Section 1: Pottery/Ceramic Art

The four main hazards and precautions when working with pottery/ceramics are:

- working with clay
- glazing and coloring
- firing in a kiln
- 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

- 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.
- Chronic inhalation of kaolin is moderately hazardous, and can result in kaolinosis, a disease in which the lungs become mechanically clogged.
- Asbestos is extremely toxic by inhalation and possibly by ingestion. Asbestos inhalation may cause asbestosis, lung cancer, mesothelioma, stomach cancer, and intestinal cancer.
- Sand, perlite, grog, and vermiculite contain free silica and are, therefore, highly toxic by inhalation. Vermiculite is also frequently contaminated with asbestos.
- There is a danger of accidents if clay or water can be added while the mixer is in operation.
- Bags of clay and glaze materials can be very heavy, and lifting can cause back problems.
• 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.
• 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.
• Hand contact with wet clay can result in abrasion and dryness of fingertips and hands. Moving parts of kickwheels can cause cuts and abrasions.
• 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
• Use premixed clay to avoid exposure to large quantities of clay dust.
• 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.
• All clay mixers should be equipped with local exhaust ventilation to remove fine silica dust particles from the air.
• 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.
• 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.
• Avoid contact of clay with broken skin. Use a skin moisturizer.
• 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.
• Keep wrists in unflexed position as much as possible to prevent carpel tunnel syndrome. Take frequent work breaks.
• Be careful of the moving parts on kickwheels.
• Recondition clay by cutting still-wet clay into small pieces, letting them air-dry, and soak in water.
• Finish green ware while still wet or damp with a fine sponge instead of sanding when dry. Do not sand greenware containing fibrous talc.
• 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. Many cases of lead poisoning were reported in British potters during the ninth century. 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 resinesates 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

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.

Lead-glazed foodware can leach lead if not fired properly, or if the glaze 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.

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 and may contain lead. Adequate control over firing conditions is very difficult in the craft studio.

- Other fluxes such as barium and lithium are also highly toxic by inhalation, but less so than lead.
- Certain colorant compounds of particular metals are known or probable human carcinogens, including: arsenic, beryllium, cadmium, chromium (VI), nickel, and uranium.
- Antimony, barium, cobalt, lead, lithium, manganese, and vanadium colorant compounds are highly toxic by inhalation.
- Antimony, arsenic, chromium, vanadium, and nickel compounds are moderately toxic by skin contact.
• 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.

• Soda ash, potassium carbonate, alkaline feldspars, and fluorspar used in glazes are skin irritants.

• Spray application of glazes is very hazardous because of the potential inhalation of glaze mists.

• Dipping, pouring, and brushing certain glazes may cause skin irritation and accidental ingestion due to careless personal hygiene habits.

• Glazes containing solvents are both flammable and hazardous.

Precautions

• Use lead-free glazes. If the glaze does not state "lead-free" or "leadless" on the label, assume it contains lead until proven otherwise.

• 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.

• 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.

• 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.

• Gloves should be worn while handling wet or dry glazes.

• Good dilution ventilation or local exhaust ventilation should be available when applying solvent-containing glazes.

• Basic personal hygiene rules should be followed including restricting eating, drinking in the studio, and wearing personal protective equipment such as gloves, and separate work clothes or coveralls. Wash hands after work. Leftover glazes and glaze scrapings can be homogenized, combined, tested, and used as a glaze.

• Smoking is prohibited in both indoor and outdoor studios.

Kilns

Electric kilns and gas-fired kilns are used to heat the pottery to the desired firing temperature. The most common type are HACC are the gas kilns. Gas-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.

Electric Kilns use heating elements that heat the kiln as electric current passes through the coils. The temperature rises until the kiln is shut off.
Firing temperatures can vary from as low as 1,382°F for raku and bisque wares, to as high as 2,372 °F for stoneware, and 2,642 °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

- 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.

- Many metal fumes generated at high temperatures are highly toxic by inhalation. Since lead vaporizes at a relatively low temperature, it is especially hazardous.

- 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, unrelietable by analgesics.

- 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.

- 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.

- Heat produced by even small electric kilns can cause fires in the presence of combustible materials or flammable liquids.

- 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

- 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.
• Do not use lead compounds at stoneware temperatures since the lead will vaporize.

• Lumber, paper, solvents, or other combustible and flammable materials should not be stored in kiln areas.

