseed oil) in tightly closing metal containers and have them picked up daily for professional laundering or disposal. (Refer to the ACTS Web site in the reference portion of this guide for additional information on setting oils.) Flammable solvents should be stored in a storage cabinet designed for flammable materials. When using flammable solvents out in the studio, store them in safety cans. If you handle chemical oxidizers such as chlorates, chromates, nitrates, or peroxides, store them apart from organic solvents and other readily combustible materials in storage units specifically designed for these materials. Some types of substances such as organic peroxides and nitric acid are so reactive they should be stored separately from all other chemicals. If you use compressed gases, such as acetylene or propane, be familiar with all the complex regulations that apply to them. Secure them in an upright position and test the regulator fittings and connections for leaks before using them. Store flammable compressed gases separately from compressed oxygen.

Physical Hazards

Physical hazards in the arts include ultraviolet and infrared radiation, noise, vibration, stress to the muscular skeletal system from repetitive motion or excessive lifting, improperly maintained equipment, and poor storage and process management. They also include injury arising from carelessness and inattention.

Ultraviolet (UV) and infrared (IR) radiation are particular wavelengths of the electromagnetic spectrum just like visible light. The sun generates these types of radiation. UV radiation is also produced by electrical arcs such as those associated with arc welding or carbon arc lamps. UV radiation from any source can cause sunburn, conjunctivitis (pink eye), cataracts, and skin cancer. IR radiation which is emitted from hot objects, such as molten metal or glass and fired ceramics, can cause skin burns. It can be especially intense when working in a foundry or around kilns, or while glassblowing. Both UV and IR can damage the cornea, lens, and retina of the eye.

Teach your students to control their exposure to these radiation sources by avoiding carbon-arc lighting when possible, covering skin surfaces, and wearing appropriate shaded eye protection. If your students are welding, it is also important that they screen their work from others so no one will be inadvertently exposed. Radiation intensity decreases quickly with distance so encourage your students to increase their distance from radiation sources if possible and keep others away.

Noise is common in arts studios and is produced by such things as woodworking and metal working machinery; hand, electrical, and pneumatic tools; and exhaust fans. Exposure to high levels of noise over a period of time can lead to permanent hearing loss. Symptoms of excessive noise exposure include a temporary ringing in the ears or difficulty hearing after exposure. If you must raise your voice to be heard by someone just a few feet away, the noise level is too high. The noise level emitted from equipment or processes may be reduced by dampening vibration, isolating noise-producing equipment, or installing sound-absorbing materials. Such changes often require specialists and may be difficult and expensive. Fortunately, hearing protection in the form of earplugs or earmuffs can be worn to reduce noise exposure in noisy environments. You should instruct your students about the different types of ear protection and the proper use and care of this protection.

The work of many artists—such as potters, glassblowers, and weavers—involves repetitive motion. Repetitive motion, particularly of the hands, wrists, and arms, can lead to painful inflammation of muscles, tendons, and nerves over time and cause the eventual deterioration of those tissues. The symptoms associated with repetitive-motion disorders can include pain, warmth, swelling, and difficulty moving the joint involved. The continuous, often extreme bending of wrist, elbow, and shoulder joints leads to these disorders. Grip positions that use high-force finger pinching along with a bent wrist have been associated with the disorder called carpal tunnel syndrome. Hand polishing and sanding, and drawing and painting in awkward postures, are examples of high-risk repetitive tasks.

To prevent these injuries, select appropriate tools and show students how to lay out their work so they can

use more neutral postures (for example, a straight wrist) while performing tasks. Encourage students to take frequent rest breaks to stretch muscles and schedule their work to alternate tasks. This lets them use and rest different muscles. Teach students to use as light a grip as possible when holding tools. If they cannot relieve joint pain by taking time off or reducing stress on the joint, they should seek medical assistance. Repetitive motion disorders can be disabling if not treated early.

Back injuries may occur from lifting heavy objects such as sculptures and lithography stones. Use mechanical aids such as hoists whenever possible to move heavy objects. Instruct students to lift in pairs if the object weights more than 50 pounds. Demonstrate proper lifting techniques for students including flexing your knees, keeping your back straight, holding the load close to your body, and lifting with your legs. Tell students they should never lift and twist at the same time.

Fires and electrical shock may be caused by overloaded electrical circuits, extension cords, or power strips or tools that are not properly grounded. Purchase tools that are double insulated. Reduce the use of extension cords and power strips by replacing them with hardwired ground fault circuit interrupter (GFCI) protected outlets whenever possible. When an extension cord must be used, purchase the type with a GFCI built into it. If your electrical circuit breaker trips, reduce the load and reset it once. If the circuit trips again, obtain the assistance of an electrician. The circuit may have a short that could lead to a fire.

Finally, poor process management can cause an injury. For instance, in one art department, bulk supplies were received in paper bags. One student grabbed the wrong bag and used lime instead of plaster of Paris. He suffered severe burns resulting in the loss of several finger tips and requiring extensive plastic surgery. Another student took concentrated nitric acid for an etching project, but slipped on a wet floor and spilled it on herself. Although she received immediate first-aid, her arm was permanently scarred.

As an instructor, it is important for you to work with your students to create a safe artistic environment. Pay attention to general housekeeping to prevent slips and falls. Clearly mark and appropriately store art materials. Communicate your school's safety policies to your students and hold each student accountable for compliance. Provide specific warnings and instructions for use of hazardous machines and equipment. Post general safety rules in a visible and conspicuous place. Do not tolerate the disabling of any safety guards or misuse of the machines, tools, or equipment. Take disciplinary action where necessary. If you are concerned about a premises hazard, or the condition of a machine or piece of equipment, immediately report it to your institution's safety coordinator and take precautions to minimize student contact with the hazard.

Safety in the Studio: Methods for Controlling Exposures

Ventilation

Older art studio designs often overlooked the importance of proper ventilation, and art instructors often have to rely on an open window, door, or a window air-conditioning unit for ventilation. In many instances, these measures do not provide appropriate ventilation. There are two basic methods for adding ventilation to spaces in which toxic materials are used: dilution and local exhaust.

