James Reason


Four levels of failure
- Organizational influences
- Preconditions for unsafe acts
- Unsafe supervision
- The unsafe acts themselves
What I tend to focus on:

- Compatible storage of chemicals
- Protective eyewear, lab coats
- Clothes compatible with safety goals (long pants, shoes, socks)
- Labelling of solids/liquids/gases that we have generated (stored on benchtops, in refrigerators, in cabinets)
- Keeping balances, instrumentation clean and in top working order.
- Log books
- General housekeeping
- Thinking ahead (having supplies, replacement parts) (anticipating hazards)
- "It takes a village" (critical mass, peer mentoring . . . . . )

What *should* we be addressing?
Focus for 2019 Inspections:

(1) Chemical Waste Disposal

(2) Eyewash Inspection Logs

(3) Biosafety Registrations

(4) Lab Exit/Decommission and Equipment Clearance
Safety Plan

(1) It is prudent to minimize all chemical exposures. Exposures should be kept below Permissible Exposure Limits (PELs) and Threshold Limit Values (TLVs).

(2) All risks should be anticipated and efforts taken to minimize them. Written plans for labeling, storing, using, and disposing of all toxic chemicals should be in place before chemical is purchased.

Manufacturer provided Material Safety Data Sheets (MSDS) are a “first step” in determining these procedures and protocols.

(3) Safety is a community effort.
For any new instrument, equipment, or protocol, everyone involved participates in a documented troubleshooting session.
- What might go wrong? What actions can be taken to prevent or lower the probability of failure?
- If failure does take place, what backup systems are in place?
- The importance of log books - documentation of all use, with attention paid to training and “certification”, maintenance, changes in performance.
Chain of Command . . . . . responsibilities

Department Chair: Responsible for the actions of all personnel, including all safety issues.

Chemical Hygiene Officer: - Coordinate and expedite training
  - Liaison with HSE (Office of Health, Safety and Environment)
  - Perform appropriate audits, ensure that procedures and protocols have been developed and are being followed; establish inventory lists

Laboratory Supervisor (each faculty member):
  - Ensure that workers know and follow rules, and have been properly trained.
  - Provide regular, formal safety and housekeeping inspections.
  - Ensure that protective equipment and emergency equipment is in good working order, and commensurate with activities and materials used.
  - Know current legal and funding source requirements.
  - For each chemical ordered (or synthesized), ensure that facilities, training, and procedures for handling and disposal are adequate.
  - Record keeping: who has been approved for particular kinds of work, maintenance of records, written protocols, and inventories.
  - Organizes the workplace, schedules and organizes housekeeping.
Each Laboratory Worker:

Do your homework: - Find out about hazards and develop strategies for minimizing them before starting work.
- Ensure that all activities are planned and conducted in accordance with JHU, state, and federal rules and regulations.

Seek out safety information, and become an expert on the materials you’re using, and the procedures you’re following: - Merck Index
- “Chemical Laboratory Safety and Security” (2010) - MSDS - SciFinder
  Lisa Moran and Tina Masciangioli (NRC, ACS)

Develop/document protocols for the labeling, storage, use, and disposal of highly toxic substances: - Pay particular attention to stock solution preparation and operations where you might be exposed to high concs. - Confine activities to appropriate areas. - Ensure safe disposal.

Properly operate and maintain equipment:
- Familiarize yourself Owner’s Manuals, especially the safety information.
- Particular equipment will require training and prior approval before use.
- Take steps to prevent equipment contamination. If contamination occurs, clean thoroughly before other users, repair personnel are exposed.
Notify faculty/lab supervisor if equipment is damaged or performing unexpectedly.

Don’t put others at risk.
- Good housekeeping, clear labeling and signs, along with a high level of organization can help keep hazards away from coworkers, repair personnel, and the custodial staff.

Notify faculty/lab supervisor if you are hurt, injured, exposed to a hazardous substance, or had a “near miss.”
(This will help to prevent future mishaps.)
How can you tell when safety is taken seriously?

Attentiveness and commitment on the part everyone involved, not just lab personnel.
- Finding out about physical, chemical, and biological hazards before beginning work.
- Thorough use of safety equipment, proper clothing. (Safety glasses, goggles)
- Written protocols, good housekeeping, orderliness, consideration of others.

Effort by administrators to understand and “stay on top of” workplace environment.
- Identify, rectify problematic procedures or materials.
- Supervision and training of lab personnel.

Financial investment in safety.
- Provision for well-lit, clean, and uncluttered facilities.
- Solvent storage cabinets, hoods, and other safety equipment.

Enforcement of Safety Regulations and Procedures.
- Effort to keep all equipment and instrumentation in good working order, including well-organized stocks of repair tools and replacement parts.
- Resist complacency concerning “low frequency” hazards.
- Open lines of communication.
- Identification and control of new risks.
- Protect those who report incidents.
How can you tell when safety is taken seriously?

- report all -
  - accidents
  - mishaps and spills
  - equipment and instrumentation behaving unexpectedly
  - all near misses (i.e. “near hits”)
  - anything that “just doesn’t seem right”
Unsafe Practices
Unsafe Conditions
Accidents with No Injury
Minor Injuries
Major Injury

Accident Severity
Reliability of Reporting
Swiss Cheese Model
Community Effort . . . Many “pairs of eyes”

- Department Chair
- Lab coordinator
- Custodial Staff
- Lab Safety Captain
- Security
- Supervisor
- Dean of Research
- Co-workers
- Homewood Safety Advocate
- Lab worker
- Homewood Safety Committee
- Office of Research and Sponsored Programs
- HSE (Office of Health, Safety and the Environment)
- JHU General Counsel
- Chief Risk Officer
- Baltimore City Fire Department
- Maryland
- USA
HSE (Health, Safety, and Environment)

http://www.hopkinsmedicine.org/hse/

- Insure compliance with all laws and regulations.
- Liaison with government agencies.
- Annual inspections.
- Incident reporting.

Maryland Occupational Safety and Health (MOSH)
Occupational Safety and Health Administration (OSHA)
Joint Commission for the Accreditation of Healthcare Organizations (JCAHO)
Environmental Protection Agency (EPA)
Maryland Department of the Environment (MDE)
Nuclear Regulatory Commission (NRC)
Baltimore City Fire Department (BCFD)
Baltimore City Health Department (BCHD)
Department of Health and Human Services (DHHS)
Center for Disease Control (CDC)
Food and Drug Administration (FDA)
United States Department of Agriculture (USDA)
Association for Assessment of Accreditation of Laboratory Animal Care (AAALAC)
Department of Transportation (DOT)
Federal Aviation Administration (FAA)
International Air Transport Association (IATA)
Maryland Workers’ Compensation Commission (MWCC)
Leaving
GALLATIN
National Forest
Land of Many Uses
U.S. DEPARTMENT OF AGRICULTURE
- documentation -

Laboratory Notebooks
Instrument Logs
Laboratory Protocol Documents
Safety Incident Reports
Project Reports
Submitted Manuscripts
Thesis
Good Housekeeping

- Workspace free of clutter.
- Hood free of obstructions.
- Chemicals, other items properly stored.
- Heavy items in low cabinets and on low shelves.
- Floor that is free of boxes, equipment, and glassware.

The custodial staff will occasionally come into the lab and clean/wax the floor.

- **Frequent use of tubs and trays**, particularly in refrigerators and freezers. (precaution against spillage) (useful for carrying multiple items)
Glassware and other items that have cracks, frayed wire, or other defects need to be replaced.

Don’t place containers near ledges or where they might be knocked over.

Don’t set hazards up for others (custodians, emergency response personnel).
Chemicals

Acute toxicants
Irritants
Corrosive substances
Allergens and sensitizers
Asphyxiants
Neurotoxins
Reproductive toxins
Developmental toxins
Toxic substances
Carcinogens

What are the risks?

