G_001 - General Laboratory Safety

Douglas Jacobs-Perkins
LLE Chief Safety Officer
While tearing open this package, a worker lacerated his thumb.

- A co-worker notified the receptionist, who paged emergency responders
- Responders arrived with first aid kits
- First aid was provided

Follow-up treatment included surgery and physical therapy to prevent loss of motion from tendon damage.

Incident report 170: An operator used ethanol to flush debris from a Ten Inch Manipulator (TIM - used to field diagnostics on OMEGA). Fumes accumulated in the TIM and were ignited by a spark from a broken wire.

- Use non-flammable solvent when appropriate
- Avoid situations that allow flammable vapors to collect
- Use flammable solvents and gas in well ventilated areas
- Be aware of ignition sources
- Limit the quantity of solvent
Do you have a suggestion to make LLE a safer work place?

- Click this image to open the LLE Safety Suggestion form (Also available from LLE Safety Zone web page)
- Anonymous suggestions allowed
  - No personally identifiable information will be collected, unless you specifically provide it
- Submissions will be copied to LLE Safety Officers for resolution
- After submission, you will get a link that can be used to edit your submission, track the response, and provide anonymous feedback
Safety is everyone’s business

- **Hazards** exist throughout the workplace, and change over time
- **Restrict your activities to those for which you are trained, qualified and authorized**
- **Stop Work** if an abnormal event occurs, or if an activity seems unsafe
- **Report** safety deficiencies or events promptly
- **Be prepared.** Know how to respond in an emergency
- **Prevent unauthorized access** to LLE
This presentation has two parts

• Part I is mandatory for all persons who have “badge access” to LLE
  • Part I is sufficient for persons who have infrequent (~1x/year) need to visit laboratories as an escorted observer
• Part II is required for persons who
  – “Work” in, or enter without escort into, LLE laboratories or other work areas (including facility mechanics, cleaning staff)
  – Supervise laboratory activity (e.g., faculty who supervise lab research)

G_005 – “Safety Training for Guest Workers at LLE” satisfies the training requirements for guest workers to obtain badge access to LLE. It is NOT necessary to complete both (G_001 and G_005) training modules.

Everyone must take the G_001 quiz to complete this training
Outline

Part I – General Safety
• Overview
• Medical emergencies
• Fire safety
• Laboratory access and visitors
• Ergonomics

Part II – Laboratory Safety
• Buddy system
• Personal Protective Equipment (PPE)
• Guest worker limitations
• Safe work practices
• Lock-out/Tag-out
• Permit-requiring activities
Part I – General Safety
Hazards are present in all aspects of daily life

- A **hazard** is a condition that poses a threat to life, health, property or environment. Most hazards are dormant, with a finite probability of causing harm.
- The probability of a hazard causing harm increases with:
  - carelessness, ignorance, or failure to follow procedures
  - defective equipment
  - equipment or techniques unsuitable for a specific task
  - unforeseen circumstances
- Hazards that are **not adequately mitigated** cause unsafe conditions
  - never undertake a job that appears unsafe
- Hazards can be mitigated only when they are identified **and their full implications are understood**

*Effective* hazard mitigation requires specialized knowledge
Employers and employees both have responsibilities to keep the workplace safe

The Occupational Safety and Health (OSH) Act of 1970\(^1\) states:

(a) Each employer

(1) shall furnish … a place of employment which is free from recognized hazards that are … likely to cause death or serious physical harm to his employees;

(2) shall comply with occupational safety and health standards promulgated under this Act.

(b) Each employee shall comply with occupational safety and health standards and all rules, regulations, … applicable to his own actions

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1) Excerpted from Occupational Safety and Health Act of 1970, General Duty Clause, Section 5
Workers need to be aware of the hazards that laboratory environments present

- Laboratories present hazards that can be dynamic, and different in each work area
- Some of the hazards present at LLE include:
  - Electro-magnetic radiation (Laser, x-ray, …)
  - Radioactive sources (neutron, beta, electron, …)
  - High pressure gas, large volume vacuum systems
  - Cryogenic fluids
  - Chemicals, Beryllium
  - High voltage
  - Working aloft (e.g., ladders, lifts, platforms)
  - Rotating machinery
- LLE management informs workers of hazards by training, signs, and other communications

Workers must restrict their activities to those for which they are trained, qualified, and authorized
Everyone has the right and RESPONSIBILITY to “Stop Work” if they perceive an Imminent Danger

- **An imminent danger** is a hazard or unsafe practice that presents an unacceptable risk of injury, environmental impairment or property damage

- **STOP, get the right people involved** to resolve the problem:
  - Experienced co-workers, supervisors, Shot Directors, Safety Officers, and/or the Laser Facility Managers

- **Provide feedback** to the Safety Officers and peers to
  - reduce future risks and
  - improve planning

No one is expected **OR PERMITTED** to undertake a job until having received instructions on how to do it properly, and authorization to perform it
Report safety concerns immediately

