Chemical Safety and Security Officer Training

Algeria
December 2011

SAND No. 2009-8395P
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

Fire Protection and Prevention in Chemical Laboratories

Fires

- Preventable
- Caused by unsafe practices
  - Electrical safety violations
  - Uncontrolled use of flammable and combustible materials
- Control
  - Inspect, inspect, inspect
    Educate, educate, educate!

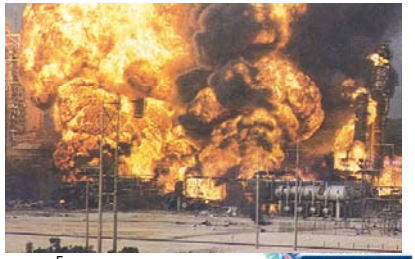
Home Fires

1 million fires and 8,000 deaths annually in the US

Leading causes:
Cigarettes
Heating/cooling equipment
Electrical
Matches, lighters, candles

Industrial Fires

- **Fifth leading cause of accidental death**
  - Vehicles, falls, poison, drowning, fire
- **Most dangerous industries from fire hazard:**
  - Mines
  - Grain elevators and mills
  - Refineries
  - Chemical plants
- **Leading causes:**
  - Electrical
  - Smoking
  - Friction
  - Overheating
  - Hot surfaces



Key Elements of Fire Safety

Get occupants out
Minimize property loss and interruption
Fire Containment/Suppression

Common Myths

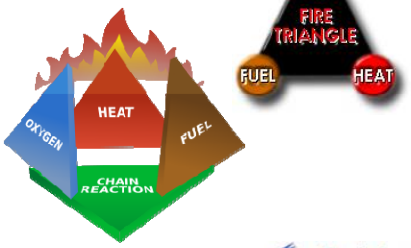
- **Fire will light the way out**
  - Smoke cloud & soot
- **Plenty of time to escape**
  - 1 min from small to inescapable fire
- **People are killed by the flames**
  - #1 killer in fires is CO, not flames
- **Wait to be rescued**
  - No! Act to save self
  - Ladders can reach to about 6th floor
- **Can not prepare for a fire**
  - Preparation can save your life

It's the Smoke…

Facial Burns

Fire

- A fire must have four things to ignite and maintain combustion:
  - Fuel
  - Heat
  - Oxygen
  - Chain reaction



Flash Point

- Flash point:
  - The minimum temperature at which a liquid gives off enough vapor to form an ignitable mixture.
  - In general, the lower the flash point, the greater the hazard.
- Flammable liquids:
  - have flash points below 38°C
  - are more dangerous than combustible liquids
  - may be ignited at room temperature
- Combustible liquids:
  - have flash points at or above 38°C
  - Can pose serious fire and/or explosion hazards when heated

OSHA Office of Training and Education

Flammability/Explosive Limits

Above UFL/UEL, mixture is **too rich to burn**

Upper Flammability/Explosive Limit (**UFL/UEL**)

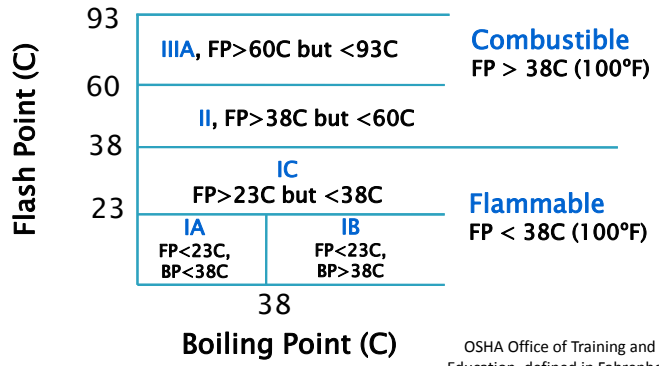
Flammability/Explosive Range

Lower Flammability/ Explosive Limit (**LFL/LEL**)

Below LFL/LEL, mixture is **too lean to burn**

Defined in terms of the amount of fuel in air.

Classes of Flammable and Combustible Liquids



OSHA Office of Training and Education, defined in Fahrenheit

Classes of Some Flammable Liquids

	Common Name	Flash Point (C)
CLASS IA	Ethyl Ether	– 45
CLASS IB	Gasoline	– 43
	Methyl Ethyl Ketone	– 6
	Toluene	4
CLASS IC	Xylene	27 – 46
	Turpentine	35

OSHA Office of Training and Education

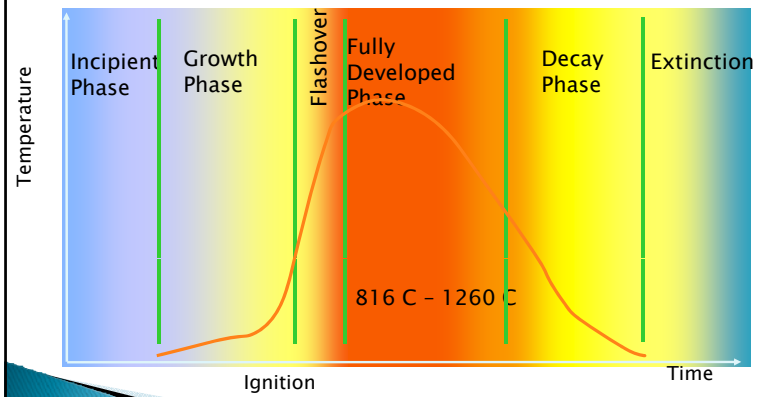
Fire Safety Program Components

A good plan for safe use of flammable and combustible liquids contains at least these components:

- Control of ignition sources
- Proper storage
- Fire control
- Safe handling

OSHA Office of Training and Education

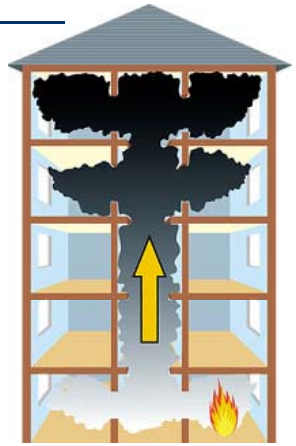
Fire Behavior



Fire Behavior

Stack Effect

- Hot expanding gases move vertically
  - Tightness of construction
  - External winds
  - Internal/external temperature
  - Vertical openings
    - Stairways
    - Elevator shafts
    - Ventilation shafts



Vapor Volume

Volume of gas formed when a liquid substance evaporates

Computed from specific gravity and vapor density

$$\text{Vapor Volume } (m^3/\text{liter}) = \frac{0.829\ (\text{SpG})}{\text{Vapor density}}$$

Example: What is the vapor volume of a liter of acetone?
[SpG = 0.9, relative to water; Vapor density = 2, relative to air]

$$\text{Vapor Volume } (m^3/l) = \frac{0.829\ (0.9)}{2} = 0.373\ m^3/l$$

Vapor Volume

What is the probability of forming a combustible mixture if a 4 liter container of acetone is used in a room 3 x 4 x 2.5 m?

