

# Art and Craft Safety Guide



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## How to Use This Guide

This guide contains three sections. Section I is a general guide for the use of art and craft supplies with children. Section II is an overview of the potential hazards associated with art and craft materials and provides applicable safety and first-aid information. Section III has more detailed information about specific art and craft disciplines and associated materials. A glossary at the end of this guide provides definitions of terms. Anyone using art or craft materials will find this information beneficial; however, note that local, state, and federal agencies, such as the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) may require procedures that are more stringent for paid employees than for hobbyists. Whenever possible, this guide directs professionals to other sources of information about requirements that may supersede the recommendations presented here.

## Regulation of Art Materials

The U.S. Consumer Product Safety Commission (CPSC) is an independent regulatory agency charged with protecting the public from unreasonable risks of injury or death associated with consumer products. The CPSC requires labeling of art materials that have the potential to cause adverse chronic health effects under the Federal Hazardous Substances Act (FHSA). Specifically, an amendment to the FHSA, the Labeling of Hazardous Art Materials Act (Public Law 100-695) or “LHAMA” made mandatory many of the requirements of the labeling of art materials as set forth in the ASTM International (ASTM) standard designated D-4236-88 [U.S.C. 1277]. ASTM D-4236 outlines procedures for developing precautionary labels for art materials that have the potential to produce chronic adverse health effects [16 CFR § 1500.14(b)(8)(i)].

Under the FHSA, an art material is defined as “any substance marketed or represented by the producer or repackager as suitable for use in any phase of the creation of any work of visual or graphic art of any medium” [U.S.C. 1277(b)(1)]. Children’s products that meet this definition include, but are not limited to, crayons, chalk, paint sets, colored pencils, and modeling clay. It is recommended that parents/guardians purchase only those products labeled with the statement “Conforms to ASTM D-4236” (CPSC Document #5016) and that do not have any cautionary warnings on the label.

Moreover, under the FHSA, most children’s products that contain a hazardous substance are banned, whether the hazard is based on chronic toxicity, acute toxicity, flammability, or other hazard identified in the statute. However, the Commission may exempt art materials satisfying all three of the following criteria: (1) the inclusion of the hazardous substance is required for their functional purpose, (2) the products are labeled with adequate directions and warnings for safe use, and (3) they are intended for use by children who are sufficiently mature, and may reasonably be expected, to read and heed such directions and warnings (15 USC 1261(q)(1)(A)).

For more information on the requirements for art materials, contact the CPSC Office of Compliance, Washington, DC 20207, telephone: 301-504-7913.

## Sources of Health and Hazard Information

Under the U.S. Occupational Safety and Health Administration (OSHA) Hazard Communication Standard (HCS), chemical manufacturers are required to develop a Material Safety Data Sheet (MSDS) for each hazardous chemical they produce and import [29 CFR 1910.1200 (g)]. The MSDS contains a variety of information including the hazards associated with the chemical(s) and precautionary information for safe handling and use. However, the chronic hazards described in the MSDS may not be applicable to the casual user, such as someone engaging in an art activity one time. Be aware that a MSDS can become outdated as new information becomes available, particularly concerning long-term or chronic exposures. Manufacturers must provide the date of preparation or the date of the last change made to the MSDS, so be sure that you have the most current document available.

According to OSHA requirements, employers of people working with chemicals must provide an MSDS for the materials used, training in federal and local regulations governing the use and disposal of materials and waste, the proper protective equipment, and other precautions. More information about OSHA regulations and mechanisms for employees to report unsafe practices can be found at [www.osha.gov](http://www.osha.gov).

Disposal practices are required to follow the Environmental Protection Agency’s (EPA) Resource Conservation and Recovery Act (RCRA), which tightly governs all garbage and industrial waste. More information is available online ([www.epa.gov/rcraonline/](http://www.epa.gov/rcraonline/))

Many sources for health and hazard information are available on the web including the National Library of Medicine website ([www.nlm.nih.gov](http://www.nlm.nih.gov)) which has links to sites such as Toxnet and Toxtown, the Integrated Risk Information System (IRIS, [www.epa.gov/iris/](http://www.epa.gov/iris/)), the National Toxicology Program (NTP, [www.niehs.nih.gov](http://www.niehs.nih.gov)), and the International Agency for Research on Cancer (IARC, [www.iarc.fr](http://www.iarc.fr)).

For example, as part of the World Health Organization, IARC performs epidemiologic and laboratory research on how humans develop cancer. IARC prepares individual monographs for many agents that include information on exposure, chemistry, production, and use. Based on available data, IARC categorizes the carcinogenic risks to humans. The list of these categories is found in the glossary.

Another information source is the Art and Creative Materials Institute (ACMI) ([www.acminet.org](http://www.acminet.org)), an international, non-profit association of over 200 art and craft material manufacturers. ACMI sponsors a certification program that identifies products that they determine to be non-toxic and those that require health warning labels.

Mention of the name of any company or product does not constitute endorsement by the U.S. Consumer Product Safety Commission (CPSC). In addition, citations to Web sites do not constitute CPSC endorsements of the sponsoring organizations or their programs or products. Furthermore, CPSC is not responsible for the content of these Web sites.

## Section I

### Children's Arts and Crafts

This section gives an overview of the hazards associated with the use of art and craft materials by children and provides guidelines for the selection of materials as well as safety rules that should be followed.

Non-toxic art and craft supplies intended for children are readily available. Read the labels and only purchase art and craft materials intended for children.

For certain chemicals and exposure situations, children may be especially susceptible to the risk of injury. For example, since children are smaller than adults, children's exposures to the same amount of a chemical may result in more severe effects. Further, children's developing bodies, including their brains, nervous systems, and lungs may make them more susceptible than adults. Differences in metabolism may also affect children's responses to some chemicals.

Children's behaviors and cognitive abilities may also influence their risk. For example, children under the age of 12 are less able to remember and follow complex steps for safety procedures, and are more impulsive, making them more likely to ignore safety precautions. Children have a much higher chance of toxic exposure than adults because they are unaware of the dangers, not as concerned with cleanliness and safety precautions as adults, and are often more curious and attracted to novel smells, sights, or sounds. Also note that children do not have to be using the art and craft materials themselves to be affected by them: careless child or adult artists can accidentally expose other children to hazards.

Good health and safety habits can be formed at any point in life, including childhood. Adults should model safety procedures, the use of appropriate safety gear, and careful reading of labels and cautionary statements. Children need regular and consistent reminders of safety rules, and there is no substitute for direct supervision.

#### Guidelines for Selecting Art and Craft Materials for Children

Up to 12 years of age (Pre-kindergarten through Grade 6):

- Note that even products labeled 'non-toxic' when used in an unintended manner can have harmful effects.
- Products with cautionary/warning labels should not be used with children pre-kindergarten through grade 6 (see Section II for information about specific materials).
- Avoid solvents and solvent-based supplies, which include turpentine, paint thinner, shellac, toluene, and some glues, inks, and a few solvent-containing permanent markers.
- Avoid materials in self-pressurized containers.
- Avoid acids, alkalis, bleaches, or corrosives.
- Avoid products or processes that produce airborne dusts which can be inhaled.

- Avoid old supplies, unlabeled supplies, and be wary of donated supplies with cautionary/warning labels and that do not contain the statement "Conforms to ASTM D-4236."
- Avoid materials with lead, cadmium and other heavy metals.
- Avoid high-temperature hot glue guns; use low-temperature models.
- Look for products that are clearly labeled with information about intended uses.
- Give special attention to students with higher exposure risks, such as:
  - Physical or mental challenges, which affect safe use of the supplies.
  - Visual or hearing difficulties that may hinder the recognition of spills or skin exposures and may require the student to get close to supplies during use which can increase their inhalation of fumes or dusts.
  - Asthma or allergies, which may elevate the students' sensitivities to fumes, dusts, or products that come into contact with the skin.

#### Safety Rules to Be Followed When Children Are Using Art Materials

- Store surplus materials away from children.
- Keep food and drinks out of the art area.
- Give only small amounts to minimize spills and mishaps.
- Supervise children closely to prevent unintended uses of art materials.
- Adults should mix powdered and extremely dusty materials.
- Wash hands after using materials. Do not use solvents to clean skin.
- Watch for unusual reactions to chemicals.
- Cover cuts and sores with bandages before using materials.
- Contact the National Poison Control Center Hotline, 1-800-222-1222, or the nearest certified Poison Control Center, if necessary (see General First Aid).

## Section II

### General Hazards Associated with Art and Craft Materials

This section is a brief guide on the potential hazards of art and craft materials and general precautions to take when using them. Artists, teachers, and hobbyists may find this information useful. More detailed information is available in Section III and in the references at the end of this guide. Please consult the glossary for any terms that may be unfamiliar. Specific technical information on chemicals or other substances can be found on various websites (see Health and Hazard Information).

It is important to recognize that while some art and craft materials may cause adverse health effects, the concentrations and exposure times required to produce them may be uncertain, particularly concerning chronic (long-term) exposures. For example, an acute (short-term) exposure to a strong acid may cause severe burns within minutes. It may take years of exposure to a certain concentration, however, for a known human carcinogen to cause cancer, and the exposure time and concentration required may vary between individuals. Being cautious and limiting exposure to potentially harmful art and craft materials will likely minimize, if not prevent, the possibility of developing adverse health effects in the long term.

#### Types of Hazards

**Mechanical Hazards:** Strains, Breaks, Cuts, Crush Injuries, and Burns

- Mechanical hazards are those involving damage to body tissue from objects, heat or electrical sources. Virtually any object can damage the human body. The most common injuries include cuts, scrapes, crush injuries, and burns.
- Such injuries can be caused by distractions, using a tool for an inappropriate function, improper handling, modification of a tool, using a tool that is worn out or functioning improperly, or using a tool that is not appropriate for the age of the user. Dull, worn, partially broken, or repaired tools can behave in unexpected ways and often require more effort to get the job done, placing a user at risk.

**Chemical Hazards:** Inhalation, Skin Absorption, and Ingestion

- Chemical exposures can occur through breathing fumes and vapors, absorption through the skin, or by swallowing. For instance, painters may ‘point’ their brushes by placing them in their mouth; children may taste art supplies or chew on drawing implements; and artists and family members may be exposed to vapors from a home studio that has inadequate ventilation, including those studios that may be located away from living areas, such as in a basement. Such conditions may seem like small exposures, but over time, many small

exposures to some chemicals may combine to damage one’s health. Use “non-toxic” products (i.e., those that are not considered to be harmful under normal use conditions) when possible. Introduce good safety practices even with the use of non-toxic products. This will help reduce exposures when hazardous materials are used.

- When gauging exposure, consider the 1) toxicity of the substance; 2) length of exposure; 3) *total body burden* on the user; 4) susceptibility of the user; and 5) combined effects of interacting substances. Chronic or repeated exposures to chemicals or short exposures to high doses of chemicals allow the body less time to detoxify and excrete the substances that have been absorbed. The *total body burden* refers to the amount of a substance that the body has already absorbed from other sources or over time from previous exposures. Using many different hazardous materials or using them for a long time will require careful monitoring. Consult your physician for proper care. Susceptibility to toxic materials varies with the physical characteristics of the person exposed, such as size, age, health, and medical history. Known medical conditions, such as asthma, may make someone more susceptible to the effects of certain chemicals. Combining chemicals can also have synergistic health effects (i.e., one chemical may amplify the negative effects of another).

#### General Precautions: Storage, Housekeeping, Protective Gear, and Safety Rules

Set up studios so that users can easily comply with the safety rules. Enforce compliance with rules.

#### General Safety and Hygiene Rules

Work intelligently.

