Rutgers University
Visual Art Safety Training Manual - 2012

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EMERGENCY RESPONSE NUMBERS
TO CONTACT THE RUTGERS POLICE (RUPD)
FOR
POLICE - FIRE - AMBULANCE

- NEW BRUNSWICK – 6-911
- NEWARK – 5111
- CAMDEN – “8” OR 6111

*NOTE – If you are located on ANY campus at Rutgers and dial 911 from a cell or non-University phone, the call will be directed to RUPD automatically.

For information about Spill Clean-up call
Rutgers Environmental Health and Safety
(REHS) at (848)-445-2550

Introduction

Purpose of this guide

This training guide provides basic information for working safely with chemicals and operations in Visual Arts. This guide is intended to supplement the hands-on training provided by departmental faculty for each discipline.

Environmental Health & Safety

The Rutgers Environmental Health and Safety (REHS) office serves the University community by providing technical support, information and training, consultation, and periodic audits of health and safety practices and regulatory compliance. Contact REHS at 848-445-2550 or consult the REHS web page at http://rehs.rutgers.edu for information and services we provide which include hazardous waste disposal, MSDS information, occupational safety and more.

Responsibility for Safety

Departmental Safety Manager

The Departmental Safety Manager has responsibility for oversight of health and safety within the department and is a principal contact for faculty, staff and students to address health and safety issues or concerns. The Departmental Safety Manager works with faculty, management, and supervisory personnel to identify potential hazards associated with their operations and activities.

Faculty

Faculty are responsible for ensuring that students attend training and work safely and

- Ensure artists understand the potential health and physical hazards of the chemicals and equipment used;
- Explain proper and safe procedures for handling hazardous substances;
- Provide appropriate equipment to allow students to work safely.

Artists

Each student, faculty and staff member is expected to attend training and:

- Follow procedures and practices outlined in this training guide; and
- Report all accidents, near misses, and potential chemical exposures to the Departmental Manager.

For more information

For more information about working safely, consult your departmental safety manager. If additional information is needed, contact REHS at 848-445-2550 or visit our web page at http://rehs.rutgers.edu. A list of additional health and safety reference materials is provided in Appendix A of this guide.

Rutgers University Emergency Action Plan

For any emergency, including fire, explosions, accidents, and medical emergencies, use the RUPD contact numbers as listed on page 1 of this manual. Rutgers University Police Department personnel will respond, determine whether additional assistance is required and alert others who can assist.

Fire Emergencies

Fire safety is an important part of our daily routine. During an emergency, proper action saves lives. For your safety, please familiarize yourself with these basic steps that pertain to employees/students on all University campuses, Marine Field Stations, Agricultural Field Experiment Stations and other facilities.

1. If you discover a fire or smell smoke, sound the building fire alarm. Know the locations of the fire stations and how they operate. Do not attempt to fight a fire due to the hazards associated with the products of combustion and the threat of a spreading fire.
2. Upon hearing a building fire alarm signal, which may be a bell, horn, or voice message depending on the building you are occupying, immediately begin evacuation. Close the doors behind you. Use the nearest safe exit, but DO NOT use elevators.
3. Leave the building and assemble in an area established by your supervisor, where you will not hinder the approaching firefighters and apparatus.
4. If caught in smoke or heat, stay low where the air is better and attempt to reach a safe exit or area of refuge.
5. Know the location of all exits from your building. All exits in University facilities are properly marked with illuminated EXIT signs and directional arrows, where applicable.
6. If you are unable to leave your room or office due to heat or heavy smoke in the hallway, or due to physical disability, telephone University Police and give your exact location so the firefighters can be directed to you.
7. Always use the universal emergency access number to reach University Police in an emergency. They are listed on page 1 of this manual.

Evacuation routes are posted in all resident halls, health centers, and high-rise buildings in accordance with the provisions of the New Jersey Uniform Fire Code. Where desired, evacuation route plans for other buildings may be prepared by unit supervisors; consultation with the Fire Safety Division is always available. However, all employees should be familiarized with ALL exits from the building in order that the nearest safe exit will be properly chosen in an emergency.

For further information regarding fire safety, to request assistance in developing office fire safety plans, or to schedule a fire safety training session contact the Fire Safety Division in New Brunswick (848)-445-5325.

Chemical Exposures

The following procedures should be followed in the event of chemical exposure. **In all cases, the incident must be reported to the department manager, and medical attention is required, regardless of the severity.** In the case of an emergency, call RUPD to dispatch an ambulance for transport to the nearest emergency room at a local hospital.

In New Brunswick

- **For ambulance transport to an emergency room at a local hospital call RUPD at "6-911" from a University phone.** Otherwise, employees must go to Occupational Health at Hurtado Health Center on College Avenue Campus (ext. 2-8254). Students must go to the following:
- **College Avenue Campus Students** must go to Hurtado Health Center (ext. 2-7401)
- **Cook/Douglass Students** must go to Willets Health Center (ext. 2-9805)
- **Busch/Livingston Students** go to the Busch-Livingston Health Center (ext. 5-3250).
- See ***NOTE** on the following page for contacting RUPD for emergency response from a cell or non-University phone.

In Newark

- **For ambulance transport to an emergency room at a local hospital call RUPD at "5111" from a University phone.** Otherwise, employees and students must go to the Newark Student Health Center in Blumenthal Hall (ext. 5231 X.2). See ***NOTE** for contacting RUPD for emergency response from a cell or non-University phone.

In Camden

- **For ambulance transport to an emergency room at a local hospital call RUPD "8" from a University phone.** Otherwise, employees and students must go to the Camden Health Center at 326 Penn Street (ext. 6005). See *NOTE for contacting RUPD for emergency response from a cell or non-University phone.

- NOTE – If you are located on any campus at Rutgers University and dial 911 from a cell or non-University phone, the call will be directed to RUPD automatically.

Chemicals in Eyes

If the chemical was splashed in the eye, immediately seek an eyewash, safety shower, or spigot. The eye must be flushed for at least 30 minutes with the eyelids held apart to allow maximum exposure of the eyeball. While washing, check for contact lenses by looking into the eye, and by asking the injured person (while contact lenses are prohibited in areas where chemicals are used, rules are sometimes broken). Ask the injured person to remove them if possible. Otherwise, contacts may be removed under gentle water pressure. Do not attempt to remove contacts by hand or with any other object. Emergency personnel are trained to do this. Be careful not to rub the eyes.

Chemicals on Skin

If chemicals are on the skin, follow the recommendations under the First Aid section of the MSDS. If such information is not readily available, wash the affected area with continuous clean water for 15 minutes. Remove any clothing contaminated with chemicals; be careful that the rescuer does not become contaminated as well.

Chemical Inhalation

If the chemical was inhaled and the injured person is conscious, call the campus emergency number and then carry or drag the victim to fresh air. Do not let the injured person walk unassisted or engage in any unnecessary activity that will increase the circulation of poison in the bloodstream. If you need to use artificial respiration, be careful you do not inhale the poison from injured person. If the injured person is not conscious, do not enter the area; the person may have been overcome by gases in the area, or by a lack of oxygen in the space. There have been many documented instances, some on University campuses, of would-be rescuers becoming injured as well.

Accidental Ingestion of Chemicals

If the chemical was ingested, call the campus emergency number and then the Poison Control Center (1-800-962-1253). Follow their instructions. If for some reason you cannot reach professional advice, do not give the injured person water, milk or anything else unless so directed by a Material Safety Data Sheet (MSDS), Hazardous Substance Fact Sheet (HSFS), or other text. Do not induce vomiting if the victim complains of pain or a burning sensation in the mouth or throat, or if the ingested substance is known to be caustic, a cleaning fluid, or a petroleum product. Induce vomiting only if directed to do so by Poison Control. To induce vomiting, place the person's head below the hips, mouth down or to the side, and place a finger at the back of the injured person's throat.

Accidental Injection of Chemicals

Be aware of the possibility of inadvertent injection of chemicals into the body (by knives, broken glass, needles or sharp objects). Many solids, oily liquids, or water solutions can enter through cuts in the skin. In addition, the skin will absorb many oily liquids and oil soluble solids. Keep the injured person quiet and wait for medical assistance.

Once again, for all chemical exposures it is required that all injured persons must seek medical attention.

Section 1: General Information About Chemical Safety

Before using any chemical, even if it is something that you have worked with at home or in other situations, it is important to understand what the hazards may be and how to work with it safely.

In order to assess the hazards of a particular chemical, both the physical and health hazards of the chemical must be considered. Generally, more information is available about physical hazards than health hazards. An overview of basic toxicology and physical hazards follows.

Physical Hazards of Chemicals

The physical hazards of a chemical include its flammability and reactivity. Flammability is the tendency of a chemical to burn. The flashpoint, auto ignition temperature and flammable limits of the material may be found in the MSDS, and are helpful in assessing the potential for a fire hazard under specified conditions. See Section 5, ***Explanation of Material Safety Data Sheet Information*** for a more detailed explanation of these terms.

Reactivity is the potential of the material to explode or react violently with air, water or other substances upon contact. The MSDS furnishes this information in the *Reactivity Data* section.

Before using any chemical, the MSDS or other appropriate source should be reviewed to determine what conditions of use may pose a hazard. Accidents with hazardous chemicals can happen quickly and may be quite severe. The key to prevention of these accidents is awareness.

Health Hazards of Chemicals

The health effects of hazardous chemicals are often less clear than the physical hazards. Data on the health effects of chemical exposure, especially from chronic exposure, are often incomplete. When discussing the health effects of chemicals, two terms are often used interchangeably – *toxicity* and *hazard*. However, the actual meanings of these words are quite different. *Toxicity* is the ability of a chemical substance to cause harm. *Hazard* is the likelihood that a material will cause harm *under the conditions of use*. Thus, with proper handling, even highly toxic chemicals can be used safely. Conversely, less toxic chemicals can be extremely hazardous if handled improperly.

The health risk of a chemical depends on the toxicity and the actual exposure. No matter how toxic the material may be, there is little risk involved unless it enters the body. An assessment of the toxicity of the chemicals and the possible routes of entry will help determine what protective measures should be taken.

Routes of Entry

Skin and Eye Contact

Skin contact with a chemical may result in a local reaction, such as a burn or rash, or absorption into the bloodstream. Absorption into the bloodstream may then allow the chemical to cause toxic effects on other parts of the body.

The absorption of a chemical through intact skin is influenced by the health of the skin and the properties of the chemical. Skin that is dry or cracked or has lacerations offers less resistance.

Wear gloves and other protective clothing to minimize skin exposure. See Section 3, *Personal Protective Equipment* for additional information. Symptoms of skin exposure include dry, whitened skin, redness and swelling, rashes or blisters, and itching. In the event of chemical contact on skin, rinse the affected area with water for at least 15 minutes, removing clothing while rinsing, if necessary. Seek medical attention if symptoms persist.

Chemical contact with eyes can be particularly dangerous, resulting in painful injury or blindness. Wearing safety goggles or a face shield can reduce the risk of eye contact. Eyes that have been in contact with chemicals should be rinsed immediately with water continuously for at least 30 minutes. Contact lenses should be removed while rinsing-do not delay rinsing to remove the lenses-seconds count.

Inhalation

The lungs are the most common route of entry for gases, vapors and particles. Such materials may be transported into the lungs and harm the tissue or enter the bloodstream.

Many chemicals have a characteristic odor. Review the MSDS for information about the odor threshold (the detection of a chemical odor perceptible at certain concentrations) of the chemical in question. Depending on the odor threshold of the particular chemical, detection of an odor may or may not indicate a chemical over-exposure.

Symptoms of over-exposure may include headaches, increased mucus production, and eye, nose and throat irritation. Narcotic affects including confusion, dizziness, drowsiness, or collapse, may result from exposure to some substances, including many common hydrocarbon solvents. In the event of exposure, close containers, open windows or otherwise increase ventilation, and move to fresh air. Medical attention is required for all chemical exposures.

Chemicals that produce vapors should be used in a well-ventilated area or in an area with localized exhaust ventilation. Occasionally, adequate ventilation may not be available, making it necessary to use a respirator. If a respirator is to be used, REHS must be contacted. Respirator use requires training, medical clearance and fit testing of an appropriate respirator, therefore, respirator use should only occur as a last resort.

Ingestion

The gastrointestinal tract is another possible route of entry for toxic substances. Although it is unlikely that anyone would eat a chemical, exposure may occur as a result of eating or drinking food or beverages or touching the mouth with contaminated hands. The possibility of exposure by this route may be reduced by not eating, drinking, smoking or storing food in the areas where chemicals are used or stored and by washing hands thoroughly after working with chemical, even when gloves are worn.

In the event of accidental ingestion, immediately go to your appropriate health center or contact the Poision Control Center at 800-962-1253 for instructions. Do not induce vomiting unless directed to do so by a health care professional or as instructed on the MSDS of the ingested chemical.

Injection

The final possible route of exposure to chemicals is by accidental injection. Injection may occur through mishaps with syringe needles, or through accidents with broken glassware or other sharp objects that have been contaminated with chemicals.

If accidental injection has occurred, wash the area with soap and water and seek medical attention as required. Cautious use of any sharp object is always important.

Health Hazards of Chemical Exposure

How a chemical exposure affects a person depends on many factors. The main factors are the concentration of the chemical, the duration of the exposure, and the inherent toxicity of the chemical.

Toxic Effects of Chemicals

The toxic effects of a chemical may be local or systemic. Local injuries involve the area of the body in contact with the chemical. For example, if you spill an acid on your arm, the effect will be on your arm. Systemic injuries involve tissues or organs other than the contact site where toxins have been transported through the bloodstream. For example, ethanol that has been swallowed may cause blindness.

Certain chemical may affect a target organ. For example, lead primarily affects the brain, kidney and red blood cells and some solvents may harm the liver and kidneys.

It is important to distinguish between acute and chronic exposure and toxicity. Acute toxicity results from a single, short exposure. Effects usually appear quickly and are usually reversible. Chronic toxicity results from repeated exposure over a long period of time. Effects are usually delayed and gradual, and may be irreversible. For example, the acute effect of drinking alcohol is becoming drunk, while the chronic effect from drinking alcohol over a long period of time is cirrhosis of the liver.

Susceptibility of Individuals

Some people may be more or less sensitive chemicals, depending on several factors including eating habits, physical condition, obesity, medical conditions, drinking and smoking and pregnancy.

Over a period of time, regular exposure to some substances can lead to the development of an allergic rash, breathing difficulty, or other reactions. This phenomenon is referred to as *sensitization*. Over time, these effects may occur with exposure to smaller and smaller amounts of the chemical, but will disappear soon after the exposure stops. For reasons not fully understood, not everyone exposed to a sensitizer will experience this reaction. Examples of sensitizers include epoxy resins, nickel salts, isocyanates and formaldehyde.

Particularly Hazardous Substances

Carcinogens

Many chemicals have been evaluated for their ability to cause cancer. The latency period for most cancers range from twenty to forty years. The risk of developing cancer from exposure to a chemical, increases with the length of exposure and with the exposure concentration.

It is important to understand the distinction between **human carcinogens** and **suspected human carcinogens**. The term *human carcinogen* is used when there is clear evidence of the ability to cause cancer in humans. Suspected human carcinogen refers to chemicals that have been shown to cause cancer in two or more animal species and are therefore suspect in humans.

Anyone who works with, or plans to work with carcinogens or suspected carcinogens must follow strict guidelines to minimize exposure. For a particular substance, the *Toxicity Data* section of the Material Safety Data Sheet will state whether or not the substance is considered a carcinogen by the Occupational Safety and Health Administration (OSHA), the National Toxicology Program (NTP) or the International Association for Research on Cancer (IARC).

Reproductive Toxins

Reproductive toxins are chemicals that affect the reproductive system, including mutates (those which cause chromosomal damage), dermatogens and embryo toxins. Embryo toxins may be lethal to the fertilized egg, embryo or fetus, may be teratogenic (able to cause fetal malformations), may retard growth or may cause post-natal functional deficits. Other reproductive toxins may cause sterility or may affect sperm motility.

Some chemicals may cross the placenta, affecting the fetus. A developing fetus may be more sensitive to some chemicals than its pregnant mother, particularly during the first twelve weeks of pregnancy, when the mother may not know she is pregnant. Proper handling of chemicals and use of protective equipment is especially important to reduce fetal exposure to chemicals.

Known human teratogens include organic mercury compounds, lead compounds, ionizing radiation, some drugs, alcohol ingestion, and cigarette smoking. Some substances which may cause adverse reproductive effects in males include 1, 2 – dibromo-3-chloropropane, cadmium, mercury, boron, lead, some pesticides, and some drugs. More than 800 chemicals have been shown to be teratogenic in animal models – many of these are suspected human teratogens.

Individual who work with teratogens and who are contemplating pregnancy or are pregnant should review the toxicity of the chemicals in their workplace and may consult with REHS to determine whether any of the materials pose additional risk during pregnancy.

Where to Find Toxicity Information

Toxicity information may be found in Material Safety Data Sheets, under the “Health Hazard Data” section, on product labels, in the Registry of Toxic Effects of Chemical Substances (RTECS). For additional information, contact REHS on the New Brunswick Campus at ext. 5-2550.