• Always check that the kiln has shut off.

• 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 Security (x2568).

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**

• 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.

• Hydrogen chloride and water vapor form hydrochloric acid, which can corrode metal fittings in the area.

**Precautions**

• Substitute safer sodium carbonate for sodium chloride.

• 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.

• 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**

• See above for the hazards and safety precautions used with gas kilns.

• The reduction step produces large amounts of smoke and carbon monoxide.

• Treated wood or other materials can yield an exposure to highly toxic preservatives or pesticides, such as arsenic and chromium compounds.
Precautions

- Raku should only be done outdoors because of smoke. Be careful to not locate raku near air intakes or open windows of buildings.

- Do not use materials that have been treated with preservatives or pesticides for the reduction phase.

Caution: Leaching of Lead Ceramic Ware

Lead Leaching

There is a real concern about lead leaching into food and drink from pottery fired with lead glazes. Both the US 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 stating:

"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 produced by HACC for retail finished with lead glazes will 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 2: Photography

Black and White Photo-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 Photo-chemicals

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

Hazards

- 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.

- 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

- Use liquid chemistry whenever possible, rather than mixing developing powders. Pregnant women, in particular, should not be exposed to powdered developer.

- When mixing powdered developers, use a glove box (a cardboard box with glass or plexiglas top, and two holes in the sides for hands and arms), local exhaust ventilation, consult EHS before wearing a NIOSH-approved dust respirator.

- Wear gloves, goggles and protective apron when mixing concentrated photo-chemicals. Always add any acid to water, never the reverse.

- In case of skin contact, rinse with lots of water. In case of eye contact, rinse for at least 15-20 minutes, preferably using an eyewash station, seek medical attention.

- 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.

- Do not store photographic solutions in glass containers
Developing Baths

The most commonly used developers are hydroquinone, monomethyl para-amo-o phenol 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

- Developers are skin and eye irritants, and in many cases strong sensitizers. Monomethyl-p-aminophenol 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.

- 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. Symptoms 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.

- 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.

- 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.

- 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

- 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

- See the section on Mixing Photochemicals for mixing precautions.

- 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 15-20 minutes and seek medical attention.

- Do not use para-phenylene diamine or its derivatives if at all possible.
**Stop Baths and Fixers**

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 bisulfite as a preservative. Fixing baths also may also contain alum (potassium aluminum sulfate) as a hardener and boric acid as a buffer.

**Hazards**

- 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 bronchitis.

- Potassium chrome alum or chrome alum (potassium chromium sulfate) is moderately toxic by skin contact and inhalation, causing dermatitis and allergies.

- 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.

- Sodium bisulfite 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.

- Alum (potassium aluminum sulfate) is only slightly toxic. It may cause skin allergies or irritation.

- 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**

- All darkrooms require good ventilation to control the level of acetic acid vapors and sulfur dioxide gas produced in photography.

- Wear gloves and goggles.

- 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 be done historically with iodine/potassium cyanide, ammonium persulfate, and potassium permanganate/sulfuric acid.

**Hazards**

- 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.

- Concentrated hydrochloric acid is corrosive; the diluted acid is a skin and eye irritant.

- 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.

- 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.

- 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.

- Potassium permanganate and ammonium persulfate are strong oxidizers and may cause fires or explosions in contact with solvents and other organic materials.

**Precautions**

- 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. Mix the powders in a glove box or wear a NIOSH-approved toxic dust respirator. Do not expose potassium chlorochromate to acid or heat.

- Do not use mercury, cyanide or uranium intensifiers, or cyanide reducers because of their high or extreme toxicity.

- 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 chemicals are also used in the toning solutions.

**Hazards**

- Sulfides release highly toxic hydrogen sulfide gas during toning, or when treated with acid.
- 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.
- Gold and platinum salts are strong sensitizers and can produce allergic skin reactions and asthma, particularly in fair-haired people.
- Thiourea is a probable human carcinogen since it causes cancer in animals.