- Substitute safer materials when possible.
  - Choose water-based products over solvent-based products.
  - Choose products that do not create dusts and mists.
- Never hold brushes or tools in your mouth, tip brushes with your lips, etc.
- Never eat, drink, or smoke in studios.
- Store tools properly; keep them in good condition.
- Read the labels on your materials. You cannot tell the toxicity of materials by the absence or presence of a particular smell.
- Never use materials in unintended ways (for example, don’t use standard paint for skin-painting).

Keep studio space neat and orderly.

- Keep floors clean and free of slippery spots.
- Keep extension cords, hoses and other tripping hazards off the floor when unused; keep traffic ways clear.
- Minimize the area in which hazardous substances are used.
- Keep art studios separate from living areas and clean yourself before entering living areas.

Ensure appropriate ventilation.

- The mouth, nose, and skin can absorb hazardous materials. Ensure ventilation provides fresh air activity (see [The Inside Story: A Guide to Indoor Air Quality](http://www.cpsc.gov/cpscpub/pubs/450.html) <http://www.cpsc.gov/cpscpub/pubs/450.html> ) to decrease exposures to dusts, fumes, gases, mists, and vapors. Adequate ventilation means that clean air is flowing toward the artist and contaminated air is flowing away. Blowing air around with a fan without a source of clean air is not adequate ventilation, and can actually increase exposures to harmful substances.
- Prevent the accumulation of flammable vapors or spray mists to limit fire hazards with proper ventilation.

Have proper protective gear and cleaning supplies available.

- Wear special work clothes and keep separate from other clothing, even during clothes washing.
- Keep cleaning supplies accessible.
- Clean up spills immediately, even small spills, and dispose of waste chemical and cleanup materials properly.
- Contain flammable spills with activated charcoal, diatomaceous earth, or deodorant-free cat litter. Workplace employees must follow the EPA's Resource Conservation and Recovery Act (RCRA) and any other applicable local regulations for spill control, containment, and disposal.
- In the event of an accidental exposure call the National Poison Control Center Hotline, 1-800-222-1222, or the number for the nearest certified Poison Control Center.

Wash hands and other exposed body parts after working, and before eating or using the bathroom.

- Avoid using toluene, turpentine, kerosene, or other solvents to clean your skin.
- Use soap and water or baby oil or a skin cleanser.
- Wash under fingernails. Keep nails trim and do not bite nails.

Maintain your health and fitness.

- Recognize your physical, emotional, and mental limits.
  - Alertness decreases with hunger and fatigue.
  - Anger, sadness, hurrying and frustration increase chances of accidents and mistakes.
- Have regular health check-ups.
- Make sure your health care provider is familiar with the art and craft materials you use, your level of exposure, and your studio environment.

## Fire Safety

Have fire protection devices, extinguishers, and alarms.

- Ensure alarms and extinguishers are in working order and approved for the materials and chemicals used and stored.
- Ensure users know fire evacuation plans for your facilities.
- Post fire safety information in clearly visible places.

Work with small amounts of materials.

- Purchase and store the smallest amounts of flammable or

combustible materials needed.

- Never store large amounts of flammable or combustible materials.
- Dispense small amounts of flammable or combustible materials.

Keep heat sources and ignition sources away from flammable materials.

- Never smoke in a studio that has flammable or combustible materials.
- To avoid spark hazard, ensure that all electrical equipment is in good repair.
- Fans in local exhaust systems require non-sparking or nonferrous blades and the motor should be explosion proof or outside the vapor pathway.
- Avoid using space heaters.

Store flammable materials safely.

- Store flammable or combustible solvents in fire safety cans in an OSHA-approved fireproof cabinet. Keep cabinet closed and vented if required by local codes.
- Linseed oil or solvent-soaked rags can spontaneously combust, so rags should be stored in a covered container that does not allow air in or vapors out, such as an OSHA-approved container.
- Store flammable or combustible materials away from escape routes.
- Clean spills immediately and properly.
- Keep a dry chemical or carbon dioxide fire extinguisher within easy reach.

## Storage and Precautions for Chemical Hazards

Buy, use and store chemicals wisely.

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Familiarize yourself with the ingredients and hazards associated with the materials you use.
- Purchase volatile and other hazardous materials in small quantities.
- Ensure proper training of materials' caretakers.
- Keep children out of studios where toxic chemicals are used.
- Ensure appropriate ventilation for this activity.
- Avoid mixing chemicals in the storage area.
- Learn local regulations and limits on storage of hazardous materials.
- Keep chemicals out of direct sunlight.
- Store toxic materials in a locked cabinet.
- Store reactive chemicals separately.
- Store hazardous chemicals in secure places away from children, but easy-to-reach to minimize falls and drops (e.g., keep large containers below shoulder height).
- Store flammable or combustible solvents in fire safety cans in an OSHA-approved fireproof cabinet. Keep cabinet closed and vented if required by local codes.
- Never store any material that you are not prepared to control if it spills.

- Avoid using food containers for storage.
- Keep containers tightly closed to prevent dust or vapor from escaping.
- Use smaller dispensers for small amounts of solvent and label them properly.
- Continually clean storage and disposal facilities.
- Never remove or deface a manufacturer's label. If it is necessary to transfer the product to another container (e.g., due to damage, lost closure, etc.), retain all the label information.
- Track the date of purchase and date of opening containers.
- Keep track of expiration dates and properly dispose of expired materials.
- Keep a current inventory of materials and properly dispose of those with a limited shelf life. Ideally, use fresh materials.

Have appropriate protective equipment and cleaning supplies available.

- Have cleaning materials for spills near the chemicals.
- If protective equipment is needed, store near the materials.
- Have fire protection, extinguishers, and alarms that are in working order and approved for the chemicals stored.
- Ensure users know fire evacuation plans for your studio. Post information in clearly visible places if you have visitors to your studio. OSHA requires workplace employees to be trained in these procedures.
- If corrosives are stored, have an accessible and functional eyewash or shower.

### Disposal Precautions for Chemical Hazards

- Know what local regulations require for hazardous waste disposal. Employers must know state and federal regulations and maintain arrangements with hazardous waste disposal companies.
- Disposal practices in the employment setting are required to follow the Environmental Protection Agency's (EPA) Resource Conservation and Recovery Act (RCRA) which tightly governs all garbage and industrial waste. More information is available online ([www.epa.gov/rcraonline/](http://www.epa.gov/rcraonline/)).
- Recycle when possible, but only donate materials that conform to ASTM D-4236, and do not donate materials with cautionary/warning statements on the label to elementary schools.
- Do not pour solvents or other hazardous materials and wastes down the drain unless allowed by the sanitary sewer authorities.
- Consider recycling used solvents. If disposing, place in sealable, metal containers clearly labeled for disposal.
- Ensure spray cans are completely empty and dispose of in garbage or recycling.
- Allow glues and cements to dry before disposal in garbage.
- Many localities have special programs for residential disposal of hazardous waste.

### Protective Equipment

More explicit details about selecting appropriate protective equipment are provided by the Occupational Safety and Health Administration (OSHA) publication #3151 and the National Institute for Occupational Safety and Health's (NIOSH) National Personal Protective Technology Laboratory (NPPTL) publications (see References at the end of this section). Employers are required to have OSHA written programs and training for protective equipment.

Respirators:

**IMPORTANT NOTE:** Proper use of a respirator requires training. Hobbyists should seek an occupational clinic for advice and training. Contact your county, local, or state health department for more information. OSHA regulations require workplace employees using respirators to have medical certification, professional fit tests, and training for selecting the appropriate filters and maintenance procedures.

- Seek professional help with fitting; ensure mask fits by performing a user seal check (a test of positive and/or negative pressure) to make certain that an adequate seal is achieved (29 CFR 1910.134 App B-1).
- Ensure that the respirator you are using complies with recommendations made by the National Institute for Occupational Safety and Health (NIOSH).
- Ensure that the type of filter used will remove the chemical or dust you are working with. Some chemicals require specific cartridges (organic vapor, acidic gas, and high efficiency particulate air (HEPA)). There are some chemicals for which there are no approved cartridges.
- Replace filters and cartridges regularly. Never rely on expired cartridges.
- Put respirator on before entering the work area and remove only after leaving the work area.
- Paper dust masks are not effective for chemical vapors and gases.

Eye Protection:

- **IMPORTANT NOTE:** OSHA regulations require employers to provide appropriate eye protection in accordance with ANSI Z87.1 standards.
- Many options for impact protection are available. Consult a reputable vendor for making an informed decision. Look for the "Z87" marking indicating compliance with ANSI Z87.1's "Basic" impact protection standard and "Z87+" to indicate the "High" impact protection standard.
- Most prescription glasses are not an adequate substitute for real safety glasses. Goggles are available for covering over prescription glasses.
- Glasses for protecting against chemical splashes are often different from impact protection glasses. Ensure that the right glasses are used for different needs.
- Face shields are sometimes an alternative to glasses, but may require safety glasses worn beneath them if splashing can occur.
- Prevent fogging of glasses and goggles to keep vision clear.



- For ultraviolet radiation (UV) and infrared (IR) protection, select an appropriate degree of filtering.

#### Gloves:

- Chemical protection is extremely complicated. Do not judge a glove's effectiveness by how waterproof it appears: solvents and other chemicals can pass through glove materials that water would not penetrate. This is called "permeation." Consult the glove manufacturer's "permeation charts" to identify the gloves that will withstand the materials you use.
- After selecting appropriate gloves for the chemicals in use, monitor the glove's effectiveness while in use and replace worn, ripped, or permeated gloves.
- Use metal-mesh or Kevlar gloves when using sharp tools or knives.
- Use insulated gloves to protect hands from thermal burns.
- Use fabric or leather gloves when exerting high pressures or performing repetitive actions to protect from blisters.

#### Hearing Protection:

- Avoid loud noises for long times or frequently repeated loud sounds.
- Power machines (e.g., compressors, pug mills) may produce sound levels that can be damaging to the ears.
- Pliable earplugs can be used for noise levels up to 120 dB.
- Do not share earplugs.
- Earmuffs provide more protection than ear plugs, up to 135 dB. Combine with earplugs for maximum protection.

#### Clothing and accessories:

- Proper work clothes can greatly reduce exposures.
- Hair restraining caps or bands are recommended when using machines or chemicals.
- Remove jewelry (e.g., rings, necklaces) that can get caught in machines.
- Avoid loose clothing that can get caught in machines or catch fire.
- Hard hats are recommended for protection from falling objects.
- Safety shoes or boots protect against liquids, heat, falling objects, sparks, electric shock and sharp objects.

#### Warning Signs:

The following warning slogans are designed to help reduce chemical exposures or mechanical injuries by attracting attention to the basics of art and craft safety. They may be reproduced, where appropriate, for use in any studio or classroom.

#### General Health and Safety:

- "If you can't do it safely, then you can't do it."
- "Hurrying hurts."
- "Absolutely no food in this area."
- "Step 1-Be careful. Step 2-Be careful. Step 3-Be careful."
- "Creative urges should not overcome your careful urges."
- "Limit exposure to this material."
- "No art is worth sacrificing your health."

- "If you are tired, hungry, angry or sad, you are at a higher risk for injury and mishap. Take a break!"
- "Power tools don't care how many fingers you have."
- "Rushing to finish your project can lead to rushing to the hospital."
- "Being careful takes longer, but a trip to the hospital takes even longer."
- "If you have to force it, it's the wrong tool."

#### Use, storage, and disposal:

- "Always know your materials."
- "Ensure adequate ventilation."
- "Keep out of reach of children."
- "Report shortages of this product to (insert name of studio manager)."
- "Don't let your materials destroy after you create. Dispose of this material properly."