Discoloration
Stains
Hypersensitivity
Poisoning
Burns
Loss of Movement
Eye Injury
Loss of Sight
Cancer
Death
HSE (Health, Safety, and Environment) requires written protocol and prior approval for work with:

A. Select Carcinogens
B. Chemicals with a TLV (Threshold Limit Value) of 5 ppm or less.
C. Known mutagens or teratogens.
D. Toxic chemicals
   - Those with LD$_{50}$ of 50 mg/kg or less when administered orally to rats.
   - Those with LD$_{50}$ of 200 mg/kg or less when administered by continuous contact for 24 hours to the bare skin of albino rats.
   - Those with LD$_{50}$ of 200 mg per kg of air or 2 mg/L or less of dust, mist, or fume when administered by continuous inhalation to rats.
E. Pathogenic organisms, blood, or blood products.
F. Organisms with recombinant DNA.
G. Live animals.
H. Radionuclides
I. Class IIIb or IV lasers.
J. Physical hazards, including high voltage equipment, high-energy light sources, or high noise levels.
Due Diligence

**Wikipedia**: The theory behind due diligence holds that performing this type of investigation contributes significantly to informed decision making by enhancing the amount and quality of information available to decision makers and by ensuring that this information is systematically used to deliberate in a reflexive manner on the decision at hand and all its costs, benefits, and risks.
Monograph ID: M6002  CAS Name: Hexane
Title: n-Hexane  Molecular Formula: C6H14
CAS Registry Number: 110-54-3  Molecular Weight: 86.18

Properties: Colorless, very volatile liquid; faint, peculiar odor. d420 0.6591. bp 69 °C. mp –100 to –95 °C. nD20 1.375. Flash point: –18.0 °C. Vapor pressure (mmHg): 186.1 at 30°, 400.6 at 50°. Partition coefficient (1-octanol/water) at 25°: >4100. Spec heat at 22.0°: 0.536 cal/g/°C. Viscosity at 15°: 0.337 cP. Heat of vaporization: 79.4 cal/g. Surface tension at 20°: 18.41 dyne/cm. Insol in water. Miscible with alcohol, chloroform, ether. LC50 (4 hr) in mice by inhalation: 48000 ppm; LD50 orally in rats: 32.0 g/kg (Couri, Milks).


Notes: Caution: Potential symptoms of overexposure are lightheadedness; giddiness; nausea, headache; peripheral neuropathy; numbness of extremities, muscle weakness; irritation of eyes and nose; dermatitis; aspiration of liquid may cause chemical pneumonia. See NIOSH Pocket Guide to Chemical Hazards (DHHS/NIOSH 97-140, 1997) p 162.
Furthermore, \textit{n}-hexane is biotransformed to 2-hexanol and further to 2,5-hexanediol by cytochrome P450 mixed function oxidases by \textit{omega oxidation}. 2,5-Hexanediol may be further oxidized to 2,5-hexanedione, which is \textit{neurotoxic} and produces a \textit{polyneuropathy}.\cite{13}

\begin{flushleft}
\end{flushleft}
1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers
Product name: Hexane
Product Number: 296090
Brand: Sigma-Aldrich
Index-No.: 601-037-00-0
CAS-No.: 110-54-3

1.2 Relevant identified uses of the substance or mixture and uses advised against
Identified uses: Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet
Company: Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO  63103
USA
Telephone: +1 800-325-5832
Fax: +1 800-325-5052

1.4 Emergency telephone number
Emergency Phone #: (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 2), H225
Skin irritation (Category 2), H315
Reproductive toxicity (Category 2), H361
Specific target organ toxicity - single exposure (Category 3), Central nervous system, H336
Specific target organ toxicity - repeated exposure, Oral (Category 2), Nervous system, H373
Aspiration hazard (Category 1), H304
Acute aquatic toxicity (Category 2), H401
Chronic aquatic toxicity (Category 2), H411

For the full text of the H-Statements mentioned in this Section, see Section 16.
### GHS Label elements, including precautionary statements

**Pictogram**

<table>
<thead>
<tr>
<th>Signal word</th>
<th>Danger</th>
</tr>
</thead>
</table>

**Hazard statement(s)**
- **H225** Highly flammable liquid and vapour.
- **H304** May be fatal if swallowed and enters airways.
- **H315** Causes skin irritation.
- **H336** May cause drowsiness or dizziness.
- **H361** Suspected of damaging fertility or the unborn child.
- **H373** May cause damage to organs (Nervous system) through prolonged or repeated exposure if swallowed.

**H411** Toxic to aquatic life with long lasting effects.

**Precautionary statement(s)**
- **P201** Obtain special instructions before use.
- **P202** Do not handle until all safety precautions have been read and understood.
- **P210** Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
- **P233** Keep container tightly closed.
- **P240** Ground/bond container and receiving equipment.
- **P241** Use explosion-proof electrical/ ventilating/ lighting/ equipment.
- **P242** Use only non-sparking tools.
- **P243** Take precautionary measures against static discharge.
- **P260** Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
- **P264** Wash skin thoroughly after handling.
- **P271** Use only outdoors or in a well-ventilated area.
- **P273** Avoid release to the environment.
- **P280** Wear protective gloves/ protective clothing/ eye protection/ face protection.
- **P301 + P310** IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician.
- **P303 + P361 + P353** IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
- **P304 + P340 + P312** IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER or doctor/ physician if you feel unwell.
- **P308 + P313** IF exposed or concerned: Get medical advice/ attention.
- **P331** Do NOT induce vomiting.
- **P332 + P313** If skin irritation occurs: Get medical advice/ attention.
- **P362** Take off contaminated clothing and wash before reuse.
- **P370 + P378** In case of fire: Use dry sanc, dry chemical or alcohol-resistant foam to extinguish.
- **P391** Collect spillage.
- **P403 + P233** Store in a well-ventilated place. Keep container tightly closed.
- **P403 + P235** Store in a well-ventilated place. Keep cool.
- **P405** Store locked up.
- **P501** Dispose of contents/ container to an approved waste disposal plant.
### 8. EXPOSURE CONTROLS/PERSOANL PROTECTION

#### 8.1 Control parameters

#### Components with workplace control parameters

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Value</th>
<th>Control parameters</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>n-Hexane</td>
<td>110-54-3</td>
<td>TWA 50.000000 ppm</td>
<td>USA. ACGIH Threshold Limit Values (TLV)</td>
<td></td>
</tr>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td>Central Nervous System impairment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Eye irritation</td>
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<td></td>
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<td></td>
<td>Peripheral neuropathy</td>
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<tr>
<td></td>
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<td></td>
<td>Substances for which there is a Biological Exposure Index or Indices (see BEI® section)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Danger of cutaneous absorption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TWA 50.000000 ppm</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>180.000000 mg/m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TWA 500.000000 ppm</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,800.000000 mg/m³</td>
</tr>
<tr>
<td></td>
<td>The value in mg/m³ is approximate.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TWA</td>
<td>50 ppm</td>
<td>USA. ACGIH Threshold Limit Values (TLV)</td>
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<tr>
<td>Remarks</td>
<td></td>
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<td>TWA</td>
<td>50 ppm</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>180 mg/m³</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TWA</td>
<td>500 ppm</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>1,800 mg/m³</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
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</tr>
<tr>
<td></td>
<td>The value in mg/m³ is approximate.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TWA</td>
<td>50 ppm</td>
<td>USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>180 mg/m³</td>
<td>USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000</td>
<td></td>
</tr>
</tbody>
</table>
### Personal protective equipment

**Eye/face protection**
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

**Skin protection**
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

- **Full contact**
  - Material: Nitrile rubber
  - Minimum layer thickness: 0.4 mm
  - Break through time: 480 min
  - Material tested: Camatriel® (KCL 730 / Aldrich Z677442, Size M)

- **Splash contact**
  - Material: Nitrile rubber
  - Minimum layer thickness: 0.2 mm
  - Break through time: 59 min
  - Material tested: Dermatriel® P (KCL 743 / Aldrich Z677388, Size M)

Data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374

If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

**Body Protection**
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

**Respiratory protection**
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multipurpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

**Control of environmental exposure**
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.
Google Scholar
Web of Science, Scopus
SciFinder
ChemSpider
EpiSuite
Journal of Chemical Education
Professional Society Publications
Stephen Stich, Eisenhower Library
Where will the neat chemical be stored?

How will I protect myself from the neat chemical when I am preparing stock solutions?

Which operations should be performed in a hood?

How will I dispose of unused stock solution, reaction solution, filters and other supplies that have come into contact with the chemical?

How will I clean up contaminated glassware and other laboratory items?

How will I clean the lab bench and other work areas?

What steps can I take to ensure that other lab personnel, custodial staff, repair personnel, and emergency response personnel aren’t exposed to this chemical?

