C_001 - Chemical Safety Training

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About this training

- **Description:**
  - **Review of UR's Chemical Hygiene Program; Safe work practices; Hazard communication, Safety Data Sheets (SDS); Personal protective equipment (PPE), and Hazardous waste management**

- **Required participants:**
  - **Persons who work in a laboratory with chemicals, hazardous materials and solvents, or persons who handle, work with, store or dispense chemicals, hazardous materials and/or solvents**

All persons taking this training for the first time must obtain the Chemical Safety Officer's signature on their quiz.

Summary

Achieving and maintaining a safe working environment is *everyone's* responsibility

Administration

- **Establish safety guidelines and protocols**
- **Ensure regulatory compliance and employee safety**

Principal Investigators (PI), work area supervisors

- **Provide task-specific *and* material-specific training**
- **Promote safe working conditions and practices:**
  - ***lead by example***

Employees

- **Learn hazards before beginning experiments**
- **Follow safety protocols in *every* experiment**
- **Identify and report potentially hazardous situations to the appropriate PI, work area supervisor, or LLE Safety Officer**

Training topics

- Identifying, classifying, and storing hazardous materials
- Hazard communication
- Exposure minimization
- Chemical emergencies
- Site specific safety procedures
- Hazardous waste

Examples of hazardous materials that pose significant physical or health risks under normal laboratory use

Physical

- Flammable
  - *Acetone*
- Combustible
  - *Kerosene*
- Corrosive
  - *Hydrochloric acid*
- Oxidizer
  - *Chlorine bleach*
- Explosive, unstable, reactive
  - *perchlorates, lithium metal*

Health

- Carcinogens, teratogens (birth defects), mutagens (genetic mutations)
  - *Formaldehyde*
- Toxic
  - *Hydrogen cyanide*
- Irritant
  - *Ammonia*
- Sensitizer
  - *Beryllium dust*
- Target organ effects
  - *Chloroform*

Radioactive Material Safety is covered in the *R_002 Safety Training*

OSHA standard 29 CFR 1910.106(a)(19) defines the terms *flash point, flammable and combustible*

- ***Flash point*** **– the minimum temperature at which a liquid will produce a sufficient concentration of vapor within a test vessel to form an ignitable mixture with air near the liquid surface when a small flame is introduced.**

- ***Flammable*** **liquids have a flash point *below 140°F (60°C).***

- ***Combustible*** **liquids have a flash point *above 140°F (60°C)***

Flashpoint

Flammable **<** 140°F (60°C) **≤** ***Combustible***

Organic peroxides undergo auto-accelerated thermal decomposition and are excluded from these flashpoint determinations

Explosion and fire are the two primary hazards associated with flammable and combustible liquids

- Many organic solvents are *highly flammable*
- Common organic solvents include (but are not limited to):
  - Acetonitrile
  - Benzene
  - Dichloromethane
  - Methyl ethyl ketone
  - Toluene
  - Ethyl Acetate

Always review safety information and work in a fume hood when using organic solvents

Hazardous materials must be stored in separate locations according to their *hazard class*

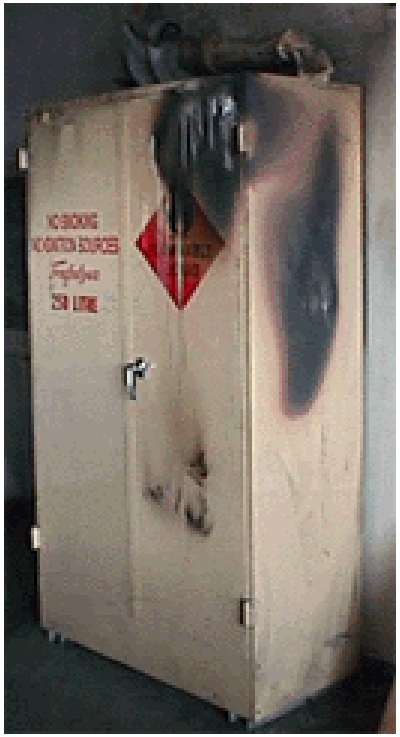
Hazard classes include:

- Flammables
- Inorganic acids (nitric acid and perchloric acid are powerful oxidizers and are stored separately)
- Bases
- Organic acids (acetic acid, formic acid)
- Oxidizing agents
- Reducing agents
- High health hazard materials
  - carcinogens
  - teratogens
  - mutagens
  - acutely toxic

No more than *3 gallons** of flammable solvent may be stored in any room, outside an approved storage cabinet

** 3 gallons is a new reduced limit within LLE*

- **Both insulated and self-closing, air-tight doors provide high fire resistance**



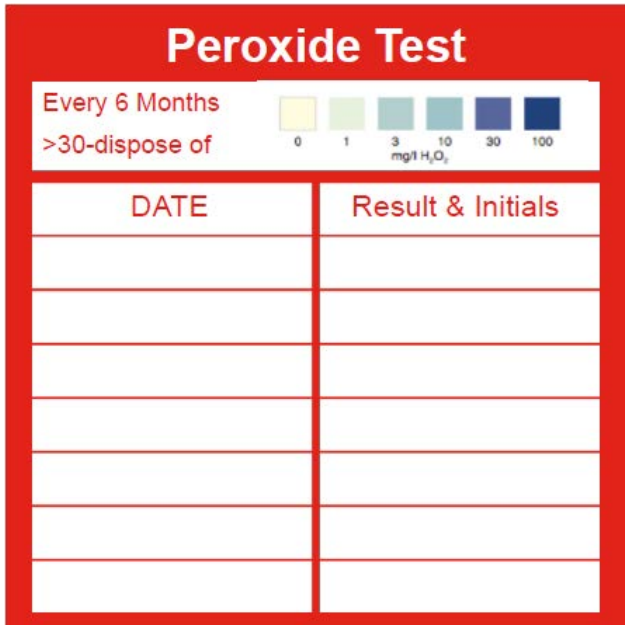
All flammable solvents in excess of the 3-gal. limit must be stored in approved flammable solvent storage cabinets

Storing items on top of a flammable storage cabinet is a violation of NYS Fire Code

Ensure that the tops of *all* flammable storage cabinets remain clear of any items

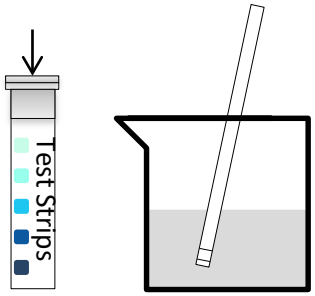
Ethers and certain alcohols form *highly unstable peroxides* upon prolonged exposure to air and/or light

- **Peroxides can be explosive if heated or allowed to evaporate to dryness!**
- **Solvents that generate peroxides include diethyl ether, tetrahydrofuran (THF), dioxane, butanol, and other secondary alcohols**
- **The lab supervisor must:**
  - **Label container with date opened**
  - **Test peroxide-forming materials every 6 months once opened**
  - **Dispose of materials that exceed the peroxide threshold of ≥10mg/L**
  - **Label containers with the date received, *and* dated test results**

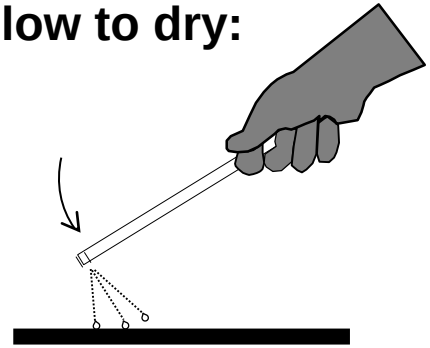


Supervisors and PI's are responsible for ensuring that peroxide-forming materials stored in their areas are tested for peroxide content every *6 months*

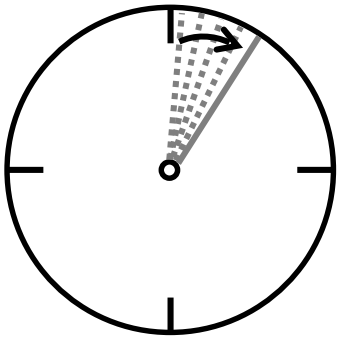
1. Dip test strip into test solution for approximately 1 second:



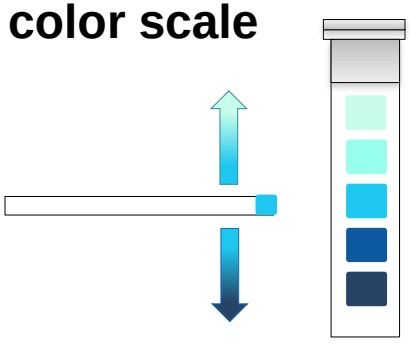
2. Gently shake off excess liquid and allow to dry:



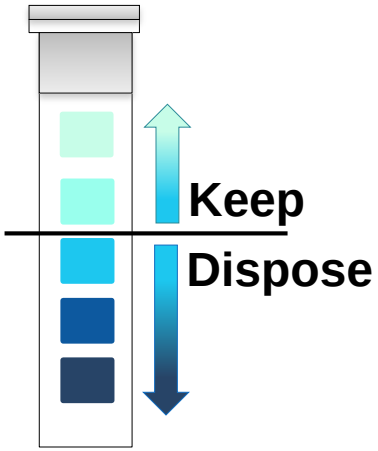
3. Wait 5 seconds:



4. Compare the test paper zone with the color scale

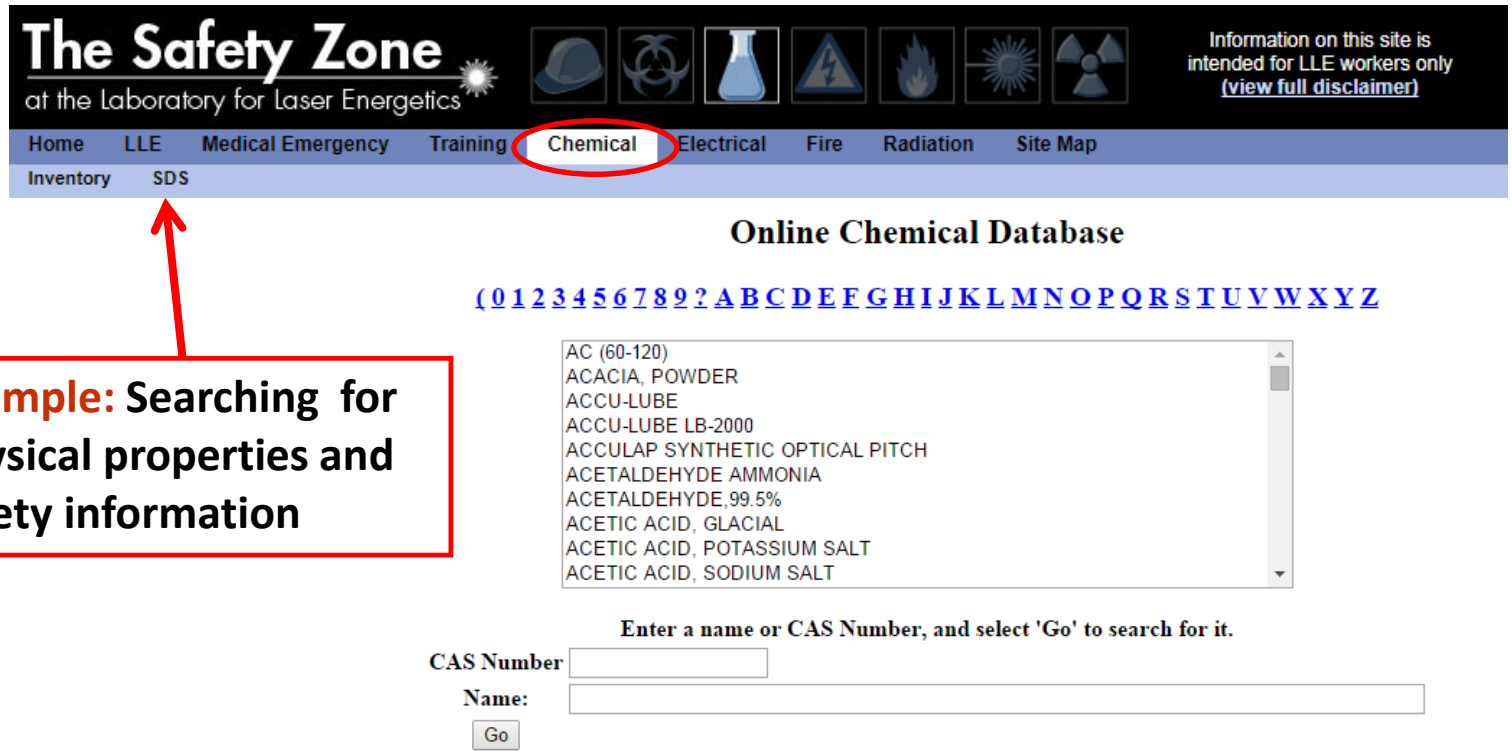


5.



Facility-wide chemical safety information at LLE is available both on-line. . . . .

SDS Database



Example: Searching for physical properties and safety information

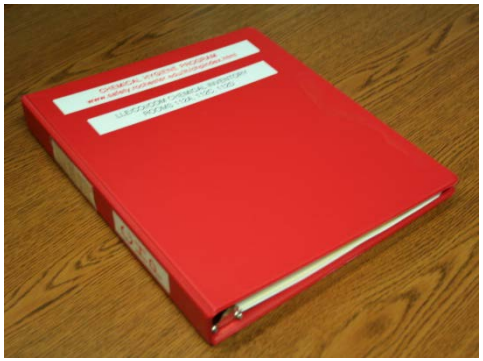
Access is limited to users with an LLE computer account

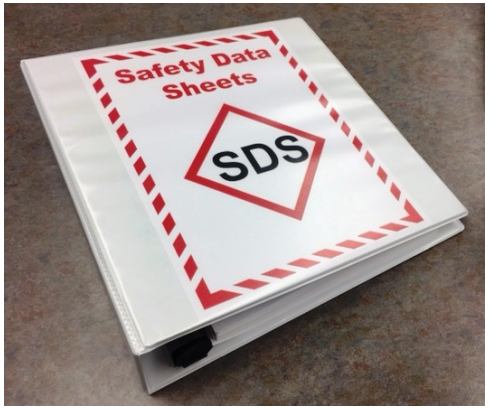
. . . . and in hard-copy format in the LLE Safety Library (Rm 1414)

- Safety Data Sheets (SDS)
- CHP binder
- National Fire Codes
- Chemical labels
- Reference texts
- Safety supplies
  - Eyewear
  - Hearing protection
  - Gloves
  - Lens cleaners
  - Sharps disposal
- Information and assistance

Each LLE laboratory or work area must have its own set of laboratory-specific materials safety data

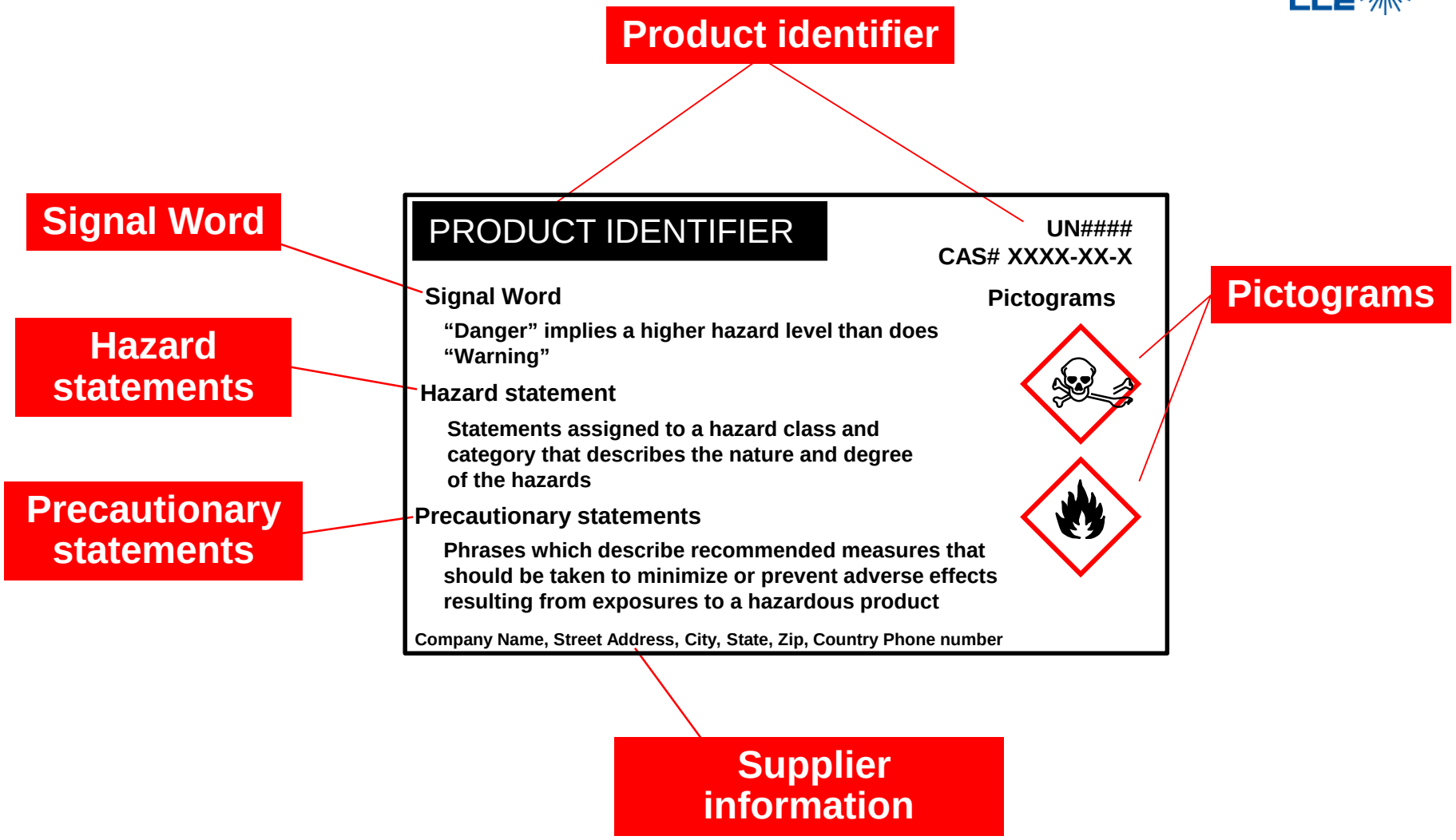
- **Safety documentation must be *prominently displayed* and *rapidly accessible;* these items include:**
  - **The Chemical Hygiene Plan (CHP) binder**
    - **CHP document**
    - **Chemical inventory**
    - **SDS's (for laboratories with a small chemical inventory)**
  - **Safety Data Sheets (SDS) binder**
    - **one or more volumes for laboratories with a large chemical inventory**





All employees must know the location of the CHP and Safety Data Sheet binders in their work areas

Chemical labeling follows the Globally Harmonized System (GHS) for hazard communication guidelines



Chemical manufacturers must provide SDS documents in a standardized 16-section format

Safety Data Sheets (SDS)

GHS (OSHA HCS 2012)

Document format is *mandated*

Safety Data Sheets (SDS) must contain:

1. Product identification /name
2. Hazard identification
3. Composition/Information on ingredients
4. First aid measures
5. Fire fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls / personal protection
9. Physical /chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transportation information
15. Regulatory information
16. Other information

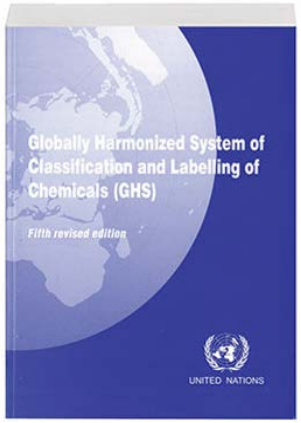
Be aware of differences between GHS and NFPA labels