[LEL = 2.5%; assume incomplete mixing factor 5]

Volume of the space = 30 m^3

Vapor volume = 0.373 m^3/L

Vapor volume necessary to form a Combustible mixture:

30 m^3 x 0.025 = 0.75 m^3

$$\frac{0.75\ m^3}{0.373\ m^3/\text{L}} = 2.01\ \text{L}$$

Applying the mixing factor of 5:

2.01 L / 5 = 0.40 L

[About = 1 coffee mug]

Since it doesn't take much more than "1 coffee mug" of acetone to form a combustible mixture, the probability appears to be high!

Housekeeping…

Flammable Liquid Containers

Tool Cleaning (Acetone)

Fire Hazards

- **Sources of fuel**
  - Flammable liquids
  - Flammable gases
  - Wood, paper, cardboard
  - Oil soaked rags
- **Sources of heat (ignition)**
  - Electrical circuits:
    - Shorts, sparks
    - Arcs (switches)
    - Heat build-up
  - Hot surfaces
  - Space heaters
  - Hotplates, coffee pots, coffee makers
  - Welding
  - Smoking
  - Open flames
  - Static electricity

Train employees to notice & report fire hazards

Periodic inspections

Drills

Classification of Fires

With recommended extinguisher distances

- **A** Ordinary combustibles – cloth, paper, wood, coal — ~23 m
- **B** Flammable/combustible liquids, gases, greases and oils – gasoline, diesel fuel — ~15 m
- **C** Energized Electrical equipment cables, motors — nearby
- **D** Combustible metals – sodium, magnesium, titanium — ~23 m
- **K** Restaurant grease fires associated with cooking — nearby

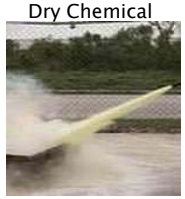
Classification of Fires

- **A** Extinguish by cooling or smothering. (water)
- **B** Extinguish by inhibiting release of combustible vapors or interfering with the chemical reaction–release of OH radicals. (CO_2 or dry powder: monoammonium phosphate)
- **C** Extinguishing agent must ***not*** be conductive. (CO_2 or dry powder)
- **D** Extinguishing agents must absorb heat and not react with the metal. (special dry powder, sand)
- **K** (Special liquid chemicals)

25

Fire Extinguishers

Dry Chemical



Placed within ~15–25 m

CO_2

Water

Annual & Monthly inspections

26

Large Fire Extinguisher

27

Fire Extinguishers

28

Fire Alarm Systems

- **Will it be recognized and followed?**
  - Audible, visual, public address systems…
- **What about deaf or blind employees?**
  - Are there "dead spaces"…
- **System reliability**
  - System failure may not be obvious
  - Supervised systems (built-in monitoring)
  - Testing, maintenance and backup systems

Fire Detection & Alarms

- **Thermal**
- **Heat**
  - Fixed temp
  - Rate of rise
    - ~6 to 8 C/min (12 to 15°F/min)

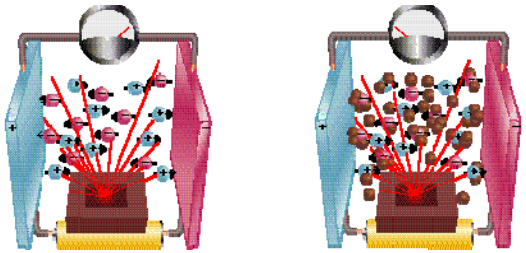
Issues:

Testing

Dust, corrosion, hot processes, weather, mechanical damage

- **Smoke**
  - Photoelectric
    - IR from smoke
  - Ionization
    - Ionize smoke
- **Flame Detectors**
  - Flames – IR or UV
- **Gas Sensors**

Smoke Detectors



- Alpha particles from Americium-241 (red lines) ionize the air molecules (pink and blue spheres).
- The ions carry a small current between two electrodes.
- Smoke particles (brown spheres) attach to ions reducing current and initiate alarm.

False Alarms

False alarms may be triggered by construction dust created during renovations

Manual Pull Stations

- Manual Pull Stations are devices located on the wall (usually near an exit)
  - Sends a signal to the building's fire alarm system when activated
  - Places the building into alarm

People are reluctant to sound fire alarms!

Responding To A Fire

Employee Training

Few employees know how to *effectively* use extinguishers!

Need for training:
- Initial training
- Annual refresher

Using a Fire Extinguisher

Video Courtesy of Washington State Emergency Management Division, Public Education Program

P	Pull
A	Aim
S	Squeeze
S	Sweep

Water

- Water is highly effective on Class A fires, by cooling down the fire and surrounding atmosphere.
- Water is usually available.
- It can be used to cool down the firefighting team to prevent heat exposure.

Disadvantages

- Water should NOT be used to control a B or C fire.
- Inadequate pressure or too high pressure can cause problems.
- The volume of water can be restricted by the length of water lines and hoses (frictional loss ~3500 Pa for every 3 meters of 4 cm diameter hose).
- The fire nozzle can clog due to non-filtered materials in the lines.
- Hydrogen can be produced if water is applied to very-hot fires.

Electrical Fires

- Pull the plug out or switch off the power at the fuse box. This may stop the fire immediately.
- Smother the fire with a fire blanket, or use a dry powder.
- Never use water on it.