- Bring safety concerns to the attention of persons with the *knowledge and authority* to rectify the situation
- If you believe a safety issue is not being addressed, inform the Chief Safety Officer

An employer may not retaliate or take unfavorable personnel action for reporting a workplace safety deficiency when the complaint is made in good faith
A worker received an electric shock while working on equipment that was under development
• A coworker asked several questions and waited to ensure the worker was OK. The coworker concluded that medical assistance was not needed. The worker sat on the floor several minutes, stated he was OK, then left the room
• Members of the project team stopped work to implement repairs before resuming equipment testing
• The worker was not consulted about the repair. After seeing it, he promptly told a Safety Officer that the root-cause of the shock had not been corrected, and recommended an alternate method of repair
• No injury report or incident investigation was initiated at the time
• Nearly one year later, the worker reported that the root-cause still had not been eliminated. A subsequent investigation identified other installations having the same deficiency.

Promptly report and investigate safety deficiencies and events; delaying an investigation can also delay implementation of important corrective actions
These conclusions shall be applied to any safety event

- Any person who suffers an injury, or exhibits altered mental state (e.g., confusion, dizziness, etc.), should be evaluated promptly by a medical professional.
- If a person is unwilling to seek medical care and first-responders are concerned or in doubt about his/her well-being, summon an ambulance for on-site evaluation.
- Immediately stop working with a piece of equipment when a safety event occurs, including ANY an electric shock (except from static electricity).
- Have qualified personnel secure affected equipment in a safe state (de-energize, and lock/tag-out), unless doing so introduces known safety risks.

If in doubt about a person’s well being, summon an ambulance for on-site evaluation (Better to be safe than sorry).
Safety event – Follow up

• Management shall initiate an incident investigation (see LLE Instruction 6950, Incident Review and Reporting, http://www.lle.rochester.edu/media/resources/documents/6950.pdf)
  – Include all persons with first-hand knowledge in the investigation (face-to-face, when possible)
  – Identify ALL necessary corrective actions
  – Develop a plan to ensure all actions are completed
  – Verify that corrective actions are completed in a timely manner

• Management shall ensure that persons assigned to evaluate and correct safety-related events are impartial and unbiased.
  – Members of a project team shall participate in an investigation of their work, but shall not lead it
  – Final corrective actions must be reviewed to ensure that all contributing factors are effectively mitigated
Safety event – Reporting responsibilities

- Witnesses shall promptly report all safety events to the worker’s supervisor, the applicable Safety Officer (SO) and/or the Chief SO.

- A supervisor who learns of an event that (could have) injured a subordinate must ensure that proper follow-up is initiated:
  - Medical evaluation/treatment for the injured workers
  - Incident investigation
  - Report all workplace injuries to LLE Human Resources (Dave VanWey, John Schoen)
    - HR will prepare and submit a University Of Rochester Employee Incident Report (https://www.safety.rochester.edu/SMH115.html)

- Safety Officers shall inform the Chief SO if a conflict of interest exists related to project involvement, professional duties, personnel conflicts, etc.

Report all workplace injuries to LLE Human Resources
LLE has a proactive safety program to ensure the safety of personnel and protection of equipment

- Safety depends on everyone’s active participation
- *Training, procedures, and qualification* are critical elements of any safety program
- *Compliance* with safety procedures is mandatory
- *Incidents* are investigated and actions taken to prevent recurrence
- Laboratories are *inspected* every 6 months
- LLE’s “Safety Zone” web site contains the latest training information
Your Job Hazard Assessment (JHA) is the first element of your safety training

- The JHA defines
  - risks associated with your work, and
  - required training
- The JHA must be updated with input from you and your supervisor
  - annually
  - when job duties change

JHA changes must be approved by your supervisor
Training presentations, quizzes, and status reports are available on-line.
Know where to find emergency equipment and learn how to use it

Notify a Safety Officer after taking first aid supplies, or if safety equipment is missing or deficient
Assess the situation: don’t expose yourself to unnecessary risk

- **Avoid exposing yourself to hazards** such as fire, laser beams, radiation, electricity, chemicals, or body fluids
- **Wear PPE.** First-aid cabinets in bathrooms and public areas contain items to treat minor injuries, and gloves, face mask, goggles and a resuscitation mask to protect the care giver
- **Wash thoroughly.** If you contacted body fluids (“anything wet or sticky”, blood, saliva, …), promptly contact your medical provider
Emergency phone numbers

<table>
<thead>
<tr>
<th></th>
<th>University phones</th>
<th>ATT or Verizon cell phone</th>
<th>All other phones</th>
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<tbody>
<tr>
<td>LLE West lobby receptionist</td>
<td>55101</td>
<td>(585) 275-5101</td>
<td>(585) 275-5101</td>
</tr>
<tr>
<td>LLE East Lobby receptionist</td>
<td>53941</td>
<td>(585) 275-3941</td>
<td>(585) 275-3941</td>
</tr>
<tr>
<td>UR Public Safety</td>
<td>13</td>
<td>#413</td>
<td>(585) 275-3333</td>
</tr>
<tr>
<td>Local emergency services (Fire, Police, Ambulance)</td>
<td>9-911</td>
<td>911</td>
<td>911</td>
</tr>
</tbody>
</table>