- importance of written protocols -
Controlling Chemical Exposures

- Is there a less toxic substitute for the chemical?
- Can it be purchased in smaller amounts or as a pre-prepared stock solution?

**Engineering Controls**
- fume hoods
- plexiglas shields
- vents
- pans & tubs in case a spill occurs.
- Containment (glove) boxes
- disposable sorptive paper
- covered weighing boats
- HEPA filtration of air

**Administrative Controls**
- Hazard signs and marking tape that designate rooms or particular working areas where hazardous chemicals are being used. Everyone working in the vicinity, whether or not they work with the chemical, needs to receive training and be aware of protocol.

**Personal Protective Equipment**
- Gloves
- Lab Coats
- Safety Glasses/Goggles/Face Shields
- Long Pants
- Face masks, respirators
- Shoes
Chemical Storage

- What does due diligence tell you about which chemicals can be stored together and which need to be segregated? Don’t be afraid to start a new kind of storage cabinet.

- Some strong acids, when mixed are even more potent. (Aqua regia, for example, is more corrosive than the nitric acid and hydrochloric acid it is made from.) Keep the components segregated.

- A purchaser name and date should be written on each bottle when it arrives. Order only what you need, and don’t keep beyond its shelf life.

- HSE places upper limits on allowable volumes of flammable solvents in each lab.

- Organic standard solutions often contain methanol or some other volatile and flammable organic solvent. Such standard solutions cannot be stored in refrigerators that are not “explosion proof.” (Most refrigerators contain lights and switches that generate sparks which can ignite vapors.)

- All chemical-containing vessels need to clearly state contents, a contact name, and a date when generated.
STANFORD COMPATIBLE STORAGE GROUP GUIDE

Effective segregation in chemical storage reduces the risk of dangerous chemical reactions. This guide must be used in conjunction with information from the manufacturer's safety data sheets and chemical-specific expert knowledge. This storage group system is intended to be used in research settings to store laboratory-scale quantities of chemicals.

What to Segregate

A. Compatible Organic Bases
B. Compatible Pyrophoric & Water-Reactive Materials*
C. Compatible Inorganic Bases
D. Compatible Organic Acids
E. Compatible Oxidizers & Peroxides (not including Strong, Oxidizing Acids)*
F. Compatible Inorganic Acids (not including Oxidizers or Combustibles)
G. Not Intrinsically Reactive, Flammable, or Combustible
H. Compatible Strong, Oxidizing Acids
I. Compatible Stable Explosives (not including Oxidizing Explosives)*
J. Flammables, Combustibles, & Organic Solvents
K. Incompatible with ALL Other Chemicals (including other chemicals within X)*

* These materials are likely to require special handling & storage conditions. Use extreme caution.

How to Segregate

USE SEPARATE SECONDARY CONTAINERS FOR EACH GROUP

SPECIAL CASE FOR GROUP X

NOTE: Different chemicals within Storage Group X must be segregated from each other.

Questions? Contact the EH&S Lab Safety Program at 723-0448
Use ChemTracker to find a chemical's Storage Group - stanford.chemtracker.org
<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Butanol or 2-butanol</td>
<td>L</td>
</tr>
<tr>
<td>1-Propanol</td>
<td>L</td>
</tr>
<tr>
<td>2-Mercaptoethanol</td>
<td>L</td>
</tr>
<tr>
<td>Acetic acid, glacial (flammable)</td>
<td>D</td>
</tr>
<tr>
<td>Acetic anhydride</td>
<td>L</td>
</tr>
<tr>
<td>Acetone</td>
<td>L</td>
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<tr>
<td>Acetonitrile</td>
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<td>Acetaldehyde</td>
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<td>Acrolein</td>
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<td>G</td>
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<td>Ammonium acetate</td>
<td>G</td>
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<tr>
<td>Ammonium chloride</td>
<td>G</td>
</tr>
<tr>
<td>Ammonium formate</td>
<td>G</td>
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<tr>
<td>Ammonium hydroxide</td>
<td>C</td>
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<tr>
<td>Ammonium nitrate</td>
<td>E</td>
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<tr>
<td>Ammonium persulfate</td>
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<tr>
<td>Benzene</td>
<td>L</td>
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<tr>
<td>BIS/Bis-acrylamide</td>
<td>G</td>
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<tr>
<td>Dextrose</td>
<td>G</td>
</tr>
<tr>
<td>Dichloromethane</td>
<td>G</td>
</tr>
<tr>
<td>Diethylenetriamine</td>
<td>A</td>
</tr>
<tr>
<td>Diethyl pyrocarbonate</td>
<td>L</td>
</tr>
<tr>
<td>Diethyl sulfoxide</td>
<td>L</td>
</tr>
<tr>
<td>Drierite</td>
<td>G</td>
</tr>
<tr>
<td>EcoLume, UniverSOL, BetaMax, CytoScint,</td>
<td>L</td>
</tr>
<tr>
<td>Scintisafe, Econo-Safe, Ecoscint, Opti-fluor</td>
<td></td>
</tr>
<tr>
<td>EDTA (in solution: G)</td>
<td>D</td>
</tr>
<tr>
<td>Ethanol</td>
<td>L</td>
</tr>
<tr>
<td>Ethanolamine</td>
<td>A</td>
</tr>
<tr>
<td>Ethers</td>
<td>L</td>
</tr>
<tr>
<td>Ethidium bromide</td>
<td>G</td>
</tr>
<tr>
<td>Ethyl acetate</td>
<td>L</td>
</tr>
<tr>
<td>Ethylene glycol</td>
<td>L</td>
</tr>
<tr>
<td>Ficol</td>
<td>G</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>L</td>
</tr>
<tr>
<td>Formamide</td>
<td>L</td>
</tr>
<tr>
<td>Formic Acid (88%)</td>
<td>D</td>
</tr>
<tr>
<td>Glutaraldehyde</td>
<td>G</td>
</tr>
<tr>
<td>Glycerol</td>
<td>L</td>
</tr>
<tr>
<td>Glycine</td>
<td>G</td>
</tr>
<tr>
<td>Guanidine hydrochloride</td>
<td>G</td>
</tr>
<tr>
<td>Guanidinium thiocyanate</td>
<td>C</td>
</tr>
<tr>
<td>Halothane, isoflurane</td>
<td>G</td>
</tr>
<tr>
<td>HEPES</td>
<td>G</td>
</tr>
<tr>
<td>Hexanes</td>
<td>L</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>F</td>
</tr>
<tr>
<td>Hydrogen peroxide, &gt; 5%</td>
<td>E</td>
</tr>
<tr>
<td>Hydrogen peroxide, &lt; 5%</td>
<td>G</td>
</tr>
<tr>
<td>Imidazole</td>
<td>A</td>
</tr>
<tr>
<td>Isobutyl alcohol</td>
<td>L</td>
</tr>
<tr>
<td>Isopentane</td>
<td>L</td>
</tr>
<tr>
<td>Isopropanol</td>
<td>L</td>
</tr>
<tr>
<td>Magnesium chloride</td>
<td>G</td>
</tr>
<tr>
<td>Magnesium sulfate</td>
<td>G</td>
</tr>
<tr>
<td>Manganese</td>
<td>G</td>
</tr>
<tr>
<td>Methanol</td>
<td>L</td>
</tr>
<tr>
<td>N-Methyl-2-pyrrolidone</td>
<td>L</td>
</tr>
<tr>
<td>N,N-Dimethylformamide</td>
<td>L</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>I</td>
</tr>
<tr>
<td>p-Dioxane</td>
<td>L</td>
</tr>
<tr>
<td>Paraformaldehyde</td>
<td>L</td>
</tr>
<tr>
<td>Perchloric acid</td>
<td>I</td>
</tr>
<tr>
<td>Periodic acid</td>
<td>I</td>
</tr>
<tr>
<td>Permount</td>
<td>L</td>
</tr>
<tr>
<td>Phenol (solid)</td>
<td>G</td>
</tr>
<tr>
<td>Phenol (liquid, ≤ 89% phenol)</td>
<td>L</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>F</td>
</tr>
<tr>
<td>Picric acid (any concentration)</td>
<td>X</td>
</tr>
<tr>
<td>Piperidine</td>
<td>A</td>
</tr>
<tr>
<td>PIPES, free acid</td>
<td>G</td>
</tr>
<tr>
<td>Potassium acetate</td>
<td>G</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>G</td>
</tr>
<tr>
<td>Potassium cyanide</td>
<td>C</td>
</tr>
<tr>
<td>Potassium hydroxide (KOH)</td>
<td>C</td>
</tr>
<tr>
<td>Potassium phosphate (K₃PO₄)</td>
<td>G</td>
</tr>
<tr>
<td>Propionic acid</td>
<td>D</td>
</tr>
<tr>
<td>Propylene oxide</td>
<td>L</td>
</tr>
<tr>
<td>Pump oil</td>
<td>L</td>
</tr>
<tr>
<td>Pyridine</td>
<td>A</td>
</tr>
<tr>
<td>SDS (Sodium dodecyl sulfate) (in solution: G)</td>
<td>L</td>
</tr>
<tr>
<td>SigmaCote</td>
<td>L</td>
</tr>
<tr>
<td>Sodium acetate</td>
<td>G</td>
</tr>
<tr>
<td>Sodium azide (in solution: G)</td>
<td>X</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>G</td>
</tr>
<tr>
<td>Sodium bisulfate</td>
<td>G</td>
</tr>
<tr>
<td>Sodium bisulfite</td>
<td>G</td>
</tr>
<tr>
<td>Sodium borate</td>
<td>G</td>
</tr>
<tr>
<td>Sodium borohydride</td>
<td>B</td>
</tr>
<tr>
<td>Sodium carbonate</td>
<td>G</td>
</tr>
<tr>
<td>Sodium chlorate</td>
<td>E</td>
</tr>
<tr>
<td>Sodium chloride (NaCl)</td>
<td>G</td>
</tr>
<tr>
<td>Sodium citrate dihydrate</td>
<td>G</td>
</tr>
<tr>
<td>Sodium dichromate hydrate</td>
<td>E</td>
</tr>
<tr>
<td>Sodium hydroxide (NaOH)</td>
<td>C</td>
</tr>
<tr>
<td>Sodium hypochlorite</td>
<td>E</td>
</tr>
<tr>
<td>Sodium hypochlorite solution (i.e. bleach)</td>
<td>E</td>
</tr>
<tr>
<td>Sodium phosphate</td>
<td>G</td>
</tr>
<tr>
<td>Sodium sulfide, anhydrous</td>
<td>B</td>
</tr>
<tr>
<td>Succinic acid</td>
<td>D</td>
</tr>
<tr>
<td>Sucrose</td>
<td>G</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>I</td>
</tr>
<tr>
<td>Tannic acid</td>
<td>D</td>
</tr>
<tr>
<td>TEMED</td>
<td>A</td>
</tr>
<tr>
<td>TES free acid</td>
<td>G</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>G</td>
</tr>
<tr>
<td>Tetrahydrofuran</td>
<td>L</td>
</tr>
<tr>
<td>Trichloroacetic acid</td>
<td>D</td>
</tr>
<tr>
<td>Trifluoroacetic acid</td>
<td>D</td>
</tr>
<tr>
<td>Toluene</td>
<td>L</td>
</tr>
<tr>
<td>Triethanolamine</td>
<td>A</td>
</tr>
<tr>
<td>TRIS</td>
<td>A</td>
</tr>
<tr>
<td>Triton X-100</td>
<td>G</td>
</tr>
<tr>
<td>Trizol</td>
<td>L</td>
</tr>
<tr>
<td>TWEEN 20</td>
<td>G</td>
</tr>
<tr>
<td>Urea</td>
<td>G</td>
</tr>
<tr>
<td>WD-40</td>
<td>L</td>
</tr>
<tr>
<td>Xylenes</td>
<td>L</td>
</tr>
<tr>
<td>Zinc chloride</td>
<td>G</td>
</tr>
</tbody>
</table>
Once a year . . . . . Each PI is charged with inspecting each stored chemical in their laboratory. If any chemical has deteriorated or is no longer useful, it should be properly disposed of.
Mouth and Lungs