What To Do If Someone Catches On Fire

If *you* should catch on fire:

STOP – where you are
DROP – to the floor
ROLL – around on the floor

This smothers the flames, possibly saving your life.

Remember ***STOP, DROP and ROLL***

If a *co-worker* catches on fire:

Smother flames by grabbing a blanket or rug
Wrap them in it.
Could save them from serious burns or death.

When Not To Fight A Fire

Don't fight a fire, when:

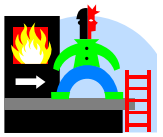
- It is bigger than a waste paper bin
- One extinguisher is not enough
- The fire is spreading beyond the spot where it started
- Smoke is affecting your breathing
- You can't fight the fire with your back to an escape exit
- The fire can block your only escape
- You don't have adequate fire-fighting equipment

DON'T FIGHT THE FIRE YOURSELF

CALL FOR HELP

Remember

When…



- The extinguisher runs out of agent
- Your path of escape is threatened
- The extinguisher proves to be ineffective
- You are no longer be able to safely fight the fire

…LEAVE THE AREA IMMEDIATELY!

Storage Guidelines

- All storage must be at least 1 m from electrical panels. In some emergency situations it will be necessary to access these panels quickly.

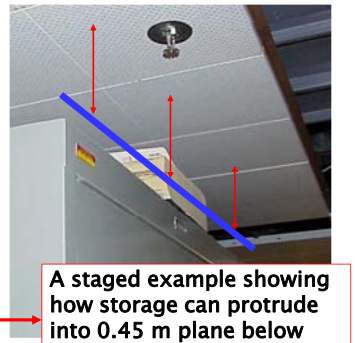
Improper Storage in front of Electrical Panel

- Maintain at least 1 m clearance from heating surfaces, air ducts, heaters, and lighting fixtures.
- Storage of combustible materials in mechanical rooms is prohibited.

Improper Mechanical Room Storage

Storage Guidelines

- No storage is allowed in corridors and stairwells. A cluttered hallway could slow down emergency evacuation.
- Storage must not exceed a plane of 0.45 m below sprinkler heads or smoke detectors. Storage that breaks this plane may prevent sprinkler heads from fully covering room during a fire.



A staged example showing how storage can protrude into 0.45 m plane below sprinkler heads.

Myths about Sprinkler Systems

- **A sprinkler system will cause excessive water damage**
  - Sprinklers use a fraction of water compared with a fire hose.
  - Sprinklers release ~30 – 100 liters per minute compared to a fire hose at ~200 – 500 liters per minute.
  - Sprinklers operate very early in the fire development, and consequently require a smaller quantity of water.
- **When a fire occurs, every sprinkler head goes off**
  - Sprinkler heads are individually activated by fire.
  - > 50% of the fires are controlled by ≤ 4 sprinkler heads, and in many instances fires are controlled with one sprinkler.
- **The pipes burst due to freezing**
  - Sprinklers can be protected with various forms of frost protection, such as installing a dry system or providing heating elements to protect the sprinkler systems.

Myths about Sprinkler Systems

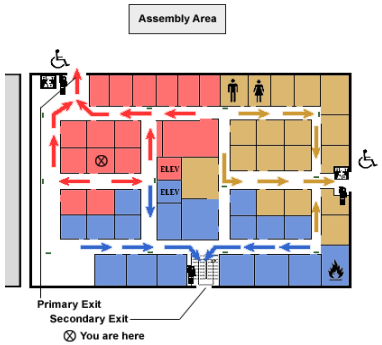
- **Sprinkler systems might accidentally go off**
  - Sprinklers are very reliable; the chances of going off without mechanical assistance are 1 in 16 million; Fork lift truck drivers soon learn to avoid them.
- **Smoke detectors provide enough protection**
  - Smoke detectors provide early warning and save lives, but do nothing to extinguish a fire or protect those physically unable to escape on their own.
  - Too often, battery operated smoke detectors fail to function because the batteries are dead or have been removed.
- **Sprinklers are designed to protect property, but are not effective for life safety**
  - Sprinklers can reduce property losses up to 85%.
  - Combining sprinklers and early warning systems can reduce overall injuries, loss of life and property damage by 50%.

Fire Safety Planning

- **Construction**
  - Building materials
  - Fire-resistive ratings (minutes to hours)
  - Interior finishes (3 classes: A, B, & C)
- **Containing the fire**
  - Stair enclosures and fire walls
  - Separate building units or zones (control spread)
  - Fire doors
  - Smoke, heat and noxious gases control
  - Exits
- **Egress**
  - Two ways out, exit to safe area

Egress – Exit Route

- Continuous and unobstructed path from any point within a workplace
- Consists of three parts:
  - Exit access
  - Exit
  - Exit discharge



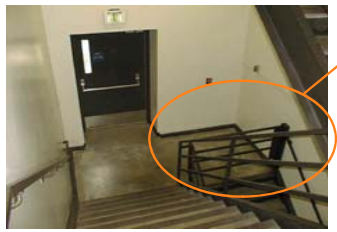
Egress – Exit Route

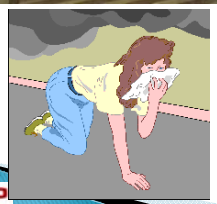
- Exit routes must be permanent
  - Exits must be separated by fire-resistant materials
  - Openings into an exit must be protected by an approved self-closing fire door that ***remains closed or automatically closes in an emergency***
  - Unobstructed
- Well marked

Egress – Exit Route

- **Exit Doors:**
  - **Must *not* be Blocked or Locked**
  - **Can use a panic bar**
  - **Must be well marked**
  - ***Open in direction of travel***

Best Practices: Safety During a Fire…





- Stairs have a bar blocking the steps going down to indicate ground level fire egress
- Keep fire exits and stairwells free from any obstruction to allow for an easy exit during a fire emergency

Emergency Lighting

Proper storage of Flammables is an important part of Fire Safety

Limit quantities stored

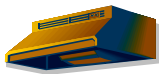
Safety cans

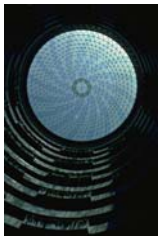
Secondary Containment

Flammable storage cabinets, rooms or buildings

Ventilation

Always provide adequate ventilation to reduce the potential for ignition of flammable vapors.