Dilution ventilation introduces clean air into the studio which mixes with the contaminated air before being exhausted outside by a fan. This ventilation method dilutes the air-borne contaminants to a safe level. It typically requires large volumes of air. Ideally the source of the contaminants is positioned between the fan and student, so the contaminated air is drawn away from the student. The preferred location for introducing clean air into the studio is behind the student—the clean air sweeps past the student before mixing with contaminated air. Dilution ventilation is typically appropriate when small quantities of slightly to moderately toxic materials are used.

Local exhaust ventilation captures contaminants at their source by use of a hood. It exhausts the contaminants directly outdoors through a duct system. In some systems, particularly those used to collect dust, a filter cleans the air stream before discharging it to the outdoors. A local exhaust system is the preferred ventilating system for processes that release moderately to highly toxic compounds and dusts. Art processes such as silk screen printing, acid etching, paint spraying, welding, woodworking operations, and photographic development often use local exhaust ventilation to protect artists.

Hood design and use often determine the effectiveness of the system. Some hoods, such as spray booths, completely enclose the source. Others consist of slotted hoods, canopy hoods, or flexible or fixed duct pipe systems that are positioned adjacent to the source. These must have a strong enough air draw to capture and pull in air contaminants.

Students should position their work as close as possible to slotted hoods or movable hoods because the contaminant-capture efficiency drops dramatically with distance. When working within a hood that encloses the source, instruct students to work as far back into the hood as practical. Before starting to work, make sure that the local exhaust system is on and that there is sufficient airflow through the system to capture air contaminants. Smoke or air-current tubes can be used to test the capture efficiency of local exhaust ventilation systems.

Personal Protective Equipment

In the process of controlling your students' exposure to hazardous chemicals or physical agents, the first step should be the substitution of safer materials, even if they are more expensive. The second step should be controlling exposure through ventilation or other protective measures (such as limiting length or amount of exposure). If these controls are not adequate, it may be necessary to wear personal protective equipment (PPE).

Gloves are one of the more common types of personal protective equipment and can be worn to protect the hands from a variety of hazards associated with the arts. Leather gloves protect hands from sources of heat, sparks, and cuts. Heavy cotton work gloves can protect against abrasions and slivers. Rubber or other elastomeric gloves protect against chemical exposure to solvents, acids, and bases.

In order to be effective, chemical protective gloves must be selected based on the chemicals used. No glove is appropriate for all chemicals. Chemicals can degrade, penetrate, and in some instances permeate gloves without visual evidence. Most glove manufacturers produce and freely distribute charts that identify appropriate gloves to wear when working with different

chemicals. Many of these are available at glove manufacturers' Internet sites. You should consult your glove manufacturer's chart when selecting gloves for your students. Instruct students about appropriate glove care. For example, students should rinse their chemical gloves before removing them and wash their hands afterwards.

It is important to protect the face and eyes from flying particles, chemical splashes, or infrared (IR) or ultraviolet (UV) radiation. The type of face or eye protection to be worn depends on the type of hazard present and severity of exposure. To protect against flying particles, wear safety glasses with side shields or goggles (preferred). Add a face shield if the potential exposure is severe. Chemical splash goggles should always be worn to protect the eyes when pouring or mixing chemicals and at all other times when there is a chance of chemical splash. The vents on these goggles are located to prevent a splash from entering the goggle. To protect the face from corrosive material, add a face shield over goggles. To protect the eyes from IR or UV radiation while welding, brazing, soldering, glassblowing, or working in a foundry, wear shaded safety glasses, goggles, or a welding helmet. Specific eye and face protection recommendations for different types of hazards can be found in several references at the end of this section.

Respirators should only be worn when the task or work area cannot be adequately vented to reduce the exposure to a safe level. Respirator selection must take into consideration a number of factors. These include the type of contaminants present (for example particulates, gas, or vapor); the concentration of the contaminant; the duration of exposure; and the functional and physical characteristics of the respirator. Seek the assistance of your institution's health and safety professional if you are considering selecting respiratory protection for use in your studio.

OSHA requires that respirator use must be governed by a written program that defines how respirators will be selected, used, stored, and maintained, as well as how users will be trained and medically evaluated prior to wearing them.

Other types of personal protective equipment that can be worn in art studios include: (1) earplugs and earmuffs to protect against high noise sources; (2) safety shoes to protect against sparks, molten metal, heavy objects, electric shock, static electricity build up, and sole punctures; (3) hard hats to protect against falling and flying objects and electric shock; and (4) miscellaneous garments such as aprons, coveralls, leggings, sleeves, and knee pads to protect the arms, legs, or front of the body from chemicals, flying objects, molten metal, and sparks.

Instruct students to carefully examine all personal protective equipment, particularly reusable equipment, before using it to ensure that there are no defects. Have students report and return any defective equipment for replacement.

Require students to tie back long hair. When working around furnaces, recommend that students wear long-sleeved closely woven cotton fabrics to protect against heat. Prohibit polyesters and other synthetic clothing which might melt from contact with molten metal or glass. Prohibit dangling jewelry and loose clothing when working with power tools.

Storing, Handling, and Disposing of Art Materials

The manner in which you store art materials, handle them, and clean up afterwards will significantly influence the risk of accident or exposure. This is particularly true in studios handling flammable and toxic materials.

Follow these general principals of safety storage: (1) only store compatible materials together (identify incompatible materials on an MSDS); (2) store chemical containers in cabinets, never on the floor or on shelves above shoulder height (particularly flammable solvents, acids, or bases) where they may fall and break; and (3) make sure all containers are labeled and in good condition (keep materials in their original containers or containers made of the same material). Avoid putting chemicals in breakable containers, food containers, coffee containers, or containers with loose fitting lids. Make sure that all compressed gas cylinders are secured in an upright position and have the valve protection cap on when storing or transporting them.

When handling flammable or toxic materials, keep containers closed except when you are actually removing material from them. Do not allow students to eat, drink, or smoke in the studio or art project area. These activities could lead to ingestion of toxic materials or cause a fire. Impress upon students the danger of working alone in the studio.

Students should wear the appropriate personal protective equipment necessary to protect their skin, eyes, or respiratory system. If working with toxic materials, instruct students to wear clothing reserved just for that purpose, and remove it when leaving the

studio. This clothing should be washed frequently, separate from other items. Better yet, provide disposable coveralls for the students. Before they leave the studio/classroom, instruct students to wash thoroughly with soap and water any skin surface such as face, hands, and arms that may have become contaminated. Warn students that they should never use solvents to clean their hands.