Campus blue phones connect directly to UR Public Safety. Add emergency numbers to your cell phone contacts now!
Medical emergencies require a rapid response

- During working hours (M-F, 8:30am – 5:30pm)
  - Call an LLE receptionist and state “MEDICAL EMERGENCY”. Receptionist will notify the Medical Emergency Response Team
    - If no response, call UR Public Safety
- Off-hours (nights, weekends)
  - Call UR Public Safety, or use any “Blue” phone outside
  - If no response, call Local Emergency Services (911)
- Inform the receptionist when the situation is stable, or if further assistance has been summoned (e.g., defibrillator, ambulance, etc.)

If a first responder determines that advanced medical assistance is required, he/she should remain with the patient and call 911 directly, then remain on the phone to provide situational information and obtain instructions. Other responders can keep the receptionist apprised of the situation.
Remain calm when seeking emergency assistance

Provide detailed information to avoid delays:

• Your exact location (e.g., “Omega Target Bay, top deck, South-West side”)
• Your phone number
• Description of the emergency (e.g., hand injury, breathing difficulty, chest pain, …)
• Enlist help; give simple, clear instructions, e.g.,
  “Amy – notify the receptionist”, “Joe – get a first aid kit”
• Stay with the injured person until more qualified help takes over
• Begin first aid if you know how
Medical emergency follow-up

- Tend to the patient first
- If the patient exhibits any of the following, call for an ambulance:
  - Altered mental status
  - Evidence of threat to self or others
  - Unable to verbalize an understanding of the situation and/or risks of refusing care
  - Unable to verbalize rational reasons for refusing care despite the risks.
- Encourage the patient to seek medical evaluation and treatment
  - The patient may refuse medical treatment if he/she is mentally competent
- Regardless of the patient’s decision to seek medical treatment, report all workplace injuries*. Notify Dave VanWey or John Schoen (LLE Human Resources)


Failure to promptly report a workplace injury can jeopardize the patient’s right to receive Worker’s compensation
Prepare for the unexpected – What to do if you observe, or are the victim of, robbery or assault

• **STAY AWARE** of your surroundings. Keeping alert is your best defense.
• **TRAVEL WITH OTHERS.** There is safety in numbers
• **LIMIT USE** of personal electronic devices when out in public.
• **DO NOT ARGUE** with a suspect or force a confrontation.
• **STAY CALM** and observe everything taking place.
• **MAKE NOTE** of a suspect's direction and means of travel; do not chase or follow!
• **HAVE A PLAN!** what you might do - think about alternatives.
• As soon as it is safe to do so, call UR Public Safety (Security) from the nearest Blue Light Emergency Phone or dial x13 if on campus. Off campus, call the police by dialing 9-1-1.

**LET IT GO!** Property can be replaced, but you are one of a kind
Fire Safety

Do:
- Use *only* electro-magnetic safety latches to hold fire doors open
- Never obstruct a sprinkler head
- Keep combustible materials 18” below fire sprinkler heads
- Maintain clear access
  - ≥ 48” through hallways, around doors
  - ≥ 36” around electrical panels, fire extinguishers and fire alarm pull stations
- Minimize storage of flammable materials
- Inform a Safety Officer of faulty safety equipment (exit light, fire extinguisher, etc.)

These boxes are too close to a sprinkler, will restrict water distribution and limit effective coverage. Items that are too close to the ceiling will not be protected.
Fire Safety

Do not:
- Prop fire doors open
- Place items on electrical raceways
- Attach items to, or drape items over, fire sprinklers or pipes
- Bring personal appliances to LLE (heaters, toasters, coffee makers, refrigerators, microwave ovens, halogen lamps, decorative lights, etc.)
- Park within 15 feet of a fire hydrant

Mag. Latch OK
Door prop NOT OK

Raceway storage NOT OK
Respond immediately to fire alarms

Evacuate via the most direct, safe route
- close windows and doors while exiting, if safe to do so
- use stairs, not elevators
- move to a location at least 50’ from the building and emergency equipment, and
- don’t re-enter the building until alarms are silenced and beacons are off

LLE hosts are responsible for their guests during an emergency

In an emergency, LLE management needs your help to account for everyone who was in the building at the time of the event

After getting to safety, notify (phone, email, text message…) a RESPONSIBLE Individual (Supervisor, Group Leader, Division Director) before leaving (e.g., lunch, class, home, etc.)
LLE has three fire alarm zones

- Alarms may not sound in all zones
- Fire doors automatically close to isolate each zone when an alarm sounds

You may move into an area that is not in an alarm state, only if it is along your most direct egress route
UR has designated LLE as a “Fight Building”

• LLE personnel are **NOT** required to fight a fire

• *Trained* personnel *MAY* fight a fire after:
  – Activating the building fire alarm
  – Assisting persons in immediate danger
  – Assessing the risks (*follow your instincts!*)
    • Is there heavy smoke or strong odor?
    • Is fire small and contained?
    • Is there an unobstructed exit?