SECTION 2: NJ Right-to-Know (R-T-K) Act

Requirements
The Four Main Elements of R-T-K are:

- R-T-K Survey – Chemical Inventory
- Chemical Labeling
- Material Safety Data Sheets (MSDS) and Hazardous Substance Fact Sheets (HSFS)
- Training – Classroom and "Hands-On"

Employee Rights under R-T-K are:

- Workers have the "Right to Know" the hazards associated with the chemicals they work with.
- Request inventory, labels, MSDS/HSFS
- Refuse to work with a chemical if the information is not provided within 5 working days of a written request.
- No Discrimination for Exercising Rights
- Opportunity to Ask Questions

    - Labeling must include:

- Chemical name
- Hazard warnings
- Manufacturer's name and address
    - The manufacturer's label must not be removed or defaced. If the product is transferred from one container to another, the new container must be labeled with the product name and appropriate hazard warnings.

Note: Single use containers are exempt from these requirements.

MSDS's are Available from:

- Chemical manufacturers and vendors
- Contact REHS

Training and Education includes:

- Overview of occupational health and safety hazards in your area
- Assessment of your work area
- Safe Handling Procedures
- Hands on training
- An opportunity to ask questions

SUMMARY

Individual who work with chemicals have the right and responsibility to know about the hazards of the chemicals they use and how to work with them in a safe manner, which minimizes exposure to chemicals.

In order to accomplish this each work must:

- Attend training.
- Maintain proper labeling of chemical containers.
- Review MSDS’s for hazardous chemicals before working with them.
- Follow instructions and recommendations when using chemicals.
- Use appropriate personal protective equipment, as necessary.
- Report potentially hazardous conditions to supervisors.

For more information about REHS and the Services we provide, log on to our website at http://rehs.rutgers.edu

SECTION 3: Personal Protective Equipment

Personal protective equipment (PPE) is special gear used to protect the wearer from specific hazards. PPE should only be used as a last resort when substitution or engineering controls are not feasible. PPE does not reduce or eliminate the hazard. It only protects the wearer and does not protect anybody else in the area or any equipment exposed to the chemical.

PPE includes gloves, respiratory protection, eye protection, and protective clothing. The need for PPE is dependent upon the type of operations and the nature and quantity of the materials in use, and must be assessed on a case by case basis. Workers who rely on PPE must understand the function, proper use and limitations of the PPE used.

Glove Selection and Use

Gloves should be worn whenever the possibility of skin contact with hazardous chemicals exists. Every glove is permeable to a chemical. The permeability varies with the chemical being used, the length of time of the exposure and the thickness of the glove. General use gloves*, such as nitrile gloves, are appropriate when using small amounts of most chemicals for short periods of time. These gloves should be changed whenever they become contaminated with the chemical.

Otherwise, the glove that offers the best resistance to the chemical should be used. The following guidelines should be used to determine the appropriate glove.

1. Review the Material Safety Data (MSDS) for the chemical of interest.
2. Determine the potential consequences of skin contact by the chemical.
3. Determine the exposure period and characteristic of the potential contact. That is, are you choosing gloves to protect you from an occasional splash or spill or are you planning to wear the gloves while you immerse your entire hand and arm in a container of material.
4. Determine which gloves or glove materials offer the best resistance to the chemical. This information may be found in the Personal Protective Equipment section of the MSDS. Avoid the use of latex gloves that may cause common allergic reactions to certain individuals.
5. Establish the dexterity and sizing requirements.
6. Determine physical resistance properties required of the glove. That is, resistance to heat, cutting, punctures, etc.
7. Other considerations – color, cuffs, length of glove, use of liners.
8. Establish a decontamination procedure. Be sure to check for pinholes before use, wash or decontaminate gloves before removing, and wash hands after removing.

In addition to protecting hands and skin from chemical exposures, there are many gloves that offer protection from physical hazards, such as high or low temperatures, electrical shock, skin abrasions, vibration or sharp objects. Always match the glove to the hazard.

Respiratory Protection

A respirator may only be used when engineering controls, such as general ventilation or fume hood are not feasible or do not reduce the exposure of a chemical to acceptable levels. The use of a respirator is subject to prior review by REHS, according to university policy, since their use is regulated by the OSHA respiratory protection standard.

Any worker/student who believes that respiratory protection is needed must notify REHS for evaluation of the hazard and enrollment in the Respiratory Protection Program. The program involves procedures for respiratory selection, medical assessment of employee health, employee training, proper fitting, respirator inspection, maintenance and record keeping.

Eye Protection

Safety glasses should be worn for protection from impact of particles. Standard eyeglasses fitted with side shields are generally not sufficient. Workers/students who are interested in prescription safety glasses should contact REHS on the New Brunswick Campus at ext. 5-2550 for more information. Goggles should be worn when a potential splash from a hazardous material exists. They may be worn over prescription glasses. Face shields are in order when working with large volumes of hazardous materials, either for protection from splash to the eye or flying particles. Face shields may be used in conjunction with goggles for maximum protection from corrosives and hot chemicals. Contact lenses do not offer any protection from chemical contact.

Protective Clothing

When the possibility of chemical contamination exists, protective clothing, which resists physical and chemical hazards should be worn over street clothes. Smocks are appropriate for minor chemical splashes and spills, while plastic or rubber aprons are best for protection from corrosive or irritating liquids.

Loose clothing (such as overlarge smocks or ties), skimpy clothing (such as shorts), torn clothing and unrestrained hair may pose a hazard. Perforated shoes, sandals, or cloth sneakers should not be worn in chemical use areas or where mechanical work is being performed.

SECTION 4: Explanation of Material Safety Data Sheet Information

Per the OSHA Hazard Communication Standard, Visual Arts is required to ensure that material safety data sheets (MSDS) are readily available for all chemicals used in the department. MSDS's specific to the chemicals you use, are to be kept in a binder in your department. If the placement of the binder is unknown, check with your supervisor/instructor for the location. New materials brought into the department must be approved for use and storage by your supervisor/instructor and if approved, an MSDS for that material must be provided and kept in the MSDS binder.

The following is an explanation which is provided to help you interpret the information found on manufacturers' MSDS's. While the format of these data sheets varies from manufacturer to manufacturer, certain components appear on each sheet.

Product Identification

This section gives the name and address of the manufacturer and an emergency phone number where questions about toxicity and chemical hazards can be directed.

Hazardous Ingredients of Mixtures

This section describes the percent composition of the substance, listing chemicals present in the mixture. If it was tested as a mixture, a list of chemicals is given, which contributes to its hazardous nature. Otherwise, chemicals making up more than 1% of the mixture and all carcinogens are listed.

The OSHA permissible exposure limit (PEL), National Institute of Occupational Safety and Health (NIOSH) recommended exposure limit (REL), and/or the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) will also be listed, if appropriate. The OSHA PEL is the enforceable standard, while the others are recommended limits. The PEL is usually expressed in parts per million parts of air (ppm) or milligrams of dust or vapor per cubic meter of air (mg/m3). It is usually a time weighted average (TWA) – concentration averaged over an eight hour day. Sometimes, an STEL or short term exposure limit may be listed. The STEL is a 15 minute TWA which should not be exceeded. A ceiling limit (c), is a concentration which may not be exceeded at any time. A skin notation means that skin exposure is significant in contributing to the overall exposure.

Physical Data

This section outlines the physical properties of the material. The information may be used to determine conditions for exposure. The following information is usually included:

Boiling Point: temperature at which liquid changes to vapor state
Melting Point: temperature at which a solid begins to change to a liquid
Vapor Pressure: a measure of how volatile a substance is and how quickly it evaporates. For comparison, the VP of water (at 20 degrees C) is 17.5 mm Hg, Vaseline (non-Volatile) is 440 mm Hg.

Vapor Density (air=1): weight of a gas or vapor compared to weight of an equal volume of air. Density greater than 1 indicates it is heavier than air, less than 1 indicates it is lighter than air. Vapors heavier than air can flow just above ground, where they may pose a fire or explosion hazard.

Solubility in Water: percentage of material that will dissolve in water, water soluble substances more readily absorb and distribute.

Appearance/Odor: color, physical state at room temperature, size of particles, consistency, odor, as compared to common substances. Odor threshold refers to the concentration required in the air before vapors are detected or recognized.

Fire and Explosion Hazard Data This section includes information regarding the flammability of the material and information for fighting fires involving the material.

Flashpoint: the lowest temperature at which a liquid gives off enough vapor to ignite when a source of ignition is present.

Autoignition Temperature: The approximate temperature at which a flammable gas –air mixture will ignite without spark or flame. Vapors and gases will spontaneously ignite at lower temperatures in oxygen than air.

Flammable Limits: the lower explosive limit (LEL) and upper explosive limit (UEL) define the range of concentration of a gas or vapor in air at which combustion can occur. For instance, an automobile carburetor controls this mixture – too lean (not enough chemical) or too rich (not enough air, as when you flood your engine), will not ignite.

Extinguishing Media: appropriate extinguishing agent(s) for the material.

Fire-fighting Procedures: appropriate equipment and methods are indicated for limiting hazards encountered in fire situations.

Fire or Explosion Hazards: hazards and/or conditions which may cause fire or explosions are defined.

Health Hazard Data

This section defines the medical signs and symptoms that may be encountered with normal exposure or overexposure to this material or its components. Information on the toxicity of the substance may also be presented. Results of animal studies are most often given. i.e. LD50 (mouse) = 250 mg/kg. Usually expressed in weight of chemical per kg of body weight. LD50 or lethal dose 50 is the dose of a substance that will cause the death of half the experimental animals.

Health hazard information may also distinguish the effects of acute (short term) and chronic (long-term) exposure. In addition, other potential health effects will be described such as inhalation, ingestion, skin and eye contact and aggravation of pre-existing conditions.

Emergency and First Aid Procedures

Based on the toxicity of the product, degree of exposure and route of contact (eye, skin, inhalation, ingestion, injection), emergency and first aid procedures are recommended in this section.

Additional cautionary statements, i.e., *Note to Physician*, for first aid procedures, when necessary, will also appear here.

Reactivity Data

This section includes information regarding the stability of the material and any special storage or use considerations.

Stability: "unstable" indicates that a chemical may decompose spontaneously under normal temperatures, pressures, and mechanical shocks. Rapid decomposition produces heat and may cause fire or explosion. Conditions to avoid are listed in this section.

Incompatibility: certain chemicals, when mixed may create hazardous conditions. Incompatible chemicals should not be stored together.

Spill, Leak and Disposal Procedures

This section outlines general procedures, precautions and methods for cleanup of spills. Appropriate waste disposal methods are provided for safety and environmental protection.

Personal Protection Information This section includes general information about appropriate personal protective equipment for handling this material. Many times, this section of the MSDS is written for large scale use of the material. Appropriate personal protection may be determined by considering the amount of the material being used and the actual manipulations to be performed.

Eye Protection: recommendations are dependent upon the irritancy, corrosivity, and special handling procedures.

Skin Protection: describes the particular types of protective garments and appropriate glove materials to provide personal protection.

Respiratory Protection: appropriate respirators for conditions exceeding the recommended occupational exposure limits.

Ventilation: air flow schemes (general, local) are listed to limit hazardous substances in the atmosphere.

SECTION 5: Compressed Gas Cylinders

Compressed gases can be toxic, flammable, oxidizing, corrosive, inert, or some combination of these hazards. In addition to the chemical hazards, the amount of energy resulting from the compression of the gas makes a compressed gas cylinder a potential rocket. Appropriate care in the handling and storage of compressed gas cylinders is essential. Following are general recommendations.

1. *Know and Understand Gas Properties:* Know and understand the properties, uses and safety precautions before using any gas or gas mixture. Consult Material Safety Data Sheets (MSDS's) for safety information on the gases that you will be using.
2. *Check Equipment:* Leak test lines and equipment before they are used. Lines and equipment should be designed and maintained to handle full cylinder pressure. Materials of construction should be compatible with the gases being used.
3. *When in Doubt, Contact Rutgers Environmental Health & Safety (REHS):* If you are unfamiliar with the hazards associated with a particular gas or unsure of the correct handling and storage procedures, call REHS at 5-2550.

Primary Hazards

The following is an overview of the primary hazards to be avoided when handling and storing compressed gases.

- **Fire and Explosion:** Fire and explosion are the primary hazards associated with flammable gases, oxygen, and other oxidizing gases. Flammable gases can be ignited by static electricity or by a heat source, such as a flame or a hot object. Oxygen and other oxidizing gases do not burn, but will support combustion of flammable materials. Increasing the concentration of an oxidizer accelerates the rate of combustion. Materials that are nonflammable under normal conditions may burn in an oxygen-enriched atmosphere.
- **High Pressure:** All compressed gases are potentially hazardous because of the high pressure stored inside the cylinder. A sudden release of pressure can cause injuries by propelling a cylinder or whipping a line.

  Improper Handling of Cylinders: Compressed gas cylinders are heavy and awkward to handle. Improper handling of cylinders could result in sprains, strains, falls, bruises, and broken bones. Other hazards such as fire, explosion, chemical burns, poisoning, and cold burns could occur if gases accidentally escape from the cylinder due to mishandling.

Handling, Storage, and Use of Gases

Only persons familiar with the hazards should handle compressed gas cylinders. All cylinder movement should be done with a cylinder cart. The cylinders should always be secured by a strap or chain to a stationery object. When in storage, cylinders must be capped. In addition, safety glasses, work gloves and appropriate work shoes should be worn when using or moving compressed gas cylinders.

If gas cylinders are stored in a cabinet, the area must be ventilated to prevent gas build up incase of a release. Compressed gas cylinders should not be subjected to any mechanical shock that could cause damage to their valves or pressure relief devices. Cylinders should not be dropped, dragged, slid or used a rollers for moving material or other equipment.

Cylinder caps perform two functions. First, they protect the valve on the top of the cylinder from damage if it knocked over. Second, if gas is accidentally released through the valve, the cap will vent the gas out of both sides, minimizing the likelihood that the cylinder will topple. Cylinder caps should not be removed until the cylinder is secured in place and ready for use.

Cylinder Storage Precautions

Several precautions should be taken to prevent the release of high-pressure gases, fire and explosion. Compressed gas cylinders should not be exposed to sparks, flames, or temperatures above 125 degrees F. Cylinders should not be placed where they could come into contact with any electrical apparatus or circuits.

Smoking and open flames should not be permitted in areas used for storage of oxygen or flammable gas cylinders. Never permit oil, grease, or other combustible substances to come into contact with oxygen or other oxidizing gas cylinders, valves and systems.

Returning Cylinders

When returning an empty cylinder, close the valve before shipment, leaving 25 psig of residual pressure in the cylinder. Replace the cylinder cap and any valve outlet caps or plugs originally shipped with the cylinder. If repair is needed on a cylinder or its valve, be sure to mark it and return it to the supplier.

Leaking Cylinders

Most leaks occur at the valve in the top of the cylinder and may involve the valve threads, valve stem, valve outlet, or pressure relief devices. Personnel should not attempt to repair leaking cylinders.

Where action can be taken without serious exposure to workers, move the cylinder to an isolated, well-ventilated area (away from combustible materials if the cylinder contains a flammable or oxidizing gas) and contact RUPD. Otherwise, evacuate the area and immediately contact RUPD.

SECTION 6: Flammable Liquids

Storage Containers

Flammable and combustible liquids should be stored in only certain types of approved containers. Containers used by the manufacturers of flammable and combustible liquids generally meet these specifications.

The type of container needed depends on the quantity and class of flammable or combustible liquid. A ***safety can*** is an approved container of not more than 5 gallons capacity that has a spring closing lid and spout cover. Safety cans are designed to safely relieve internal pressure when exposed to fire conditions.

A ***flammable liquid storage cabinet*** is an approved cabinet that has been designed and constructed to protect the contents from external fires.

Storage Considerations

- Quantities should be limited to the amount necessary for the work in progress.
- No more than 10 gallons per room combined or flammable and combustible liquids, may be stored outside of a flammable storage cabinet unless safety cans are used.
- Storage of flammable liquids must not obstruct any exit.
- Flammable liquids should be stored separately from strong oxidizers, shielded from direct sunlight, and away from heat sources.
- Containers must be sealed when not in use.

Handling Precautions

Control all ignition sources in areas where flammable liquids are used. Smoking, open flames and spark producing equipment should not be used.

Flammable Aerosols

Flammable aerosols are in pressurized containers that may rupture when exposed to fire. As with flammable liquids, these should be stored in a flammable storage cabinet.

SECTION 7: Electrical Safety

The major hazards associated with electricity are electrical shock and fire. Electrical shock occurs when the body becomes part of the electric circuit, either when an individual comes in contact with both wires of an electrical circuit, one wire of an energized circuit and the ground, or a metallic part that has become energized by contact with an electrical conductor.

The severity and effects of an electrical shock depend on a number of factors such as the pathway through the body, the amount of current, the length of time of the exposure, and whether the skin is wet or dry. Water is a great conductor of electricity, allowing current to flow more easily in wet conditions and through wet skin. The effect of the shock may range from a slight tingle to severe burns to cardiac arrest. The chart below shows the general relationship between the degree of injury and amount of current for a typical household/office outlet from hand to foot path of one second's duration of shock. While reading this chart, keep in mind that most electrical circuits can provide, under normal conditions, up to 20,000 milliamperes of current flow.

