George Mason University

Art Safety Manual

Prepared by:
Environmental Health and Safety Office
August 2009

Foreword

George Mason University has developed the *Art Safety Manual* to for the purpose of establishing mechanisms, methods, engineering controls, administrative controls and work practice controls that employees must use to safely create and display art.
This document outlines George Mason University's *Art Safety Program* and describes specific policies and procedures designed to satisfy federal and state safety and health requirements. The components and information required by Virginia Occupational Safety and Health and federal Occupational Safety and Health Administration Standards as they relate to the hazards involved in creating art are contained within this document.

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Acronyms

ANSI	American National Standards Institute
AIHA	American Industrial Hygiene Association
boPET	Biaxially-oriented Polyethylene Terephthalate
CCA	Chromated Copper Arsenate
dBa	A-weighted decibel
DEHP	Di(2-ethylhexyl) phthalate
EPA	Environmental Protection Agency
EHS	Environmental Health and Safety Office
GFCI	Ground Fault Circuit Interrupter
HEPA	High Efficiency Particulate Air
JSA	Job Safety Analyses
MSDS	Material Safety Data Sheet
NIOSH	National Institute for Occupational Safety and Health
NSC	National Safety Council
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PPE	Personal Protective Equipment
RCRA	Resource Conservation and Recovery Act
VOSH	Virginia Occupational Safety and Health Administration

Document History

Version	Date	Comments
1	August 4, 2009	Initial *Art Safety Manual*

This *Art Safety Manual* is reviewed annually and amended as necessary and whenever:

- New art procedures are introduced.
- There is a significant change to existing processes or techniques.
- Applicable regulations are revised.
- An employee or contractor is exposed or injured while working.
- A "near miss" accident occurs.
- Property or the environment is negatively impacted.

EHS will evaluate this *Art Safety Manual* at least annually and update it as needed to ensure continued program effectiveness and compliance with applicable regulations and industry standards. All revisions to this *Art Safety Manual* will be shared with the various parties identified in this document.

1.0 Introduction

Artists use a variety of art media including hazardous and industrial chemicals. This program provides basic information on how to work safely with chemicals and how to control hazardous operations while creating and displaying art.
The purpose of George Mason University's *Art Safety Manual* is to establish a program that provides guidance to personnel who are involved in art at George Mason University. The manual offers technical support for regulatory compliance as well as information on required training and periodic inspections of health and safety practices. The *Art Safety Manual* can also be used as a training tool for students. This manual is to be used in conjunction with other guidance provided by the Environmental Health and Safety Office (EHS) such as the *Fire Safety Plan, Electrical Safety Guide*, and *Hand and Power Tool Safety Guide*.

2.0 Roles and Responsibilities

All employees in the School of Art are responsible for following the guidance provided within this document. The following individuals, offices, and units are responsible for ensuring that the components of the *Art Safety Manual* are implemented and maintained.

2.1 Environmental Health and Safety Office

EHS is responsible for designing, overseeing, implementing, and updating the *Art Safety Manual*. EHS works with the School of Art to assist with implementation and enforcement of the *Art Safety Manual*. Specific responsibilities are to:

- Identify areas where hazardous chemicals are used and stored in conjunction with the supervisors, staff, and faculty.
- Design and provide health and safety training to meet Occupational Safety and Health Administration (OSHA) requirements.
- Maintain training records.
- Inspect work areas to assist with compliance.
- Provide safety and health technical support to employees.
- Conduct Job Safety Analyses (JSA) in order to evaluate chemical usage, and recommend appropriate engineering and administrative controls as well as personal protective equipment (PPE).
- Coordinate inclusion in the university's *Medical Surveillance Program* when necessary.
- Conduct air and noise monitoring to determine exposure levels as needed and upon request.
- Assist in identifying, accumulating, storing, and reducing hazardous waste.
- Provide hazardous waste containers and labels.
- Conduct routine inspection of waste accumulation areas.
- Coordinate hazardous waste pick up.
- Conduct annual program review with feedback from participants of the program.

2.2 School of Art Safety Liaison

Supervisors oversee George Mason University employees and their work. Specific responsibilities of supervisors related to art safety are to:

- Inform EHS if there is a new piece of equipment that needs to be evaluated to ensure OSHA compliance.
- Inform EHS when a new chemical or process is introduced.
- Inform EHS if respiratory protection is anticipated for any hazard.
- Provide proper PPE to employees based on the results of PPE assessments by EHS.
- Ensure that employees attend one-time *Art Safety Training*.
- Maintain and update a chemical inventory and Material Safety Data Sheets (MSDS).
- Ensure proper labeling and storage of hazardous chemicals or products and hazardous waste.
- Ensure that tools and equipment are maintained in good working condition.
- Defective or damaged tools must be marked with the words **"Out of Service, Do Not Use."**
- Ensure that established safety procedures are followed.
- Request air and/or noise monitoring to assess hazards as necessary.
- Report near-misses to EHS.
- Submit *First Report of Accident Form* to Human Resources and Payroll Workers' Compensation Department
- Provide feedback for annual program evaluation upon request.

2.3 Employees

Employees includes faculty (professors, adjunct, and research), staff (classified, wage, and student wage), and graduate students receiving compensation. This does not refer to students in instructional courses. Specific responsibilities for employees are to:

- Register for and attend *Art Safety Training*.
- Use all required PPE.
- Inspect tools and machines prior to use to ensure all guards are in place and functioning.
- Report missing guards or malfunctioning equipment to supervisor.
- Defective or damaged tools must be marked with the words **"Out of Service, Do Not Use."**
- Review MSDS and know hazards associated with chemicals being used.
- Use equipment and chemicals in designated areas only.
- Provide feedback for annual program evaluation upon request.
- Report near-misses to EHS and your supervisor.
- Report injuries and accidents by submitting a *First Report of Accident Form* to your supervisor.

3.0 Identifying Hazardous Materials

It is important to identify and understand the hazards associated with the materials used and stored in the workplace. An evaluation is done to institute controls in order to prevent exposure to these hazards.

When evaluating and assessing hazards it is important to know the following ahead of time:

- How will material be handled?
- Who will be handling the material?
- Where will work be done?
- Who else could be affected by work being done?

This section outlines how hazardous materials are identified and addressed when creating art.

3.1 Job Safety Analysis and Personal Protective Equipment Assessments

Job Safety Analysis (JSA) is a procedure that focuses on individual job tasks as a way to identify hazards associated with each job task. Hazards can lead to injuries and illnesses and are controlled by evaluating workplace operations and establishing appropriate engineering controls, administrative controls, and personal protective equipment (PPE) for each job task.

Jobs tasks which have JSA priority are:

- Jobs with high injury or illness rates.
- Jobs with a potential to lead to or cause severe injuries and/or illnesses.
- Jobs that have undergone changes in procedure and/or processes.
- Jobs that are new to the operation.
- Jobs that are complex enough to require written instructions.

PPE is used as a last line of defense against the hazards associated with tasks being performed and can be used alone or in conjunction with engineering and administrative controls.

PPE assessments are conducted to ensure that PPE being used is adequate for hazards associated with each task being performed. EHS works with supervisors and employees to determine the most appropriate PPE including but not limited to respirators, protective clothing, hard hats, safety glasses, and hearing protection.

It is important that EHS is contacted if PPE is not functioning properly, PPE poses a greater hazard, or additional PPE is required.

3.2 Hazard Communication

The George Mason University *Hazard Communication Program* complies with 29 Code of Federal Regulations (CFR) 1910.1200 and covers employees who work with hazardous chemicals. It provides guidance on how to safely manage chemicals and communicate the hazards associated with chemicals and other media used in the studio through the training of

employees on safety information, labels, signage, and other forms of warning. Elements of the program include chemical inventories, MSDS, storage and handling of toxic chemicals, container labeling, and waste management.

3.2.1 Chemical Inventories

An inventory of the hazardous chemicals in use and in storage must be maintained for each work area. The chemical inventory must contain at least the following information:

- Chemical name, trade name, or the common name used on the MSDS and/or container label.
- The chemical manufacturer's name.
- Location of the chemical.
- Date that the chemical was placed in inventory.

Chemical inventories must be routinely updated to capture changes in inventory. Please contact EHS for guidance or assistance with maintaining a hazardous chemical inventory. Chemical inventories are to be kept in the MSDS binder at the *Right-to-Know Stations* located in each work area.

3.2.2 Material Safety Data Sheets

A Material Safety Data Sheet (MSDS) contains detailed information about the possible health, chemical, and physical hazards of a product and how to safely handle and store the product. Under the federal Hazardous Products Act, suppliers are required to provide MSDS for all hazardous materials, as a condition of sale. If a MSDS is not provided, the supervisor must make a reasonable effort to obtain the MSDS as soon as possible. *Right-to-Know Stations* containing MSDS binders are provided for storage of MSDS for all hazardous chemicals used or stored within a work area.

3.2.3 Storage and Handling of Chemicals

The *Hazard Communications Program* and the MSDS will provide information regarding the storage and handling of specific items. In addition the *Flammable and Combustible Liquid Safety Guide* provides information on the safe storage and use of flammable and combustible liquids. The sections below provide additional guidance for the storage and handling of hazardous chemicals.

Handling of Chemicals:

- Cover containers to prevent liquids from evaporating and powders from spilling.
- Transfer powders carefully to avoid getting large amounts of dust in the air.
- Pour liquids carefully to avoid splashing. Use a funnel where possible.
- Wear appropriate PPE

Storage of Chemicals:

- Keep the minimum amount of materials on hand and purchase the smallest practical container size to reduce risk of spills or fire, and to minimize waste.
- Choose appropriate containers. Avoid breakable glass containers whenever possible.
- Dyes and other powdered materials that come in small paper bags should be transferred to solid containers or sealed plastic bags to avoid tears in bags releasing dust into the air.
- Hazardous chemicals should not be stored above eye level.
- Do not store chemicals that are incompatible together. Appendix D lists the incompatibility of common chemicals found in art materials.
- Never store chemicals in food containers.

Storage of flammable chemicals:

- Flammable chemicals must be stored in flammable storage cabinets that are clearly labeled **"Flammable – Keep Fire Away."**
- At least one Class ABC fire extinguisher must be located within 10 feet of any flammable and/or combustible liquid storage area and within 50 feet of a flammable liquid use area.
- Other combustible materials (e.g., wood, cloth, paper) must not be stored in the same area or on top of flammable or combustible liquids storage areas.

Container Labeling

Hazardous chemicals should remain in the manufacturer's container throughout their use. However, if this is not feasible and the hazardous chemical must be transferred to another container, or if one or more hazardous chemicals are mixed in a container, the new container must be labeled with the following:

- Complete chemical name, trade name, or common name found on the MSDS.
- The chemical name must be written in English and clearly legible.
- Appropriate hazard warning, or alternatively, words, pictures, symbols, or combination thereof which provides at least general information regarding the hazards of the chemicals.

