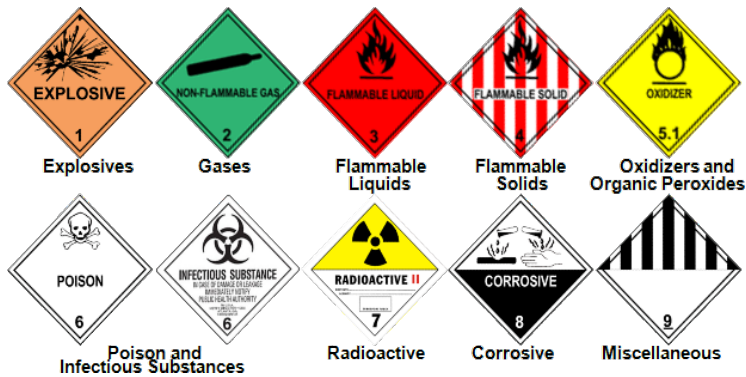


UNIVERSITY OF
ARKANSAS



GENERAL CLASSES OF HAZARDOUS CHEMICALS

Office of Environmental Health and Safety

Contents

FLAMMABLE AND COMBUSTIBLE CHEMICALS	4
Flammable Liquids (Class I).....	4
Combustible Liquids (Classes II and III).....	4
Control Measures	4
Training and Information	4
Substitution / Chemical Management.....	5
Ventilation	5
Work Practices	5
Personal Protective Equipment (PPE).....	5
Storage.....	5
Spill Cleanup	6
Hazard Assessment.....	6
Other Considerations.....	6
CORROSIVE MATERIALS	7
Control Measures	7
Training and Information	7
Ventilation	7
Work Practices	7
Personal Protective Equipment.....	7
Storage.....	8
Spill Cleanup	8
CARCINOGENS	8
Signs and Labels	9
Designated Area	9
Personal Protective Equipment.....	9
Hazard Assessment.....	9
Vacuum Equipment.....	10
Waste Disposal	10
Decontamination Procedure.....	10
OXIDIZING CHEMICAL	10
NFPA Class 1 Oxidizers (Relatively Stable)	10
NFPA Class 2 Oxidizers (moderately unstable).....	11
NFPA Class 3 Oxidizers (less stable than class 2).....	11
NFPA Class 4 Oxidizers (unstable).....	11
Signs and Labels	11
Personal Protective Equipment.....	11
Handling of Oxidizing Materials.....	12
Storage.....	12
Vacuum Protection	12
Waste Disposal	12
Decontamination Procedure.....	12
ETHERS AND PEROXIDES	12
CLASS 1	13
CLASS II	13
CLASS III	13
Working with Ethers and Other Peroxides.....	13
Storage of Ethers and Peroxides	14
Testing for Peroxides.....	14
REACTIVE CHEMICALS	14
Signs and Labels	15
Personal Protective Equipment.....	15

Storage.....	15
Hazard Assessment.....	15
Vacuum Protection	15
Waste Disposal	15
Decontamination	16
TOXIC CHEMICALS	16
Reproductive Toxins.....	17
Signs and Labels	18
Personal Protective Equipment.....	18
Vacuum Protection	18
Hazard Assessment.....	18
Storage.....	19
Waste Disposal	19
Decontamination	19
WATER SENSITIVE CHEMICALS	19
Signs and Labels	20
Personal Protective Equipment.....	20
Storage.....	20
Hazard Assessment.....	20
Decontamination	20
Waste Disposal	21
COMPRESSED GASES	21
Responsibilities	21
General guidelines	21
Storage.....	22
Transport.....	23
Hazard Assessment.....	23
Personal Protective Equipment.....	23
Waste Disposal	23
NANOMATERIALS.....	23
Standard Operating Procedures for the Handling of Nanoparticles	23
Working with Solutions or Suspension of Particles	24
Working with dry powders – not recommended.....	24
Work Involving Animals	24
PERCHLORIC ACID.....	25
Cold Perchloric Acid (Less than 72% concentrated at room temperature)	25
Heated Perchloric Acid (less than 72% concentrated).....	25
Anhydrous Perchloric Acid (more than 85% concentrated).....	26
Storage.....	26
PICRIC ACID	26
Storage of Picric Acid	27



FLAMMABLE AND COMBUSTIBLE CHEMICALS

Flammable and combustible chemicals include liquids such as organic solvents, oils, greases, tars, oil base paints, and lacquers as well as flammable gases. Flammable and combustible liquids are defined by their flash points. The flash point of a liquid is the minimum temperature at which it gives off sufficient vapor to form an ignitable mixture with the air near its surface or within its containment vessel. As a general rule, the lower the flash point of a liquid, the greater the fire and explosion hazard.

Flammable and combustible liquids are classified by and divided into classes by the National Fire Protection Association based on their flash points:

Flammable Liquids (Class I)

Liquids having flash points below 100°F (37.8°C) and having vapor pressures not exceeding 40 pounds per square inch (absolute) at 100°F (37.8°C).

Flammable Class I liquids are subdivided as follows:

- Class IA: Liquids having flash points below 73°F (22.8°C) and boiling points below 100°F (37.8°C). Flammable aerosols (spray cans) are included in Class IA.
- Class IB: Liquids having flash points below 73°F (22.8°C) and having boiling points at or above 100°F (37.8°C).
- Class IC: Liquids having flash points at or above 73°F (22.8°C) and below 100°F (37.8°C). The boiling point is not considered.

Combustible Liquids (Classes II and III)

Liquids having flash points at or above 100°F (37.8°C). Combustible liquids in Classes II and III are subdivided as follows:

- Class II: Liquids having flash points at or above 100°F (37.8°C) and below 140°F (60.0°C).
- Class IIIA: Liquids having flash points at or above 140°F (60.0°C) and below 200°F (93.4°C).
- Class IIIB: Liquids having flash points at or above 200°F (93.4°C).

Control Measures

PIs and Supervisors are responsible for identifying flammable and combustible liquids used in their respective work areas. MSDS for specific compounds should be reviewed. An evaluation of the controls in place is necessary to limit employee exposures to these agents. For assistance in performing evaluations, contact EH&S at 575-5448. Some operations involving flammable and combustible liquids may need to be approved by the EH&S and/or the TSC.

Training and Information

- Employees who handle or who may be exposed to hazardous materials must be trained in the specific hazards and controls of the materials being handled. Providing for area-specific training for handling flammable and combustible materials is the responsibility of the PI. EH&S is available to provide assistance.
- Primary and secondary containers must be labeled with the identity and classification of the substance.
- The entrance to the work area shall be posted with a caution placard (NFPA diamond) depicting the hazards.

