

## Laboratory Safety Audit Categories Standards and Explanations

The following are descriptions of audit items organized by category. They are supported by government regulations or are considered best practices by accredited and respected sources.

### Lab Safety Plan

Laboratories should have access control measures to secure laboratory materials and equipment from unauthorized persons.

Signs that inform all entrants prior to entry of 1) hazards present in the space, 2) safety or administrative requirements for the space, and 3) contact information for key personnel should be present on exterior room doors leading to public access ways. This information is important for emergency responders. The information should be kept current and reviewed at least annually.

All laboratories working with hazardous chemicals are required to have a [Laboratory Safety Plan](#). The plan shall be available to all laboratory personnel, be reviewed annually, and updated as necessary. Standard Operating Procedures and lab-specific training should be provided and documented. In addition to the PI/supervisor, one or more laboratory safety contact(s) should be identified for each laboratory group.

Access to Safety Data Sheets (SDS) for chemicals and other references for handling hazardous materials should be available.

### Prudent Practices 2011: Chapter 6.D.4 Access Control

*“Restrict access to laboratories where highly toxic chemicals are in use to personnel who are authorized for this laboratory work and trained in the special precautions that apply. Administrative procedures or even physical barriers may be required to prevent unauthorized personnel from entering these laboratories.*

*Keep laboratory doors closed and locked to limit access to unattended areas where highly toxic materials are stored or routinely handled. However, security measures must not prevent emergency exits from the laboratory...*”

### 29 CFR 1910.1450 Appendix A

*D. 7. Prominent signs of the following types should be posted:*

- (a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers;*
- (b) Location signs for safety showers, eyewash stations, other safety and first aid equipment, and exits; and*
- (c) Warnings at areas or equipment where special or unusual hazards exist.*

### 29 CFR 1910.1450

*(e)(1) “Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:..”*

*(f)(1) “The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.”*

*(h)(1)(ii) “Employers shall maintain any safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.”*

*(e)(3)(vii) Designation of personnel responsible for implementation of the Chemical Hygiene Plan...*

*(e)(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.*

## **BMBL 5<sup>th</sup> ed**

### Section IV-A-1

*“The laboratory supervisor must enforce the institutional policies that control access to the laboratory.”*

### Section IV-A-9

*“A sign incorporating the universal biohazard symbol must be posted at the entrance to the laboratory when infectious agents are present. The sign may include the name of the agent(s) in use, and the name and phone number of the laboratory supervisor or other responsible personnel. Agent information should be posted in accordance with the institutional policy.”*

### BL2 Section IV-B-4

*“A laboratory-specific biosafety manual must be prepared and adopted as policy. The biosafety manual must be available and accessible.”*

## **General PPE**

Appropriate PPE shall always be worn when handling hazardous materials.

Gloves to protect against the hazards present in the lab shall be available. Because of potential allergic reactions, alternatives to latex gloves should be provided. If cryogenics are handled, loose-fitting cryogenic gloves should be available.

Appropriate eye/face protection for the hazards present in the lab shall be available. At a minimum, safety glasses with side shields should be available for every person working with chemicals. Splash goggles or a face shield are recommended for splash/spray hazards and for handling highly corrosive or toxic liquids.

Laboratory coats that provide protection adequate for the hazards present in the laboratory shall be available.

See the DRS safety guide on [PPE](#) for more information.

All personnel required to wear a respirator shall follow the UIUC Respiratory Protection Policy and implement their own respirator protection program. The program is administered on campus by the Division of Safety and Compliance. For more information view the [Respiratory Protection Fact Sheet](#).

### **29 CFR 1910.1450 App A**

*E 1(f) Wear appropriate PPE at all times.”*

### **29 CFR 1910.132 General Requirements**

*“Application. Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.”*

### **29 CFR 1910.133 Eye and face protection**

*“The employer shall ensure that each affected employee uses appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation...”*

### **29 CFR 1910.134 Respiratory Protection**

*“...When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to this section... A respirator shall be provided to each employee when such equipment is necessary to protect the health of such employee. The employer shall provide the respirators*

*which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protection program... The employer shall include in the program the following provisions of this section, as applicable... Fit testing procedures for tight-fitting respirators; Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations...*

## **29 CFR 1910.138 Hand Protection**

*“General requirements. Employers shall select and require employees to use appropriate hand protection when employees' hands are exposed to hazards such as those from skin absorption of harmful substances; severe cuts or lacerations; severe abrasions; punctures; chemical burns; thermal burns; and harmful temperature extremes. Selection. Employers shall base the selection of the appropriate hand protection on an evaluation of the performance characteristics of the hand protection relative to the task(s) to be performed, conditions present, duration of use, and the hazards and potential hazards identified.”*

### **BMBL 5<sup>th</sup> ed,**

#### **Section IV-C-3**

*“Wear protective eyewear when conducting procedures that have the potential to create splashes of microorganisms or other hazardous materials. Persons who wear contact lenses in laboratories should also wear eye protection.”*

#### **Section IV-C-4**

*“Gloves must be worn to protect hands from exposure to hazardous materials. Glove selection should be based on an appropriate risk assessment. Alternatives to latex gloves should be available... Do not wash or reuse disposable gloves. Dispose of used gloves with other contaminated laboratory waste.”*

## **Laboratory Housekeeping**

Food and beverages must not be permitted in laboratories or stored in refrigerators that are used to store biological, chemical, or radioactive materials. Empty food containers must not be used to collect hazardous waste.

