

Work Practices to Reduce Laboratory Hazardsⁱ

A hazard assessment should be completed before undertaking any laboratory activity involving toxic or flammable materials. This is especially important when unfamiliar chemicals, apparatus, and reactions are used or when operating parameters are altered. The hazard assessment must include:

1. hazards (physical properties, toxicity, routes of entry) associated with the properties and the reactivity of the materials used and any intermediate and end products that can be formed,
2. hazards associated with the operation of the equipment at the operation conditions (Where and when will the chemicals be evolved and at what release rate? Will the chemical release have velocity?), and,
3. hazards associated with the proposed reactions (polymerization and oxidation).

Where reactions are being performed to synthesize materials, the hazard characteristic of which have not yet been determined by test, precautions must be employed to control the highest possible hazard based on a known hazard of similar material.

Regular reviews of laboratory operations and procedures must be conducted with special attention given to any change in materials, operations, or personnel.

Emergency Planning

Each laboratory must prepare an emergency plan and all personnel should be familiar with it. This emergency plan should include:

1. A chemical inventory that includes the quantities and locations of all flammable, pyrophoric, oxidizing, toxic, corrosive, radioactive nonionizing radiation and biological materials, including compressed and liquefied gases.
2. A list of responsible personnel who are designated and trained to be liaison personnel for the fire department or other emergency responders.
3. Action to be taken by laboratory personnel upon activation of the fire alarm. This should include instructions to turn off flames and other ignition sources, close the fume hood sash, close all hazardous materials containers, and turn off all electrical equipment.
4. Location of emergency equipment in the laboratory (fire extinguishers, emergency shower, eyewash, fire blanket and spill kit).
5. Procedures for extinguishing clothing fires (stop, drop & roll, cover face with hands and use fire blanket, do not use fire extinguisher), using emergency shower and eyewash and spill kits.
6. Primary and secondary evacuation routes to the outside of the building.
7. Identify an area outside of the building to meet and account for all laboratory personnel.
8. Instructions not to reenter the building until qualified Emergency Responders provide notification that it is safe to return.

Chemical Handling and Storage

Ordering Procedures:

1. When a chemical is ordered, determine the hazards (e.g. from the Material Safety Data Sheet) and transmit that information to those who will receive, store, use, or dispose of the chemicals.

2. Chemicals must not be brought into a laboratory work area unless design, construction, and fire protection of receiving and storage facilities are commensurate with the quantities and hazards of chemicals involved.
3. Glass containers of Class IA flammable liquids must not be larger than 500 mL, Class IB must not be larger than 1 L and Class IC must not be larger than 4 L (1.1 gal). If larger containers (up to 5 gal) must be ordered due to purity or availability needs, these containers must be kept in a secondary container that is large enough to hold the contents of the primary container. Metal containers must not exceed 19 L (5 gal). When the containers are larger than 4 L (1.1 gal), the containers must be electrically interconnected by direct bonding. In instructional labs, no container for Class I or Class II flammable liquids can exceed 4 L (1.1 gal).

Handling:

1. Receiving, transporting, unpacking, and dispensing of chemicals and other hazardous materials must be carried out by trained personnel in such locations and in such a manner as to minimize hazards from flammable, reactive, or toxic materials.
2. Transfer of Class I flammable liquids must be performed in a laboratory hood or in an area provided with ventilation adequate to prevent accumulations of flammable vapor from exceeding 25 percent of the lower flammable limit.

Storage:

1. Hazardous chemicals must not be stored or handled in any EXIT corridor.
2. Incompatible materials must be segregated to prevent accidental contact with one another.
3. Containers of materials that might become hazardous during prolonged storage must be dated when first opened. This includes materials that may form shock sensitive peroxides after exposure to air or light (e.g. ethyl ether), materials that are hygroscopic or water reactive (metallic sodium), or material that when water content evaporates, the material (e.g. picric acid) becomes shock sensitive. At the end of 6 months, the material must be evaluated or tested for continued safe use. Material that is found to be safe or that can be treated to be made safe must be permitted to be redated and retained for an additional 6-month period. All other material must be safely discarded. Compressed gas cylinders of corrosive or unstable gases should be returned to the supplier when the expiration date has been reached. If no expiration date is provided, the maximum retention time is 36 months.
4. Flammable storage cabinets must not be vented. All closures will be kept in place. The door must be kept closed at all times.
5. Gas cylinders of gases with a NFPA Health Hazard Rating of 2 (without physiological warning properties), 3 or 4 and pyrophoric gases, must be stored in a continuously mechanically ventilated hood (lecture bottles) or other continuously mechanically ventilated enclosure.

Maximum Quantities:

1. Hazardous chemicals stored in the open must be kept to the minimum necessary for the work being done.
2. No more than 25 lecture bottle cylinders can be stored in a lab (maximum of 10 lecture bottle cylinders in an instructional lab).

Laboratory Operations

Unattended Operations: A laboratory procedure or operation at which there is no person present who is knowledgeable regarding the operation and emergency shutdown procedures is considered an "unattended operation". Absence for lunch, telephone calls, and so forth, without coverage by a knowledgeable person, constitutes an unattended laboratory operation.