Substitution / Chemical Management

- The PI or supervisor should determine whether a safer chemical alternative (i.e., materials with higher flash points and boiling points) is available.
- Keep working quantities of flammable and combustible liquids to a minimum.

Ventilation

- A chemical fume hood or other appropriate exhaust ventilation system must be used when handling flammable and combustible liquids in a manner that may produce vapors. This includes procedures such as transfer operations, preparation of mixtures, blending, sonication, spraying, heating, and distilling.

Work Practices

- Control all ignition sources when handling flammable and combustible liquids.
- Electrically bond and ground containers when transferring Class I flammable liquids and other flammable and combustible liquids at temperatures above their flashpoints.
- Use a mechanical aid or a pipette bulb for pipetting.
- Open bottles or carboys slowly and carefully and wear protective equipment to guard hands, face, and body from splashes and vapors/gases.
- Wipe drips/residues from containers and work surfaces.
- Wash hands before leaving the work area and prior to consuming food/beverages.

Personal Protective Equipment (PPE)

General guidelines are presented below:

- At a minimum, safety glasses with side shields, laboratory coats (or appropriate coveralls in shop settings) and closed toed shoes will be worn when handling flammable and combustible materials.
- Additional PPE such as face shields, chemical aprons, disposable coveralls, chemically resistant gloves and respiratory protection must be worn as appropriate.

Storage

- Glass containers of no more than 1 gallon capacity may be used for Class IA or IB flammable liquids if such liquid would be rendered unfit for its intended use by contact with metal or would excessively corrode a metal container so as to create leakage hazard. **Note: this exemption does not apply to the accumulation of non-corrosive ignitable hazardous waste.**
- Flammable liquids must be stored in appropriately designed flammable liquid cabinets. Reagent bottles should be returned to the cabinets in a timely manner and should not accumulate on the bench top. Cabinet doors shall be kept in the closed position. Bulk storage of solvents should be done in areas specifically designed for this function. EHS personnel should be consulted if large quantities of flammable liquids are to be stored. Note that gravity flow shall not be used to transfer flammable liquids.
- A maximum of 180 gallons of flammable and combustible liquids with a flash point of < 140 °F can be stored in a fire area (room with one-hour fire rated walls and self closing 20-minute fire rated door). This amount must be stored in the following manner:

- Not more than 10 gallons in containers or 25 gallons in safety cans shall be located outside a flammable storage cabinet.
- Not more than 60 gallons in a flammable storage cabinet.
- Not more than 3 flammable storage cabinets per laboratory.
- In addition to the 180 gallons as stated above, a maximum of 60 gallons of combustible liquids with a flash point 140 °F and < 200 °F can be stored outside of a flammable liquids cabinet.
- There is no gallon limit to combustible liquids with a flash point of 200 °F in a fire area.

Spill Cleanup

- Laboratory/Shop personnel may clean up small spills of flammable and combustible liquids provided that all of the following conditions are met:
 - The hazards of the material(s) are known, and appropriate precautions can be taken to prevent personal exposure.
 - Ensure that all ignition sources are controlled during clean up.
 - There is no potential of a release to the environment.
 - There are no personal injuries.
 - The clean up procedures are known and the proper equipment (e.g., PPE and spill cleanup materials) is available.
 - The spill can be cleaned up safely by two people in one hour or less.
 - The spill does not involve elemental mercury. Special cleanup and air monitoring is required. Contact an EH&S for assistance.
 - If all of these conditions are not met then EH&S (575-5448) should be summoned for spill response.

Hazard Assessment

- The following factors need to be considered when assessing risks of working with flammable liquids, their hazards due to the toxic effects of chemicals, hazards due to flammability, explosion potential and reactivity.
- Flammable liquids are those that readily catch fire and burn in air. For a fire to occur, three conditions must exist simultaneously: an oxidizing atmosphere, usually air, a concentration of flammable gas or vapor that is within the flammable limits of the substance, and a source of ignition. In most situations, oxygen or air is present. Prevention of the coexistence of flammable vapors and an ignition source is the optimal way to deal with the hazard. When the vapor of a flammable liquid cannot be controlled, strict control of ignition sources is the only way to reduce the risk of flammability.

Other Considerations

- Never use combustible or reactive materials to clean up or absorb spills of flammable or combustible liquids. Laboratories and shop areas where flammable and combustible liquids are handled should have an adequate number of appropriate spill kits to meet anticipated needs. These are commercially available through VWR Scientific.
- An emergency eyewash and safety shower must be located in all areas where flammable and combustible liquids are used. In the event of skin or eye contact, flush the affected area for at least 15 minutes and report to the Health Center for evaluation and treatment.



CORROSIVE MATERIALS

Corrosive materials cause destruction of tissue through chemical action at the point of contact. As corrosive chemicals can be liquids, solids, or gases, corrosive effects can affect the skin, eyes, and respiratory tract. Examples of corrosive chemicals include: liquids such as acids and bases, bromine, and hydrogen peroxide; gases such as chlorine and ammonia; and solids such as phosphorous and phenol.

Control Measures

- Pls and Supervisors are responsible for identifying corrosive materials used in their respective work areas. An evaluation of the controls in place is necessary to limit employee exposures to these agents. MSDS for specific compounds should be reviewed. For assistance in performing evaluations, contact EH&S at 575-5448.

Training and Information

- Employees who handle or who may be exposed to hazardous materials must be trained in the specific hazards and controls of the materials being handled. Providing for area-specific training for handling corrosive materials is the responsibility of the PI. EH&S is available to provide assistance.
- Primary and secondary containers must be labeled with the identity and classification of the substance. The entrance to the work area shall be posted with a caution placard (NFPA diamond) depicting the hazards.
- Replenish first aid kit

Ventilation

- Strong acids or bases and other chemicals that can form mists/ vapors shall be handled in a fume hood. Refer to MSDS for proper handling of all chemicals. If the process does not permit the handling of such materials in a fume hood, contact Environmental Health and Safety at 575-5448 to review the adequacy of ventilation measures.

Work Practices

- Wherever hydrofluoric acid is used, ensure to have a calcium gluconate kit on-site. Contact EH&S for further information.
- Never pour water into acid. Slowly add the acid to the water and stir.
- Never empty carboys or drums of chemicals by means of air pressure. Use a tilting rack, a safety siphon, or a liquid pump.
- Open bottles or carboys slowly and carefully and wear protective equipment to guard hands, face, and body from splashes, vapors, gases and fumes.
- Clean drips from containers and bench tops. Skin contact with dry residue from chemicals like sodium hydroxide and potassium will result in burns.
- Corrosives should never be stored above eye level.
- Wash hands before leaving the work area and prior to consuming food/beverages.

Personal Protective Equipment

- Consult MSDS to determine the PPE required handling of each chemical.
- In general a minimum, safety goggles, long sleeve shirt and pants, chemically resistant gloves, and closed toed shoes will be worn when handling corrosive materials.