Cluttered work spaces increase the risks of spills and accidents. Spills that have not been properly cleaned are potentially hazardous and can lead to accidental exposures as well as damage to surfaces and equipment.

Aisles and exits must be free of objects to provide unimpeded access to emergency equipment and emergency exits. Emergency response personnel need to be able to access all areas of the laboratory and move freely even in poor visibility when smoke is present. Access to exits must be at least 28 inches wide at all points. See the Division of Research Safety (DRS) safety guide on [Laboratory Housekeeping](#) for more information.

Sprinklers require an 18-inch vertical clearance to function properly.

### **29 CFR 1910.141(g)(2)**

*“Eating and drinking areas. No employee shall be allowed to consume food or beverages in a toilet room nor in any area exposed to a toxic material.”*

### **29 CFR 1910.1450 Appendix A**

*E.1. (k) “Eating, drinking, smoking, gum chewing, applying cosmetics, and taking medicine in laboratories where hazardous chemicals are used or stored should be strictly prohibited.”*

*E.1. (l) “Food, beverages, cups, and other drinking and eating utensils should not be stored in areas where hazardous chemicals are handled or stored.”*

### **BMBL 5<sup>th</sup> ed**

#### **Section IV-A-3**

*“Eating, drinking, smoking, handling contact lenses, applying cosmetics, and storing food for human consumption must not be permitted in laboratory areas. Food must be stored outside the laboratory area in cabinets or refrigerators designated and used for this purpose.”*

### **Prudent Practices in the Laboratory 2011 Chapter 6.C.3**

*“A definite correlation exists between orderliness and the level of safety in the laboratory. In addition, a*

*disorderly laboratory can hinder or endanger emergency response personnel.”*

## **29 CFR 1910.22 Walking-Working Surfaces**

*(a)(1) “All places of employment, passageways, storerooms, and service rooms shall be kept clean and orderly and in a sanitary condition.”*

*(b)(1) “Aisles and passageways shall be kept clear and in good repairs, with no obstruction across or in aisles that could create a hazard.”*

## **29 CFR 1910.36(g)(2) Means of Egress**

*“An exit access must be at least 28 inches (71.1 cm) wide at all points. Where there is only one exit access leading to an exit or exit discharge, the width of the exit and exit discharge must be at least equal to the width of the exit access.”*

## **29 CFR 1910.37 Means of Egress**

*(a)(3) “Exit routes must be free and unobstructed.”*

## **29 CFR 1910.159(c)(10) Automatic Sprinkler Systems**

*“Sprinkler spacing. The employer shall assure that sprinklers are spaced to provide a maximum protection area per sprinkler, a minimum of interference to the discharge pattern by building or structural members or building contents and suitable sensitivity to possible fire hazards. The minimum vertical clearance between sprinklers and material below shall be 18 inches (45.7 cm).”*

## **Electrical**

Extension cords should be used only temporarily. They should not be run through holes in walls, doors, or windows, or be attached to building surfaces. Power strips with circuit breakers may be used but should not be connected in a series or to an extension cord.

Extension cords that have a three-wire design shall have the ground plug intact. Three-to-two-prong adapters should never be used to plug a three-wire plug into a two-wire system.

All electrical cords should be inspected by the user for damage to the integrity of the cord. Electrical cords with damage to the insulation (i.e., wires are visible or tape is needed to hold it together) or frayed cords should be replaced immediately. Equipment with cords that have obvious shorts should be taken out of service until the cords are replaced.

Electrical circuits should not be overloaded. “Overloaded” is defined as excessive electrical cords plugged into a circuit through the use of adapters, which allow multiple-plug capability. Power strips with circuit breakers may be used but should not be used in a series or with adapters.

Ground Fault Circuit Interrupter (GFCI) protection must be used for electrical appliances that will operate within six feet of water sources. For outlets that must be used within the six feet of a water source, portable GFCIs are available for purchase.

Equipment with high voltage (> 600 V) or equipment with exposed live parts of > 50 V must be guarded against accidental contact and labeled with a sign warning of the electrical shock hazard.

Electrical panels must be kept accessible for repair and maintenance by service personnel.

See the DRS guide on [Electrical Safety in the Laboratory](#) for more information.

## **29 CFR 1910.305 Wiring methods, components, and equipment for general use**

*(a)(2)(ii) “Temporary Wiring: Temporary wiring shall be removed immediately upon completion of the project or purpose for which the wiring was installed.”*

*(g)(1)(iv) “Unless specifically permitted otherwise in paragraph (g)(1)(ii) of this section, flexible cords and cables may not be used:*

- (A) As a substitute for the fixed wiring of a structure;*
- (B) Where run through holes in walls, ceilings, or floors;*
- (C) Where run through doorways, windows, or similar openings;*
- (D) Where attached to building surfaces;*
- (E) Where concealed behind building walls, ceilings, or floors; or*

*(F) Where installed in raceways, except as otherwise permitted in this subpart.”*

## **29 CFR 1910.334 Use of equipment**

*(a)(2)(ii) “If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.”*

*(a)(3)(iii) “Adapters which interrupt the continuity of the equipment grounding connection may not be used.”*

