Chapter 6: OPERATING PROCEDURES FOR HANDLING CHEMICALS

Standard Operating Procedures

Evaluation of Potential and Known Hazards

Prior to initiating a new experiment or procedure, all laboratory employees must evaluate the potential physical and health hazards associated with its chemicals and processes. Container labels and material safety data sheets, as well as other references, will be used to conduct the evaluation. Laboratory personnel will be familiar with their own and previous evaluations prior to beginning work, and will use appropriate ventilation, protective equipment and procedures to minimize exposure. The evaluation will include preparation for any potential emergency.

Substitution as a Primary Method of Control

Following hazard evaluation, laboratory personnel should always consider substituting less hazardous and toxic substances. Only chemicals for which appropriate exposure controls are present may be used.

Prior Approval

Laboratory employees must obtain prior approval to proceed with a laboratory task from a supervisor whenever:

- a new laboratory procedure or test is carried out;
- there is a significant change in a procedure or test likely to alter the hazard. A significant change is defined as a 10% or greater increase or decrease in the amount of one or more chemicals used, a substitution or deletion of any of the chemicals in a procedure, or a change in the conditions under which the procedure is conducted;
- there are unknown or unexpected test results;
- members of the laboratory staff become ill, suspect exposure or otherwise suspect failure of the engineering safeguards.

Reporting Laboratory Incidents and Unsafe Conditions

Report all laboratory incidents no matter how minor to a supervisor. Incident report forms are available from the CHO. Unusual or unexplainable chemical incidents should be discussed with others in the department, to caution others as to the risk of the procedure.

Report any unsafe conditions by contacting the CHO and filing a written report so that the condition may be corrected as soon as possible. Unsafe conditions which must be reported include:

- non-functioning hoods in areas where hazardous chemicals are being used;
- unsafe storage conditions;
- blocked emergency exits;
- improperly charged fire extinguishers;
- inoperable eyewash stations or safety showers;
- absence of personal protective equipment (PPE) (e.g, goggles, gloves) .

General Rules

Working with hazardous chemicals (and procedures) alone in a laboratory or chemical storage area is strictly PROHIBITED. Lab personnel must schedule research and experiments involving hazardous substances and procedures so that other lab members are present. Rules are as follows:

- Undergraduate teaching laboratories: A faculty member must be present in the lab at all times when undergraduate students are conducting experiments;
- Research Laboratories: Personnel working alone must contact Public Safety to make them aware of their presence in the facility and encourage them to periodically check on them. These personnel should plan a route of escape in case of an emergency;
- Wear appropriate eye protection at all times;
- When working with flammable chemicals, be certain that there are no sources of ignition near enough to cause a fire or explosion in the event of a vapor release or liquid spill;
- Use a tip-resistant shield for protection whenever an explosion or implosion might occur.

For the chemicals they are using, all employees should be aware of:

- The chemicals' hazards, as determined from the MSDS and other appropriate references;
- Appropriate safeguards (e.g. chemical fume hood, personal protective equipment, etc.);
- The location(s) and proper use of emergency equipment (e.g. emergency shower/eyewash, fire extinguisher, spill kit);
- How and where to properly store the chemical when it is not in use;
- Proper personal hygiene practices;
- The proper methods of transporting chemicals within the facility;
- Appropriate procedures for emergencies, including evacuation routes, spill cleanup procedures and proper waste disposal.

Personal Hygiene

- Never store food or beverages in storage areas, refrigerators, glassware, or use utensils which are also used for laboratory operations;
- Do not eat, drink, smoke, chew gum, or apply cosmetics in laboratories where chemicals or other hazardous materials (e.g., radioactive or biohazards) are present;
- Never mouth pipet. Always use a pipet bulb or other mechanical pipet filling device;
- Do not smell or taste chemicals;
- Wash areas of exposed skin well before leaving the laboratory;
- Confine long hair and loose clothing. Wear shoes at all times in the laboratory but do not wear sandals, perforated shoes or sneakers;
- Always wear clothing that completely covers arms and legs. While performing laboratory work, never wear short-sleeved T-shirts, short skirts, or shorts;
- Jewelry should not be worn which interferes with gloves and other protective clothing, or which could come into contact with electrical sources or react with chemicals.