#### Protective Equipment:

- "Hazardous Chemical: Wear protective clothing."
- "Are you wearing your safety glasses?"
- "You haven't felt pain until you've had an eye injury."
- "Safety gear now or bandages later – You choose."
- "In case of emergency, call \_\_\_\_\_"

It is also advisable to post the National Poison Hotline number, 1-800-222-1222, or the contact information for the nearest certified Poison Control Center.

## General First Aid

Workplace employees must follow the first-aid procedures set out by their employer. Hobbyists are advised to seek medical advice for serious incidents.

### Eye Exposure:

1. Hold eye(s) open with fingers and immediately RINSE with water for at least 5 minutes. If wearing contact lenses, remove them after 5 minutes of washing and continue to rinse eye(s) at least 5 minutes. Note: Rinse time depends on the degree of irritancy associated with a particular product.
2. For more information and advice, call the National Poison Control Center Hotline, 1-800-222-1222, the nearest certified Poison Control Center, or a doctor.

### Skin Exposure:

1. RINSE skin with water.
2. Call the National Poison Control Center Hotline, 1-800-222-1222, the nearest certified Poison Control Center, or a doctor for more advice.

### Inhalation:

1. Move person into fresh air.
2. Call the National Poison Control Center Hotline, 1-800-222-1222, the nearest certified Poison Control Center, or a doctor for more advice.

### If Swallowed:

1. IMMEDIATELY call the National Poison Control Center Hotline, 1-800-222-1222, the nearest certified Poison Control Center, or a doctor.

## Summary of Ways to Minimize Risks

*Know your materials.* Read warnings and labels. Take extra care when using unfamiliar products.

*Limit exposures.* Substitute more hazardous materials with less dangerous ones. Avoid exposures to toxic materials.

*Stay clean.* Use protective gear and practice good hygiene and waste disposal.

*Clear the air.* Control dusts, filter air, add clean air, and remove fumes with proper exhausts.

*Store materials properly.* Keep out of reach of children. Keep labels on all products.

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## Section III

### Hazards Associated with Specific Art and Craft Materials

Section I of this guide provided guidelines for use of art and craft materials by children. Section II provided an overview of the general types of hazards associated with art and craft materials, the precautions one can take in using, storing and disposing of materials, as well as first-aid information. Please familiarize yourself with that information in addition to the specific information found in this section.

This section is a reference guide to the potential hazards of specific art and craft materials and specific precautions to take when using them. More detailed information is available in the references at the end of this document. Please consult the glossary for any terms that may be unfamiliar. Specific technical information on chemicals/substances can be found on websites such as those of the National Library of Medicine ([www.nlm.nih.gov](http://www.nlm.nih.gov)), the International Agency for Research on Cancer (IARC, [www.iarc.fr](http://www.iarc.fr)), and the Integrated Risk Information System (IRIS, [www.epa.gov/iris/](http://www.epa.gov/iris/)).

It is important to recognize that while some art and craft materials may cause adverse health effects, the concentrations and exposure times required to produce them may be uncertain, particularly concerning chronic (long-term) exposures. For example, an acute (short-term) exposure to a strong acid may cause severe burns within minutes. It may take years of exposure to a certain concentration, however, for a known human carcinogen to cause cancer, and the exposure time and concentration required may vary between individuals. Being cautious and limiting exposure to potentially harmful art and craft materials will likely minimize, if not prevent, the possibility of developing adverse health effects in the long term.

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### Ceramics and Clay

*Clay/modeling clay:*

- Components may include hydrated aluminum silicates (with crystalline silica), talc, vermiculite, asbestos (a contaminant in some talc & vermiculite), kaolin, alumina, diatomaceous earth (silicon dioxide), and sand.
- Potential health effects from chronic long-term exposure to clay dust or powdered mix include skin irritation, lung

diseases/infections (e.g., asbestosis, silicosis), and cancer (e.g., from asbestos).

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid inhaling dust. Ensure appropriate ventilation or use a National Institute for Occupational Safety and Health (NIOSH)-approved toxic dust respirator.
- When possible, use premixed clays to minimize exposure to large amounts of clay dust.
- To reduce dust inhalation, do not pulverize dry clay or sand “green ware”. Finish “green ware” (unbaked molded & shaped pottery) while damp/wet.
- When cleaning do not sweep dust. Use a wet mop, rags, and/or a vacuum with a HEPA filter system.
- Use machine guards when mixing clay.
- Check extruder mounting to make sure it is tightly fastened to the work surface.
- Do not wear ties or other loose clothing when working with slab rollers.
- Wear gloves and/or use moisturizer to prevent dry skin.
- Rest wrists frequently to avoid repetitive stress injury (e.g., carpal tunnel syndrome).

*Glazes (mixtures of silica, fluxes, and colorants for finishing or coloring clay):*

- Components may include arsenic, uranium, lead, chromium VI, lithium, beryllium, cobalt, antimony, cadmium, nickel, barium, vanadium, soda ash, potassium carbonate, feldspars, and flourspar. Some glazes may contain solvents (see Solvents).
- May be toxic by inhalation, ingestion, and skin contact.
- Potential health effects from exposure include lung disease, skin irritation, sensitization, heavy metal poisoning, and cancer (e.g., those associated with arsenic, beryllium, cadmium, chromium VI, nickel, and uranium exposure).
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Label lead- and cadmium-containing pieces with phrases such as “Contains Lead, Not for Food Use” or “Contains Lead, For Decoration Only.” Consider designing or puncturing holes in utilitarian objects to discourage use with food/beverages. If there is even a slight chance that your pottery could be used for food, you should have it tested to meet FDA or state standards if you sell it, but also if you just give pieces to family and friends. The liability remains even if you do not sell pottery.
- A glaze labeled “food safe” does not mean that it is lead-free, rather it means that if fired and applied properly it will not leach lead or cadmium at concentrations above those allowed by the Food and Drug Administration (FDA) into food or beverages.
- Do not mix different glazes together because this disrupts the balance of ingredients and could make a “food safe” glaze into an unsafe product.
- Consider testing all finished ware to ensure that it does not leach potentially toxic metals or lead.

- Consider using lead-free glazes or those with sodium, potassium, calcium, or magnesium fluxes.
- Use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator when working with powdered glazes.
- Be aware of the flammability and hazard potential of solvents (see Solvents).
- Wear protective clothing and gloves.
- Use a wet mop, rags or HEPA vacuum to clean up spilled powders. Do not sweep.
- When spraying glazes use a spray booth equipped with a fan that exhausts to the outside.

#### *Tools:*

- Users should understand how to operate all tools and take all safety precautions.
- *Pug mills* can cause crushing and amputation injuries. Always keep safety guards in place.
- *Throwing wheels* can cause skin or ergonomic injuries.
- *Kick wheels* can cause shin injuries.
- *Kilns*: Contact local or state authorities for information on proper installation and safe operation of all kilns. Importantly, indoor use of ceramic kilns (electric or fuel-fired) requires mechanical ventilation to the outdoors. Adverse health effects from firing clays and glazes are possible via inhalation (common kiln emissions include chlorine, fluorine, carbon monoxide, metallic vapors, and ozone), dermal contact (burns), and eye exposure (heating ceramic materials to glowing emits infrared radiation). To avoid injuries, ensure appropriate ventilation, use appropriate protective clothing and gloves, and wear infrared goggles or a welding shield.
- To avoid electrocution while working with electrical equipment, use ground fault circuit interrupter (GFCI)-protected electrical outlets.

*Salt glazing (the sodium from a salt added to the hot kiln combines with the hydrogen on the clay to convert it to a sodium aluminum silicate which appears as a glass- or glaze-like material.):*

- Check local building codes to ensure that salt kilns are allowed.
- Hydrogen chloride gas, which can be toxic if inhaled, will form during this process if the salt used is sodium chloride. Also, hydrogen chloride gas may combine with water vapor to form hydrochloric acid, which is corrosive to the skin and may corrode fittings. Check for metal corrosion regularly.
- Sodium carbonate (which forms carbon dioxide rather than hydrogen chloride) is a safer alternative to sodium chloride.
- If working with sodium chloride, use only outside with a canopy hood and a high stack.

*Raku firing (involves the addition of sawdust or other materials to heated ceramic ware):*

- The major hazard with raku is burns from handling the pottery with tongs: work carefully.

- Smoke and carbon monoxide formed during this process may be inhalation hazards.
- To avoid carbon monoxide and smoke exposure, only perform raku firing outdoors away from open windows and air intakes.
- Avoid using sawdust from wood treated with preservatives or pesticides (e.g., chromated copper arsenate-treated wood).

## Computers

*Input devices* (keyboard, joystick, mouse) often require repetitive motions.

- Position devices in comfortable locations.
- Vary motions as much as possible to decrease strain injuries.
- Keep wrists straight and muscles relaxed.
- Take short breaks often (every 10 minutes).

*Monitors* can cause neck, back, and eyestrain.

- Position monitors as far away as possible and at an elevation that does not require bending the neck.
- Ensure proper task lighting.
- Avoid staring at computer monitors without blinking, which can lead to dry eyes. Occasionally look away from the monitor and focus on something far away.

*Workstation ergonomics:*

- Ensure that feet can touch the floor or footrests when seated.
- Arms should be placed in a relaxed position.
- Wrists should be as straight as possible.

*Repetitive strain injury:*

- If pain, stiffness, or aches occur during some activity, stop immediately and seek alternative positions or motions.
- Vary motions and change positions and activities.
- Take short breaks often (every 10 minutes).
- Use alternate hands for the same activity.

## Drawing

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).

*Chalk:*

- Components include calcium salts (e.g., calcium carbonate, calcium sulfate).
- Dusts can be irritating if inhaled. Use non-dusty chalk.

*Charcoal:*

- Dust may be irritating if inhaled.
- Remove excess dust by tapping, not blowing.
- Use a wet mop when cleaning.

#### *Inks:*

- Solvent-based inks may be toxic if ingested or inhaled (see Solvents).
- Use water-based, water-soluble inks.

#### *Markers:*

- Ensure appropriate ventilation or use water-based markers.

#### *Pastels:*

- Some pigments such as chrome yellow (lead chromate) may be toxic (e.g., chronic inhalation may cause lung cancer and skin contact may cause irritation). Avoid pigments with lead chromate.
- Dust may be irritating if inhaled, particularly to asthmatics. Use less dusty supplies. Do not blow excess dust, tap the drawing instead.
- Reduce exposure with appropriate ventilation and use a dust mask, when indicated.
- Clean with a wet cloth or mop.
- Oil pastels are a safe alternative because they create less dust.

#### *Pencils:*

- Potentially hazardous components include graphite and some pigments in colored pencils.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).

#### *Pens:*

- Inks can be inhalation irritants.
- Solvent-based inks (see Solvents) may be highly toxic if inhaled or absorbed through the skin.
- Use water-based pens.

#### *Spray fixatives:*

- Contain solvents (see Solvents), which may be hazardous following an exposure, particularly when inhaled.
- Avoid breathing vapors. Follow all directions on the product label, such as using a National Institute for Occupational Safety and Health (NIOSH)-approved respirator or an exhaust fan.

## **Gems (Lapidary) and Stones**

#### *Hard stone (granite, marble):*

#### *Soft stone (soapstone, sandstone, limestone, greenstone, serpentine):*

#### *Lapidary (quartz gemstones (e.g., amethyst and onyx), opal, garnet, etc.):*

#### *Stone casts (Portland cement, crushed stone, and sand):*

- Some stones contain silica (e.g., quartz, granite, sandstone, soapstone) and asbestos (e.g., New York soapstone, serpentine, greenstone), which may be toxic if inhaled. Potential health effects include lung diseases (e.g., asbestosis, silicosis) and cancer (caused by asbestos and crystalline silica).