3.3 Hazardous Waste Management

There are several categories of chemicals used by artists that meet the criteria of hazardous waste. Although the Resource Conservation and Recovery Act (RCRA) designates specific categories of hazardous waste, one can also define hazardous waste as a material that is no longer in use, and cannot be safely returned to the environment, in original form.

At George Mason University, EHS is responsible for picking up any hazardous waste generated and provides the following supplies and assistance to support the proper management of chemical, hazardous, and universal wastes:

- Waste containers appropriate for a variety of hazardous waste.

- Supplies for creating a satellite accumulation area such as secondary containment, flammable storage cabinets, and signage.
- Labels ("Hazardous Waste" and "Universal Waste").
- Routine inspections of satellite accumulation areas and transport of waste to a central accumulation area.
- Routine pick-up of central oil-soaked rag disposal can.
- Assistance in identifying, accumulating, storing, and reducing hazardous waste.

4.0 Safe Work Practices

4.1 Painting and Drawing

This section will discuss the hazards and precautions of working with paints, pastels, inks, pencils, crayons, and other painting and drawing media. Working safely can involve changes in how art materials are selected and handled.

4.1.1 General Requirements

- Local exhaust ventilation (see Section 6.2) is required when working with hazardous substances.
- Whenever possible replace harmful substances with less toxic substitutes.
- Obtain and review the MSDS for all chemicals used.
- Contact EHS for JSA and PPE assessments.
- Wear appropriate gloves, goggles and other protective clothing. A face shield should also be worn where there is a splash hazard or impact hazard to the face.
- Contact EHS to evaluate the need for inclusion in the *Respiratory Protection Program*.
- An emergency shower and eyewash station must be available where chemicals are used or stored.
- Do not eat, drink or smoke in the art studio.
- See Section 5.0 for a list of applicable safety guides.

4.1.2 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. Dry pigments are especially hazardous because they are easily inhaled and ingested if methods such as spraying, heating, or sanding are used.

Lead pigments can cause anemia, gastrointestinal problems, peripheral nerve damage, kidney damage and reproductive system damage. Other inorganic pigments may be hazardous, including pigments based on cobalt, cadmium, and manganese. See Appendix B: Known or Probable Carcinogens/Highly Toxic Pigments.

In addition to general requirements for Painting and Drawing, the following precautions are required:

- Use the least toxic pigments possible. Do not use lead or carcinogenic pigments.
- Avoid mixing dry pigments whenever possible otherwise do so in an exhaust hood.
- Wet mop and wipe all surfaces when using dry pigments, never dry sweep.
- If any pigments contain any of the above mentioned chemicals, contact EHS for a JSA and PPE assessment.

4.1.3 Water-based paints

Water-based paints include water color, acrylic, gouache, tempera and casein. In addition to pigment hazards, all water-based paints contain a preservative to prevent mold or bacterial growth. Although present in small amounts, certain preservatives may cause allergic reactions in some people.

Acrylic paints contain a small amount of ammonia which can cause eye, nose and throat irritation. Acrylics and some gouaches also contain a very small amount of formaldehyde as a preservative. If a product containing formaldehyde is used, contact EHS immediately to evaluate the use and determine if additional controls need to be put in place.

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 to the skin and highly irritating by eye contact, ingestion, and inhalation.

In addition to general requirements for Painting and Drawing, the following precautions are required:

- See section above for precautions when mixing dry pigments.
- If preservative is added, avoid using sodium fluoride, phenol or mercury compounds. For tempera, a small amount of pine oil works for short periods of time.

4.1.4 Non water-based paints

Oil paints, encaustic, and egg tempera use linseed oil, wax and egg respectively as vehicles. 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.

Most organic solvents become potential fire hazards when they evaporate. Combustible liquids, such as kerosene, mineral spirits, and cellosolves are a fire threat if heated.

In addition to general requirements for Painting and Drawing, the following precautions are required:

- Apply the same health and safety considerations for the use of "citrus" or "pine" solvents. These can be irritating to the skin and eyes.

- Wax should be only heated to the minimum temperature needed for proper flow of the paint. Do not heat with an open flame or hot plate with exposed element. Use a double boiler or electric frying pan.
- Acrylic paint can be substituted for underpainting.
- Wear neoprene gloves while using epoxy paints and cleaning brushes with mineral spirits or turpentine.
- Solvents are flammable and must be stored in a flammable storage cabinet.
- During pregnancy and nursing, switch to water-based paints to avoid exposure to solvents.

4.1.5 Airbrush, Spray Cans, and Spray Guns

Artists use many products in spray form, including fixatives, retouching sprays, paint sprays, varnishes, and adhesive sprays. Spray mists are particularly hazardous because they are easily inhaled and can contain solvents. In addition pigments are also easily inhaled, creating a greater potential hazard than applying paint by brush. Aerosol spray cans also contain propellants, such as isobutanes and propane, which are extremely flammable.

In addition to general requirements for Painting and Drawing, the following precautions are required:

- See Section 4.1.2 for precautions with pigments.
- All light fixtures within 20 feet of the spray booth should be enclosed and shatter-proof.
- There should be no sources of ignition (electric switches, motors, flames etc.) within 10 feet of the spray booth opening.
- Use spray cans or an airbrush in a spray booth (see Section 6.2).
- Use water-based airbrushing paints and inks rather than solvent-based paints.
- Try to brush items rather than spraying if possible.
- Never try to spray paint by blowing air from your mouth through a tube. This can lead to accidental ingestion of the paint.

4.1.6 Dry Drawing Media

Dry drawing media 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. Although charcoal is only 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.

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). Like charcoal, 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.

In addition to general requirements for Painting and Drawing, the following precautions are required:

- 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 in a spray booth. If use of spray fixatives is occasional, they can be used outdoors.
- Never try to spray fixative by blowing air from your mouth through a tube. This can lead to accidental ingestion of the fixatives.
- Do not blow off excess pastel or charcoal dust with your mouth. Instead tap off the built up dust so it falls onto paper on floor.
- Wet-mop and wet-wipe all surfaces clean of dusts.

4.1.7 Liquid Drawing Media

This includes both water-based and solvent-based pen and ink, and felt tip markers. Although drawing inks are usually water-based, there are some solvent-based drawing inks. These usually contain solvents like xylene. Permanent felt tip markers used in design or graphic arts contain solvents also contain xylene. Newer brands often contain the less toxic propyl alcohol (although it is an eye, nose and throat irritant). The inhalation hazard from using permanent markers increases when using a number of them at the same time in close proximity to each other.

In addition to general requirements for Painting and Drawing, the following precautions are required:

- Use water-based markers and drawing inks if possible.
- Alcohol-based markers are less toxic than aromatic solvent-based markers.
- Make sure to recap markers when not in use. If there is more than one user, spread out and make sure there is enough dilution ventilation to disperse the vapors.
- Never paint on the body with markers or drawing inks. Body painting should be done with cosmetic materials.

4.2 Photography

4.2.1 General Requirements

- Local exhaust ventilation (see Section 6.2) is required when working with hazardous substances.
- Whenever possible replace harmful substances with less toxic substitutes.
- Obtain and review the MSDS for all chemicals used.
- Contact EHS for JSA and PPE assessments.
- Contact EHS to evaluate the need for inclusion in the *Respiratory Protection Program*.
- Chemical splash goggles should be worn when mixing and dispensing photochemical solutions and in all darkrooms where hazardous chemicals can splash into the eyes. Nitrile gloves should also be worn when mixing photochemicals.

- Wear appropriate gloves, goggles and other protective clothing. A face shield should also be worn when there is a splash hazard or impact hazard to the face.
- An emergency shower and eyewash station must be available where chemicals are used or stored.
- Do not eat, drink or smoke in the art studio.
- See Section 5.0 for a list of applicable safety guides.

4.2.2 Black-and-White Photographic Processing

A wide variety of chemicals are used in black and white photographic processing. 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. Premixed ready-to-use photochemicals are recommended in order to avoid hazards associated with mixing concentrated chemicals.

4.2.2.1 Mixing Photochemicals

Photochemicals can be bought in liquid form, which only need to be diluted, or powder form, which need to be dissolved and diluted. Developer solutions and powders are often highly alkaline (corrosive). Glacial acetic acid, used in making the stop bath, is also corrosive by skin contact, inhalation and ingestion.

In addition to general requirements for Photography, the following precautions are required:

- Always add any acid to water, never the reverse.
- Use liquid products instead of powder products due to the higher risk of inhalation of powders.
- 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.
- Label all solutions according to hazard communication requirements (see Section 3.2.4) making sure to identify the chemical and the hazard associated with it.
- Pregnant women, in particular, should not be exposed to powdered developer.

4.2.2.2 Developing Baths

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

Developers are skin and eye irritants, and in many cases strong sensitizers. Most are moderately to highly toxic by ingestion, with ingestion of less than one tablespoon of some compounds being possibly fatal.

In addition to general requirements for Photography, the following precautions are required:

- See Section 4.2.2.1 on mixing photochemicals for mixing precautions.
- Never place hands in developer baths, ALWAYS use tongs.
- If developer solution splashes on your skin or eyes immediately rinse with water for 15 – 20 minutes and seek medical attention immediately.
- Do not use para-phenylene diamine or its derivatives. If products are found to contain para-phenylene diamine, contact EHS immediately for proper disposal.

4.2.2.3 Stop Baths and Fixer

Stop baths are usually weak solutions of acetic acid. Acetic acid is commonly available as pure glacial acetic acid or 28% acetic acid. Some stop baths contain potassium chrome alum as a hardener. Fixing baths contain sodium thiosulfate ("hypo") as the fixing agent, and sodium sulfite and sodium bisulfite as a preservative. Fixing baths also may also contain alum (potassium aluminum sulfate) as a hardener and boric acid as a buffer.

In addition to general requirements for Photography, the following precautions are required:

- Chemical use in darkrooms must be done in front of a slot hood (see Section 6.2) to control the level of acetic acid vapors and sulfur dioxide gas produced in photography.
- Cover all baths when not in use to prevent evaporation or release of vapors and gases.

4.2.2.4 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. Reduction of negatives is usually done with Farmer's reducer, consisting of potassium ferricyanide and hypo. These chemicals are highly toxic and have adverse effects on the body.

In addition to general requirements for Photography, the following precautions are required:

- The safest reducer to use is Farmer's reducer. Do not expose Farmer's reducer to acid, ultraviolet light, or heat.
- Do not use mercury, cyanide or uranium intensifiers, or cyanide reducers because of their high or extreme toxicity.
- Do not expose potassium chlorochromate to acid or heat.