CURRENT	REATION
1 Milliampere	Perception Level
5 Milliamperes	Slight shock felt; not painful but disturbing
6-30 Milliamperes	Painful shock; let-go range
50-150 Milliamperes	Extreme pain, respiratory arrest, sever Muscular contraction
1000-4,300 Milliamperes	Ventricular fibrillation
10,000 + Milliamperes	Cardia arrest, severe burns and probable death

In addition to the electrical shock hazards, sparks from electrical equipment can serve as an ignition source for flammable or explosive vapors.

Preventing Electrical Hazards

There are various ways of protecting people from the hazards caused by electricity, including insulation, guarding, grounding, and electrical protective devices. Employees/Students can significantly reduce electrical hazards by following some basic precautions:

- Inspect wiring of equipment before each use. Replace damaged or frayed electrical cords immediately. Cords must be repaired by a qualified individual (from Facilities Maintenance/Physical Plant).
- Use safe work practices every time electrical equipment is used. For instance, do not remove the ground plug (third prong on the plug), Ground fault circuit interrupters (GFCI's) must be installed for outlets in wet locations, etc.
- Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire or electrocution.
- Limit the use of extension cords. Use only for portable equipment, when necessary.
- Use only multi-plug adapters equipped with circuit breakers or fuses.
- Minimize the potential for water or chemical spills on or near electrical equipment.

Insulation

All electrical cords should have sufficient insulation to prevent direct contact with wires. It is particularly important to check all cords before each use, since corrosive chemicals or solvent vapors may erode the insulation.

Damaged cords should be repaired or taken out of service immediately, especially in wet environments.

Grounding

Only equipment with three-prong plugs should be used. The third prong provides a path to ground that helps prevent the buildup of voltages that may result in an electrical shock or spark. This does not guarantee that no one will receive a shock, be injured, or be killed. It will, however, substantially reduce the possibility of such accidents, especially when used in combination with other safety measures.

Circuit Protection Devices

Circuit protection devices are designed to automatically limit or shut off the flow of electricity in the event of a ground-fault, overload, or short circuit in the wiring system. Fuses, circuit breakers, and ground-fault circuit interrupters are three well-known examples of such devices.

Fuses and circuit breakers prevent over-heating of wires and components that might otherwise create hazards to protect equipment. They disconnect the circuit when it becomes overloaded.

The ground-fault circuit interrupter, or GFCI, is designed to shutoff electric power if a ground fault is detected. The GFCI is particularly useful near sinks and wet locations. The main function of a GFCI is to protect the user.

Safe Work Practices

The following practices may reduce risk of injury or fire when working with electrical equipment:

- When it is necessary to handle equipment that is plugged in, be sure hands are dry. If it is not safe to do so, work with only one hand, keeping the other hand at your side or in your pocket, away from all conductive material.
- Do not wear jewelry.
- Use a non-conductive ladder (wood or fiberglass).
- If water or a chemical is spilled onto equipment, shut off power at the main switch or circuit breaker and unplug equipment.
- If an individual comes in contact with a live electrical conductor, do not touch the equipment, cord or person. Disconnect the power source from the circuit breaker or pull out the plug using a leather belt.
- Visually inspect equipment and plug to assure that they are in good condition before energizing it. Check that the cord is not frayed.
- Plan your work before you start. Make sure you are using the correct tool(s) for the job.

SECTION 8: Spill Response/Emergency Procedures

In the event of a chemical spill, the individual(s) who caused the spill is responsible for prompt and proper clean up. It is also their responsibility to have spill control equipment for the chemicals being handled, readily available. There should be a sufficient quantity of absorbents or other types of materials to control any spill that can be reasonably anticipated. Vermiculite, lined 5-gallon pails and limited spill control materials are available throughout the building.

In the event of a SMALL SPILL you should:

- **Assess Spill:** Can the spill be safely cleaned up by room personnel with available hazard information, spill control equipment, training and protective equipment?
- **Notify:** If spilled material poses a hazard to personnel or the environment, evacuate the area (room, floor, building) and control traffic around spill cleanup area.
- **Review** MSDS and other hazard information.
- **Wear** appropriate protective clothing and equipment.
- **Clean up** spill using appropriate spill kit. Use absorbent; prevent spilled material from spreading.
- **Retain** spilled material and contaminated equipment, place in sturdy plastic bag, apply hazardous waste label, contact REHS for disposal.

In the event of a LARGE SPILL you should:

- Attend to Injured Persons: Appropriate Medical Attention.
- Evacuate Area/Building
- Contact Campus Police:

New Brunswick – 6-911
Newark – ext. 5111
Camden – 6111 or “8”
REHS: (848)-445-2550

If you are located on ANY campus at Rutgers and dial 911 from a non university phone, the call will be directed to RUPD automatically.

- **Extinguish** ignition and heat sources if there is time, and prevent spill from spreading.
- **Follow-up** by filling out an Incident Report that includes the Student/Employee Health assessment if applicable.

SECTION 9: Waste Disposal

Types of Wastes

There are several types of wastes that can be generated in Visual Arts. Some examples include:

- Oily rags
- Solvent wastes (turpentine, paint thinner, etc.)
- Paints
- Baby oil
- Linseed oil
- Ceramic glaze
- Photographic chemicals
- Acids and bases
- Sharp implements
- Lubricating oils
- Empty chemical containers

Many of these wastes are considered hazardous waste by the US Environmental Protection Agency and require special handling. These materials may not be poured down the drain.

OILY RAGS

Rags soaked in thinner or linseed oil should be treated as hazardous waste. Red oily rag cans should be located in your area for disposal. Do not leave oily rags lying around the floor. Linseed oil, in particular, can ignite on its own if left out, causing fire that may spread to other areas. The oily rag can is self-closing to prevent such occurrences.

SOLVENTS

Solvents, such as paint thinner, turpentine, toluene, xylene, and alcohols are considered hazardous waste. DO NOT DUMP THEM DOWN THE DRAIN!
Follow the instructions for handling hazardous waste.

PAINTS

Oil-based paints are considered hazardous waste. DO NOT DUMP oil-based paint down the drain or place in regular trash. Separate the oil-based paint from the thinner for disposal. REHS can provide additional waste containers if they are needed. REHS can be contacted at 5-2550.

BABY OIL

Baby oil is not considered a hazardous waste. Baby oil can be used to clean brushes and can be washed down the drain. Excess baby oil can be disposed in the regular trash.

LINSEED OIL

Because of its potential for fire, linseed oil should be handled as a hazardous waste, in a similar manner as solvents. Linseed oil must be disposed of separate from solvents. Follow the university's disposal procedure for handling hazardous waste.

CERAMIC GLAZE

Many ceramic glazes contain metals that are considered hazardous waste. Unused glazes should be disposed as hazardous waste. Glaze preparation should be done over a pan, in a ventilation cabinet or hood where excess or spilled glaze can be collected for disposal and the prep worker is protected from inhaling the material.

PHOTOGRAPHIC CHEMICALS

Photographic chemicals generally fit into four categories: fixers, developers, rinses and specialized chemicals. Standard developers must be collected for disposal. Most fixers contain silver in quantities above the amount allowed for sewer disposal. Fixer waste must be collected in silver recovery units. Specialized chemicals, such as special acids and bases should be assumed to be hazardous waste and collected accordingly.

ACIDS AND BASES

Materials with a pH of less than 2 or more than 12.5 are considered hazardous waste. Do not mix these wastes with the solvent or oil wastes. Use care when handling acids and bases and follow the instructions for handling hazardous waste.

LUBRICATING OILS

Oils such as pump oil, motor oil and other machine oils are recyclable. These materials should be placed in a plastic container, sealed and labeled as Used Oil and placed in secondary containment. Do not label them as hazardous waste or as waste oil. Call REHS at 5-2550 for disposal.

BROKEN GLASS AND SHARP IMPLEMENTS

Sharp objects, such as razor blades, knives and broken glass should be packaged in a puncture proof jar or box and placed in the regular trash. Pre-packing helps to avoid injury to janitors or others handling the trash.

EMPTY CHEMICAL CONTAINERS

Empty chemical containers should be triple-rinsed and placed in regular trash. The label must be defaced and the rinsate must be collected as hazardous waste.

Handling Hazardous Waste

Site Accumulation Areas (SAA's) have been established to identify locations of hazardous waste storage. Yellow and black striped tape has been placed to designate these areas. All hazardous waste containers must be placed within the SAA, segregated by hazard class, and must be in secondary containment.

Materials that are to be disposed of as hazardous waste must be placed in sealable containers. Containers should be filled, leaving a headspace for expansion of the contents. If you routinely generate significant quantities of compatible solvents; bulking of waste in five gallon carboys provided by REHS may be practical.

Containers must be kept closed except during actual transfers. Do not leave a hazardous waste container with a funnel in it.

Waste containers must be labeled as hazardous waste as soon as the material is first put into the container.
Waste container labels can be obtained by calling REHS. Be sure to include the name and phone number of a person (the SAA Manager) that can be reached on the day of waste pickup.

Procedure

1. Place the waste materials in an appropriate waste container.
2. Seal the container. Do not leave a funnel in an open container.
3. Ensure the container has a completed hazardous waste sticker on it.
4. Once the container is near full, arrangements for waste removal by REHS can be made by filling out a "Request of Hazardous Waste Disposal". It can be mailed or faxed to REHS.

General Recommendations

- Don't purchase more of a material than you expect to use in the foreseeable future. The costs of disposal often exceed the purchase cost by a considerable margin.
- Substitute with a less hazardous material whenever possible.
- Consistent with safe practice, bulk compatible waste in containers up to five gallons in capacity to reduce disposal costs. (consult with REHS first).
- Keep all chemical containers clearly and unambiguously labeled.
- Dispose of your wastes at the completion of a project – don't abandon them for someone else to deal with later.

REQUEST FOR HAZARDOUS WASTE DISPOSAL

Instruction for Completing

I. The requester is the person who is responsible for the generation of waste.

II. This request form is to be completed by the requester.

III. The correct chemical name or names should be written on the form and the waste labels to identify the material. Chemical formulas and trade names are not acceptable; i.e. Methylene Chloride, not CH2 CI2.

For mixtures of liquids, all constituents must be listed on the form as well as the waste label and add up to 100%. Solutions of solids or gases in liquids must be expressed in concentrations of either weight percent, molarity (moles per liter), or normality (equivalents/liter).

List each hazard presented by the substance, by using the corresponding letter shown below:

C – Corrosive O – Oxidizer
E – Explosive P – Poison
F – Flammable R – Reactive

Fill in the unit used to record the amount of substance listed, such as gram, ml, liter, gallon, pound.

<u>PLEASE XEROX THIS FORM FUTURE USE</u>

When a supply of labels is needed or when questions arise, call 848-445-2550

The completed form can either be returned to the address below or faxed to 732-445-3109

RUTGERS, THE STATE UNIVERSITY
RUTGERS ENVIRONMENTAL HEALTH & SAFETY
24 STREET 1603
BLDG 4127 LIVINGSTON CAMPUS

Send to: Rutgers Environmental Health & Safety
24 Street 1603
Building 4127 Livingston Campus
(Tel) 848-445-2550 (Fax) 732-445-3109

Page ____ of ____

Date of Pick-Up _________

REQUEST FOR HAZARDOUS WASTE DIPSOAL

Requester _____________________Bldg_________________ Date__________

Telephone _____________________ Dept ______________________________

Substance Location: Building ___________ Room ______ Campus __________

Name of Chemical(s) (No Formulas)	Hazard Class	Quantity	Other Information

REMEMBER TO LABEL HAZARDOUS WASTE CONTAINERS.
CONTAINER WHICH ARE UNIDENTIFIED
CANNOT BE ACCEPTED FOR COLLECTION BY REHS

SECTION 10: Painting and Drawing

Introduction

The health hazards associated with painting and drawing have been known since Ramazzini described such illnesses 1713. Working safely can involve changes in how you select your art materials, and how you handle them.

PLEASE NOTE: For turpentine and thinners, please use labeled jars supplied by Visual Arts. Keep containers capped when not in use. Do not use food or beverage containers.

Pigments

Painters use pigments in oil paints, acrylics, watercolor paints, gouache, encaustic, poster paints, casein paints and tempera. Sometimes commercial paints such as oil, enamel, epoxy paints and automobile paints are used.

Paints and pigments mixed with a vehicle or binder. Both inorganic and organic pigments are used as colorants. Dry pigments are especially hazardous because they are easily inhaled and ingested. They are used in encaustic, paper-marbleizing and in the fabrication of paint product, and will be discussed more thoroughly in the section below on pastels.

Pigments vs. Hues

Most paints used in Visual Arts do not contain metal pigments and are considered non-toxic. These are most easily identified by the product name. If the paint is described as hue, such as “chromium yellow hue”, there is no (or too little to be concerned about) toxic metal contained in the product.

Hazards

1. Poisoning can occur if toxic pigments are inhaled or ingested. The main hazard in standard painting techniques is accidental ingestion of pigments due to eating, drinking or smoking while working, inadvertent hand to mouth contact, or pointing the paint brush with the lips. If methods such as spraying, heating, or sanding are employed then there is an opportunity for inhalation of toxic pigments.
2. The classic example of a toxic inorganic pigment in painting is white lead, or flake white (basic lead carbonate). Lead pigments can cause anemia, gastrointestinal problems, peripheral nerve damage (and brain damage in children), kidney damage and reproductive system damage. Other inorganic pigments may be hazardous, including pigments based on cobalt, cadmium, and manganese. (See Table 1)
3. Some of the inorganic pigments, in particular cadmium pigments, chrome yellow and zinc yellow may cause lung cancer. In addition lamp black and carbon black may contain impurities that can cause skin cancer.
4. Chromate pigments (chrome yellow and zinc yellow) may cause skin ulceration and allergic skin reactions (such as rashes).
5. The long-term hazards of the modern synthetic organic pigments have not been well studies (See Table 1)

Precautions

1. Obtain MSDS's on your paints to find out what pigments you are using. This is especially important because the name that appears on the tube of color may or may not truly represent the pigments present. Manufacturers may keep the name of a color while reformulating the ingredients.
2. Use the least toxic pigments possible. Do not use lead or carcinogenic pigments.
3. Avoid mixing dry pigments whenever possible. If dry pigments are mixed, do it inside a glove box (a box with a glass or plexiglass top and holds in the sides for arms) or inside a laboratory-type fume hood.
4. Wet mop and wipe all surfaces when using dry pigments.
5. Avoid using dishes, containers or utensils from the kitchen to mix and store pains and pigments.

Table 1 – Toxic Pigments

Known or Probable Carcinogens/Highly Toxic Pigments

- Antimony white (antimony trioxide)
- Barium yellow (barium chromate)
- burnt umber or raw umber (iron oxides, manganese silicates or dioxide)
- cadmium red or orange (cadmium sulfide, cadmium selenide)
- cadmium yellow (cadmium sulfide)
- cadmium barium colors (cadmium colors and barium sulfate)
- cadmium barium yellow (cadmium sulfide, cadmium selenide, barium sulfate, zinc sulfide)
- chrome green (Prussian blue, lead chromate)
- chrome orange (basic lead carbonate)
- chrome yellow (lead chromate)
- cobalt violet (cobalt arsenate or cobalt phosphate)
- cobalt yellow (potassium cobaltinitrate)
- lead or flake white (basic lead carbonate)
- lithol red (sodium, barium and calcium salts of soluble azo pigment)
- manganese violet (manganese ammonium pyrophosphate)
- molybdate orange (lead chromate, lead molybdate, lead sulfate)
- naples yellow (lead antimonite)
- strontium yellow (strontium chromate)
- vermilion (mercuric sulfite)
- zinc sulfide
- zinc yellow (zinc chromate)

Moderately Toxic Pigments/slightly Toxic Pigments

- alizarin crimson (lakes of 1,2 –dihydroxyanthaquinone or insoluble
- anthraquinone pigment
- carbon black (carbon)
- cerulean blue (cobalt stannate)
- cobalt blue (cobalt stannate)
- cobalt green (calcined cobalt, zinc and aluminum oxides)
- chromium oxide green (chromic oxide)
- manganese blue (barium manganate, barium sulfate)
- Prussian blue (ferric ferrocyanide)
- Toluidine red (insoluble azo pigment
- Toluidine yellow (insoluble azo pigment)
- Viridian (hydrated chromic oxide)
- Zinc white (zinc oxide)

Water-Based Paints

Water-based paints include water color, acrylic, gouache, tempera and casein. Water is used for thinning and cleanup.

Hazards

1. See section above for pigment hazards.
2. Acrylic paints contain a small amount of ammonia. Some sensitive people may experience eye, nose and throat irritation from the ammonia. Acrylics and some gouaches contain a very small amount of formaldehyde as a preservative. Only people already sensitized to formaldehyde would experience allergic reactions from the trace amount of formaldehyde found in acrylics. The amounts can vary from manufacturer to manufacturer.
3. Casein paints use the protein casein as a binder. While soluble forms are available, casein can be dissolved in ammonium hydroxide which is moderately irritating by skin contact and highly irritating by eye contact, ingestion, and inhalation.
4. All water-based paints contain a preservative to prevent mold or bacterial growth. Sometimes artists add preservatives when they make their own paints. Although present in small amounts, certain preservatives may cause allergic reactions in some people.