Proper Equipment Use

- Use equipment only for its intended purpose;
- Inspect equipment or lab apparatus for damage before use. Never use damaged equipment such as cracked glassware, or equipment with frayed electrical wiring;
- Shield or wrap Dewar flasks and other evacuated glassware to contain chemicals and glass fragments should implosion occur.

Personal protective Equipment (PPE)

Choose protective clothing and other equipment based on the types of chemicals handled, the degree of protection required, and the areas of the body which may become contaminated. All clothing and equipment must at a minimum, meet standards set by the American National Standards Institute (ANSI). All respiratory protective equipment must be chosen in conjunction with the CHO, since there are strict legal requirements as to the use and distribution of these devices.

Every effort must be made to evaluate the effectiveness of equipment and make improvements where possible. The CHO should be consulted for suggestions. Special consideration must be given to purchasing appropriate PPE and other safety equipment when extremely hazardous substances are involved. Choice of this equipment under these circumstances must be reviewed by the CHO in advance of purchase requests.

Eye Protection

All personnel, students, and any visitors in locations where chemicals are stored or handled must wear protective goggles at all times. Setting the requirements for their use is the responsibility of lab supervisors and directors. All eyewear must meet the American National Standards Institute's (ANSI) *Practice for Occupational and Educational Eye and Face Protection*, Z87.11989. Prior to use, personnel will verify that the equipment has been approved for the particular procedure (e.g., eye protection may be ANSI certified for chemical splashes but not for explosions). ANSI standards require minimum lens thickness of 3mm, impact resistance, passage of a flammability test, and lens-retaining frames.

Contact lens use in laboratories. Recent studies By the Centers for Disease Control and Prevention have produced varying views on the issue of contact lens use in laboratories. Traditional safety lore claimed that contaminated aerosols or particulate matter would concentrate behind contact lenses and cause permanent eye damage. In contradiction to this assumption, some researchers have found that contact lenses may minimize injuries to the eye from metal particles, paint fumes, and chemical splashes from solvents and acids. *Working in a properly-performing chemical fume hood must always be the first line of defense against chemical exposure.* The following table will be consulted in choosing protective eyewear.

Eye Protection Guidelines

Type of eye protection	Condition Requiring Use
Standard goggles	handling corrosive chemicals
Acid/Caustic goggles with side	danger of splashing chemicals or flying particles

shields	
Impact protection goggles	working with glassware under vacuum or elevated pressures; using glass apparatus in combustion or other high temperature operations
Face shields (protects face, throat and neck)	potential for flying particles, harmful liquid
Both goggles and face shields	vacuum system (danger of implosion); chemical reactions with potential for mild explosion
Specialized eye protection	lasers; intense ultraviolet and other light sources; glass blowing

ORDINARY PRESCRIPTION GLASSES ARE NOT ADEQUATE TO PROTECT EYES FROM INJURY!

Guidelines for Use of Gloves

It is the responsibility of the lab director/supervisor and the employee, to choose and use the appropriate gloves.

Gloves must be worn whenever there is a chance for hand contact with chemicals, such as during the transfer of chemicals from one container to another or during the transfer of chemical wastes. Gloves must be worn if the chemicals involved are easily absorbed through the skin and/or are acute or chronic toxins. When working with the corrosive liquids, also wear gloves made of material known to be resistant to permeation by the corrosive chemical and tested by air inflation (do not inflate by mouth!) for the absence of pin-hole leaks.

Lab personnel must inspect gloves prior to each use. Gloves must be washed before removal except those that are easily permeated/degraded by water (e.g. leather, polyvinyl alcohol).