## **29 CFR 1910.303 General-Electrical**

*(g)(1) “Space about electric equipment. Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.”*

*(g)(2) Guarding of live parts.*

*(g)(2)(i) “Except as elsewhere required or permitted by this standard, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by use of approved cabinets or other forms of approved enclosures or by any of the following means:...”.*

*(g)(2)(iii) “Entrances to rooms and other guarded locations containing exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter.”*

*(h)(5)(iii) “The following requirements apply to the entrances to all buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 volts, nominal:*

*(h)(5)(iii)(A) “The entrances shall be kept locked unless they are under the observation of a qualified person at all times; and*

*(h)(5)(iii)(B) “Permanent and conspicuous warning signs shall be provided, reading substantially as follows: “DANGER HIGH VOLTAGE KEEP OUT.”*

## **29 CFR 1910.304 Wiring design and protection**

*(e)(2)(ii) “Signs warning of high voltage shall be posted where unqualified employees might come in contact with live parts.”*

## **NFPA, electrical safety tips**

*“U.S. fire departments responded to an estimated annual average of 47,820 reported home structure fires involving electrical failure or malfunction in 2007-2011. These fires resulted in 455 civilian deaths, 1,518 civilian injuries and \$1.5 billion in direct property damage.*

- Replace or repair damaged or loose electrical cords.*
- Avoid running extension cords across doorways or under carpets.*
- In homes with small children, make sure your home has tamper-resistant (TR) receptacles.*
- Consider having additional circuits or outlets added by a qualified electrician so you do not have to use extension cords.*
- Follow the manufacturer's instructions for plugging an appliance into a receptacle outlet.*
- Avoid overloading outlets. Plug only one high-wattage appliance into each receptacle outlet at a time.*
- If outlets or switches feel warm, frequent problems with blowing fuses or tripping circuits, or flickering or dimming lights, call a qualified electrician.*
- Place lamps on level surfaces, away from things that can burn and use bulbs that match the lamp's recommended wattage.*
- Make sure your home has ground fault circuit interrupters (GFCIs) in the kitchen bathroom(s), laundry, basement, and outdoor areas.*
- Arc-fault circuit interrupters (AFCIs) should be installed in your home to protect electrical outlets.”*

## **NFPA 70.210.8.**

*“Ground-fault circuit-interruption for personnel shall be provided as required in 210.8(A) through (C). The ground-fault circuit-interrupter shall be installed in a readily accessible location.*

*B.5 Sinks – where receptacles are installed within 1.8 m (6 ft) of the outside edge of the sink.”*

## Fume Hoods

Fume hoods are inspected annually by Safety and Compliance to ensure that airflow meets established standards and that it is not impeded by material in the hood. In addition, sashes and sidewalls must be intact for the hood to function properly. Proper use of the fume hood is also essential to properly protect laboratory personnel. See the DRS safety guide on [Chemical Fume Hood](#) for more information.

### 29 CFR 1910.1450

*(e)(3)(iii) “A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;”*

### NFPA 45 2011, 8.13.1

*When installed or modified and at least annually thereafter, chemical fume hoods, chemical fume hood exhaust systems, and laboratory special exhaust systems shall be inspected and tested as applicable, as follows:*

- 1. Visual inspection of the physical condition of the hood interior, sash, and ductwork*
- 2. Measuring device for hood air flow*
- 3. Low airflow and loss-of-airflow alarms at each alarm location*
- 4. Face velocity*
- 5. Verification of inward airflow over the entire hood face*
- 6. Changes in work area conditions that might affect hood performance*

## Prudent Practices in the Laboratory 2011

### 9 C.2.5 Housekeeping

*“Keep laboratory chemical hoods and adjacent work areas clean and free of debris at all times. Keep solid objects and materials (such as paper) from entering the exhaust ducts, because they can lodge in the ducts or fans and adversely affect their operation. The chemical hood will have better airflow across its work surface if it contains a minimal number of bottles, beakers, and laboratory apparatus; therefore, prudent practice keeps unnecessary equipment and glassware outside the chemical hood at all times and stores all chemicals in approved storage cans, containers, or cabinets. Furthermore, keep the workspace neat and clean in all laboratory operations, particularly those involving the use of chemical hoods, so that any procedure or experiment can be undertaken without the possibility of disturbing, or even destroying, what is being done.”*

## Other Equipment

**Biosafety cabinets** should be inspected annually by a qualified professional certifier.

**All gas lines** connected to a biosafety cabinet must have an accessible shut-off valve on the outside of the cabinet.

**Work surfaces** should be impervious to liquids and chemically resistant so that they can be cleaned and decontaminated easily.

**Chairs** used near work areas in both Biosafety Level 1 and Biosafety Level 2 spaces must be covered with non-porous material that can be decontaminated easily.

**Sinks** are necessary in laboratories using hazardous materials to allow personnel to wash hands immediately after glove removal.

Systems under **vacuum** must use appropriate-sized traps in a manner that prevents damage to vacuum sources and reduces the dispersal of volatile substances in the building. The vacuum exhaust of pumps has to be vented correctly to prevent hazardous vapors from escaping into the room. All vacuum equipment must be constructed of appropriate material, in good working order, and coated in a manner that will minimize flying glass in the event of an implosion. See the DRS guide on [Vacuum Safety](#) for more information.