- Additional PPE such as face shields, chemical aprons, disposable coveralls, and respiratory protection must be worn as appropriate.

Storage

- Ensure secondary containment and segregation of incompatible chemicals per guidance within MSDS.
- Corrosive materials should be stored in approved metal cabinets and below eye level.
- Toxic substances must be segregated in a well identified area with local exhaust ventilation.
- Highly toxic chemicals or chemicals whose containers have been opened must be placed in unbreakable secondary containers.
- Stored chemicals must be examined periodically (at least annually) for replacement, deterioration, and container integrity.

Spill Cleanup

Laboratory/Shop personnel may clean up small spills of corrosive material provided that all of the following conditions are met:

- The hazards of the material(s) are known, and appropriate precautions can be taken to prevent personal exposure.
- There is no potential of a release to the environment.
- There are no personal injuries.
- The clean up procedures are known and the proper equipment (e.g., PPE and spill cleanup materials) is available. Corrosive spill controls neutralize the hazardous nature of the spilled material. Acids and bases require different types of spill control materials.
- The spill can be cleaned up safely by two people in one hour or less.
- The spill does not involve elemental mercury. Special cleanup and air monitoring is required.

If the above conditions are not met, then EH&S (575-5448) should be called to assist in spill cleanup procedure.



CARCINOGENS

A carcinogen is an agent that can initiate or spread the development of malignant or potentially malignant cells or cells that possess such a material.

Compounds that are known to pose the greatest carcinogenic hazard are referred to as “selected carcinogens”, and they constitute another category of substances that must be handled as “particularly hazardous substances” according to the OSHA Laboratory Standard. A select carcinogen is defined in the OSHA Laboratory Standard as a substance that meets one of the following criteria:

- It is regulated by OSHA as a carcinogen
- It is listed as “known to be a carcinogen” in the latest *Annual Report on Carcinogens* issued by the National Toxicology Program (NTP)
- It is listed under Group 1 (“carcinogenic to humans”) by the International Agency for Research on Cancer (IARC)
- It is listed under IARC Group 2A (“probably carcinogenic to humans”) or 2B (“possible carcinogenic to humans”)

Examples of carcinogens and suspected carcinogens:

- 4-Nitrobiphenyl, Chemical Abstracts Service Register Number (CAS No.) 92933;
- alpha-Naphthylamine, CAS No. 134327;
- methyl chloromethyl ether, CAS No. 107302;
- 3,3'-Dichlorobenzidine (and its salts) CAS No. 91941;
- bis-Chloromethyl ether, CAS No. 542881;
- beta-Naphthylamine, CAS No. 91598;
- Benzidine, CAS No. 92875;
- 4-Aminodiphenyl, CAS No. 92671;
- Ethyleneimine, CAS No. 151564;
- beta-Propiolactone, CAS No. 57578;
- 2-Acetylaminofluorene, CAS No. 53963;
- 4-Dimethylaminoazo-benzene, CAS No. 60117; and
- N-Nitrosodimethylamine, CAS No. 62759.

The lists of substances NIOSH considers to be potential occupational carcinogens can be found on the [CSC website](#).

Signs and Labels

- All laboratories where carcinogenic materials are handled should have "carcinogen" sticker posted on the NFPA diamond at the laboratory entrance, inside the laboratory it should have a clearly marked designated area for working with carcinogens (this includes fume hoods and bench tops where carcinogens are handled).

Designated Area

- Whenever possible, carry out all manipulations with carcinogens in a designated fume hood or glove box. If the use of a fume hood or glove box proves to be impractical in regards to the amounts or the techniques used, then the work can be carried out on a bench top.
- When possible, the work with carcinogens should be done over disposable paper towels to minimize work area contamination and simplify clean up.

Personal Protective Equipment

- Disposable nitrile gloves should be worn to protect against accidental hand contact from small quantities of most laboratory chemicals. For advice on glove chemical resistance please refer to MSDS or contact Chemical Hygiene Officer at 575-5448.
- Appropriate safety glasses with side shields must be worn at all times when working with carcinogens and must meet the requirements of the ANSI Z87.1-1989, "American National Standard Practice for Occupational and Educational Eye and Face Protection". When necessary, face shields can be used.

Hazard Assessment

- When evaluating the carcinogenic potential of chemicals, it should be noted that exposure to certain combinations of compounds (not necessarily simultaneously) can cause cancer even at exposure levels where neither of the individual compounds would have been carcinogenic. For example, 1,8,9-Trihydroxyanthracene and certain phorbol esters are examples of "tumor promoters". Although not

carcinogenic themselves, they can dramatically amplify the carcinogenic effects of other compounds. At lower doses, natural protective systems prevent genetic damage. However, the individual susceptibility varies with respect to differences between individual genetic factors and exposure to chemicals within and outside of the laboratory.

Vacuum Equipment

- Vacuum work involving carcinogens must be conducted in a fume hood, glove box or isolated in an acceptable manner (portable shields). Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood.

Waste Disposal

- All materials contaminated with carcinogens should be disposed of as hazardous waste.

Decontamination Procedure

- Wash your hands with liquid soap and rinse it thoroughly immediately after handling carcinogens.
- All surfaces must be wiped with the cleaning agent right after handling of carcinogen.
- Glassware that will be removed from designated area must be decontaminated and washed thoroughly.



OXIDIZING CHEMICAL

Oxidizing chemicals are materials that readily yield oxygen or its equivalents to promote the combustion (oxidation) of organic matter. This class of chemicals may cause fire if in contact with flammables or combustibles materials without any source of ignition or oxygen. These chemicals may increase the spread and intensity of a fire and may cause noncombustible materials to burn rapidly. Oxidizers may react with other chemicals to produce toxic gas. Examples of strong oxidizer are organic peroxides, nitrates, perchlorates and permanganates.

Oxidizing liquids and solids are any liquids or solids that readily give off oxygen or other oxidizing substances (such as ozone or chlorine), or that chemically react to oxidize combustible materials. Oxidizing liquids and solids can be severe fire and explosion hazards.

NFPA Class 1 Oxidizers (Relatively Stable)

These chemicals may increase the burning rate of combustible materials that they contact.

Aluminum Nitrate	Silver Nitrate
Calcium Chlorate	Sodium Dichloroisocyanurate
Lithium Hypochlorite	Barium Peroxide
Nitric Acid (70% or less concentration)	Magnesium Perchlorate
Potassium Nitrate	Perchloric Acid Solution (less than 60% by weight)
Sodium Nitrate	Sodium Dichromate
Sodium Perborate	Sodium Nitrate
Strontium Peroxide	Zinc Peroxide
Sodium Persulfate	Ammonium Persulfate
Hydrogen Peroxide Solution (8-27.5% by weight)	Lead Nitrate
Magnesium Nitrate	Potassium Dichromate

NFPA Class 2 Oxidizers (moderately unstable)

These may moderately increase the burning rate or may cause spontaneous ignition of the combustible materials that they contact.