OSHA Office of Training and Education

Storage Containers

- Oily Rags
- Drying process exothermic
- Container (reduces fire risk)
  - Limits oxygen.
  - Encourage air circulation to remove heat.
  - Limits access to ignition source.

Storage Containers

- Containers should be tightly sealed when not in use.
- Approved safety cans are recommended for smaller quantities.
  - The spring-loaded safety cap prevents spillage.
    - Prevents vapors from escaping
    - Acts as a pressure vent if engulfed in fire
    - Prevents explosions and rocketing of the can

Flame Arrester Screen

- **Prevents fire flashback into can contents.**
- **Double wire – mesh construction**
- **Large surface area provides rapid dissipation of heat from fire so that vapor temperature inside can remains below ignition point.**

OSHA Office of Training and Education

Storage Areas

Flammables should be stored in an approved cabinet in a cool, well ventilated area to avoid pressure buildup and vaporization

Flammable Storage Cabinets

Storage Cabinets

- Not more than 225 L of Class I and/or Class II liquids, or not more than 450 L of Class III liquids permitted in a cabinet.
- Must be conspicuously labeled, **"Flammable – Keep Fire Away"**
- Doors on metal cabinets must have a three-point lock (top, side, and bottom), and the door sill must be raised at least 5 cm above the bottom of the cabinet.

OSHA Office of Training and Education

Flammable Storage Cabinets

Static Electricity

- **Some flammable liquids accumulate a static electric charge, which can release a spark that ignites the liquid**
- **Static electricity is generated by contact and separation of dissimilar materials:**
  - **Fluid flow through a pipe or into a tank**
  - **Agitation or mixing**
  - **Splash filling of containers**

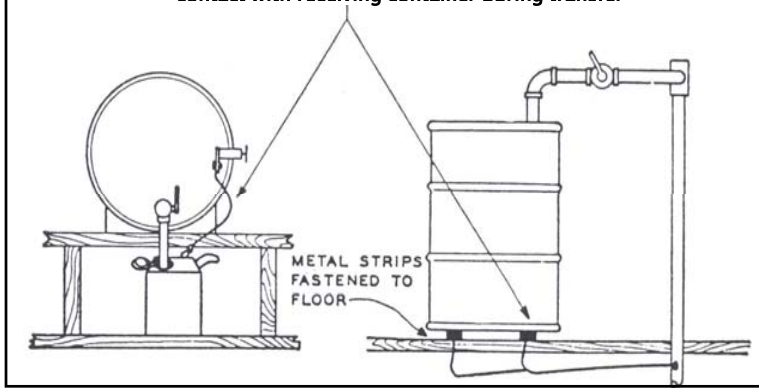
benzene toluene gasoline xylene

Transfer Techniques

- **Bond containers**
  - Containers are wired together before pouring
  - One container is connected to a good ground point to allow any charge to drain away safely
- **Limit use of plastic containers to small volumes (< 4L)**
  - No easy way to bond plastic containers

Control of Static

Bond wire necessary except where containers are inherently bonded together, or arrangement is such that fill stem is always in metallic contact with receiving container during transfer



Fire Prevention Inspections

- **Minimize size of fires**
  - Control storage of combustible and flammable materials
- **Reduce possibility of a fire**
  - Control ignition sources
- **Ensure fire protection equipment is operational**
  - Fire extinguishers not blocked
- **Ensure exits are maintained**
  - Don't block egress pathways
  - Don't prop open fire doors

Violations

Violations

6-Way Multi-plug

Multi-plug

Any Questions?

Break

Laboratory Emergency Planning, Response, and Management

Video – Explosion and Fire at T2 Lab

Emergency Planning and Response is based on principles of:

- Anticipation
- Recognition
- Evaluation
- Control

Preparing For Emergencies

- Emergencies
  - potentially life threatening
  - occur suddenly without warning
- Quick response will:
  - make difference between life and death
  - minimize damage
  - prevent panic, timely control
- Emergency responders
  - organize, stabilize, administer
- Adequate preparation requires
  - planning, practice, evaluation, adjustment

Emergency Management

- Mitigate
  - eliminate / reduce occurrence or effects of an emergency
- Preparedness
  - plan how to respond; resources
- Response
  - assist victims, reduce damage
- Recovery
  - return to normal and assess

Planning & Preparation

Anticipate types of emergencies:

- Step-by-step procedures
- Assess resources available
- Coordinate with all responding agencies
- Chain of command
- Roles & assignments Clearly spelled out and understood
- Accident prevention strategies
- First aid – inspect, date, replacements
- Site maps – update
- Train & practice
- Evaluate & improve

Emergency Response Plan

Include all situations and conditions:

- Weather emergencies:
  - Flood
  - Tidal waves
  - Cyclones
  - Heavy rains
  - High winds
- Fire
- Earthquakes

- Security breaches
- Distraught employees
- Medical Emergencies
- Student unrest
- Political unrest
- Explosion
- Evacuation
- Terrorism

Prepare for and expect the unexpected

Dr. Walters home, Raleigh NC, USA After Hurricane Fran 1996

Emergency Action Plan

- Have a written plan and distribute it to all employees, especially new employees:
  - Emergency escape/evacuation procedures & routes
  - Critical process emergency shutdown procedures
  - Procedures to account for evacuated employees
  - Rescue or medical duties if employees required to perform them
  - Procedure for reporting emergencies
  - Contact information for Q&A
- Alarm systems
- Training

Emergency Response Plan

- Comprehensive employee training
  - General employee training
  - Specialized & emergency responders
  - Annual refresher training or drills
  - Untrained personnel should not participate
- Spill & emergency response plans
- Contingency plans
- Medical response/first aid
- Personal Protective Equipment
- Safety Data Sheet's
- Site maps
- Clean up procedures
- Decontamination techniques

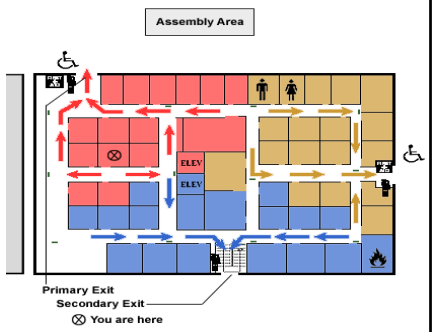
Include:
Fire Prevention Plan

- Written plan
  - List major fire hazards
  - Proper handling and storage procedures
  - Potential ignition sources & controls
  - Type of fire prevention systems
  - Contact information for those responsible for system maintenance
  - Contact information for Q&A
- Housekeeping requirements
- Training
- Maintenance requirements

Emergency Planning & Response

Have an evacuation plan for all buildings and areas and

POST IT



Emergency Planning & Response

Don't use hallways for storage

Dangerous!!