1. Unattended or automatic laboratory operations involving hazardous chemicals must be provided with regular surveillance for abnormal conditions.
2. Unattended operations must be provided with an override control and automatic shutdown to prevent system failure that can result in fire or explosion.
3. All unattended electrical heating equipment shall be equipped with a manual reset over-temperature shut-off switch, in addition to normal temperature controls, if over-heating could result in a fire or explosion.

Lab Operations:

1. Filtrations, extractions, sublimations, adsorptions, evaporations, centrifuging operations, other separation techniques, and mixing grinding, stirring, and agitating operations that involve flammable or combustible materials must be protected from ignition sources and must be provided with ventilation that prevents the accumulation of an ignitable concentration of vapors in the work area. Precautions must be taken to avoid local overheating during grinding and mixing of solids.
2. Distillations must be conducted in equipment designed and fabricated for this use and must be assembled with consideration being given to fire hazards from vent gases and possible equipment breakage or failure. Care must be taken to avoid the presence of unstable components in the still pot (e.g. peroxides) and to avoid overheating still contents.
3. Reactions at temperatures and pressures either above or below ambient conditions must be conducted in a manner that minimizes hazards. Shielding must be used whenever there is a reasonable probability of explosion or vigorous chemical reaction and associated hazards during charging, sampling, venting, and discharge of products.
4. Flammable or combustible vapors evolved during drying operations must be condensed, trapped, or vented to avoid ignition.
5. Quantities of reactants must be limited and procedures must be developed to control or isolate vigorous or exothermic reactions. Procedures might include chilling, quenching, cut-off of reactant supply, venting, dumping, and "short-stopping" or inhibiting.
6. Equipment operating controls must be accessible under normal and emergency conditions.

Fume Hoods:

Generally, because a laboratory hood is used to conduct various operations involving larger quantities of toxic or flammables compared to work done on the laboratory bench, the following items should be reviewed and considered before beginning work in the hood:

1. When a hazard assessment is performed, a list of possible hazards should be prepared and engineering controls should be used to reduce the probability of the event occurring.
2. The minimum quantity of flammable or combustible liquids or flammable gases that are necessary to achieve the desired results considering the airflow capabilities of the hood should be determined.
3. Possible ignition sources, including hot surfaces, electrical equipment, static charge, and so forth, should be identified.
4. If the activity is conducted when personnel are not in attendance, the equipment has to be designed to shut down in a fail-safe mode in the event of ventilation failure, fire, over temperature, and so forth. Audible and visible alarms should also be installed.
5. If the operations are designed for unattended use, a measuring device for hood airflow equipped with electrical contacts can be used to warn of defective hood performance and to provide a means to initiate an automatic safe shutdown of equipment.
6. Switches that control power to equipment should be outside the hood and within 15 m (50 ft) so apparatus can be de-energized in an emergency.
7. When flammable or combustible liquids are pressurized, the equipment layout should be arranged so that potential leaks from pump seals, piping components, glassware, and so forth, cannot occur near ignition sources. In some extra hazardous operations, a partition

- between ignition sources and flammable and combustible liquid or flammable gas supplies might be required. If partitions are used, a smoke test of the airflow patterns should be conducted to assure good distribution across the hood opening.
8. Risk of accidental spill of liquids should be minimized by using nonglass apparatus where possible.
 9. Spill containment must be provided to prevent spilled liquids from escaping from the hood or down the drain.
 10. Hoods with once-through flow that are equipped with a bypass airfoil or mechanical stops on the sash that assure good ventilation rates even with the sash in the closed position should be used.
 11. All flammable and combustible materials that are not being used should be removed.
 12. Unauthorized use or operation of the hood should be prevented.
 13. Hood sashes should be kept closed when operations do not require them to be open.
 14. An emergency plan and off-hour instructions that can be followed during an emergency must be developed.

Glass:

1. Glass equipment used for distillations must be inspected for cracks, scratches, and other defects prior to each use. Faulty glass equipment must be discarded or repaired.
2. Glass equipment operated under either vacuum or pressure must be shielded, wrapped with tape, or otherwise protected from shattering during use.

Heating Operations:

1. All heating of flammable or combustible liquids must be conducted so as to minimize fire hazards.
2. Provisions must be made to contain liquid that might be accidentally release from glass apparatus.
3. Strong oxidizing materials, such as perchloric acid, must not be heated by gas flames or oil baths.

Refrigeration and Cooling Equipment:

1. Each refrigerator, freezer or cooler must be prominently marked to indicate whether or not it meets the requirements for safe storage of flammable liquids. Refrigerator temperatures are higher than the flash points of most flammable liquids.
2. Domestic refrigerators must not be used to store flammable or combustible liquids. Self-defrosting domestic refrigerators can never be made safe to store flammable or combustible liquids. Ignition sources include thermostats, light switches, and heater strips. Also, the compressor and its circuits are usually located at the bottom of the unit where vapors from flammable liquid spills or leaks could accumulate.
3. Only "Explosion-safe" or "Laboratory-safe" refrigerators can be used to store flammable or combustible liquids.
4. Flammable liquids stored in refrigerated equipment must be stored in closed containers.

For additional safety information, visit the EH&S web page at:

<http://www.stonybrook.edu/ehs> or call 632-6410

ⁱ Excerpted from NFPA 45 *Standard on Fire Protection for Laboratories Using Chemicals*. National Fire Protection Association, 2004 Edition.