• Evacuate immediately if:
  – the fire spreads beyond the point of origin
  – the fire could block your exit
  – one fire extinguisher is insufficient

Cleanroom garments are **NOT** required when responding to emergencies, but don’t ignore hazards such as lasers, machinery, high voltage, ...
Learn how to use a fire extinguisher

- **Pull** the pin. This will allow you to discharge the extinguisher.
- **Aim** at the base of the fire. You must hit the fuel, not the flames.
- **Squeeze** the top handle or lever. Start using the extinguisher from a safe distance, then move forward.
- **Sweep** from side to side. Once the fire is out, monitor the area in case it re-ignites.

Source: http://www.fireservicepro.com

### Types of Fires

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<thead>
<tr>
<th>Class</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Ordinary combustibles: wood, paper, rubber, fabrics and many plastics</td>
</tr>
<tr>
<td>B</td>
<td>Flammable liquids &amp; gases: gasoline, oils, paint, lacquer and tar</td>
</tr>
<tr>
<td>C</td>
<td>Fires involving live electrical equipment</td>
</tr>
<tr>
<td>D</td>
<td>Combustible metals or combustible metal alloys (no picture symbol)</td>
</tr>
<tr>
<td>K</td>
<td>Fires in cooking appliances that involve combustible cooking media</td>
</tr>
</tbody>
</table>

### Types of Extinguishers

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Class A</td>
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<td>A:B</td>
<td>Class A:B</td>
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<td>A:B:C</td>
<td>Class A:B:C</td>
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<td>A:C</td>
<td>Class A:C</td>
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<tr>
<td>B:C</td>
<td>Class B:C</td>
</tr>
<tr>
<td>K</td>
<td>Class D:K</td>
</tr>
</tbody>
</table>

LLE has type B:C (Carbon Dioxide, CO₂) fire extinguishers in laboratories because of the electronics and optics. When used on ordinary combustibles (e.g. paper), use caution; CO₂ may scatter burning materials, causing the fire to spread.

Source: http://ehs.okstate.edu
LLE infrastructure policies

• LLE facility mechanics, under direction of John Sawyer, are responsible for installation, modifications, maintenance and repair of
  – Electrical power distribution and permanent fixtures
  – Water, chilled water, and house gas (compressed air & nitrogen) distribution
  – Permanent infrastructure, including walls, doors, floors, fume hoods, etc.

• LLE staff (other than facility mechanics) are NOT permitted to
  – Modify any laboratory infrastructure
  – Open circuit panels or enable/reset/disable circuit breakers, except when part of written and approved procedures
LLE electrical safety policies

- If it is 50 Volts or greater, it is high voltage
- Extension cords must not:
  - have connected loads exceeding the manufacturer’s rating
  - be “daisy-chained” (connected in series)
- Equipment used at LLE must be Underwriters Laboratory (UL) certified, or approved by the Electrical Safety Officer
- Do not repair any high voltage equipment. Contact the LLE Electronics shop if repairs are needed
- Orange outlets are “clean” power for instruments only (e.g., no pumps, motors, etc.)

Warm, damaged, frayed, or deteriorated cord?
STOP! Seek assistance
Access to LLE is restricted to provide physical and personal security

- Building access is controlled by card readers and receptionists
- Everyone must visibly display (e.g., above the waist) their UR/LLE ID or visitors pass while in the building
- Visitors must sign in with a receptionist and wait for an LLE staff member to escort them to their destination
- Never allow people to enter LLE to use the phone, bathroom, get a drink, etc. unless they are personally known to you and escorted by you.
- Before you leave the building, make sure the path to your vehicle is safe. Wait inside the building if you observe unusual vehicles or suspicious activities. Call UR Public Safety and ask an officer to investigate or provide an escort if there are concerns

Do NOT allow unauthorized persons to enter the building
Guest and Visitor policies

- Non-US citizen visitors must be preapproved through the Director’s office
  - LLE host must contact J. Steve **60 days** before planned visit
  - This rule applies to vendors and contractors
  - This rule does NOT apply to UR faculty or UR students
- All group tours (more than 3-4 people) must be scheduled in advance through the Director’s office (J. Steve)
- Visitors must be escorted in technical areas (Labs, cleanrooms, shops, OMEGA facility)
  - The Responsible Supervisor must authorize visitor access
  - No photos are allowed in technical areas
  - Photos are allowed in viewing galleries
- LLE Employees, and students with LLE badge access, may bring family members into LLE viewing galleries on evenings & weekends (technical areas are prohibited).
- The LLE host is responsible for their guests at all times.