Blocks passage and emergency exit path

Emergency Planning & Response

Label and keep all exits clearly.
Keep unlocked or equipped with panic bars.

Emergency Planning & Response

- Have routine, unannounced evacuation drills.
- Test and maintain alarms.
- Designate person for each area to ensure bathrooms, etc. are evacuated.

- Locate outside staging areas sufficient distance from building.
- Designate person to meet/direct emergency vehicles.

Emergency Planning & Response

Alarm systems need to be properly located, maintained, and serviced regularly.

Alarm Systems: Reminder

- Will it be recognized and followed?
  - Audible, visual, public address systems…
- What about deaf or blind employees?
  - Are there "dead spaces"…
- System reliability
  - System failure may not be obvious
  - Supervised systems (built-in monitoring)
  - Testing, maintenance and backup systems

Manual Pull Stations: Reminder

- Manual Pull Stations are devices located on the wall (usually near an exit)
  - Send a signal to the building's fire alarm system when activated
  - Places the building into alarm

Remember:
People are reluctant to sound fire alarms!

Emergency Planning & Response

If people are expected to use extinguishers, they must be trained.

Emergency Planning & Response

Backup power

Does switch-over automatically?

How long will it run?

How much fuel do you have?

What areas will it support?

How often is it tested and maintained?

Emergency Planning & Response

Post each room with:

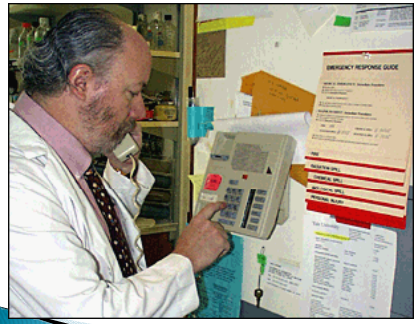
- Emergency phone numbers
- After hours phone numbers
- Person(s) to be contacted
- Alternate person(s)
- Unique procedures to be followed

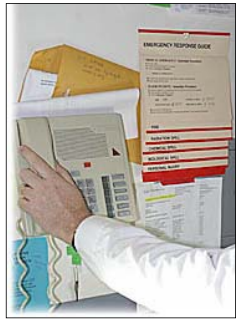
Location	
Hazards Within:	
Primary Contact:	
Second Contact:	
Building Monitor/Safety:	
Department Head:	
Fire/Police/Ambulance:	911
Envir. Health & Safety (or RSO, if needed):	646-3327

Emergency Phone Numbers

Clearly post emergency numbers

Do employees know what to do?





Emergency Planning & Response

Hoods should have low flow alarms.

Chemical specific toxicity alarms may be needed in certain areas.

Emergency Planning & Response

Centrally locate safety showers and eyewashes.

Schedule routine, periodic maintenance of all safety equipment.

Teach employees to properly use the Safety Shower

Time can make a difference…

Chemical Spills

Centrally locate spill clean-up kits

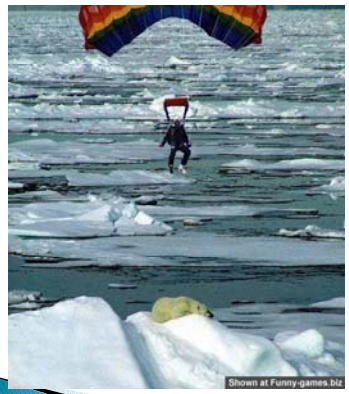
Clean up spill only if you know the chemical hazards, have appropriate equipment and are trained to do so!

- Alert colleagues and secure area
- Assess ability to clean-up spill
- Find spill kit
- Use appropriate PPE and sorbent material
- Protect sinks and floor drains
- Clean-up spill, collect/label waste for disposal
- Report all spills

Centrally locate, inspect and maintain:

- First aid kits
- Special chemical antidotes, if necessary
- Respirators
- Specially train emergency personnel, if necessary
- Post inspection dates on equipment, including hoods

Always Expect the Unexpected



Chemical Spill Response and Clean-up

Size of spill determines response

Emergency Notification and Response

- The notification and emergency response procedure for accidents and incidents should be written and understood by everyone.
- A rapid and effective response helps insure injured persons receive rapid and correct medical attention and/or that incidents are quickly contained and controlled, and that effects and damage to people, facilities, the environment and the community are minimized.

Chemical Spill Response Medical Treatment

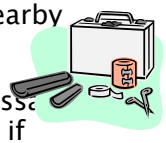
- Employer should provide the following medical services in emergencies:
  - Medical examination after exposures
  - If exposures are above required/regulated levels of exposure
  - Follow-up exams as necessary
- Employer should provide to the physician:
  - Identity of chemical
  - Description of exposure conditions
  - Description of signs and symptoms of exposure
- Employer and victim should obtain a confidential written report from the examining physician

Chemical Spill Response Record Keeping

- **Maintain accurate records of accidents/incidents response.**
  - **All involved personnel**
  - **Exposure measurements**
  - **Medical examination, consultations**
  - **Medical tests**
  - **Medical follow-ups**
- **Records should be confidential and protected from unauthorized disclosure.**
- **Records should be shared with victim.**
- **Records should be examined for patterns.**

Chemical Laboratory First Aid

- First aid kits for minor injuries should be centrally located and available in or nearby each laboratory.
- Use for minor accidents/incidents.
- Determine if medical attention is necessa
- Immediately notify proper authorities, if necessary or in doubt.
- Determine if chemical exposure occurred.
- If necessary, take immediate preventative action to make lab safe, e.g., shut down reactions, electricity, etc.