4.2.2.5 Toners

Toning a print usually involves replacement of silver by another metal such as gold, selenium, uranium, platinum, or iron. In some cases, the toning involves replacement of silver metal by brown silver sulfide which releases a highly toxic hydrogen sulfide gas during toning, or when treated with acid. A variety of other chemicals are also used in the toning solutions.

In addition to general requirements for Photography, the following precautions are required:

- Follow precautions for mixing photochemicals (see Section 4.2.2.1).

- Take precautions to make sure that sulfide or selenium toners are not contaminated with acids. For example, with two bath sulfide toners, rinse the print well after bleaching in acid solution before dipping it in the sulfide developer.

4.2.2.6 Other Hazards

Many other chemicals are also used in black and white processing, including formaldehyde, a variety of oxidizing agents (e.g., hydrogen peroxide and ammonia, potassium permanganate, bleaches, and potassium persulfate), sodium sulfide, silver nitrate, and concentrated acids.

If a product containing formaldehyde is used, contact EHS immediately to evaluate the use and determine if additional controls need to be put in place.

In addition to general requirements for Photography, the following precautions are required:

- See previous sections for precautions in handling photographic chemicals.
- Cleaning acids should be handled with great care. Always add acid to the water when diluting, never the reverse.
- 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 circuit interrupters (GFCI) whenever electrical outlets or electrical equipment (e.g., enlargers) are within six feet of the risk of water splashes.

4.2.3 Color Processing

Color processing is much more complicated than black and white processing, and can either be done in trays or in automatic processors. In some old processes, the film emulsion was hardened during the process, typically before the bleach. Such a hardening bath often used aldehydes, such as formaldehyde and gluteraldehyde. In modern processing, these hardening steps are unnecessary because the film emulsion is sufficiently hardened to withstand the processing chemicals.

4.2.3.1 Developing Baths

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

In general, color developers are more hazardous than black and white developers. Recent color developing agents are supposed to be less hazardous, but still can cause skin irritation and an allergic reaction.

In addition to general requirements for Photography, the following precautions are required:

- Wash non-disposable gloves with an acid-type hand cleaner (e.g., pHisoderm (R)), and water before removing them. Barrier creams are not an acceptable alternative to wearing gloves.

4.2.3.2 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.

In addition to general requirements for Photography, the following precautions are required:

- Use premixed solutions whenever possible.
- Do not add acid to solutions containing potassium ferrocyanide or thiocyanate salts because this releases cyanide gas.
- When diluting solutions containing concentrated acids, always add the acid to the water, never the reverse.
- A water rinse step is recommended between acid bleach steps and fixing steps to reduce the production of sulfur dioxide gas.
- Control the temperature carefully according to manufacturer's recommendations to reduce emissions of toxic gases and vapors.

4.2.3.3 Disposal of Photochemicals

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.

See Section 3.2.5 for information on hazardous waste management.

4.3 Printmaking

There are many different printmaking processes, including lithography, relief printing, intaglio, and screen printing.

4.3.1 General Requirements

- Local exhaust ventilation (see Section 6.2) is required when working with hazardous substances.
- Whenever possible replace harmful substances with less toxic substitutes.
- Follow precautions on Acids, Solvents, and Pigments (see Sections 4.3.1.2 to 4.3.1.4).
- Obtain and review the MSDS for all chemicals used.
- Contact EHS for JSA and PPE assessments.
- Contact EHS to evaluate the need for inclusion in the *Respiratory Protection Program*.

- Wear appropriate gloves, goggles and other protective clothing. A face shield should also be worn where there is a splash hazard or impact hazard to the face.
- An emergency shower and eyewash station must be available where chemicals are used or stored.
- Do not eat, drink or smoke in the art studio.
- See Section 5.0 for a list of applicable safety guides.

4.3.2 Inks, Pigments, Solvents, and Acids

4.3.2.1 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. Oil vehicles are flammable when heated, and rags soaked in these could ignite by spontaneous combustion.
In addition to general requirements for Printmaking, the following precautions are required:

- Do not use an open flame to heat linseed oil, linseed oil varnishes, or burnt plate oil.
- Oil-soaked rags should be kept to a minimum and placed in an approved, metal, self-closing waste disposal can which is emptied each day into a like container located outside the building. This should be disposed of as hazardous waste or recycled by professional laundering.

4.3.2.2 Pigments

There are two types of pigments: inorganic pigments, and organic pigments. Pigment poisoning can occur if pigments are inhaled or ingested.

In addition to general requirements for Printmaking, the following precautions are required:

- Avoid lead pigments.
- Avoid mixing dry pigments whenever possible.
- Never mix chrome yellow, zinc yellow, chrome green, molybdate orange or any other pigments which are known human carcinogens.
- If possible, do not mix highly toxic pigments such as lead white or cadmium colors.
- If dry pigments are mixed, use a slot hood (see Section 6.2) designed for capturing particulates.

4.3.2.3 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. Solvents are harmful through absorption, inhalation, and ingestion.
Most solvents, except chlorinated hydrocarbons, are also either flammable or combustible. For example, ethyl alcohol and toluene are flammable, and kerosene and mineral spirits (Varsol® or paint thinner) are combustible.

In addition to general requirements for Printmaking, the following precautions are required:

- Do not use solvents to clean ink off hands. Mineral oil (baby oil) is a good substitute.
- Do not use solvents when pregnant or nursing.
- 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 (see Section 3.2.3).
- Never store solvents or solvent-containing materials in food or drink containers.
- Always label containers.
- Do not allow open flames or other sources of ignition near solvents.
- Fire extinguishers have to be available where solvents are used.
- Store solvents and other organic materials away from heat.
- Solvent-soaked rags should be placed in an approved, metal self-closing waste disposal can which is emptied each day and disposed of as hazardous waste or recycled by professional laundering.
- Do not induce vomiting if petroleum distillates are swallowed. Contact a regional Poison Control Center immediately at 1-800-222-1222.

4.3.2.4 Acids

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

In addition to general requirements for Printmaking, the following precautions are required:

- Add the acid to the water when diluting concentrated acids; never the reverse.
- Whenever possible avoid concentrated acids.
- Store concentrated nitric and chromic acids away from organic materials.
- Concentrated nitric acid should always be stored separately even from other acids.
- If acid is spilled on skin, immediately flush with water for 15 minutes. In case of eye contact, rinse the eyes with water for at least 15-20 minutes and contact a physician.
- Do not induce vomiting if concentrated acids are swallowed. Give 1-2 glasses of water or milk and contact the regional Poison Control Center at 1-800-222-1222.

4.3.3 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.

4.3.3.1 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 solutions containing acids and gum arabic, counteretch solutions containing acids and sometimes dichromate salts, and fountain solutions containing dichromate salts.

In addition to general requirements for Printmaking, the following precautions are required:

- See the Acids and Solvents Sections (4.3.1.3 and 4.3.1.4) for the precautions with acids and 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 powder.
- Avoid dichromate-containing counteretches and fountain solutions if possible.
- Do not use hydrofluoric acid.
- Do not use phenol.
- Air brushing or application of spray paints should only be done in a spray booth (see Section 6.2).

4.3.3.2 Printing and Cleanup

Many art lithographic inks contain treated linseed oil as a vehicle so are not solvent-based. However, some lithographers use commercial lithographic inks which can contain solvents, such as mineral spirits. 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.

Some roller cleaners and glaze cleaners can contain chlorinated hydrocarbons such as perchloroethylene and methylene chloride. Most chlorinated solvents are suspected human carcinogens. In addition perchloroethylene can cause liver damage, and methylene chloride, heart attacks.

In addition to general requirements for Printmaking, the following precautions are required:

- If product contains methylene chloride, contact EHS for air monitoring and possible inclusion in George Mason University's *Medical Surveillance Program*.
- Choose products that do not contain chlorinated solvents whenever possible.

4.3.4 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.

4.3.4.1 Printing and Cleanup

Intaglio inks contain pigments, treated linseed oil, and modifiers. Cleanup of inking slab, press bed, and cleaning the plate is done with a variety of solvents including mineral spirits, alcohol, lithotine, turpentine, etc.

Preparing inks from dry pigments can involve inhalation of toxic pigments. 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 cause spontaneous combustion if improperly stored.

In addition to general requirements for Printmaking, oil-soaked rags should be kept to a minimum and placed in an approved, metal, self-closing waste disposal can which is emptied each day into a like container located outside the building. This should be disposed of as hazardous waste or recycled by professional laundering.

4.3.5 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. For unetched parts, the plates 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. Inhalation of solvents and pigments can result from use of aerosol spray paints.

In addition to general requirements for Printmaking, the following precautions are required:

- For etching copper plates, ferric chloride (iron perchloride) should be used. This forms acidic solutions that must be handled accordingly.
- Application of spray paints should be done inside a spray booth (see Section 6.2) or outdoors.
- Rosin (or asphaltum) boxes should be explosion-proof. Use sparkproof metal cranks, explosion-proof motors, or compressed air.
- Do not use hair dryers to stir up rosin dust.
- Use local exhaust ventilation (see Section 6.2) when working with rosin.

4.3.6 Relief Printing

Relief printing techniques include woodcuts, linoleum cuts, and acrylic plates for plaster relief. Relief inks can be oil-based or water-based.

Wood carving and cutting tools can cause carpel tunnel syndrome. Also accidents involving sharp tools can result in lacerations. Caustic soda (sodium hydroxide) is sometimes used for etching linoleum and can cause skin burns and severe eye damage if splashed in the eyes. Hazardous solvents are used in stopouts and resists in linoleum etching, and for cleaning up after printing with oil-based inks.

In addition to general requirements for Printmaking, the following precautions are required:

- Water-based inks are preferable to oil-based inks since solvents are not needed.
- Always cut in a direction away from you, with your free hand on the side or behind the hand with the tool.

- Carpel tunnel syndrome can be minimized or avoided by using tools with wide handles, avoiding tight grips, and rest periods with hand flexing exercises. Linoleum cutting is softer to work, and thus can reduce musculoskeletal injury.
- High Efficiency Particulate Air (HEPA) Vacuum or wet mop to keep plaster dust levels low. Do not dry sweep.

4.3.7 Collagraphs

A wide variety of materials and adhesives can be used in making collagraphs. Rubber cement, a common adhesive used with collagraphs, is extremely flammable. Epoxy glues can cause skin and eye irritation and sensitivities. A wide variety of other materials with varying toxicities can be used in making collagraph plates.

In addition to general requirements for Printmaking, the following precautions are required:

- Use water-based glues and mediums (e.g., acrylic medium) whenever possible.
- Use spray fixatives in a spray booth (see Section 6.2) or outdoors.

4.3.8 Plastic Prints

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.

Please ensure compliance with general precautions (see Section 4.3.1).