Poor housekeeping can create an unsafe studio and cause exposure to toxic materials. Instruct students how to clean up spilled materials and spread absorbent to dry wet spots to prevent slipping hazards. Stress the importance of a prompt clean-up response. At the end of each session, wet mop or vacuum with a HEPA-filtered vacuum if students' work could generate highly toxic dusts such as lead, other heavy metals, or silica (fine clay). Dry sweeping re-suspends settled dust and does not remove it. Keep aisles free of obstructions such as chairs, boxes, and waste containers. Do not clutter the studio with combustible materials such as paper and cardboard.

Inspect all tools at the end of each day to make sure they are in good operating condition. Remind students to report any physical or mechanical problems with tools. Put tools and supplies away in a locked area to prevent unauthorized and unsupervised use of power tools which could lead to accidents.

Flammable, corrosive, or reactive materials and some toxic chemicals are considered hazardous wastes. Dispose of all hazardous wastes in accordance with your institution's hazardous waste policies and procedures. If you have questions, contact your institution's environmental health and safety officer about separating, labeling, and storing hazardous waste. Never dispose of hazardous wastes in the normal trash or down the drain. They will need to be sent to an EPA-permitted disposal or treatment site. Most institutions also have procedures for disposing of normal solid waste such as metal containers or cardboard. Always follow your institution's existing waste disposal procedures.

Emergency Preparedness

Studios in which artists handle hazardous materials should have eyewashes, safety showers, fire extinguishers, and first aid kits close at hand. Know where this equipment is located and how to use it. Instruct your students about the appropriate emergency response.

Keep all passageways to the emergency eyewash station and shower clear of any obstacles. Routinely check eyewash stations to be certain that water flows through them. Allow them to run for several minutes once a week to clear out the supply lines. Routinely check showers to assure that access is not restricted and that the start chain is within reach. The water flow through the safety showers should be tested periodically to ensure sufficient flow and clean out the water lines. The institution's facilities maintenance personnel should perform this test because of the high flow rates involved (30 gallons per minute).

Fire safety equipment should be easily accessible and must include a fire extinguisher (type ABC). Other equipment may include fire hoses, fire blankets, and automatic extinguishing systems. Check the closest fire extinguisher occasionally to make sure that it is fully charged and ready to use. Know how to activate the building's fire alarm and what the emergency procedures are for your classroom or studio. Make sure your students know this also.

Pay attention to housekeeping issues to ensure that emergency evacuation routes are clear and that materials on the premises will not cause someone to slip or trip and fall.

Maintain a first aid kit in close proximity to the classroom/studio. One individual should be assigned responsibility for ensuring that the kit is fully stocked, including PPE to avoid blood exposures. If medical assistance is not immediately available, consider first aid training for technicians or aides.

Make sure each studio has a phone accessible with emergency numbers prominently posted. Post the appropriate evacuation routes and make sure students know them.

Conclusion

Safety should be a constant focus in the studio and conveyed to your students daily. Providing a safe and healthful learning environment and teaching good safety and hygiene practices will help ensure that your students enjoy an enriching academic experience. The good habits they develop will carry forward to all their future artistic endeavors.

Where Can I Get Additional Information?

The following books and Internet sites contain information about safety in the arts and would be good sources to learn more about these issues.

Books

McCann, M. (1992). *Artist Beware.* New York: Lyons & Burford Publishers

McCann, M. (1994). *Health Hazards Manual for Artists.* Lyons & Burford Publishers

Rossol, M. (1996), *Keeping Clay Work Safe and Legal*. DC: National Council on Education in the Ceramic Arts.

Rossol, M. (1994). *The Artist's Complete Health and Safety Guide.* New York: Allworth Press

Shaw, S. & Rossol, M. (1991). *Overexposure: Health Hazards in Photography.* New York: Allworth Press

Spanderfer, M. (1993). *Making Art Safely: Alternative Methods & Materials in Drawing, Painting, Printmaking, Graphic Design and Photography*. New York: Van Nostrand Reinhold

Internet Sites

Government Resources

www.osha-slc.gov/SLTC/healthguidelines/index.html
www.osha-slc.gov/SLTC/contents.html
Lots of additional information on most of the topics discussed in this guide, as well as many additional links.

www.cdc.gov/niosh/homepage.html
Contains additional information on the topics discussed here.

Occupational Safety and Health Administration: www.osha.gov

Environmental Protection Agency: www.epa.gov

National Institute of Standards and Technology: www.nist.gov

Professional Associations and Resources

American Conference of Governmental Industrial Hygienists: www.acgih.org/links/welcome.htm

National Safety Council: www.NSC.org

National Fire Protection Association: www.nfpa.org

American National Standards Institute: www.ANSI.org

American Society for Testing and Materials: www.astm.org

Consumer Product Safety Commission: www.cpsc.org

Art-Specific Resources

www.caseweb.com/ACTS *Lists services, publications, and links to ACTS (Arts, Crafts and Theater Safety) e-mail addresses where individuals can obtain answers to safety questions. Also offers a monthly newsletter with current research, new regulations, and other relevant news items.*

www.acminet.org (available soon)
Web site for ACMI (Art & Creative Materials Institute) which certifies materials as safe for use by children and offers product substitution ideas. Lists certified products, informational publications, and other resource information.

www.goshen.edu/art/DeptPgs/safety.htm
Goshen College's Art Department Web site contains safety information on a variety of art materials and art processes. It includes gopher pages with information on hazards associated with the arts and their control.

www.arcat.com/arcatcos/cos08/arc08376.cfm
Web site for the National Art Materials Trade Association.

Painting/Printmaking

The hazards of painting and printmaking relate to the paints, inks, solvents, and corrosive materials associated with these activities. Carefully review the Material Safety Data Sheet (MSDS) for the products your students will be using in the studio and identify the hazardous components in each so you may inform your students. Learn how to protect your students by reviewing the information on the MSDS or by obtaining one of the references listed on page 9 and reviewing the specific information on the materials being used. The following table identifies some of the hazards associated with materials students may use in painting and printmaking and is followed by a list of precautions.