**Precautions**

- 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.
- Toning solutions must be used with local exhaust ventilation.
- 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.
- 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.
- Concentrated sulfuric acid, mixed with potassium permanganate or potassium dichromate, produces highly corrosive permanganic and chromic acids.
- Hypochlorite bleaches can release highly toxic chlorine gas when acid is added, or if heated.
- 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

- See previous sections for precautions in handling photographic chemicals.
- Cleaning acids should be handled with great care. Wear gloves, goggles and acid-proof, protective apron. Always add acid to the water when diluting.
- Do not add acid to, or heat, hypochlorite bleaches.
- Keep potassium persulfate and other strong oxidizing agents separate from flammable and easily oxidizable substances.
- Install ground fault interrupters 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

- See the developing section of black and white processing for the hazards of standard black and white developers.
- In general, color developers are more hazardous than black and white developers. Para-phenylene 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.
- Most amines, including ethylene diamine, tertiary-butylamine borane, the various ethanolamines, etc. are strong sensitizers, as well as skin and respiratory irritants.
- 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

- Wear gloves and goggles when handling color developers. Wash gloves with an acid-type hand cleaner (e.g. pHisoderm (R)), and then water before removing them.
- Mix powders in a glove box, or wear a NIOSH-approved toxic dust respirator.
- 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

- 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.
- Succinaldehyde is similar in toxicity to formaldehyde, but is not a strong sensitizer or carcinogen.
- 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.
- Concentrated acids, such as glacial acetic acid, hydrobromic acid, sulfamic acid and p-toluenesulfonic acids are corrosive by skin contact, inhalation and ingestion.
- 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.
- Potassium ferricyanide will release hydrogen cyanide gas if heated, if hot acid is added, or if exposed to strong ultraviolet radiation.

Precautions

- Local exhaust ventilation is required for mixing of chemicals and color processing.
- Use premixed solutions whenever possible.
- Avoid color processes using formaldehyde, if possible.
- 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.
• A water rinse step is recommended between acid bleach steps and fixing steps to reduce the production of sulfur dioxide gas.

• Do not add acid to solutions containing potassium ferricyanide or thiocyanate salts.

• Control the temperature carefully according to manufacturer's recommendations to reduce emissions of toxic gases and vapors.

Disposal of Photo-chemicals

There is considerable environmental and health concern about the effect of dumping photographic chemicals and solutions down the drain. Please contact EHS x:1567 for proper disposal methods.

• 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.

• 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 (pH 7).

• Stop bath left over from neutralization of developer can be poured down the drain, once mixed with wash water.

• 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.

• 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 3: 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 the pre-labeled containers supplied by the Art Department. Keep containers sealed or covered with foil 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 are 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 products, and will be discussed more thoroughly in the section below on pastels.

**Pigments vs. Hues**

Most paints used at HACC 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**

- 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.

- 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)

- 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.

- Chromate pigments (chrome yellow and zinc yellow) may cause skin ulceration and allergic skin reactions (such as rashes).

- The long-term hazards of the modern synthetic organic pigments have not been well studied.

1. **Highly Toxic Pigments**

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

2. Moderately Toxic Pigments

- alizarin crimson
- carbon black
cerulean blue (cobalt stannate)
cobalt blue (cobalt stannate)
cobalt green (calcined cobalt, zinc and aluminum oxides)
chromium oxide green (chromic oxide)
Phthalo blue and greens (copper phthalocyanine)
manganese blue (barium manganate, barium sulfate)
Prussian blue (ferric ferrocyanide)
toluidine red and yellow (insoluble azo pigment)
viridian (hydrated chromic oxide)
zinc white (zinc oxide)

Precautions

- MSDSs are available online from any campus computer. From the HACC intranet click on MSDS SEARCH and look 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.
- Use the least toxic pigments possible. Do not use lead or carcinogenic pigments.
- Avoid mixing dry pigments whenever possible. If dry pigments are mixed, do it inside a glove box (a box with a glass or plexiglas top and holes in the sides for arms) or inside a laboratory-type fume hood.
- Wet mop and wipe all surfaces when using dry pigments.
- Avoid using dishes, containers or utensils from the kitchen to mix and store paints and pigments.
Water-based Paints

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

Hazards

- See section above for pigment hazards.

- 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.

- 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.

- 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

- See section above for precautions when mixing dry pigments.

- 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.

- If you experience eye, nose or throat irritation while using acrylics, opening a window is usually sufficient; if not try a window exhaust fan.

- If you mix casein paints using ammonium hydroxide, you will need a window exhaust fan to provide ventilation.

- 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

- See section above for pigment hazards.

- 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.

- 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.

- 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.

- 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.

- Natural resins (copal, damar, rosin, Japanese Lacquer) may cause skin irritation or allergies. Rosin dust can cause asthma.