Questions? Contact Jean Steve
The UR established an Ergonomics Program to reduce the incidence of Work-Related Musculoskeletal Disorders

- Musculoskeletal Disorders (MSDs) are injuries caused by overuse or excessive repetition involving muscles, nerves, tendons, ligaments, cartilage, joints and spinal disk
- MSDs can be caused or aggravated by
  - Repetitive motion
  - Poor posture & inadequate back support
  - Improper lifting techniques
- The UR Environmental Health & Safety Occupational Safety group will assist with
  - Worksite evaluations
  - Employee and supervisor training
  - Implementation of ergonomic control strategies

For more information, visit: [http://www.safety.rochester.edu/ih/ergonomic/ergonometrics.html](http://www.safety.rochester.edu/ih/ergonomic/ergonometrics.html)
Do not share personal items assigned by LLE/UR

- University ID cards
- Computer accounts & passwords
- Radiation badges
- Keys
- Confidential personal information

The individual to whom these items are assigned is personally responsible for their appropriate use. Improper use may cause termination.
AlertUR emergency notification system disseminates critical safety information to the University community

What is considered critical?

• In-progress police emergencies on University property and/or an imminent danger to the community

• Civil disturbances, acts of terrorism, fires that impact operations, release of hazardous materials and medical emergencies, which pose a severe threat to personal safety and/or cause a major disruption to University operations

• Warnings about natural disasters, health emergencies, and other dangerous occurrences connected to the University

To register, or change notification options, go to: https://alert.rochester.edu
Safety is everyone’s business

- **Hazards** exist throughout the workplace, and change over time
- **Restrict** your activities to those for which you are trained, qualified and **authorized**
- **Stop Work** if an abnormal event occurs, or if an activity seems unsafe
- **Report** safety deficiencies or events promptly
- **Be prepared.** Know how to respond in an emergency
- **Prevent unauthorized access** to LLE
This is the last slide of Part I

• If you work in any LLE laboratory area or supervise laboratory activity, proceed to the next slide

• If you do not work in any LLE laboratory spaces and visit laboratories infrequently only with an escort, you do NOT need to complete Part II

• You must complete the on-line G_001 Quiz
• Submit LLE Safety Suggestions any time

Use any web browser to access these links on the LLE Safety Zone, “Training” tab

You must complete the G_001 quiz to satisfy your training requirement
Part II – Laboratory Safety

Persons who perform or supervise laboratory work MUST understand and comply with the information presented in the following section
Outline

Part I – General Safety
• Overview
• Medical emergencies
• Fire safety
• Laboratory access and visitors
• Ergonomics

Part II – Laboratory Safety
• Buddy system
• Personal Protective Equipment (PPE)
• Guest worker limitations
• Safe work practices
• Lock-out/Tag-out
• Permit-requiring activities
Part II Summary

• The Buddy System must be used when working in potentially hazardous conditions
• Understand the limitations of PPE. Know what PPE is required for the tasks assigned to you, and for the areas in which you work
• Summaries of several incident reports are presented to highlight lessons learned
• Guest workers are only permitted to perform pre-approved tasks
• Lock-out/Tag-out is used to protect people and equipment
• Housekeeping can help mitigate hazards and prevent the spread of contamination
• Permits are required to perform energized work, hot work, or to enter a confined space
LLE requires use of the Buddy System

• “Buddy System” means working with a partner when
  – using potentially hazardous equipment or processes or
  – working in a potentially hazardous environment

• Buddies are responsible for
  – Being available to assist in an emergency
  – Verifying that safe work practices are used
  – Remaining in contact with partner, and knowing he/she is OK

• Workers must review plans for off-hours laboratory work with their Supervisor and obtain approval prior to starting. Review:
  – Planned work hours
  – Activities being performed
  – Worker training and qualification
  – Buddy System implementation

• Sign in/out at the receptionist desk when working off-hours
Training about the proper use of PPE is covered in other training modules
PPE is provided by LLE

• Some areas within LLE require workers to wear PPE. Many rooms have signs indicating the specific type of PPE required.
• Each worker must know/understand what PPE is required prior to starting a task. Contact the work-area supervisor or a Safety Officer if there is any question about what PPE is needed
• Types of PPE include
  – Laser, chemical, and mechanical safety eyewear (all must meet ANSI Z87.1 standard for impact resistance)
  – Face shields (must be used with safety eyewear)
  – Hardhats
  – Gloves
  – Lab coats, shoe covers, hair nets/covers
  – Safety shoes (required when moving items > 50 lbs = 22 kg)
  – Hearing protection
  – Fall protection
Redundant safety barriers reduce the probability of accidents