Although you might not be working with highly toxic or carcinogenic compounds, others in the laboratory are. Since labware, tabletops, and floors are potentially contaminated, everyone must follow these rules:

- **Absolutely no eating, drinking or smoking** is allowed in the lab. No “ChapStick” or gum either, since they involve hand-to-mouth contact.

- **Absolutely no pipetting by mouth**. Use rubber bulbs for pipetting.

- **Absolutely no food or drink** in laboratories, or laboratory refrigerators. Anything you touch will reach your eyes, nose, and mouth if you do not wash your Hands. Frequent replacement of gloves and washing of hands before leaving the lab Can minimize contamination.

It may be necessary to fold back loose clothes or tie in long hair to prevent contact with contaminated surfaces and gloves.

Face masks have a limited ability to remove aerosols and gases. They’re most Helpful in preventing you from touching your mouth and nose when working with hazardous substances.

Minimize exposure to odors and vapors. Handle volatile toxic compounds in hoods. Use sealable containers to minimize evaporative release. Beware! Many compounds (e.g. \(\text{H}_2\text{S}\)) exhibit toxic effects at concentrations below their odor threshold level.
We try to minimize exposure to concentrated toxic substances.

When weighing powders:

“Weighing bottles” have lids that prevent powders from blowing around. They also make it possible to weigh powders inside a hood.

When pouring liquids:

A glass rod can be used to minimize splash.

Consider lower concentration and lower volume stock solutions.

Analytical Balances

Complete log entries are mandatory.

Clean the balance and balance area after every use.
Clothing

- Wear a lab coat.
- Cover legs (no shorts or skirts).
- Cover feet (no sandals or open toe or heel shoes).
- Nylons/pantyhose are not recommended. They melt upon contact with acid.

Clothes provide an additional barrier between your skin and toxic chemicals. Don’t wear your lab coat outside of the lab. This might spread toxic chemicals around.

If you spill chemicals on you clothes, don’t be shy! **Remove the contaminated clothing and wash thoroughly with soap and water.** Keep a spare set of clothes handy.

Leather shoes provide a complete barrier to spilled liquids and broken glass.

Be especially careful with chemicals (such as phenol) which have a numbing effect on skin.

Strong acids and strong bases readily soak through canvas shoes (e.g. sneakers.)
Hands and Skin  
Many compounds are readily absorbed through the skin. (Check the Merck Index for details.)

When a toxic compound gets on your hand, anything you touch will become contaminated. Lab equipment, cellphone, clothes, nose, eyes . . . .

Gloves help us manage skin exposure. Replace gloves frequently!

- Frequent glove replacement lessens the risk of exposure from a tear or puncture.
- Frequent glove replacement minimizes the spread of contamination throughout the lab.
- To avoid contaminating the entire building, remove gloves and wash hands thoroughly with soap and water before leaving the lab.
- Remove gloves before talking on your cellphone or opening doors.
Labels

__ Chemical Names, Concentrations
__ Date generated
__ Your name

Intended Audience:
Emergency Response Personnel
Physical Hazards

What are the risks?

Burns
Bruises
Cuts
Hearing Impairment
Eye Injury
Loss of Sight
Debilitating Injury
Death

Heavy Equipment
Compressed gases
Nonflammable cryogens
Explosions
High pressure reactions
Radiation, Radionuclides
Electrical Hazards
Centrifuges
Large pumps
Loud Noise
Whatever **common sense** you have was built on a mountain of experience. Family members and friends helped you accumulate this experience.

In the lab, you’ll need common sense for every instrument that you use.

*Common Sense*  
*Due Diligence*  
*Inquisitiveness*  
*Mindfulness*
Avoiding Cuts and Punctures

Inserting a glass tube, rod, or thermometer through a rubber stopper or o-ring is a frequent cause of serious wounds in laboratories. Pointers:
- Glass is tricky material. Seemingly resistant to considerable force, then breaking into sharp shards.
- Think carefully about how the forces is being applied, how the glass might break, and where broken glass might go.
- Find someone that has experience with glass to help you.

The glass and rubber can be first lubricated with soapy water. Pulling on a piece of glass is better than pushing it. Glass tubing can be slowing rotated as it goes into the rubber, which lessens the force being applied.

**Disposing of broken glass and other “sharp” trash:**

Ordinary broken glass should be placed in a small cardboard box, which is then sealed with tape. The box then is placed in a biohazard box along with other lab waste. Be sure not to exceed the weight limit on the biohazard box.