Activity	Material	Potential Hazard
Painting	Paint pigments/ Chalk dust	May be toxic by ingestion or inhalation (if mixing dry powders, sanding paints, or using pastels). Many inorganic pigments contain highly toxic metals and some organic pigments may cause long-term effects such as cancer. Wherever possible, substitute less toxic materials for powdered pigments containing lead, cadmium, or mercury.
Painting	Vehicle	Vehicles in paints may include solvents, oils, resin, and polymer emulsions that are released to the air as the paint dries. They are moderately toxic. Some vehicles are adsorbed through the skin and others may cause skin disorders.
Painting	Solvents	Solvents are used to thin paints and clean up materials. Solvents commonly used include turpentine, mineral spirits, acetone, toluene, xylene, acetates, and petroleum distillates. These materials evaporate quickly, contaminating the air, and are moderately toxic by inhalation. Some solvents are adsorbed through the skin. Many are flammable.
Painting	Varnishes and lacquers	These are solutions of natural and synthetic resins that are dispersed in solvents such as mineral spirits, turpentine, methyl and ethyl alcohol, acetates, toluene, and petroleum distillates. After being applied, the solvent base evaporates leaving the resin to react and harden. These solvents are moderately toxic by inhalation, and many are flammable. Some solvents are adsorbed through the skin.
Spray application	Paint pigments, vehicles, and solvents, varnishes/ lacquers	Spray guns, airbrushes, and aerosol spray cans release very fine mist particles that can remain in the air for several hours and are readily inhaled. All of the materials identified above (solvents, pigments, resins, and paint vehicles) may be present. Spraying dramatically increases your risk of exposure to these toxic materials. Many of these solvents are also flammable and spraying them into the air creates a flammable atmosphere. High-pressure spray guns may actually inject paint directly under the skin if it gets in the way of the spray.
Printmaking	Ink pigments, vehicles, and solvents	Same as paint (see above)
Printmaking	Acids and caustics	A variety of acids and caustics are used to etch and clean various media in intaglio and lithography. These materials are very corrosive to the skin, eyes and respiratory system, especially when concentrated.
Printmaking	Miscellaneous materials	A wide variety of miscellaneous materials used in lithography, intaglio, relief printing, and screen printing are irritants or moderately toxic. Consult the references on page 9 for information sources on these materials and their hazards.

Painting/Printmaking Precautions for Your Students

- If possible, use tube or pre-mixed paints and commercially available inks to avoid mixing your own. If you mix your own pigments, do it in a ventilation hood. Use water-based products instead of solvent-based ones where possible. Keep all chemical containers closed when they are not in use.
- Never use your lips to point the end of your paintbrush or hold your brush handle with your teeth. Because your hands become contaminated while working, do not eat, drink, or smoke in the studio. Wash your hands thoroughly when you finish working or leave the studio. Never wash your hands in a solvent. If your hands have cuts or are chaffed, wear gloves. Chemicals can pass through these breaks in the skin and enter directly into your blood stream. Washing your hands frequently may dry them out, increasing the risk for cracks and breaks to develop in the skin. Apply skin moisturizers regularly to prevent your skin from drying out. Good personal hygiene is one of the most important ways you can reduce your exposure.
- Use the ventilation measures described in this guide to control solvent exposures.
- Wear a full-length smock or coveralls in the studio and do not wear them outside the studio. Wash them frequently and separately from other clothing. If toxic materials are being used, wear a full-length disposable smock or coveralls that are removed and properly disposed of in the studio. Wear chemical protective gloves, apron, and eye protection (goggles) as necessary when handling solvents and corrosive chemicals, or when cleaning brushes, screens, and other equipment.
- If you will be applying a pint or more of a product that contains a flammable solvent, remove all sources of ignition from the area. Store flammable materials in a flammable-storage cabinet. Place all solvent-soaked rags and paper in self-closing oily waste cans and empty them daily. Know the location of the closest fire extinguisher and learn how to use it.
- Perform spray applications in a paint-spray booth or other locally exhausted hood. Choose brushing techniques rather than spray applications if possible.
- Avoid exposure to solvents during clean up by using disposable screens, brushes, and other equipment. Clean up small spills immediately.
- Use barrier creams to prevent casual contact with toxins.
- Wear glasses instead of contact lenses in etching studios to avoid acid vapors under the contact lenses.
- When moving heavy items such as litho stones, use appropriate lifting techniques, get help from another person, or use mechanical aids.

Ceramics

The hazards associated with ceramics have been recognized for hundreds of years. They are related to three aspects of the process: preparing and molding the clay, glazing, and firing the clay. Carefully review the Material Safety Data Sheet (MSDS) for the products your students will use, particularly glazing compounds, which often contain some highly toxic compounds. Identify the hazardous components in each product. Teach students how to protect themselves either by reviewing the information on the MSDS or by obtaining one of the references listed on page 9 and reviewing the specific information on the materials being used. The following table describes the potential hazards associated with different ceramic processes.

Activity	Material	Potential Hazard
Mixing dry clay	Dry clay	Clay contains crystalline silica, which if inhaled over the course of many years can lead to the debilitating lung disease silicosis. Loading and mixing dry clay in a clay mixer creates the most likely opportunity for exposure to the silica-containing clay dust.
Mixing dry clay	Talc	Talc added to clay may be contaminated with asbestos or "asbestos-like" fibers.
Mixing dry clay	Clay mixer, bulk materials	Like all mechanical equipment, clay mixers have moving parts that could catch your hand or arm if you reach into it while it is operating. Bags of dry clay and clay additives are heavy; repeated lifting can cause back injuries.
Handling wet clay	Wet clay, potter's wheel	Wet clay is a growth medium for mold and other microorganisms that can cause allergies and infections of the skin or nail beds. Mold can aggravate some pre-existing medical conditions such as asthma. Working with clay for extended periods of time on a potter's wheel can lead to a repetitive trauma disorder of the hand or wrist.
Glazing	Glaze	Glazes are mixtures of silica, alumina, metal fluxes (such as lead, barium, lithium, calcium, or sodium), and colorants. Some colorants contain highly toxic metals such as lead, cadmium, chromium, uranium, and arsenic. These metals should not be used in school programs if at all possible because safer substitutes are available. Many prepared glazes contain frits which are created by melting various glaze ingredients into a glass and grinding them into a powder. Frits containing toxic metals are hazardous and should be handled with caution since they can leach into the body over time and should not be used.
Firing Kiln	Clay	During the firing process, clay releases combustion products and gases whether using a fuel-fired or electric kiln. These emissions include carbon monoxide, formaldehyde, sulfur oxides, chlorine, fluorine, metal fume, and nitrogen oxides. Unless ventilation is excellent, metal fume particles such as lead and cadmium can settle and contaminate other ware and surfaces. In addition, fuel-fired kilns release the products of combustion from their fuel sources.
Firing Kiln	Clay	Infrared radiation emanates from hot (glowing) fired ceramics and can cause cataracts after long periods of exposure. Unloading hot objects from a kiln can cause burns.