Precautions

1. See section above for precautions when mixing dry pigments.
2. If you add your own preservative, avoid using sodium fluoride, phenol or mercury compounds. For tempera, a small amount of pine oil works for short periods of time.
3. If you experience eye, nose or throat irritation while using acrylics, opening a window is usually sufficient; if not try a window exhaust fan.
4. If you mix casein paints using ammonium hydroxide, you will need a window exhaust fan to provide ventilation.
5. Wear gloves, goggles and protective apron when handling ammonia. An eyewash fountain should be available when handling ammonia.

Non Water-Based Paints

Oil paints, encaustic and egg tempera use linseed oil, wax and egg respectively as vehicles, although solvents are often used as a thinner and for cleanup. Turpentine and mineral spirits (paint thinner), for example, are used in oil painting mediums, for thinning, and for cleaning brushes. Alkyd paints use solvents as their vehicle. In addition many commercial paints used by artists also contain solvents.

Hazards

1. See section above for pigment hazards.
2. All solvents can cause defatting of the skin and dermatitis from prolonged or repeated exposure. Turpentine can also cause skin allergies and be absorbed through the skin.
3. Acute inhalation of high concentrations of mineral spirits, turpentine vapors, and other solvents can cause narcosis, which can include symptoms of dizziness, headaches, drowsiness, nausea, fatigue, loss of coordination, coma, as well as respiratory irritation.

4. Chronic inhalation of large amounts of solvents could result in decreased coordination, behavioral changes and brain damage. Chronic inhalation of turpentine can cause kidney damage and respiratory irritation and allergies. Odorless mineral spirits and turpenoid, in which the aromatic hydrocarbons have been removed, are less hazardous.
5. Ingestion of either turpentine or mineral spirits can be fatal. In the case of mineral spirits, this is usually due to chemical pneumonia caused by aspiration (breathing in) of the mineral spirits into the lungs after vomiting.
6. Natural resins (copal, dammar, rosin, Japanese Lacquer) may cause skin irritation or allergies. Rosin dust can cause asthma.
7. Encaustic involves suspending pigments in molten was. If the wax is overheated, flammable wax vapors and wax decomposition fumes are produced, which are strong respiratory irritants.
8. Epoxy paints consist of an epoxy resin component containing the pigment, and a hardener component. The epoxy resin may contain diglycidyl ethers which are irritants, may cause bone marrow damage, and are suspect carcinogens. Epoxy hardeners may cause skin and respiratory allergies and irritation.

Precautions

1. Whenever possible replace turpentine or ordinary mineral spirits with the less toxic odorless minerals spirits. Mineral spirits is also less flammable than turpentine, since its flashpoint is over 100 F (38 C), while turpentine has a flashpoint of 95 F, (35 C).
2. Apply the same health and safety considerations for the use of “citrus” or “pine” solvents. These have been found to be quite irritating to the skin and eyes.
3. If possible, artists should set up their easel about 3 feet from a window that has a fan exhausting at work level and pulling the solvent vapors away from your face.
4. Techniques such as turpentine washes will require a lot of ventilation because they result in the evaporation of large amounts of solvents in a short period of time. Acrylic paint can be substituted for underpainting.
5. Ventilation only needs to be provided while the solvent is evaporating from the canvas, not during the time while the oil paint film is drying (oxidizing).
6. Wear neoprene gloves while cleaning brushes with mineral spirits or turpentine.
7. Used solvent can be reclaimed by allowing the paint to settle and then pouring off the clear solvent.
8. Paint can be removed from your hands with baby oil, and then soap and water.
9. Wax should be only heated to the minimum temperature needed for proper flow of the paint. Do not heat with open flame or hot plate with exposed element. During pregnancy and nursing, switch to water-based paints to avoid exposure to solvents.

Airbrush, Spray Cans and Spray Guns

Artists use many products in spray form, including fixatives, retouching sprays, paint sprays, varnishes, and adhesive sprays. Airbrush, aerosol spray can and spray guns are used.

Hazards

1. Spray mists are particularly hazardous because they are easily inhaled. If the paint being sprayed contains solvents, then you can be inhaling liquid droplets of the solvents. In

addition the pigments are also easily inhaled, creating a much more dangerous situation than applying paint by brush.

2. Aerosol spray paints have an additional hazard besides pigments and solvents. They contain propellants, usually isobutanes and propane, which are extremely flammable and have been the cause of many fires. Other aerosol spray products such as retouching sprays, spray varnishes, etc. also contain solvents, propellants and particulates being sprayed.
3. Airbrushing produces a fine mist which is a serious inhalation hazard because artists work so close to their art work. Airbrushing solvent-containing paints is especially dangerous.
4. Spray guns are less common in art painting but usually involve spraying much larger quantities of paint than either spray cans or airbrush. Spraying solvent-based paints is a serious fire hazard.

Precautions

1. See section above for precautions with pigments
2. Try to brush items rather than spraying if possible.
3. Use water-based airbrushing paints and inks rather than solvent-based paints.
4. Use spray cans or an airbrush in a spray booth if possible.
5. If ventilation is not adequate, then respiratory protection is necessary while air brushing or spraying. REHS must be contacted prior to use for instruction on required protocols for using a respirator.
6. Never try to spray paint by blowing air from your mouth through a tube. This can lead to accidental ingestion of the paint.

Dry Drawing Media

This includes dust-creating media such as charcoal and pastels which are often fixed with aerosol spray fixatives, and media such as crayons and oil pastels which do not create dust.

Hazards

1. Pencils are made with graphite, rather than lead and are not considered a hazard. Colored pencils have pigments added to the graphite, but the amounts are small so that there is no significant risk of exposure. Over 10 years ago, a significant hazard in pencils was from lead chromate paint on the exterior of yellow pencils. However this has since been eliminated as a risk.
2. Charcoal is usually made from willow or vine sticks, where wood cellulose has been heated without moisture to create the black color. Compressed charcoal sticks use various resins in a binder to create the color. Although charcoal is just considered a nuisance dust, inhalation of large amounts of charcoal dust can create chronic lung problems through a mechanical irritation and clogging effect. A major source of charcoal inhalation is from the habit of blowing excess charcoal dust off the drawing.
3. Colored chalks are also considered nuisance dusts. Some chalks are dustier than other. Individuals who have asthma sometimes have problems with dusty chalks, but this is a nonspecific dust reaction, not a toxic reaction.
4. Pastel sticks and pencils consist of pigments bound into solid form by a resin. Inhalation of pastel dusts is the major hazard. Some pastels are dustier than others. Pastels can

contain toxic pigments such as chrome yellow (led chromate) which can cause lung cancer, and cadmium pigments (which can cause kidney and lung damage and are suspect human carcinogens). Blowing excess pastel dust off the drawing is one major source of inhalation of pastel pigments. Pastel artists have often complained of blowing their nose different colors for days after using pastels, a clear indication of inhalation.

5. Crayons and oil pastels do not present and inhalation hazard, and thus are much safer than pastels. Some oil pastels can contain toxic pigments, but this is only a hazard by accidental ingestion.
6. Both permanent and workable spray fixatives used to fix drawings contain toxic solvents. There is high exposure by inhalation to these solvents because the products are sprayed in the air, often right on a desk or easel. In addition you can be inhaling the plastic particulates that comprise the fixative itself.
7. Never try to spray fixative by blowing air from your mouth through a tube. This can lead to accidental ingestion of the fixative.

Precautions

1. Use the least dusty types of pastels, chalks, etc. Asthmatics in particular might want to switch to oil pastels or similar non-dusty media.
2. Spray fixatives should be used with a spray booth that exhausts to the outside. If fixatives are occasional, you can use them outdoors if respiratory protection is used. REHS must be contacted prior to use or purchase for instruction on required protocols for wearing a respirator.
3. Don’t blow off excess pastel or charcoal dust with your mouth. Instead tap off the built up dust so it falls to the floor (or paper on floor)
4. Wet-mop and wet-wipe all surfaces clean of dusts.
5. If inhalation of dusts is a problem, a respirator may be appropriate. If so, contact REHS prior to use or purchase for instruction on required protocols for using a respirator.

Liquid Drawing Media

This includes both water-based and solvent based pen and ink and felt tip markers. Hazards of dry erase or white board markers can be considered here, although they are more used in teaching or commercial art.

Hazards

1. Drawing inks are usually water-based, but there are some solvent-based drawing inks. These usually contain toxic solvents like xylene.
2. Permanent felt tip markers used in design or graphic arts contain solvents. Xylene, which is a highly toxic aromatic hydrocarbon, is the most common ingredient; newer brands often contain the less toxic propyl alcohol (although it is an eye, nose and throat irritant). The major hazard from using permanent markers results from using a number of them at the same time at close range.

Precautions

1. Use water based markers and drawing inks if possible.
2. Alcohol based markers are less toxic than aromatic solvent-based markers.

3. Solvent based drawing inks and permanent markers should be used with good dilution ventilation (e.g. window exhaust fan).

Never paint on the body with markers or drawing inks. Body painting should be done with cosmetic colors.

SECTION 11: Photography

BLACK AND WHITE PHOTOGRAPHIC PROCESSING

A wide variety of chemicals are used in black and white photographic processing. Film developing is usually done in closed canisters. Print processing uses tray processing, with successive developing baths, stop baths, fixing baths, and rinse steps. Other treatments include use of hardeners, intensifiers, reducers, toners, and hypo eliminators.

Mixing Photochemicals

Photochemicals can be bought in liquid form, which only need diluting, or powder form, which need dissolving and diluting.

Hazards

1. Developer solutions and powders are often highly alkaline, and glacial acetic acid, used in making the stop bath, is also corrosive by skin contact, inhalation and ingestion.
2. Developer powders are highly toxic by inhalation, and moderately toxic by skin contact, due to the alkali and developers themselves (see Developing Baths below).

Precautions

1. Use liquid chemistry whenever possible, rather than mixing developing powders. Pregnant women, in particular, should not be exposed to powdered developer.
2. When mixing powdered developers, use a glove box (a cardboard box with glass or plexiglass top, and two holds in the sides for hands and arms), local exhaust ventilation, or wear a NIOSH approved toxic dust respirator.
3. Wear gloves, goggles and protective apron when mixing concentrated photochemicals. Always add any acid to water, never the reverse.
4. In case of skin contact, rinse with lots of water. In case of eye contact, rinse for at least 30 minutes, preferably using an eyewash station, seek medical attention.
5. Store concentrated acids and other corrosive chemicals on low shelves so as to reduce the chance of face or eye damage in case of breakage and splashing.
6. Do not store photographic solutions in glass containers.

Developing Baths

The most commonly used developers are hydroquinone, monomethyl para-aminophenol sulfate, and phenidone. Several other developers are used for special purposes. Other common components of developing baths include an accelerator, often sodium carbonate or borax, sodium sulfite as a preservative, and potassium bromide as a restrainer or antifogging agent.

Hazards

1. Developers are skin and eye irritants, and in many cases strong sensitizers. Monomethyl-paminophenol sulfate creates many skin problems, and allergies to it are frequent (although this is thought to be due to the presence of para-phenylene diamine as a contaminant). Hydroquinone can cause depigmentation and eye injury after five or more years of repeated exposure, and is a mutagen. Some developers also can be absorbed through the skin to cause severe poisoning (e.g., catechol, pyrogallic acid). Phenidone is only slightly toxic by skin contact.

2. Most developers are moderately to highly toxic by ingestion, with ingestion of less than one tablespoon of compounds such as monomethyl-p-aminophenol sulfate, hydroquinone, or pyrocatechol being possibly fatal for adults. Symptons include ringing in the ears (tinnitus), nausea, dizziness, muscular twitching, increased respiration, headache, cyanosis (turning blue from lack of oxygen) due to methemoglobinemia, delirium, and coma. With some developers, convulsions also can occur.
3. Para-phenylene diamine and some of its derivatives are highly toxic by skin contact, inhalation, and ingestion. They cause very severe skin allergies and can be absorbed through the skin.
4. Sodium hydroxide, sodium carbonate, and other alkalis used as accelerators are highly corrosive by skin contact or ingestion. This is a particular problem with the pure alkali or with concentrated stock solutions.
5. Potassium bromide is moderately toxic by inhalation or ingestion and slightly toxic by skin contact. Symptoms of systemic poisoning include somnolence, depression, lack of coordination, mental confusion, hallucinations, and skin rashes.
6. Sodium sulfite is moderately toxic by ingestion or inhalation, causing gastric upset, colic, diarrhea, circulatory problems, and central nervous system depression. It is not appreciably toxic by skin contact. If heated or allowed to stand for a long time in water or acid, it decomposes to produce sulfur dioxide, which is highly irritating by inhalation.

Precautions

1. See the section on Mixing Photochemicals for mixing precautions.
2. Do not put your bare hands in developer baths. Use tongs instead. If developer solution splashes on your skin or eyes immediately rinse with lots of water. For eye splashes, continue rinsing for 30 minutes and seek medical attention.
3. Do not use para-phenylene diamine or its derivatives if at all possible.

Stop Baths and Fixer

Stop baths are usually weak solutions of acetic acid. Acetic acid is commonly available as pure glacial acetic acid or 28% acetic acid. Some stop baths contain potassium chrome alum as a hardener.

Fixing baths contain sodium thiosulfate (“hypo”) as the fixing agent, and sodium sulfite and sodium bisulfate as a preservative. Fixing baths also may contain alum (potassium aluminum sulfate) as a hardener and boric acid as a buffer.

Hazards

1. Acetic acid, in concentrated solutions, is highly toxic by inhalation, skin contact and ingestion. It can cause dermatitis and ulcers, and can strongly irritate the mucous membranes. The final stop bath is only slightly hazardous by skin contact. Continual inhalation of acetic acid vapors, even from the stop bath, may cause chronic bronchititis.
2. Potassium chrome alum of chrome alum (potassium chromium sulfate) is moderately toxic by skin contact and inhalation, causing dermatitis and allergies.
3. In powder form, sodium thiosulfate is not significantly toxic by skin contact. By ingestion it has a purging effect on the bowels. Upon heating or long standing in

solution, it can decompose to form highly toxic sulfur dioxide, which can cause chronic lung problems. Many asthmatics are particularly sensitive to sulfur dioxide.

4. Sodium bisulfate decomposes to form sulfur dioxide if the fixing bath contains boric acid, or if acetic acid is transferred to the fixing bath on the surface of the print.
5. Alum (potassium aluminum sulfate) is only slightly toxic. It may cause skin allergies or irritation.
6. Boric acid is moderately toxic by ingestion or inhalation and slightly toxic by skin contact (unless the skin is abraded or burned, in which case it can be highly toxic).

Precautions

1. All darkrooms require good ventilation to control the level of acetic acid vapors and sulfur dioxide gas produced in photography.
2. Avoid eye and skin contact. Wear goggles and gloves for added protection.
3. Cover all baths when not in use to prevent evaporation or release of toxic vapors and gases.

Intensifiers and Reducers

A common after treatment of negatives (and occasionally prints) is either intensification or reduction. Common intensifiers include hydrochloric acid and potassium dichromate, or potassium chlorochromate. Mercuric chloride followed by ammonia or sodium sulfite, Monckhoven's intensifier consisting of a mercuric salt bleach followed by a silver nitrate/potassium cyanide solution, mercuric iodide/sodium sulfite, and uranium nitrate are older, now discarded, intensifiers.

Reduction of negatives is usually done with Farmer's reducer, consisting of potassium ferricyanide and hypo. Reduction has also been done historically with iodine/potassium cyanide, ammonium persulfate, and potassium permanganate/sulfuric acid.

Hazards

1. Potassium dichromate and potassium chlorochromate are probable human carcinogens, and can cause skin allergies and ulceration. Potassium chlorochromate can release highly toxic chlorine gas if heated or if acid is added.
2. Concentrated hydrochloric acid is corrosive; the diluted acid is a skin and eye irritant.
3. Mercury compounds are moderately toxic by skin contact and may be absorbed through the skin. They are also highly toxic by inhalation and extremely toxic by ingestion. Uranium intensifiers are radioactive, and are especially hazardous to the kidneys.
4. Sodium or potassium cyanide is extremely toxic by inhalation and ingestion, and moderately toxic by skin contact. Adding acid to cyanide forms extremely toxic hydrogen cyanide gas which can be rapidly fatal.
5. Potassium ferricyanide, although only slightly toxic by itself, will release hydrogen cyanide gas if heated, if hot acid is added, or if exposed to strong ultraviolet light (e.g. carbon arcs): Cases of cyanide poisoning have occurred through treating Farmer's reducer with acid.
6. Potassium permanganate and ammonium persulfate are strong oxidizers and may cause fires or explosions in contact with solvents and other organic materials.

Precautions

1. Chromium intensifiers are probably the least toxic intensifiers, even though they are probable human carcinogens. Gloves and goggles should be worn when preparing and using these intensifiers. REHS must be contacted prior to use for instruction on required protocols for using and purchasing a respirator.
2. Do not use mercury, cyanide or uranium intensifiers, or cyanide reducers because of their high or extreme toxicity.
3. The safest reducer to use is Farmer's reducer. Do not expose Farmer's reducer to acid, ultraviolet light, or heat.