PPE **NEVER** prevents an accident; it **may** reduce the severity of injuries

**Potential Hazard**

- **Engineered safety**
  - Structures
  - Interlocks
  - Guards
  - Software

- **Administrative**
  - Policies
  - Access Control
  - Buddy System

- **Education**
  - Training
  - Qualification
  - Procedures

- **Warnings**
  - Signs
  - Voice
  - Alarms

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4002A Omega Facility Controlled Access

Laser Safety Training

Laser Facility Organization and Regulation Manual

LFORM LLEINST 3000M
1 February 2013

S-AB-P-120 Rev. V
August 16, 2013

527,1053 nm
PPE is your LAST form of protection

- When safety barriers fail, PPE is critical
- PPE is effective only when properly maintained and used
- Wear PPE correctly
- Many types of PPE are designed to withstand a single catastrophic event (e.g., hard hats, impact-resistant eyewear, fall arresters)
  - If such an event occurs, or if the PPE appears to be damaged, remove it from service immediately!
- Some PPE is designed for single-use to prevent spread of contamination (e.g., disposable gloves and lab coats, ear plugs)
  - Discard single-use PPE after use

Know the capabilities and limitations of the PPE you use, and use it accordingly
The user is responsible inspecting PPE before every use

• Keep PPE clean and in good working order
• Check PPE before each use
• Immediately remove damaged PPE from service; return it to the work area supervisor who will dispose of it and replace it
• Return PPE to the point of origin. Do NOT move PPE from one laboratory to another
  – For example: do not “upgrade” your laser safety eyewear from another lab, the wavelengths may not be compatible

Not all safety eyewear is interchangeable!
Laser eyewear ≠ Mechanical eyewear ≠ Chemical eyewear
Dress properly when working in laboratory areas

• Understand what PPE is required, wear it as prescribed
• No open-toed shoes or sandals in OMEGA, labs, machine shop, etc
  – fully-closed footwear affords greatest foot protection
• Wear long pants, without cuffs
  – cuffs trap chips, hot/cold materials, spilled materials
• Wear cleanroom or protective garments to prevent street clothes from:
  – becoming contaminated
  – contaminating the lab

Is your buddy properly dressed and using PPE correctly?
Safety eyewear or face protection of the appropriate type must be worn under the following conditions:

- “... 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” OSHA 1910.133(a)(1)
- When required by signs, or by the work area supervisor
- At all times in the following areas:
  - OMEGA Facility areas (e.g., Laser Bays, Target Bays, LaCave)
  - Any room where Class 3B or Class 4 lasers with free-space beam propagation are in operation
  - Machine shop, all Chemistry labs and LLE Mechanical rooms
- By all persons working or passing within 20 feet of:
  - Chemical processes areas
  - Compressed gas system operation
  - Vacuum system operation
  - Activities that can generate particulate, debris, or projectiles

All safety eyewear used at LLE (Mechanical, Laser, Chemical) must have side protectors, and satisfy ANSI Z87.1 impact resistance standards
Ensure that new and existing equipment is both safe to operate and operated safely

- No equipment or diagnostic will be operated until requirements set forth in LLE Instruction 7700 are satisfied
- Only qualified operators may operate OMEGA facility equipment, with authorization from the appropriate Shot Director or Laser Facility Manager
- Equipment will be installed by qualified personnel only, with authorization and coordination from the Laser Facility Manager, Engineering Group Leaders, and Facilities Engineering

Anything, no matter how carefully designed and built, can be operated in a manner that renders it unsafe
Consider safety risks at all times

- **Failure Mode and Effects Analysis (FMEA)** is required by LLE Instruction 7700. Consider what can cause failure and the consequences thereof. FMEA is applicable to systems, software and procedures. Effective use can help define requirements that improve both safety and reliability.
- **Risks are mitigated to the maximum extent practical** by:
  - Engineering controls (interlocks, guards, pressure relief devices, …)
  - Procedures and training
  - Administrative controls (restrict access, buddy system, …)
  - Personal protective equipment (PPE)
- **Never alter, remove or defeat Safety Features** without review and approval from the relevant safety officer; examples include software and hardware interlocks, guards on moving machinery, electrical and laser enclosures
- **Keep procedures accurate**
  - Stop and correct procedures that are unclear or inaccurate
  - Obtain authorization before deviating from procedures
LLE’s Electrically Energized Work policy

Definitions

High voltage: ≥ 50V potential relative to earth ground

Electrically Energized: Conductors are exposed with high voltage

• Work on Electrically Energized equipment is permitted only when essential:
  – If disabling power will affect critical safety systems
  – When necessary to evaluate operation of electrical equipment
  – In all other situations, high voltage equipment MUST be de-energized before servicing

LLE will apply DOE guidelines (DOE-HDBK-1092-2013) to establish criteria for electrically energized equipment safe work practices.