4.3.9 Other Techniques

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

In addition to general requirements for Printmaking, the following precautions are required:

- Keep tools sharp, store them safely, and always cut away from you.
- Sharps should be disposed of in non-biohazard sharps containers.
- Full containers should be closed, taped shut and disposed of with regular trash.
- 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.
- Contact EHS for ergonomic evaluations and suggestions.

4.3.10 Photoprintmaking, Photolithography, and Photoetching

4.3.10.1 Photoprintmaking

Photoprintmaking involves exposing a light-sensitive emulsion or film to ultraviolet light through a transparent support containing an opaque image to transfer the image to a plate. The transparency through which the photoemulsions are developed can include drawings on a transparent support such as a biaxially-oriented polyethylene terephthalate (boPET) sheet (e.g. Mylar®) or acetate, or photographic images processed on graphic arts film to yield a positive image.

Please ensure compliance with general precautions (see Section 4.3.1).

4.3.10.2 Photolithography

Photolithography involves transferring graphic images to stones or metal plates that are coated with a light-sensitive emulsion. 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.

In addition to general requirements for Printmaking, the following precautions are required:

- Avoid ammonium dichromate and use presensitized plates if possible.
- Store solvents and other organic materials away from heat.
- Use ammonia solutions or solvent-containing photolithographic solutions with a slot hood (see Section 6.2).
- When using the carbon arc, wear welding goggles with as dark a shade number of 14 as required by OSHA standard 1910.133.

4.3.10.3 Photoetching –

Photoetching is typically done using Kodak photo resist (KPR) products. Photoresist dyes often contain a variety of highly toxic solvents. Developers used for safer presensitized plates also contain solvents. Exposure of the plate is done with ultraviolet sources such as carbon arcs, mercury lamps, or metal halide lamps.

In addition to general requirements for Printmaking, the following precautions are required:

- Use photofloods or other light sources instead of carbon arcs.
- Use presensitized plates if possible.
- Wear butyl rubber gloves when handling KPR solutions.
- Pregnant or nursing women and men trying to conceive should not work with photoetching materials.

4.4 Sculpture

Many artists work with traditional sculptural materials including plaster, stone, lapidary, clay, wax, and modeling materials. This section will provide hazards and safety information for certain traditional processes.

4.4.1 General Requirements

- Local exhaust ventilation (see Section 6.2) is required when working with hazardous substances.
- Whenever possible replace harmful substances with less toxic substitutes.
- Obtain and review the MSDS for all chemicals used.
- Contact EHS for JSA and PPE assessments.
- Contact EHS to evaluate the need for inclusion in the *Respiratory Protection Program*.
- Wear appropriate gloves, goggles and other protective clothing. A face shield should also be worn where there is a splash hazard or impact hazard to the face.
- Wear appropriate clothing that fits correctly and is free of loose material. Confine loose clothing, ties, long hair, or jewelry that can become caught in moving parts.
- An emergency shower and eyewash station must be available where chemicals are used or stored.
- Do not eat, drink or smoke in the art studio.
- See Section 5.0 for a list of applicable safety guides.

4.4.2 Plaster

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.

Plaster dust (calcium sulfate) is slightly irritating to the eyes and respiratory system. Many of the additives used such as silica and vermiculite dust are highly toxic. Potassium sulfate, potassium alum, borax are also toxic. Concentrated acetic acid and burnt lime (calcium oxide) are corrosive.

In addition to general requirements for sculpturing, the following precautions are required:

- Always carve or cut in a direction away from you, and keep hands behind the tool. If the tool falls, do not try to catch it.
- When adding materials to plaster, use an N-95 National Institute for Occupational Safety and Health (NIOSH)- approved filtering facepiece (see Appendix E) and clean up dust carefully.
- Store plaster in sealed containers or plastic sealed bags rather than paper bags which can rip open.
- HEPA Vacuum or wet mop to keep plaster dust levels low.
- Do not dry sweep.

4.4.3 Plaster Molds

When plaster molds are used, methods need to be put in place to release the molds. Mold releases used with plaster include vaseline, tincture of green soap, auto paste wax-benzine, silicone-grease-benzine, and mineral oil-petroleum jelly. In waste molding, the plaster mold is chipped away.

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

In addition to general requirements for sculpturing, the following precautions are required:

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

4.4.4 Plaster Finishing

Paints, powdered pigments, and dyes that are used to finish plasters are often hazardous by inhalation or ingestion, and in some cases by skin contact. Alcohol, shellac, and solvents used in lacquers are moderately toxic. These solvents are also flammable.

In addition to general requirements for sculpturing, the following precautions are required:

- Use an N-99 NIOSH- approved filtering facepiece when using powdered pigments or dyes (see Appendix E).
- Brush or dip dyes or paints rather than spraying.
- Store solvents safely, and keep them away from open flames.
- Solvent-soaked rags should be kept to a minimum and placed in an approved, metal, self-closing waste disposal can which is emptied each day into a like container located outside the building. This should be disposed of as hazardous waste or recycled by professional laundering.

4.4.5 Stones

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.

4.4.5.1 Soft Stones and Hard Stones

Soft stones include soapstone (steatite), serpentine, sandstone, African wonderstone, greenstone, sandstone, limestone, alabaster, and several others. Hard stones include granite and marble.

4.4.5.2 Casting Stones

Stone casts and cast concrete sculptures can be made using sand and Portland cement, and crushed stone. Portland cement contains calcium, aluminum, iron and magnesium oxides, and about 5% free silica. Some modern cements have acrylic resins in them and sometimes, fiberglass is added as a reinforcement.

The most common mold is plaster with stearic acid/benzine as the mold release. Sandstone, soapstone, and granite are highly toxic by inhalation because they contain large amounts of free silica.

In addition to general requirements for sculpturing, the following precautions are required:

- Use a water spray over the sculpture when carving.
- When using carving tools, keep hands behind tools, and carve or cut in a direction away from you.
- Do not try to catch falling tools.
- Use proper lifting techniques (bent knees).
- Pneumatic and electric carving tools should be equipped with portable exhaust systems.
- All electric tools should be properly grounded and in good repair. See Section 5.0 for a list of applicable guides.
- Isolate the compressor far away and shield with sound- absorbing materials. Wear hearing protection if necessary.
- Contact EHS for a noise assessment.
- Protect against vibration damage from pneumatic tools by measures such as having comfortable hand grips, or using vibrating tools for a limited time.
- Direct the air blast away from hands, keeping hands warm, take frequent work breaks, and use preventive medical measures such as massage and exercises.
- Use wet sanding and polishing techniques whenever possible to keep down dust levels.
- Use an N-99 NIOSH- approved filtering facepiece (see Appendix E) when carving all stones. Particular care should be taken with stones that contain free silica.
- Change clothes and shower after work so as not to track the dust home. Wash work clothes regularly.
- HEPA Vacuum or wet mop to keep dust levels low.
- Do not dry sweep.

4.4.5.3 Finishing Stone

Stones can be finished by grinding, sanding, and polishing, by 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.

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.

In addition to general requirements for sculpturing, the following precautions are required:

- Use a water spray over the sculpture when carving.
- When using carving tools, keep hands behind tools, and carve or cut in a direction away from you.
- Do not try to catch falling tools.
- Use proper lifting techniques (bent knees).
- Pneumatic and electric carving tools should be equipped with portable exhaust systems.
- All electric tools should be properly grounded and in good repair. See Section 5.0 for a list of applicable guides.
- Isolate the compressor far away and shield with sound- absorbing materials. Wear hearing protection if necessary.
- Contact EHS for a noise assessment.
- Protect against vibration damage from pneumatic tools by measures such as having comfortable hand grips, or using vibrating tools for a limited time.
- Direct the air blast away from hands, keeping hands warm, take frequent work breaks, and use preventive medical measures such as massage and exercise.
- Use wet sanding and polishing techniques whenever possible to keep down dust levels.
- Use an N-99 NIOSH- approved filtering facepiece (see Appendix E) when carving all stones. Particular care should be taken with stones that contain free silica.
- Change clothes and shower after work so as not to track the dust home. Wash work clothes regularly.
- HEPA Vacuum or wet mop to keep dust levels low.
- Do not dry sweep.

4.4.6 Modeling Materials

4.4.6.1 Clay

Modeling materials used in sculpture include traditional moist clays, non-hardening modeling clays, self-hardening clays, oven-hardening clays, wax, and paper mache type products.

Modeling clays of the plasticine type usually contain China clay in an oil and petrolatum base. Additive, including dyes, sulfur dioxide, vegetable oils, aluminum silicate, preservatives, and turpentine are often present. 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. Polymer clays are not used at the university.

In addition to general requirements for sculpturing, the following precautions are required:

- Use gloves if skin irritation results from using plasticine modeling clays. Wash hands with soap and water after contact.
- Never bake any art material in an oven which is also used for food.
- Use a separate oven, that has reliable temperature control and only bake these products to their particular hardening temperature.

- Do not use hardening modeling clays that have di(2-ethylhexyl) phthalate (DEHP) as a plasticizer. At this time, the long-term hazards of replacement plasticizers have not been adequately researched.

4.4.6.2 Wax

Waxes used for modeling, carving, and casting 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.

In addition to general requirements for sculpturing, the following precautions are required:

- Do not overheat waxes.
- Do not use an open flame to melt waxes.
- Use a double boiler and a temperature-controlled hot plate, or a crock pot.
- Use the least hazardous solvent to dissolve wax. Do not use carbon tetrachloride under any circumstances.
- Store solvents safely, do not smoke or have open flames near solvents.
- Solvent-soaked rags should be placed in an approved, metal self-closing waste disposal can which is emptied each day and disposed of as hazardous waste or recycled by professional laundering.
- Do not use chlorinated synthetic waxes.

4.4.7 Wood Work

Different types of hard and soft woods are used to make sculptures, including many exotic tropical woods. Many of these woods are hazardous themselves and sometimes, woods are treated with hazardous preservatives or pesticides.

4.4.7.1 Hardwood and Softwood

Many hardwood dusts, especially those from exotic woods, are common sensitizers and can cause allergic skin reactions, conjunctivitis (eye inflammation), hay fever, asthma, coughing, and other respiratory diseases. Some hardwoods also contain chemicals that are toxic.

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.

In addition to general requirements for sculpturing, the following precautions are required:

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

- If allergies are of concern to individuals using hardwoods, avoid common sensitizing woods e.g. western red cedar.
- Wash hands carefully after work.
- Avoid inhalation of wood dusts by using a dust collector (see Section 6.2).
- See precautions for particular woodworking processes described below.

4.4.7.2 Plywood and Composition boards

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. These materials can emit 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 which is a respiratory sensitizer.