Chromic Acid	Calcium Hypochlorite (50% or less by weight)
Potassium Permanganate	Hydrogen Peroxide (27.5% to 52% by weight)
Sodium Peroxide	Nitric Acid (more than 70% concentration)
Sodium Permanganate	1,3-Dichloro-5,5-dimethylhydantoin
Trichloroisocyanuric Acid	

NFPA Class 3 Oxidizers (less stable than class 2)

These can severely increase the burning rate of the combustible materials they contact or they can undergo vigorous decomposition when in contact with a catalyst or exposed to heat.

Ammonium Dichromate	Sodium Dichloroisocyanurate
Potassium Bromate	Hydrogen Peroxide (52% to 91% by weight)
Potassium Chlorate	Perchloric Acid (60% to 72% by weight)
Sodium Chlorate	Potassium Dichloroisocyanurate

NFPA Class 4 Oxidizers (unstable)

These can explode when in contact with a catalyst or when exposed to heat, shock or friction.

Ammonium Perchlorate	Hydrogen Peroxide (more than 91% by weight)
Ammonium Permanganate	Perchloric Acid Solution (more than 72.5% by weight)

Signs and Labels

- The NFPA diamond at the laboratory entrance should be appropriately marked and "oxidizers" sticker should be posted.
- All containers with oxidizing chemicals must be clearly labeled with the correct chemical name, the date chemical was received, and the date chemical was opened. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.

Personal Protective Equipment

- Eye protection (safety glasses) must be worn at all times when handling oxidizing chemicals. Adequate safety glasses must meet the requirements of the "Practice for Occupational and Educational Eye and Face Protection" (ANSI Z.87. 1 1989) and must be equipped with side shields.
- Gloves should be worn when handling oxidizing chemicals. Disposable nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals.
- Lab coats closed toed shoes and long sleeved clothing should be worn when handling oxidizing chemicals.
- Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of oxidizing chemicals which pose this risk should occur in a fume hood with the sash in the lowest feasible position.

Handling of Oxidizing Materials

- Use only minimum amount of oxidizer that necessary.
- Keep work area free of materials that could react with oxidizers.
- If reaction can be violent, use barriers to isolate it.
- All manipulations of oxidizing chemicals which pose this risk of explosion, splash hazard or a highly exothermic reaction should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.
- The use of certain concentrations of perchloric acid must be performed in a fume hood equipped with wash down facilities.

Storage

- Oxidizers should be stored in a cool, dry location and well ventilated area.
- Keep oxidizers segregated from all other chemicals in the laboratory. Segregate oxidizing acids (nitric acid) from organic acids (acetic acid).
- Store separately to avoid contact with flammable and combustible materials and reducing agents.
- Secondary containers should be used when storing in wooden cabinets or shelves.
- Minimize the quantities of strong oxidizers stored in the laboratory.
- Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container which may cause a fire or explosion.

Vacuum Protection

- Vacuum work involving oxidizing chemicals must be conducted in a fume hood, glove box or isolated in an acceptable manner.
- Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood.

Waste Disposal

- All materials contaminated with oxidizing chemicals pose a fire hazard and should be disposed of as hazardous waste. Pure oxidizing chemicals that can readily form peroxides should never be disposed of directly but must be diluted before disposal.

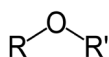
Decontamination Procedure

- Wash hands and arms with soap and water immediately after handling oxidizing chemicals.
- Carefully clean work area after use. Paper towels or similar materials contaminated with strong oxidizing chemicals may pose a fire risk and should be disposed of as a hazardous waste.



ETHERS AND PEROXIDES

Ethers can act as severe irritants to the eyes and mucous membranes. In high concentrations ethers (like ethyl ether) can cause central nerve system depression and sometimes deep anesthesia. Acute exposure can result in symptoms that include eyes irritation, dizziness, drowsiness, vomiting, muscle relaxation.



Many ethers are very unstable and dangerous due to formation of organic peroxides and increasingly high potential for explosion. Organic peroxides are among the most hazardous chemicals handled in the laboratory. They are generally low-power explosives that are sensitive to shock, sparks, or other accidental ignition. They are far more shock-sensitive than most primary explosives such as TNT. These chemicals are also highly sensitive to heat, friction, impact, light, reducing and oxidizing agents, they can cause violent explosion.

Classes of Chemicals that can form Peroxides upon Aging (list is illustrative but not exhaustive)

CLASS 1: Unsaturated materials, especially those of low molecular weight, may polymerize violently and hazardedly due to peroxide initiation.

Acrylic acid	Tetrafluoroethylene
Acrylonitrile	Vinyl acetate
Butadiene	Vinyl acetylene
Chlorobutadiene (chloroprene)	Vinyl chloride
Chlorotrifluoroethylene	Vinyl pyridine
Methyl methacrylate	Vinylidene chloride
Styrene	

CLASS II: The following chemicals are a peroxide hazard upon concentration (distillation/ evaporation). A test for peroxide should be performed if concentration is intended or suspected.

Acetal	Dioxane (<i>p</i> -dioxane)
Cumene	Ethylene glycol dimethyl ether (glyme)
Cyclohexene	Furan
Cyclooctene	Methyl acetylene
Cyclopentene	Methyl cyclopentane
Diacetylene	Methyl- <i>i</i> -butyl ketone
Dicyclopentadiene	Tetrahydrofuran
Diethylene glycol dimethyl ether (diglyme)	Tetrahydronaphthalene
Diethyl ether	Vinyl ethers

CLASS III: Peroxides derived from the following compounds may explode without concentration.

Organic:

Divinyl ether
Divinyl acetylene
Isopropyl ether
Vinylidene chloride

Inorganic:

Potassium metal
Potassium amide
Sodium amide (sodamide)

The following should be considered when working with ethers.

