Annual LLE Refresher Training:
Chemical Safety (C001-R)

Kenneth L. Marshall
LLE Chemical Hygiene Officer
Summary

Achieving and maintaining a safe working environment is a shared responsibility

Administrative

- Safety guidelines and protocols
- Regulatory compliance / employee safety

Supervisory (P.I.’s)

- Task-specific and material-specific training
- Promote safe working conditions and practices
  - lead by example

Implementation (Lab personnel)

- Learn hazards before beginning experiments
- Follow safety protocols in every experiment
- Identify and report potentially hazardous situations
Hazardous materials are those that pose significant physical and health risks under normal laboratory use.

<table>
<thead>
<tr>
<th>Hazardous Material</th>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerosene</td>
<td><img src="image" alt="Kerosene" /></td>
<td>Flammable</td>
</tr>
<tr>
<td>Acetone</td>
<td><img src="image" alt="Acetone" /></td>
<td>Explosive</td>
</tr>
<tr>
<td>Perchlorates</td>
<td><img src="image" alt="Perchlorates" /></td>
<td>Corrosive</td>
</tr>
<tr>
<td>Acids, bases</td>
<td><img src="image" alt="Acids, bases" /></td>
<td>Cryogenic liquid</td>
</tr>
<tr>
<td>Bleach</td>
<td><img src="image" alt="Bleach" /></td>
<td>Oxidizer</td>
</tr>
<tr>
<td>Compressed gas</td>
<td><img src="image" alt="Compressed gas" /></td>
<td>Irritant</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td><img src="image" alt="Formaldehyde" /></td>
<td>Tox</td>
</tr>
<tr>
<td>Hydrogen cyanide</td>
<td><img src="image" alt="Hydrogen cyanide" /></td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td><img src="image" alt="Ammonia" /></td>
<td></td>
</tr>
<tr>
<td>Beryllium dust</td>
<td><img src="image" alt="Beryllium dust" /></td>
<td></td>
</tr>
</tbody>
</table>
Hazardous materials storage

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

- Flammables
- Inorganic acids
  - *exceptions: nitric and perchloric acids*
- Bases
- Organic acids
- Oxidizing agents
- Reducing agents
- High health hazard materials
  - Carcinogens, teratogens, mutagens, acutely toxic

Flammable solvent storage outside of an approved storage cabinet is limited to 8 gallons per “fire area”
Special precautions must be taken when working with pressurized gases and cryogenic liquids

- *NEVER* replace, modify or tamper with pressure relief valves (PRV) on gas cylinders, regulators, or cryogenic containers!

*If a PRV fails, leave the area immediately*
The high-pressure liquid nitrogen fill station is intended for filling closed, PRV-equipped cryogenic containers and requires user training and certification.

- **Training**: C_004: Liquid Nitrogen Fill Station

- Certified users can obtain key from the West Lobby receptionist
- Users name MUST be on the certified users list to sign out key - *no third party designates*
- Key must be returned by no later than 5:00 PM - *no exceptions!*

*Fill open cryogenic containers from low-pressure storage dewar*
Flammable gases and gas mixtures must be stored at least 20 ft away from any oxidizing gases.

- Use and store only in well-ventilated, readily accessible areas.
- Cylinders and connected apparatus must be electrically grounded to prevent sparks and static charge buildup.

Spark-proof tools (aluminum / bronze alloy) must be used when changing regulators and fittings.
Facility-wide chemical safety information at LLE is available from several resources

- Both UR and other safety resources (links to EHS web site)
- Off-site access limited (password protected)
The LLE Safety Library (Rm 1414) is your resource for “hard-copy” safety information, supplies and assistance

- MSDS collection
- CHP document
- Chemical inventory
- Safety references
- Training videotapes and DVDs
- Training records (quizzes)

Labels, hazardous waste forms, safety supplies, information and assistance
Each LLE laboratory or work area has its own set of laboratory-specific materials safety data

- CHP binder
  - CHP document
  - Chemical inventory
  - MSDS sheets (for laboratories with a small chemical inventory)

- MSDS sheet binder
  - one or more volumes for laboratories with a large chemical inventory

Safety documentation must be *prominently displayed* and *rapidly accessible*
Labeling

NFPA and HMIG graphical warning labels provide rapid communication of critical safety information.