Ceramics Precautions for Your Students

- If possible, avoid exposure to clay dust by purchasing pre-mixed clay. If you mix your own clay, the mixer should have local exhaust ventilation and be equipped with appropriate machine guards to prevent access to moving parts while operating. Consider wearing a respirator when mixing clay.
- When lifting heavy items such as bags of clay, clay additives, or glazing compounds, use appropriate lifting techniques, get help from another person, or use mechanical aids. Raise your potter's wheel so you can work in an upright position.
- Use asbestos-free talcs. Regularly wet mop, hose down, or vacuum (with a HEPA vacuum) the studio—particularly the dry mixing area—to remove potentially toxic dust such as silica and heavy metals. Do not allow spilled clay to dry; it can be crumble into an airborne dust.
- Purchase prepared glazes without toxic components whenever possible. If you do use or mix glazes containing highly toxic metals such as lead, cadmium, arsenic, or uranium, your institution must meet the applicable OSHA regulations.
- If you mix your own glazes, wear gloves. Mix glazes under local exhaust ventilation or wear a respirator. Avoid spraying techniques that will aerosolize the glazes. Instead, brush or drip glaze on your clay. If you must use spraying techniques, use a paint spray booth.
- Because your hands become contaminated while working, do not eat, drink, or smoke in the studio. Wash your hands thoroughly when you finish working or leave the studio. Good personal hygiene is one of the most important ways you can reduce your exposure.
- Regularly apply hand cream to replace lost oils and to keep your hands from drying out. Cover cuts or other broken skin with gloves to prevent infections
- Wear a full-length smock or coveralls in the studio and do not wear them outside the studio. Wash them frequently and separately from other clothing.
- Wear a disposable smock or coveralls if working with toxic metals. Remove the smock or coveralls before leaving the studio and dispose of in your institution's designated hazardous material container.
- All kilns must be locally exhausted and vented to the outside. Keep combustible materials, particularly flammable materials, away from kilns. Small kilns should be raised at least a foot off the floor with a refractory brick placed underneath. Keep a fire extinguisher close by and know how to use it.
- Wear appropriate shaded eye protection when looking directly into the kiln.

Note: If you are creating ceramics that will come into contact with food or drink, select a food-safe glaze that is periodically tested by a laboratory. Some glazes contain heavy metals such as lead and cadmium that can leach from glazed items after they have been fired. Using prepared glazes labeled "food safe" will not assure a safe product since small variations in application and firing can alter leaching characteristics. Most glazes leach their metals faster when exposed to acid solutions such as orange juice. The federal government has developed test protocols for evaluating the leachability of glazes and strict guidelines for the maximum acceptable lead/cadmium release from ceramic food ware.

Sculpture and Modeling Materials

The hazards associated with sculpture and modeling materials relate to the materials used in this art form and the techniques used to shape the medium. Materials include a variety of soft and hard stones, cement, plaster, self-hardening clays, and plasticine. Carefully review the Material Safety Data Sheet (MSDS) for the products you will use or the media with which you will work (such as the type of stone) and identify the hazardous components in each. Learn how to protect yourself either by reviewing the information on the MSDS or by obtaining one of the references listed on page 9 and reviewing the specific information for your materials. The following table describes the potential hazards associated with sculpting and modeling. The list of precautions below describes ways to protect yourself from these hazards.

Activity	Material	Potential Hazard
Sculpture	Stones	Stone carving involves chipping, carving, grinding, and polishing. The shaping process involves using hand tools to shape softer rocks, while harder rocks may require electric or pneumatic tools. By law, stone quarries must provide MSDSs on the stones they sell which must list all toxic materials such as silica and asbestos. Shaping processes generate flying chips of rock that can injure eyes and dust that can be inhaled. Sandstone, soapstone, slate, and granite are examples of rocks that contain large amounts of free silica that can become airborne during shaping. Stones such as serpentine, soapstone, and greenstone may contain asbestos.
Sculpture	Tools	Pneumatic and electric shaping tools may create high levels of noise and vibration. Exposure to loud noise can cause hearing loss over a long period of time. Using vibrating hand tools over an extended period of time can lead to Raynaud's syndrome, a condition in which hands cramp up, lose circulation, and are unable to move. Untreated it can lead to permanent hand impairment. Improperly grounded electrical tools may cause electrical shock, particularly if water is used to control dust. The hand tools used in carving can cause cuts and bruises if they are used improperly.
Sculpture	Plaster	Plaster dust (calcium sulfate) adsorbs water rapidly from any moist surface (such as skin or eyes) it contacts and can be very irritating to the skin, eyes, and respiratory system. Sometimes lime (calcium oxide), acetic acid, potassium sulfate, or other compounds are added to plaster to either retard or hasten the setting of the plaster. These materials are also irritants.
Sculpture	Cement	Cement, which is a mixture of lime, alumina, and silica, is a strong skin, eye, and respiratory system irritant for the same reasons as plaster.
Modeling	Clays	Self-hardening clays contain clay mixed with plastic resins and hardening agents. Non-hardening clays contain oils and petrolatum. Additional (often proprietary) materials are added to provide the desired properties. Consult the MSDS for your clay for a list of the materials it contains. Some materials in these products are irritants, while other materials (in self-hardening clays) have not been adequately tested for their health effects.
Modeling	Wax	Overheating wax can result in release of decomposition products that are highly irritating if inhaled. Chlorinated synthetic waxes are highly toxic though skin contact and absorption. Overheating wax containing water may lead to an explosion. Solvents used to dissolve wax may be moderately to extremely toxic.
Modeling	Plastics	A wide variety of resins (acrylic, phenolic, epoxy, polyester silicone, and polyurethane) may be used to mold, cast, and form plastic sculpture. As resins cure, some of the chemical components volatilize. They may reach high concentrations if used in large volume or if the work area is poorly ventilated. These materials are often irritants and may be toxic by skin contact or inhalation. Some are skin and respiratory sensitizers. Two-component urethane resin systems release extremely toxic isocyanates for which there are no approved air-purifying respirators. They may only be used with a supplied air hood.