Working with Ethers and Other Peroxides

- Buy only the quantities you expect to use in 6 month period
- Write opening date on the container.
- Do not open a container that is more than two years old and unless it has been tested for peroxides.
- Use appropriate PPE when handling peroxides (eye goggles, nitrile or neoprene gloves and lab coat)

- Use peroxides in a fume hood with the face velocity at least 100 fpm, with the lowest sash position possible.
- Use only minimum amount necessary and never return excess chemical in the original container.
- Reduce the sensitivity of peroxides to impact and heat by using them in inert solvents such as aliphatic hydrocarbons.
- Never use a metal spatula to handle peroxides because contamination by metals can lead to the formation of explosive compounds. Use wood, ceramic, or plastic spatulas.
- If a volatile solvent must be used, avoid losses due to evaporation which could increase the peroxide concentration, eventually causing the formation of dangerously explosive crystals upon complete evaporation of the solvent.
- Avoid flames, sources of heat and direct sunlight.
- Avoid friction or impact with solid peroxides. Never use glass containers with ground glass or metal tops. Use only polyethylene bottles with screw tops.
- Do not cool liquid peroxides or its solutions to temperatures where they could solidify or precipitate because in this form they are extremely sensitive to impact and to heat.
- Note that alkali metals and their amides may form peroxides on their surface. **DO NOT** apply standard peroxide tests to such materials because they are both water and oxygen reactive!
- Immediately clean up spilled peroxide.

Storage of Ethers and Peroxides

- Store ethers in a cool, dry, well-ventilated area in tightly sealed containers.
- Flammable liquids cabinet should be used for storage.
- Store peroxides at lowest temperature possible above the freezing point, to minimize the rate of decomposition.
- Store away from direct sunlight and ignition sources
- Segregate peroxides from strong oxidizing agents, halogens, interhalogens, sulfur and its compounds.

Testing for Peroxides

Examples of chemicals that can form peroxides include aldehydes, ethers, and numerous unsaturated hydrocarbon compounds (i.e. hydrocarbon compounds having double or triple bonds). This group includes allyl compounds, haloalkenes, dienes, monomeric vinyl compounds, vinylacetylenes, unsaturated cyclic hydrocarbons like tetrahydronaphthalene or dicyclopentadiene. Please refer to the MSDS for specific details on peroxide formation.

- Keep current inventory of peroxidizable materials
- Test open containers every 3-6 month
- Use Quantofix peroxide test strips or other recommended test strips.
- Record test results and date tested on the container.
- If the peroxide concentration is greater than 100 ppm it should be treated as a potential explosive. **DO NOT USE** this chemical. Contact EH&S for special waste disposal.



REACTIVE CHEMICALS

Unstable (reactive) means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Signs and Labels

- The NFPA diamond at the laboratory entrance should be appropriately marked and “reactive materials” sticker should be posted.
- All containers with reactive chemicals must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.

Personal Protective Equipment

- Eye protection in the form of safety glasses must be worn at all times when handling reactive chemicals. Adequate safety glasses must meet the requirements of the Practice for Occupational and Educational Eye and Face Protection (ANSI Z.87. 1 1989) and must be equipped with side shields.
- Gloves must be worn when handling reactive chemicals. Please refer to the MSDS for advice on glove selection.
- Lab coats closed toed shoes and long sleeved clothing should be worn when handling reactive chemicals.
- Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations with reactive chemicals may pose this risk and should occur in a fume hood with the sash in the lowest feasible position and equipment must be shielded.

Storage

- Store reactive chemicals segregated from all incompatible chemicals, free from shock, vibration in a cool and dry location. Minimize the quantity of reactive chemicals stored in the laboratory.
- Date all containers upon receipt. Examine storage containers frequently. Dispose of any container that exhibits salt build up around the cap. Dispose of all reactive liquids whenever they are no longer required for current research.
- Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container that may cause a fire or explosion.

Hazard Assessment

- Carefully review MSDS to determine reactivity and compatibility of materials being used.
- Hazard assessment of work involving reactive chemicals should address proper use and handling techniques, fire safety (including the need for Class D fire extinguishers), storage, the specific reactive nature of the material (such as water and air reactivity), and waste disposal issues.

Vacuum Protection

- Vacuum pumps used in experiments with reactive materials should have tags indicating the date of the most recent oil change.
- Oil should be changed once a month or sooner if it is known that the oil has been exposed to reactive gases in the course of the experiment.

Waste Disposal

- All materials contaminated with reactive liquids should be disposed of as hazardous waste.
- Large quantities of waste may pose a flammability risk and should not remain in the laboratory overnight. Contact EH&S for waste pick up.

Decontamination

- Wash hands thoroughly after handling reactive materials. Work clothing should be changed at once if it is possible that clothing is contaminated.
- All surfaces should be wiped with appropriate cleaning material following reactive material handling.





TOXIC CHEMICALS

Materials that may cause long term and immediate health effects such as cancer, allergic reactions, diseases of organs, neurological problems, reproductive problems, sensitization, and eye, skin, and respiratory system irritation, if personnel are repeatedly exposed to them in small amounts. Examples of toxic chemicals are sodium cyanide and hydrogen sulfide.

Toxic substances include a group chemicals that calls reproductive toxins which means chemicals that affect reproductive capability including chromosomal; damage (mutations) and effect on fetus (teratogenic effect).

Reproductive Toxins

Acrylonitrile	Formamides
Aniline	Lead (Organic)
Arsenic and its compounds	Manganese and its compounds
Benzene	Mercury and its compounds (Inorganic)
Benzo(a)pyrene	Methyl n-butyl ketone
Beryllium	Methyl chloroform
Boric acid (Boron)	Methyl ethyl ketone (MEK)
Cadmium and its compounds	Nitrogen Dioxide
Carbon monoxide	Ozone
Chlordecone (Kepone)	Platinum and its compounds
Chloroform	Polybrominated biphenyls (PBB)
Chloroprene	Polychlorinated bipenyls (PCB)
Dibromochloropropane (DBCP)	Selenium and its compounds
Dichlorobenzene	Styrene
1,1-Dichloroethane	Tellurium and its compounds
Dichloromethane	Tetrachloroethylene
Dioxane	Thallium and its compounds
Epichlorohydrin	Toluene
Ethylene Dibromide	Toluene-2,4-diisocyanate
Ethylene Dichloride	o-Toluidine
Ethylene Oxide	Trichloroethylene
Fluorocarbons	Vinyl chloride
Formaldehyde	Vinylidene chloride
	Xylene

The effects of toxic materials are related to route of entry, dose and duration of exposure and can result in chronic or acute health effects.

A highly toxic chemical is a chemical falling under one of the following categories:

- A chemical with a median lethal dose (LD50) of 50 mg or less per Kg of body weight when administered orally to albino rats weighing between 200 and 300 gm each.
- A chemical with a median lethal dose (LD50) of 200 mg or less per Kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 Kg each.
- A chemical that has a median lethal concentration (LC50) in air of 5000 ppm by volume or less of gas or vapor, or 50 mg per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 gm each.

Many of these chemicals may also be characterized as a toxic gas, CDC Select Agent toxin, corrosive, irritant or sensitizer.