- Encaustic involves suspending pigments in molten wax. If the wax is overheated, flammable wax vapors and wax decomposition fumes are produced, which are strong respiratory irritants.

- 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

- Whenever possible replace turpentine or ordinary mineral spirits with the less toxic odorless mineral 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).

- 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.

- 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.

- 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.

- 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).

- Wear neoprene gloves while cleaning brushes with mineral spirits or turpentine.
• Used solvent can be reclaimed by allowing the paint to settle and then pouring off the clear solvent.

• Paint can be removed from your hands with baby oil, and then soap and water.

• 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**

• 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.

• 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.

• 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.

• 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**

• See section above for precautions with pigments.

• Try to brush items rather than spraying if possible.

• Use water-based airbrushing paints and inks rather than solvent-based paints.

• Use spray cans or an airbrush in a spray booth if possible.

• If ventilation is not adequate, then respiratory protection is necessary while air brushing or spraying. Contact EHS for selection and fit-testing.

• 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

- 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.

- 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.

- Colored chalks are also considered nuisance dusts. Some chalks are dustier than others. Individuals who have asthma sometimes have problems with dusty chalks, but this is a nonspecific dust reaction, not a toxic reaction.

- 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 (lead 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.

- Crayons and oil pastels do not present an 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.

- 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.

- Never try to spray fixative by blowing air from your mouth through a tube. This can lead to accidental ingestion of the fixative.
Precautions

- Use the least dusty types of pastels, chalks, etc. Asthmatics in particular might want to switch to oil pastels or similar non-dusty media.

- Spray fixatives should be used with a spray booth that exhausts to the outside. If use of spray fixatives is occasional, you can use them outdoors with a NIOSH-approved respirator equipped with organic vapor cartridges and dust and mists filter for protection against inhalation of solvent vapors and particulates. An exhaust fan is also needed to remove organic vapors and particulates.

- 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).

- Wet-mop and wet-wipe all surfaces clean of dusts.

- If inhalation of dusts is a problem, a respirator may be appropriate. Contact EHS for selection and fitting.

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

- Drawing inks are usually water-based, but there are some solvent-based drawing inks. These usually contain toxic solvents like xylene.

- 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

- Use water-based markers and drawing inks if possible.

- Alcohol-based markers are less toxic than aromatic solvent-based markers.

- 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 4: Printingmaking

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

- 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

- Know what materials are used. Obtain the material safety data sheets (MSDSs) on all products used. Use the least toxic inks possible.
- 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).
- 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

- 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.
- 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.
- 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.
- Chromate pigments (chrome yellow and zinc yellow) may cause skin ulceration and allergic skin reactions.
- The long-term hazards of the modern synthetic organic pigments have not been well studied.
Precautions

- 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.
- Use the safest pigments possible. Avoid lead pigments.
- Avoid mixing dry pigments whenever possible. If dry pigments are mixed, consult EHS prior to wearing a NIOSH approved 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

- 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.
- Inhalation of solvent vapors is the major way in which solvents are harmful. High concentrations of most solvents can cause dizziness, nausea, fatigue, loss of coordination, or coma. This can also increase the chances for mistakes and accidents.
- Many solvents are toxic if ingested. Swallowing an ounce of turpentine can be fatal.
- Most solvents, except chlorinated hydrocarbons, are also either flammable or combustible.

Precautions

- 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.
- Use adequate ventilation.
- 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.
- Never store solvents or solvent-containing materials in food or drink containers. Always label containers.
- Do not allow smoking, open flames or other sources of ignition near solvents.
- Have a class B fire extinguisher in the area. (If ordinary combustible materials are present, you may need a Class ABC fire extinguisher).
- Wear nitrile 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. Consult EHS for the proper glove type to be worn.
Acids

Acids are used in intaglio (acid etching) and lithograph. These are strong acids which commonly include nitric acid, hydrochloric acid, and phosphoric acid, and less commonly carbolic acid (phenol), chromic acid, hydrofluoric and sulfuric acids.