Sculpture and Modeling Materials Precautions for Your Students

- Obtain MSDSs on your stones and make certain that they are asbestos-free and, if possible, low in silica content, such as limestone.
- Wear goggles to protect your eyes against stone chips. Wear a respirator. Wear steel-toed shoes to protect your feet.
- If you are using power tools to work stone that contains high concentrations of silica or other hazardous materials, equip your tools with point-of-operation local exhaust ventilation. To remove silica dust, wet mop the studio or vacuum with a HEPA-filtered vacuum. Never dry sweep. Applying a fine water spray over your sculpture while carving will significantly reduce the generation of dust.
- When using a hand-carving tool, keep your hands behind the tool and cut away from your body. When lifting heavy items, such stones or bags of plaster or cement, use appropriate lifting technique, get help from another person, or use mechanical aids.
- Because your hands become contaminated while working, do not eat, drink, or smoke in the studio. Wash your hands thoroughly when you finish working or leave the studio. Good personal hygiene is one of the most important ways you can reduce your exposure.
- Wear a full-length smock or coveralls in the studio and do not wear them outside the studio. Wash them frequently and separately from other clothing. Better yet, wear disposable smocks or coveralls.
- Do not overheat wax. Use a temperature-controlled crock pot or a double boiler.
- Dissolve wax in the least hazardous solvent and do not use chlorinated synthetic waxes.
- Do not use oil-based modeling clay that contains sulfur which can cause sensitivity.
- Make sure all electrical tools are double insulated, properly grounded, and connected to a ground fault circuit interrupter (GFCI).
- Wear hearing protection such as earplugs or muffs when using noisy tools. If possible, enclose noisy equipment such as pneumatic compressors or move it as far away as possible.
- Wear gloves and goggles as necessary to protect your hands and eyes from contact with irritating substances in plaster and cement. Wear a respirator while handling large quantities of dry material.
- Use ventilation (as described in this document) to control exposures during the curing of resins.
- Wear chemical protective gloves, apron, and goggles as necessary when handling bulk quantities of resins. If you will be applying a pint or more of a product that contains a flammable solvent, remove all sources of ignition from the area. Store flammable materials in a flammable-storage cabinet.

Woodworking

Woodworking hazards include the wood itself, preservatives that may be present within wood, hand and machine tools used to shape it, glues used to fasten pieces together, and finishing compounds that provide a surface coat. Carefully review the Material Safety Data Sheet (MSDS) for the products your students will use or the media with which your students will work (such as the type of wood) and identify the hazardous materials involved in their projects. Teach your students how to protect themselves either by reviewing the information in the MSDS or by obtaining one of the references listed on page 9 and reviewing the specific information on the materials being used. The following table describes the potential hazards associated with woodworking. The list of precautions below describes ways your students can protect themselves from these hazards.

Activity	Material	Potential Hazard
Wood-working	Woods	The dusts from many hardwoods are sensitizers, and both hardwoods and softwoods can cause allergic reactions of the eyes, skin, and respiratory system. Wood dust can also be toxic (for example, ebony, rosewood, blackwood, sequoia, and redwood). It is believed that some hardwoods cause a particular type of nasal carcinoma after an extended exposure and a long latency period. Softwoods are generally considered safer to work with.
Wood-working	Wood preservatives	Many of the preservatives used to treat wood are quite toxic (for example, pentachlorophenol, chromated copper arsenate, zinc, and copper naphthenate). Exposures can occur from sawing wood or from handling the wood with bare hands.
Wood-working	Tools	Machines used to shape or cut wood are noisy and can lead to hearing loss. Severe accidents can occur if: 1) hands or other body parts come in contact with unguarded moving parts, 2) cutting surfaces are dull, or 3) equipment is used improperly. Extended use of vibrating hand tools can cause deterioration of the muscles and tendons in the hand and cause Raynaud's syndrome, a condition in which hands cramp up, lose circulation, and are unable to move. Untreated it can lead to permanent hand impairment. Improperly grounded electrical tools may cause electrical shock.
Wood-working	Sawdust	Fine sawdust suspended in the air in an enclosed environment can explode if it comes in contact with an ignition source.
Wood-working	Glue	Some of the glues and adhesives used in woodworking (epoxy, cyanoacrylate, formaldehyde resin, and contact adhesives) are moderately toxic and may cause skin and respiratory irritation.
Wood-working	Paints and other solvent-based finishes	Wood may be finished with paint, stain, lacquer, varnish, and various types of oil. These products contain solvents that evaporate quickly and contaminate the air. They are moderately toxic by inhalation. Some solvents are adsorbed through the skin. Many of these solvents are flammable. Oily rags can spontaneously.