NFPA

<table>
<thead>
<tr>
<th>Hazardous Materials Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health Hazard</strong></td>
</tr>
<tr>
<td>4: Severe</td>
</tr>
<tr>
<td>3: Extreme</td>
</tr>
<tr>
<td>2: Hazardous</td>
</tr>
<tr>
<td>1: Slightly Hazardous</td>
</tr>
<tr>
<td>0: Normal material</td>
</tr>
<tr>
<td><strong>Fire Hazard</strong></td>
</tr>
<tr>
<td>Flash Point:</td>
</tr>
<tr>
<td>4: Below 23 °F</td>
</tr>
<tr>
<td>3: Below 100 °F</td>
</tr>
<tr>
<td>2: Below 200 °F</td>
</tr>
<tr>
<td>1: Above 200 °F</td>
</tr>
<tr>
<td>0: Will not burn</td>
</tr>
<tr>
<td><strong>Reactivity</strong></td>
</tr>
<tr>
<td>4: May detonate</td>
</tr>
<tr>
<td>3: Shock and breakage may occur.</td>
</tr>
<tr>
<td>2: Vapors may irritate</td>
</tr>
<tr>
<td>1: Unstable or unstable</td>
</tr>
<tr>
<td>0: Stable</td>
</tr>
</tbody>
</table>

HMIG

<table>
<thead>
<tr>
<th>Name of Material</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health</strong></td>
</tr>
<tr>
<td><strong>Flammability</strong></td>
</tr>
<tr>
<td><strong>Reactivity</strong></td>
</tr>
<tr>
<td><strong>Protective Equipment</strong></td>
</tr>
</tbody>
</table>

PPE categories: A-K and X
Labeling for hazardous materials containers must be clearly legible and unambiguous

Avoid using recycled food containers for hazardous materials storage - if used, they MUST have all old labels removed!
Experimental activities must be designed and conducted with exposure minimization and containment in mind

- Exposures are best prevented through a combination of:
  - Engineering controls
  - Personal Protective Equipment (PPE)
  - Safe work practices

- Supervisors and P. I. s must:
  - provide PPE in their work areas
  - enforce wearing of required PPE

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

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

Engineering controls are the preferred method for keeping hazardous materials concentrations below OSHA exposure limits.

- Keep work at least 6” inside of sash to avoid turbulence
- Check regularly - leaks will contaminate lab environment

Working with hazardous materials in an open and uncontrolled environment must be avoided if at all possible.
Eyewash stations must be both readily available and completely accessible in all work areas where chemicals are stored, used or handled.

- Must be flushed once a week for 3-5 min by laboratory personnel and date recorded.
- Flushing log to be kept near each eyewash.
PPE requirements are determined by both the hazards of the material and the process it is used in.

- Check condition of PPE prior to use

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

*Do not launder lab coats at home - use a commercial laundry service!*
MSDS sheets detail the specific PPE that needs to be worn for a particular material or process
Respirators are deployed in special circumstances only- NOT as a substitute for engineering controls!

- All respirator users must be certified through UR Respirator Wearers Program (UHS)

<table>
<thead>
<tr>
<th>Initial</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical history form</td>
<td>Verify medical history</td>
</tr>
<tr>
<td>Physical exam and spirometry test</td>
<td>Repeat respirator fit test</td>
</tr>
<tr>
<td>Respirator fit test</td>
<td></td>
</tr>
</tbody>
</table>

Report respiratory problems / issues in work areas to your supervisor or the Chemical Hygiene Officer
Special procedures and training are required when working with certain hazardous materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Hazard</th>
<th>Mitigation</th>
<th>Training requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beryllium</td>
<td>CBD, Cancer suspect agent</td>
<td>Wet crimp cutting (no drilling or machining)</td>
<td>C_002: Beryllium Safety Training</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Respiratory protection</td>
<td>(annual)</td>
</tr>
<tr>
<td>Lead</td>
<td>Dust</td>
<td>No drilling or machining</td>
<td>“Lead Encapsulation Procedure” (V 1.0, 6/10/09)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cover large items (shielding bricks) with tape and label</td>
<td>(one-time)</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>Carcinogen, allergic sensitizer</td>
<td>Use in fume hoods only with proper PPE</td>
<td>C_003: Formaldehyde Safety Training</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(annual)</td>
</tr>
</tbody>
</table>
Repeated exposure to beryllium particles is a risk factor for both *Chronic Beryllium Disease (CBD)* and cancer.

- Beryllium is used in both OMEGA and OMEGA EP as vacuum windows, x-ray filters, blast shields, and target supports.

- LLE Instruction 6706 establishes procedures to insure safe handling and exposure minimization:
  - prohibits any beryllium shaping processes that can generate dust (sawing, drilling, abrading)
  - beryllium articles can only be shaped by wet crimp cutting
Hazardous 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
  - **Corrosive:** acids, bases, developers, metal etchants
  - **Toxic:** heavy metals, cyanides, carcinogens
  - **Reactive:** oxidizers, reducing agents, air-sensitive compounds
  - **Unstable:** catalysts, peroxides, perchlorates
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)*

*Other hazardous wastes (radioactive, biological) are covered by different regulatory agencies*
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 UNKOWNNS**
  - collect according to **hazard class**

- **Drain disposal of chemicals requires special permits**

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**UR Dept: Hazardous Waste Management Unit (5-2056)
Sharps management

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 non-biohazard sharps containers (small items) or glass disposal boxes

NEVER put sharps or glass items in the regular trash!
EPA mandates specific requirements for hazardous waste storage in laboratories and work areas

- Storage areas must be labeled as: *Variations are unacceptable!*

- Secondary containment required to control spills or container leaks

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

Waste containers must be kept closed and stored in the labeled accumulation area *except when being filled*
Proper management and disposal of hazardous waste follows a multi-step process.
Proper management and disposal of hazardous waste follows a multi-step process

Is the waste hazardous?