Hazards

- Concentrated acids are corrosive to the skin, eyes, respiratory system and gastrointestinal system. Dilute acids can cause skin irritation on repeated or prolonged contact.
- Chromic acid is a skin sensitizer, suspect carcinogen, and oxidizer.
- 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.
- 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.
- 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

- Know what is used. Obtain the MSDS for all acids.
- Whenever possible avoid concentrated acids.
- Doing acid etching requires working in an enclosed hood, or in front of a slot exhaust hood or window exhaust fan at work level.
- Store concentrated nitric and chromic acids away from organic materials. Concentrated nitric acid should always be stored separately even from other acids.
- An important safety rule when diluting concentrated acids is to add the acid to the water, never the reverse.
- Wear appropriate gloves, goggles and protective apron or lab coat when handling acids.
- If adequate ventilation is not available, wear a NIOSH-approved respirator with acid gas cartridges.
- 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 15-20 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

- 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.
- Lithotine, kerosene, and mineral spirits are skin and eye irritants and inhalation can cause intoxication and respiratory irritation.
- 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.
- Dichromate salts may cause skin and nasal ulceration and allergic reactions, and are suspect cancer-causing agents.
- 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.
- Talc may be contaminated with asbestos and silica.
- Airbrushing drawing materials or using spray enamel paints is more hazardous than drawing with a brush because the inhalation hazard is higher.

Precautions

- Obtain the MSDS for all materials used.
- See Acids and Solvents sections for the precautions with acids and solvents.
- Use the least toxic solvents. Gasoline should never be used. Lithotine and mineral spirits are less toxic than the more irritating kerosene.
- Use asbestos-free talcs such as baby powders.
- Avoid dichromate-containing counteretches and fountain solutions if possible. Do not use hydrofluoric acid or phenol.
- 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 suspected human carcinogens.
- In addition perchloroethylene can cause liver damage, and methylene chloride heart attacks.

Precautions

- Know materials used. Obtain the MSDS for all solvents. See Solvents section for the precautions with solvents.
- Choose products that do not contain chlorinated solvents whenever possible.
- 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

- 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.
- 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.
- 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.
- 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.
- 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.
- Inhalation of solvents and pigments can result from use of aerosol spray paints.
Precautions

- Obtain the MSDS for all materials used.
- See Solvents and Acids sections for specific precautions.
- 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 handled accordingly, but does not have the dangers of handling concentrated acids. Ferric chloride solution might cause minor skin irritation from prolonged contact.
- Application of grounds or stopouts should be done with local exhaust ventilation, (e.g. slot or enclosed hood).
- 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

- One major hazard associated with these types of processes involves accidents with sharp tools.
- 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

- Keep tools sharp, store them safely and always cut away from yourself.
- When possible, clamp down plates to avoid slippage.
- 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

- Preparing your own inks from dry pigments can involve inhalation of toxic pigments. See Pigments section for the hazards of pigments.
- See Solvent 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.
- Lithotine, turpentine, or oil-soaked rags can be a spontaneous combustion hazard if improperly stored.

Precautions

- See pigments and solvent sections for the specific precautions for pigments and solvents.
- See EHS prior to using a NIOSH-approved respirators with organic vapor cartridges can be used if ventilation is not adequate.
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

- Some woods used for woodcuts can cause skin irritation and/or allergies. This is particularly true of tropical hardwoods.
- Accidents involving sharp tools can result in cuts.
- Wood carving and cutting tools can cause carpal tunnel syndrome. This was discussed earlier in the section that included drypoint and mezzotint.
- Caustic soda (sodium hydroxide) is sometimes used for etching linoleum. It can cause skin burns and severe eye damage if splashed in the eyes.
- Eating, drinking or smoking while printing can result in accidental ingestion of pigments.
- 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

- Obtain the MSDS for all materials used.
- See Acids and Solvents sections for precautions with acids and solvents.
- Water-based inks are preferable to oil-based inks since solvents are not needed.
- Wear appropriate gloves, goggles and protective apron when handling caustic soda.
- 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.
- Always cut in a direction away from you, with your free hand on the side or behind the hand with the tool.
- Carpal 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

- 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.
- Epoxy glues can cause skin and eye irritation and allergies.
- Spraying fixatives on the back of collagraph plates to seal them can involve risk of inhalation of the solvent-containing spray mist.
- Sanding collagraph plates which have been treated with acrylic modeling compounds or similar materials can involve inhalation of irritating dusts.

Precautions

- Know the hazards of materials used. Obtain the MSDSs from the manufacturer.
- 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 heptane, which is less toxic than n-hexane, primarily because peripheral neuropathy is not associated with its use.
- Wear gloves when using epoxy glues.
- Wear a NIOSH-approved toxic dust respirator when sanding collagraph plates.