In addition to general requirements for sculpturing, the following precautions are required:

- Contact EHS to conduct baseline formaldehyde monitoring.
- Do not store large amounts of plywood or composition board in the shop since it will emit formaldehyde.
- Dust collectors connected to woodworking machines should be exhausted to the outside since emitted formaldehyde will not be captured by dust collectors.

4.4.7.3 Wood Preservatives and Other Treatments

Pesticides and preservatives are often applied to wood when it is being timbered, processed or shipped. Unfortunately, it is hard to find out what chemicals, if any, have been added especially with imported woods.

Pentachlorophenol and its salts, creosote, and chromated copper arsenate (CCA) have been banned for sale in the United Sates as wood preservatives because of their extreme hazards however, they can still be found in older woods. Chromated copper arsenate is still allowed as a commercial treatment (e.g., "green" lumber, playground equipment, and other outdoor uses). A variety of other chemicals can be used in treating wood including fire retardants, bleaches, etc.

In addition to general requirements for sculpturing, the following precautions are required:

- Do not handle woods that have been treated with pentachlorophenol or creosote. In the United States, CCA-treated wood is required to have a label and information on safe handling.
- Do not saw, sand, or otherwise machine CCA-treated wood.
- Do not burn wood that has been treated with creosote, pentachlorophenol or chromated copper arsenate.
- When adding wood preservatives, use zinc or copper naphthenates, if possible.
- Avoid using scrap or old woods of unknown origin.

4.4.7.4 Carving and Machining Wood

There are several hazards associated with carving and machining wood. Many wood dusts are hazardous by skin contact or inhalation and are also fire hazards.

Woodworking machinery accidents are often due to missing machine guards, faulty equipment, or using the wrong type of machine for a particular operation. Woodworking machines may be noisy and can cause permanent hearing loss with long-term exposure.

Tool accidents are often caused by dull tools or improper use of the tool. Vibrating tools such as chainsaws can cause Raynaud's phenomenon ("whitefingers") involving numbness of the fingers and hands.

There are also electrical and fire hazards from faulty or inadequate wiring of electrical equipment.

In addition to general requirements for sculpturing, the following precautions are required:

- Keep hand tools sharpened, and cut away from your body. Do not place hands in front of the tool.
- Keep all electrical equipment and wiring in good repair (see *Electrical Safety Guide* or *Hand and Power Tool Safety Guide*), and avoid extension cords which can be tripped over and are electrical hazards.
- Equip woodworking machines that create substantial amounts of sawdust with dust collectors.
- When cutting or machining particle board or plywood, place the dust collector outdoors.
- Make sure that all woodworking machines are equipped with proper guards to prevent accidents (see *Machine and Machine Shop Safety guide*).
- Shield noisy machines whenever possible. Mount the machinery with vibration isolators (like shock absorbers), and keep all machinery in good working condition.
- Replace old, noisy machinery whenever possible. Contact EHS to evaluate the need for inclusion in the *Hearing Conservation Program*.
- Use the proper machine for particular operations and repair defective machines immediately, or tag out of service.
- Clean wood dust from around and inside machines to avoid fire hazards.
- HEPA Vacuum or wet mop to keep sawdust levels low.
- Do not dry sweep.

4.4.7.5 Gluing Wood

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 are used for laminating and joining wood. These glues all have specific hazards associated with them.

In addition to general requirements for sculpturing, the following precautions are required:

- Use water-based glues rather than solvent-type glues whenever possible.
- When using solvent-based glues, do not allow open flames in the studio.
- Eliminate all other sources of ignition in the room.

4.4.7.6 Paint Stripping

Paint and varnish removers contain a wide variety of solvents. "Nonflammable" paint strippers contain methylene chloride. They may also contain many other solvents, including acetone, glycol ethers, methyl alcohol, and acetates. Caustic soda, acids, blowtorches and heat guns are also used to remove old paint. Old stains on wood are often removed with bleaches, which can contain caustic soda, hydrogen peroxide, oxalic acid, or hypochlorite.

In addition to general requirements for sculpturing, the following precautions are required:

- Do not use methylene chloride containing strippers. Contact the distributor for a viable substitute.
- Do not use lead containing paint.
- Use dimethyl adipate paint strippers which are safer than other solvent types.
- Volatile, solvent-based paint strippers should preferably be used outside.
- Do not have open flames or other sources of ignition (e.g., pilot light) in the room when using flammable solvents.
- Avoid using torches to remove paint.
- Solvent-soaked rags should be placed in an approved, metal self-closing waste disposal can which is emptied each day and disposed of as hazardous waste or recycled by professional laundering.

4.4.7.7 Painting and Finishing

Wood can be painted, stained, lacquered, or varnished. It can be oiled with linseed oil, tung oil, or other types of oil. Other materials used in finishing include shellacs, polyurethane coatings, and waxes. Some woodworkers mix their own paints from dry pigments.

In addition to general requirements for sculpturing, the following precautions are required:

- Avoid open flames, and other sources of ignition when applying flammable finishes, or when spraying.
- Use water-based paints rather than solvent-based paints if possible.
- Use latex paints containing ethylene glycol or propylene glycol rather than glycol ethers.
- Use ready-made paints rather than mixing your own.
- Use shellacs containing denatured (ethyl) alcohol rather than ones containing methyl alcohol.
- Brush on materials whenever possible, to avoid the hazards of spraying.
- Finishes should be sprayed inside an explosion-proof spray booth (see Section 6.2).
- Touchup with spray cans should be done outdoors.
- Oil-soaked rags should be placed in an approved, metal self-closing waste disposal can which is emptied each day and disposed of as hazardous waste or recycled by professional laundering.

4.4.8 Metal Work

This section covers the precautions of the various types of metal sculpture and metalworking techniques to include metal casting, welding, brazing, soldering, forging, metal fabrication, and surface treatment of metals.

4.4.8.1 General Requirements

- Local exhaust ventilation (see Section 6.2) is required when working with hazardous substances.
- Whenever possible replace harmful substances with less toxic substitutes.
- Obtain and review the MSDS for all chemicals used.
- Contact EHS for JSA and PPE assessments.
- Contact EHS to evaluate the need for inclusion in the *Respiratory Protection Program*.
- Wear appropriate gloves, goggles and other protective clothing. A face shield should also be worn to protect eyes against flying metal pieces or filings.
- Wear appropriate clothing that fits correctly and is free of loose material. Confine loose clothing, ties, long hair, or jewelry that can become caught in moving parts.
- An emergency shower and eyewash station must be available where chemicals are used or stored.
- Do not eat, drink or smoke in the art studio.
- See Section 5.0 for a list of applicable safety guides to include the *Welding and Cutting Safety Guide*, the *Electrical Safety Guide*, the *Hand and Power Tool Safety Guide* and the *Oil and Chemical Spill Guide*.

4.4.8.2 Welding and Cutting

- Appropriate personal protective equipment (PPE) must be used whenever hot work is conducted. Eye, face, and hand protection is required at a minimum. Other PPE such as boots, hard hat, and protective welding apparel must be used as necessary.
- All operators and attendants on fire watch must also be provided with appropriate PPE such as transparent face shields with safety glasses.
- Screens must be used and arranged in a manner that provides protection for surrounding persons. Screens may not obstruct or prevent ventilation or egress.
- Welding cables and other equipment must not obstruct egress and kept clear of passageways, ladders, and stairways.

Please review the *Welding and Cutting (Hot Work) Safety Guide* available on the EHS website (ehs.gmu.edu).

4.4.8.3 Polishing and Finishing

Filing, sand blasting, grinding, wire brushing, and buffing are examples of the various types of polishing and finishing treatments used with metals.

4.4.8.4 Grinding, Polishing, and Other Mechanical Techniques

Grinding, wire-brushing, buffing wheels, sanding, and other similar techniques using powered equipment can produce flying metal particles, dust, and, in some cases, particles from abrasives and the grinding wheel. Hand-operated sanding and polishing using abrasives such as rouge, tripoli (silica), and pumice can also produce dust. Filing can produce flying metal particles.

In addition to general requirements for welding and cutting, the following precautions are required:

- Do not use sandstone grinding wheels. Instead use silicon carbide (carborundum) or alumina.
- Use grinding wheels with rubber or shellac binders.
- All grinding wheels should be equipped with a vacuum attachment or similar local exhaust system (see Section 6.2) to trap dusts and particles.
- Use wet techniques whenever possible to keep dust levels low.
- Use cutting oils which do not contain amines or nitrites.
- Other precautions should include wearing impervious clothing, washing exposed areas with soap and water, frequent showering, and use of non-amine barrier creams.

4.4.9 Ceramics

4.4.9.1 General Requirements

- Local exhaust ventilation (See Section 6.2) is required when working with hazardous substances.
- Whenever possible replace harmful substances with less toxic substitutes.
- Obtain and review the MSDS for all chemicals used.
- Contact EHS for JSA and PPE assessments.
- Contact EHS to evaluate the need for inclusion to the *Respiratory Protection Program*.
- Wear appropriate gloves, goggles and other protective clothing. A face shield should also be worn to protect eyes against flying metal pieces or filings.
- Wear appropriate clothing that fits correctly and is free of loose material. Confine loose clothing, ties, long hair, or jewelry that can become caught in moving parts.
- An emergency shower and eyewash station must be available where chemicals are used or stored.
- Do not eat, drink or smoke in the art studio.
- See Section 5.0 for a list of applicable safety guides.

4.4.9.2 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.

In addition to general requirements for Ceramics, the following precautions are required:

- Use premixed clay whenever possible to avoid exposure to large quantities of clay dust.
- Do not use asbestos or asbestos-contaminated talcs.
- 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.
- Avoid contact of clay with broken skin.
- To prevent back problems, always lift with knees bent. Also, use a standup wheel, or elevate electric wheels to a height that does not require bending over.
- Keep wrists in an unflexed position as much as possible to prevent carpel tunnel syndrome. Take frequent work breaks.
- Recondition clay by cutting still-wet clay into small pieces, letting them air-dry, and soak in water.
- Finish greenware while still wet or damp with a fine sponge instead of sanding when dry. Do not sand greenware containing fibrous talc.
- 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.
- Wear separate work clothes while in the studio. Choose clothes of material and design that do not trap dust and wash these clothes separately from other laundry.
- Floors should be sealed or made of easy-cleaning material.
- HEPA Vacuum or wet mop to keep dust levels low and prevent dry scraps from becoming pulverized.
- Do not dry sweep.

4.4.9.3 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. Glaze components are weighed, sorted and mixed with water. These materials are often in fine powdered form, and result in high dust exposures.