Examples of Compounds with a High Level of Acute Toxicity

Acrolem	Nickel carbonyl
Arsine	Nitrogen dioxide
Chlorine	Osmium tetroxide
Diazomethane	Ozone
Diborane (gas)	Phosgene
Hydrogen cyanide	Sodium azide
Hydrogen Fluoride	Sodium cyanide
Methyl Fluorosulfonate	(other cyanide salts)

Signs and Labels

- The NFPA diamond at the laboratory entrance should be appropriately marked and “acutely toxic” chemical sticker should be posted.
- A designated area should be clearly marked where acutely toxic chemicals are stored or used.
- A designated area may be the entire laboratory, an area of a laboratory or a device such as fume hood.
- All containers with acutely toxic chemicals must be clearly labeled with the correct chemical name.
- Hand written labels are acceptable; chemical formulas and structural formulas are not acceptable.

Personal Protective Equipment

- Eye protection in the form of safety glasses must be worn at all times when handling acutely toxic chemicals. Adequate safety glasses must meet the requirements of the Practice for Occupational and Educational Eye and Face Protection (ANSI Z.87. 1 1989) and must be equipped with side shields.
- Gloves should be worn when handling acutely toxic chemicals. Lab workers should review the MSDS for advice on glove selection.
- Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction.
- All manipulations of acutely toxic chemicals which pose this risk should occur in a fume hood with the sash in the lowest feasible position.

Vacuum Protection

- Vacuum work involving acutely toxic chemicals must be conducted in a fume hood, glove box or isolated in an acceptable manner.
- Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release.
- Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices.

Hazard Assessment

In assessing the risks associated with acutely toxic chemicals, it is useful to classify a substance according to the acute toxicity level with respect to their LD50 values (see Table below)

Acute Toxic Hazard Level

Hazard Level	Toxicity Rating	Oral LD50 (Rats, per kg)	Skin Contact LD50 (rabbits, per kg)	Inhalation LC50 (Rats, ppm for 1h)	Inhalation LC50 (Rats, mg/m ³ for 1h)
High	Highly toxic	<50mg	<200mg	<200	<2,000
Medium	Moderately toxic	50 to 500 mg	200mg to 1g	200 to 2,000	2,000 to 20,000
Low	Slightly toxic	500mg to 5 g	1 to 5 g	2,000 to 20,000	20,000 to 200,000

LD50 values can be found for any given substance in such references like MSDS, Sigma-Aldrich Library of Chemical Safety Data and A Comprehensive Guide to the Hazardous Properties of Chemical Substances, etc.

Special attention should be given when working with any substance classified as having a high level of acute toxicity hazard. Please refer to the MSDS for particular advice on safe handling of these substances.

Storage

- Store chemicals known to be highly toxic in ventilated storage in unbreakable chemically resistant secondary containers.
- Keep quantity at a minimum possible level. Label storage area with appropriate warning sign. Maintain an inventory of all highly toxic chemicals.

Waste Disposal

- All materials contaminated with acutely toxic chemicals should be disposed of as a hazardous waste.

Decontamination

- Wash hands and arms with soap and water immediately after handling acutely toxic chemicals.
- Decontamination procedures vary depending on the material being handled. Wherever possible, acutely toxic chemicals should be handled over disposable paper covered work surfaces to minimize decontamination process.
- All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling.
- All glassware should be decontaminated before removing it from the designated area.





WATER SENSITIVE CHEMICALS

Water sensitive materials are those that react violently with water. Alkali metals (e.g. lithium, sodium and potassium), many organometallic compounds and some hydrides react with water to produce heat and flammable hydrogen gas, which can ignite or combine explosively with atmospheric oxygen. Some anhydrous metal halides (e.g. aluminum bromide), oxides (e.g. calcium oxide), and nonmetal oxides (e.g. sulfur trioxide) and halides (e.g. phosphorous pentachloride) react exothermically with water, and the reaction can be violent if there is insufficient coolant water to dissipate the heat produced.

Signs and Labels

- The NFPA diamond at the laboratory entrance should be appropriately marked.
- All containers with water sensitive chemicals must be clearly labeled with the correct chemical name.
- Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable. Date containers upon receiving.

Personal Protective Equipment

- Eye protection in the form of safety glasses must be worn at all times when handling reactive chemicals. Adequate safety glasses must meet the requirements of the Practice for Occupational and Educational Eye and Face Protection (ANSI Z.87. 1 1989) and must be equipped with side shields.
- Gloves must be worn when handling reactive chemicals. Please refer to the MSDS for advice on glove selection.
- Lab coats, closed toed shoes, and long sleeved clothing should be worn.
- Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction.

Storage

- Store water-sensitive chemicals in a cool, dry location.
- Segregate these chemicals from all other chemicals in the laboratory.
- Minimize quantity of the water sensitive chemicals in the laboratory.
- Be aware that potassium, when stored under oil at room temperature, will form peroxides and super-oxides.
- Containers that have signs of salt build up on its exterior must be disposed of.

Hazard Assessment

Before assuming work with water sensitive chemicals the following should be noted.

- Alkali metals may ignite quickly on exposure to humid air and, therefore, should be handled under the surface of a hydrocarbon solvent such as mineral oil or toluene. Some of them can form explosive peroxides on contact with air.
- Using larger particles is preferable than using "sand" for drying solvents.
- Scraps of alkali metals should be destroyed by reaction with *n*-butyl alcohol.

Decontamination

- Wash hands and arms with soap and water immediately after handling water sensitive chemicals.
- All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling.

Waste Disposal

- All water sensitive materials should be segregated from incompatible chemicals when disposing.
- Some water sensitive materials can be neutralized before disposal, consult MSDS.
- Alkali metals react violently with water, common hydroxylic solvents and halogenated hydrocarbons. The metals are usually destroyed by controlled reaction with an alcohol. The final aqueous alcoholic material can usually be disposed of in the sanitary sewer.



COMPRESSED GASES

Gases may present a hazard because they are: flammable, an asphyxiant, an oxidizer, corrosive, toxic, cryogenic and/or under pressure.

Users of compressed gas should be familiar with procedures for the safe operation of cylinders and the properties and inherent hazards of the products they contain. Information concerning specific gases can be found on the product label and in the MSDS.



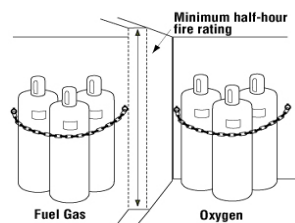
Responsibilities

- Compressed gases must be handled only by properly trained personnel in accordance with applicable regulations and the guidelines.
- The end user (Principal Investigator or Laboratory Supervisor) is responsible for the safe handling and use of compressed gas cylinders and their contents, and for placing and securing the cylinder in the lab.