High

Low

GHS Hazard Level (current)

Cat. 1 = Severe
Cat. 2 = Serious
Cat. 3 = Moderate
Cat. 4 = Slight
Cat. 5 = Minimal

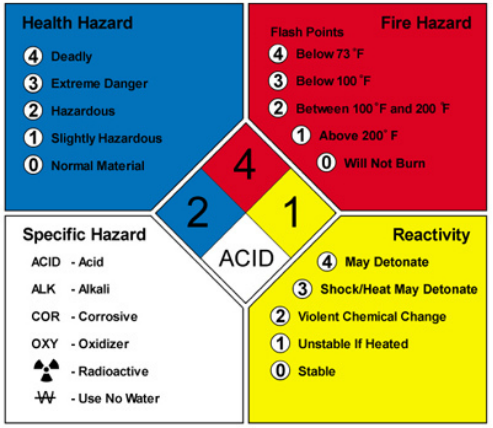


High

Low

NFPA Hazard Level (phasing out)

Cat. 4 = Deadly
Cat. 3 = Extreme Danger
Cat. 2 = Hazardous
Cat. 1 = Slightly Hazardous
Cat. 0 = Normal Material



GHS numeric hazard levels (1 = Severe; 5=Minimal) are the *OPPOSITE* of the NFPA numbering system

Flammables are separated into four categories according to their flash points and boiling points

Category 1 **(extremely flammable):**

- **Flash point < 73.4ºF (23ºC)**
- **Boiling point ≤ 95ºF (35ºC)**

Ex: Diethyl ether

DANGER

Category 2 **(highly flammable):**

- **Flash point < 73.4ºF (23ºC)**
- **Boiling point > 95ºF (35ºC)**

Ex: Toluene, acetone

Category 3 **(Flammable liquid and vapor):**

- **Flash point ≥ 73.4ºF (23ºC) and ≤ 140ºF (60ºC)**

Ex: Acetic acid, acetylacetone

WARNING

Category 4 (Combustible liquid):

- **Flash point ≥ 140°F (37.8°C) and ≤ 199.4 °F (93 °C)**

Ex. Kerosene, chloroform

WARNING

(no symbol)

Pictograms communicate chemical hazards

Flame

* Flammables
* Self-Heating
* Self Reactives
* Organic Peroxides
* Pyrophorics
* Emits Flammable Gas

Exploding Bomb

* Explosives
* Self Reactives
* Organic Peroxides

Flame over Circle

* Oxidizers

Skull & Crossbones

* Acute Toxicity (fatal or toxic)

Health Hazard

* Carcinogen
* Respiratory Sensitizer
* Reproductive Toxicity
* Target Organ Toxicity
* Mutagenicity
* Aspiration Toxicity

Gas Cylinder

* Gases Under Pressure

Corrosion

* Corrosives

Exclamation Mark

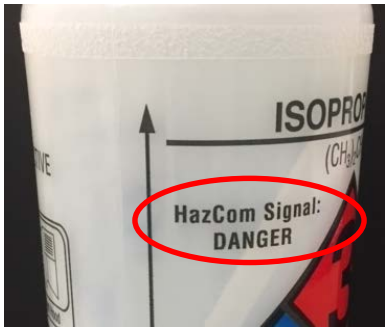
* Irritant
* Dermal Sensitizer
* Acute Toxicity (harmful)
* Narcotic Effects
* Respiratory Tract Irritant

Environment

* Acute Aquatic Toxicity

Chemical storage and container labeling follows the GHS format

- **Container label:**



- **Cabinet label:**

Labeling for secondary chemical containers must be *clearly legible and unambiguous*

- **Re-used/ recycled chemical containers MUST have new labels provided with chemical name and associated hazards**

- **Preformatted blank labels are available in the Safety Library (Rm 1414)**

Containers re-purposed for chemical storage must be properly cleaned and labeled before use

RIGHT:

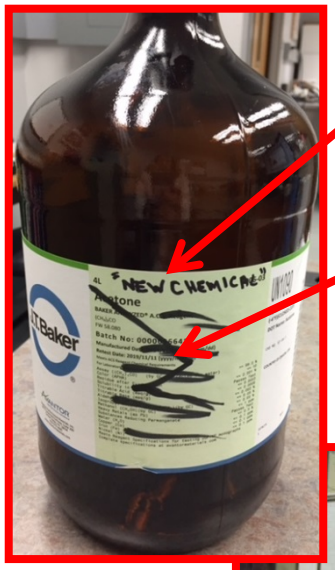
Previous labels removed

Rinsed 3x with a suitable solvent* followed by tap water

Labeling in accordance with GHS

** Rinsate may or may not need to be collected as hazardous waste, see Chemical Hygiene Officer for guidance*

WRONG:



Non-GHS compliant label

Old label not removed

Rubber stopper

No label

Damaged or illegible labels

Hazardous material storage in food containers is strictly prohibited

Hazardous materials may enter the body by four different routes of exposure

Inhalation *Skin/eye contact* *Injection* *Ingestion*

- **The level of exposure can have widely varying health effects for different people**
- **Exposures can be:**
  - **Acute: brief, high concentration (e.g., cleaning up a spill)**
  - **Chronic: extended over days or weeks (e.g., cleaning parts with solvent)**
- **Health effects from exposure can be reversible or irreversible, depending on the materials toxicology**
- **Individuals can respond differently to the same exposure (e.g., allergies)**

OSHA has established inhalation exposure levels below which adverse health effects normally do not occur

- **Permissible exposure limit (PEL):**[1] **the limit on the amount or concentration of a substance in the air based on an 8-hour time weighted average (TWA) exposure**

- **Short-term exposure limit (STEL):**[2] **the acceptable average exposure over a short period of time, usually 15 minutes, as long as the TWA is not exceeded**

- **Ceiling limit:**[3] **the concentration of a chemical or material that no person should be exposed to for any period of time to prevent ill effects or death**

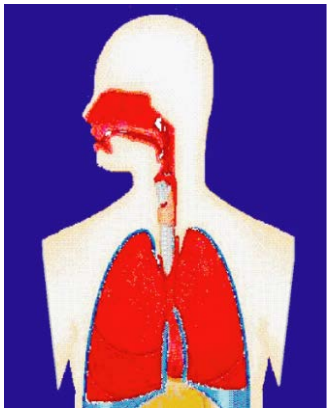
[1] https://www.osha.gov/dsg/topics/pel/
[2] http://en.wikipedia.org/wiki/Short-term_exposure_limit
[3] https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=Standards&p_id=9991

Exposure *minimization* is the most effective means for preventing adverse health effects

Exposures are best prevented through a combination of:

- ***Engineering controls:*** **the first line of defense in minimizing exposure potential. Both the work environment and the job should be designed to eliminate hazards or reduce exposure to hazards to the extent feasible**

- ***Safe work practices:*** **include general workplace and other operation-specific rules**



- ***Administrative controls:*** **aimed at reducing exposure to hazards**

- ***Personal Protective Equipment (PPE)*****: used when exposures cannot be mitigated by engineering and administrative controls**

For many hazardous materials, there are NO established exposure limits; personnel should use *maximum caution* when working with unknowns

Engineering controls keep the concentration of hazardous contaminants within known OSHA exposure limits

- ***Fume hoods*** **the primary control device for protecting laboratory personnel**

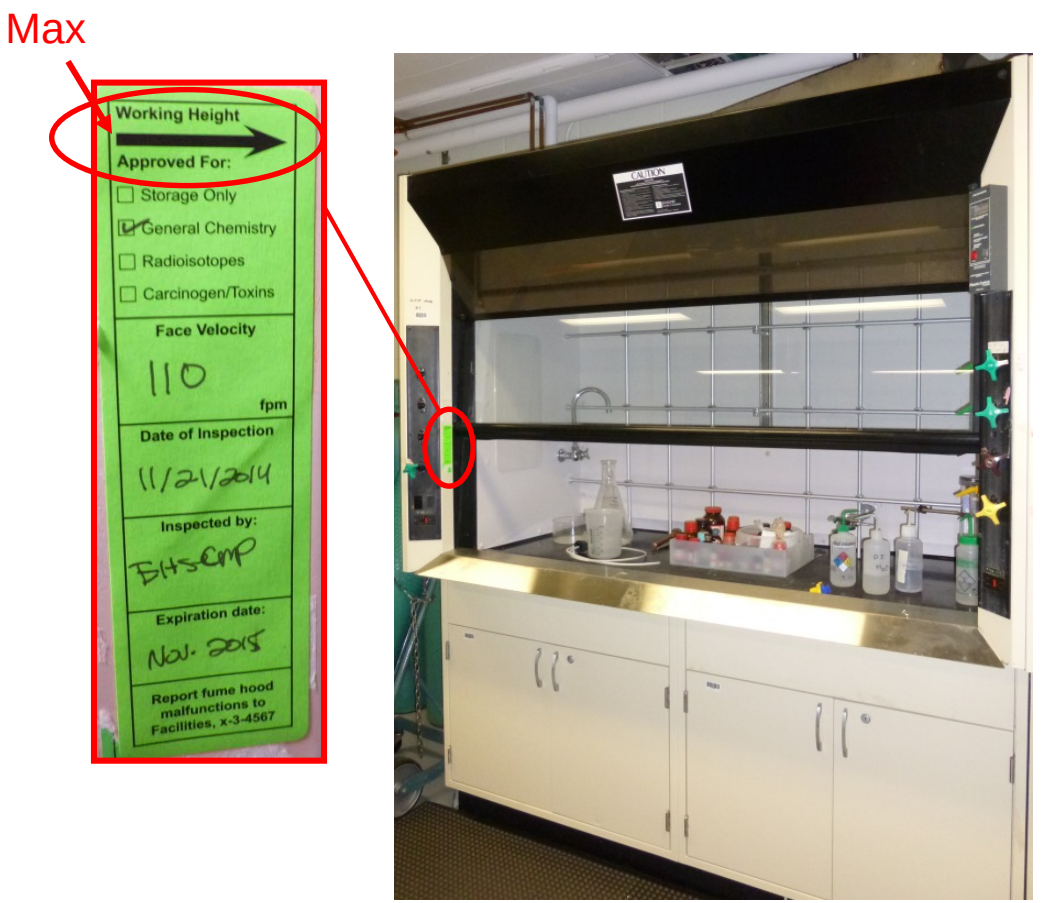
- ***Glove boxes*** **used when the substance poses too great a hazard for use in a fume hood**