Prior to use, lab personnel will consult the glove manufacturers permeation and resistance charts (available from the manufacturer) to make sure that the glove is appropriate for the chemicals being used. Glove materials vary in the way they resist being degraded and permeated. No glove totally resists degradation and permeation over time and must be replaced periodically, depending on frequency of use, chemical concentration, and duration of contact. The glove material and its thickness determine the appropriateness of a specific glove type.

Clothing

The choice of protective clothing depends upon the degree of protection required. Protective and appropriate clothing is required when a potential exists for chemical splashes, fire, extreme heat or cold, excessive moisture, and radiation. Setting requirements for their use is the responsibility of lab supervisors and directors.

Protective clothing which should be readily available to laboratory personnel include:

- Lab coats
- Boots
- Lab aprons
- Shoe Covers

- Gauntlets
- Jump suits/coveralls

Laboratory personnel must be instructed to consider the following characteristics in protective clothing selection and purchase:

- ability to resist fire, heat and the chemicals used;
- impermeability, when needed;
- comfort, permitting easy execution of tasks when worn
- ease of cleaning (unless disposable);
- ability to be removed quickly during an emergency or chemical splash (e.g. snap fasteners rather than buttons).

Safety Shields

Safety shields should be used on or near equipment when there is potential for explosion, implosion or splash hazards. Fixed shields will be used whenever possible, recognizing that their weight and resistance provides superior protection against minor blasts. Portable shields may be used when the hazard is limited to small splashes, heat or fire. Where combustion is possible, the shield must be made of flame-resistant material. It is the laboratory supervisor's responsibility to assure that shields are used appropriately. The sash of a chemical fume hood can serve as a splash or (minor) blast shield.

Prior to large volume purchases, personal protective equipment should be evaluated under real or simulated conditions to ensure that it meets both safety and performance standards. For example, chemical splash goggles may meet ANSI standards but fog up rapidly or are so uncomfortable that they will not be worn.

Respirators

OSHA requires all employers to primarily prevent air contamination. If vapor concentrations cannot be kept below regulated levels, the employer must implement a written respirator program (29 CFR 1910.134). The written program will address issues such as respirator selection criteria, inspection, and maintenance. All personnel using respirators must be trained in their proper use and care. Additionally, medical evaluation and proper fit testing are required. However, respirator use is considered the very last line of defense against chemical exposures. Engineering controls, changes in work practices, chemical substitution, and changes in experimental procedures must be employed before respirator use will even be considered. EH&S will determine if respirator use is required, and will determine the proper respiratory protection equipment to be used if it is determined that it is indeed necessary.

Transporting chemicals within Lehman College (between rooms and/or between buildings)

- Carry chemicals by hand in secondary containment (carrying bucket) to prevent breakage;
- Transport chemicals on stable, wheeled carts that move smoothly over uneven surfaces; cart shelving should have raised edges to contain chemicals if containers break;
- Laboratory employees transporting chemicals must wear goggles and lab coats;
- Use freight elevators whenever possible; passenger elevators only during periods of low use;

- Transport compressed gas cylinders using hand trucks with the cylinder strapped in place. NEVER roll or drag cylinders. Keep the cylinder capped until used.

Housekeeping

- Keep all work areas, including work benches and floors, clean, dry and uncluttered;
- Access to emergency equipment, utility controls, showers, eyewash stations and laboratory exits must never be blocked;
- Label all chemical containers with the full chemical name(s) of the contents and hazards;
- Return all chemicals to their assigned storage areas at the end of each workday;
- Properly label all waste containers;
- Promptly clean up all chemical spills; properly dispose of the spilled chemical, cleanup materials;
- Chemicals must be stored in FDNY-permitted laboratories and storage rooms *only*, in proper secondary containment, in cabinets with closeable doors, or chemical shelving (storage rooms).