- Components in cement include calcium oxide, lime, silica, aluminum, iron compounds, and small amounts of magnesia, sodium, chromium, sulfur, and potassium compounds. Potential health effects include skin/eye burns, respiratory effects if inhaled, and gastrointestinal burns if ingested.
- Avoid stone with asbestos.
- Chips may be hazardous to the eyes. Wear eye protection and carve away from the body.
- To avoid inhalation of dust, use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.
- Keep dust levels down by wet mopping or vacuuming regularly. Avoid sweeping dust.
- Lifting heavy stones can be hazardous. Lift carefully to avoid injuries.
- Wear protective shoes and appropriate clothing (no ties or loose clothing), and tie up long hair to avoid getting entangled in machinery.
- Power tools (e.g., grinding/polishing wheels, sanding machines) generate noise and vibration, which may lead to hearing loss, particularly after long-term exposure. Use hearing protection.
- Ensure appropriate ventilation when using power tools. Direct air away from body.
- Ensure that power tools are properly grounded.
- To avoid electrocution while working with electrical equipment, use ground fault circuit interrupter (GFCI)-protected electrical outlets.
- Keep motors away from water.

## **Glass**

#### *Making glass:*

- Components include lead/potash, borosilicates, soda/lime, colorants (e.g., cadmium, chrome, cobalt, iron). Some of these substances may be hazardous via inhalation, ingestion, and skin contact.
- Use glass cullet or scrap glass if possible to avoid exposure to the powdered chemical components.
- Use a fume hood, respirator, and gloves.
- Clean up with a wet mop.

#### *Firing, melting, annealing, slumping and fusing glass:*

- Emissions from the firing process (e.g., carbon monoxide, nitrogen oxides, fluorine, sulfur oxides, chlorine, and metal fumes) may be toxic if inhaled.
- Beware of thermal hazards (e.g., burns, heat exhaustion).
- Fibers (ceramic or asbestos) used as insulation in ceramic ovens may be carcinogenic. Ensure appropriate ventilation for this activity.
- Avoid asbestos insulation.
- Use reflective heat shields and infrared goggles to protect the eyes from infrared radiation.

#### *Working glass (glassblowing), lampworking:*

- Potential hazards include burns, cuts, infrared radiation and exposure to fumes from colorants.
- Wear protective shoes, gloves, infrared goggles.

- Use a canopy hood.
- Glassworkers should cool off frequently.

#### *Decorating glass:*

- Methods for decorating glass include etching, staining, and painting.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Silver nitrate (a corrosive) and gamboge (a yellow pigment which may be toxic by ingestion) are used for staining.
- Hydrofluoric acid and ammonium bifluoride (both are corrosives) are used for etching and may be highly toxic by ingestion, inhalation, and skin contact.
- Avoid hydrofluoric acid, but if used, use with a hood, gloves, a National Institute for Occupational Safety and Health (NIOSH)-approved respirator, and a face shield.
- Metal colorants used to paint glass include those containing cobalt, lead, manganese, chromium VI, nickel, iron, zinc and copper. These may be toxic by inhalation, ingestion, and skin contact. Potential health effects include lung disease, skin irritation, ulceration, sensitization, cancer (e.g., from exposure to nickel and chromium VI) and metal fume fever.
- Avoid lead.
- If an exposure occurs, immediately contact a poison control center for help (dial 1-800-222-1222 for the National Poison Control Center Hotline).
- Use a spray booth, canopy hood, respirator, gloves, goggles, and an apron.
- When diluting acids, add acid to water slowly.

#### *Cutting/sandblasting glass:*

- Glass particles and abrasives may be an inhalation hazard.
- Wear goggles or a face shield and a National Institute for Occupational Safety and Health (NIOSH)-approved respirator to avoid exposure.
- To avoid electrocution while working with electrical equipment, use ground fault circuit interrupter (GFCI)-protected electrical outlets.
- Clean water reservoirs.

#### *Antiquing:*

- Antiquing agents include antimony sulfide, copper sulfate, and selenium dioxide.
- Selenium dioxide may be highly toxic by inhalation and ingestion. In acid it may form hydrogen selenide, a highly toxic gas.
- Antimony sulfide may be highly toxic by skin contact, inhalation, and ingestion.
- Wear appropriate gloves, provide local ventilation or use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.

#### *Stained glass:*

- Potential hazards associated with stained glass work include exposure to lead, fluxes (e.g., zinc chloride,

rosin<sup>1</sup>, and oleic acid), antimony, and arsenic.

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Lead dust may be highly toxic if ingested or inhaled.
- Zinc chloride flux may be highly toxic if fumes from the heated flux are inhaled.
- Inhaled fumes from heated rosin flux may cause asthma.
- Use copper foil, zinc came, or something other than lead. Avoid red lead.
- Use lead-free and antimony-free solders.
- Ensure appropriate ventilation for this activity, and use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.
- Clean up with a wet mop.

## **Glues/Adhesives**

- Included in this category are cyanoacrylates, rubber cement, silicones, and epoxies.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Cyanoacrylate found in instant glue may cause adhesion of mucous membranes (e.g., eyelids, skin, etc.).
- Solvent-based glues such as rubber cement and some epoxies may: 1) be toxic by ingestion and inhalation; 2) be flammable; 3) cause skin and eye irritation, and 4) cause allergies. (see Solvents).
- Use paste, mucilages, or homemade flour glues, but avoid wheat pastes with people who are allergic to wheat.
- Wear appropriate protection (e.g., gloves, goggles, etc.).
- Ensure appropriate ventilation for this activity, particularly when using solvent-based products.
- Avoid smoking, open flames, and other ignition sources when using glues with flammable components (e.g., solvents).

## **Leather and Other Animal Products**

#### *Leather:*

- Dust from sanding leather contains tanning agents, dyes, and glues that may be harmful.
- Avoid dust inhalation. Ensure appropriate ventilation and use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.
- Clean dust with a wet mop.

#### *Cementing, dyeing, finishing:*

- Leather dyes and glues may contain solvents (e.g., mineral spirits, turpentine, and toluene) which may be flammable or toxic after an exposure (see Solvents).
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Use water-based dyes or those dissolved in ethyl alcohol.

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<sup>1</sup> A rosin is a solid form of resin

- Some leather cleaners may contain oxalic acid which is corrosive and may be highly toxic by ingestion, inhalation, and skin contact. Avoid cleaners with oxalic acid.
- Wear appropriate protection. Use gloves, goggles, etc.
- Ensure appropriate ventilation for this activity and/or use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.
- Store solvent-soaked rags in a safety container.

#### *Feathers:*

- Dust from duck/goose feathers may cause “feather-pickers disease.” The symptoms, which may diminish if the user becomes tolerant, include coughing, fever, nausea, and headaches.
- Naphthalene and paradichlorobenzene may be applied to feathers as moth repellents. These agents are possibly carcinogenic to humans (IARC, Group 2B). Air these feathers outdoors before use.
- Naphthalene and paradichlorobenzene may be toxic following ingestion, inhalation, or skin exposures.
- Vacuum feathers on a screen from below before use.
- Use a dust mask and wear gloves.

#### *Shells:*

- Dust generated from sanding shells may be harmful following inhalation (e.g., inhalation of mother-of-pearl dust may cause fever and respiratory problems such as infections).
- Clean well or purchase pre-cleaned shells.
- Use a wet grinder and/or a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.

#### *Bones:*

- Degrease bones immediately. Bones not cleaned properly may cause infections or spread anthrax.
- Degreasing solvents (e.g., carbon tetrachloride) that are used to dissolve fats/oils may be hazardous (see Solvents).
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid chlorinated hydrocarbon solvents. Use mineral spirits.
- Dust formed from sanding may cause respiratory problems when inhaled.
- Use gloves and ensure appropriate ventilation for this activity or work outdoors. Use a wet technique and/or a dust mask.

## **Metals**

*Anodizing (involves the electrolytic treatment of metals (e.g., aluminum and magnesium) with coatings (e.g., titanium) to form a heavy, stable metal oxide coating):*

- The primary electrolytes used are sulfuric, oxalic, and chromic acids, which are corrosive and may be toxic by inhalation, ingestion, and skin/eye contact.

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Metal cleaners contain caustics (sodium hydroxide) which may be toxic by inhalation, ingestion, and skin/eye contact.
- Some metals are flammable. Be aware of potential fire hazards.
- To avoid electrocution while working with electrical equipment, use ground fault circuit interrupter (GFCI)-protected electrical outlets.
- Wear appropriate protective gloves, goggles, and apron.

*Electroplating (the deposition of a metal onto an object via an electrolytic method):*

- Ingredients in electrolytic solutions include copper sulfate, sulfuric acid, and cyanide.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Cyanide salts can be toxic by ingestion, inhalation, or skin absorption.
- Avoid cyanide plating solutions. If used, ensure appropriate ventilation for this activity, be familiar with the hazards, and alert your local emergency room to have a cyanide kit available.
- Sulfuric acid (> 10%) is corrosive on contact with the skin/eyes, mucous membranes, respiratory and gastrointestinal tracts.
- Wear protective clothing, chemical splash goggles, and gloves.

*Forging or smithing (shaping metals by hammering):*

- Furnaces used for forging with heat may release metal fumes and toxic gases (e.g., carbon monoxide) and infrared radiation.
- Be aware of fire and thermal hazards. Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).
- Ensure appropriate ventilation for this activity.
- Install carbon monoxide alarms.
- Wear protective clothing, gloves, earplugs, and infrared goggles or a face shield.

*Foundry (the art of casting metals into molds):*

- Mold types include channel, cuttlebone, sand, and lost wax.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Potential hazards associated with mold making include exposure to the following materials or contaminants: silica, formaldehyde, isocyanates, asbestos, and resins.
- Avoid casting in lead.
- Potentially toxic gases, including hydrogen cyanide and carbon monoxide, may form depending on the mold used.
- Ensure appropriate ventilation for this activity and/or use a respirator.
- Wear protective clothing, gloves, and goggles.

- Clean dust and mold materials with a wet mop or sponge.

*Gilding (involves overlaying a thin layer of gold or silver on a surface using size (glue) or amalgamation with mercury):*

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid using mercury, if possible. Heating the amalgam of mercury with gold and/or silver will release mercury vapor which may be toxic if inhaled.
- Potential health effects from inhalation exposure to mercury include swollen gums, vomiting, diarrhea, kidney failure, bronchitis, pneumonitis, and nervous system problems.
- Avoid prolonged or repeated skin contact with mercury because it may cause allergic contact dermatitis.
- Ensure appropriate ventilation when working with mercury.
- Carefully store mercury in closed containers and thoroughly clean up all spills with special kits. Only vacuum with equipment designed to pick up mercury.

*Grinding and polishing:*

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid using metals that may be highly toxic such as lead and cadmium.
- Wear appropriate clothing and eye protection.
- Ensure appropriate ventilation for this activity to avoid exposure to metal dust and fumes.
- Clean by wet mopping or with a HEPA vacuum. Do not sweep dust.

*Melting/pouring metal:*

- Furnace and metal fumes may be toxic if inhaled.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Be aware of fire and thermal hazards. Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).
- Ensure appropriate ventilation for this activity.
- Install carbon monoxide alarms.
- Furnaces can cause heat stress and emit infrared radiation.
- Wear protective clothing, gloves, and eye protection.

*Niello (involves decorating or inlaying an incised design on metal with black metallic alloys of sulfur with lead, copper or silver):*

- Inhalation of lead sulfide dust from grinding or lead fumes from heating is toxic.
- Ensure appropriate ventilation for this activity and/or use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.
- Wear protective clothing and eye protection.

*Patina (a green or brown coloring of metal produced by natural or chemically induced oxidation):*

- Numerous patina chemicals are available including ammonium sulfide, ammonium hydroxide, acetic acid, hydrochloric acid, barium sulfide, chromium VI compounds, copper compounds, ferric chloride, hydrogen peroxide, lead acetate, liver of sulfur (potassium sulfide), nitric acid, oxalic acid, potassium ferricyanide, sodium hydroxide, and zinc chloride.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Many patina chemicals may be toxic by ingestion, inhalation, and/or skin/eye contact.
- Wear protective clothing and eye protection.