**Tubing** should be kept in good condition as cracks can lead to vapors escaping into the room or poor vacuum that can lead to the pump overheating.

**Equipment** such as vacuum traps, filtration funnels and flasks, etc. should be secured to prevent them from falling over, breaking, and causing a spill.

**Mercury thermometers** should not be used in ovens due to the high toxicity of mercury vapors that could result if the thermometer broke within the oven. See the DRS safety guide on [Mercury](#) for more information.

**Machine guards** should be kept in place to avoid injury. All safety features for instruments and machines must be kept intact and not tampered with.

**Engineering controls** such as adequate ventilation is required to keep concentrations of airborne contaminants below permissible exposure limits.

## **BMBL 5<sup>th</sup> ed. Appendix A**

### Section VII - Certification of BSCs

*“The operational integrity of a BSC must be validated before it is placed into service and after it has been repaired or relocated. Relocation may break the HEPA filter seals or otherwise damage the filters or the cabinet. Each BSC should be tested and certified at least annually to ensure continued, proper operation.”*

### Section IV - Utility Services

*“When propane or natural gas is provided, a clearly marked emergency gas shut-off valve outside the cabinet must be installed for fire safety.”*

## **BMBL 5<sup>th</sup> ed, BL1**

### Section IV-A-2

*“Persons must wash their hands after working with potentially hazardous materials and before leaving the laboratory.”*

### Section IV-D-2

*“Laboratories must have a sink for hand washing.”*

### Section IV-D-4-b

*“Chairs used in laboratory work must be covered with a non-porous material that can be easily cleaned and decontaminated with appropriate disinfectant.”*

## **29 CFR 1910.1450 App A**

*C1(a) “Work surfaces should be chemically resistant, smooth, and easy to clean.”*

*E1(j) “Hands should be washed with soap and water immediately after working with any laboratory chemicals, even if gloves have been worn.”*

## **NFPA 45 2011 12.1.6.3**

*“Glass apparatus containing gas or vapors under vacuum or above ambient pressure shall be shielded, wrapped with tape, or otherwise protected from shattering (such as engineering control or by apparatus design) during use.”*

## **Prudent Practices in the Laboratory 2011**

### 7.C.2 Vacuum Pumps.

*“Distillation or similar operations requiring a vacuum must use a trapping device to protect the vacuum source, personnel, and the environment. This requirement also applies to oil-free Teflon-lined diaphragm pumps. Normally the vacuum source is a cold trap cooled with dry ice or liquid nitrogen..*

*Vent the output of each pump to a proper air exhaust system. This procedure is essential when the pump is being used to evacuate a system containing a volatile toxic or corrosive substance. Failure to observe this precaution results in pumping the untrapped substances into the laboratory atmosphere. Scrubbing or absorbing the gases exiting the pump is also recommended. Even with these precautions, volatile toxic or corrosive substances may accumulate in the pump oil and thus be discharged into the laboratory atmosphere during future pump use. Avoid this hazard by draining and replacing the pump oil when it becomes contaminated.*

*Belt-driven mechanical pumps must have protective guards. Such guards are particularly important for pumps installed on portable carts or tops of benches where laboratory personnel might accidentally entangle clothing or fingers in the moving belt or wheels. Glassware under vacuum is at risk for implosion, which could result in flying glass. (For more information about working under vacuum, see Chapter 4, section 4.E.4.)”*

### 7.C.5.1 Ovens

*“Bimetallic strip thermometers are preferred for monitoring oven temperatures. Do not mount mercury*

*thermometers through holes in the tops of ovens with the bulb hanging into the oven. If a mercury thermometer is broken in an oven of any type, close the oven and turn it off immediately to avoid mercury exposure. Keep it closed until cool. Remove all mercury from the cold oven with the use of appropriate cleaning equipment and procedures (see Chapter 6, section 6.C.10.8). After removal of all visible mercury, monitor the heated oven in a laboratory chemical hood until the mercury vapor concentration drops below the threshold limit value. (For information about reducing the use of mercury in thermometers, see Chapter 5, section 5.B.8.).”*

## **29 CFR 1910.212 General requirements for all machines**

*(a)(1) “Types of guarding. One or more methods of machine guarding shall be provided to protect the operator and other employees in the machine area from hazards such as those created by point of operation, ingoing nip points, rotating parts, flying chips and sparks. Examples of guarding methods are-barrier guards, two-hand tripping devices, electronic safety devices, etc.”*

## **29 CFR 1910.1450(c)**

*Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees’ exposure to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.*

## **29 CFR 1910.1450 Appendix A**

*A General Principles. 4. Provide Ventilation: The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by the use of hoods and other ventilation devices.*

## **Emergency Equipment**

Fire extinguishers must be appropriate for the hazards in the laboratory and readily accessible. They are replaced annually by Facilities and Services (F&S). Monthly condition checks should be performed to ensure the pressure gauge is in the green, the safety pin is in place, and the tamper indicator is intact. If there is any indication of use, the extinguisher must be serviced through F&S, Campus Code Compliance and Fire Safety.