- **Check regularly – leaks will contaminate the lab environment**

Never work with hazardous materials in an open or uncontrolled environment

Proper fume hood use is essential in maintaining laboratory safety

- **Make sure the sash is open within the proper operating range (maximum height indicated by arrow)**
- **Keep all materials inside the hood at least *six inches* from the sash opening**
- **Verify the inspection expiration date has not passed**



Do NOT use fume hoods for long-term chemical storage

Proper fume hood use is essential in maintaining laboratory safety

- ***Before* using a fume hood:**
  - understand its functional controls and how they work
  - know the hazards of the chemical(s) that will be used
  - ensure the hood exhaust is on, functioning and the air flow is within the required range (above 100 linear ft/min)

- **When using the fume hood:**
  - never allow your head to enter the plane of the hood opening when experiments are in progress
  - always wear chemical safety eye wear
  - make sure nothing is blocking the air flow baffles at the rear of the hood

https://www.osha.gov/Publications/laboratory/OSHAquickfacts-lab-safety-chemical-fume-hoods.pdf

Safe work practices are employed as an additional means of reducing exposure risk

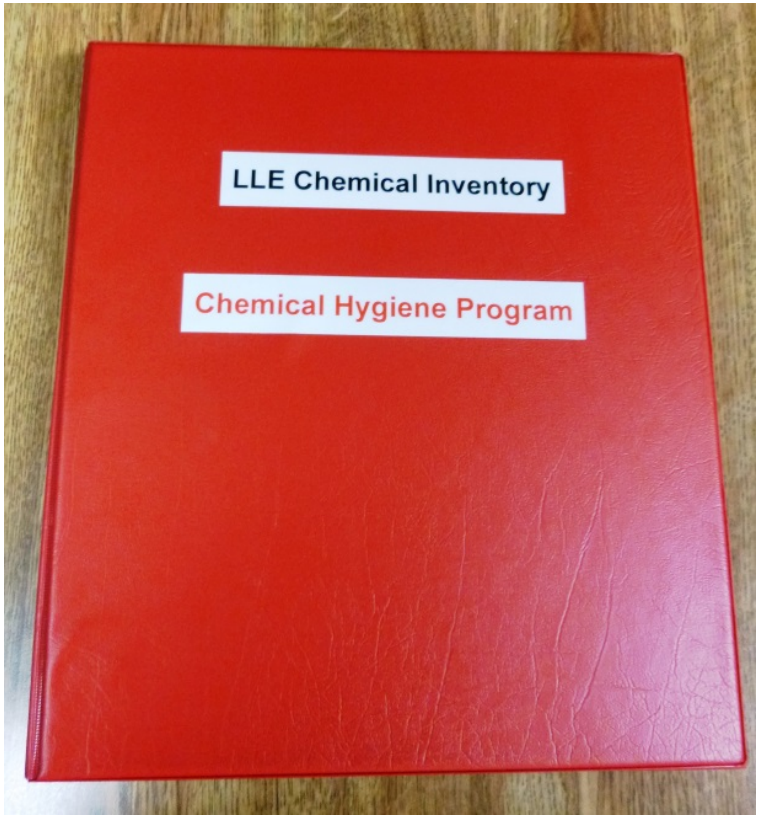
- **Exposures can still occur even when a hazard is contained**
- **Examples of safe work practices for specific OSHA standards include (but are not limited to):**

➢ **Respiratory protection – all respirator users must be certified through the University Health Services (UHS) Respiratory Protection Program annually**

➢ **Lockout/Tagout (LOTO) – prevents operation of equipment that could cause injury or equipment damage. LLE instructions 6300 defines LLE-specific LOTO procedures**

The Chemical Hygiene Program promotes safe work practices by a number of different means

- **Provides standard operating procedures and control measures to reduce employee exposure to hazardous chemicals**
- **Classifies chemical hazards and mandates communication of these hazards to both employers and employees**
- **Requires a facility-wide chemical inventory to identify the locations and quantities of hazardous materials to aid in mitigation of accidents and spills**



Work habits make the single largest impact on both your safety and that of the people working around you

The good ….

Poor work habits are one of the leading causes of laboratory accidents

the bad . . .

Ignorance of materials hazards and proper procedures can result in catastrophic accidents

. . . and the ugly

Supervisors and PI's set the standard for safe working habits in their areas!

Operations involving large volumes and/or highly hazardous materials must undergo design/process safety reviews

What is wrong with this picture?

Experimental activities must be designed and conducted giving exposure minimization and containment top priority

Lessons Learned

The majority of chemical laboratory accidents are caused by *poor work practices*

Incompatible Waste Incident

- During an undergraduate organic chemistry lab class, a student poured a small quantity of waste material into a hazardous waste collection bottle
- Moments after the student walked away, the container *exploded* in the hood

- ***Because the student had remembered to lower the hood sash, the explosion was contained and no one was injured***

The majority of chemical laboratory accidents are caused by *poor work practices*

Incompatible Materials Use and Storage Incident

- A graduate student was slicing potassium metal in a toluene-filled dish next to a sink
- A fragment of potassium fell into the damp sink
- Hydrogen generated by reaction of potassium with water was ignited by heat of reaction, which then ignited the toluene
- ***The student received superficial first-degree facial burns, but no other injuries***

Eating and drinking in laboratory and work areas is *strictly* prohibited

Food and drink consumption in laboratories and work areas greatly increases the risk of accidental ingestion of hazardous materials

PPE requirements are determined by both the hazards of the material and the process in which it is used

- PPE (goggles, gloves, facemasks, garments, etc.) is provided by LLE and usage is mandatory when indicated
- Work area supervisors and PI's must:
  - provide appropriate PPE in their work areas
  - enforce wearing of required PPE
- PPE must:
  - fit properly and be inspected before each use for flaws, proper fit, and function
  - must meet ANSI standards

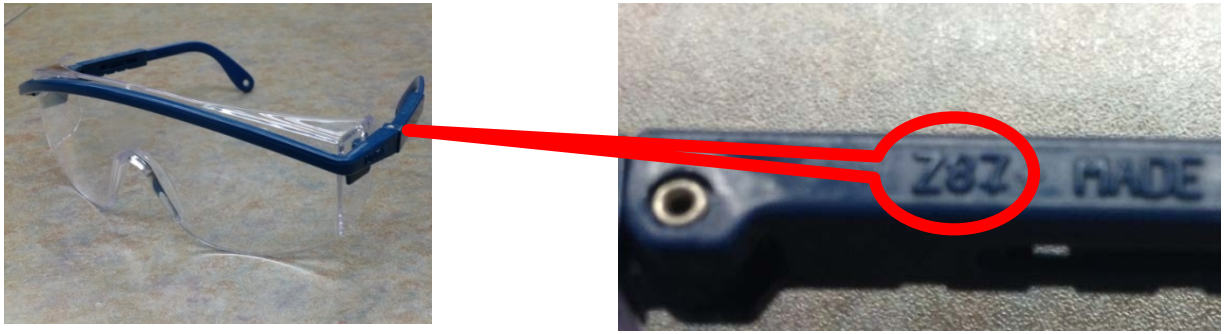
- *Section 8* of the SDS provides guidance on each chemical's PPE requirements

Inspection and care of PPE is the employee's responsibility

Eye protection and gloves are *mandatory* for ***all*** chemical operations at LLE

Chemical safety eyewear must:

- **bear the American National Standards Institute (ANSI) Z87 approval marking**



- **provide adequate protection against hazards**
- **fit snugly and not interfere with movements of the wearer**
- **have side shields**
- **be reasonably comfortable**

Regular prescription glasses *DO NOT* provide adequate protection

Prescription safety eyewear can be ordered through the LLE if needed

The eyes can be rapidly and irreversibly damaged by even momentary contact with certain materials

- ***Safety "glasses"*** **are the minimum acceptable protection for working with chemicals**

- ***Safety goggles*** **fit tightly around the eyes, and are secured with a strap that goes around the back of the head. They provide better protection against splashes and solvent vapor and are required for contact lens wearers**

- **A *full face shield* is required when working with corrosive chemicals that can burn the skin**
- **Safety eyewear is still necessary when wearing a face shield**

Selection of the proper glove material and thickness is critical for minimizing potential exposures

Disposable gloves:

- **For incidental contact with low toxicity materials**
  - **nitrile rubber or chloroprene provide better protection**
  - **latex and PVC are NOT recommended**

Reusable gloves:

- **Discuss glove material with the Chemical Safety Officer before use**
- **For repeated and/or prolonged exposure with moderately toxic materials**

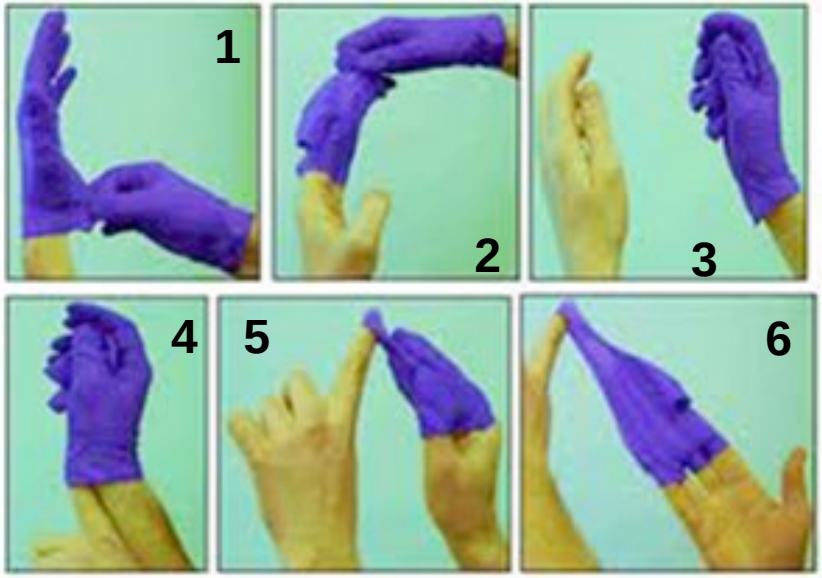
  *****Rinse thoroughly after each use*****