*Pickling (a method of cleaning metal using chemicals (e.g., dilute inorganic acid solutions)) :*

- Components may include sulfuric acid, nitric acid, hydrofluoric acid, and sodium bisulfate.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Concentrated acid solutions are corrosive and some, such as hydrofluoric acid, may cause toxicity throughout the body (e.g., hypocalcemia, metabolic acidosis, hyperkalemia, and cardiac dysrhythmias).
- Avoid cyanide-containing metal cleaning solutions.
- If possible, use steel wool to clean metal instead of chemicals.
- Wear protective clothing, gloves, eye protection, and apron and have an eyewash fountain and emergency shower available when using concentrated acids.
- Ensure appropriate ventilation for this activity and/or use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.

*Soldering:*

- Metals (e.g., cadmium, lead, silver, antimony, and zinc), fluxes (e.g., zinc chloride, rosin, and fluoride), and cleaners/degreasers (e.g., solvents and acids) used in the soldering process may be toxic.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Use lead-free and cadmium-free solder.
- Various fluxes are available including those with acid, borax, fluoride, and rosin. Do not mix fluxes because potentially toxic vapors may form. Avoid fluxes with fluoride.
- Silver salts may discolor the skin, eyes, and mucous membranes. Some silver salts are irritants and others may be corrosive (e.g., silver nitrate).
- Wear eye protection and gloves.
- Ensure appropriate ventilation for this activity.

*Welding (e.g., oxyacetylene and arc welding):*

- Follow safety standards established by federal and state governments, and other organizations (e.g., the American



Welding Society, National Fire Protection Association, and the American National Standards Institute).

- Gases and fumes from gas cylinders, vaporized metals, and fluxes may be toxic if inhaled. Follow appropriate respiratory hygiene.
- Byproducts from welding stainless steel have been known to be carcinogenic.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Formal training in a certified program is advisable.
- Use care when handling gas cylinders (e.g., oxygen, acetylene, propane, nitrogen, carbon dioxide, etc.).
- Ensure appropriate ventilation for protection from potentially dangerous gases, metal fumes, and heat.
- Infrared and ultraviolet radiation generated during welding may be an eye hazard. Wear appropriate eye protection (goggles or face shield).
- Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).
- Noise can damage hearing. Wear fire-resistant earplugs.
- Wear protective clothing and eye protection.

## Painting

### General Information/Precautions

- The potential hazards from paints are primarily associated with some of the vehicles/solvents (e.g., aliphatic and aromatic hydrocarbons, ketones, and alcohols; see Solvents) and pigments (e.g., lead carbonate, chrome yellow, cobalt arsenate).
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Use premixed paints to avoid inhalation of dry pigments/dyes/powders.
- Use water-based products or observe the precautions on hazard-labeled products to reduce the potential hazards from solvents.
- Be aware that small amounts of formaldehyde, bleach and phenol used as preservatives in some paints may cause allergic reactions in sensitive individuals. If sensitive to these chemicals, contact the manufacturer of the paints you intend to use.
- The Environmental Protection Agency (EPA) prohibited the use of mercury compounds in interior-use wall paints after July 1990 but there is no prohibition against mercury in artists' paints.
- Wear protective clothing and gloves to prevent skin contact and tracking of materials to non-work areas.
- Ensure appropriate ventilation, especially when spraying or airbrushing paint. It may be advisable to use a spray booth and/or use an appropriate respirator (e.g., a National Institute for Occupational Safety and Health (NIOSH)-approved respirator with an organic vapor cartridge).

- Close containers of paint, pigments/dyes, and solvents when not in use.
- Remove paint from hands with vegetable or baby oil then wash with soap and water.
- Avoid turpentine and mineral spirits.
- Be aware of the flammability potential of solvents.

### *Spray painting/airbrushing:*

- This category includes the use of spray guns, airbrushes, and aerosol spray cans for paint application.
- The paints used may be water-based or solvent-based and contain pigments.
- Use water-based paints to reduce exposure to solvents.
- Aerosol spray paints sometimes contain propellants or pigments that may be toxic when inhaled (e.g., isobutanes and propane). Read the label.
- Fine particulates from spraying may remain airborne up to 2 hours and may cause headaches, nausea, fatigue, and breathing problems if inhaled.
- Propellants in aerosol spray products may be flammable. Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).
- If possible, use outdoors or with a spray booth or a fume hood and a National Institute for Occupational Safety and Health (NIOSH)-approved respirator with an organic vapor cartridge.
- Heated or punctured cans may explode.
- Use clear acrylic polymer emulsion to fix drawings.

### Paints

#### *Acrylics (water-based):*

- Some contain small amounts of ammonia (as a stabilizer) and formaldehyde (as a preservative), which may cause respiratory irritation and may also cause allergies in sensitized individuals. If sensitive to these chemicals, contact the manufacturer of the paints you intend to use.
- Ensure proper ventilation for this activity.

#### *Acrylics (solvent-based):*

- Contain solvents and are thinned/cleaned with solvents including turpentine, xylene, toluene, and methyl ethyl ketone (see Solvents).
- May be toxic primarily from inhalation of the solvent vapors.
- Ensure appropriate ventilation for this activity.

#### *Alkyds:*

- Contain solvents and are thinned/cleaned with solvents including turpentine, xylene, toluene, and methyl ethyl ketone (see Solvents).
- May be toxic primarily from inhalation of the solvent vapors.
- Ensure appropriate ventilation for this activity.

#### *Caseins:*

- Consist of dried milk, pigments, and preservatives.
- Can be hazardous to people with asthma.

- May be dissolved in ammonium hydroxide which may cause irritation after skin/eye contact, ingestion, and inhalation.

#### *Encaustics:*

- Consist of a suspension of pigments and other materials in wax.
- Can be a burn hazard.
- Wax decomposition materials (e.g., acrolein, formaldehyde, pigment fumes) formed from heating or torching the wax may cause respiratory irritation.
- Minimize vapor formation by only heating the wax to the minimum temperature required for melting.
- Avoid open flames when melting wax. Use a double boiler.
- Ensure appropriate ventilation for this activity.

#### *Epoxy paints:*

- Consist of a pigment-containing epoxy resin, which may contain solvents such as diglycidyl ethers, and a hardener.
- Hardeners may cause respiratory irritation and skin/respiratory allergies.
- Diglycidyl ether may be highly toxic by inhalation, ingestion, and skin/eye contact. It may cause a number of health effects including dermal burns, severe eye, skin, and respiratory tract irritation, and skin sensitization. It is also a possible reproductive toxin in laboratory animals.
- Wear gloves and goggles.
- Ensure appropriate ventilation for this activity, and use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator with an organic vapor cartridge to avoid inhalation. Replace cartridge regularly.

#### *Latex paints:*

- Consist of water emulsions of plastic resins, pigments, and about 5 to 15% solvents including glycol ethers (see Solvents).
- Glycol ethers may be toxic if ingested, inhaled, or absorbed by skin contact.
- Ensure appropriate ventilation for this activity.

#### *Water-based paints:*

- Use formaldehyde-free products, when possible.
- Some water-based paints may contain formaldehyde as a preservative which may cause allergic reactions in sensitive individuals. If sensitive to this chemical, contact the manufacturer of the paints you intend to use.
- Ensure appropriate ventilation for this activity.

#### *Oils:*

- Contain pigments, fillers, and sometimes solvents including paint thinner, turpentine, and mineral spirits (see Solvents). When possible, choose oil paints with few or no cautionary/warning labels.
- Some pigments and solvents may be toxic if ingested, inhaled, or absorbed by the skin.
- Use turpentine and mineral spirits only as directed on the product warning label or use non-toxic alternatives and only use clean-up products that say they conform to

ASTM D4236 to ensure that you are using a clean-up product that has been properly evaluated under LHAMA.

- Remove paint from hands with vegetable/baby oil or non-toxic artist's soaps and detergent cleaners rather than with solvents.
- Ensure appropriate ventilation for this activity.
- Use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator with an organic vapor cartridge and gloves when specified on the product label.

#### *Tempera paints:*

- Contain emulsions of oils, or wax, and some have egg or gum casein, and small quantities of preservatives.
- Some preservatives may cause allergic reactions in sensitive individuals.

#### *Fresco paints:*

- Fresco is a method of applying powdered pigments mixed in limewater (a saturated aqueous solution of calcium hydroxide) to a wall of damp fresh plaster.
- Powdered lime and limewater are corrosive and may be toxic by ingestion, inhalation, or skin/eye contact.
- Wear gloves and goggles to protect the eyes and skin.

#### *Varnishes, lacquers:*

- Some contain solvents (e.g., turpentine, methanol, ethyl alcohol, toluene, and mineral spirits) which may be toxic by ingestion, inhalation, and/or by skin contact/absorption (see Solvents).
- Be aware of the flammability potential of various solvents. Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).
- Use gloves, ensure appropriate ventilation, and use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator with an organic vapor cartridge when specified on the product label or use non-toxic alternatives.
- Dispose of solvents properly.
- Remove lacquers from hands with vegetable/baby oil or non-toxic artist soaps and detergent cleaners rather than with solvents.
- Wash hands with soap and water if solvents get on hands.

#### *Watercolors and gouache (opaque watercolor):*

- Watercolors in dry cake form contain pigments, preservatives, and binders (e.g., gum arabic and gum tragacanth). Water, glycerin, and glucose are also included in liquid watercolor formulations.
- Gouache contains pigments, gums, preservatives, glycerin, and opacifiers (e.g., chalk and talc).
- Some pigments may be toxic by inhalation. Avoid inhaling powders.
- Gum arabic and gum tragacanth may cause skin irritation and allergies.
- Some paints may contain small amounts of formaldehyde or paraformaldehyde as preservatives. If sensitive to these

chemicals, contact the manufacturer of the paints you intend to use to determine if they contain preservatives.

#### *Paint stripping:*

- Ingredients in paint stripping formulations include solvents (e.g., acetone, methanol, and toluene; see Solvents), methylene chloride, N-methylpyrrolidone, or dibasic esters.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Methylene chloride may be toxic by inhalation, ingestion, or skin exposure. It is a possible carcinogen in humans (IARC, Group 2B), an eye, skin, nose, and lung irritant, it may be corrosive, produce adverse cardiovascular effects, cause liver and kidney damage after prolonged exposure, and is metabolized to carbon monoxide.
- Those with heart, lung, and blood problems should avoid methylene chloride.
- N-methylpyrrolidone may cause skin blistering/burning.
- Solvent-based paint strippers are flammable. Avoid open flames and practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).
- Use products with methylene chloride and/or solvents outdoors.
- Ensure appropriate ventilation for this activity and use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.
- Wear appropriate gloves and goggles.
- Have an eyewash and shower available.

## **Paper and Canvases**

#### *Papermaking:*

- Substances typically used in papermaking include alum (potassium aluminum sulfate), lye, ammonia, chlorine bleach, hydrogen peroxide, pigments, natural colorants/dyes, washing soda (sodium carbonate), acetic acid, and potassium ferricyanide.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Household solutions of chlorine bleach (5%), ammonia (< 3%), hydrogen peroxide (3%), and acetic acid (vinegar ~ 4 to 6%) may cause skin/eye, respiratory, and mucous membrane irritation. Concentrated solutions of these chemicals are corrosive.
- Washing soda and lye are corrosive.
- Some pigments may be hazardous. Use pre-mixed pigments.
- Identify and avoid toxic woods and plants.
- Wear gloves, apron, goggles or a face shield, and have an eyewash and/or shower available.
- To avoid electrocution while working with electrical equipment, use ground fault circuit interrupter (GFCI)-protected electrical outlets.