Toners

Toning a print usually involves replacement of silver by another metal, for example, gold selenium, uranium, platinum, or iron. In some cases, the toning involves replacement of silver metal by brown silver sulfide, for example, in the various types of sulfide toners. A variety of other chemical are also used in the toning solutions.

Hazards

1. Sulfides release highly toxic hydrogen sulfide gas during toning, or when treated with acid.
2. Selenium is a skin and eye irritant and can cause kidney damage. Treatment of selenium salts with acid may release highly toxic hydrogen selenide gas. Selenium toners also give off large amounts of sulfur dioxide gas.
3. Gold and platinum salts are strong sensitizers and can produce allergic skin reactions and asthma, particularly in fair-haired people.
4. Thiourea is a probable human carcinogen since it causes cancer in animals.

Precautions

1. Carry out normal precautions for handling toxic chemicals as described in previous sections. In particular, wear gloves and goggles. See also the section on mixing photochemicals.
2. Toning solutions must be used with local exhaust ventilation.
3. Take precautions to make sure that sulfide or selenium toners are not contaminated with acids. For example, with two bath sulfide toners, make sure you rinse the print well after bleaching in acid solution before dipping it in the sulfide developer.
4. Avoid thiourea whenever possible because of its probable cancer status.

Other Hazards

Many other chemicals are also used in black and white processing, including formaldehyde as a pre-hardener, a variety of oxidizing agents as hypo eliminators (e.g., hydrogen peroxide and ammonia, potassium permanganate, bleaches, and potassium persulfate), sodium sulfide to test for residual silver, silver nitrate to test for residual hypo, solvents such as methyl chloroform and freons for film and print cleaning, and concentrated acids to clean trays.

Electrical outlets and equipment can present electrical hazards in darkrooms due to the risk of splashing water.

Hazards

1. Concentrated sulfuric acid, mixed with potassium permanganate or potassium dichromate, produces highly corrosive permanganic and chromic acids.
2. Hypochlorite bleaches can release highly toxic chlorine gas when acid is added, or if heated.
3. Potassium persulfate and other oxidizing agents used as hypo eliminators may cause fires when in contact with easily oxidizable materials, such as many solvents and other combustible materials. Most are also skin and eye irritants.

Precautions

1. See previous sections for precautions in handling photographic chemicals.
2. Cleaning acids should be handled with great care. Wear gloves, goggles and acid proof, protective apron. Always add acid to the water when diluting.
3. Do not add acid to, or heat, hypochlorite bleaches.
4. Keep potassium persulfate and other strong oxidizing agents separate from flammable and easily oxidizable substances.
5. Install ground fault interrupters (GFCIs) whenever electrical outlets or electrical equipment (e.g. enlargers) are within six feet of the risk of water splashes.

COLOR PROCESSING

Color processing is much more complicated than black and white processing, and there is a wide variation in processes used by different companies. Color processing can be either done in trays or in automatic processors.

Developing Baths

The first developer of color transparency processing usually contains monomethyl-p-aminophenol sulfate, hydroquinone, and other normal black and white developer components. Color developers contain a wide variety of chemicals including color coupling agents, penetrating solvents (such as benzyl alcohol, ethylene glycol, and ethoxydiglycol), amines, and others.

Hazards

1. See the developing section of black and white processing for the hazards of standard black and white developers.
2. In general, color developers are more hazardous than black and white developers. Paraphenylene diamine, and its dimethyl and diethyl derivatives, are known to be highly toxic by skin contact and absorption, inhalation, and ingestion. They can cause very severe skin irritation, allergies and poisoning. Color developers have also been linked to lichen planus, an inflammatory skin disease characterized by reddish pimples which can spread to form rough scaly patches. Recent color developing agents such as 4-amino-N-ethyl-N-[P methane-sulfonamidoethyl]-m-toluidine sesquisulfate monohydrate and 4-amino-3-methyl-N-ethyl-N-[,3-hydroxyethyl]-aniline sulfate are supposedly less hazardous, but still can cause skin irritation and allergies.
3. Most amines, including ethylene diamine, tertiary-butylamine borane, the various ethanolamines, etc. are strong sensitizers, as well as skin and respiratory irritants.

4. Although many of the solvents are not very volatile at room temperature, the elevated temperatures used in color processing can increase the amount of solvent vapors in the air. The solvents are usually skin and eye irritants.

Precautions

1. Wear gloves and goggles when handling color developers. Wash gloves with an acid-type hand cleaner (e.g pHisoderm ® and then water before removing them.
2. Mix powders in a glove box, or use a NIOSH-approved respirator. REHS must be contacted prior to use for instruction on required protocols for using and purchasing a respirator.
3. Color processing needs more ventilation than black and white processing due to the use of solvents and other toxic components at elevated temperatures.

Bleaching, Fixing, and other steps

Many of the chemicals used in other steps of color processing are essentially the same as those used for black and white processing. Examples include the stop bath and fixing bath. Bleaching uses a number of chemicals, including potassium ferricyanide, potassium bromide, ammonium thiocyanate, and acids. Chemicals found in prehardeners and stabilizers include succinaldehyde and formaldehyde; neutralizers can contain hydroxylamine sulfate, acetic acid, and other acids.

Hazards

1. Formaldehyde is moderately toxic by skin contact, and highly toxic by inhalation and ingestion. It is a skin, eye and respiratory irritant, and strong sensitizer, and is a probable human carcinogen. Formaldehyde solutions contain some methanol, which is highly toxic by ingestion.
2. Succinaldehyde is similar in toxicity to formaldehyde, but is not a strong sensitizer or carcinogen.
3. Hydroxylamine sulfate is a suspected teratogen in humans since it is a teratogen (causes birth defects) in animals. It is also a skin and eye irritant.
4. Concentrated acids, such as glacial acetic acid, hydrobromic acid, sulfamic acid and p-toluenesulfonic acids are corrosive by skin contact, inhalation and ingestion.
5. Acid solutions, if they contain sulfites or bisulfites (e.g. neutralizing solutions), can release sulfur dioxide upon standing. If acid is carried over on the negative or transparency from one step to another step containing sulfites or bisulfites, then sulfur dioxide can be formed.
6. Potassium ferricyanide will release hydrogen cyanide gas if heated, if hot acid is added, or if exposed to strong ultraviolet radiation.

Precautions

1. Local exhaust ventilation is required for mixing of chemicals and color processing.
2. Use premixed solutions whenever possible.
3. Avoid color processes using formaldehyde, if possible.
4. Wear gloves, goggles and protective apron when mixing and handling color processing chemicals. When diluting solutions containing concentrated acids, always add the acid to the water. An eyewash should be available.

5. A water rinse step is recommended between acid bleach steps and fixing steps to reduce the production of sulfur dioxide gas.
6. Do not add acid to solutions containing potassium ferricyanide or thiocyanate salts.
7. Control the temperature carefully according to manufacturer's recommendations to reduce emissions of toxic gases and vapors.

Disposal of Photochemicals

There is considerable concern about the effect of dumping photographic chemicals and solutions down the drain. The following recommendations are for disposing small volumes of photographic solutions daily.

1. Old or unused concentrated photographic chemical solutions, toning solutions, ferricyanide solutions, chromium solutions, color processing solutions containing high concentrations of solvents, and non-silver solutions should be treated as hazardous waste.
2. Alkaline developer solutions should be neutralized first before being poured down the drain. This can be done with the stop bath or citric acid, using pH paper to tell when the solution has been neutralized (pH7).
3. Stop bath left over from neutralization of developer is to be collected for disposal as hazardous waste.
4. Fixing baths should never be treated with acid (e.g. mixing with stop bath), since they usually contain sulfites and bisulfites which will produce sulfur dioxide gas.
5. Fixing baths contain large concentrations of silver thiocyanate, well above the 5 ppm of silver ion allowed by the U.S. Clean Water Act. Collect fixers and either pour into the silver recovery unit or dispose as hazardous waste.

SECTION 12: Ceramics

Ceramic art and pottery has a wide variety of hazards. The specific hazards and precautions can be divided into four areas: 1) Working with clay; 2) glazing and coloring; 3) firing in a kiln; 4) potential leaching of finished ware.

Clay

Clays are minerals composed of hydrated aluminum silicates, often containing large amounts of crystalline silica. Other impurities may include organic matter or sulfur compounds. Sometimes grog (ground firebrick), sand, talc, vermiculite, perlite, and small amounts of minerals such as barium carbonate and metal oxides, are added to modify clay properties. Clays can be worked by hand or on the potter's wheel, or cast in a clay slurry into molds.

Clay is made by mixing dry clay with water in clay mixer. Clay slip is made by adding talcs which themselves can be contaminated with fibrous asbestos or asbestos-like materials. Geographical sources of talcs are relevant, for example, New York State talcs are notoriously asbestos contaminated, while Vermont talcs are not. Pfizer has some fiber-free talcs.

Hazards

1. There have been known cases of silicosis, or "potter's rot, from chronic inhalation of large amounts of free silica during clay mixing. Symptoms of silicosis include: shortness of breath, dry cough, emphysema, and high susceptibility to lung infections such as tuberculosis. The disease may take years to develop. Silica dust exposure is not hazardous by skin contact or ingestion.
2. Chronic inhalation of kaolin is moderately hazardous, and can result in kaolinosis, a disease in which the lungs become mechanically clogged.
3. Asbestos is extremely toxic by inhalation and possibly by ingestion. Asbestos inhalation may cause asbestosis, lung cancer, mesothelioma, stomach cancer, and intestinal cancer.
4. Sand, perlite, grop and vermiculite contain free silica and are, therefore, highly toxic by inhalation. Vermiculite is also frequently contaminated with asbestos.
5. There is a danger of accidents if clay or water can be added while the mixer is in operation.
6. Bags of clay and glaze materials can be very heavy, and lifting can cause back problems.
7. Hypersensitivity pneumonia, asthma or other respiratory problems may occur with exposure to molds growing in wet clay that is being soured or aged in a damp place, in slips that stand for months, or with inhalation of dry aged clay. Molds can cause or exacerbate skin problems and change the workability of clay.
8. Throwing on a potter's wheel for long periods of time can result in carpel tunnel syndrome because of the awkward position of the wrists. Pain, numbness and/or pins and needles in the thumb and first three fingers, are common symptoms. Back problems can occur from bending over the potters wheel for long periods of time.
9. Hand contact with wet clay can result in abrasion and dryness of fingertips and hands. Moving parts of kickwheels can cause cuts and abrasions.
10. Clay scraps on the floor, bench and other surfaces can dry and pulverize, producing an inhalation hazard due to the presence of free silica. Similarly, reconditioning clay by

pulverization and sanding finished green ware, can create very high concentrations of hazardous silica dust.

Precautions

1. Use premixed clay to avoid exposure to large quantities of clay dust.
2. Clay storage and mixing should take place in a separate room. Bags of clay (and other pottery materials) should be stacked on palettes or grids off the floor for easier clean up.
3. All clay mixers should be equipped with local exhaust ventilation to remove fine silica dust particles from the air.
4. Clay mixers should be equipped with proper machine guards so that they cannot be opened to add clay or water while the mixer blades are turning.
5. Wear separate work clothes while in the studio. Choose clothes of material and design that don't trap dust. Wash these clothes weekly, and separately from other laundry.
6. Avoid contact of clay with broken skin. Use a skin moisturizer.
7. To prevent back problems, always lift with knees bent. Also use a standup wheel (Cranbrook style treadle wheel), or elevate electric wheels to a height that doesn't require bending over. Exercise and massage may relieve minor muscular pain.
8. Keep wrists in unflexed position as much as possible to prevent carpel tunnel syndrome. Take frequent work breaks.
9. Be careful of the moving parts on kickwheels.
10. Recondition clay by cutting still-wet clay into small pieces, letting them air dry, and soak in water.
11. Finish green ware while still wet or damp with a fine sponge instead of sanding when dry. Do not sand greenware containing fibrous talc.
12. Wet mop floors and work surfaces daily to minimize dust levels and prevent dry scraps from becoming pulverized.

Glazes

Glazes used to color or finish clay pieces are a mixture of silica, fluxes and colorants. Common fluxes include lead, barium, lithium, calcium and sodium, and are used to lower the melting point of silica. The actual colorants, which are an assortment of metal oxides usually account for less than 5% of the glaze by weight.

Originally, soluble raw lead compounds including red lead, white lead, galena, and litharge were used as fluxes in low fire glazes. In fact, over 400 cases of lead poisoning were reported in British potters in 1897. Lead frits and good housekeeping greatly lowered the number of potters that had been poisoned by these highly toxic lead compounds. Frits are made of melted minerals and metal compounds that are sintered and ground into powder form. While lead frits are sometimes assumed to be insoluble and nontoxic, leaching tests with acids have shown that many frits are as soluble as raw lead compounds and, in fact, there have been cases of lead poisoning from both inhalation or ingestion of these.

High fire porcelain and stoneware techniques eliminate the need for lead as a flux. Also, alkali earth or alkaline earth fluxes can be used for low-fire conditions instead of lead. Silica may also be removed from leadless type glazes. The substitution can be based on boric oxide as the glass former, instead of silica. Alkali earth fluxes include sodium, potassium, and lithium oxides;

alkaline earth fluxes include calcium, magnesium, barium, and strontium oxides. Minerals containing these fluxes include certain feldspars, nepheline syenite, petalite, bone and plant ashes, whiting and dolomite.

An assortment of metal oxides or other metal compounds produce particular colors when fired. These are added in such small amounts to the glaze, that they aren't usually a great hazard. Luster or metallic glazes are fired in a reduction atmosphere. These glazes can contain mercury, arsenic, highly toxic solvents such as aromatic and chlorinated hydrocarbons, and oils such as lavender oil. The common metals are often resonates of gold, platinum, silver and copper. Some underglazes and overglazes use mineral spirits as the vehicle instead of water.

Glaze components are weighed, sorted and mixed with water. These materials are often in fine powdered form, and result in high dust exposures. Glazes can be dipped, brushed, poured, or sprayed on the ceramic piece.

Hazards

1. Lead compounds are highly toxic by inhalation or ingestion. Symptoms of lead poisoning include: damage to the peripheral nervous system, brain, kidney, or gastrointestinal system, as well as anemia, chromosomal damage, birth defects and miscarriages.
2. Lead-glazed foodware can leach lead if not fired properly, or if the glaza composition is not correctly adjusted. For example, the addition of copper to lead frits renders a higher solubility of lead in the final fired ware. Acidic drinks and foods such as tomato juice, citric juices, sodas, tea, or coffee, can increase this hazard.
3. A glaze label marked "lead-safe" means that the finished ware, if fired properly, will not release lead into food or drink. The actual glaze is still hazardous to handle and fire may contain lead. Adequate control over firing conditions is very difficult in the craft studio.
4. Other fluxes such as barium and lithium are also highly toxic by inhalation, but less so than lead.
5. Certain colorant compounds of particular metals are known or probable human carcinogens, including: arsenic, beryllium, cadmium, chromium (VI), nickel, and uranium.
6. Antimony, barium, cobalt, lead, lithium, manganese, and vanadium colorant compounds are highly toxic by inhalation.
7. Animony, arsenic, chromium, vanadium, and nickel compounds are moderately toxic by skin contact.
8. Free silica occur in many of the clays, plant ash, flint, quartz feldspars, talcs, etc. used in glazes. See the discussion above for the hazards of silica and the disease silicosis. Weighing and mixing glazes can result in the inhalation of these toxic materials.
9. Soda ash, potassium carbonate, alkaline feldspars, and fluorspar used in glazes are skin irritants.
10. Spray application of glazes is very hazardous because of the potential inhalation of glaze mists.
11. Dipping, pouring, and brushing certain glazes may cause skin irritation and accidental ingestion due to careless personal hygiene habits.
12. Glazes containing solvents are both flammable and hazardous.

Precautions

1. Use lead-free glazes. If the glaze does not state “lead-free” or “leadless” on the label, assume it contains lead until proven otherwise.
2. Lead glazes should only be used on non-foodware items. Design lead-glazed pieces so that they won’t be used for food or drink. Lead-glazed pottery should be labeled as lead-containing.
3. If possible, don’t use colorants that are known human carcinogens and avoid probable human carcinogens. There is no known safe level of exposure to carcinogens.
4. Consider wearing a respirator when weighing and mixing powdered. Wet glazes are not an inhalation hazard. Good housekeeping procedures and cleanup of spills reduce the risk of inhalation or ingestion of toxic dusts. Wet mop spilled powders.
5. Gloves should be worn while handling wet or dry glazes.
6. Good dilution ventilation or local exhaust ventilation should be available when applying solvent-containing glazes.
7. Basic personal hygiene rules should be followed including restricting eating, drinking, or smoking in the studio, and wearing personal protective equipment such as gloves, and separate work clothes or coveralls. Wash hands after work.
8. Leftover glazes and glaze scrapings can be homogenized, combined, tested, and used as a glaze.

Kilns

Electric kilns and fuel-fired kilns are used to heat the pottery to the desired firing temperature. The most common types are the electric kilns. Heating elements heat the kiln as electric current passes through the coils. The temperature rises until the kiln is shut off.

Fuel-fired kilns are heated by burning gas (natural or propane), oil, wood, coke, charcoal or other materials. Propane gas or natural gas is used most often. These kilns can be either located indoors or outdoors. The fuels produce carbon monoxide and other combustion gases. Fuel-fired kilns are usually vented from the top through a chimney.