ONLY qualified electrical workers (must complete E_001) may work on high voltage equipment or perform Electrically Energized Work
Confined-space and hot-work also require permits

Permits are approved for specific tasks of finite duration

Confined Space\textsuperscript{1} - has limited or restricted means for entry or exit, and it is not designed for continuous employee occupancy
LLE manages access to the Target Chambers and Grating Compressor Chamber by procedure
• Access to any other confined space requires a review following the same approach as for Energized Work

Hot Work\textsuperscript{2} - Any operation that will generate heat, sparks or flame
• Persons conducting hot work must complete training administered by the UR Fire Marshall’s office
• Purpose-designed work areas (e.g., welding station) can be approved for long-term use

Every work area is subject to Lock-out /Tag-out (LOTO) procedures

• Purpose: LOTO Prevents operation of equipment that could cause injury or equipment damage
• LOTO policy is defined in LLE Instruction 3000 (OMEGA) and LLE Instruction 6300 (Labs)
• Locks and Tags are:
  – used to communicate that a safety risk exists if operated
  – installed prior to beginning work
  – tracked in an out-of-commission (OOC) log
  – installed and removed by qualified personnel
• A watch stander who is following a written procedure, after receiving authorization from the Shot Director on-duty
• A facility mechanic or electrician assigned to the job
• An individual who has the requisite training and skills, AND is assigned responsibility by management

Do not remove a “DANGER DO NOT OPERATE” tag without following these rules!
Lock-out/Tag-out (con’t)

- Never use equipment that has a known or suspected safety deficiency
  - Stop using it immediately and contact the area supervisor or a Safety Officer to tag it out
  - This ensures that others are aware of the deficiency
  - Have it professionally repaired before returning it to service
- The LOTO must remain in place until
  - Repairs are complete and/or the equipment is deemed safe to operate
  - Or, a qualified individual is assigned to perform troubleshooting
- If you find a tag on a piece of equipment that you need, contact the area supervisor and/or a Safety Officer. They can help determine the proper course of action to return an item to service
- Do not attempt to perform repairs for which you are not specifically trained and authorized
Visitor and Contractor Safety

• Continuous escort is required for visitors and short term contractors working in laboratories or technical areas
  – Technicians (e.g., laser, crane, …)
  – Vendors and other persons requiring access to laboratories
• Training is required for long term contractors
  – Contract employees are managed by the work area supervisor
  – Facilities contractors are managed by the Administrative Division
• LLE Host personnel are responsible for ensuring that guests:
  – receive site-specific safety training and supervision
  – follow LLE Safety and Access policies
  – are appropriately escorted/supervised

All persons are required to wear UR/LLE issued ID or visitors badge, where it is readily visible, while in the building
Contractor Safety (continued)

• Contractors are hired for their knowledge and expertise
• LLE hosts are responsible for
  – ensuring contractors receive training of site-specific hazards and work-area protocol (managed by “Work Authorization Procedure”)
  – mitigating hazards to the maximum extent practical before allowing a contractor to begin work

Example: A factory technician comes to service a laser in the OMEGA target bay. The technician must:
• Receive Target Bay (TB) access training
• Be escorted while working in the bay
• Wear proper TB cleanroom garments and PPE
• Adhere to hazard mitigation defined in Work Authorization Procedure (e.g., how to operate safely with covers removed, interlocks are defeated, etc.)
• Consult with the LLE host to obtain authorization when necessary to deviate from approved plans
LLE hosts and escorts: know that Guest Workers are NOT permitted to perform the activities listed below *

* Exceptions must be approved by LLE management

- Service energized equipment, unless following written, LLE-approved procedures
- Remove “Danger - Do Not Operate” tags (they may participate in LOTO using gang locks when appropriate)
- Use ladders > 6 feet (1.8 m) tall, rolling stairs, aerial lifts, or perform activities requiring fall protection
- Operate hoists or cranes, or perform rigging operations
- Use cryogens (e.g., liquid N\textsubscript{2})
- Chemical processes
- Modify, or authorize changes to equipment, software, or procedures
- Allow people to enter LLE buildings
- Activities requiring a respirator
- “Hot work” (e.g., open flames, welding)
- Fight fires (unless trained by home institution. Fire extinguisher only.)
- Machine shop work
Permanent cables, fibers, hoses, etc. or those longer than ~12 feet, are to be installed by LLE staff

This is necessary to ensure that cables:

- Meet electrical safety standards
- Follow designated paths
- Remain clear of beam paths & walkways
- Do not interfere with moving mechanical equipment
- Are properly strain relieved
- Do not overload cable trays
- Do not interfere with fire suppression systems
Good housekeeping can eliminate many types of hazard

- Clutter can result in
  - Trip/fall hazards
  - Fire hazards
  - Lost productivity (e.g., personnel injuries, searching for items)

- Good housekeeping minimizes the spread of contamination
  - Metal shavings
  - Beryllium dust
  - Tritium
  - Chemicals (e.g., dyes)

- Discard outdated books, catalogs, papers, boxes, packing materials
- Salvage, repair or discard equipment that is no longer useable
- Check chemical inventory; dispose of outdated and unnecessary chemicals
Eliminate contamination at the source to prevent it from spreading