- Noise and debris from beaters, macerators, and blenders may cause injury. Use proper machine guards and earplugs.

#### *Marbling (involves floating paints on a layer of carrageenan gel on water):*

- Typically, paint adhesion is improved by sponging the paper with alum (potassium aluminum sulfate).
- Some pigments and dyes may be toxic.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Alum may cause skin irritation or allergic reactions.
- Mix powdered pigments in a glove box (a sealed transparent container with built-in gloves used to manipulate materials) or, when possible, use premixed paints.

## **Photographic Materials**

#### *Mixing developing powders:*

- Developing powders are usually highly alkaline and may cause chemical burns. Powders may be toxic by ingestion, inhalation, or skin contact.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid photochemicals with the greatest toxicity potential (e.g., chromic acid, cyanide, and lead).
- Use a glove box (a sealed transparent container with built-in gloves used to manipulate materials) to mix powdered developers or use solutions when possible.
- Ensure appropriate ventilation for this activity and/or use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.
- Wear eye protection, gloves, and an apron.
- Store acids on low shelves to decrease chances of face/eye exposure in case of container breakage.
- Have an eyewash and shower available. To avoid spreading the chemicals to other body parts, perform eye irrigation at low water pressure.
- Avoid storing photochemicals in glass containers which may explode under pressure.

#### *Film developers:*

- Chemicals used in developing film include hydroquinone (a mutagen), N-methyl p-aminophenol, sodium sulfite, sodium carbonate (concentrations greater than 15% may be caustic), and potassium bromide.
- Some of these chemicals may be toxic if ingested, inhaled, or absorbed by skin contact.
- Many developers cause skin/eye irritation and allergic reactions (contact dermatitis).
- Use tongs instead of bare hands to handle prints.
- Keep an eyewash available.

#### *Stop baths:*

- Stop baths usually contain acetic acid and may contain potassium chrome alum as a hardener.

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Potassium chrome alum may be toxic by inhalation or skin contact.
- Concentrated acetic acid may be highly toxic if ingested, inhaled, or absorbed by the skin.
- Avoid glacial acetic acid. If necessary, use solutions with 50% or less acetic acid.
- Store acids on low shelves to decrease chances of face/eye exposure in case of container breakage.
- Keep baths covered when not in use to prevent evaporation/release of potentially toxic vapors.

#### *Fixers:*

- Components may include hypo or sodium thiosulfate (fixing agent), acetic acid (neutralizer), sodium sulfite or sodium bisulfite (preservatives), potassium aluminum sulfate (hardener), and boric acid (buffer).
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Concentrated solutions of acetic acid may be highly toxic if ingested, inhaled, or absorbed by the skin.
- Decomposition of sulfites may lead to formation of sulfur dioxide gas which may cause respiratory problems, especially in asthmatics.
- Boric acid may be toxic if ingested, but it is poorly absorbed through the skin.
- Ensure appropriate ventilation that removes contaminated air with exhaust above and behind trays and provides lots of fresh air.
- Wear appropriate gloves and goggles.
- Keep baths covered when not in use to prevent evaporation/release of potentially toxic vapors.

#### *Intensifiers and reducers:*

- Components of intensifiers include hydrochloric acid, potassium dichromate, potassium chlorochromate, and mercuric chloride.
- Components of reducers include potassium ferricyanide (in Farmer's reducer), ammonium or potassium persulfate, potassium permanganate, and sulfuric acid.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Potassium dichromate and other hexavalent chromium compounds are human carcinogens (IARC, Group 1).
- Potassium chlorochromate and potassium ferricyanide may release toxic gases (chlorine and hydrogen cyanide, respectively) when heated, combined with acid, or when exposed to strong UV light.
- Mercury compounds may be toxic if ingested, inhaled, or absorbed via skin contact.
- Avoid intensifiers with mercury, cyanide, or uranium.
- Hydrochloric acid, potassium dichromate, potassium chlorochromate, and sulfuric acid are corrosive.
- Potassium permanganate and ammonium persulfate are powerful oxidizers which may cause fires or explosions

when in contact with organic or other oxidizable materials.

- Wear appropriate gloves and goggles.
- Ensure darkroom ventilation that provides lots of fresh air and exhausts contaminated air at the rate of at least 10 room volume changes per hour.

#### *Toners:*

- The toning process involves replacing silver in a print with another metal (e.g., gold, brown silver sulfide, selenium, uranium lead, cobalt, platinum, or iron). Toners may also contain thiourea.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Sulfides may release toxic hydrogen sulfide gas during toning or when combined with acid.
- Selenium may release sulfur dioxide gas and in combination with acid may form hydrogen selenide gas.
- Gold and platinum salts are skin sensitizers.
- Use appropriate gloves, goggles, a respirator, or a glove box, and ensure appropriate ventilation for this activity.
- Ensure sulfide and selenium toners are not contaminated with acids.
- Rinse prints well between bleaching and developing.
- Always dilute acid by adding acid to water.
- Do not add acid to bleach and do not heat acid.
- Wear appropriate gloves, goggles, and an acid-proof apron.
- To avoid electrocution while working with electrical equipment and various solutions, use ground fault circuit interrupter (GFCI)-protected electrical outlets.

## **Plastic**

Potentially hazardous components used to make plastic include monomers (e.g., methyl methacrylate), initiators (e.g., organic peroxides: methyl ethyl ketone peroxide, benzoyl peroxide, etc.), and other additives (e.g., plasticizers, solvents, etc.).

#### *Acrylic resins:*

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Methyl methacrylate is a moderate irritant and sensitizer. It may be toxic if inhaled or following skin contact.
- Benzoyl peroxide (an initiator or hardener) is an allergen and it may also irritate the skin, eyes, and mucous membranes. It is also flammable.
- Avoid inhaling acrylic polymers. Use appropriate gloves and a dust mask/respirator and ensure appropriate ventilation for this activity.

#### *Amino and phenolic resins (e.g., urea formaldehyde and phenol formaldehyde):*

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).

- Formaldehyde may be toxic by ingestion, inhalation, or skin contact. It is a probable human carcinogen (IARC, Group 2A). Avoid exposure to formaldehyde.
- Phenol may be toxic by ingestion, inhalation, or skin contact.
- Carbon monoxide, cyanide (from amino resins), and formaldehyde gas can be released from machining (e.g., sanding, sawing, drilling) or heating the cured resins.
- Use appropriate gloves, and ensure appropriate ventilation for this activity.

#### *Epoxy resins:*

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Amine-containing epoxy hardeners may be toxic if inhaled or absorbed via skin contact.
- Solvents (e.g., glycidyl ethers) in epoxies may be toxic (see Solvents).
- Epoxy resins may irritate the skin and lungs, and may also cause allergies.
- If fiberglass is used with epoxies for reinforcement, avoid fiberglass dust which may cause respiratory and skin irritation.
- Use appropriate gloves, goggles, and ensure appropriate ventilation.

#### *Polyester resins:*

- Contents include a cross-linking agent (e.g., styrene), an initiator (e.g., organic peroxides: methyl ethyl ketone peroxide or MEK-P) and fiberglass.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Styrene may be toxic via inhalation or skin contact. It is possibly carcinogenic in humans based on evidence in animals (IARC, Group 2B).
- Methyl ethyl ketone peroxide (MEK-P) may be toxic by inhalation, ingestion, or skin/eye contact. It may be absorbed by the skin and may cause serious eye damage or blindness. Concentrated solutions may be corrosive.
- Handle MEK-P carefully. Do not mix with certain solvents (e.g., acetone or accelerator) because it may form an explosive mixture. Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).
- Fiberglass dust may cause respiratory and skin irritation.
- Use appropriate gloves, goggles, respirator, protective clothing, and ensure appropriate ventilation for this activity.

#### *Polyurethane resins:*

- Other components may include isocyanates, metal salts, and amine initiators.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Isocyanates are respiratory/skin/eye irritants and sensitizers. Avoid products with isocyanates.

- Do not heat urethane plastics. Heating may release toxic gases (e.g., carbon monoxide, hydrogen cyanide).
- Polyurethane resins are not recommended for those with allergies, respiratory and/or cardiac problems.
- Use appropriate protective clothing, gloves, and goggles.
- Use appropriate exhaust, a spray booth, and an air-supplied respirator.

#### *Silicones & natural rubber:*

- Substances in silicone resin systems include acetic acid, methanol, acetone, methylene chloride, peroxides, and ethyl silicate (see Solvents).
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Methanol and acetic acid vapors released during the curing process may be toxic if inhaled.
- Methylene chloride may be toxic by inhalation, ingestion, or skin exposure. It is a possible carcinogen in humans, an eye, skin, nose, and lung irritant, it may be corrosive, produce adverse cardiovascular effects, cause liver and kidney damage after prolonged exposure, and is metabolized to carbon monoxide.
- Avoid methylene chloride if you have heart, lung, and/or blood problems.
- Silicone resin systems may cause skin damage.
- Natural rubber latex contains isoprene, natural proteins (which may cause serious allergies) and may contain solvents such as n-hexane (see Solvents) or other additives. n-Hexane may be toxic by inhalation causing neurologic effects such as headache, dizziness, numbness, and central nervous system depression. n-Hexane may also be irritating to the eyes, skin, and mucous membranes.
- Ensure appropriate ventilation for this activity.
- Wear appropriate gloves and goggles.

#### *Organic peroxides:*

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Methyl ethyl ketone peroxide (MEK-P) may be toxic by inhalation, ingestion, or skin/eye contact. It may be absorbed by the skin and may cause serious eye damage or blindness. Concentrated solutions may be corrosive.
- Handle MEK-P carefully. Do not mix with certain solvents (e.g., acetone or accelerator) because it may form an explosive mixture. Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).
- Benzoyl peroxide is an allergen. It may also irritate the skin, eyes, and mucous membranes. It is also flammable.
- Cumene hydroperoxide may irritate the skin, eyes, and mucous membranes and it is a known skin sensitizer.
- Organic peroxides are reactive and unstable and should not be heated, exposed to direct heat or sunlight, mixed with other materials (e.g., solvents or accelerators), stored in clear glass, or kept in large quantities.

- Wear appropriate gloves, goggles, and protective clothing.
- Ensure appropriate exhaust, and use a respirator.
- Soak tools and containers that have been in contact with organic peroxides in water before disposal. Ensure proper disposal at a hazardous waste facility.

#### *Finished plastic (sheets, films, beads, or blocks):*

- Heating or cutting plastics may release potentially toxic decomposition products (e.g., polyvinyl chloride may produce hydrochloric acid vapors and nylon may produce hydrogen cyanide gas).
- Solvents may be toxic (see Solvents).
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Dust generated from cutting plastics may contain a number of additives including plasticizers (e.g., phthalates), stabilizers, adhesives (with solvents), and colorants.
- Polymer dusts may irritate the lungs.
- Use appropriate gloves, goggles, dust mask or respirator.
- Ensure appropriate ventilation for this activity.
- Clean up with a vacuum or wet mop.
- Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).

#### *Styrofoam:*

- Gases released from heating or burning styrofoam may be toxic.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).

## **Printmaking**

Techniques include lithography, intaglio, silkscreen, and relief.

### **Inks**

#### *Pigments/dyes:*

- Some ink pigments (e.g., chrome- or cobalt-containing) and dyes may be toxic.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid lead-containing pigments.
- Use premixed and water-based inks when possible.
- Use a glove box (a sealed transparent container with built-in gloves used to manipulate materials), or a toxic dust respirator, and ensure appropriate ventilation when working with powdered pigments.
- Do not sweep powders. Use a wet mop to clean spills.
- Wear appropriate gloves or use barrier cream to protect hands.