Insulated gloves:

- **For high temperature operations or when working with cryogenics**

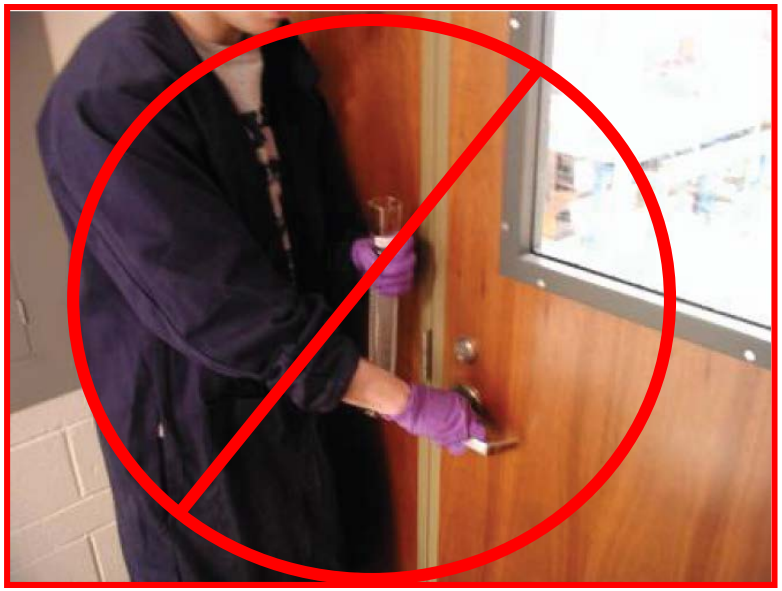
Inspect gloves carefully for holes or rips before each use

Proper donning and doffing of gloves is necessary to prevent cross-contamination



1. Pinch the outside of the glove near the wrist (careful not to touch exposed skin below)
2. Pull glove up *slowly*, turning the glove inside out
3. Ball up the used glove and grasp it with the gloved-hand
4. Using non-gloved hand, put finger inside cuff of glove
5. Pull glove up *slowly*, turning glove inside-out *and* encapsulating the balled glove
6. Finish removing glove and dispose of properly

Remove gloves before touching keyboards, telephones, door handles or leaving the work area



Chemical burns, skin irritation, or other exposures can occur if contaminated gloves come in contact with the skin (i.e. scratching an itch)

Laboratory coats and aprons provide additional protection against splashes and spills

Laboratory coats made of ***100% cotton (or disposable lab coats made of synthetic materials)*** provide secondary protection from minor exposures

Rubber aprons may be needed for larger scale processes or highly corrosive materials

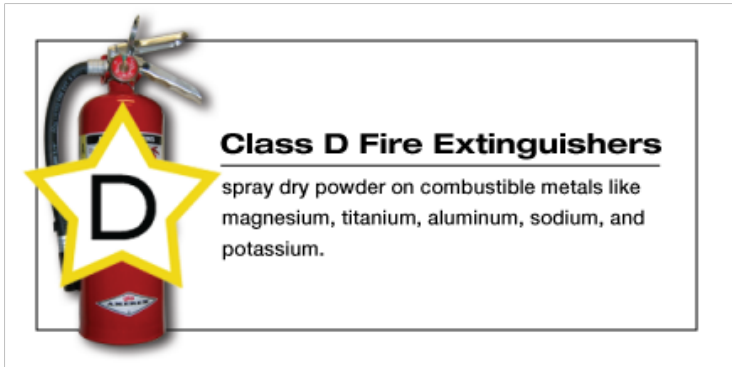
Do not launder lab coats at home
LLE provides commercial laundry service!

Flame resistant (FR) lab coats are *required* where *pyrophoric* materials are used

- ***Pyrophoric materials*** **can spontaneously ignite in air and will react vigorously with water or high humidity, often igniting upon contact**

- **Flame resistant lab coats:**
  - **must have FR label**
  - **be made with Nomex (fire resistant material)**
  - **polyester coats are NOT suitable**

- **Fires involving pyrophoric materials generally require a *Class D* fire extinguisher, which *must be* located near pyrophoric material use**



Lessons Learned

In 2008, a research assistant died from injuries sustained in a chemical fire in a laboratory at UCLA

Inadequate Training Incident

- The researcher was working with tert-butyllithium (t-BuLi) when the syringe plunger came out of the barrel and the t-BuLi was exposed to the atmosphere

- The t-BuLi ignited and a nearby flask of hexane caught fire, igniting the workers clothes
- She was wearing safety glasses and nitrile gloves, *no lab coat and a polyester blouse*
- Her clothing from the waist up was largely burned and melted into the skin. Large blisters formed on her abdomen and hands - *She passed away 18 days later*

In 2008, a research assistant died from injuries sustained in a chemical fire in a laboratory at UCLA

- **OSHA concluded the accident was a result from safety lapses and inadequate training. Criminal charges were brought against both UCLA and the student's supervisor**
- **The supervisor settled out of court and paid $10,000 and was required to participate in community service**
- ***What could have been done to prevent the incident?***
  - **Safety and emergency training for laboratory personnel**
  - **Utilization of safety shower**
  - **Use smaller reagent volumes**
  - **Use of flame-resistant Nomex lab coat**

The clothing you wear when working in the laboratory is an important part of your PPE - dress appropriately for the task at hand

Respirators are deployed in special circumstances *only* and are *NOT* a substitute for engineering controls

All **respirator users must be certified annually through the UR Respiratory Protection Program**

Initial certification

- **Medical history form**
- **Physical exam and spirometry test**
- **Respirator fit test**

Annual re-certification

- **Verify medical history**
- **Repeat respirator fit test**

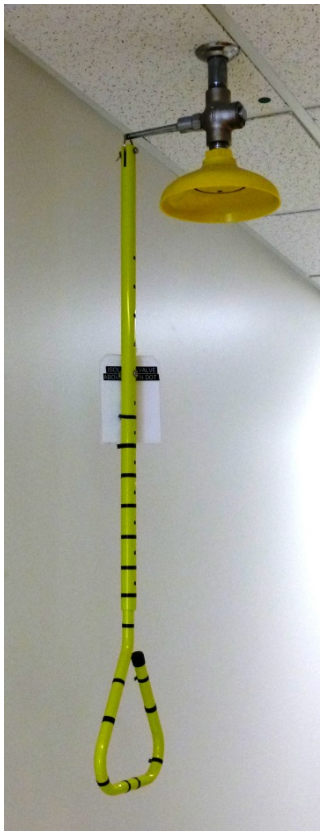
- **The OMEGA and OMEGA EP target chambers are beryllium-regulated areas and require respiratory protection for entry**

Report respiratory problems / issues in work areas to your supervisor or the Chemical Hygiene Officer

Eyewash and safety showers must be accessible near areas where hazardous chemicals are stored or used

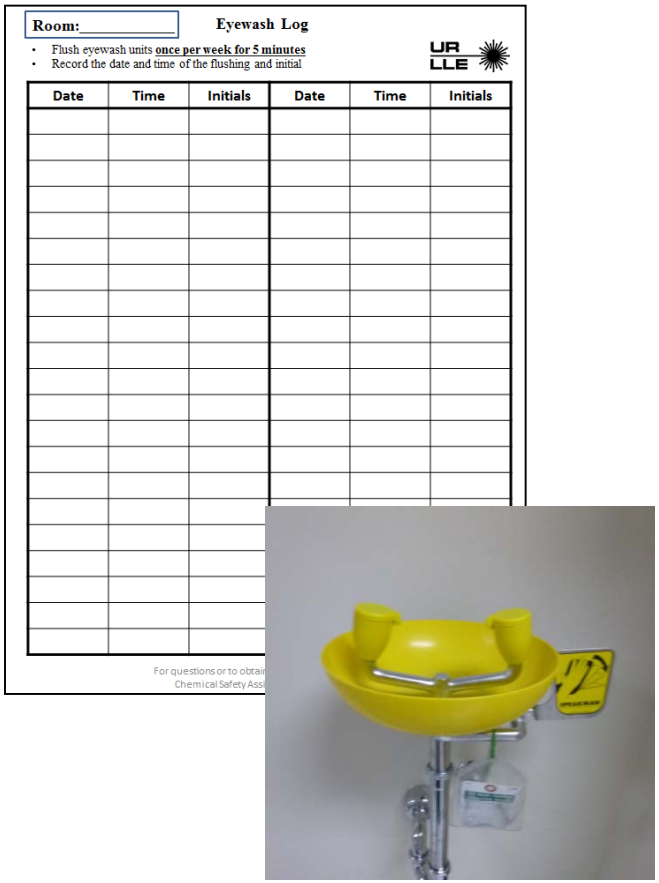
Safety eyewashes and showers *must*:

- **be located within 55 feet (10 sec), unobstructed from the hazard**
- **be flushed on a regular basis**
  - **eyewashes: 1x weekly for 3-5 min (laboratory personnel)**
  - **showers: 1x every 6 mos. for 3-5 min (assigned personnel)**
- **have a log with recorded flush dates near each unit**



All personnel must know the location of the emergency units in or near work areas

Laboratory personnel are responsible for flushing eyewash stations in their areas


Room:_____ Eyewash Log

- Flush eyewash units once per week for 5 minutes
- Record the date and time of the flushing and initial

Date	Time	Initials	Date	Time	Initials

- **Flush eyewash for 3-5 minutes weekly**
  - **Verify:**
    - **The water is clear**
    - **The area around the station is clear of obstructions**
  - **Record flushing information for safety verification**
  - **The Chemical Safety Co-op provides new eyewash logs and archives full logs**

In an emergency, hold eyes open and flush for at least 15 minutes

If a chemical spill or emergency occurs, contact the work area supervisor *and* a safety officer immediately

Minor spills

- Clean up using a spill control kit
- Dispose of absorbed material as hazardous waste

Major spills/ injuries/ emergencies

- During *working* hours call LLE reception:
  - 55101 or 53941
    - 275-5101 or 275-3941 (cell)
- *After* hours:
  - 13 – for UR Public Safety
    - 275-3333 (cell)
  - 9-911 if no response on 13 (911 cell)

Emergency Numbers

During working hours:
55101 or 53941

After hours:
13 (UR Public Safety)
If no response, dial 9-911

After hours protocols

- Minimum of two people must be present when conducting any chemical processes (buddy system)
- Supervisor permission is *required for* anyone working after hours

Know what to do if a chemical exposure occurs

Touching, breathing or ingesting harmful chemicals can result in varying symptoms with different degrees of danger.