Woodworking Precautions for Your Students

- If possible, use less-toxic softwoods instead of rare tropical hardwoods and more highly toxic hardwoods, particularly if you have a history of allergies.
- All floor-mounted woodworking equipment should be fitted with local exhaust ventilation at the point of operation and filtered. If possible, select hand tools that have attached dust collectors. If your hands have cuts or are chaffed, wear gloves. Wear respiratory protection when working with exotic hardwoods or when using equipment that is not locally exhausted. Wear hearing protection such as earplugs or muffs when using noisy hand tools or machines. Wear goggles when working with equipment that generates dust or chips. Make sure all equipment is equipped with guards, and consider panic buttons for shutting off equipment in an emergency. Only use equipment on which a qualified instructor has given you a safety and operational orientation.
- When cutting and handling wood treated with preservative, wear a respirator and gloves. Wash thoroughly when finished and before eating, drinking, or smoking. Never burn wood treated with preservative.
- Do not use treated wood for sculpture. When working with found objects or scrap wood, be sure you do not accidentally cut or burn treated wood.
- When using hand-carving tools, keep your hands behind the tool and cut away from your body. Keep tools sharp.
- Vacuum up wood dust regularly.
- Substitute the more toxic glues identified above with safer “white glue” (polyvinyl acetate) whenever possible. Wear a light pair of gloves when handling epoxy, cyanoacrylate, formaldehyde-resin glues, or contact adhesives. Wear chemical protective gloves and goggles as necessary when handling solvents or cleaning brushes.
- If you will be applying a pint or more of a product that contains a flammable solvent, remove all sources of ignition from the area. Make sure you have adequate ventilation. Store flammable materials in a flammable-storage cabinet. Place all solvent-soaked rags and paper in self-closing oily waste cans and empty them daily. Know the location of the closest fire extinguisher and learn how to use it.
- When finished working or leaving the shop, wash your hands thoroughly with soap and water. Never wash your hands in a solvent. Chemicals can pass through breaks in the skin and enter directly into your blood stream. Washing your hands frequently may dry them out, increasing the risk for cracks and breaks to develop in the skin. Apply skin moisturizers regularly to prevent your skin from drying out. Good personal hygiene is one of the most important ways you can reduce your exposure.

Photography

The hazards associated with photography relate to the chemicals used in the photographic process, some of which can cause severe skin and respiratory reactions in sensitized individuals. Choose products that contain less toxic compounds when possible. Carefully review the Material Safety Data Sheet (MSDS) for the products your students will use and identify the hazardous materials involved in their work. Teach students how to protect themselves either by reviewing the information on the MSDS or by obtaining one of the references listed on page 9 and reviewing the specific information on the materials they are using. The following table describes the potential hazards associated with photo processing. The list of precautions below describes ways students can protect themselves from these hazards.

Activity	Material	Potential Hazard
Photography	Photochemicals	The organic and inorganic chemicals found in black-and-white and color photographic processing solutions can adversely affect the skin and respiratory systems after direct skin contact or inhalation. Organic amines found in developer solutions can cause allergic contact dermatitis. Some individuals become severely sensitized to these chemicals and can no longer work in darkrooms. Acidic solutions (found in stop baths) and bleaches are skin irritants and cause skin rashes. Many of the chemicals in photo processing solutions are highly toxic if ingested. Photo processing working solutions emit a variety of respiratory irritants including acetic acid, formaldehyde, hydrogen sulfide, and sulfur dioxide. Exposure to these irritants can cause increased susceptibility to respiratory infections. Long-term exposure to high concentrations can cause acute and chronic bronchitis. Some photographic chemicals, typically associated with bleaches and toners, may be extremely toxic and include cyanide, chrome, lead, and mercury compounds. Highly irritating and toxic substances can become airborne if stock or working solutions are mixed with incompatible materials, such as mixing stop bath solutions with fixer, toner, or any bleaching solutions. Photochemicals can cause severe burns to the eyes.

Photography Precautions for Your Students

- Wear gloves, chemical splash goggles, and an apron when mixing working solutions and pouring them into trays or other equipment. If highly toxic compounds are involved, do it under local exhaust ventilation. Use premixed chemicals instead of dry chemicals if possible.
- Wherever possible, substitute less-toxic alternatives for highly toxic photochemical developers, toners, and bleaches. Consult the product's MSDS.
- When working with powders for special projects, perform measuring and mixing in a glove box.
- Never put your bare hands in working solutions (particularly developer solution, which may contain a strong sensitizer). Use tongs instead. If you come in contact with any solutions, wash the affected area immediately with soap (acidic cleanser such as pHisoderm) and water. When finished working or when leaving the darkroom, wash your hands thoroughly.
- Wear a full-length smock or coveralls in the darkroom and do not wear them outside the darkroom. Wash them frequently and separately from other clothing.
- Never eat, drink, or smoke in the darkroom.
- Store concentrated photochemicals (particularly stop baths) on low shelves where they will not spill and splash your face or eyes. Store photochemicals in original or polypropylene containers—never glass.
- Always turn on ventilation when working with chemicals. Darkrooms that process prints in open trays should be equipped with local exhaust "slotted" ventilation that draws air from the back of the trays. If local exhaust ventilation is not provided, the darkroom should have a general exhaust rate of at least 10 room air changes per hour. The complete volume of air in the room is exhausted every six minutes. Fresh make-up air should be introduced into the darkroom from behind the photographer.
- Cover working solutions when not in use.
- Learn where the eyewash station and safety shower are located and know how to operate them.
- Clean up any spills immediately. Keep the work area uncluttered.
- To prevent the release of toxic gases, never mix stop bath solutions directly with fixer, toner, or any bleaching solutions.
- To the degree possible, separate electrical equipment from water sources and install ground fault circuit interrupters.

Metalworking

The hazards associated with metalworking depend on the type of work performed and methods used. Artists may weld, braze, or solder metals as well as cast or forge them. Carefully review the Material Safety Data Sheet (MSDS) for the products your students will use and identify the hazardous materials involved in their projects. Teach your students how to protect themselves either by reviewing the information on the MSDS or by obtaining one of the references listed on page 9 and reviewing the specific information on the materials being used. Before students use metal working equipment, have a qualified instructor provide a safety and operational orientation for them. The following table describes the potential hazards associated with metalworking. The list of precautions below describes ways your students can protect themselves from these hazards.