Needles, syringes, razor blades, pasteur pipettes, small glass tubes, capillary tubes, and other items that pose an acute puncture hazard should be placed in “sharps” containers that can be purchased in Mudd Hall. Once sealed, sharps containers go into biohazard boxes for disposal.

Occasionally someone tries to “compact” the trash within a biohazard box. If there is an unprotected “sharp” in the box, that person will suffer a cut or puncture.
**Eyes**
- Acutely vulnerable to flying projectiles!
- Possible route of entry for toxic gases, dusts, and splashed liquids.

*Safety glasses are required at all times in the laboratory.*
Why? As a safeguard against low probability but high risk events.

- **“minimum” safety glasses**
- Use when splash protection is required

*Contact lenses require full splash protection.*
(Splashed toxics can get behind the lens, making it difficult to rise out, thereby increasing exposure.)

---

**- Hazards -**

Splash of even a small amount of hazardous chemical can results in permanently impaired vision.

Pressurized equipment (gas cylinders, autoclaves, heaters) and operating machinery are potential sources of flying projectiles.

Splash protection goggles are required when working with solutions that can cause rapid and irreversible damage to the eyes, including:
- All strong bases, e.g. $> 10^{-4}$ M NaOH, NH$_3$
- All strong acids, e.g. $> 10^{-3}$ M H$_2$SO$_4$, HCl, HF, HNO$_3$

*If you get any chemical in your eye, continuously flush with lots of water for 5 minutes or more. Then seek help!*
# Selection Chart for Eye and Face Protection

The following chart provides general guidance for the proper selection of eye and face protection for hazards associated with the listed hazard "source" operations.

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>TYPE OF HAZARD</th>
<th>PROTECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT – Chipping, grinding, machining, masonry work, woodworking, sawing, drilling, chiseling, powered fastening, riveting, and sanding.</td>
<td>Flying fragments, objects, large chips, particles, sand, dirt, etc.</td>
<td>Spectacles with side protection, goggles, face shields. For severe exposure use face shield over primary eye protection. See notes (1), (3), (5), (6), (10).</td>
</tr>
<tr>
<td>HEAT – Furnace operations, pouring, casting, hot dipping, and welding.</td>
<td>Hot sparks</td>
<td>Face shields, goggles, spectacles with side protection. For severe exposure use a face shield. See notes (1), (2), (3).</td>
</tr>
<tr>
<td></td>
<td>Splash from molten metals</td>
<td>Face shields worn over goggles. See notes (1), (2), (3).</td>
</tr>
<tr>
<td></td>
<td>High temperature exposure</td>
<td>Screen face shields, reflective face shields. See notes (1), (2), (3).</td>
</tr>
<tr>
<td>CHEMICALS – Acid and chemical handling, use of cleaning products, paint use and clean-up products, pesticide and herbicide use.</td>
<td>Splash</td>
<td>Chemical splash goggles, eyecup and cover types. For severe exposure, use face shield. See notes (3), (11).</td>
</tr>
<tr>
<td></td>
<td>Irritating mists</td>
<td>Special-purpose goggles.</td>
</tr>
<tr>
<td>DUST – Woodworking, buffing, general dusty conditions.</td>
<td>Nuisance dust</td>
<td>Goggles or spectacles with side protection. See note (8).</td>
</tr>
<tr>
<td>WELDING: Gas</td>
<td>Optical radiation</td>
<td>Welding goggles or welding face shield. Typical shades: gas welding 4-8, cutting 3-6, brazing 3-4. See note (9).</td>
</tr>
<tr>
<td>WELDING: Torch brazing, Torch soldering.</td>
<td>Optical radiation</td>
<td>Spectacles or welding face shield. Typical shades: 1-5. See notes (3), (9).</td>
</tr>
<tr>
<td>GLARE</td>
<td>Poor vision</td>
<td>Spectacles or welding face shield. Spectacles with shaded or special-purpose lenses, as suitable. See notes (9), (10).</td>
</tr>
</tbody>
</table>

# Notes to Eye and Face Protection Selection Chart

1. Care should be taken to recognize the possibility of multiple and simultaneous exposure to a variety of hazards. Adequate protection against the highest level of each of the hazards should be provided. Protective devices do not provide unlimited protection.

2. Operations involving heat may also involve light radiation. When necessary, protection from other hazards must be provided.

3. Face shields should only be worn over primary eye protection (spectacles or goggles).

4. Filter lenses must meet the requirements for shade designations as outlined in the OSHA regulations and ANSI standards. Tinted and shaded lenses are not filter lenses unless they are marked or identified as such.

5. As required by the standard, persons whose vision requires the use of prescription lenses must wear either protective devices fitted with prescription lenses or protective devices designed to be worn over regular prescription eyewear.

6. Wearers of contact lenses must also wear appropriate eye and face protection devices in a hazardous environment. It should be recognized that dusty and/or chemical environments may represent an additional hazard to contact lens wearers.

7. Caution should be exercised in the use of metal frame protective devices in electrical hazard areas.

8. Atmospheric conditions and the restricted ventilation of the protector can cause lenses to fog. Frequent cleaning may be necessary.

9. Welding helmets or face shields should be used only over primary eye protection (spectacles or goggles).

10. Non-shielded spectacles are available for frontal protection only, but are not acceptable eye protection for the sources and operations listed for "impact".

11. Must provide adequate ventilation (indirect ventilation holes) and also protect the wearer from splash entry. Eye and face protection should be designed and used so that it provides both adequate ventilation (indirect ventilation holes) and protects the wearer from splash entry.

12. Protection from light radiation is directly related to filter lens density. See note (4). Select the darkest shade that allows the task to be performed.
Before generating a spark or flame:
- Make sure that there are no flammable solvents in the same room (or on the same cabinet top)
- Make sure that paper, wood, or other items that might catch on fire are a safe distance away.
- Tie up hair and bind clothing so that they don’t come close to flames.
- Some instrumentation involves mixing a fuel and an oxidant (e.g. flame atomic absorption spectrophotometry). Make sure gas pressures and flow are within targeted ranges.

Before using organic solvents:
- Many electrical devices generate sparks. (Conventional refrigerators, freezers, and dehumidifiers; thermostatted baths; stir plates)

Hot plates, ovens, and other heat sources:
- Stay clear of chemicals, materials, and solvents that might ignite.
- Heating increases volatility. (Both an explosion hazard and an exposure hazard).
Pressure Hazards

- Compressed gases
- Liquid Nitrogen
- Dry Ice
- Vacuum Systems
- Ovens
- Pumps
- Chemical Reactions
- Heating/cooling sealed vessels
- Capped waste collection bottles

The larger the vessel, the greater the hazard.

\[
\text{force} = (\text{pressure}) \times (\text{area})
\]

<table>
<thead>
<tr>
<th>Surface Area</th>
<th>Force at 2.0 atm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test tube</td>
<td>43 cm(^2)</td>
</tr>
<tr>
<td>1 Liter flask</td>
<td>484 cm(^2)</td>
</tr>
<tr>
<td>10 Liter flask</td>
<td>2450 cm(^2)</td>
</tr>
</tbody>
</table>

- Special glassware can be purchased that can handle slight vacuum (e.g. filter flasks) or slight pressure. Don’t use regular glassware for pressure or vacuum applications, and don’t use any glassware that is chipped or cracked.

- Implosion hazards from a vacuum can be just as damaging as explosion hazards.

- If you are using a vacuum filtration apparatus or vacuum desiccator, place behind shield boxes.

- Chemical reactions within sealed vessels can easily generate enough pressure to drive explosions.
Compressed Gas Cylinders

- Compressed gases are high energy sources and should be treated as potential explosives.
- Cylinders must be secured at all times.
- Never use a cylinder that cannot be identified properly.
- Know the attributes and special safety considerations of the gas that you are using.