- **Mild reactions can include tearing of the eyes, burning sensation of the throat, nose, chest, or skin**
- **Severe reactions can include coughing, wheezing, dizziness, and even death**

For ingestion or other serious exposures, *immediately*:

- **Alert the LLE Medical Response Team (by calling LLE reception)**
- ***And* call Poison Control *1-800-222-1222***

For eye or skin exposure:

- **Flush exposed area for 15 minutes**

For inhalation exposure:

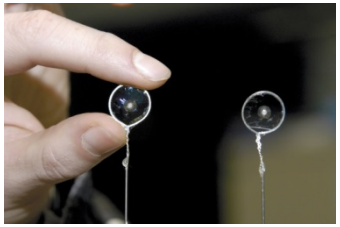
- **Move victim to fresh air**

Report all chemical exposure incidents to the PI and Chemical Safety Officer

Repeated exposure to beryllium particles is a risk factor for both *Chronic Beryllium Disease (CBD) and cancer*

- **CBD: is an irreversible lung disease produced by a sensitization (allergic) reaction to beryllium particles**
- ***Beryllium dust has been determined to cause cancer in humans***
- **Beryllium is used at LLE for vacuum windows, x-ray filters, blast shields, and target supports**
- **LLE Instruction 6706 establishes procedures to insure safe handling and exposure minimization by:**
  - ***requiring beryllium to be purchased in article form***
  - ***prohibiting any beryllium shaping processes that can generate dust (sawing, drilling, abrading, laser cutting/engraving)***
  - **allowing beryllium articles to only be shaped by *wet crimp cutting***

4
Be
Beryllium
9.012



Employees who work with beryllium must complete the LLE *C_002 Beryllium Safety Training*

Lead dust can be harmful if inhaled or ingested

- Lead enters the body primarily through inhalation and ingestion
- When ingested or inhaled as dust, lead enters into the bloodstream where it can result in adverse health effects such as impaired cognitive function, impaired kidney function, high blood pressure, reproductive impairment, anemia and more.
- Lead soldering should be conducted in dedicated work stations
  - Away from areas where food will be consumed
- Wash hands, especially under fingernails, once soldering is complete
- For lead bricks: follow the steps in the Lead Encapsulation Procedure to reduce the risk of exposure
  - *Drilling or machining of lead is prohibited at LLE*

Lead bricks must be *fully* encapsulated and labeled

Exposure to hydrofluoric acid or buffered oxide etch can result in serious acute and chronic health effects

Hydrofluoric acid (HF) and ammonium bifluoride* (ABF) are primarily used at LLE to strip hard oxide coatings from optics and etch MLD gratings

***Ammonium bifluoride is also known as "ammonium hydrogen fluoride" or "Buffered Oxide Etch (BOE)"**

HF or ABF exposure can have mild to serious consequences ranging from mild irritation to *death!*

*****Use BOE in place of HF whenever possible*****

LLE Employees are not permitted to work with HF or BOE until they have satisfactorily completed the C_006 HF Safety Training

Most exposure effects have a delayed response, if you *think* you may have been exposed, seek *immediate* medical assistance

Use of the LLE high pressure liquid nitrogen filling station (LN2) is limited to trained individuals

- **The training process is "hands-on" and is conducted by either a certified fill station operator or the LLE Chemical Hygiene Officer (CHO)**
- **A "certified" fill station operator is one who has:**
  - **successfully demonstrated proficient operation of the fill station under the observation of the CHO**
  - **completed the LLE Mechanical Safety (M_001), Compressed Gas Safety (M_002), and Chemical Safety (C_001) trainings**

This training is NOT required for filling open cryogenic containers from low-pressure LN2 storage tanks

Users must complete LLE *C_004 High Pressure Liquid Nitrogen Fill Station Safety Training* before operation

Hazardous chemical waste disposal is governed by EPA and NYSDEC regulations

- **Hazardous chemical waste is defined as any chemical-containing product, item or material that is unwanted or has no further use *and* is:**
  - ***Ignitable*: solvents, oils, organic liquids, paint strippers**
  - ***Corrosive*: acids, bases, photoresist developers, metal etchants**
  - ***Toxic:* heavy metals, organometallics, cyanides, carcinogens, tetragons**
  - ***Reactive:* lithium, sodium, oxidizers, reducing agents, air-sensitive compounds and catalysts**
  - ***Unstable:* catalysts, peroxides, perchlorates**
  - ***Misc.:* *batteries, sharps, E-waste, aerosol cans***
- ***Hazardous waste disposal information* can be found at the LLE Safety Zone (http://safety.lle.rochester.edu/530_chemical/disposal.php)**

Other hazardous wastes (radioactive, biological) are covered by different regulatory agencies

Nearly everyone working at LLE handles or generates some form of hazardous chemical waste

- **Many items commonly used in laboratories qualify as hazardous chemical waste under the EPA guidelines:**
  - **batteries:** *(toxic, corrosive, reactive):* **lead-acid, mercury, NiCd, NiMH, Li+, AgO - but *NOT* alkaline or carbon batteries**

  - **"sharps"** *(toxic)*
  - **"universal wastes"** *(toxic):* **mercury-containing lamps, bulbs, switches, electronics**

  - **"E-waste"** *(toxic):* **computers, power supplies, electronics**

  - **beryllium, lead and other powdered metals** *(toxic , ignitable)*
  - **aerosol cans** *(ignitable, corrosive, toxic)*

Contact with chemically contaminated “sharps” can result in some of the most serious exposure injuries

- Syringe needles (new or used)
- Razor blades/scalpels
- Broken glass items (including optics)
- Microscope slides
- Pipettes
- Use approved sharps containers - ***NEVER put sharps in the regular trash!***

Use *non-biohazard* sharps containers to dispose of *chemically contaminated sharps**

*syringes, needles, razor blades, or other small sharp objects

Green or yellow containers are to be used for *non-infectious sharps waste*

Red containers are to be used for *biohazard sharps only*

Special containers can be requested for *biohazard* items

Syringe needles should *NEVER* be bent, sheared, or re-capped using two hands - either during use or before disposal

- ***Serious or possibly fatal exposure could occur, depending on the material contained in the syringe or needle***
- **Alternative: one-handed "scoop" technique**
  - **place needle cap on table**
  - **hold syringe only, guide needle into cap**
  - **lift syringe so that cap is sitting on needle hub**
  - **secure needle cap in place**
- **Better: use a safety needle**
  - **mechanism to blunt or cover the needle after use**
  - **one-handed operation**

EPA mandates specific requirements for hazardous waste storage in laboratories and work areas

- **Storage areas *must* be labeled as:**

HAZARDOUS WASTE SATELLITE ACCUMULATION AREA

Ignitable, corrosive, reactive, toxic, and other noxious chemical wastes must be disposed of as directed by the Hazardous Waste Management Unit. EPA & Monroe County regulations prohibit drain disposal, trash disposal, or the intentional evaporation of such wastes. If you have any questions concerning the disposal of chemical wastes, contact the hazardous Waste Management Unit at x5-2056.

All Hazardous Waste Containers must be:

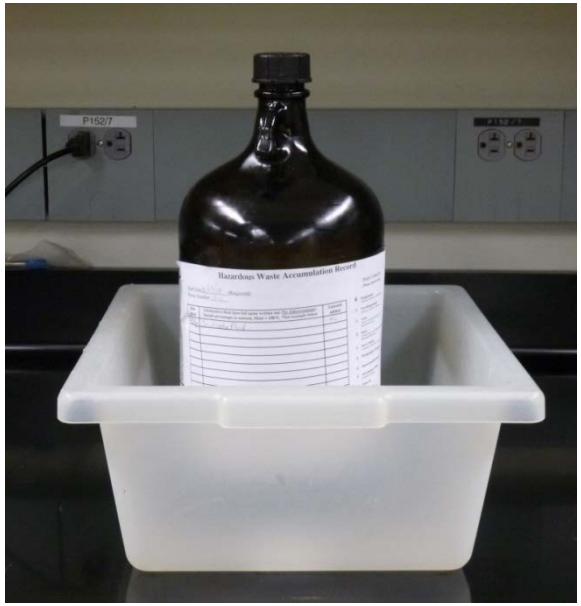
- Labeled "Hazardous Waste" **and** state the chemicals contained within the bottle. A running log of what is placed into the container with quantities must be attached to the container at all times.
- Free of old labels. All other labels on waste containers must be removed.
- Compatible with the wastes placed into them.
- Kept closed when not actually adding to their contents.
- Placed into secondary containment. Non-compatible wastes must be kept separate. Do not mix wastes. Waste containers may not be located in sinks.
- Clean. Remove chemical residue immediately from the outside of the containers.

Variations are unacceptable!

- **Hazardous waste should not be stored in Satellite Areas longer than *1 year***
- **Labels are available in the Safety Library (Rm. 1414) and under *Related Links* on the SafetyZone**

Waste containers must be kept closed and stored in the labeled accumulation area *except* when being filled

- ***All*** **containers must be triple-rinsed before being used for waste accumulation**
- **Secondary containment equal to 110% of the waste containers volume is required to control spills or container leaks**



Incompatible wastes (i.e., oxidizers and organic liquids) must be segregated

Proper management and disposal of hazardous waste follows a multi-step process

Is the waste hazardous ?