Firing temperatures can vary from as low as 1,382F for raku and bisque wares, to as high as 2,372 F for stoneware, and 2642 F for certain porcelains.

The early stages of bisque firing involves the oxidization of organic clay matter to carbon monoxide and other combustion gases. Sulfur breaks down later producing highly irritating sulfur oxides. Also nitrates and nitrogen containing organic matter break down to nitrogen oxides.

Galena, Cornish stone, crude feldspars, low grade fire clays, fluorspar, gypsum, lepidolite and cryolite can release toxic gases and fumes during glaze firings. Carbonates, chlorides, and fluorides are broken down to releasing carbon dioxide, chlorine, and fluorine gases.

At or above stoneware firing temperature, lead, antimony, cadmium, selenium and precious metals vaporize and the metal fumes can either escape from the kiln, or settle inside the kiln or on ceramic ware in the kiln. Nitrogen oxides and ozone can be generated from oxygen and nitrogen in air.

Hazards

1. Chlorine, fluorine, sulfur dioxide, nitrogen dioxide, and ozone are highly toxic by inhalation. Bisque firings of high sulfur clay have caused the production of great amounts of choking sulfur dioxide. Other large acute exposures to gases are not common. Inhalation of large amounts of these gases can result in severe acute or chronic lung problems. Long-term inhalation of low levels of these gases can cause chronic bronchitis and emphysema. Fluorine gas can also cause bone and teeth problems.
2. Many metal fumes generated at high temperatures are highly toxic by inhalation. Since lead vaporizes at a relatively low temperature, it is especially hazardous.
3. Carbon monoxide from fuel-fired kilns or the combustion of organic matter in clays is highly toxic by inhalation and can cause oxygen starvation. One symptom of carbon monoxide poisoning is an intense frontal headache, un-relievable by analgesics.
4. Hot kilns produce infrared radiation, which is hazardous to the eyes. There have been reports of cataracts, from years of looking inside the hot kilns.
5. Heat generated by the kiln can cause thermal burns. The Edward Orton Jr. Ceramic Foundation reported that when a kiln was operated at 2370 F, the surface temperature was at and above 595 F, and the temperature one foot away from the peephole was 156 F.
6. Heat produced by even small electric kilns can cause fires in the presence of combustible materials or flammable liquids.
7. If an electric kiln fails to shut off, the heating elements melt which can cause fires. Gas kilns also generate a lot of heat, and room temperatures often exceed 100 F.

Precautions

1. Infrared goggles approved by the American National Standards Institute (ANSI) or hand-held welding shields should be worn when looking into the operating kiln. Shade number from 1.7 to 3.0 is recommended, but a darker shade may be required if spots appear in front of one’s eyes after looking away from the kiln.
2. Do not use lead compounds at stoneware temperatures since the lead will vaporize.
3. Lumber, paper, solvents, or other combustible and flammable materials should not be stored in kiln areas.
4. Always check that the kiln has shut off.
5. If gas leaks are suspected (e.g. gas odor): shut off gas at the source; shut off power to the kiln room at the circuit breaker; and call the gas company. Test for leaks with nonfat, soapy water or use approved leak detection solutions.

SPECIAL PROCESSES

While most glaze firings refer to firing a glaze-coated pot in the kiln, special processes sometimes are used. Salt glazing and raku firing are two examples.

Salt Glazing

This process involves throwing wet salt (sodium chloride) into the heated kiln while the bisque ware is being fired. Wet salt at high temperatures decomposed to sodium and chlorine. The sodium reacts with the bisque ware to form a glaze. Large amounts of hydrogen chloride gas and possibly chlorine are also formed.

Sodium carbonate (washing soda) can also be used. Carbon dioxide is generated instead of hydrogen chloride.

Hazards

1. Hydrogen chloride gas is highly toxic by inhalation. Health effects are both similar and more irritating compared with most other kiln gases. Often, local environmental protection laws ban salt kilns.
2. Hydrogen chloride and water vapor form hydrochloric acid, which can corrode metal fittings in the area.

Precautions

1. Substitute safer sodium carbonate for sodium chloride.
2. Sodium chloride salt glazing should only be done outdoors. Kilns should be equipped with canopy hoods and chimney stacks that are tall enough to disperse the hydrogen chloride safely.
3. All gas piping and metal fixtures should be routinely checked for corrosion.

Raku Firing

Raku involves first firing ware at a low temperature in a regular gas kiln, and then removing the still hot pieces and placing them in sawdust, leaves or other organic materials for a reduction phase.

Hazards

1. See above for the hazards and safety precautions used with gas kilns.
2. The reduction step produces large amounts of smoke and carbon monoxide.
3. Treated wood or other materials can yield an exposure to highly toxic preservatives or pesticides, such as arsenic and chromium compounds.

Precautions

1. Raku should only be done outdoors because of smoke. Be careful to not locate raku near air intakes or open windows of buildings.
2. Do not use materials that have been treated with preservatives or pesticides for the reduction phase.
3. Personal protection is to be used to protect employees/students from the heat. This includes a long sleeved cotton shirt (polyester and other synthetics might melt), fire-proof gloves and safety goggles.

LEACHING OF FINISHED CERAMIC WARE

Lead Leaching

There is a real concern about lead leaching into food and drink from pottery fired with lead glazes. Both the U.S. Food and Drug Administration (FDA) and the Canadian Consumer and Corporate Affairs have regulated how much lead can leach from food ware into food and drink. Acidic liquids are of particular concern. Similarly, continual microwave reheating, (e.g. a coffee mug at work) can yield greater leaching of lead glazes. Many cases of lead poisoning, and even some fatalities, have occurred from the leaching of lead from lead-glazed pottery.

While commercial ceramics companies routinely test their ware for lead leaching, craft potters do not have the same quality control as does the ceramics industry, and lead leaching is more of a problem.

According to United States regulation, ceramic ware that does not pass the lead leaching tests must have a permanent fired decal sating:

"NOT FOR FOOD USE – MAY POISON FOOD
FOR DECORATIVE PURPOSES ONLY"

As mentioned earlier, you can also drill a hole in the pottery so it cannot be used for liquids or food.

Preferably, do not use lead glazes, especially for food and drink vessels. Any food ware finished with lead glazes should be tested regularly by certified laboratories.

Other Leachable Metals

Other metals can leach into food and drink. Cadmium is the single metal besides lead presently regulated in the United States and Canada. However, other possible toxic metals in glazes can leach. Barium has been seen in some tests to leach in hazardous amounts from certain glaze formulations. If a barium glaze, or other glaze, changes color from contact with food, do not use the vessel for food. Try and use only glazes with calcium, magnesium, potassium, and sodium fluxes and minimize the amounts of toxic metal colorants. Routine testing for other metal leaching should be done. More research needs to be done in this area.

SECTION 13: Lithography and Relief Printing

Inks

Intaglio, lithography and relief inks consist of pigments suspended in either linseed oil or water as a vehicle. There can be additional hazardous binders or preservatives, etc.

Hazards

1. Oil-based inks contain treated linseed oils. While linseed oil is not considered a hazard by skin contact or inhalation, ingestion of large amounts of some treated linseed oils might be hazardous due to presence of small amounts of toxic heavy metals. Oil vehicles are flammable when heated, and rags soaked in these may ignite by spontaneous combustion.

Precautions

1. Know what materials are used. Obtain the material safety data sheets (MSDSs) on all products used. Use the least toxic inks possible.
2. Do not use an open flame to heat linseed oil, linseed oil, varnishes, or burnt plate oil. Take normal fire prevention measures (e.g. no smoking or open flames in work area).
3. Place oil-soaked rags in self-closing disposal cans and remove from the studio each day. An alternative is to place the oil soaked rags in a pail of water.

Pigments

Pigments are the colorants used in lithography, intaglio, and relief printing inks. There are two types of pigments: inorganic pigments, and organic pigments.

Hazards

1. Pigment poisoning can occur if pigments are inhaled or ingested. For normal printing with prepared inks, the main hazard is accidental ingestion of pigments due to eating, drinking, or smoking while working, or inadvertent hand to mouth contact.
2. The classic example of a toxic inorganic pigment in printmaking is lead chromate (chrome yellow). Lead pigments can cause anemia, gastrointestinal problems, peripheral nerve damage (and brain damage in children), kidney damage and reproductive system damage. Other inorganic pigments may be hazardous also, including pigments based on cobalt, cadmium and manganese.
3. Some of the inorganic pigments, in particular cadmium pigments, chrome yellow and zinc yellow (zinc chromate) may cause lung cancer if inhaled. In addition, lamp black and carbon black may contain impurities that can cause skin cancer.
4. Chromate pigments (chrome yellow and zinc yellow) may cause skin ulceration and allergic skin reactions.
5. The long-term hazards of the modern synthetic organic pigments have not been well studied.

Precautions

1. Obtain MSDSs on all pigments. This is especially important because the name that appears on label of the color may or may not truly represent the pigments present.
2. Use the safest pigments possible. Avoid lead pigments.

3. Avoid mixing dry pigments whenever possible. If dry pigments are mixed, wear a NIOSH-approved toxic dust respirator.

Solvents
In general, organic solvents are one of the most underrated hazards in art materials. Organic solvents are used in printmaking to dissolve and mix with oils, resins, varnishes, and inks; and to clean plates, rollers, tools, and even hands.

Hazards
1. Repeated or prolonged skin contact with solvents can cause defatting of the skin and resultant dermatitis. Many solvents can also be harmful through skin absorption.
2. Inhalation of solvent vapors is the major way in which solvents are harmful. High concentrations of most solvents can cause dizziness, nausea, fatigue, lost of coordination, or coma. This can also increase the chances for mistakes and accidents.
3. Many solvents are toxic if ingested. Swallowing an ounce of turpentine can be fatal.
4. Most solvents, except chlorinated hydrocarbons, are also either flammable or combustible.

Precautions
1. Obtain the MSDS on all solvent products used. Use the least toxic solvent possible. For example, replace the more toxic methyl alcohol with denatured alcohol or isopropyl alcohol.
2. Use adequate ventilation.
3. Keep minimum amounts of solvents on hand and purchase in smallest practical container size. Large amounts of solvents or solvent-containing materials should be stored in a flammable storage cabinet.
4. Never store solvents or solvent-containing materials in food or drink containers. Always label containers.
5. Do not allow smoking, open flames or other sources of ignition near solvents.
6. Have a class B fire extinguisher in the area. (If ordinary combustible materials are present, you may need a Class ABC fire extinguisher.)
7. Wear gloves when handling solvents to avoid skin contact in particular do not use solvents to clean ink off hands. Baby oil is a good substitute.

Acids
Acids are used in intaglio (acid etching) and in lithography. Strong acids commonly used include nitric acid, hydrochloric acid, and phosphoric acid, and less commonly carbolic acid 9phenol), chromic acid, hydrofluoric and sulfuric acids.

Hazards
1. Concentrated acids are corrosive to the skin, eyes, respiratory system and gastrointestinal system. Dilute acids can cause skin irritation on repeated or prolonged contact.
2. Chromic acid is a skin sensitizer, suspect carcinogen, and oxidizer.
3. Phenol is highly toxic by skin absorption and ingestion. It may cause severe kidney damage, central nervous system effects and even death if absorbed in large amounts.

4. Hydrofluoric acid is highly toxic and can cause severe, deep burns which require medical attention. There is no immediate pain warning from contact with hydrofluoric acid.
5. Concentrated nitric acid is a strong oxidizing agent and can react explosively with other concentrated acids, solvents, etc. Nitric acid gives off various nitrogen oxide gases, including nitrogen dioxide which is a strong lung irritant and can cause emphysema.

Precautions

1. Know what is used. Obtain the MSDS for all acids.

2. Whenever possible avoid concentrated acids.

3. Doing acid etching requires working in an enclosed hood, or in front of a slot exhaust hood or window exhaust fan at work level.

4. Store concentrated nitric and chromic acids away from organic materials. Concentrated nitric acid should always be stored separately even from other acids.

5. An important safety rule when diluting concentrated acids is to add the acid to the water, never the reverse.

6. Wear appropriate gloves, goggles and protective apron or lab coat when handling acids.

7. If adequate ventilation is not available, use of a respirator will be necessary. REHS must be contacted prior to use for instruction on required protocols for using and purchasing a respirator.

8. If acid is spilled on your skin, wash with lots of water. In case of eye contact, rinse the eyes with water for at least 30 minutes and seek medical attention.

Lithography

Lithography uses either zinc and aluminum metal plates or stones for printing. It involves use of a variety of chemicals to make the image ink-receptive and non-image areas receptive to water and ink-repellent.

Plate and Stone Preparation

A variety of drawing materials with high wax and fatty acid content are used to make the image, including tusche and lithographic crayons. Airbrushing liquid drawing materials or using spray enamel or lacquer is also common. Other materials used in stone or plate processing include etch solution containing acids and gum Arabic, counteretch solutions containing acids and sometimes dichromate salts, and fountain solutions containing dichromate salts. Phenol (carbolic acid) has been used for removing grease from stones, and a variety of solvents including lithotine, gasoline, kerosene, and mineral spirits, which are used for diluting drawing materials, washing out images and correction of images. Talc and rosin mixtures are also used. Metal plates are prepared with solvent-based vinyl lacquers.

Hazards

1. Acids used include phosphoric, nitric, acetic, hydrochloric, hydrofluoric and tannic acids. The concentrated acids are corrosive and even dilute acid solutions can cause skin irritation from prolonged or repeated contact. Hydrofluoric acid and phenol are the most dangerous to use.
2. Lithotine, kerosene, and mineral spirits are skin and eye irritants and inhalation can cause intoxication and respiratory irritation.
3. The solvents contained in vinyl lacquers can include highly toxic isophorone and cyclohexanone. Methyl ethyl ketone (MEK), which is moderately toxic, is often used as a thinner.
4. Dichromate salts may cause skin and nasal ulceration and allergic reactions, and are suspect cancer-causing agents.
5. Rosin dust may cause asthma and allergic dermatitis. There is the hazard of explosion from the buildup of rosin dust, in enclosed rosin boxes, around an ignition source.
6. Talcs may be contaminated with asbestos and silica.
7. Airbrushing drawing materials or using spray enamel paints is more hazardous than drawing with a brush because the inhalation hazard is higher.

Precautions

1. Obtain the MSDS for all materials used.
2. See Acids and Solvents sections for the precautions with acids and solvents
3. Use the least toxic solvents. Gasoline should never be used. Lithotine and mineral spirits are less toxic than the more irritating kerosene.
4. Use asbestos fee talcs such as baby powders.
5. Avoid dichromate-containing counteretches and fountain solutions if possible. Do not use hydrofluoric acid or phenol.
6. Appropriate gloves, goggles and a protective apron should be worn when mixing or using concentrated acids.

Printing and Cleanup

For all types of lithographic inks, solvents are used to make image corrections on the press, to remove images, and to clean the press bed and rollers.

Hazards

Some roller cleaners and glaze cleaners can contain chlorinated hydrocarbons such as perchloroethylene and methylene chloride. Most chlorinated solvents (except 1,1,1-trichloroethane) have been shown to cause liver cancer in animals and are therefore suspect human carcinogens. In addition perchloroethylene can cause liver damage, and methylene chloride heart attacks.

Precautions

1. Know materials used. Obtain the MSDS for all solvents. See Solvents section for the precautions with solvents.
2. Choose products that do not contain chlorinated solvents whenever possible.
3. For small scale solvent use in correcting images or cleaning the press bed using lithotine or mineral spirits, dilution ventilation (e.g. window exhaust fan) is sufficient.

Intaglio

Intaglio is a printmaking process in which ink is pressed into depressed areas of the plate and then transferred to paper. These depressed areas can be produced by a variety of techniques, including acid etching, drypoint, engraving and mezzotint.

Etching

Etching involves use of dilute nitric acid, Dutch mordant (hydrochloric acid plus potassium chlorate) or ferric chloride to etch the zinc or copper (respectively) metal plate. Unetched parts the plate are protected with resists such as stopout varnishes containing ethyl alcohol, grounds containing asphaltum or gilsonite and mineral spirits, rubber cement, and rosin or spray paints for aquatinting. Sometimes, soft grounds contain more toxic solvents.

Hazards

1. See Solvents section for the hazards of solvents. 1,1,1-trichloroethane found in some soft grounds is moderately toxic by inhalation under normal conditions but may cause fatalities at very high concentrations.
2. See Acids section for the hazards of acids. In particular nitric acid etching releases the respiratory irritant nitrogen dioxide which has poor odor warning properties. During the etching process, flammable hydrogen gas is also produced.
3. Concentrated nitric acid is a strong oxidizing agent and can react with many other chemicals, especially solvents or other organic compounds, to cause a fire.
4. Mixing hydrochloric acid with potassium chlorate to make Dutch mordant produces highly toxic chlorine gas. Potassium chlorate is a key ingredient in many pyrotechnics, and is a potent oxidizing agent. It can react explosively with organic compounds, sulfur compounds, sulfuric acid or even dirt or clothing. On heating it can violently decompose to oxygen and potassium chloride. Storage and use are very dangerous require special precautions especially when mixing.
5. Rosin dust (and asphaltum dust which is also sometimes used) is combustible. Sparks or static electricity have caused explosions in enclosed rosin and aquatint boxes. Rosin dust may also cause asthma and dermatitis in some individuals.
6. Inhalation of solvents and pigments can result from use of aerosol spray paints.