Chemical Laboratory First Aid

Wounds:

- If bleeding is profuse, apply steady, direct pressure over the wound using a sterile dressing, if possible, or clean cloth.
- Keep the wound as clean as possible.
- Remove or cut away any clothing covering the wound.
- Flush with water to wash out loose dirt and debris.
- Do NOT try to remove foreign matter embedded in the wound
- If there is an impaled object, Do NOT try to remove it. Efforts to do so may cause severe bleeding and further damage.
- Control bleeding by direct pressure, but do not apply pressure on the impaled object itself or on immediately adjacent tissues.
- Stabilize the impaled object with a bulky dressing.

Chemical Laboratory First Aid

Thermal Burns:

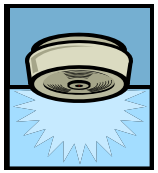
- Immerse burned area in cold water or apply cold compresses for 30 minutes
- Do NOT attempt to rupture blisters on the burn

Chemical Laboratory First Aid

- Chemical Burns:
  - Speed is essential.
  - Consult chemical labels & MSDS for special instructions.
  - Flush burn area immediately with water for 15 minutes.
  - Taking care not to spread the chemical, remove any clothing,especially shoes and socks, that may be contaminated.
  - Do NOT use salves, ointments, cream, sprays, or any other covering except for chemical-specific remedies such as for HF or phenol.
  - Do NOT attempt to rupture blisters over the burn.
- If chemicals splashed into the eyes:
  - Flush the affected area with water for a minimum of 15 minutes.
  - Remove contact lenses, if present, as rapidly as possible, since they prevent water from reaching the cornea.
  - Eyelids may have to be forced open so eyes can be totally flushed.
  - If large particles are in the eye, an eye wash should not be used.
  - Do NOT use salves, ointments, cream, sprays, or any other covering except for chemical-specific remedies such as for HF or phenol.

Spill Cleanup Preparation

- Emergency Equipment
  - Internal communication/alarm system
    - Telephones (Label all phones with emergency numbers)
    - Alarm pull boxes
  - External communication/alarm system
  - Fire extinguishers
  - Emergency eyewash and showers
  - Spill stations



Spill Cleanup Preparation

- Knowledge Needed
  - Location of emergency electrical circuit breakers, shutoff valves, switches, disconnects for building, area, laboratory, room, equipment
  - Response procedures for personal injuries/ exposures and emergencies
  - Emergency evacuation routes (posted)

Spill Cleanup Preparation

- Maintain Current Safety Data Sheets
  - Attention to:
    - Chemical hazards
    - First aid information
    - Spill response
    - Firefighting information
    - Engineering controls
    - Stability and reactivity
    - Proper storage
    - Disposal considerations

Spill Cleanup Preparation

- Maintain complete Spill Kits
  - Absorbent material
    - Absorbent pillows or powders
    - Activated carbon for organic solvents
  - Neutralizing agents
    - Acid Neutralizers –e.g., sodium bicarbonate ($NaHCO_3$) powder
    - Base Neutralizers–e.g., citric acid powder
    - Solvent Spills–activated carbon

Spill Cleanup Preparation, cont'd

Spill Kit should also contain:

- Personal Protective Equipment (PPE)
  - 2 pairs of chemical splash proof goggles
  - Several pair of disposable gloves
  - Disposable, charcoal (volatile, aerosol) respirators
  - Disposable aprons or jump suits
  - Disposable shoe covers (for floor spills)



Spill Cleanup Preparation

- Additional cleanup equipment:
  - Plastic pail/bucket(s) with lids (large enough to contain spill and cleanup material)
  - Plastic dust pan
  - Broom or brush
  - Plastic bags
  - Sealing tape
  - pH paper
  - Sign(s):
    Danger Chemical Spill
    Keep Out

Spill Cleanup Preparation

SCBA Respirators

- Two persons are required to use a Self Contained Breathing Apparatus (SCBA)
- One person stands-by to rescue/assist the other in case of a problem
- Never rely on a single SCBA
- Never use a SCBA alone
- SCBAs must be well maintained and inspected weekly if they are part of the safety program

Spill Cleanup Preparation Risk Assessment

(Anticipation)

- What is the worst thing that could happen if a chemical was dropped/spilled, etc.?
  - inconvenience
  - skin burns
  - fire
  - explosion
  - chemical exposure (fatality; injury, permanent, temporary)
- Know the worst case scenario for a spill.
- How you would respond to a spill, emergency situation?
- What are the appropriate clean-up and decontamination procedures?

Spill Cleanup Preparation Risk Assessment

Estimating Potential Hazards (Evaluation)

- What are the chemical, physical and toxicological properties of the chemicals you are using?
- What is the amount of chemical?
- What are your knowledge and skills?
- What are possible locations/conditions of a spill, accident?
- Ask for assistance if you are unsure

Spill Cleanup Preparation Risk Assessment

Chemical Toxicity (Evaluation)

- Route of exposure
- Acute toxins
- Acids and corrosives
- Lachrymators, irritants and allergens
- Carcinogens, repro-toxins, etc.
- Biohazardous, radioactive material

Spill Cleanup Risk Assessment

Chemical Flammability (Evaluation)

- Hazardous locations
- Ignition sources
- Presence of other flammables
- Store excess flammables in flammable storage cabinets
  - Use external flammable storage rooms for large quantities.