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 solvents section for the precautions with solvents.
3. Use the least toxic material available.

Monoprints

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

Photo-printmaking

Photo-printmaking 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 photo-emulsions 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 photo-printmaking 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

- Diazo photoemulsions are the least hazardous although they can cause eye irritation.
- 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.
- Ammonia is a skin irritant and highly toxic by inhalation. Ammonia is highly corrosive to the eyes. It has good odor-warning properties.
- 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 produce hazardous metal fumes, and ozone and nitrogen dioxide (which can cause emphysema), and toxic carbon monoxide.
- Screen cleaning solutions include strong caustic solutions, enzyme detergents which can cause asthma, and chlorine bleach. These are skin and respiratory irritants.
- Many solvents used in developing solutions are highly toxic both by inhalation and skin absorption.

Precautions

- Obtain a MSDS for all materials used.
- See Solvents section for more precautions with solvents.
- Avoid ammonium dichromate and use presensitized plates if possible. If you cannot substitute, wear gloves and goggles. Store it away from heat, solvents and other organic materials.
- 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, a respirator.
- 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.
- Wear gloves, goggles and plastic apron or laboratory coat when mixing hazardous chemicals

Photo-etching

Photo-etching is usually done using the KPR products. Photoresist dyes often contain a variety of highly toxic solvents, including ethylene glycol monomethyl ether acetate (2-ethoxyethyl acetate, cellosolve acetate), ethylene glycol monooethyl 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 also contain solvents. Exposure of the plate is done with ultraviolet sources such as carbon arcs, mercury lamps, or metal halide lamps.
Hazards

- See the Solvent 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.
- Xylene is moderately toxic by skin absorption, and highly toxic by inhalation and ingestion. It is a strong narcotic.
- See photolithography section for discussion on carbon arc hazards.

Precautions

- See Solvent section for precautions with solvents.
- Pregnant or nursing women, children, and men trying to conceive should not work with these materials.
- Use photofloods or other light sources instead of carbon arcs. Precautions with carbon arcs is discussed in the Photolithography section.
- Use presensitized plates if possible.
- Use photoresist solutions with local exhaust ventilation, or wear an organic vapor respirator. Wear butyl rubber gloves when handling KPR solutions.

Section 5: Sculpture

Many artists work with traditional sculptural materials including plaster, stone, lapidary, clay, wax, and modeling material. 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-benzine, and mineral oil-petroleum jelly. In waste molding, the plaster mold is chipped away.

Hazards

- 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.
- 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.
- 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.
• Concentrated acetic acid is highly corrosive by ingestion, inhalation, and skin contact.

• Burnt lime (calcium oxide) is moderately corrosive by skin contact (especially if the skin is wet), and highly toxic by inhalation or ingestion.

• Careless use and storage of sharp tools can cause accidents. Chipping set plaster can result in eye injuries from flying chips.

• Benzene used with many mold releases is moderately toxic by skin contact and inhalation, and is highly toxic by ingestion. It is also flammable.

• Making plaster casts of hands, legs, and other body parts can be very hazardous due to the heat released during the setting process.

Precautions

• Wear gloves and goggles when mixing acetic acid and burnt lime.

• 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.

• Wear safety goggles when chipping plaster.

• Wear gloves and goggles when pouring benzene. Store in safety containers and do not use near open flames.

• Do not use plaster for body part casts. Instead, use a plaster-impregnated bandage (such as Johnson and Johnson’s) along with vaseline or similar mold release as protection.

Stone 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.

Stone Types:

• **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 rotomhammers, 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

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

- 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.

- Serpentine, soapstone, and greenstone may contain asbestos, which can cause asbestosis, lung cancer, mesothelioma, and stomach and intestinal cancers.

- 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.

- Lifting heavy pieces of stone may cause back injuries.

- Power tools create larger amounts of fine dust than hand tools. Pneumatic tools can create large amounts of fine silica dust.

- 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.

- 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. Acrylic resins are skin irritants and sensitizers.

- 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.

- 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

- 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.

- 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.

- 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.

- Use proper lifting techniques (bent knees).

- 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 measures such as massage and exercises.

- Tie long hair back, and don't wear ties, jewelry, or loose clothing which can get caught by machinery.