Precautions

1. Obtain the MSDS for all materials used.
2. See Solvents and Acids sections for specific precautions.
3. Use Dutch mordant with extreme caution. A safer substitute for etching copper plates is ferric chloride (iron perchloride). This forms acidic solutions so should be handles accordingly, but does not have the dangers of handling concentrated acids. Ferric chloride solution might cause minor skin irritation from prolonged contact.
4. Application of grounds or stopout should be done with local exhaust ventilation, (e.g. slot or enclosed hood).
5. Acid etching should be done with local exhaust ventilation. See section on precautions for Acids for more information. Rosin (or asphaltum) boxes should be explosion-proof. Use sparkproof metal cranks, explosion-proof motors, or compressed air. Don’t use hair dryers to stir up rosin dust.

Other Techniques

Drypoint, mezzotint and engraving use sharp tools to incise lines in metal plates.

Hazards

1. One major hazard associated with these types of processes involves accidents with sharp tools.
2. Long-term use of these tools can cause carpel tunnel syndrome, which can cause numbness and pain in the first three fingers. Severe cases can be incapacitating.

Precautions

1. Keep tools sharp, store them safely and always cut away from yourself.
2. When possible, clamp down plates to avoid slippage.
3. Minimize the chance of carpel tunnel syndrome by choosing tools with wide handles, avoiding tight grips, and doing hand flexing exercises during regular rest periods. Set work table height so wrist flexing motions are minimal.

Printing and Cleanup

Intaglio inks contain pigments, treated linseed oil and modifiers. Printing involves placing the ink on the inking slab, inking the plate by hand, and then printing. Cleanup of inking slab, press bed, and cleaning the plate is done with a variety of solvents including mineral spirits, alcohol, lithotine, turpentine, etc.

Hazards

1. Preparing your own inks from dry pigments can involve inhalation of toxic pigments. See Pigments section for the hazards of pigments.
2. See Solvents section for the hazards of solvents. Plate cleaning is more hazardous than cleaning inking slabs or press beds because larger amounts of solvents are used.
3. Lithotine, turpentine, or oil-soaked rags can be a spontaneous combustion hazard if improperly stored.

Precautions

1. See Pigments and Solvents sections for the specific precautions for pigments and solvents.
2. If adequate ventilation is not provided, respiratory protection may be necessary. REHS must be contacted prior to use for instruction on required protocols for using and purchasing a respirator.

Relief and Other Printing Processes

Other printing processes include relief printing, collagraphs, monoprints, and plastic prints.

Relief Printing

Relief printing techniques include woodcuts, linoleum cuts and acrylic plates for plaster relief. These techniques involve the cutting away of plate areas that are not to be printed. Relief inks can be oil based or water-based.

Hazards

1. Some woods used for woodcuts can cause skin irritation and/or allergies. This is particularly true of tropical hardwoods.
2. Accidents involving sharp tools can result in cuts.
3. Wood carving and cutting tools can cause carpel tunnel syndrome. This was discussed earlier in the section that included dry point and mezzotint.
4. Caustic soda (sodium hydroxide) is sometimes used for etching linoleum. It can cause skin burns and severe eye damage if splashed in the eyes.
5. Eating, drinking or smoking while printing can result in accidental ingestion of pigments.
6. Hazardous solvents are used in stopouts and resists in linoleum etching, and for cleaning up after printing with oil-based inks. See Solvents section for more information on the hazards of solvents.

Precautions

1. Obtain the MSDS for all materials used.
2. See Acids and Solvents sections for precautions with acids and solvents.
3. Water-based inks are preferable to oil-based inks since solvents are not needed.
4. Wear appropriate gloves, goggles and protective apron when handling caustic soda.
5. If the chemical is spilled on your skin, wash with lots of water. In case of eye contact, rinse the eyes with water for at least 15-20 minutes and contact a physician.
6. Always cut in a direction away from you, with your free hand on the side or behind the hand with the tool.
7. Carpel tunnel syndrome can be minimized or avoided by using tools with wide handles, avoiding tight grips, and rest periods with hand flexing exercises. Linoleum cutting is softer to work, and thus can reduce musculoskeletal injury.

Collagraphs

Collagraphs are prints produced by using a collage of different materials glued onto a rigid support. A wide variety of materials and adhesives can be used in making collagraphs.

Hazards

1. Rubber cement, a common adhesive used with collagraphs, is extremely flammable and most rubber cements and their thinners contain the solvent n-hexane which can cause damage to the peripheral nervous system (hands, arms, legs, feet) from chronic inhalation.
2. Epoxy glues can cause skin and eye irritation and allergies.
3. Spraying fixatives on the back of collagraph plates to seal them can involve risk of inhalation of the solvent-containing spray mist.
4. Sanding collagraph plates which have been treated with acrylic modeling compounds or similar materials can involve inhalation of irritating dusts.

Precautions

1. Know the hazards of materials used. Obtain the MSDSs from the manufacturer.
2. Use the least toxic materials available. In particular use water-based glues and mediums (e.g. acrylic medium) whenever possible. Some rubber cements are made with the

solvent heptanes, which is less toxic than n-hexane, primarily because peripheral neuropathy is not associated with its use.
3. Wear gloves when using epoxy glues.
4. When sanding collagraph plated, use of a respirator may be necessary. REHS must be contacted prior to use for instruction on required protocols for using and purchasing a respirator.

Plastic Prints

Plastic prints can involve making prints from a wide variety of plastic materials and resins.

Hazards

Plastic prints can involve hazards from inhalation of plastic resin vapors (e.g. epoxy resins) and also from inhalation of decomposition fumes from drilling, machining, sawing, etc. of finished plastics.

Precautions

1. Obtain the MSDS for all materials used.
2. See Solvent section for the precautions with solvents.
3. Use the least toxic material available.

Monoprints

Monoprints involve standard intaglio, lithographic and other printmaking techniques, but only one print is made. Monopints have the same hazards involved in plate preparation and printing as the parent techniques.

Photoprintmaking

Photoprintmaking involves exposing a light-sensitive emulsion or film to ultraviolet light through a transparent support containing an opaque image to transfer the image to a plate. The transparency through which the photoemulsions are developed can include drawings on a transparent support such as Mylar or acetate, or photographic images processed on graphic arts film to yield a positive image. Several photoprintmaking methods will be discussed.

Photolithography

Photolithography involves transferring graphic images to stones or metal plates that are coated with a light sensitive emulsion. One can coat the stone or metal plate, or use presensitized metal plates. Light sensitive emulsions used on stone consist of a mixture of powdered albumin, ammonium dichromate, water, and ammonia; commercial emulsions are usually based on diazo compounds. Developing solutions for these mixtures often contain highly toxic solvents. Diazo-sensitizing solutions, developers with highly toxic solvents, plate conditioners containing strong alkali, and other brand name mixtures are used for metal plates.

Hazards

1. Diazo photoemulsions are the least hazardous although they can cause eye irritation.
2. Ammonium dichromate used for stone is a probable human carcinogen, is moderately toxic by skin contact, and may cause allergies, irritation, and external ulcers; it is highly flammable and a strong oxidizer.

3. Ammonia is a skin irritant and highly toxic by inhalation. Ammonia is highly corrosive to the eyes. It has good odor-warning properties.
4. Light exposure sources include photoflood lamps, vacuum Poly-Lite units, and carbon arcs. Carbon arcs produce large amounts of ultraviolet radiation which can cause skin and eye damage and possible skin cancer. Carbon arcs also product hazardous metal fumes, and ozone and nitrogen dioxide (which can cause emphysema), and toxic carbon monoxide.
5. Screen cleaning solutions include strong caustic solutions, enzyme detergents which can cause asthma, and chlorine bleach. These are skin and respiratory irritants.
6. Many solvents used in developing solutions are highly toxic both by inhalation and skin absorption.

Precautions

1. Obtain a MSDS for all materials used.
2. See Solvents section for more precautions with solvents.
3. Avoid ammonium dichromate and use presensitized plates if possible. If you cannot substitute, wear gloves and goggles. Store is away from heat, solvents and other organic materials.
4. Use ammonia solutions or solvent-containing photolithographic solutions inside a laboratory hood, or in front of a slot exhaust hood. Wear gloves, goggles, and if ventilation is inadequate, use of a respirator may be necessary. REHS must be contacted prior to use for instruction on required protocols for using and purchasing a respirator.
5. Do not use carbon arcs unless they are equipped with local exhaust ventilation exhausted to the outside. Quartz mercury or metal halide lamps are safer.
6. Wear gloves, goggles and plastic apron or laboratory coat when mixing hazardous chemicals.

Photoetching

Photoetching is usually done using the KPR products. Photoresist dyes ofter contain a variety of highly toxic solvents, including ethylene glycol monomethyl ether acetate (2-ethoxyethyl acetate, cellosolve acetate), ethylene glycol monoethyl ether, and xylene, and benzaldehyde. The developers contain xylene and ethylene glycol monomethyl ether acetate (2-methoxyethyl acetate or methyl cellosolve acetate). Developers used for safer presensitized plates also contain solvents. Exposure of the plate is done with ultraviolet sources such as carbon arcs, mercury lamps, or metal halide lamps.

Hazards

1. See the Solvents section for the hazards of various solvents. In particular, methyl and ethyl ether acetates of ethylene glycol are highly toxic by skin absorption and inhalation and can cause anemia, kidney damage, testicular atrophy and sterility in men, and miscarriages and birth defects in pregnant women.
2. Xylene is moderately toxic by skin absorption, and highly toxic by inhalation and ingestion. It is a strong narcotic.
3. The Photolithography section discusses carbon arc hazards.

Precautions

1. See Solvents section for precautions with solvents.
2. Pregnant or nursing women, children, and men trying to conceive should not work with these materials.
3. Use photofloods or other light sources instead of carbon arcs. Precautions with carbon arcs is discussed in the Photolithography section.
4. Use presensitized plates if possible.
5. Use photoresist solutions with local exhaust ventilation, or use of a respirator may be necessary. REHS must be contacted prior to use for instruction on required protocols for using and purchasing a respirator.

SECTION 14: Sculpture

Many artists work with traditional sculptural materials including plaster, stone, lapidary, clay, wax, and modeling materials. See ceramics for information on some other sculpting media.

Plaster and Plaster Molds

Plaster can be carved, modeled, and casted. Varieties of plaster include: Plaster of Paris, casting plaster, white art plaster, molding plaster, and Hydrocal. These are all varieties of calcined gypsum, composed of calcium sulfate. Mold releases used with plaster include Vaseline, tincture of green soap, auto paste wax-benzene, silicone-grease benzene, and mineral oil petroleum jelly. In waste molding, the plaster mold is chipped away.

Hazards

1. Plaster dust (calcium sulfate) is slightly irritating to the eyes and respiratory system. In situations where there is heavy inhalation of the dust, more severe respiratory problems can result.
2. Potassium sulfate and potassium alum are slightly toxic by ingestion; potassium alum is slightly toxic by skin contact, and can cause mild irritation or allergies in some people.
3. Borax is moderately toxic by ingestion, by inhalation, and by absorption through burns or other skin injuries. It is also slightly toxic by skin contact, causing alkali burns.
4. Concentrated acetic acid is highly corrosive by ingestion, inhalation, and skin contact.
5. Burnt lime (calcium oxide) is moderately corrosive by skin contact (especially if the skin is wet), and highly toxic by inhalation or ingestion.
6. Careless use and storage of sharp tools can cause accidents. Chipping set plaster can result in eye injuries from flying chips.
7. Benzene used with many mold releases is moderately toxic by skin contact and inhalation, and is highly toxic by ingestion. It is also flammable.
8. Making plaster casts of hands, legs, and other body parts can be very hazardous doe to the heat released during the setting process.

Precautions

1. Wear gloves and goggles when mixing acetic acid and burnt lime.
2. Always carve or cut in a direction away from you, and keep hands behind the tool. If the tool falls, don’t try to catch it.
3. Wear safety goggles when chipping plaster.
4. Wear gloves and goggles when pouring benzene. Store in safety containers and do not use near open flames.
5. Do not use plaster for body part casts. Instead, use a plaster-impregnated bandage (such as Johnson and Johnson’s Pariscraft), along with Vaseline or similar mold release as protection.

Stones and Lapidary

Stone carving involves chipping, scraping, fracturing, flaking, crushing, and pulverizing with a wide variety of tools. Soft stones can be worked with manual tools whereas hard stones require crushing and pulverizing with electric and pneumatic tools. Crushed stone can also be used in casting procedures.

Soft stones include soapstone (steatite), serpentine, sandstone, African wonderstone, greenstone, sandstone, limestone, alabaster, and several others. Hard stones include granite and marble. Electric tools include saws, drills, grinders, and sanders, and pneumatic tools include rotohammers, drills, and other tools powered by compressed air. **Stone casts** can be made using Portland cement, sand and crushed stone. Marble dust is often used with this technique. Cast concrete sculptures can also be made using sand and Portland cement. **Lapidary** involves cutting and carving semiprecious stones and has similar risks as hard stone carving. Stones carved include garnet, jasper, jade, agate, travertine, opal, turquoise and many others.

Stones can be finished by grinding, sanding, and polishing, by either hand or with machines. Polishing can use a variety of materials, depending on the hardness of the stone being polished. Polishing materials include carborundum (silicon carbide), corundum (alumina), diamond dust, pumice, putty powder (tin oxide), rouge (iron oxide), Tripoli (silica), and cerium oxide.

Hazards

1. Sandstone, soapstone, and granite are highly toxic by inhalation because they contain large amounts of free silica. Limestone containing small amounts of free silica, is less hazardous.
2. Serpentine, soapstone, and greenstone may contain asbestos, which can cause asbestosis, lung cancer, mesothelioma, and stomach and intestinal cancers.
3. During chipping and other carving, flying chips and pieces of rock may cause eye injury. Grinding and sanding can release small pieces of stone and dust which are hazardous to the eyes.
4. Lifting heavy pieces of stone may cause back injuries.
5. Power tools create larger amounts of fine dust than hand tools. Pneumatic tools can create large amounts of fine silica dust.
6. Vibration from pneumatic equipment can cause Raynaud's phenomenon, ("white fingers" or "dead fingers") a circulation disease. The hazard is greater with exposure to cold, (e.g.the air blast from pneumatic tools). This temporary condition can spread to the whole hand and cause permanent damage.
7. Calcium oxide in Portland cement is highly corrosive to the eyes and respiratory tract, and is moderately corrosive to the skin. Allergic dermatitis can also occur due to chromium contaminants in the cement. The silica in the cement is also highly toxic by inhalation. Lung problems from inhalation of Portland cement include emphysema, bronchitis and fibrosis.
8. Acrylic resins are skin irritants and sensitizers.
9. The dust from quartz gemstones such as agate, amethyst, onyx and jasper is highly toxic because they are made of silica. Other gemstones such as turquoise and garnet may be contaminated with substantial amounts of free silica. Opal is made of amorphous silica, which is slightly toxic by inhalation.
10. Grinding and sanding, especially with machines can create fine dust from the stone which is being worked. There are also inhalation hazards from grinding wheel dust (especially

sandstone wheels). Some polishing materials such as Tripoli are highly toxic if inhaled in powder form.

Precautions

1. Do not use stones which may contain asbestos unless you are certain that your particular pieces are asbestos free. New York soapstones may contain asbestos, whereas Vermont soapstones are usually asbestos free. Alabaster is a substitute.
2. Wear chipping goggles to protect against flying particles; wear protective shoes to protect against falling stones. Wear approved safety goggles when grinding, sanding, or polishing. For heavy grinding also wear a face shield.
3. When using carving tools, keep your hands behind the tools, and carve or cut in a direction away from you. Don't try to catch falling tools.
4. Use proper lifting techniques (bent knees).
5. Protect against vibration damage from pneumatic tools by measures such as having comfortable hand grips, directing the air blast away from your hands, keeping hands warm, taking frequent work breaks, and using preventive medical measurers such as massage and exercises.
6. Tie long hair back, and don't wear ties, jewelry, or loose clothing which can get caught by machinery.

MODELING MATERIALS

See Section 12 for information about clay compounds. Modeling clays of the plasticine type usually contain China clay in an oil and petrolatum base. Additives are often present, including dyes, sulfur dioxide, vegetable oils, aluminum silicate, preservatives, and turpentine. These are modeled and carved with simple tools. There are also a variety of polymer clays that are self hardening, or over-hardening (e.g. FIMO, Sculpey), which are not really clays at all. These are often based on polyvinyl chloride.

Hazards

1. Some of the additives in plasticine clays such as turpentine and preservatives might cause skin irritation or allergies, and sulfur dioxide might cause some respiratory problems in certain asthmatics. The amounts present are usually small.
2. The curing temperatures of different product are not the same, and in some cases, very close to the temperatures at which decomposition can occur.

Precautions

1. Use gloves or apply a barrier cream to hands if skin irritation results from using plasticine modeling clays. Wash hands with soap and water after contact.
2. Obtain the Material Safety Data Sheet (MSDS) from the manufacturer or supplier, and make sure the temperature of decomposition is not reached.