- Areas near, and connected to, the target chambers (target bays, LaCave, TIMs, GCC, etc) are the most likely areas to find Beryllium dust and tritium contamination

- Persons who handle items that have been exposed to the TC, or work in areas around the TC (e.g. Target Bays, LaCave, ...) must
  - be LLE qualified/authorized
  - assume items are contaminated when first removed from the TC
  - ensure items are below contamination limits before they are released to “general” work areas
  - wash hands after working in areas or after working with equipment that may have been contaminated
Secondary exposure occurs when persons are indirectly exposed to contamination

Examples:

- A worker opens a door while wearing contaminated chemical gloves, transferring chemicals to the door handle. The primary worker is not affected, but other people who touch the handle without wearing gloves may be.

- The beryllium filter in a TIM diagnostic is shattered during a target shot. The diagnostic is transferred to a workbench for repairs. Particulate dislodged during repairs may become airborne, or may be left behind on the workbench. Prevent spread of contamination:
  - Consider vacuuming or bagging the diagnostic prior to moving it from the TIM to a beryllium workstation
  - Clean the TIM before installing another diagnostic
  - Work in a Be hood to trap airborne particulate in the HEPA filter
  - Clean the interior of the Be hood after work is complete
What should have been done differently?
Excerpts from Incident Report 178

A student was working at a fume hood with a mixture of Sulfuric Acid and Hydrogen Peroxide. He was working with a buddy, and was wearing personal protective equipment (PPE) including: a lab jacket, safety eyewear and nitrile gloves. He scratched his neck with a gloved hand.

He felt a tingling sensation, but no pain. His buddy saw no sign of irritation. That evening, the area was red and raised. The following day, it had the appearance of a first degree burn.

Lessons learned
• Initiate prompt treatment if contact with any hazard occurs or is suspected (e.g., chemical, electrical, thermal).
• Remain vigilant and aware of your surroundings, including activities of others working nearby
• When using gloves as a chemical barrier, be sure to
  • Rinse gloves before removing as a safety precaution
  • Remove glove before handling non-contaminated items (including scratching yourself!)
  • Use proper technique to remove gloves without spreading contamination
  • Properly dispose of gloves designed for single use

General recommendations
• Periodically review location and condition of eye wash stations, safety showers, first aid kits, and emergency contact information on LLE telephones
• Manage (separate) contaminated items and non-contaminated items
• Review emergency response procedures for your work area
Design work areas to prevent eye injury, not like the lab shown below!

- Install laser curtains (or equivalent) to isolate laboratory work from office areas
- Install laser barriers around tables that are >2” taller than the highest beam
- Chair height must keep users eyes >12” above laser beam paths
- Computer workstation height should allow operators to stand
An example of unacceptable practices (#1)

A belt guard was lying on the floor beside a vacuum pump during a safety inspection. No one was present, the guard was reinstalled.

- On a follow up visit, the guard was on the floor again. Student response “the motor doesn’t start, so we spin the pulley by hand to start it”

The user knew that the equipment was malfunctioning. Rather than having it repaired, he used it with safety guards removed to allow starting it by hand. What should have occurred?

1. Stop using the equipment immediately
2. Tag out the defective item
3. Contact a supervisor or a Safety Officer to arrange for repairs to be made
4. Replace the item or have it professionally serviced
5. In retrospect, the Safety Officer who replaced the guard should have tagged the equipment out immediately, then followed up when the user was available
An example of unacceptable practices (#2)

The “post-it” on the right was on a partially disassembled power supply.

- equipment known to be deficient, improperly tagged out
- several pieces of equipment in various stages of disassembly were being operated with covers off
- unqualified persons were performing repairs

This was one of many safety infractions that caused the offending laboratory to be shut down for several weeks. LLE Director Dr. McCrory issued a letter to the lab supervisor requiring an action plan that implemented better supervision of students, enforcing use of the buddy system, keeping current with LLE mandated safety training and properly maintaining equipment by qualified persons. This equipment could not be serviced by LLE staff, and a factory authorized representative made a site visit to perform repairs.

Supervisors are responsible for ensuring that their staff, students and guests are properly trained and following LLE policies.
Part II Summary

- The Buddy System must be used when working in potentially hazardous conditions.
- Understand the limitations of PPE. Know what PPE is required for the tasks assigned to you, and for the areas in which you work.
- Summaries of several incident reports were presented to highlight lessons learned.
- Guest workers are not permitted to perform all tasks that LLE staff are.
- Lock-out/Tag-out is used to protect people and equipment.
- Housekeeping can help mitigate hazards and prevent the spread of contamination.
- Permits are required to perform energized work, hot work, or to enter a confined space.
This is the last slide of Part II

- You must complete the on-line **G_001 Quiz**
- Submit **LLE Safety Suggestions** any time

Use any web browser to access these links on the LLE Safety Zone, “Training” tab