In addition to general requirements for Ceramics, the following precautions are required:

- Wash hands after work.
- Use lead-free glazes whenever possible. If the glaze does not state "lead-free" or "leadless" on the label, assume it contains lead until proven otherwise.
- Contact EHS to conduct air and surface monitoring to determine lead exposure levels.
- If possible, do not use colorants that are known human carcinogens and avoid probable human carcinogens such as lead, chromium, etc.
- Lead-glazed pottery should be labeled as lead-containing.
- Good housekeeping procedures and cleanup of spills reduce the risk of inhalation or ingestion of dusts.
- Wet mop spilled powders.

4.4.9.4 Kilns

Electric kilns and fuel-fired kilns are used to heat pottery to the desired firing temperature. The fuels in fuels-fired kilns produce carbon monoxide and other combustion gases.
Firing temperatures can vary from as low as 1382°F for raku and bisque wares, to as high as 2372°F for stoneware, and 2642°F for certain porcelains.

In addition to general requirements for Ceramics, the following precautions are required:

- Electric or fuel-fired kilns should be kept in a separate room to reduce excess heat in the working studio.
- Do not use lead compounds at stoneware temperatures this will cause the lead to vaporize.
- Chimneys should have a high enough stack to prevent exhaust from re-entering the building. High-velocity stack fans may be necessary.
- Lumber, paper, solvents, or other combustible and flammable materials should not be stored in kiln areas.
- Raise electric kilns at least a foot off the floor and place at least two feet from any wall, allowing air circulation.
- Wooden floors should be protected with non-asbestos containing fireproof materials (e.g. firebrick).
- Always check that the kiln has shut off.
- Regulators, to automatically shut off kilns if the air flow stops or if a negative pressure develops are needed.
- ANSI approved infrared goggles 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.

5.0 Safety Guides

There are physical hazards involved in creating art. Safety guides provide information on engineering controls, administrative controls, and appropriate PPE that should be used when faced with hazards addressed in each guide. Safety guides include the following:

- *Chemical, Hazardous, and Universal Waste*
- *Compressed Gas Safety Guide*
- *Electrical Safety Guide*
- *Flammable and Combustible Liquid Safety Guide*
- *Hand and Power Tool Safety Guide*
- *Machine and Machine Shop Safety Guide*
- *Materials Handling Safety Guide*
- *Oil and Chemical Spill Response*
- *Walking and Working Surfaces Safety Guide*
- *Welding and Cutting (Hot Work) Safety Guide*

These Guides are referenced throughout the manual and are available on the EHS website (ehs.gmu.edu) and in the *University Safety Manual* located within the *Right-To-Know Stations*.

6.0 Engineering Controls

Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection. This can be achieved by elimination, or minimization of the hazard. The hazard could also be isolated, enclosed, or redirected.

6.1 Chemical Substitution

One of the major ways to reduce the hazards associated with chemical substances is the substitution of the hazardous chemical by less hazardous alternatives and using the safest materials and processes possible. When deciding if substitution is a viable alternative:

- Use the least toxic solvents possible. Examples include denatured alcohol, isopropyl alcohol, acetone, and odorless mineral spirits.
- Eliminate toxic metals such as lead and cadmium. Use cadmium-free silver solders and lead-free glazes and enamels.
- Use water-based materials instead of solvent-based ones.
- Use liquid materials to replace powders, e.g. wet clay or water-based dyes instead of dry clay or powdered dyes.
- Use wet techniques such as wet sanding and wet grinding instead of dry techniques.
- Apply coatings by brushing or dipping instead of spraying.
- Eliminate cancer-causing agents such as asbestos, cadmium, lead and zinc chromate, benzene, and chromate copper arsenate.

Note: It is important when substituting one material for another to allow sufficient time to learn how to use the substitute properly, and to ensure that the substitute does not introduce a different set of hazards.

6.2 Ventilation

Maintaining a clean indoor air environment in the studio and during art procedures is an important way to prevent chemical exposures. This can be accomplished through the use of air cleaning and pollution control systems such as HEPA filters, dust collection systems, paint booths, welding fume collectors, etc.

There are two types of ventilation for toxic substances: dilution ventilation and local exhaust ventilation. Dilution ventilation involves bringing in clean air to dilute the contaminated air, and then exhausting the diluted air to the outside via exhaust fans. Dilution Ventilation should not be used to exhaust highly toxic solvent vapors or particulates. The exhausted air should be completely exhausted to the outside and not re-circulated.

Local Exhaust Ventilation utilizes a hood, slots, or a down draft to capture the contaminants at the source, ducts to transport them to the outside, an exhaust fan to move the air, and sometimes air cleaners to remove particulates from the air. Examples of typical local exhaust systems for art operations include slot exhaust hoods for cleaning etching plates, enclosed hoods for acid etching, spray booths for spray painting and spray glazes, movable exhaust hoods for welding, and dust-collecting hoods for woodshops. A canopy hood should never be used for the control of hazardous exhaust.

When using local exhaust ventilation, enclose the process as much as possible and place the hood as close to the operation as possible. Make sure to have the system evaluated by EHS as proper air flow is important and may require annual certification.

7.0 Administrative Controls

Administrative controls work with engineering controls and PPE to reduce exposure to hazards in the work place. They include implementing safe work practices such as written standard operating procedures (SOP), monitoring the use of highly hazardous materials and the use of alarms, warning signs, and a buddy system where necessary. Training is also an administrative control.

7.1 Training

All persons working in an art studio or participating in creative activities that use hazardous materials must attend *Art Safety Training* within 30 days of employment and annually thereafter. This training provides an overview of the policies and safety practices that must be observed when working with hazardous materials. *Art Safety Training* provides guidance on how to identify hazards, wear proper personal protection equipment, safety equipment, disposal of hazardous waste, and develop good safety habits. This course satisfies regulatory requirements for Hazard Communication, or Right-to-Know training, in the context of the art studio. To register, email EHS at safety@gmu.edu.

7.2 Personal Protective Equipment

Personal protective equipment (PPE) is used whenever engineering and/or administrative controls are not viable or do not adequately protect employees from hazards. PPE serves to prevent or minimize the exposure to hazards including hazardous chemicals. Examples of PPE are; gloves, eye protection, face protection, respiratory protection, aprons, hearing protection, and uniforms. Any employee expected to work with hazardous chemicals must review the MSDS to determine what PPE is required to be worn. Supervisors must review non-routine and routine work tasks and contact EHS to conduct PPE assessment in order to provide employees with appropriate PPE.

Selection of PPE should be centralized to ensure that proper equipment is chosen, and that training is given on its proper use and maintenance. A variety of sizes should be made available as one size will not fit everyone. It is essential to choose PPE that is specific to the hazard and type of work to be performed. PPE must be compatible, provide proper dexterity, limit interference, fit properly, and be comfortable.

Employees who are required to wear PPE must be trained in the following:

- When PPE is necessary
- What PPE is necessary
- How to wear the PPE
- How to adjust the PPE
- How to store and dispose of PPE

Employees must demonstrate an understanding of the training and an ability to use PPE before being allowed to perform work requiring its use. Retraining is necessary if an employee doesn't show this understanding or skill, or if changes in the workplace or types of PPE make previous training obsolete. Please contact EHS for assistance in assessing proper PPE and to assist with training on PPE use.

7.2.1 Respiratory Protection

Harmful chemical vapors and particulates may be release into the atmosphere while sanding, welding and grinding, working with organic solvents thinners or degreasing, painting or using epoxies, abrasive blasting, and scraping or sanding surfaces that are coated with lead-based paints. George Mason University's *Respiratory Protection Program* (available at ehs.gmu.edu) has been developed to protect employees from exposure to respiratory hazards and complies with OSHA standard 29 CFR 1910.134. EHS administers the *Respiratory Protection Program*, including conducting air monitoring to evaluate occupational exposure to harmful chemical vapors and particulates and determining inclusion in the Program.

To evaluate occupational personal exposure to respiratory hazards, employees wear a portable air sampling pump attached which draws air through a sampling media for the duration of the workshift or task. The collected sample is analyzed by a laboratory currently accredited by the American Industrial Hygiene Association (AIHA) Industrial Hygiene Laboratory Accreditation Program (IHLAP). The samples are analyzed to determine a time-weighted average of occupational noise exposure which is compared to the applicable OSHA action level and Permissible Exposure Limit (PEL) per eight-hour workshift. The OSHA action level is typically equal to one-half of the PEL.

Based on the measured concentration of a respiratory hazard, EHS may identify control engineering or administrative control measures to reduce the employee exposure to these hazards. Where these methods are not possible or practical, respiratory protection may be required. Employees exposed to respiratory hazards in excess of the OSHA action level or PEL are included in the *Respiratory Protection Program*, which includes exposure monitoring, medical evaluations, engineering and administrative controls, issuance of respiratory protection, annual fit testing and training, recordkeeping, and program evaluation.

7.2.2 Hearing Protection

Noise can be caused by vibration, forging, machinery, power tools, exhaust fans, and old or improperly maintained equipment. George Mason University's *Hearing Conservation Program* (available at ehs.gmu.edu) has been developed to protect employees from exposure to excessive noise and complies with OSHA standard 29 CFR 1910.95. EHS administers the *Hearing Conservation Program* and conducts noise monitoring to evaluate occupational noise exposure and determine inclusion in the *Program* as well as to evaluate the noise output from a source.

To evaluate occupational noise exposure, employees wear a dosimeter for the duration of the workshift or task. The dosimeter calculates a time-weighted average of occupational noise exposure which is compared to the OSHA action level of 85 dBA per eight-hour workshift with a 5 dBA doubling rate. Employees exposed to occupational noise in excess of the OSHA action level are included in the *Hearing Conservation Program*, which includes exposure monitoring, audiometric testing, engineering and administrative controls, hearing protection devices (HPD), annual training, recordkeeping, and program evaluation.

To evaluate a noise source, EHS measures the noise output from a source using a sound level meter. The sound level meter records the measured sound intensity at the various octave bands. Based on noise output from a source, EHS may identify noise control measures such as quieter machines, isolation, proper maintenance, silencers and mufflers, vibration isolators (shock absorbers) and sound insulation. Where these methods are not possible or practical, PPE may be required.

8.0 Displaying Art

Art is displayed throughout campus and the School of Art. Safety precautions should be observed when mounting and displaying art work including sculptures. General safety considerations include:

- Safe clearance should be maintained around sharp edges, protruding pieces, or other trip hazards.
- Extension cords are only to be used as a temporary means of providing electricity where needed. Using extension cords is not appropriate for displaying art.
- Art work must be compatible with display lighting and corresponding heat load.
- Unsecure hazardous materials may not be displayed as part of an art exhibit.
- Art work should not be displayed where they would pose a hazard to others.
- Art work should be secured to limit vandalism and theft.

The following safety guides should be referenced when displaying art:

- *Electrical Safety Guide*
- *Hand and Power Tool Safety Guide*
- *Materials Handling Safety Guide*
- *Walking and Working Surfaces Safety Guide*

The EHS office also offers Ladder Safety training to employees as needed.