A plumbed or self-contained eyewash must be provided in all work areas where the eyes of any person may be exposed to hazardous material (corrosives, eye irritants, acutely toxic, chronic health effects, biological materials that require biosafety level 2 containment or greater). An emergency shower must be provided in all work areas where a person may be exposed to hazardous material (corrosive or irritating to the skin, acutely toxic, or chronic health effects). Researchers should have unobstructed, rapid (10 seconds) access from their workspace. Showers should be tested annually and marked with a highly visible sign. Eye washes should be tested weekly and repairs scheduled immediately if equipment is not functioning properly.

See [Emergency Eyewashes and Showers](#) for more information.

A spill kit should be readily available and stocked with material needed to clean up spills of all chemicals present in the laboratory. If any materials are used, compromised, or contaminated, they should be replaced immediately.

All work surfaces where biological materials are used should be cleaned with appropriate disinfectant following the procedure.

Based on current knowledge on the best first aid treatment, antidotes for HF must be present in labs where HF is stored or used. See the DRS safety guide on [Hydrofluoric Acid](#) for more information.

## **29 CFR 1910.157 Portable fire extinguishers**

*(c)(1) “The employer shall provide portable fire extinguishers and shall mount, locate and identify them so that they are readily accessible to employees without subjecting the employees to possible injury.”*

*(d)(1) “Portable fire extinguishers shall be provided for employee use and selected and distributed based on the classes of anticipated workplace fires and on the size and degree of hazard which would affect their use.”*

*(e)(2) “Portable extinguishers or hose used in lieu thereof under paragraph (d)(3) of this section shall be visually inspected monthly.”*

*(e)(3) “The employer shall assure that portable fire extinguishers are subjected to an annual maintenance check. Stored pressure extinguishers do not require an internal examination. The employer shall record the annual maintenance date and retain this record for one year after the last entry or the life of the shell, whichever is less. The record shall be available to the Assistant Secretary upon request.”*

## **29 CFR 1910.151 Medical services and first aid**



(c) *“Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use.”*

#### **ANSI/ISEA Z358.1-2009 American National Standard for Emergency Eyewash and Shower Equipment**

*“This standard establishes minimum performance and use requirements for eyewash and shower equipment for the emergency treatment of the eyes or body of a person who has been exposed to hazardous materials.”*

##### **Section 4 Emergency Showers**

*4.5.2 Be in accessible locations that require no more than 10 seconds to reach. The emergency shower shall be located on the same level as the hazard and the path of travel shall be free of obstructions that may inhibit its immediate use.*

*4.5.3 Be located in an area identified with a highly visible sign positioned so the sign shall be visible within the area served by the emergency shower. The area around the emergency shower shall be well-lit.*

##### **Section 5 Eyewashes**

*5.4.2 Be in accessible locations that require no more than 10 seconds to reach. The eyewash shall be located on the same level as the hazard and the path of travel shall be free of obstructions that may inhibit its immediate use.*

*5.4.3 Be located in an area identified with a highly visible sign positioned so the sign shall be visible within the area served by the eyewash. The area around the eyewash shall be well-lit.*

*5.5.2 Plumbed eyewashes shall be activated weekly for a period long enough to verify operation and ensure that flushing fluid is available.*

#### **29 CFR 1910.1450 App A**

##### **D Chemical Hygiene Plan**

###### **“7. Signs:**

*Prominent signs of the following types should be posted:*

- (a) Location signs for safety showers, eyewash stations, other safety and first aid equipment, and exits; and*
- (b) Warnings at areas or equipment where special or unusual hazards exist.*

###### **8. Spills and Accidents:**

*Before beginning an experiment, know your facility’s policies and procedures for how to handle an accidental release of a hazardous substance, a spill or a fire. Emergency response planning and training are especially important when working with highly toxic compounds. Emergency telephone numbers should be posted in a prominent area. Know the location of all safety equipment and the nearest fire alarm and telephone. Know who to notify in the event of an emergency. Be prepared to provide basic emergency treatment. Keep your co-workers informed of your activities so they can respond appropriately. Safety equipment, including spill control kits, safety shields, fire safety equipment, PPE, safety showers and eyewash units, and emergency equipment should be available in well marked highly visible locations in all chemical laboratories. The laboratory supervisor or CHO is responsible for ensuring that all personnel are aware of the locations of fire extinguishers and are trained in their use. After an extinguisher has been used, designated personnel must promptly recharge or replace it (29 CFR 1910.157(c)(4)). The laboratory supervisor or CHO is also responsible for ensuring proper training and providing supplementary equipment as needed.”*

#### **BMBL 5<sup>th</sup> ed, BL1 Section IV-A-7**

*“Decontaminate work surfaces after completion of work and after any spill or splash of potentially infectious material with appropriate disinfectant.”*

**First aid for a unique acid, HF: A sequel, Chemical Health & Safety, January/February 2000:**  
<http://depts.washington.edu/cosmolab/chem/hfsafety.pdf>

# Chemical Handling and Storage

## General Storage

Hazardous materials should be stored safely in cabinets or on stable shelving to prevent containers from falling or being knocked over. Chemicals should not be stored on the floor. If storage on the floor cannot be avoided, secondary containment should be used.

Chemicals should not be stored in hallways or locations that would jeopardize egress.

Incompatible chemicals may react dangerously with each other when mixed. To avoid accidental mixing, incompatible chemicals should be stored separately, i.e., in different cabinets or separated by secondary containment in the same cabinet.