#### *Vehicles/modifiers:*

- Common vehicles include mixtures of oils, solvents and oils, and polymer emulsions. Additives include stabilizers, preservatives, plasticizers, and fillers.
- Modifiers such as oils, solvents, driers, antiskinning agents, tack reducers and stiffeners (e.g., petroleum jelly and vegetable shortening), may be added to vehicles to alter their performance (e.g., drying time).
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid driers with lead or manganese.
- Solvents may be toxic by inhalation, ingestion, or skin absorption.
- Some vehicles may be flammable, so avoid open flame and place oil-soaked rags in special disposal cans or pails of water.
- Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).
- Use appropriate gloves, goggles, dust mask or respirator.

*Lithography (involves drawing on metal plates or stone with grease-based crayons/ink then washing the plate/stone with a solution so that only the image area is receptive to ink and will be printed when pressed to paper):*

#### *Drawing materials:*

- Solvents (e.g., turpentine) in lithographic tusches may be toxic by inhalation, ingestion, or skin absorption (see Solvents).
- Lithographic crayons/pencils may contain pigments (e.g., lead chromate, lampblack, zinc chromate) which may be toxic and/or have carcinogenic potential.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid lead-containing pigments.
- Avoid skin contact with solvents and lampblack. Wear appropriate protective clothing and gloves.
- Ensure appropriate ventilation, and use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator when airbrushing.

#### *Stone or metal plate processing:*

- Substances used in stone or plate processing include acids, rosin dust, talc, dichromate salts, solvents, and solvent-based vinyl lacquers.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid asbestos-contaminated talcs.
- Some etching solutions contain acids (e.g., hydrochloric acid, nitric acid, and hydrofluoric acid).
- Dutch mordant, an etching product containing potassium chlorate, hydrochloric acid and water, is corrosive. Toxic chlorine gas is released during preparation.
- Nitric acid may ignite/combust when mixed with other materials including some acids, solvents, or sawdust.

Also, etching with nitric acid may release nitrogen dioxide which may be toxic by inhalation.

- Concentrated acid solutions are corrosive and some may cause burns and systemic toxicity (e.g., hydrofluoric acid).
- Dichromate salts are corrosive and may be toxic by ingestion, inhalation, and skin contact. Hexavalent chromium compounds are known human carcinogens (IARC, Group 1).
- Avoid etches with concentrated acids (e.g., hydrofluoric acid or nitric acid) and counter-etches and fountain solutions with dichromate salts. Use prepared etches when possible.
- Rosin dust may cause allergic reactions (e.g., asthma and dermatitis) in sensitive individuals.
- Store acids separately from other materials.
- Dilute acid by adding acid to water.
- Wear appropriate protection (e.g., gloves, goggles, and apron) and have an eyewash fountain and emergency shower available when using concentrated acids.
- Ensure appropriate ventilation for the particular product (e.g., solvent, acid, etc.). You may need an exhaust hood, a window exhaust fan, and/or a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.
- Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).

#### *Stone cleaning:*

- Phenol, caustic soda (sodium hydroxide), and mixtures of gum arabic and phosphoric acid are used to clean stones.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Phenol and caustic soda (sodium hydroxide) are corrosive and may be toxic by ingestion, skin contact/absorption, and inhalation.
- Remove phenol quickly after skin contact with undiluted polyethylene glycol 300 to 400 (PEG 300 or PEG 400) or isopropyl alcohol. Use soapy water for washing, not water alone.
- If possible, avoid products with phenol and caustic soda.
- Use appropriate gloves, goggles, respirator, and apron.

#### *Photolithography (the transfer of a graphic image to an emulsion-coated stone or metal plate):*

- Components of the emulsions used include powdered albumin, ammonia, water, ammonium dichromate, diazo compounds, and plate conditioners with strong alkali. Solvents may be a component of the developing solutions.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Solvents may be toxic and/or flammable (see Solvents).
- Strong alkali (e.g., concentrated ammonia) is corrosive and may be toxic by ingestion, inhalation, and skin/eye contact. Ammonia may be irritating at low concentrations (< 3%).

- Ammonium dichromate is corrosive and may be toxic by ingestion, inhalation, and skin/eye contact.
- Hexavalent chromium compounds are known human carcinogens (IARC, Group 1).
- Ammonium dichromate is flammable and a strong oxidizer.
- Carbon arc lights used in photolithography generate potentially toxic fumes (e.g., nitrogen dioxide, carbon monoxide, metal, and ozone) and ultraviolet (UV) radiation. Avoid using these lights or ensure appropriate ventilation for this activity.
- Use gloves, welding goggles (for protection against UV radiation), an exhaust hood, plastic apron, and a National Institute for Occupational Safety and Health (NIOSH)-approved respirator (for mixing powders and/or spraying photoemulsions).
- Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).

#### *Intaglio (the etching/engraving of an image onto a metal plate followed by the addition of ink into the depressions and then the transfer of the image to paper):*

- Intaglio involves the use of etches (e.g., acids, Dutch mordant, ferric chloride) and resists (to protect unetched plate areas) such as stopout varnishes containing solvents, and grounds with asphaltum dust, and rosin dust, or spray paints for aquatinting.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Rosin dusts and asphaltum dusts may cause respiratory effects (e.g., irritation) if inhaled. Rosin may cause allergic reactions (e.g., asthma and dermatitis) in sensitive individuals.
- When confined in an aquatint box (a sealed box in which one creates a cloud of resin dust) resin or asphaltum dust may explode from sparks or static electricity. Use an explosion-proof box when using these dusts.
- Solvents may be toxic by inhalation, ingestion, or skin/eye contact and some solvents are flammable (see Solvents).
- Ferric chloride may cause respiratory, skin, and eye irritation.
- Dutch mordant, an etching product containing potassium chlorate, hydrochloric acid and water, is corrosive. Toxic chlorine gas is released during preparation. Avoid using Dutch mordant or use with extreme caution.
- Acids used for etching are corrosive and may cause systemic toxicity (e.g., hydrofluoric acid).
- Nitric acid may ignite/combust when mixed with other materials including some solvents and acids. Also, etching with nitric acid may release nitrogen dioxide which may be toxic by inhalation.
- Use extreme caution when using concentrated acids. Wear appropriate protection (e.g., gloves, goggles, and apron) and have an eyewash fountain and emergency shower available.

- Store acids separately from other materials.
- Dilute acid by adding acid to water.
- Ensure appropriate ventilation when acid etching and applying stopouts or grounds.
- Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).

*Photoetching (involves using photoresist dye, developers, and ultraviolet lamps):*

- Photoresist dyes and developers typically contain solvents including various glycol ether acetates, xylene, and benzaldehyde. These may be toxic when ingested, inhaled, or absorbed via skin contact.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Some methylene and ethylene ether acetates may cause adverse reproductive effects (e.g., birth defects, low sperm counts).
- Carbon arc lights generate potentially toxic fumes (e.g., nitrogen dioxide, carbon monoxide, metal, and ozone) and ultraviolet (UV) radiation. Avoid using these lights or ensure appropriate ventilation for this activity and wear welder's goggles.
- Ensure appropriate ventilation for this activity and wear appropriate gloves (e.g., butyl rubber) and a National Institute for Occupational Safety and Health (NIOSH)-approved respirator.

*Drypoint, engraving, and mezzotint (involves using sharp tools to make lines in metal plates):*

- Metal dust generated may be irritating when inhaled. Use a respirator or appropriate mask for protection.
- Repetitive movements from long-term tool use may cause carpal tunnel syndrome.
- Rest frequently, avoid gripping the tools tightly, and set an appropriate work table height to avoid repetitive strain injuries.
- Avoid laceration injuries by using a clamp plate to prevent slipping, cutting away from the body, keeping tools sharp, and storing tools with guards.

*Relief printing (involves cutting away areas of materials, such as wood, linoleum, or acrylic, while the remaining surface is inked and printed):*

- Inks used in relief printing contain pigments (see Printmaking), solvents (see Solvents), and other materials that may be toxic.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Use water and non-toxic inks, water-soluble glues, liquid wax, rubber, or paper resists.
- Use low temperatures to heat linoleum. Avoid open flame.
- Use the appropriate gloves, goggles, protective apron, and ensure appropriate ventilation for this activity.

- Prevent carpal tunnel syndrome by resting frequently and avoiding tight gripping of the cutting tools.
- Avoid laceration injuries by cutting away from the body, using bench hooks while carving, and storing tools with guards in place.

*Screen printing (involves stenciling or blocking with a resist on a framed screen and then applying ink through the screen to paper):*

- Inks used in screen printing contain pigments (see Printmaking), solvents (see Solvents), and other materials that may be toxic and/or hazardous (e.g., flammable).
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Stencil films may be attached or removed from screens with water-based or solvent-based products (see Solvents).
- Products made to resist inks known as "resists" may be solvent-based (e.g., containing lacquers, shellacs, polyurethane varnishes, see Solvents) or water-based.
- When possible use water-based products (i.e., inks, emulsions, resists, etc.).
- Screen cleaners contain solvents (see Solvents). Use care when cleaning or use disposable screens. Do not put solvent-soaked rags in open waste cans; place in covered metal cans to prevent combustion.
- Ensure appropriate ventilation for this activity and/or use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator particularly when using solvent-based products.
- Diazo photoemulsions may cause eye irritation, but are safer than emulsions with ammonium dichromate, a human carcinogen (IARC, Group 1), which is also flammable and may be toxic by ingestion, inhalation, and skin/eye contact.
- Carbon arc lights generate potentially toxic fumes (e.g., nitrogen dioxide, carbon monoxide, metal, and ozone) and ultraviolet (UV) radiation. Avoid using these lights or ensure appropriate ventilation for this activity and wear welder's goggles.
- Wear appropriate gloves and goggles.
- Store solvents in proper containers.
- Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).

*Collagraphs (prints made by gluing a collage of materials to a rigid support):*

- Glues, fixatives, and other materials are used to make collagraphs.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Glues may contain solvents that may be toxic if inhaled and flammable. Avoid glues with solvents (see Solvents); use water-based glues.



- Spray fixatives used to seal collagraph plates may also contain solvents which may be hazardous when inhaled. If possible, brush on fixatives.
- Dust generated from sanding collagraph plates may irritate the lungs if inhaled. Use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator when sanding.
- Wear appropriate gloves and ensure appropriate ventilation for this activity.
- When spraying fixatives, use a spray booth that exhausts to the outside or spray outdoors.

#### *Plastic prints:*

- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid inhalation of plastic resin vapors and decomposition fumes when working with plastic.
- Avoid solvent-based inks and other products. Use water-based products.
- Ensure appropriate ventilation for this activity or use a National Institute for Occupational Safety and Health (NIOSH)-approved respirator with organic vapor cartridges.

#### *Presses:*

- Keep hands and loose clothing out of the way to prevent injury.

## **Sculpture**

- Plaster or plaster of paris contains calcium sulfate which occurs naturally as gypsum. Other substances may be added: 1) to hasten (e.g., salt or potassium alum) or delay (e.g., borax, diluted acetic acid, or burnt lime) setting of the plaster; and 2) to provide texture (e.g., silica sand, vermiculite, coarse stone).
- Polymer clays consist of fine particles of polyvinyl chloride suspended in plasticizers.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Plaster (calcium sulfate) dust may be irritating to the skin, eyes, mucous membranes, and respiratory tract.
- Casting body parts may cause thermal burns from the heat released during setting. Alternatively, use white petrolatum (e.g., petroleum jelly) to protect the skin then apply plaster-impregnated bandages.
- Potassium alum may cause skin irritation or allergic reactions.
- Concentrated solutions of acetic acid (100%) are corrosive and may be highly toxic if ingested, inhaled, or absorbed by the skin.
- Borax and lime may be toxic if ingested, inhaled, or absorbed by the skin.
- Silica sand and vermiculite dust may be toxic if inhaled.
- When working with plaster, use an appropriate dust mask, vacuum, and wet mop. Avoid sweeping. Protect hands with gloves.