Yes

No

Select container

Triple rinse container

Label container, record contents

Generate Chematix tag

Transport to LLE main hazardous waste storage area

Date container, place in appropriate cabinet

Sewer or landfill disposal as appropriate

Proper management and disposal of hazardous chemical wastes is the responsibility of those who generate them

- **Disposal requirements:**
  - **identify by name, quantity and composition *NO UNKNOWNS* are permitted**
  - **collect according to *hazard class***
- ***Drain disposal of chemicals requires special permits***

Strong acids and bases

Heavy metals

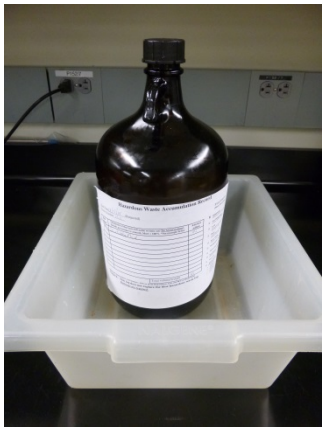
Volatile Organic Compounds (VOC's)

Water-insoluble organics

UR Environmental Compliance / Hazardous Waste Office 275-2056

Container selection depends on both the physical properties and quantity of waste disposed

Must be chemically compatible with leak-free closure

Glass bottles	Heavy-walled plastic containers	Metal cans and drums
		
All materials *except HF (or BOE)*	HF-containing materials, other corrosives, solids	*Non-corrosive* liquids and solids

Containers must be *triple-rinsed before disposal or when re-used for hazardous waste storage**

* See slide 23 for rinsing details

Three UR graduate students were injured in an explosion on River Campus

UR LLE

Incompatible Waste Incident

- A glass container was being used to collect hazardous waste
- Residual organic material was present in the waste container
- Nitric acid waste was added to the container
- A chemical reaction created a rapid pressure build up, causing failure of the glass waste container

- Emergency crews recovered pieces of a container that contained a mixture of hydrochloric, nitric and sulfuric acids

- Nitric acid is a strong oxidizer and can react even with trace quantities of organic materials

Improper hazardous waste container labeling is one of EPA's most frequently issued citations

- **Use *ONLY* the pre-printed *Hazardous Waste Accumulation Record* labels for waste collection in the labs Hazardous Waste Satellite Accumulation areas:**

Hazardous Waste Accumulation Record

Start Date 3-4-08 (Required)
Room Number 112 D

Date added	Chemicals(s)-Must have full name written out (No Abbreviations). Include percentages or amount, Must = 100%. *See example below	Amount added
3/1/08	Hydrochloric Acid / Water 25/225	250 ml
3/4/08	Hydrochloric Acid / Water 25/225	250 ml
	Total volume/weight	500 ml

*100ml 10% Hydrochloric Acid Solution – 10% or 10 ml Hydrochloric Acid, and 90% or 90 ml Water
**NOTE: This tag does not replace the blue hazardous waste tag.
Both tags are required.

Waste Categories:
(Please check one)

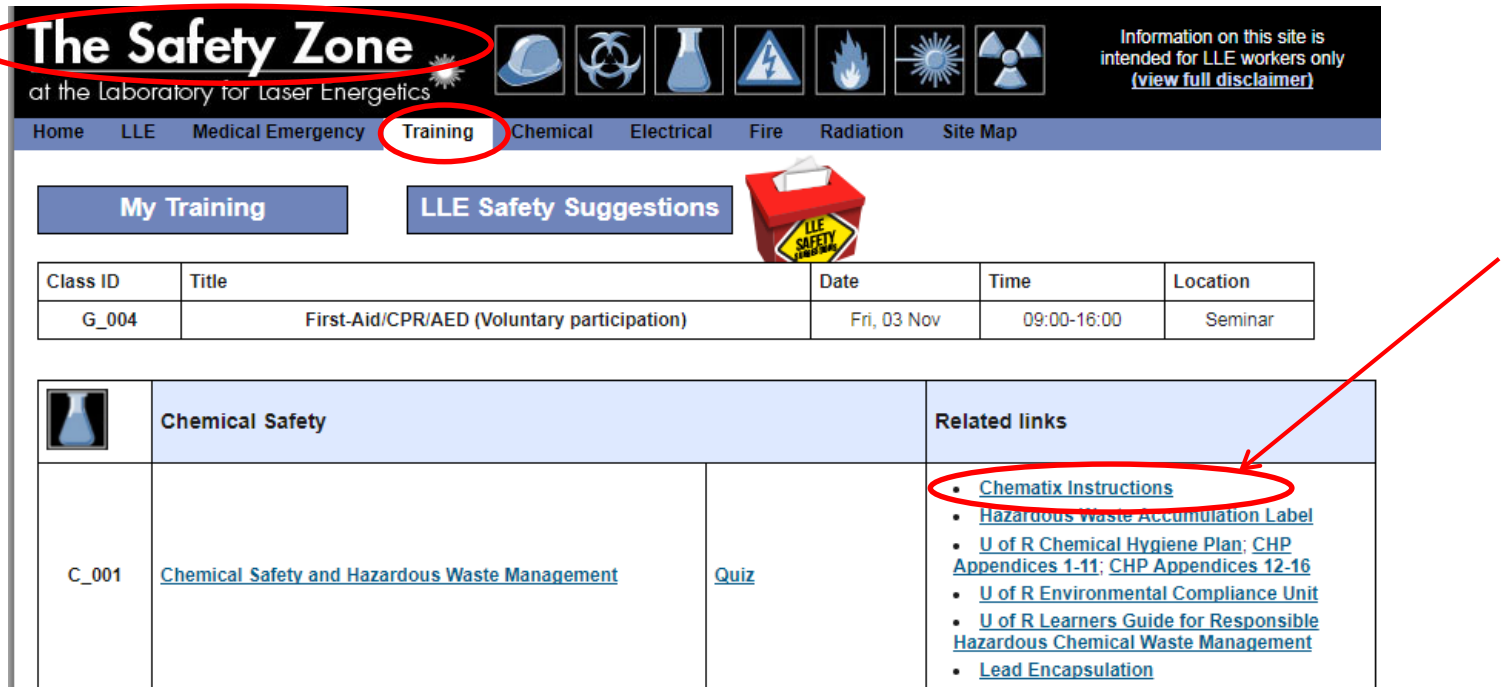
- ☐ Halogenated (Methylene chloride, chloroform)
- ☐ Non-Halogenated (Acetone, Alcohols, Toluene)
- ☑ Acids (Acetic Acid, Hydrochloric Acid, Hydrofluoric Acid)
- ☐ Bases (Sodium Hydroxide, Magnesium Sulfate, Potassium Hydroxide)
- ☐ Heavy Metals (Cadmium, Lead, Silver, Copper)
- ☐ Photographic Chemicals
- ☐ Photoresists/Developers
- ☐ Miscellaneous Solids (Potassium Bromide)
- ☐ Waste Oil
- ☐ Special Wastes (Must be collected separately)
  - ○ Cyanides
  - ○ Oxidizers
  - ○ Explosives
  - ○ Peroxides
  - ○ P-Listed (Acutely Toxic)

- **Accumulation record labels are available:**
  - **LLE main hazardous waste storage area**
  - **Safety Library (Rm 1414)**
  - **LLE Safety Zone: Hazardous Waste Accumulation Label**

Hazardous waste disposal tags must be generated for final disposal using the UR Chematix system

Instructions for use are located on the LLE SafetyZone:

- **You may also request a one-on-one training when requesting account access**

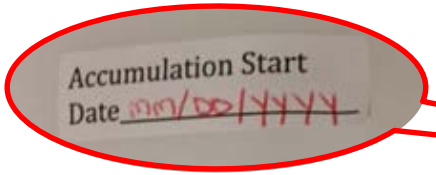


Contact Karen Cera or the LLE Chemical Safety Co-op student (Rm 1414) to request access to the UR Chematix System.

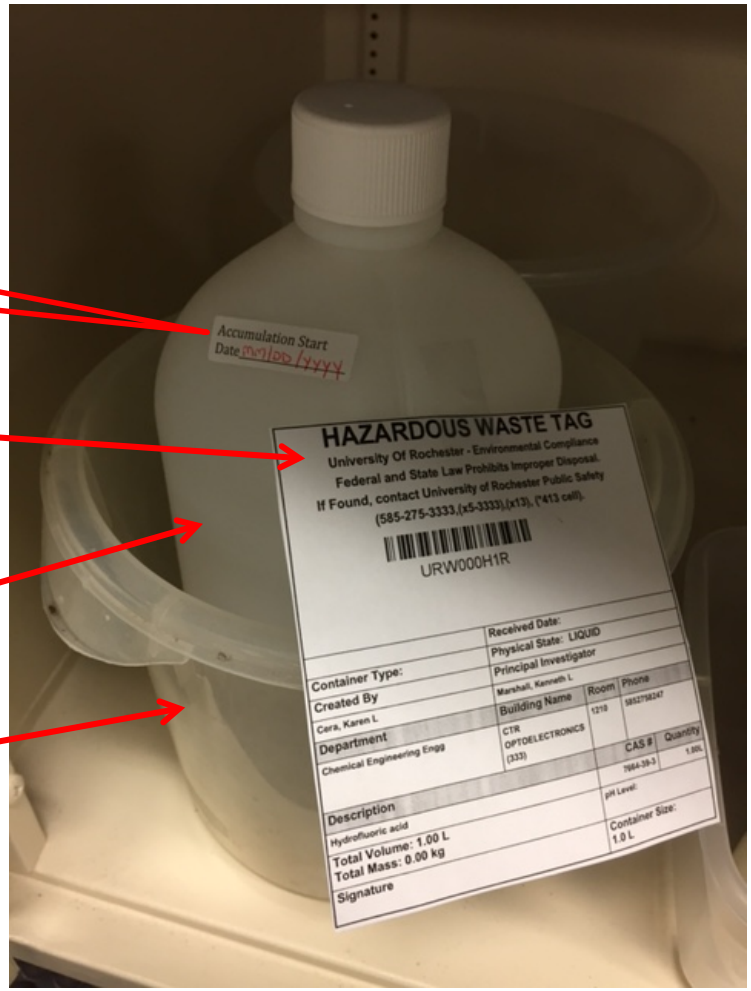
Hazardous waste containers must be properly stored and labeled when ready for pick-up