Secondary containment should be used for highly corrosive and toxic chemicals, especially when stored outside of storage cabinets. Secondary containment is necessary when transporting chemicals through buildings and outdoors.

The container materials should be appropriate for the chemical contents (i.e., hydrofluoric acid should never be stored in glass; nitric acid and other oxidizers should be stored only in glass). Food containers are never to be used for chemical storage, even if the label has been removed. Containers must be leak proof and in good condition with intact, leak-proof lids. Containers must be closed at all times unless in immediate use, meaning that someone is actively adding or removing chemicals from the container.

Contents and hazards shall be indicated on all containers of chemical, biological, and radioactive materials. The original label shall not be removed, and if it becomes illegible a new label must be applied. Temporary containers should be labeled so that another person can identify its contents.

All appliances (refrigerators, ice chests, cold rooms, and ovens) that are used for hazardous materials shall be marked with the appropriate label to prevent storage of food, beverages, or other consumables in these appliances.

See the DRS safety guides on [Chemical Storage](#) and [Labeling Chemicals in Laboratories](#) for more information.

Storing certain chemicals for an extended period of time can result in elevated hazards. Chemicals kept past the expiration date or under conditions not recommended by the manufacturer can result in decomposition of the chemical to a potentially more hazardous substance. Chemicals must be maintained properly or disposed of as recommended in order to eliminate these hazards.

### 29 CFR 1910.1450

*(h)(1)(i) "Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced."*

### 29 CFR 1910.1450 App A

#### Section D 2 chemical storage

*(a) "Chemicals should be separated and stored according to hazard category and compatibility."*

*(c) "Maintain existing labels on incoming containers of chemicals and other materials".*

*(e) "The contents of all other chemical containers and transfer vessels, including, but not limited to, beakers, flasks, reaction vessels, and process equipment, should be properly identified."*

*(h) "Open shelves used for chemical storage should be secured to the wall and contain 3/4-inch lips. Secondary containment devices should be used as necessary."*

*(k) "Chemicals should not be stored in the chemical hood, on the floor, in areas of egress, on the benchtop, or in areas near heat or in direct sunlight."*

#### Section E 1

*(m) "Laboratory refrigerators, ice chests, cold rooms, and ovens should not be used for food storage or preparation."*

## Prudent Practices in the Laboratory 2011

### 2.D.2 Chemical Storage

*“Do not store chemicals in the laboratory chemical hood, on the floor, in the aisles, in hallways, in areas of egress, or on the bench top.”*

#### 2.D.5 Transporting, Transferring, and Shipping Chemicals

*“It is prudent practice to use a secondary containment device (i.e., rubber pail) when transporting chemicals from the storeroom to the laboratory or even short distances within the laboratory.”*

#### 5.E.2 Storage according to compatibility

*“It is prudent to store containers of incompatible chemicals separately. Separation of incompatibles will reduce the risk of mixing in case of accidental breakage, fire, earthquake, or response to a laboratory emergency. Even when containers are tightly closed, fugitive vapors can cause deleterious incompatibility reactions that degrade labels, shelves, cabinets, and containers themselves.”*

#### 5.E.3 Containers and Equipment

*“Specific guidelines regarding containers and equipment to use in storing chemicals are as follows:*

- Use of corrosion-resistant storage trays as secondary containment for spills, leaks, drips, or weeping is a good idea. Polypropylene trays are suitable for most purposes.*
- Use secondary containment (i.e., an overpack) to retain materials if the primary container breaks or leaks.*
- Seal containers to minimize escape of corrosive, flammable, or toxic vapors.”*

#### 6.C.3 Housekeeping

*“Keep chemical containers closed when not in use.”*

*“Do not use floors, stairways, and hallways as storage areas. Items in these areas can become hazardous in the event of an emergency.”*

#### 7.C.3 Refrigerators and Freezers

*“laboratory refrigerators are never used to store food or beverages for human consumption. Add permanent labels warning against the storage of food and beverages to all laboratory refrigerators and freezers.”*

#### Appendix A

*“Passageways. Stairways and hallways should not be used as storage areas. Access to exits, emergency equipment, and utility controls should never be blocked.”*

#### **NFPA 101 2012 Life Safety Code**

*“8.4.3.2\* No storage or handling of flammable liquids or gases shall be permitted in any location where such storage would jeopardize egress from the structure, unless otherwise permitted by 8.4.3.1.”*

### **Waste Storage**

The main requirements pertaining to waste generated in laboratories are:

- Waste containers must be appropriate for the type of waste and in good condition
- All containers must be labeled with the word "Waste" and the complete names of the chemicals. Abbreviations and chemical formulas are not sufficient. A generic label such as "Waste Halogenated Solvents" may be used, but a list of the contents must be kept nearby. The containers must be labeled before or at the time the first drop of waste is added.
- Waste containers must be closed at all times, except when waste is *actively* being added.
- For waste streams that evolve gas, vented caps should be used to prevent over-pressurization.
- Incompatible waste streams should be stored in separate areas.
- Waste containers should be placed in secondary containment, especially when stored on the floor or near sinks.
- DRS should be contacted when waste containers are full to avoid excessive accumulation.
- Dispose of all sharps in a puncture-resistant, leak-proof sharps disposal container. This includes needles, syringe barrels, Pasteur pipettes, scalpels, razor blades, blood vials, microscope slides and coverslips, and glassware contaminated with infectious agents.
- All “red bag” waste containers and bags used for the collection of biological materials or biologically-contaminated items must be labeled with the international biohazard symbol.
- Clean laboratory glassware (broken or unbroken) must be placed in a sturdy cardboard box. The

glassware must be free of liquids and solids. The sealed box, properly labeled with “Clean Laboratory Glass – Trash” may be placed into the trash or a dumpster.