**Flammable gases** (e.g. acetylene, ammonia, ethylene)

**Corrosive gases** (e.g. ammonia, chlorine, sulfur dioxide)

**Oxidizers** (e.g. oxygen, nitrous oxide)

**Explosives** (e.g. hydrogen)

**Simple asphyxiants** (nitrogen, helium, argon, carbon dioxide)

Acetylene is dissolved in a solvent and then compressed. *It is important not to let tank pressure drop too low!*

Oxygen must be stored away from flammable gases and chemicals. Fittings must be grease- and oil-free.
- Never discharge gas from a tank without using a regulator.
- The regulator and associated gas lines must be depressurized before removing a regulator.
- Use the regulator that is appropriate for the gas and the cylinder being used. (Know the right CGA fitting.) Under no circumstances should you replace one fitting with another or attempt a repair to a cylinder, valve, or regulator. Instead, contact Huan Luong and the gas supplier.
- Get training regarding the proper procedure for attaching regulators, turning on gas flow, and turning off gas flow.
- Use a correctly sized open end wrench or adjustable wrench to tighten fittings; never use a channel lock or pliers.
- Do not apply grease or oil to fittings. Do not use teflon tape on the high pressure side of a regulator.
- Be aware of the consequences of pressurizing apparatus and instrumentation.
- Always use safety glasses (preferably with a face shield) when handling and using compressed gases, especially when connecting and disconnecting compressed gas regulators and lines.

- Regulators must be removed and safety caps secured before moving a cylinder. A cart specifically designed for moving gas cylinders must be used. (The cart must have a chain for securing the cylinder.)

- Do not store cylinders near sources of heat (including instrumentation and computers) or in high traffic areas.
**Liquid Nitrogen:** boiling point of -195.8°C  (77.355 Kelvin)

Volume of expansion liquid to gas (at 15°C, 1 atm.) = 682.1

Liquid nitrogen and other cryogenic liquids must be stored, shipped, and handled only in containers designed for this purpose.

Splash-protecting goggles are required. Arm, leg, and foot protection is essential for limiting the possibility of frostbite. Insulating gloves or leather gloves should be used, but be careful. Gloves, pant cuffs, belts, etc. can "cup" liquid nitrogen, increasing damage.

Liquid nitrogen picks up water from air. Funnels may freeze and splash liquid nitrogen upward.

Materials can become embrittled by low temperatures and break.

Liquid nitrogen condenses oxygen from the air. Oxygen accumulated in a leaky container may evaporate later, leading to explosion.

Heat slowly reaches liquid nitrogen in a dewar. Gas generated in this way must be able to exit, or pressure will accumulate.

Simple asphyxiants such as nitrogen do not give much warning! You might feel light-headed, or simply pass out. If you don't receive enough oxygen while you are unconscious, you will die.)
Several instruments are potentially quite dangerous.

- Instruction manuals must be read and fully understood. Instruction manuals should never leave the lab. (Most are now available online.)

- With most instruments, your first use will be supervised by a contact person from the “Czar List”. When the contact person believes you are ready to independently use the instrument, you will be placed on the “approved users” list.

There is a log book for most departmental instruments. Each time an instrument is used, a full log entry in the log book is required. Each log entry should include:

- Your full first and last name. The date and duration of use.
- Specifics of your use. Which lamp? How long was it used? If consumables were used, how many, how much? (e.g. acetylene, argon)
- A brief description of instrument performance is required.
- If something was broken or not working right, you must inform the two contacts. Your log entry should contain as many specifics as possible, to help them make repairs.
- Was preventative maintenance performed? This needs to be logged.

- our goal is for all instruments to be in good working order at all times -
Items designed to wear out, degrade, get spent:

<table>
<thead>
<tr>
<th>Tires</th>
<th>Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brake Pads</td>
<td>Oil Filters</td>
</tr>
<tr>
<td>Belts</td>
<td>Lubes</td>
</tr>
<tr>
<td>Air Filters</td>
<td>Radiator Fluid</td>
</tr>
</tbody>
</table>
HPLC

Solvent Inlet Filter
Pump
Inline Solvent Filter
Pre-column Filter
Column
Injection Valve
Detector
Backpressure Regulator
Waste Reservoir

Plunger
Plunger seal
Check Valve
Inlet Valve

Cam
Piston

Check valve assy.
Sapphire ball
Sapphire ring (seat)
- Use trays to keep together related items.
- Do you know how to re-assemble without stripping threads?
- Do not "cannibalize" one instrument to repair another.

**Our goal is to maintain all instrumentation in good working order.**
- Precisely follow instructions in the manual.
- Use small trays to keep track of screws, other small parts.
- Bring in technical support. (Make sure their work space is safe.)
What risks does it pose? What control measures need to be in place?

What might fail? What backup allows us to deal safely with failure?

What procedures need to be in place to ensure safe operation? How should users be trained and certified?

What needs to be inspected? What preventative maintenance is needed? How frequently? How logged and reported?

How do we control access? Is a “lockout mechanism” necessary?
Centrifuges

Strict adherence to operating manuals and written procedures is crucial!

- What is the rpm limit for the rotor?
- Which centrifuge tubes can be used?
- Stated maximum fluid volumes in each tube must not be exceeded.
- Tubes need to be “matched” (by position and weight.)
- Rotors need to be cleaned after every use (remove spilled fluids and condensate; rinse and dry.)
- Rotors that are etched, scratched, or corroded may fail at high speeds. (Propagation of cracks.)
- It is imperative that all uses be appropriately logged.

Strict training protocols.

“Approved user” lists.

“Lockout” hardware.
Can an experiment run unattended?

- If possible, find someone to cover for you. (Every experiment should be periodically checked.)

- Appropriate signs on the apparatus and on the door to the lab are essential. State the nature of the experiment and identify hazardous substances in use.

- The setup should not pose a hazard in the event of interruptions in utility services such as electricity, cooling water, and inert gas.

- *Anticipate and prevent situations where water and electricity (or water-reactive chemicals) come into contact.*

Unattended experiments involving running water have caused flooding damage in departmental laboratories.
Please! No “jerry-rigging” of equipment involving:

- pressure or vacuum
- force
- flame
- flammables
- toxic substances
- radionuclides
- UV or X-ray radiation. (Or high-flux visible sources.)

**masking tape used to construct a support structure for heavy piece of equipment**
Organic Solvents

- Most are volatile. Keep in sealed containers and handle under ventilation.

- Most are flammable. The vapor, not the liquid, ignites first. Raising the temperature of a flammable liquid raises the vapor pressure, increasing risks.

- Many solvents are absorbed through the skin. Some, like DMSO, can facilitate passage of other toxic compounds through the skin.

- Do not dispose of organic solvents in sinks or drains.

- Store all flammable liquids away from possible reactants. Strong oxidizing agents in particular need to be kept away, i.e. permanganate or chlorates.

- Keep flammable liquids away from sources of sparks. These include stir plates, motors, and most refrigerators. (Thermostats contain an open electrical contact.)
Electrical Hazards

- Know the location of circuit breakers and how to turn off electrical service in case of accident.

- Never use electrical wires as supports or pull on live wires.

- **Water and electricity don’t mix!** Make sure electrical wires and contacts are protected from sources of splash and puddles.

- Only use extension cords that have amps ratings significantly higher than what’s plugged in.

- Do not connect together two+ extension cords.

- Extension cords should not be in the way, and should not lie on the floor (where they might be exposed to ponded water.)

In support of safety considerations, funds are available to bring in new circuits.
**Current issues:**

1. What level of training is appropriate for undergraduate students? Grad students? Postdocs?
2. What aspects of training get incorporated into daily activities? What gets lost or ignored? (How do we know?)
3. What evidence do we have that students have thought about the consequences of each activity they set out to perform?
4. What oversight is necessary for a beginning undergraduate, graduate student, or postdoc?
   - Should all students start out working with a mentor, and does that mentor need to be in the lab with them?
   - When can a person work unsupervised Monday through Friday, 9 to 5?
   - When can a person work completely alone? Does someone have to be on the same floor, or in the same building?
   - Are there activities where someone else must be present? What risks require special scrutiny?
5. What checks on performance should be in place? - PI walk-throughs.
   - PI familiarization with standard operating procedures documents.
6. If someone arrives in the lab with prior experience, how do we evaluate what they do/do not know?
7. How do we deal with “guests”, e.g. people from a collaborator’s group?