Modeling Materials

See Ceramics 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 oven-hardening (e.g. FIMO, Sculpey), which are not really clays at all. These are often based on polyvinyl chloride.

Hazards

- 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.

- 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

- 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.

- 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, benzine, 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

- Overheating wax can result in the release of flammable wax vapors, as 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.

- Alcohol and acetone are slightly toxic solvents by skin contact and inhalation; benzine 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.

- 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

- 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.

- Use the least hazardous solvent to dissolve your wax. Do not use carbon tetrachloride under any circumstances. Store solvents safely, do not smoke or have open flames near solvents. Dispose of solvent-soaked rags in an approved waste disposal container which is emptied daily.

- 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

- 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.

- 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.

- 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.

- 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.

- 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.

- 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

- Whenever possible, use common hardwoods rather than rare tropical hardwoods.

- If you have a history of allergies, you should avoid common sensitizing woods.

- 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

- 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.

- 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

- Use low-formaldehyde products whenever possible. There are particle boards that are made without formaldehyde, but these are very expensive.

- 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 Preservation 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 chromated 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 chromated 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

- 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.

- 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.

- 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.

- 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

- Obtain a MSDS on all chemicals being used in wood treatment. Treated wood itself does not have MSDS, so you have to try and find out about any treatments from the supplier; contact EHS for assistance. In the United States, CCA-treated wood is required to have a label and information on safe handling.

- Do not handle woods that have been treated with pentachlorophenol or creosote. Avoid scrap or old woods of unknown origin.

- If you add wood preservatives yourself, use zinc or copper naphthenates, if possible.

- Do not burn wood that has been treated with creosote, pentachlorophenol or chromated copper arsenate.

Carving and Machining Wood

Woods 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

- 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.

- 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.

- Electrical equipment can also present electrical shock and fire hazards from faulty or inadequate wiring.

- Sawdust and wood are fire hazards. In addition, fine sawdust is an explosion hazard if enclosed.

Precautions

- Wear goggles when using machines that create dust. For lathes and similar machines which may produce wood chips, use a face shield and goggles, and make sure the machines are properly shielded.

- 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.

- 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

- 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.

- 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.

- 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.

- 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 1,1,1-trichloroethane (methyl chloroform), which are moderately toxic by skin contact, inhalation and ingestion.

- 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.

- 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

- Avoid formaldehyde resin glues because of allergic reactions and the carcinogenicity of formaldehyde.

- Use water-based glues rather than solvent-type glues whenever possible.

- Wear gloves or barrier creams when using epoxy glues, solvent-based adhesives, or formaldehyde-resin glues.
Section 6: Art Department Waste Disposal

Waste Streams

There are several types of wastes that can be generated by the Art department. 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 and require special handling. **Please consult EHS for proper waste disposal.**

Oily Rags

Oily rags must be placed in a red oily rag can such as the one pictured here. The rags are emptied out each night by the custodial staff. 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 an occurrence.

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. Oil-based paints may be combined with solvents and linseed oil for disposal. Follow the instructions for handling hazardous wastes. Latex paints should be dried out and placed in regular trash. Water-based paints may be disposed via the regular trash.

Baby Oil

Baby oil is not considered 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 can be combined with oil-based paints and solvents for disposal. Follow the instructions for handling hazardous waste.
Ceramic Glaze

Many ceramic glazes contain metals that are considered hazardous waste. Unused portions of the glazes should be disposed as hazardous waste. Glaze preparation and rinsing should be conducted in the sink specified for this purpose. This sink is equipped with a settling tank to prevent the solids from entering the drain.

At least monthly, the settling tank must be opened and emptied. The collected material must be handled as hazardous waste. See the instructions at the end of this section.

Photographic Chemicals

Photographic chemicals generally fit into four categories: fixers, developers, rinses, and specialized chemicals. Standard developers and rinses can be rinsed down the drain during processing. Most fixers contain silver in quantities above the amount allowed for sewer disposal. Fixer wastes must be collected and either poured through the silver recovery unit on the first floor photo area or collected as hazardous waste. 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*. Do not label them as hazardous waste or as waste oil. The used oil should be disposed via the monthly waste pickup.

Broken Glass 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-packaging helps to avoid injury to janitors or others handling the trash.

Empty Chemical Containers

Empty chemical containers should be triple-rinsed and recycled or placed in regular trash.

If you have any question on the proper disposal method please contact the Director of Environmental Health and Safety at extension 1567.