General guidelines

- Cylinders must be secured in an upright position at all times during storage, transport and use.
- A cylinder's contents must be identified at all times. Cylinder status (empty, full, in service, etc.) should also be specified.
- The prescribed markings on the cylinders shall be made and kept in a legible condition. The user must not remove or alter any of these markings. If these markings become illegible, the user must provide adequate labeling to identify the contents.
- The labels applied by the gas manufacturer to identify the cylinder contents must not be defaced or removed.
- The user must not modify, tamper with, obstruct, remove, or repair any part of the cylinder, including the pressure relief device and the cylinder valve or the valve protection device.

- Compressed gas streams must not be directed toward any person as this may cause serious injury to the eyes or body.
- Cylinder valve connections must have threads on the regulator connections or other equipment to match those on the cylinder valve.
- The cylinder valve must be kept closed at all times (charged or empty) except when the cylinder is in use. Valve outlets should be pointed away from all personnel when the valve is being opened.
- Piping, regulators, and other apparatus must be kept gas tight to prevent leakage, and this must be confirmed using compatible leak test solution or an appropriate leak-detection instrument. A leak test must be conducted every time the cylinder is reconnected such as during cylinder replacement.
- Before a regulator is removed from a cylinder, the cylinder valve should be closed and the regulator relieved of gas pressure.
- Regulators, gauges, hoses and other apparatus provided for use with a particular gas, or group of gases, must not be used on gas cylinders having different chemical properties unless information obtained from the gas manufacturer indicates that this can be done safely.
- Maintenance of cylinders and their valves or relief devices shall be performed only by trained personnel. This activity is best handled by the original manufacturer.
- An emergency response plan shall be implemented wherever compressed gas cylinders and products are used, handled or stored.



Storage

- Containers must not be placed where they might become part of an electrical circuit or arc.
- Compressed gas cylinders must not be exposed to temperature extremes. Storage area temperatures should not exceed 125 degrees F.
- The user must keep valve protection caps on cylinders at all times except when cylinders are secured and connected to dispensing equipment.
- Where valve outlet caps and/or plugs are provided, the user should keep the device on the valve outlet at all times except when the cylinders are secured and connected to dispensing equipment.
- Vented storage areas should be designed to accommodate the various gases required by the user. Adequate spacing, or segregation by partitioning must be provided so that cylinders can be grouped together according to hazard class (flammable gasses should be separated from oxidizing gases (acetylene and propane cylinders should be separated from oxygen cylinders))
- Incompatible gases must be separated by a minimum distance of twenty feet, or by a wall with a thirty minute fire rating. There are a few exceptions to the storage requirements; contact EH&S for assistance.
- Additional consideration should be given to separate storage of full and empty containers.
- Containers are not to be stored near readily ignitable substances or be exposed to corrosive chemicals or fumes.
- Containers must not be stored near elevators, walkways, building egresses, unprotected platform edges, or in locations where heavy moving objects may strike or fall on them. Cylinders are not to be stored in mechanical rooms, custodial closets, or utility spaces.

- All compressed gas cylinders in service or in storage at user locations must be secured to prevent falling/tipping/rolling and shall be stored and used valve end up. They can be secured with straps or chains connected to a wall bracket or other fixed surface, or by use of a cylinder stand.
- Compressed gas cylinders which contain acutely toxic gases must be stored in a designated area.



Transport

- Users of compressed gas cylinders must ensure that the cylinders are not rolled in the horizontal position or dragged. A suitable hand truck, forklift truck, or similar material handling device designed for cylinder transport should be used with the container properly secured to the device. Extreme caution should be used when handling cylinders to guard against dropping or permitting cylinders to violently strike against each other or other surfaces.
- It is necessary to take precautions so that gas cylinders are not dropped or allowed to strike each other or other objects. Dropping or striking may damage the cylinder valve, which could turn the cylinder into a dangerous torpedo with the potential to destroy property and/or injure personnel.
- Personnel who handle cylinders must be trained and instructed NEVER to lift cylinders by using the cylinder cap.

Hazard Assessment

Hazard assessment for work with compressed gases should assure

- that all staff understands proper use and handling precautions
- that all pressurized equipment is properly shielded
- regulators are not interchanged between different gas types
- that all hose connections are properly secured and are appropriate for the pressure used.

Personal Protective Equipment

- Lab coats, closed toed shoes and long sleeved clothing should be worn when handling compressed gases.

Waste Disposal

- All empty or partially filled compressed gas cylinders should be returned to the supplier.



NANOMATERIALS

Standard Operating Procedures for the Handling of Nanoparticles

Definition: Nanoparticles are particles that range in size <math><100\text{ nm}</math>.

Solution vs. Dry Powder: In general the use of nanoparticles in the form of dry powders should be avoided.

Working with Solutions or Suspension of Particles

Routine laboratory safety procedures must be followed including:

- Wear safety glasses
- Wear gloves (nitrile gloves are recommended for most materials) when handling the material and then dispose of the gloves. Wearing gloves outside of the laboratory is not appropriate and can lead to contamination of the laboratory, hallway and lab personnel.
- Wear lab coat while in the laboratory. Wearing a lab coat outside of the laboratory is not appropriate and can lead to contamination of the laboratory, hallway and lab personnel.
- Work in hood whenever possible
- Labs must be under negative pressure with respect to the hallways and must have a non-recirculation ventilation system
- Cadmium containing materials are considered carcinogenic and use of these (as well as others) must be indicated on the safety placards.
- Dispose of nanoparticle containing waste, gloves, wipes, pipettes and other contaminated material as hazardous waste.

In addition the following specific procedures must be followed:

- Designate specific areas for the use of nanoparticles and provide signs indicating the designation
- Wipe down all areas where nanoparticles are used at least weekly (“baby wipes” are useful for this application and should be disposed of as hazardous waste). Drops of solution lose solvent and become dry powders which are significantly more hazardous than the solutions.
- Activities which may lead to the production of an aerosol, such as sonication or vortexing, must be performed in a hood.
- Transportation of nanoparticles in any form should involve the use of secondary containers and the outsides of the secondary should be wiped clean before transportation outside of the laboratory.
- Tube furnaces used to produce or alter nanoparticles must be used in a hood or exhausted into the hood ducting. The same applies to pumps attached to glove boxes.

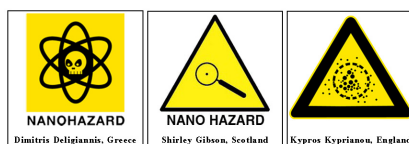
Working with dry powders – not recommended

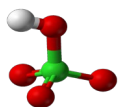
In addition to the above procedures use of dry powders require the following:

- All work must be performed in a properly functioning hood. Determining mass of a sample (difficult in a hood because of drafts) can best be accomplished by the methods of difference using a balance outside of the hood and transferring the sample in closed containers. All operations with the exposed sample are then confined to the hood. *Be aware that static electricity can cause dry powders to actually “jump” out of a container or off a spatula.*
- Work area and container must be cleaned and wiped down after the each time the particles are dispensed.