**New Initiatives:**

- A “safety captain” for each faculty member’s research group.
- Software for tracking purchase, use, storage, disposal of chemicals.
- “Umbrella licenses” for chemical hazard classes, for lasers and other physical hazards.
In terms of specifics, here’s what we’re asking:

1. Safety glasses are required at all times in departmental labs.

2. Appropriate clothing is required at all times.
   (Legs fully covered. Shoes, not sandals. No open toes or heels.)

3. Mindfulness.
   - Think ahead and consider the consequences of what you are about to do.
   - Don’t set traps for other people who share the laboratory space.
     (This includes custodial staff, repair personnel, fire fighters)
   - Don’t allow yourself to be distracted or to be in the lab when you’re tired or emotionally upset.

4. Maintain records.
   - Log books for instrumentation.
   - Written protocols for potentially hazardous operations, chemicals, and organisms.
   - Written reporting of all incidents and accidents, no matter how minor.

5. Openness.
   - Communicating “early and often” with others in the lab, your supervisor, and the faculty member in charge.

   If something doesn’t look right, feel right, smell right then act on it.
   (discuss with others, pursue resolution)
EHE Safety Training, Part II

Sept 17, 2019
EHE Homewood Lab website

+ [https://ehelabs.wse.jhu.edu/](https://ehelabs.wse.jhu.edu/)

+ Notes from lectures will be available on the website
Who to call in case of an accident

+ In case of a life threatening emergency on campus, call campus security
  + 410-516-7777 or 911

+ In case of a non-life threatening accident on campus, call campus security
  + 410-516-4600

+ This has the dual benefit of getting you the proper medical help and starting the incident reporting process
Best Practices in EHE

- Required Safety Protection
  - Safety glasses
  - Sturdy, closed-toed shoes
  - Long pants

- Lab Coat—Recommended

- Gloves—Use to limit contact with chemicals and minimize transfer of chemicals

- Consequences
  - Time out of the lab
  - Case by case for repeat offenders
Biosafety in EHE
What are the goals of Biosafety?

• Prevent illness by accidental exposure to potentially pathogenic organisms

• Ensure proper containment of known pathogens or recombinant organisms
What are biological hazards?

- Biohazards are hazards posed by living organisms, their constituents or their products
- Examples
  - *E. coli*
  - DNA
  - Biologically produced toxins
What are the risks?

**Biological Hazards**

- Cultured Pathogens
- Sewage treatment plant samples
- Recombinant Organisms
- Opportunistic Pathogens
- Concentrated Environmental Samples

**Diarrhea**

- Dysentery
- Cancer
- Pulmonary infection
- Sepsis
- Liver damage
- Death
What likely situations in EHE are considered a biosafety hazard?

- People work with potentially harmful organisms or samples
  - BSL-2 agents like *Pseudomonas aeruginosa* and recombinant organisms
  - sewage samples
  - concentrated environmental samples
What are biological hazards?

• **Principle concern**: laboratory-acquired infections

• Many microorganisms cause infection particularly if victim is immunocompromised or exposed via direct blood exposure (needlestick)

• The most important factors determining biohazard:
  – Pathogenicity of the agent
  – Mode of transmission
What are biological hazards?

• Risk is associated with amount of material
  – BSL-2 level organism might require BSL-3 containment if creating large batches

• Additional risk associated with certain laboratory procedures
  – Generating aerosols
  – Use of needles
Before starting work with biohazards, register with Biosafety office

• Register any organisms or material with the Biosafety Office including:
  – Recombinant or synthetic nucleic acid molecules
  – Infectious agents/pathogens
  – Biological toxins
  – Human tissues

• Biosafety Office, Johns Hopkins Medicine
  2024 E. Monument Street, Suite B-200
  Office 410.955.5918
  Fax 410.955.5929
Biosafety level 1

• Work with well-characterized organisms not known to cause disease in adults and present minimal hazards to laboratory workers

• Work can be conducted on bench-tops with standard microbiological practices

http://2014.igem.org/Safety_Hub
Standard Microbiological Practices

• Hand-washing before leaving the lab
• Eating, drinking, smoking, applying cosmetics and storing food prohibited in lab
• Mouth pipetting prohibited
• Proper handling of sharps to reduce risk of sharps injuries
  – Never recap needles
  – Never directly handle broken glass
• Reduce the creation of aerosols
Biosafety level 2

- All of the requirements for BSL-1, plus the additional precautions
- Control access to the lab while working with BSL-2 organisms (i.e. no open doors)

http://2014.igem.org/Safety_Hub
Biosafety level 2

- All lab procedures creating an aerosol or splashes are conducted in a biological safety cabinet (BSC)
- Wear goggles, mask, splatter guard or splash shield when working with BSL-2 organisms outside of BSCs

http://2014.igem.org/Safety_Hub
Be familiar with the different types of hoods

• Chemical fume hood
  – To protect you from the sample
  – Air flow into the hood and out to the roof

• Clean air hood
  – To protect your sample from you
  – Air flow out of the workspace

• Biological safety cabinet
  – To protect both you and your sample
  – Air flow into hood but filtered air on sample
Biological hazards

Figure 8.6 illustrates the airflow pattern inside a Class II Type A2 biological safety cabinet. Outside (laboratory) air is first drawn into the cabinet and down into a plenum through a set of grilles located at the very front of the hood; this prevents outside air from mixing directly with the air inside the cabinet. It also prevents air from inside the BSC from escaping through the front of the cabinet, providing personnel protection to the user and any other laboratory occupants.

The ingested air passes through a plenum at the back of the cabinet (or sometimes at the sides) to be blown down through a HEPA (high-efficiency particulate air) or ULPA (ultra-low penetration air) filter gently across the work surface. The flow through the cabinet down to the work surface is non-turbulent—the air moves in separate layers (lamina), so the flow is called laminar flow. The laminar flow helps prevent entrainment of particulate material from inside the cabinet, which might re-deposit on research samples or accidentally escape the cabinet. This provides product protection to the research materials.

Figure 8.6: Class II Type A2 biosafety cabinet airflow detail.

[Diagram showing airflow through the cabinet with labels for front and side views, indicating room air, potentially contaminated air, HEPA-filtered air, and other components of the airflow system.]
Decontamination of waste

• Containment is another principle concern
• All material contaminated with cultures of bacteria, fungi, viruses, protozoa, insects, fluids or tissues containing microorganisms or insects must be decontaminated:
  – Autoclaving for up to one hour in a approved orange, polypropylene autoclave bag; Place in red lined biohazard bag after autoclaving
  – Decontamination with 10% bleach (final) for 1 hour
How to Clean Up Spills

1. Wear gloves and eye/face protection

2. Wipe up the spill with disposable towel and discard in orange autoclave bag

3. Pour bleach/water solution or other approved disinfectant over the spill area and let sit for 10 minutes

4. Wipe up the spill with disposable towels and discard towels and gloves in red bag

Click the small right arrow below to continue.
Autoclave Safety

September 17, 2019
Autoclave Use

- Used to sterilize growth media, reagents, and laboratory apparatus
- Used prior to disposal of microbial cultures for control of biohazards
- Works with building steam
- 15-30 psi pressure
- 120-135 °C
**Autoclaves**: Used to sterilize growth media, reagents, and laboratory apparatus.

- **High pressure**: 15-30 psi
- **High temperature**: 120-135°C

Proper maintenance and housekeeping are crucial - there are many fluid lines that can clog.

Not all materials are autoclave compatible!
Guidelines for Autoclave Use

- Be careful about high heat and pressure
  - Do not attempt to open the door while the system is pressurized
  - Stand back from the door when it opens at the end of a run
  - Many surfaces in the unit are hot
  - Wear protective gloves and avoid contact

- Clean the unit after use, especially if there is broken glass or other solid materials which may block the drainpipes

- Never leave EHE/Ames Hall with the autoclave in operation

- Contact Tugba Yildiz (Ames 313, x66028; tugbayildiz@jhu.edu) for specific questions and instructions about the autoclave operation
Radiation Safety

September 17, 2019
Radiation Safety

- We have a formal and organized program to deal with radioactive materials
- The university follows Maryland and Federal regulations
- Our goal is to insure that the exposure of individuals to radiation is kept as low as possible (and certainly within regulations)
- The ultimate responsibility for radiation safety lies with each one of us!
Contact Information

- **JHU Radiation Safety Officers**
  - Stan Wadsworth (HSE), 410-955-3710
  - Mina Razavi (Macaulay Hall), x67278

- **Licensee**
  - Ed Bouwer (Ames 307), x67437; bouwer@jhu.edu

- **Department Assistant**
  - Tugba Yildiz (Ames 313), x66028 tugbayildiz@jhu.edu
Responsibilities