Activity	Material	Potential Hazard
Metal casting	Mold making	The sand used in molds has high silica content, which can become airborne when being mixed with binders and resins. Some resins (phenol-formaldehyde, hexamethylenetetramine, polyurethane) are moderately toxic by skin contact and inhalation. Some mold releases may contain asbestos as a contaminant.
Metal casting	Melting and pouring metal; removing molds	Melting metal can liberate metal fume (a small, deeply inhaled particle). The lead and zinc commonly found in bronze, as well as other metals, are highly toxic in this form. Furnaces may generate combustion products, such as carbon monoxide, that are highly toxic. Furnaces also generate high heat and infrared radiation that can lead to heat stress, skin burns, and possible cataracts. Pouring metal liberates metal fume, and the hot metal will burn the organic resins and binders in the sand mold, releasing potentially toxic decomposition products. Molten metal can cause severe burns. Breaking up sand molds can release high levels of silica dust.
Metal forging	Hot or cold metals	Metal forging involves shaping hot or cold metal with hammers and generates high noise levels and potential for crushing injuries. The furnaces used to heat metal may generate combustion products, such as carbon monoxide, that are highly toxic. Furnaces also generate high heat and infrared radiation. Hot metal can cause severe burns.
Welding, brazing, soldering	Metals and fluxes and welding rods	The welding process generates a number of toxic air contaminants, including metal fume. If high energies are involved, such as in arc welding, oxides of nitrogen, ozone, and highly irritating acidic gases can also be created. If the metals being welded are coated with metals such as lead paint, zinc, chrome, cadmium, or other toxic materials, these metals will become vaporized and could be highly toxic if inhaled. Cobalt, chromium, cadmium, nickel, and beryllium are carcinogenic and cause brain damage. The ultraviolet radiation emitted from arc welding can transform chlorinated hydrocarbons into extremely toxic phosgene gas. Oxyacetylene torches produce carbon monoxide. The physical hazards associated with welding include electric shock (arc welding), burns, fires, and exposure to infrared and ultraviolet radiation. Lead and zinc are sometimes found in brazing rods, and fluoride and lead are common hazards associated with soldering.

Metalworking Precautions for Your Students

- Use silica-free sand. Mix molding sand under local exhaust ventilation if possible. Otherwise, wear appropriate respiratory protection.
- If possible, avoid using formaldehyde and polyurethane resins in molding sand and all asbestos-containing mold releases. Avoid using metals that contain lead, zinc, nickel and other toxic metals.
- The furnace should be locally exhausted to remove combustion gases and fume generated from molten metal (casting).
- Wear appropriately shielded goggles, a helmet and/or a face shield (depending on the work you are doing), coveralls, apron, insulated gloves, and shoe coverings when working around hot metal and furnaces. Wear earplugs or muffs while forging.
- Work in pairs to pour metals into molds or use mechanical lifting aids. The pouring area should be equipped with local exhaust ventilation and contain a sand pit to catch overflow metal. Never pour directly over cement. Never let molten metal come in contact with water, grease, oil, or other organic materials.
- Keep a fire extinguisher close by and know how to use it.
- Before using welding equipment, carefully review the manufacturer's operational and safety procedures for all electrical equipment, compressed gas cylinders, regulators, and torches. After reviewing this information, obtain additional instruction and assistance in using the equipment from a qualified instructor. Follow all operational and safety instructions for your equipment.
- Report any damaged welding equipment to your instructor immediately.
- Use local exhaust ventilation to collect air contaminants generated while welding.
- Never store or use chlorinated hydrocarbons or flammable or combustible materials in the same area in which you are welding, particularly arc welding. Use a welding curtain to shield your work from others.
- Do not eat, drink, or smoke in the studio. When finished working or leaving the studio wash your hands thoroughly. Good personal hygiene is one of the most important ways you can reduce your exposure.
- Wear a full-length smock or coveralls in the studio and do not wear them outside the studio. Wash them frequently and separately from other clothing.

Glass Making

The hazards associated with glass making relate to the processes and materials used. Glass making includes mixing, firing, melting, working, and annealing the glass. Carefully review the Material Safety Data Sheet (MSDS) for the products your students will use and identify the hazardous materials involved in their projects. Teach your students how to protect themselves either by reviewing the information on the MSDS or by obtaining one of the references listed on page 9 and reviewing the specific information on the materials being used. The following table describes the potential hazards associated with metalworking. The list of precautions below describes ways your students can protect themselves from these hazards.

Activity	Material	Potential Hazard
Glass making	Formers, flux, and stabilizers	Glass formers include silica in the form of sand, silica flour, or flint. Chronic inhalation of free silica can lead to silicosis. Chemicals used in glass making, including lead compounds, arsenic oxide, antimony oxide, and sodium cyanide, are highly toxic causing cancer, brain damage, and other target organ damage. Potassium carbonate, sodium carbonate, and lime are corrosive to the skin, eyes, and respiratory system.
Glass making	Firing, melting, and annealing	Gas-fired furnaces give off carbon monoxide. Melting products to make glass produces toxic gases. Furnaces and ovens give off tremendous amounts of heat. Thermal burns can result from reaching into the furnace. Infrared radiation from the molten glass can cause burns and cataracts. Refractory ceramic fibers used in the boards and blankets around furnaces may be carcinogenic.
Free blowing glass	Molten glass and decorations	Furnaces generate high heat and infrared radiation. Molten glass can cause severe burns. Heavy gathers of glass and a steel blow pipe involve considerable expenditure of physical energy. Addition of colorants can result in the vaporization of metal fumes.
Cutting and finishing glass	Tools such as saws and grinders. Chemical etching agents.	There is danger of injury from glass breakage. Dust may be inhaled. Etching acids are highly corrosive.

Glass Making Precautions for Your Students

- Use cullet whenever possible to eliminate dust.
- Use premixed, pelletized batches when possible.
- Substitute less toxic chemicals for fluxes and stabilizers. Avoid using lead, arsenic, and antimony compounds. Do not use sodium cyanide if at all possible.
- Use local exhaust when weighing out glass blowing materials.
- Wet mop all powder spills.
- Do not eat, drink, or smoke in work areas. Wash hands frequently.
- Wear appropriate personal protective equipment including long-sleeved cotton shirts, infrared goggles, and gloves. Use shields to protect from infrared radiation.
- Provide proper ventilation for all furnaces and insulate them with firebrick or other refractory materials. Do not use asbestos and avoid refractory ceramic fibers.
- Take frequent rest breaks and acclimate your body to the heat slowly.
- Use painting and dipping instead of spraying when decorating glass. Wear appropriate personal protective equipment.
- Perform fuming, firing, or marvering with metal salts using local exhaust ventilation.
- Make sure an eyewash station and emergency shower are readily available.
- Use less hazardous abrasives when cutting and finishing glass such as alumina or silicon carbide. For abrasive blasting use an enclosed machine or appropriate blasting hood and respirator.
- Do not use hydrofluoric acid solutions for etching. Use ammonium bifluoride pastes instead.

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