Wax

Many different types of waxes are used for modeling, carving, and casting. These include beeswax, ceresin, carnauba, tallow, paraffin, and micro-crystalline wax. In addition there are the synthetic chlorinated waxes. Solvents used to dissolve various waxes include alcohol, acetone, benzene, turpentine, ether, and carbon tetrachloride. Waxes are often softened for carving or modeling by heating in a double boiler or with a light bulb, by sculpting with tools warmed over an alcohol lamp, or by the use of soldering irons, alcohol lamps, and blowpipes. Wax can be melted for casting in a double boiler. Additives used with waxes include rosin, dyes, petroleum jelly, mineral oil, and many solvents.

Hazards

1. Overheating wax can result in the release of flammable wax vapors, a well as in the decomposition of the wax to release acrolein fumes and other decomposition products which are highly irritating by inhalation. Explosions have occurred from heating wax that contained water.
2. Alcohol and acetone are slightly toxic solvents by skin contact and inhalation; benzene and turpentine are moderately toxic by skin contact, inhalation, and ingestion. Carbon tetrachloride is extremely toxic, possibly causing liver cancer and severe liver damage, even from small exposures. Exposure to carbon tetrachloride can be fatal by skin absorption or inhalation.
3. Chlorinated synthetic waxes are highly toxic by skin contact and skin absorption, causing a severe form of acne (chloracne). Some may be contaminated with polychlorinated biphenyls (PCBs), which are highly toxic, causing chloracne, liver problems, and possibly cancer of the pancreas and melanoma (a fatal form of skin cancer).

Precautions

1. Do not overheat waxes. Use a double boiler and a temperature-controlled hot plate, or a crock pot. Do not use an open flame to melt waxes.
2. Use the least hazardous solvent to dissolve your wax. Do not use carbon tetrachloride under any circumstances. Store solvents safety, do not smoke or have open flames near solvents. Dispose of solvent-soaked rags in an approved waste disposal container which is emptied daily.
3. Do not use chlorinated synthetic waxes.

WOODWORKING

Wood sculpture uses a large number of different types of hard and soft woods, including many exotic tropical woods. Many of these woods are hazardous themselves. Sometimes woods are treated with hazardous preservatives or pesticides.

Hazards

1. Saps present in many green woods, and lichens and liverworts present on the surface of freshly cut wood, can cause skin allergies and irritation from direct contact.
2. Many hardwood dusts, especially those from exotic woods, are common sensitizers and can cause allergic skin reactions. Some hardwoods can cause allergic reactions in individuals working with or using finished hardwoods. Softwoods do not cause as high a frequency of skin and respiratory problems as do hardwoods. A few individuals can develop allergic reactions to some softwoods.

3. Contact with the dust of many hardwoods can cause conjunctivitis (eye inflammation), hay fever, asthma, coughing, and other respiratory diseases. Canadian and Western Red Cedar are examples.
4. Some hardwoods can cause hypersensitivity pneumonia (alveolitis), and frequent attacks can cause permanent lung scarring (fibrosis). Examples of these highly toxic woods include giant sequoia, cork oak, some maple woods and redwood.
5. Some hardwoods contain chemicals that are toxic, and can cause a variety of symptoms, including headaches, salivation, thirst, giddiness, nausea, irregular heartbeat, etc. A classic example is hemlock.
6. Inhalation of hardwood dust is associated with a particular type of nasal and nasal sinus cancer (adenocarcinoma). This type of cancer has a latency period of 40-45 years, and occurs to the extent of about 7 in 10,000 among woodworkers who are heavily exposed. This rate is many times higher than the rate of nasal adenocarcinoma in the general population. Over half of all known cases of this type of cancer are found in woodworkers.

Precautions

1. Whenevr possible, use common hardwoods rather than rare tropical hardwoods.
2. If you have a history of allergies, you should avoid common sensitizing woods.
3. If you are handling woods that can cause skin irritation or allergies, wear gloves.

Plywood and Composition Board

Plywood is made by gluing thin sheets of wood together with either urea-formaldehyde glues (for indoor use) or phenol-formaldehyde glues (for outdoor use). Composition board, for example particle board, is made by gluing wood dust, chips, etc. together with urea-formaldehyde resins. The materials can emit unreacted formaldehyde for some years after manufacture, with composition board emitting more formaldehyde. In addition, heating these materials or machining them can cause decomposition of the glue to release formaldehyde.

Hazards

1. Formaldehyde is highly toxic by inhalation, highly toxic by eye contact and ingestion, and moderately toxic by skin contact. It is an irritant and strong sensitizer. Formaldehyde is a probable human carcinogen. Even trace amounts of free formaldehyde may cause allergic reactions in people who are already sensitized to it.
2. Machining, sanding, or excessive heating of plywood or composition board can cause decomposition releasing formaldehyde, carbon monoxide, hydrogen cyanide (in the case of amino resins) and phenol (in the case of phenol-formaldehyde resins).

Precautions

1. Use low-formaldehyde products whenever possible. There are particle boards that are made without formaldehyde, but these are very expensive.
2. Do not store large amounts of plywood or composition board in the shop since it will emit formaldehyde. Instead store in a ventilated area where people do not work.

Wood Preservatives and Other Treatments

Pesticides and preservatives are often applied to wood when it is being timbered, processed or shipped. Unfortunately, it is hard to find out what chemicals, if any have been added. This is especially a problem with imported woods, since pesticides and wood preservatives banned in the United States and Canada are often used in other countries. Pentachlorophenol and its salts, creosote, and chromate copper arsenate (CCA) have been banned for sale in the United States as wood preservatives because of their extreme hazards. They can, however still be found in older woods and chromate copper arsenate is still allowed as a commercial treatment (e.g. "green" lumber, playground equipment, and other outdoor uses). It is supposed to be labeled. A variety of other chemicals can be used in treating wood including fire retardants, bleaches, etc.

Hazards

1. Pentachlorophenol is highly toxic by all routes of entry. It can be absorbed through the skin, cause chloracne (a severe form of acne) and liver damage, and is a probable human carcinogen and reproductive toxin.
2. Chromated copper arsenate is extremely toxic by inhalation and ingestion, and highly toxic by skin contact. It is a known human carcinogen and teratogen. Skin contact can cause skin irritation and allergies, skin thickening and loss of skin pigmentation, ulceration, and skin cancer. Inhalation can cause respiratory irritation, and skin, lung and liver cancer. Inhalation or ingestion may cause digestive disturbances, liver damage, peripheral nervous system damage, and kidney and blood damage. Acute ingestion may be fatal.
3. Creosote has a tarry look, and is also used for outdoor wood. It is a strong skin and respiratory irritant, and is a probable human carcinogen and teratogen.
4. Zinc and copper naphthenate are slight skin irritants; copper naphthenate is moderately toxic by ingestion. If suspended in solvents, the solvent would be the main hazard.

Precautions

1. Obtain Material Safety Data Sheets on all chemicals being used in wood treatment. Treated wood itself does not have Material Safety Data Sheets, so you have to try and find out about any treatments from the supplier. In the United States, CCA-treated wood is required to have a label and information on safe handling.
2. Do not handle woods that have been treated with pentachlorophenol or creosote. Avoid scrap or old woods of unknown origin.
3. If you add wood preservatives yourself, use zinc or copper naphthenates, if possible.
4. Do not burn wood that has been treated with creosote, pentachlorophenol or chromated copper arsenate.

Carving and Machining Wood

Wood can be hand carved with chisels, rasps, files, hand saws, sandpaper, and the like, or they can be machined with electric saws, sanders, drills, lathes and other woodworking machines.

Hazards

1. Woodworking machinery and tools also present physical hazards from accidents. Machinery accidents are often due to missing machine guards, faulty equipment, or using

the wrong type of machine for a particular operation. Tool accidents are often caused by dull tools or improper use.

2. Vibrating tools, for example chain saws, can cause “white fingers” (Raynaud’s phenomenon) involving numbness of the fingers and hands. This can lead to permanent damage.
3. Electrical equipment can also present electrical shock and fire hazards from faulty or inadequate wiring.
4. Sawdust and wood are fire hazards. In addition, fine sawdust is an explosion hazard if enclosed.

Precautions

1. Wear goggles when using machines that create dust. For lathes and similar machines which may product wood chips, use a face shield and goggles, and make sure the machines are properly shielded.
2. Be sure that all woodworking machines are equipped with proper guards to prevent accidents. Use the proper machine for particular operations and repair defective machines immediately. Do not wear ties, long loose hair, loose sleeves, necklaces, long earrings or other items that could catch in the machinery.
3. Keep hand tools sharpened, and cut away from your body. Do not place your hands in front of the tool.

Gluing Wood

A variety of glues are used for laminating and joining wood. These include contact adhesives, casein glue, epoxy glues, formaldehyde-resin glues (e.g. formaldehyde-resorcinol), hide glues, and white glue (polyvinyl acetate emulsion), and the cyanoacrylate “instant” glues.

Hazards

1. Epoxy glues are moderately toxic by skin and eye contact, and by inhalation. Amine hardeners (as well as other types of hardeners) can cause skin allergies and irritation in a high percentage of the people using them. Inhalation can cause asthma and other lung problems.
2. Cyanoacrylate glues: These are moderately toxic by skin or eye contact. They can glue the skin together or glue the skin and other materials together, sometimes requiring surgical separation. Eye contact can cause severe eye irritation. Their long term hazards are not well studied, especially with respect to inhalation.
3. Formaldehyde-resin glues: Resorcinol-formaldehyde and urea-formaldehyde glues are highly toxic by eye contact and by inhalation, and moderately toxic by skin contact. The formaldehyde can cause skin and respiratory irritation and allergies, and is a known human carcinogen. The resin components may also cause irritation. Even when cured, any unreacted formaldehyde may cause skin irritation and sanding may cause decomposition of the glue to release formaldehyde. Formaldehyde can be a problem when working with fiber-board and plywood.
4. Contact adhesives: Extremely flammable contact adhesives contain hexane, which is highly toxic by chronic inhalation, causing peripheral nerve damage. Other solvents in contact adhesives are mineral spirits or naphtha, and 1,1,-trichloroethane (methyl chloroform), which are moderately toxic by skin contact, inhalation and ingestion.

5. Water-based glues: Water based contact adhesives, casein glues, hide glues, white glue (polyvinyl acetate), and other water based adhesives are slightly toxic by skin contact, and not significantly or only slightly toxic by inhalation or ingestion.
6. Dry casein glues: These are highly toxic by inhalation or ingestion and moderately toxic by skin contact since they often contain large amounts of sodium fluoride and strong alkalis.

Precautions

1. Avoid formaldehyde resin glues because of allergic reactions and the carcinogenicity of formaldehyde.
2. Use water-based glues rather than solvent-type glues whenever possible.
3. Wear gloves or barrier creams when using epoxy glues, solvent –based adhesives, or formaldehyde-resin glues.

SECTION 15: Stage and Theatre Safety

Set Design & Construction

Props and Decoration

Decorative materials include curtains, draperies, streamers, fabrics, cotton batting, straw, hay, vines, leaves, stalks, tress and moss. Decorative materials may be used only if they are noncombustible or flame resistant or have been rendered so with commercially available products. Contact the Fire Safety Division in New Brunswick at (732) 445-5325 if you have any questions about the approved use of decorative materials.

Power and Hand Tools

Crewmembers should use a power tool only after receiving proper training. Stage managers should review the operation of the equipment making sure to point out safety features and guards. This hands on training should be documented and the record is to be maintained. Crewmembers should be familiar with the owner's manual for the tool, and should know both the use and the limitations of a power tool.

Some guidelines for using tools include:

- Inspect tools before use to check for any defects such as frayed wires, or damaged hand tools. Remove defective tools from service and have repaired or replaced.
- Only use power tools that are grounded with a 3-pronged plug or that are double insulated.
- Never carry a power tool by its cord.
- Unplug power tools before loading them, changing blades or bits, making adjustments, or cleaning them – and follow the manufacturer's instructions.
- Never use power tools on wet surfaces or in wet weather.
- Discontinue use of defective or unsafe equipment as soon as the defect becomes known.
- Dull tools are unsafe and can damage work. Maintain your tools and always use sharp cutting blades.
- Never alter or remove any machine or blade guards.

Rigging

Some guidelines for rigging are as follows:

1. Anything attached to a flybar must have a safety cable attached as well.
2. Make sure the rope or cord is strong enough for what you are lifting and that the rope or cord is not frayed or damaged in any way.
3. Warn people on the stage or grid before moving any rigged scenery or other objects.
4. Maintain visual contact with a moving piece at all times.
5. Rigging should also be inspected by the production crew before each use.

Ladders

Portable ladders should be inspected at frequent, regular intervals and maintained in good condition free from oil, grease, or other slippery materials. Defective ladders should be removed from service until repaired. Those that cannot be repaired should be destroyed.

Ladders should always be placed on stable bases and, whenever possible, should be secured near the top and at the bottom. Boxes, barrels, or other unstable surfaces should never be used to extend the reach of a ladder.

Housekeeping

Work areas can become congested while set building and rehearsals take place. Clutter makes it difficult to move around and can be a fire hazard. To prevent accumulation of materials, trash should be removed daily.

1. Place trash in proper receptacles, preferable in metal containers.
2. Clean up after each work session. Avoid accumulating scrap lumber and materials.
3. Purchase materials as needed to avoid the need for additional storage.
4. Store tools in the proper areas when not in use.

Storage of Materials

The proper storage of materials in theater spaces is extremely important to the efficiency of the production and the safety of the cast, crew and audience. The NJ Uniform Fire Code mandates certain storage requirements, such as:

1. Flammable and combustible liquids must be stored in approved flammable storage cabinets.
2. If the building has sprinklers, materials must be a minimum of 18 inches below sprinkler head. Materials in any building must be a minimum of 24 inches below the ceiling.
3. Materials must never obstruct an exit from the building.
4. Stored materials must be a minimum of three feet in all directions from unit heaters, duct furnaces and flues.
5. Smoking is prohibited in all places of assembly and in spaces where combustible materials are stored or handled.
6. Materials may not be stored under seating risers or steps.

Lifting and Material Handling

Back pain and injuries related to lifting and material handling are some of the most frequent types of injuries. While some factors that contribute to the potential for injury cannot be controlled, other can be reduced or minimized. Stage pieces are often awkward, heavy, or unusually shaped, which impedes proper lifting techniques.

Before lifting plant to:

1. Perform stretching exercises and warm-ups prior to lifting – Warming up your back muscles can help reduce the stress of an initial lift.
2. Use the right personal protective equipment
    - Some work gloves offer non-slip grips to handle a load easier.
    - Wear non-slip shoes to avoid a fall while carrying a load.
3. Take time to size up the load – Is it too large or heavy for one person to lift? Will you be able to get through doorways and corridors as you are carrying it? Can it be broken down into several trips?
4. Plan your route ahead of time – Make sure there is a clear path to avoid tripping hazards. Be able to see where you are going and avoid sharp turns or difficult courses.

Proper lifting techniques

- Stand close to the load – Carrying an object as close to your body as possible will keep the strain on your back at a minimum and will also help keep your center of gravity over your feet to maintain balance.
- Bend your knees – Your leg muscles are much more equipped to handle heavy loads than your back muscles. Bending your knees will allow you to lift with your legs and reduce the load on your lower back.
- Grip the load securely – Get a secure handle on the object before you lift to avoid slipping. If a load does start to fall away from you, let it go. You can do enormous damage to your back if you attempt to catch a heavy object in an awkward position.
- Lower the load in reverse – All the effort put into a proper lift will be erased if the load is lowered by bending at the waist and putting pressure on the back.

Back belts provide no protection from back injuries. REHS does not recommend the use of back belts for such purposes.

APPENDIX A: References and Resources

References

The sections on specific art hazards are based on the following resources:

- Section 10 is based on *Art Painting and Drawing* by Angels Babin, M.S.
- Section 11 is based on *Photographic Processing Hazards* by Michael McCann, Ph.D., CIH
- Section 12 is based on *Ceramics* by Michael McCann, Ph.D., CIH
- Section 13 is based on *Lithography, Intaglio and Relief Printing* by Angela Babin, M.S.; Michael McCann, Ph.D., CIH; and Devora Neumark
- Section 14 is based on *Woodworking Hazards and Traditional Sculpting Hazards* both by Michael McCann, Ph.D., CIH and Angela Babin, M.S.

Resources

Web Sites

- Center for Safety in the Arts
  http://artsnet.heinz.cmu.edu:70/0/csa
- ACTS: Arts, Crafts and Theater Safety
  http://www.caseweb.com/acts/
- Princeton University Theater Operations Manual
  http://www.princeton.edu/-ehs/theater/Title.html

Books

- *The Artist's Complete Health and Safety Guide*, Monona Rossol, MS, MFA
- *Artist Beware* – Michael McCann, Ph.D., CIH
- *Overexposure*: Photography Hazards – Susan Shaw and Monona Rossol
- *Making Art Safely* – M. Spandorfer, D. Curtiss, J. Snyder, MD
- *Stage Fright*: Health & Safety in Theater – Monona Rossol, MS, MFA
- *Health Hazards Manual for Artists* – Michael McCann, Ph.D., CIH