- **Radiation Safety Officers**
  - Enforce the rules, provide training, and accept radioactive waste

- **Licensee**
  - Comply with rules 24/7, provide training and supervision to workers, and maintain proper records

- **Individual**
  - Safe handling of radioactive materials so that the cumulative annual dose is kept below 100 millirem.
  - Follow good laboratory practice
General Guidelines

- Read the JHU Radiation Safety Manual
  - Contains procedures, suggestions for handling radionuclides, and methods to calculate and limit exposures
- Attend JHU Radiation Safety Training session
- Become familiar with the characteristics and hazards of the radionuclide being used
  - Alpha, beta, or gamma emitter
  - Decay half-life
  - Radiation energy
  - Biological half-life
  - Shielding/protection options
Good Housekeeping

- Weekly the labs are “wipe-tested” to spot check for radioactive sources and spills.
  - See map and printed sheet for locations
- Use survey meter to check for radioactive contamination (if applicable)
- Signs and radioactive tape are used to clearly mark where radioactive materials are used
- All spills of radioactive material must be immediately contained and proper decontamination carried out
- Report all spills to Radiation Safety
- Keep accurate records of receipt, transfer, and disposal of radioactive materials
- Follow the printed document on “Radioactive Waste Disposal Procedures”
Weekly Radiation Wipe Test

Note: Ames 409 will be wipe tested biweekly. All other locations will be wipe tested weekly only when they are actively being used for radioactive research and immediately thereafter.
FIELD SAFETY IS CHALLENGING

Compared to the lab,

- Hazards aren’t labeled
- More difficult to raise the alarm
- Help is further away

Every situation is different!
“There’s no official policy/guidance document at this time. A guidance document is forthcoming (still true as of Sept 2019).

If policy is produced, it will likely state that a written plan must be generated by the responsible faculty/department member and that all participants must sign off as having reviewed and understood the risks of doing field work.

In the absence of an official guidance, each department must produce their own specific safety plans based on the location and situation risks expected.

Every field research trip should have a specific safety plan [along the lines of the UC Berkeley one]. The plan should be filed with your department hierarchy so they are aware.”
SAFETY IN THE FIELD IS EVERYONE’S BUSINESS

Faculty are responsible for safety of field research and field trips

...but faculty are not always there.

Research fieldwork trips should have a lead person who will be present on the trip, and is responsible for ensuring the safety plan is filed and followed.

Faculty should be discussing risks and expectations with students before they begin fieldwork, and when there is a change in the nature of the fieldwork.

These discussions should be codified in the field safety plan, and signed off on by all participants.
THE BASIC APPROACH - RAMP

1. Recognize hazards – everyone participating needs to know what they are getting into, and are prepared. We are all responsible for identifying hazards and communicating them.

2. Assess hazards – take time to assess risks to yourself and others, and communicate to all

3. Mitigate hazards – take steps to reduce risks, including bringing appropriate equipment and clothing

4. Prepare for emergencies – make a plan for dealing with emergencies, and make sure everyone knows it

5. If/when incidents occur: react, report, record, and re-assess
1. RECOGNIZING HAZARDS & PARTICIPANT EXPECTATIONS

Everyone must know what they are getting into – risks, expectations, physical demands, appropriate clothing and equipment, emergency procedures

- Everything in the safety plan!

Everyone is expected to abide by JHU policy on ethical and responsible research, and sexual harassment policies

Undergrads must abide by the university alcohol policy while on field trips

Work in teams or pairs wherever possible

No working alone in the field unless the risks of doing so have been carefully considered and appropriate emergency measures are in place (e.g. frequent scheduled check-in times, etc.)

Individuals should make others aware of any special circumstances that carry risks (e.g. allergies), and bring medical insurance card with them

Individuals should sign liability waivers (still getting info on this)
2. ASSESSING HAZARDS AND CAPABILITIES

Anticipate risks to yourself and others. Communicate risks and expectations.

Be aware of who has first-aid training, and bring an appropriate first-aid kit.

Trips far from prompt EMT response areas should include someone trained in first aid, equipped with a first aid kit.

“Culture of safety” As you depart, take a moment to talk as a group about hazards and safety.

• E.g. everyone in the group state one hazard, and one thing they are going to do to mitigate it.
3. MITIGATING HAZARDS: COMMON EXAMPLES

Weather
- Heatstroke, hypothermia, dehydration, flooding, lightning
- Look at the weather for today. Ask if everyone have clothing that protects them from the sun / cold? Does everyone have enough water? Talk ahead of time about what you’ll do if conditions change.

Terrain
- Does everyone have appropriate footwear? Is the terrain steep? Is it likely to be slippery? Can we choose an access route that avoids dangerous ground?

Flora and fauna
- Does everyone know what poison ivy looks like? What other hazards are there? Does everyone know to check themselves for ticks?

Tools and equipment
- Does any of the equipment require training for safe operation? Can this been conducted in a safe location prior to the field trip? Is the equipment safe and secure while it is being used?

Legal / community relationship
- Has permission from the landowner / administrator been obtained? Do they know you are coming?
3. MITIGATING HAZARDS: OTHER PEOPLE

If you do not feel safe with another person, (regardless of whether they are a student, faculty, staff, or someone you encounter in the field) it is always OK to remove yourself, rather than continuing the work.

- No data is worth jeopardizing your personal safety
- Leave the area, make someone aware
3. MITIGATING HAZARDS – DRIVING

JHU vehicles can only be driven by people with JHU Transportation training

Don’t drive more than 10 hours a day

When caravanning long distances:

• Plan route and regular stops
• Use walkie-talkies to communicate between cars
• Be responsible for the car behind you
• Have a contingency plan in case you get separated

Carry extra water in the car
4. PLAN FOR EMERGENCIES: MAKE A SAFETY PLAN

a. Have a record of who, what, where, when
b. Have a homebase, & leave a copy of the record with them
c. Detail emergency procedures, and communicate them
4.A) RECORD
WHO, WHAT, WHERE, WHEN

Make a record of essential information

- Roster of participants, with emergency contacts
- Plan of major tasks and activities
- Locations – including parking areas, access points, nearest street address, Lat/Long if necessary
- Date/times of departure, expected return, check in times
- Contact info of local field contacts
- Contact info of JHU responsible contacts
4.B) HAVE A HOMEBASE, AND LEAVE THE PLAN WITH THEM

Have a homebase: someone who

- is aware that you are out
- expects you to check in by a certain time (perhaps multiple times)
- knows what to do if you don’t check in
- has all relevant information (i.e. the safety plan)

File your safety plan with the department (How? -- TBD)

For international trips, use the travel registry
Welcome to the Johns Hopkins International Travel Registry

The Johns Hopkins University International Travel Registry provides an easy-to-use way for faculty, staff, postdoctoral fellows and students travelling internationally on university-related business to register their travel plans. In partnership with International SOS, registered travelers will receive assistance with pre-travel preparations, including notifications about the destination country, risks, and prevention measures. All information you provide is held securely at the university; no personal information will be shared with third parties.

Using the Travel Registry is simple. After you create your Travel Profile, you enter your itinerary each time you travel, including flights, accommodations and in-country contacts. This critical information allows your divisional crisis management staff to contact and support you in the event that there is a natural disaster, political unrest or other emergency situation.

To start, click on “My Travel Profile” at the top of this page. Bon Voyage!
4.C) EMERGENCY PROCEDURES

In the event of an emergency, how will you send for help?

• Cell phone?
  • Carry an extra charge pack in case it dies.
  • Is there a good signal everywhere, or only some places?
• Sat phone? Can be rented if heading out of cell coverage
• Personal Locator Beacon (PLB)?

Do you know the closest address to your location if you need to call an ambulance?
5. IN THE EVENT OF AN INCIDENT

React
- Immediately call 911 in all cases involving serious injury or death, multiple injuries, or extensive property damage. The first priority is to care for any injured individuals.
- Prevent further injury to yourself and others

Report
- Once the situation has stabilized, report the incident to your responsible faculty member. They will contact the university administration, and may require an incident report

Record
- As soon as possible write down your best recollection of the incident and the events leading up to it. You may need this later, and it is easiest when it is fresh

Re-assess
- Future incidents can be prevented by having a frank discussion about what happened, and how it can be prevented in the future