For more information on waste disposal, see the DRS guides on [Chemical Waste](#), [Sharps Disposal](#), and [Biological Waste Information](#).

## Compressed Gases

Gas cylinders shall be stored in an upright position and secured to a wall or solid surface at or slightly above the mid-point to prevent tipping. Cylinders should not be exposed to extreme temperatures. Tubing and pipe material should be compatible with the gas to avoid material degradation and leakage. The tubing should not hinder movement through passageways or pose any other hazard. Hazardous gases shall not be stored next to exits. See the DRS guide on [Compressed Gas Cylinder Safety](#) for more information.

## Flammable and Oxidizing Gases

Flammable and oxidizing gases are incompatible and are to be kept a minimum of 20 feet away from each other or separated by a non-combustible material with a half-hour fire resistance rating built between the two storage areas. The amount of flammable and oxidizing gases permitted in a laboratory is limited by the size of the lab space.

## Toxic Gases

Toxic gases shall be stored in a continuously mechanically ventilated hood (for lecture size bottles) or continuously ventilated gas cabinets (for cylinders larger than lecture size).

## NFPA 45 2011

### 1.1.4 Special Ventilation Requirements for Gas Cylinders

*“Lecture bottle-sized cylinders of the following gases located in laboratory units shall be kept in a continuously mechanically ventilated hood or other continuously mechanically ventilated enclosure:*

- (1) All gases that have health hazard ratings of 3 or 4.*
- (2) All gases that have a health hazard rating of 2 without physiological warning properties*
- (3) Pyrophoric gases*

*Cylinders of all gases that are greater than lecture bottle size and have health hazard ratings of 3 or 4 and cylinders of gases that have a health hazard rating of 2 without physiological warning properties that are located in laboratory units shall meet both the following conditions:*

- (1) Storage in approved continuously mechanically ventilated gas cabinets*
- (2) Compliance with NFPA 55, Compressed Gases and Cryogenic Fluids Code.”*

### 11.1.5.1 Cylinder Safety

*“Cylinders shall be secured from tipping over by holders designed for such service.”*

### 11.1.6.5 Cylinders in Use

*“The quantity of compressed and liquefied gases in Class A, Class B, and Class C laboratory units shall be in accordance with the amounts listed in Table 6.3.1 of NFPA 55, Compressed Gases and Cryogenic Fluids Code.”*

## NFPA 55 2010

### 7.1.10.2 Incompatible Materials

*“Gas containers, cylinders, and tanks shall be separated in accordance with table 7.1.10.2.”*

According to the table a distance of 20 ft is required between different gas categories.

### 7.1.10.5 Temperature Extremes

*“Compressed gas containers, cylinder, and tanks, whether full or partially full, shall not be exposed to temperatures exceeding 125 °F (52 °F) or subambient (low) temperatures unless designed for use under such exposure.”*

## 29 CFR 1910.22(b)(1) Walking-Working Surfaces

*“Aisles and passageways shall be kept clear and in good repairs, with no obstruction across or in aisles that*

*could create a hazard.”*

## **29 CFR 1910.37(a)(2)- Means of Egress**

*“Exit routes must be arranged so that employees will not have to travel toward a high hazard area, unless the path of travel is effectively shielded from the high hazard area by suitable partitions or other physical barriers.”*

## **Prudent Practices in the Laboratory 2011 chapter 7.D.2.2.3 Piping, Tubing, and Fittings**

*“The proper selection and assembly of components in a pressure system are critical safety factors. Considerations include the materials used in manufacturing the components, compatibility with the materials to be under pressure, the tools used for assembly, and the reliability of the finished connections. Use no oil or lubricant of any kind in a tubing system with oxygen because the combination produces an explosion hazard. Use all-brass and stainless steel fittings with copper or brass and steel or stainless steel tubings, respectively. Fitting of this type must be installed correctly. Do not mix different brands of tube fittings in the same apparatus assembly because construction parts are often not interchangeable.”*

## **Cryogenics**

Due to the rapid expansion of evaporating cryogenic liquids into gas, adequate room ventilation is required to prevent oxygen depletion and asphyxiation. The extreme cold requires special containers to avoid material embrittlement and pressure build-up. Condensation of oxygen from the surrounding air poses a fire and explosion hazard, especially in contact with organic material. See the DRS safety guide on [Cryogenics and Dry Ice](#) for more information.

## **NFPA 45 2011**

### 11.4.1

*“All system components used for cryogenic fluids shall be selected and designed for such service.”*

### 11.4.2

*“Pressure relief of vessels and piping handling cryogenic fluids shall comply with the applicable requirements of section 11.2 Storage and Piping Systems.”*

### 11.4.3

*“The space in which cryogenic systems are located shall be ventilated commensurate with the properties of the specific cryogenic fluid in use.”*

## **Flammable Liquids**

The National Fire Protection Association (NFPA) has set limits on flammable liquids stored in laboratories.