All waste must:

- **have an accumulation start date label affixed to the container**



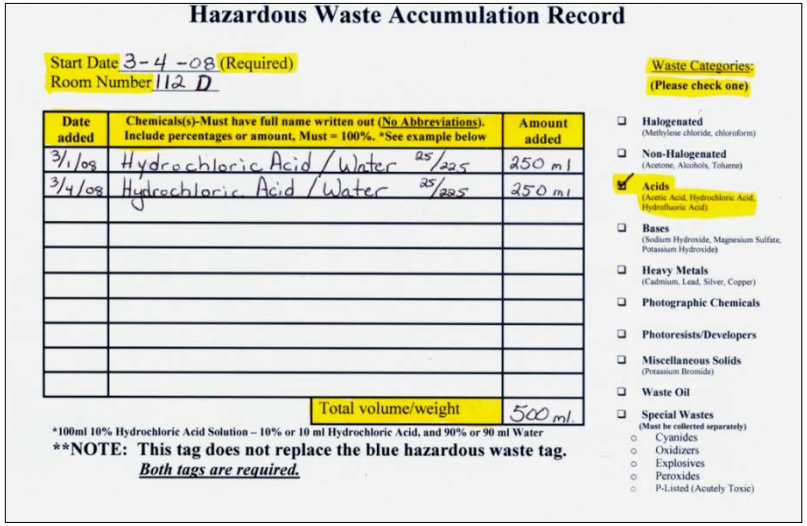
- **be labeled with a Chematix Waste Tag**
- ***be stored in chemically compatible containers with a leak-free closure***
- **be stored in secondary containment that is at least 110% of the volume of the waste container**



Know the different uses of the waste labels

The Hazardous Waste Accumulation Record

- Must be used in the labs hazardous waste satellite accumulation area
- Can be left on the container when brought to the waste storage area for pick-up



Hazardous Waste Accumulation Record

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	Total volume/weight	500 ml

*100ml 10% Hydrochloric Acid Solution – 10% or 10 ml Hydrochloric Acid, and 90% or 90 ml Water

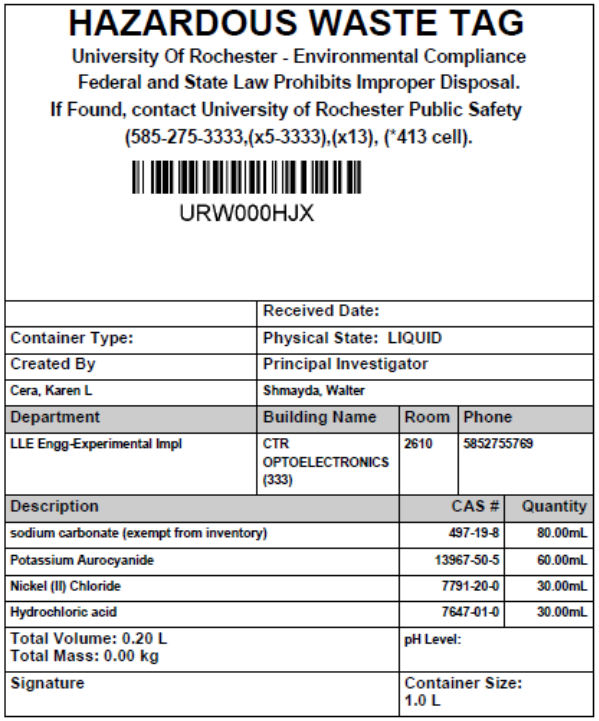
**NOTE: This tag does not replace the blue hazardous waste tag.
Both tags are required.

Waste Categories: (Please check one)

- ☐ Halogenated (Methylene chloride, chloroform)
- ☐ Non-Halogenated (Acetone, Alcohols, Toluene)
- ☑ Acids (Acetic Acid, Hydrochloric Acid, Hydrofluoric Acid)
- ☐ Bases (Sodium Hydroxide, Magnesium Sulfate, Potassium Hydroxide)
- ☐ Heavy Metals (Cadmium, Lead, Silver, Copper)
- ☐ Photographic Chemicals
- ☐ Photoresists/Developers
- ☐ Miscellaneous Solids (Potassium Bromide)
- ☐ Waste Oil
- ☐ Special Wastes (Must be collected separately)
  - ○ Cyanides
  - ○ Oxidizers
  - ○ Explosives
  - ○ Peroxides
  - ○ P-Listed (Acutely Toxic)

Chematix Tag

- Must be used for final disposal



HAZARDOUS WASTE TAG

University Of Rochester - Environmental Compliance
Federal and State Law Prohibits Improper Disposal.
If Found, contact University of Rochester Public Safety
(585-275-3333,(x5-3333),(x13), (*413 cell).

URW000HJX

	Received Date:		
Container Type:	Physical State: LIQUID		
Created By	Principal Investigator		
Cera, Karen L	Shmayda, Walter		
Department	**Building Name**	**Room**	**Phone**
LLE Engg-Experimental Impl	CTR OPTOELECTRONICS (333)	2610	5852755769

Description	CAS #	Quantity
sodium carbonate (exempt from inventory)	497-19-8	80.00mL
Potassium Aurocyanide	13967-50-5	60.00mL
Nickel (II) Chloride	7791-20-0	30.00mL
Hydrochloric acid	7647-01-0	30.00mL

Total Volume: 0.20 L Total Mass: 0.00 kg	pH Level:
Signature	Container Size: 1.0 L

Transport properly filled and labeled containers to the main LLE hazardous waste storage area for pickup by the UR Hazardous Waste Management Unit (HWMU)

Waste labels, date stickers

Corrosives, oxidizers

Batteries, sharps, universal wastes

Large containers (5 gal max)

Secondary containment required when transporting glass containers

Aerosol cans

Weekly waste pickups are scheduled for Thursday mornings

All waste containers must be “date-stamped” before placing in the appropriate hazardous waste cabinets

- **By law, all waste containers must be removed by HWMU within 90 days of the “*accumulation date*”**

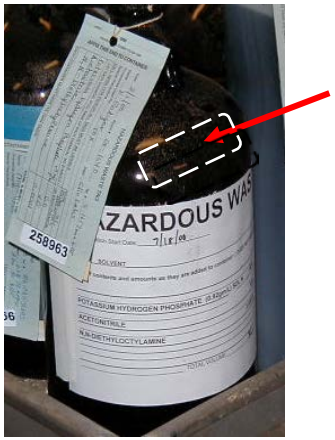
Accumulation date
Month/day/year

Accumulation start date labels are located in the red-box in the Hazardous Waste accumulation area

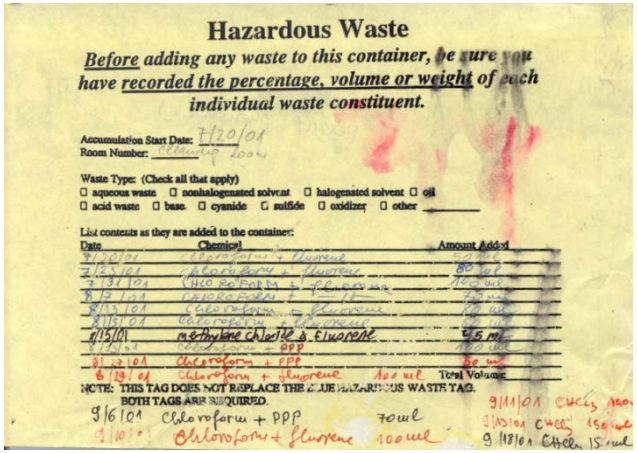
DO NOT leave empty containers* or those with unidentified contents in the cabinets!

***Consult Chemical Hygiene officer for proper disposal of empty containers**

Any deficiencies in the disposal process will result in rejection of the waste by HWMU and require corrective action by the waste generator

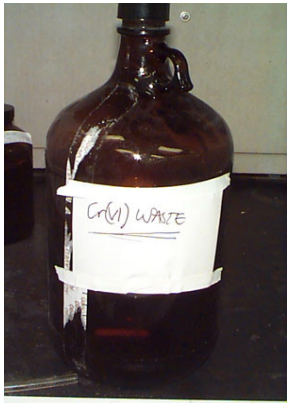


Missing date sticker



Illegible labels

"Rusty/crusty" containers



Improper label

HAZARDOUS WASTE TAG

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URW000HJX

	Received Date:		
Container Type:	Physical State: LIQUID		
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Cera, Karen L	Shmayda, Walter		
Department	Building Name	Room	Phone
LLE Engg-Experimental Impl	CTR OPTOELECTRONICS (333)	2610	5852755769

Description	CAS #	Quantity
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Nickel (II) Chloride	7791-20-0	30.00mL
Hydrochloric acid	7647-01-0	30.00mL
Total Volume: 0.20 L Total Mass: 0.00 kg	pH Level:	
Signature	Container Size: 1.0 L	

No Chematix Tag

Unknowns

Summary

Achieving and maintaining a safe working environment is *everyone's* responsibility!

- ***"Human Factors" are responsible for the majority of accidents involving hazardous materials***

- **Learn material-specific hazards *before* starting experiments**
- **Make exposure minimization and containment *your* "S.O.P."**
- **Use proper-fitting PPE in *every* experiment *every* time**
- **Avoid risky, "quick and dirty" procedures to save time**
- **Know what to do and who to call when something goes wrong**

When uncertain about proper procedure or operational safety: STOP and ASK!

You have completed the the C_001 training – but there is still *one more thing*……

Complete the on-line quiz for C_001 and follow instructions when you receive your grade by email.