Spill Cleanup Prevention

(Control)

- Eliminate clutter
- Purchase only amount of chemical required
- Understand work practices and procedures
- Use unbreakable secondary containers
- Store chemicals properly
- Dispose of waste /excess chemicals properly and timely

Cleanup Responsibilities

- Laboratory Staff:
  - Ensuring timely spill reporting and cleaned up
  - Cleaning up nuisance spills in their area, even if someone else spills them (janitors, service people)
  - Knowing the properties of what they work with
  - Taking reasonable steps to prevent spills
- Specially trained Safety Cleanup Team:
  - Assist researchers not comfortable cleaning up spills (including nuisance spills)
  - Clean-up serious/major spills

Nuisance Spills

- **Spills of < 4L of known hazard, that you are comfortable cleaning up**
  - **Assess the hazard**
  - **Wear appropriate PPE**
  - **If unsure or need assistance with PPE selection or cleanup, call the Safety Cleanup team.**

Nuisance Chemical Spill Cleanup Procedure

- Alert people in immediate area
- Post area
- Confine spill
- Absorb excess, surround area with absorbent material
- Wear appropriate PPE
- Avoid breathing aerosols
- Use forceps, etc., to pickup broken glassware, etc.
- Work from outer edge toward center to cleanup
- Do not dry sweep
- Clean spill area with soap & water, specific solvent or neutralizing material (if known)
- Collect contaminated absorbent, gloves, residues in plastic bag(s)
- Label, with chemical name if possible, and dispose of waste properly

Potentially Hazardous Spills

- **Spills of > 4L or**
- **Smaller spills of:**
  - **Low LD_{50} (high acute toxicity)**
  - **Carcinogens, repro-toxins, etc.**
  - **Flammable liquids or metals**
  - **Chemicals of unknown toxicity or hazards**

Potentially Hazardous Chemical Spill Cleanup Procedure

- Attend to injured/contaminated or exposed individuals.
- Remove persons from the exposure without endangering yourself.
- Alert persons in the immediate area to evacuate.
- Consider people with disabilities.
- If spill is flammable, turn off heat and ignition sources (if possible).
- Call Emergency Phone Number to report incident.
- Post area—**Danger, Keep Out! Hazardous Chemical Spill**
- Close doors to affected area.
- Locate MSDS.
- Assist Specialized Safety Cleanup personnel if you are knowledgeable about the spill.

Only trained personnel should do cleanup!

Mercury Exposure and Cleanup

- Mercury metal exposure can cause severe health problems:
  - Tremors
  - Changes in vision or hearing
  - Insomnia
  - Weakness
  - Memory difficulty
  - Headaches
  - Irritability
  - Nervousness or shyness
  - Acrodynia (painful extremities) – *a condition caused by chronic exposure to mercury*

Mercury Exposure & Prevention

- Routes of exposure
  - Inhalation
    - Main hazard
    - Evaporates releasing hazardous vapors
  - Skin absorption
- Personal Protective Equipment Required
  - Nitrile gloves
  - Safety glasses
  - Closed-toed shoes
  - Lab coat

Mercury Spill and Exposure

- Preparation is critical.
- Substitution/elimination is the best prevention.
- All mercury spills, including those from broken laboratory thermometers and manometers, should be cleaned up immediately.

Mercury Spill Prevention

- Trays should be used under equipment where mercury is used.
- Mercury beads, splashes, and rolls around.
- Prevent mercury from entering cracks, crevices, and drains.
- Cease activities.
- Secure spill area, contain mercury spill area.
- Restrict area until entire spill is cleaned up.
- Do not walk in spill area.
- Evacuate room via route away from spill.
- Lower room temperature to reduce evaporation.

Mercury Spill Cleanup

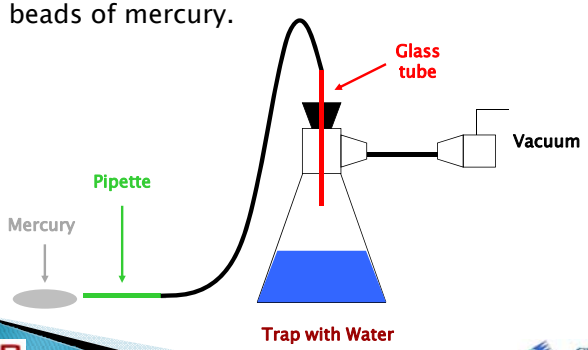
- Spill powders can be used as temporary controls:
  - Commercial spill kits are available
  - Or mix 85 grams of finely powdered sodium thiosulfate with 15 grams of powdered EDTA

Mercury Spill Cleanup

- Cover spill from perimeter toward the center.
- Remove debris:
  - Dispose of as hazardous waste and cleanup material (gloves, towels, etc).
  - All waste should be placed in labeled, sealed, leak-proof, containers.
  - Never dispose of mercury waste in sewer system.
- Special vacuum cleaners designed to pick up mercury safely are available for cleanup.
- NEVER sweep up spill or use a regular vacuum.

Other Mercury Spills Cleanup Equipment

- A side-arm flask connected to a vacuum pump or sink aspirator can be used to vacuum up small beads of mercury.



Mercury Spill Cleanup Special Precaution

- Special attention should be given to cleaning cracks and crevices where the mercury beads may have settled.

Mercury Spill Cleanup Special Precautions

- Large spills
- Spills in confined areas with poor ventilation
- Spills in areas heated above room temperature
- Should be cleaned up by trained personnel with protective equipment
- There is a risk of high exposure to mercury vapors in these situations.

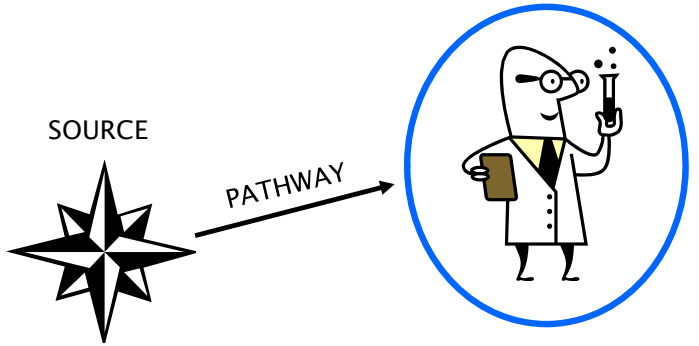
Acknowledgement

Mercury Spill Cleanup,
University of Wisconsin Safety Office
http://www.uwm.edu/Dept/EHSRM/LAB/labHg.html

Lunch

Personal Protective Equipment (PPE) and Safety Equipment Performance Specifications

Worker Protection



Personal Protective Equipment (PPE)

- Should be a last resort, but may be necessary if:
  - engineering controls inadequate or being installed
  - administrative controls don't do the job
  - emergency response or spill cleanup
  - supplement other control techniques if can't achieve required level
- Depends upon human behavior
  - proper selection, fit and comfort issues
- Hazard is still present with PPE …