- When modeling or carving stone or plaster, carve away from the body and wear goggles to protect the eyes from flying chips of the sculpture material.
- Benzine (petroleum ether), a component of mold releases, is flammable and may be toxic if ingested, inhaled, or absorbed by the skin.
- Methods for finishing plaster include painting (with paint, powdered pigments, or the addition of dyes to the plaster), preparing patinas with shellac/acrylic sprays or mixtures containing water, glue, lacquer, alcohol, or bronzing liquids.
- Lacquers contain solvents that may be flammable and toxic if inhaled (see Solvents).
- To avoid inhalation of powdered pigments/dyes and solvents when spraying, use an appropriate dust mask, gloves, goggles, spray booth, and a respirator. Ensure appropriate ventilation and keep solvents away from flame. Alternatively, brush or dip plaster instead of spraying.
- Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).

## **Solvents**

Solvents may be a component of art materials (e.g., inks, varnishes, paints, glues, etc.) and may also be used for cleaning paint brushes, tools, and other equipment in the studio or workplace. Chemical classes of solvents include: alcohols, ketones, hydrocarbons (e.g., aromatic, chlorinated, and aliphatic), and glycol ethers. Depending on the solvent, toxicity may result from inhalation, ingestion, aspiration, and/or dermal contact/absorption. Also, the toxic effects may vary depending on whether the exposure is acute (short term) or chronic (long term).

While there are some general toxic effects associated with many solvents (i.e., central nervous system (CNS) effects such as depression, dizziness, and confusion), other effects may be more specific to a particular solvent (e.g., benzene is a known human carcinogen). Additionally, some solvents are flammable and may present a fire hazard. Practice fire prevention (e.g., store combustibles away from heat, install sprinklers, obtain a fire extinguisher, etc.).

The following is a list of some solvents found in art and craft supplies. This list is not exhaustive.

*Acetone* is highly flammable. Potential health effects include respiratory irritation, central nervous system depression, respiratory depression, hyperglycemia, and ketonemia. Two to three milliliters (~ ½ teaspoon) per kilogram may be considered a toxic oral dose in children (Poisindex, 2004).

*Alcohol (ethanol)* is highly flammable. Potential health effects include: upper respiratory tract irritation, CNS depression, hypoglycemia, and acidosis. Three grams/kilogram is a lethal oral dose in children (Poisindex, 2004).



- Follow the necessary precautions when using pigments containing lead.
- Some vat dyes must be oxidized with dichromate salts to produce color. Dichromate salts are corrosive and may be toxic after an exposure. Hexavalent chromium compounds are human carcinogens (IARC, Group 1). If possible, oxidize with heat and air instead.
- Batik dyeing involves using heated wax and possibly solvents (see Solvents) for wax removal. Be aware of potential fire hazards and the emission of irritating vapors from heating the wax. Ensure appropriate ventilation for this activity.
- Discharge dyeing involves removing colors from fabric with bleach or other chemicals. Household bleach (5%) may be irritating to the eyes, skin, mucous membranes, and respiratory tract. Do not heat bleach solutions or add ammonia or acid to bleach.
- Use a canopy hood over a dye bath.
- Wear appropriate gloves, goggles, respirator, and protective clothing when dyeing.
- To avoid skin/eye exposures, be careful not to splash when tie dyeing.
- Avoid sweeping. Use a HEPA vacuum or a wet mop to clean.

## Waxes

- Various waxes are used for sculpting, casting, making candles, etc. including beeswax, carnauba, tallow, synthetic chlorinated, and paraffin. Wax additives include rosin, dyes, and solvents. Also, solvents used to dissolve wax include alcohol, acetone, and turpentine.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Avoid using synthetic chlorinated waxes.
- Be aware of the potential hazards associated with solvents (see Solvents). Choose the safest solvent and use the least amount necessary for the job. Avoid carbon tetrachloride.
- Wax becomes a potential hazard when it is overheated and releases vapors (e.g., acrolein, wax fumes, and formaldehyde) which may cause lung irritation and other respiratory problems. Also, overheated wax may explode near an open flame or from a spark. Avoid overheating wax. Do not use an open flame to melt wax.
- Use appropriate protection and ensure appropriate ventilation when working with wax and solvents.

## Woodworking

Includes framing, sculpting, furniture-making, etc., using various types of hard and soft woods, exotic woods, plywood, composition board, etc.

### *Hardwoods and Softwoods:*

- Wood dust contains a variety of substances including cellulose, lignin, fatty acids, sterols, alcohols, terpenes, tannins, and alkaloids.

- Become familiar with the potential toxic effects associated with a particular wood type.
- Inhalation of wood dust may irritate the lungs and cause other respiratory effects.
- Occupational exposures (e.g., furniture and cabinet-making) to some hardwood dusts have been associated with cancer of the nasal cavities and sinuses (IARC, Group 1).
- Numerous hardwood dusts (particularly from exotic woods) are sensitizers which may cause allergic reactions such as dermatitis, hay fever, conjunctivitis, and asthma. When possible use common woods rather than exotic woods.
- Constituents of some hardwoods may cause a number of effects including headaches, nausea, cardiac symptoms, etc.
- Avoid inhaling wood dust by using a National Institute for Occupational Safety and Health (NIOSH)-approved toxic dust respirator or ensure appropriate ventilation.
- Use gloves or barrier cream to protect hands.

*Plywood and composition boards (contain glues/adhesives with urea-formaldehyde or phenol-formaldehyde):*

- Formaldehyde may be toxic by ingestion, inhalation, or skin/eye contact. Potential health effects include respiratory, eye, and skin irritation/burning depending on the concentration, allergic reactions (e.g., dermatitis), nausea, vomiting, seizures, and CNS depression. Also, formaldehyde is probably carcinogenic to humans (IARC, Group 2A).
- Decomposition from working with (e.g., sanding, machining, etc.) plywood/composition boards may release vapors such as carbon monoxide, hydrogen cyanide, formaldehyde, and phenol.
- If possible, use wood products with a low formaldehyde content.
- Store wood in a well-ventilated area.
- Exhaust dust to the outdoors.

### *Wood preservatives:*

- Preservatives and pesticides are sometimes applied to wood under pressure to protect it from dry rot, termites, etc. Such chemicals are potentially toxic.
- Be aware of the chemicals in the wood you use. Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).
- Look for the most current information on any potentially hazardous components.
- To avoid inhalation or skin/eye exposures, do not machine (e.g., sand, saw, drill, etc.) or burn preserved wood that contains potentially toxic chemicals.

### *Gluing wood:*

- Glues used for wood include epoxies, contact adhesives, cyanoacrylates, and formaldehyde-resin.
- Read the product label. When possible, choose the safest materials available (e.g., those with few or no cautionary/warning labels).

- Some contact adhesives and other glues (some epoxies) contain solvents (e.g., n-hexane) that may be toxic if inhaled and are also flammable (see Solvents). Avoid glues with solvents; use water-based glues.
- Cyanoacrylate found in instant glue may cause adhesion of skin and/or mucous membranes (e.g., eyelids, etc.).
- Formaldehyde may be toxic by ingestion, inhalation, or skin/eye contact. Potential health effects include respiratory, eye, and skin irritation/burning depending on the concentration, allergic reactions (e.g., dermatitis), nausea, vomiting, seizures, and CNS depression. Also, formaldehyde is probably carcinogenic to humans (IARC, Group 2A).
- Avoid formaldehyde-resin glues.
- Wear appropriate protection. Use gloves, barrier cream, goggles, and a National Institute for Occupational Safety and Health (NIOSH)-approved toxic dust mask.
- Ensure appropriate ventilation for this activity.
- Avoid smoking, open flames, or other ignition sources when using glues containing flammable solvents.

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## Glossary

**Acute exposure** – a short term exposure (usually less than 24 hours) to a substance or chemical.

**Albuminuria** – the presence of albumin (a protein that can be dissolved in water) in the urine.

**Anemia** – a condition characterized by a reduction in red blood cells and hemoglobin.

**Aplastic anemia** – anemia caused by a lack of cell production in the bone marrow.

**Asbestosis** – formation of fibrous tissue in the lungs as a result of prolonged inhalation of asbestos dust.

**Ataxia** – loss of muscle coordination.

**Benign pneumoconiosis** – any lung disease caused by dust inhalation, particularly mineral dusts.

**Bronchitis** – inflammation of the mucous membrane of the airways.

**Carcinogen/Carcinogenic** – any agent or substance which causes cancer.

**Cardiac dysrhythmia** – disordered heart rhythm.

**Chemical pneumonitis** – lung inflammation produced by aspiration of certain chemicals (e.g., petroleum distillates, lacquer thinner, etc.).

**Chronic exposure** – a long term exposure (usually greater than 3 months) to a substance or chemical.

**Contact dermatitis** – a condition caused by direct injury to the skin via the irritant effect of a substance or by sensitization (see definition of sensitizer below) to a substance that contacts the skin.

**Corrosive** – a substance capable of destroying tissue on contact.

**Defatting dermatitis** – an inflammatory skin condition caused by the removal of natural skin oils.

**Emphysema** – a condition of the lung characterized by distension, progressive loss of elasticity, and eventual rupture of the alveoli (the smallest components of the lungs where air is exchanged with the blood) and accompanied by labored breathing, a husky cough, and frequently by impairment of heart action.

**Feather picker's disease** – a condition characterized by fever, chills, nausea, coughing, and headaches.

**Fibrosis** – formation of fibrous tissue as a reaction to a substance.

**Hematologic** – related to the blood or blood-forming tissues.

**Hematuria** – blood in the urine.

**Hyperglycemia** – elevated blood sugar.

**Hypoglycemia** – decreased blood sugar.

**Hypoxia** – a deficiency of oxygen reaching body tissues.

**IARC categories on carcinogenic risks to humans** –

Group 1: The agent (mixture) is carcinogenic to humans.

Group 2A: The agent (mixture) is probably carcinogenic to humans.

Group 2B: The agent (mixture) is possibly carcinogenic to humans.

Group 3: The agent (mixture) is not classifiable as to carcinogenicity in humans.

Group 4: The agent (mixture) is probably not carcinogenic to humans.

**Ketonemia** – a condition characterized by an abnormal elevation of ketone bodies (a product of the bodies metabolism) in the circulating blood.

**Metabolic acidosis** – acidosis (reduced alkalinity of the blood) caused by excess acid from abnormal metabolism, excessive acid intake, renal retention, or from excessive loss of bicarbonate (as in diarrhea).

**Metal fume fever** – an acute allergic condition caused primarily by the inhalation of zinc oxide or magnesium oxide fumes.

**Mutagen** – an agent that promotes a genetic mutation.

**Pneumonitis** – inflammation of the lungs.

**Pulmonary edema** – an abnormal accumulation of fluid in the lungs.

**Resin** – a man-made polymer made from the chemical reaction of two or more substances, usually with heat or a catalyst, or an organic substance formed in plant secretions.

**Rosin** – a solid form of resin.

**Sensitizer** – a substance that upon subsequent exposure will cause an allergic response in a susceptible individual.

**Silicosis** – a condition caused by prolonged inhalation of silica dusts, which is characterized by massive fibrosis of the lungs leading to shortness of breath.

**Systemic** – affecting the entire body.

**Synergistic** – an interaction of substances such that the total effect is greater than the sum of the individual effects.

**Teratogenic** – causing birth defects.

**Toxicity** – of, relating to, or caused by a poison or toxin.

**Volatile** – evaporates readily at room temperature.

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