Working with Toxic Chemicals

Laboratory personnel usually are aware of the physical properties (reactivity, corrosivity, flammability) of the chemicals they use. They are often not aware of the toxicology of these same chemicals. MSDSs (and SDSs) will state several exposure limits (if established) for a specific chemical, such as Threshold Limit Values (TLV, American Conference of Governmental Industrial Hygienists, ACGIH), Permissible Exposure Limits (PEL, OSHA), and Action Levels (1/2 of the PEL). When such limits are stated, they will be used to assist the CHO in determining the safety precautions, control measures, and PPE that apply when working with toxic chemicals. Chemicals must be used in a properly-operating fume hood, glove box, vacuum line, or similar device, which is equipped with appropriate traps and/or scrubbers if:

- the TLV or PEL < 50 ppm or 50 mg/m3;
- the Lethal Concentration (LC50) < 200ppm or 200mg/m3 (when administered continuously for one hour or less);
- the chemical is highly volatile and likely to exceed maximum air concentration limits.

Deposit chemical waste in their appropriate, labeled, receptacles and follow all other disposal procedures described in Chapter 5 of the CHP.

Be particularly cautious about releasing hazardous substances into designated cold rooms or warm rooms, since these facilities have recirculated atmospheres.

Minimize the release of toxic vapors into the laboratory by venting apparatus such as vacuum pumps and distillation columns into local exhaust system (i.e. chemical fume hoods). When especially toxic or corrosive vapors are involved, they should pass through scrubbers prior to being discharged from the local exhaust system.

Working with Flammable Chemicals

- In general, the flammability of a chemical is determined by its flash point, the lowest temperature at which an ignition source can cause the chemical to ignite momentarily under certain controlled conditions.

- Chemicals with a flash point below 200^{O}F (93.3^{O}C) will be considered "fire-hazard chemicals" (flammable or combustible);
- In all work with fire-hazard chemicals, follow the requirements of 29 CFR, Subparts H and L; NFPA Manual 30, *Flammable and Combustible Liquids Code*; and NFPA Manual 45, *Fire Protection for Laboratories Using Chemicals*;
- Fire-hazard chemicals must be stored in a flammable storage rooms or in flammable storage cabinets;
- Fire-hazard chemicals must be used only in chemical hoods, away from sources of ignition.

Working with Reactive Chemicals

A reactive chemical is one that:

- is described as such in the MSDS;
- is ranked by the NFPA as 3 or 4 for reactivity;
- is identified by the Department of Transportation (DOT) as an oxidizer, an organic peroxide, or an explosive, Class A, B, or C;
- meets the EPA definition of reactive in 40 CFR 261.23;
- meets the OSHA definition of unstable in 29 CFR 1910.1450;
- is known or found to be reactive with other substances.

Handle reactive chemicals with all proper safety precautions: segregation in storage, prohibition on mixing even small quantities with other chemicals without prior approval; appropriate PPE, precautions and work practices.

Working with Corrosive and Contact Hazard Chemicals

Corrosivity, allergenic, and sensitizer information is sometimes provided on manufacturers' MSDSs and labels. Also, guidelines on corrosive chemicals can be found in other OSHA standards and in regulations promulgated by DOT in 49 CFR and the EPA in 40 CFR.

A corrosive chemical is one that:

- meets the OSHA definition of corrosive in Appendix A of 29 CFR 1910.1200;
- has a pH greater than 12.5 or less than 2.0;
- is known or found to be corrosive to living tissue.

A contact-hazard chemical is an allergen or sensitizer that:

- is so identified or described in the MSDS or on the label;
- is so identified or described in the medical or industrial hygiene literature;
- is known or found to be an allergen or sensitizer.

Handle corrosive and contact-hazard chemicals with all proper safety precautions including wearing both safety goggles and face shield, gloves tested for absence of pin holes and known to be resistant to permeation or penetration, and a laboratory apron or lab coat.