Yes → Select container

No → Sewer or landfill disposal as appropriate
Container selection depends on both the physical properties and quantity of waste disposed

- Must be chemically compatible with leak-free closure

<table>
<thead>
<tr>
<th>Glass bottles</th>
<th>Heavy-walled plastic containers</th>
<th>Metal cans and drums</th>
</tr>
</thead>
<tbody>
<tr>
<td>All materials except HF</td>
<td>HF-containing materials, other corrosives, solids</td>
<td>Non-corrosive liquids and solids</td>
</tr>
</tbody>
</table>

“Recycled” containers must be triple-rinsed before disposal or when re-used for hazardous waste storage
Proper management and disposal of hazardous waste follows a multi-step process

Is the waste hazardous?

Yes

Select container

Label container, record contents
Waste container contents must be identified using only approved hazardous waste accumulation record labels.

### Hazardous Waste Accumulation Record

<table>
<thead>
<tr>
<th>Date added</th>
<th>Chemical(s) Must have full name written out (No Abbreviations). Include percentages or amount. Must = 100%.* See example below.</th>
<th>Amount added</th>
<th>Total volume/weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/1/0x</td>
<td>Hydrochloric Acid / Water <strong>87/13</strong></td>
<td>250 mL</td>
<td>500 mL</td>
</tr>
<tr>
<td>3/4/0x</td>
<td>Hydrochloric Acid / Water <strong>87/13</strong></td>
<td>250 mL</td>
<td></td>
</tr>
</tbody>
</table>

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

- LLE main hazardous waste storage area
- Safety Library (Rm 1414)
- Safety Zone (download)
Proper management and disposal of hazardous waste follows a multi-step process
Hazardous waste tracking tags are generated using the information on the accumulation record.

- Tracking tags are available at:
  - LLE main hazardous waste storage area
  - Safety Library (Rm 1414)
Proper management and disposal of hazardous waste follows a multi-step process

Is the waste hazardous?

Yes

Select container

Label container, record contents

Transport to LLE main hazardous waste storage area

Generate tracking tag
Transport properly filled and labeled containers to the main LLE hazardous waste storage area for pickup by the UR HWMU.

Each container must have appropriate labels, tags, and date stickers.

- Batteries, sharps, universal wastes
- Corrosives, oxidizers
- Large containers (5 gal max)
- Small containers (1 gal max)

Secondary containment required when transporting glass containers.

Weekly waste pickups are scheduled for Thursday afternoons.
Proper management and disposal of hazardous waste follows a multi-step process.

1. **Is the waste hazardous?**
   - **Yes**
     - **Select container**
     - **Label container, record contents**
     - **Generate tracking tag**
     - **Transport to LLE main hazardous waste storage area**
     - **Date container, place in appropriate cabinet**
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”

DO NOT leave empty containers or those with unidentified contents in the cabinets!
Any deficiencies in the disposal process will result in rejection of the waste by HWMU and require corrective action by the waste generator.
Chemical emergencies

Know what to do and who to call when something goes wrong

Minor spills

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

Major spills/injuries/emergencies

After hours protocols

• Minimum of two people present when conducting a “chemical process”
• Supervisor consent must be obtained for working after hours
Unsafe work habits are one of the leading causes of laboratory accidents.
OSHA regulations specifically forbid food and beverage consumption in areas where hazardous materials are used or stored

Food and beverage in covered containers are NOT exempt!
The *GAWILT syndrome* has been identified as a root cause of many serious and fatal accidents in industry and academia.

- Occurs at all levels, but especially virulent when found in supervisors, managers, and planners

*Paul R. Robinson, Oil Refinery Safety Engineer Katy, Texas (C&EN, Oct 11 2010)
The **GAWILT syndrome*** has been identified as a root cause of many serious and fatal accidents in industry and academia

*Got Away With It Last Time*

“Blatant disregard of both well-known and accepted safety practices and site-specific safety guidelines” *

*Paul R. Robinson, Oil Refinery Safety Engineer
Katy, Texas (C&EN, Oct 11 2010)
Summary

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

- 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!
Thanks for your attention - now it’s time for the quiz . . . .

Did you remember to sign the training log??