Work Involving Animals

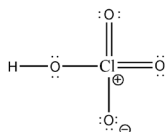
- Applications of nanoparticles involving the use of animals require the approval of the Institutional Animal Care and Use Committee and appropriate SOP's must be developed and approved prior to the start of experimentation.
- Applications of nanoparticles containing genetic material require the approval of the Biosafety Committee and appropriate SOP's must be developed and approved prior to the start of experimentation.





PERCHLORIC ACID

Perchloric acid is a very strong mineral acid that can cause severe burns to the skin, eyes, and respiratory tract. Perchloric acid is also a strong oxidizing agent and will react violently with reducing agents or organic substances. It can form explosive mixture with organic materials such as wood, paper, cardboard and many organic solvents. Aqueous perchloric acid can cause violent explosions if not handled properly. Clothing and rubber materials become highly flammable if contaminated with perchloric acid.



Cold Perchloric Acid (Less than 72% concentrated at room temperature)

At normal room temperatures perchloric acid acts as a strong non-oxidizing acid. It is highly corrosive and will cause severe burns on contact with skin, eyes and mucous membranes. The following should be considered when working with it:

- Substitute with less hazardous substance when possible
- Dilute solution to less than 60% pure acid
- Use only in the properly functioning fume hood
- Handle perchloric acid over chemically resistant surface or suitable containment to minimize spill and decontamination clean up.
- Always wear appropriate personal protective equipment.

Heated Perchloric Acid (less than 72% concentrated)

When heated perchloric acid becomes strong oxidizer and eventually becomes unstable. It will react violently with most of the oxidizing substances; vapors may contaminate ventilation equipment with residues and form highly unstable metallic perchlorites. The following must be taken into consideration when working with heated perchloric acid:

- All handling of the heated perchloric acid should be done in specially design perchloric acid fume hood with the face velocity at least 100 fpm.
- A notice posted on the fume hood must identify it as being used for perchloric acid and prohibit the use or storage of combustibles in the fume hood.
- Exhaust duct must be as short as possible. The fume hood and duct work are usually made of stainless steel and must have water wash down facilities.
- The ducting and fume hood must be washed down at least once a day when in use.
- For use of appropriate personal protection refer to MSDS. Polyvinyl chloride (PVC) gloves would provide better protection than nitril.
- When handling beakers of hot acid use properly designed tongs.
- Lower fume hood sash as much as possible or use a safety shield to provide splash protection.
- Before setting your experiment be sure to understand the reactions that can occur and possible end products of it.
- Never mix perchloric acid with sulfuric acid because through dehydration, anhydrous perchloric acid is obtained, which is even more unstable.
- If the end product of the reaction involves formation of perchlorate esters be advised that, when exposed to impact, they will behave in the same manner as nitroglycerine.
- Always destroy any organic material with nitric acid before adding perchloric acid.

- All apparatus should have glass-to-glass joints and use silicon based lubricants. Never use rubber stoppers or tubes.
- Never use direct flame or oil baths for heating perchloric acid. Use electric hot plates, steam heated sand baths or steam baths to heat perchloric acid.
- Inspect all bottles of perchloric acid once a month, keep inspection records. If you notice any color change, dispose the bottle immediately.
- Spill of perchloric acid is a fire and explosion hazard. In case of a spill, dilute the spill to prevent the formation of anhydrous perchloric acid. Use inert, inorganic absorbent to soak up spill. In case of a large spill isolate and evacuate the area contact EH&S for assistance at 575-5448.

Anhydrous Perchloric Acid (more than 85% concentrated)

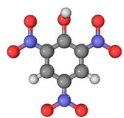
Anhydrous perchloric acid is unstable even at room temperature, decomposing spontaneously and exploding violently. In addition to the above steps, the following should be considered:

- Only experienced researchers can handle anhydrous perchloric acid. They should be well familiar with the literature on the acid.
- When handling anhydrous acid the body system should be used to monitor reaction progress.
- Safety shields must be used to protect against possible explosion.
- Use only freshly prepared acid.

Storage

- Keep quantity of the perchloric acid in the lab to a minimum.
- Perchloric acid should be stored in its original container and in compatible secondary container (glass or porcelain)
- It may be stored with other inorganic acids in the corrosive storage cabinet. Small quantities of the acid can be stored in the perchloric acid fume hood.
- Perchloric acid must be stored away from any organic, flammables or combustible chemicals and strong dehydrating agents like sulfuric acid.

If a bottle of perchloric acid has turned dark and has crystals forming around the bottom or the cap, there is a potential for explosion hazard. **DO NOT MOVE THE BOTTLE.** Immediately contact EH&S at 575-5448.



PICRIC ACID

Picric acid is a strong irritant and sensitizer to eyes and skin. It is corrosive to the eyes and skin on contact. Inhalation of dust will produce irritation of the respiratory system and gastrointestinal problems. Severity of the damages will depend on the length of the contact. Medical surveillance should be focus on hypersensitivity, atopic dermatitis and liver and kidney function.

Dry picric acid is an explosive compound. It easily forms picrate salts that are heat, friction and impact-sensitive and more unstable and explosive than pure picric acid. These unstable picrate salts are formed when in contact with amines, bases, concrete and metals like copper, lead, mercury and zinc. Mixtures with aluminum and water may also ignite.



The following should be considered when working with picric acid:

- Dry picric acid is highly explosive material
- Order minimum amounts
- Wear appropriate personal protective equipment (splash goggles, lab coat, synthetic apron, and vapor or dust respirator if applicable). Refer to MSDS for more information.
- Never shake a bottle of picric acid
- Inspect container before opening, it must not be allowed to accumulate and dry (form crystals) around the container cap.
- After opening of the container, inspect it monthly to ensure moisture level is contained (more than 10%) and material had not dried out.
- Dehydrate the content of the container every 6 month with deionized water to maintain a wet paste. Document this dehydration process in the lab's log book.
- When practical handle picric acid in the fume hood to minimize airborne contamination below the exposure limit (TWA: 0.1 mg/m³) or use enclosure or local exhaust ventilation.
- Ground all equipment containing picric acid
- Use explosion proof electrical equipment (ventilation, lightning, material handling)
- Empty containers may contain hazardous residue and pose a risk of fire
- Take precautionary measures against electrostatic discharge.
- Keep away from sources of ignition
- Keep away from direct sun light
- Dispose of old stock (after two years of initial receipt) as a hazardous waste.

Storage of Picric Acid

- Store with at least 10% moisture content
- Store away from direct sun light and ignition sources
- Picric acid must be stored in original container in cool, dry, well ventilated cabinet.
- Store separately from incompatibles like oxidizing agents, reducing agents, metals alkalis.