Flammable chemicals should be stored in a spark-free environment and in approved flammable storage cabinets.

Grounding and bonding of bulk storage (>4L) and receiving vessels should be used when transferring flammable liquids to prevent static charge buildup.

Flammable materials that require refrigerator storage must be stored in one designed or modified for flammable storage or one that is spark-proof. Standard household refrigerators have exposed ignition sources, making the refrigerator unsuitable for flammable material storage.

See the DRS guide on [Flammable Liquids](#) for more information.

## **29 CFR 1910.1450 App A section D 2 chemical storage**

*(l) Laboratory-grade, flammable-rated refrigerators and freezers should be used to store sealed chemical containers of flammable liquids that require cool storage. Do not store food or beverages in the laboratory refrigerator.*

*(n) “Flammable chemicals should be stored in a spark-free environment and in approved flammable-liquid containers and storage cabinets. Grounding and bonding should be used to prevent static charge buildups when dispensing solvents.”*

## **NFPA 45 2011, Chapters 10 Flammable and Combustible Liquids and NFPA 45 2011, Table 10.1.1(a)**

## **NFPA 45 2011, 12.2.2**

*“Each refrigerator, freezer, or cooler shall be prominently marked to indicate whether it meets the requirements for safe storage of flammable liquids. Refrigerators, freezers, and other cooling equipment used to store or cool flammable liquids shall be listed as special purpose units for use in laboratories or equipment listed for Class I, Division 1 locations, as described in Article 501 of NFPA 70 National electrical Code.”*

#### **Campus Administrative Manual V-B-6.6**

*“All enclosed laboratory equipment subject to explosion should bear on the door or lid a label specifying that the unit has been safeguarded against explosion or that it is not safe and no flammable solvents or materials should be stored therein.”*

### **Peroxide-Forming Chemicals**

Documentation is necessary to keep track of the age of peroxide-forming chemicals. Containers shall be dated when received and when opened. The chemical shall be checked for peroxides according to the guidelines presented in the [Peroxide-Forming Chemicals](#) safety guide.

#### **29 CFR 1910.1450 App A section D 2 chemical storage (g)**

*“Peroxide formers should be dated upon receipt, again dated upon opening, and stored away from heat and light with tightfitting, nonmetal lids.”*

#### **NFPA 45 2011**

##### 9.2.3.4

*“Containers of materials that might become hazardous (i.e. time sensitive) during prolonged storage shall be dated when first opened, and properly managed.”*

##### 9.2.3.4.1

*Proper management shall consist of the following elements:*

- (1) Defining those materials present that are time sensitive*
- (2) Defining each time-sensitive materials inspection frequency*
- (3) Defining proper or approved inspection methodologies to determine the relative hazard of the time-sensitive material*
- (4) Defining pass/fail criteria for inspection results*

### **Pyrophoric Materials**

Gas cylinders shall be stored in an upright, secured position in a ventilated gas cabinet with a sprinkler. Tubing and pipe material has to be compatible with the pyrophoric gas to avoid material degradation and leakage. Pyrophoric gases are extremely hazardous and must not be stored next to exits. Sprinkler systems are required in rooms where pyrophoric materials are being used. Appropriate PPE, including flame-resistant lab coats, shall be provided.

#### **NFPA 45 2011, 11.1.4.4**

*“Cylinders of pyrophoric gases that are greater than lecture bottle size that are located in laboratory units shall be kept in approved continuously mechanically ventilated, sprinklered gas cabinets.”*

#### **NFPA 400 Table 5.2.1.1.3**

*Pyrophoric gases, liquids, solids: “Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.”*

#### **Prudent Practices in the Laboratory 2011**

##### 7.D.2.2.3 Piping, Tubing, and Fittings

*“The proper selection and assembly of components in a pressure system are critical safety factors. Considerations include the materials used in manufacturing the components, compatibility with the materials to be under pressure, the tools used for assembly, and the reliability of the finished connections. Use no oil or lubricant of any kind in a tubing system with oxygen because the combination produces an explosion hazard. Use all-brass and stainless steel fittings with copper or brass and steel or stainless steel tubing, respectively. Fitting of this type must be installed correctly. Do not mix different brands of tube fittings in the same apparatus assembly because construction parts are often not interchangeable.”*

## **29 CFR 1910.37(a)(2) Means of egress**

*“Exit routes must be arranged so that employees will not have to travel toward a high hazard area, unless the path of travel is effectively shielded from the high hazard area by suitable partitions or other physical barriers.”*

## **29 CFR 1910.132 Personal Protective Equipment**

*“Application. Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.”*

## **Explosive Material**

It is important to have a protocol in place that prevents potentially explosive chemicals from drying out and becoming an explosion hazard.

### **NFPA 45 2011, 9.2.3.4**

*“Containers of materials that might become hazardous (i.e. time sensitive) during prolonged storage shall be dated when first opened, and properly managed.”*

## **Regulations Explanations:**

ANSI: American National Standards Institute

CFR: Code of Federal Regulations

29 CFR: OSHA Regulations

29 CFR 1910: Occupational Safety and Health Standards

29 CFR 1910.1450: Occupational Exposure to hazardous chemicals in laboratories

(“OSHA Lab Standard”)

NFPA: National Fire Protection Association