Appendix A: Definitions

ACCELERATOR: a chemical, usually an alkali, added to a developer to increase the rate of development. An accelerator is added to oil paints to speed drying (also called a "drier"), and to polyester resin to promote curing.

ACID BATH- A term used in heat treating and tempering of steel.

ACID-TYPE HAND CLEANER: Is often used when handling color developers. Wash gloves with an acid-type hand cleaner (e.g., pHisoderm®) and then water before removing them. According to Kodak, barrier creams are not effective in preventing sensitization due to color developers.

ADDITIVE COLOR: Color resulting from the mixture of two or more colored lights, the visual blending of separate spots of transmitted colored light.

ALCOHOL LAMP: Used to heat modeling tools for wax detailing; alcohol fueled with wick or possible spout for flame direction.

ANSI-APPROVED GOGGLES: The American National Standards Institute or ANSI is a nonprofit group that publishes standards for equipment for industry. Lenses shall resist impact from a 25.4 mm diameter steel ball dropped from 127 cm. It is universally agreed that the use of proper eye protection is required of everyone who enters a chemical work area.

ANTIFOGGING AGENT: Prevents the condensation of water on a surface in the form of small droplets which resemble fog.

ART: The class of objects subject to aesthetic criteria; works of art collectively, as paintings, sculptures, or drawings: a museum of art; an art collection.

AUTOMATIC PROCESSORS: reduces film processing time when compared to manual development by a factor of four.

BASELINE FORMALDEHYDE MONITORING: Monitors personnel exposure levels to formaldehyde vapor. Formaldehyde is a chemical compound. Because of its widespread use, toxicity and volatility exposure to formaldehyde is a significant consideration for human health.

BLOWPIPE: Is a narrow tube by means of which a stream or jet of air or a specific gas or gas mix can be directed onto a flame to concentrate or increase heat.

BRAZING: Is a joining process whereby a filler metal or alloy is heated to melting temperature above 800 °F (427 °C)—and distributed between two or more close-fitting parts by capillary action.

BUFFER: to cushion, shield, or protect.
BUTYL RUBBER GLOVES: Are impermeable to water vapors, gases and toxic chemicals. They provide superior resistance to and most oxygenated oxidizing chemicals.

CARBON ARC WELDING (CAW): Is a process which produces coalescence of metals by heating them with an arc between a non consumable carbon (graphite) electrode and the work-piece.

CENTRAL ACCUMULATION AREA (CAA): The CAA is the point of central or bulk accumulation of hazardous wastes prior to shipment to an offsite disposal facility and has been registered with the state.

CHEMICAL FUME HOOD: (as defined by OSHA in 29 CFR 1910.1450) Device located in a laboratory, enclosed on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the individual's body other than hands and arms.

CHEMICAL WASTE: Solid or liquid laboratory waste containing chemicals that must be disposed of through George Mason University's chemical waste management program.

COMBUSTION: is a complex sequence of exothermic chemical reactions between a fuel (usually a hydrocarbon) and an oxidant accompanied by the production of heat or both heat and light in the form of either a glow or flames, appearance of light flickering.

CONE-OPERATED SHUT-OFF: A shutoff-valve, for high pressures, has a common pressure chamber for a differential piston driven by the liquid or gas and the control piston in the form of a cone.

CONTACT ADHESIVES: Bond to materials when applied.

CORROSIVE: A substance that causes visible destruction or permanent changes in human skin tissue at the site of contact; having a pH less than 2 or greater than 11.5.

DEHP: Also referred to as Bis(2-ethylhexyl)phthalate. DEHP is an organic compound and is widely used as a plasticizer in manufacturing of articles made of PVC. It can also be used as a hydraulic fluid and as a dielectric fluid in capacitors. DEHP also finds use as a solvent in lightsticks.

DEVELOPERS: A reducing agent or solution for developing a film or the like.

DEVELOPING BATHS: The most commonly used developers are hydroquinone, monomethyl para-amino 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.
DIAZO-SENSITIZING SOLUTIONS: Developers with highly toxic solvents.

DILUTION VENTILATION: Is usually accomplished with the use of large exhaust fans in the walls or roof of a building or room.

DOUBLE BOILER: A utensil consisting of two pots, one of which fits partway into the other: water is boiled in the lower pot to warm or melt a substance in the upper.

DRYPOINT: A technique of intaglio engraving in which a hard steel needle is used to incise lines in a metal, usually copper plate, with the rough burr at the sides of the incised lines often retained to produce a velvety black tone in the print.

DUST COLLECTOR: Designed to handle heavy dust loads, consists of a blower, dust filter, a filter-cleaning system, and a dust receptacle or dust removal system.

EGRESS: A means or place of exit; especially from an enclosed space.

ELECTRIC KILNS: Generally has a series of tangentially aligned burners firing the underside of the kiln shell. Heat is released through combustion, and combustion requires a continuous supply of air being introduced into the furnace to oxidize the fuel.

EMISSIONS: A substance discharged into the air, especially by an internal combustion engine

EMULSION: The coating of photosensitive silver halide grains in a thin gelatin layer on a photographic film

ENCLOSED HOOD: Provides adequate local exhaust ventilation. An enclosed hood requires a lower exhaust rate and therefore less makeup air.

ENERGIZED ELECTRICAL EQUIPTMENT: Examples of energized electrical equipment are transformers, substations, and electric vaults to name a few. Electricity will travel any conductive path it can as it seeks a ground. A direct path to ground can occur when contact is made between something energized and a portion of your body such as your hand, arm, head, or other body part. An indirect path to ground occurs when you are holding something or touching an object that is in contact with something energized. This could include tools or other equipment you may be holding or when touching a fence, vehicle, or other object that may be in contact with something energized.

ERGONOMIC EVALUATIONS: Assessment of the workplace and tasks performed, specifically paying attention to safety, comfort, ease of use, productivity/performance, and aesthetics in order to improve working conditions and reduce or prevent injuries on the job.

ETCHING: The act or process of making designs or pictures on a metal plate, glass, etc., by the corrosive action of an acid instead of by a burin.

FIRE RETARDANTS: A substance that helps delay or prevent combustion.
FIXATIVE: A solution, usually of shellac and alcohol, sprayed onto drawings, to prevent their smudging or crumbling off the support.

FIXATIVE SPARY: For fixing charcoal drawing on canvas before painting. Fixative spray is available in spray cans, or for use with mouth atomizer.

FIXING BATH: Used in film processing, dissolves only silver halide crystals, leaving the silver metal behind.

FRACTURIZING: To break or go beyond the limits or tolerance of an object, usually occurring in bronze casting or ceramic firing. Can also be a break in a boulder to be used in stone carving.

FUEL-FIRED KILNS: Are used for cement, wood, and chemical processing. They are especially adapted for utilizing solid fuel in which one or more burners are accommodated within the kiln and a fuel and air mixture and a supplementary air supply are supplied to the combustion chamber of the burner through a pair of conduits arranged in heat exchange relationship one inside the other.

FUME HOODS - These specialized, fixed cabinets contain and draw in contaminants and vent the contaminated air remotely (usually through a stack on the roof of the building). A good supply of properly conditioned makeup air is required so these systems require professional

GALVANIZED DUCTS: Air path to lead out of an enclosed area.

GROUND FAULT INTERRUPTERS (GFCIs): Are designed to protect people from severe or fatal electric shocks. Since a GFCI detects ground faults, it can also prevent some electrical fires and reduce the severity of others by interrupting the flow of electric current.

HAZARDOUS CHEMICAL: A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

HAZARDOUS MATERIALS: A substance, natural or man-made, which is intrinsically dangerous or otherwise poses a safety hazard. Examples are materials which are explosive, poisonous, chemically active (including acids and other corrosives), radioactive, or biologically active (including human blood and other medical waste).

HAZARDOUS SUBSTANCE: Any material that may present a danger to human health and welfare or the environment. This includes hazardous chemicals biohazardous materials, and sources of ionizing radiation.

HAZARDOUS WASTE: A waste with properties that make it dangerous or potentially harmful to human health or the environment and exhibits at least one of the four characteristics: ignitability, corrosivity, reactivity, or toxicity.

HEARING PROTECTION: Devices designed to prevent Noise-Induced Hearing Loss (NIHL), a type of post-lingual hearing impairment.

HEPA FILTER (High Efficiency Particulate Air Filter): A disposable, extended medium, dry type filter with a particle removal efficiency of no less than 99.97 percent for 0.3m particles.

HEPA VACUUM: Contains a special filter that is able to trap very fine dust particles that are too small to see. This type of filter is called a High Efficiency Particulate Air (HEPA) filter.

HIGH VELOCITY STACK FANS: Are ideally suited to exhausting contaminants from ventilation systems where corrosion is also a concern.

HIGHLY TOXIC: Referring to a chemical that 1. Has a median lethal dose–LD_{50} of ≤ 50 mg/kg when administered orally to 200-300 g albino rats 2. Has an LD_{50} of ≤ 200 mg/kg when administered by continuous contact for 24 hrs on the shaved skin of 2.0-3.0 kg albino rabbits 3. Has an LD_{50} of ≤ 200 ppm of volume of gas or vapor, or ≤ 2 mg/L of mist or dust, when administered by continuous inhalation to 200-300 g albino rats.

INFRARED RADIATION: Invisible radiation in the part of the electromagnetic spectrum characterized by wavelengths just longer than those of ordinary visible red light and shorter than those of microwaves or radio waves.

INTAGLIO: The process of incising a design beneath the surface of a metal or stone. Plates are inked only in the etched depressions on the plates and then the plate surface is wiped clean. The ink is then transferred onto the paper through an etching press. The reverse of this process is known as relief printing.

INTENSIFIERS: 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.

KPR: Koester Performance Research is a technology company with an emphasis on the needs of people who have disabilities.

LATHES: A machine for use in working wood, metal, etc. that holds the material and rotates it about a horizontal axis against a tool that shapes it.

LITOGRAPHY: Printing technique using a planographic process in which prints are pulled on a special press from a flat stone or metal surface that has been chemically sensitized so that ink sticks only to the design areas and is repelled by the non-image areas.

LOCAL EXHAUST VENTILATION: Is a form of engineering control that encloses the material, equipment or process as much as possible and ensures that air flow is into the enclosure at necessary rates.

LOCAL EXHAUST: Protects workers from contaminants as well as excessive heat exposure.

MATERIAL SAFETY DATA SHEET (MSDS): A standard formatted information sheet prepared by a material manufacturer, describing the potential hazards, physical properties, and procedures for safe use of a material.

MSDS LIBRARY: Binder or book present in each "Right-To-Know" station that contains MSDS for each chemical and biohazardous material present in the studio.

MEDICAL SURVEILLANCE PROGRAM: The process of evaluating the health of employees as it relates to their potential occupational exposures to hazardous agents.

METAL FABRICATION: Process that involves the construction of machines and structures from various raw materials.

METAL HAILDE LAMPS: Produce a bright, white light with the best color rendition among high-intensity lighting types.

METAL SNIPS: Tool used to cut thin sheet metal.

MEZZOTINT: A reverse engraving process used on a copper or steel plate to produce illustrations in relief with effects of light and shadow. The surface of a master plate is roughened with a tool called a rocker so that if inked, it will print solid black. The areas to be white or gray in the print are rubbed down so as not to take ink. It was widely used in the 18th and 19th centuries to reproduce portraits and other paintings, but became obsolete with the introduction of photo-engraving.
N-95, N-99 NIOSH: National Institute of Occupational Safety and Health, filtering facepieces (N95 or N-99 respirator). Please refer to the *Respirator Protection Program* for more information.

NEGATIVES: Noting an image in which the brightness values of the subject are reproduced so that the lightest areas are shown as the darkest.

NEUTRALIZERS: To counterbalance or counteract the effect of; render ineffective.

NIOSH: The National Institute for Occupational Safety and Health is a federal agency. It conducts research on health and safety concerns, tests and certifies respirators, and trains occupational health and safety professionals.
NOISE ASSESSMENT: EHS will conduct representative noise exposure monitoring according to the Exposure Monitoring Standard Operating Procedures to identify employees in similar exposure groups for inclusion in the Hearing Conservation Program and to enable proper selection of hearing protection devices.

OPAQUE: A paint that is not transparent by nature or intentionally. A dense paint that obscures or totally hides the underpainting in any given artwork.

ORGANIC VAPOR CARTRIDGES: Cartridges come in half face or full face versions, and are used when handling solvents, paints, etc.

OXIDIZER: A substance that gives up oxygen readily. Presence of an oxidizer increases the fire hazard.

OXIDIZING AGENTS: A chemical compound that readily transfers oxygen atoms.

PERSONAL PROTECTIVE EQUIPTMENT (PPE): Clothing and other work accessories designed to create a barrier against workplace hazards. Examples include safety goggles, blast shields, hard hats, hearing protectors, gloves, respirators, aprons, and work boots.

PHOTOFLOOD: Light that is a source of artificial illumination having a broad beam; used in photography

PHOTOFLOOD LAMP: An incandescent lamp used in photography which has a high-temperature filament, so that it gives high illumination and high color temperature for a short lifetime.

PICKLING BATHS: A cleaning process for bronze and other metals.

PILOT LIGHT: A small jet of gas that is kept burning in order to ignite a gas burner, as in a stove.

PNEUMATIC TOOLS: Instrument activated by air pressure. Pneumatic tools are designed around three basic devices: the air cylinder, the vane motor, and the sprayer.

PORTLAND CEMENT: A hydraulic cement made by heating a limestone and clay mixture in a kiln and pulverizing the resulting material.

POWDERED PIGMENTS: In paint, the pigment in a powered substance which, when mixed in the liquid

PRESENSITIZED PLATES: A printing plate used in offset lithography that has been pretreated with a light-sensitive coating.

PRESERVATIVES: Is a natural or synthetic chemical that is added to products to prevent decomposition by microbial growth or by undesirable chemical change.
PROTECTIVE APRON: Aprons offer a broad spectrum of protection. Neoprene styles are resistant to a wide range of chemicals. Hycar styles (a tough nitrile blend) are ideal for grease and animal fats in cold conditions, while Urethane styles offer lightweight comfort and long wear.

PYROMETER: Is a non-contacting device that intercepts and measures thermal radiation. This device can be used to determine the temperature of an object's surface.

PULVERIZED: To reduce to dust or powder, as by pounding or grinding.

REDUCERS: Common after-treatment of negatives (and occasionally prints) is either intensification or reduction. 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.

RELIEF PRINTING: All printing processes in which the non-printing areas of the block or plate are carved, engraved or etched away. Inks are applied onto the projected surface and transferred onto the paper. The reverse process is known as intaglio printing.

RESTRAINER: A chemical added to a developer to retard its action.

SANDSTONE: A sedimentary rock formed by the compacting of grit or sand with a high silica content bound in a natural cement — the silica itself. Many sandstones are soft and easily eroded, but some are quite hard and durable. Sandstone is generally more difficult to carve than limestone, for the particles wear down the metal of the chisel. Some sandstone can be polished.

SATELLITE ACCUMULATION AREAS: A satellite accumulation area is space within the work area designated for the temporary accumulation and storage of hazardous waste. EHS will collect hazardous wastes from satellite accumulation areas on a routine basis.

SCREEN PRINTING: Is a printing technique that uses a woven mesh to support an ink-blocking stencil. The attached stencil forms open areas of mesh that transfer ink as a sharp-edged image onto a substrate. A roller or squeegee is moved across the screen stencil, forcing or pumping ink past the threads of the woven mesh in the open areas.

SENSITIZERS: A substance which on first exposure causes little or no reaction but which on repeated exposure may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form of sensitization in the industrial setting

SHELLAC: Lac that has been purified and formed into thin sheets, used for making varnish.

SLOT HOOD: There are many types of slot hoods, each suited for different types of operations. In general, a slot hood requires less airflow than a canopy hood and is much more effective than an elephant trunk or canopy hood, when installed properly. Slot hoods are best used for operations that require more working room than a fume hood and where a limited number of low toxicity chemicals are used.
SOAPSTONE: A soft metamorphic rock composed mostly of the mineral talc. Soapstone is highly toxic by inhalation because it contains large amounts of free silica.

SOLDERING IRON: A tool used for applying heat to two adjoining metal parts such that solder may melt and flow between those parts, binding them securely and conductively.

SOLDERING: A process in which two or more metal items are joined together by melting and flowing a filler metal into the joint. The filler metal has a relatively low melting point.

SPONTANEOUS COMBUSTION: Ignition of a substance or body from the rapid oxidation of its own constituents without heat from any external source.

SPRAY BOOTH: A pressure controlled closed environment, used to paint objects. To ensure the ideal working conditions (temperature, air flow, humidity), these environments are equipped with one or more groups of ventilation, consisting of one or more engines and one or more burners to heat the air blown.

SPRAY FIXITIVES: A fixative substance, as a gummy liquid sprayed on a drawing to prevent blurring, or a solution for killing, hardening, and preserving material for microscopic study.

STABILIZERS: A substance, added to a fast-drying oil paint to improve the dispersion of pigment.

STOP BATH: A chemical bath usually used in processing traditional black-and-white photographic films, plates, and paper used after the material has finished developing. The purpose of the stop bath is to halt the development of the film, plate, or paper by either washing off the developing chemical or neutralizing it.

SYNERGEST EFFECT: The cooperative action of two or more stimuli or drugs.

TOXIC MATERIALS: Materials that are carcinogenic, teratogenic or pose an inhalation hazard. Examples: pesticides, solvents, cyanides, and heavy metals.

TOXIC PIGMENTS: Poisonous; capable of causing injury or death. Among toxic art materials are many solvents and adhesives; whose dry pigment (finely powered color material) should never be handled.

TRAY PROCESSING: The tray method is used primarily for processing only a few sheets of film.

UNIVERSAL WASTE: Universal wastes are common products that exhibit hazardous waste characteristics but are regulated differently to reduce the regulatory burden on waste generators.

VAPORIZE: To convert into vapor from a liquid or a solid, as by the application of heat, whether naturally or artificially.

VASELINE: A yellowish translucent substance, almost odorless and tasteless, obtained as a residue in the purification of crude petroleum, and consisting essentially of a mixture of several

of the higher members of the paraffin series. It is used as an unguent, and for various purposes in the arts.

VENTILATION: Is the process of supplying fresh air to an enclosed space in order to refresh/remove/replace the existing atmosphere. Ventilation is commonly used to remove contaminants such as fumes, dusts or vapors and provide a healthy and safe working environment; in other words, it is an engineering control. Ventilation can be accomplished by natural means (e.g., opening a window) or mechanical means (e.g., fans or blowers).

VISE: A mechanical screw apparatus used for holding or clamping a work piece to allow work to be performed on it with tools such as saws, planes, drills, mills, screwdrivers, sandpaper, etc. Vises usually have one fixed jaw and another, parallel, jaw which is moved towards or away from the fixed jaw by the screw.

Appendix B: Known or Probable Carcinogens/Highly Toxic Pigments

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

Appendix C: Moderately Toxic Pigments/Slightly Toxic Pigments

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

Appendix D: Incompatibilities of Common Art Materials

Chemical	Incompatibilities
Acetic acid	chromates, dichromates, chlorates, nitric acid, hydrogen, peroxide, and other oxidizers
Acids, inorganic	alkalis, hypochlorite bleach, sulfides, metals
Alkalis	acids, aluminum
Ammonium hydroxide	silver, chlorine, bromine, mercury, acids
Chlorinated hydrocarbons	ultraviolet radiation, aluminum
Chromates and dichromates	glacial acetic acid, camphor, glycerin, naphthalene, turpentine, and many other flammable liquids
Copper	hydrogen peroxide, many acids, acetylene
Cyanides, inorganic	acids, alkalis
Flammable liquids	chromates, dichromates, chlorates, nitric acid, hydrogen peroxide, and other oxidizers
Hydrofluoric acid	ammonium hydroxide, glass
Hydrogen peroxide (concentrated)	most metals and their salts, organic substances, many flammable liquids
Mercury	nitric acid, ammonia
Nitrates, inorganic	metals, sulfuric acid, sulfides,
Nitric acid	metals, sulfuric acid, sulfides, nitrites, solvents, combustible materials, chromates, dichromates
Peroxides, organic	acetone, heat
Potassium chlorate	ammonium salts, acids, metal powders, finely divided organic or combustible substances
Silver	acetylene, ammonia compounds, oxalic acid, tartaric acid
Sulfides, inorganic	acids
Sulfites, bisulfites	acids
Sulfuric acid	nitric acid, metals, chlorates, permanganates

Appendix E: Information for Employees Using Respirators When Not Required Under the OSHA Standard

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If the employer provides respirators for voluntary use, or if you provide your own respirator, follow the procedures outlined below so that the respirator itself does not present a hazard:

1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirators limitations.

2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.

3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.

4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

Acknowledgement of Voluntary Use of Filtering Facepiece Respirator

I have read and understand the contents of 29 CFR 1910.134, Appendix D *(Mandatory) Information for Employees Using Respirators When Not Required Under Standard.*

Date	G#	Name	Signature

Note: Completed forms should be sent to EHS at fax number 703-993-8996 or copy mailed to MSN 5E2.