US–OSHA PPE Regulations

- Eye and face protection
  - 29 CFR 1910.133
- Respiratory protection
  - 29 CFR 1910.134
- Head protection
  - 29 CFR 1910.135
- Foot protection
  - 29 CFR 1910.136
- Hand protection
  - 29 CFR 1910.138
- Hearing Protection
  - 29 CFR 1910.95

www.cdc.gov/nasd/menu/topic/ppe.html
www.osha.gov/SLTC/personalprotectiveequipment/index.html
www.osha.gov/Publications/osha3151.pdf

Training and Qualification

Employees should be trained to know:

- When PPE is necessary?
- What PPE is necessary?
- How to properly don, doff, adjust and wear PPE.
- Limitations of PPE.
- Proper care, storage, maintenance, useful life, and disposal of PPE.

www.free-training.com/osha/ppe/ppemenu.htm

Training and Qualification

Retraining is necessary when there is:

- Change in the process.
- Change in type of PPE used.
- Inadequate employee knowledge or use of PPE.
  - retrain to reinforce understanding or skill

Personal Protective Clothing (PPE)

- Evaluate task, select appropriate type and train to use it properly
  - lab coats, gowns, aprons
  - safety glasses (with side shields), goggles, face shields
  - gloves
- Remove PPE before leaving the lab

Protective Equipment Works

"It's a hot day, why wear a lab coat?"

An experiment reacted unexpectedly and a flammable solvent from a hood splashed out and landed on the bottom of the lab coat

Eye and Face Protection

- Thousands are blinded each year from work-related eye injuries.
- Nearly *three out of five* workers are injured while failing to wear eye and face protection.

Eye & Face Protection

- Safety glasses
- Goggles
- Face shield

Eye and Face Protection

Eye protection shields eyes by:

- Primary protection:
  - Safety glasses with side shields protect from flying objects.
  - Goggles prevent objects from entering under or around the eyewear.
- Secondary protection:
  - Face shields
    - Combine with safety glasses or goggles
    - Do not protect from impact hazards

Hazard Assessment

Hazard Type	Hazard Type	Common related tasks
Impact	Flying objects such as large chips, fragments, particles, sand, and dirt	Chipping, grinding, machining, masonry work, wood working, sawing, drilling, riveting, sanding,…
Heat	Anything emitting extreme heat	Furnace operations, pouring, casting, hot dipping, welding, …
Chemicals	Splash, fumes, vapors, and irritating mists	Acid and chemical handling, degreasing, plating, and working with blood or OPIMs
Dust	Harmful dust	Woodworking, buffing, and general dusty conditions
Optical Radiation	Radiant energy, glare, and intense light	Welding, torch-cutting, brazing, soldering, and laser work

Biohazards

Use caution anytime you are working with blood or other bodily fluids.
Contaminated blood or bodily fluids may result in transmission through the eyes.

Eye and Face Protection

Optical Hazards

- **Welding helmets are secondary protection to shield from UV, heat, and impact.**
- **Exposure to laser beams requires suitable laser safety goggles with protection for the specific wavelength.**

Eye and Face Protection\Requirements

- Eye and face protection should comply with the American National Standards Institute:
  - ANSI Z87.1-1989
- Ensure employees who wear prescription lenses or contact lenses:
  - Use safety eyewear that incorporates the prescription
  - Use eye protection that can be worn over prescription lenses

Additional Considerations

- Provide adequate protection against the specific hazards.
- Safe design and construction for the work to be performed.
- Comfortable.
- Don't interfere with the wearer's movements.
- Durable!
- Capable of being disinfected.
- Easily cleaned.
- Distinctly marked to indicate they are approved eye protection.
- Worker satisfaction.
  - – Include workers in the selection process.

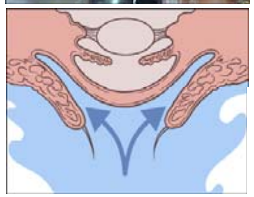
Eyewash and Showers

- US regulations
  - 29 CFR 1910.151(c)
  - ANSI Z358.1-2004
- Types
  - eyewash
  - shower
  - drench hose
- Concerns
  - drainage
  - freezing
  - contaminated water

Eyewash and Showers

- **Know their locations**
- **Maintenance and testing program**
- **Concerns:**
  - **drainage**
  - **freezing**
  - **contaminated water**

Eyewash Standards



ANSI Z358.1 NC DOL Guide:
www.nclabor.com/osha/etta/indguide/ig28.pdf

- Eye wash stations
  - Minimum 0.4 to 3.5 gal/min (1.4 – 13.2 l/min.)
  - Flush for 15 minutes
- Provide flow for both eyes
  - Hold eyes open
  - Tepid, pH match eye (preferred)
- Easily accessible locations
  - 33 to 45 in. (84–114 cm) from floor
  - 6 in. (15cm) from wall
- Test weekly
  - Portable: clean/refill (6 mo – 2 yrs)
- Various types

Safety Shower Standards

- Within 55 ft. (17 m) or 10 seconds
  - Normal walking = 3.8 mph (6.1 km/hr)
- Test monthly
- Pull within reach (highly visible)
  - 82 to 96 in. high (208 – 244 cm)
  - Deliver 20 in (51 cm) column
  - Height: 60" (152 cm) above floor
- 20–30 gal/min (76–114 L/min)
- Tepid: 60 to 100 °F (16 – 38°C)

Safety Shower Standards cont.

Consider:

- Drains
- Blankets/modesty curtains

Avoid or protect electrical outlets

- ANSI Z358.1-2004

157

Blocked Eyewash & Safety Shower

158

Dirty Eyewash Station

Blocked Eye Wash Station

Hand Protection

- Glove considerations
  - Type glove
    - Dexterity required
    - Chemical & physical
      - material
      - strength
    - Exposure time
      - breakthrough time
    - Size, comfort, reusable/disposable
  - Manufacturer selection charts

Glove Selection

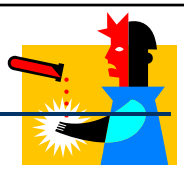
- Considerations:
  - Chemicals (splashes vs immersion)
  - Thermal (extreme heat/cold)
  - Abrasion; cuts; snags; splinters; punctures
  - Grip: oily, wet, dry
  - Comfort, fit, size
  - Ergonomics

Chemical Protective Gloves/Clothing

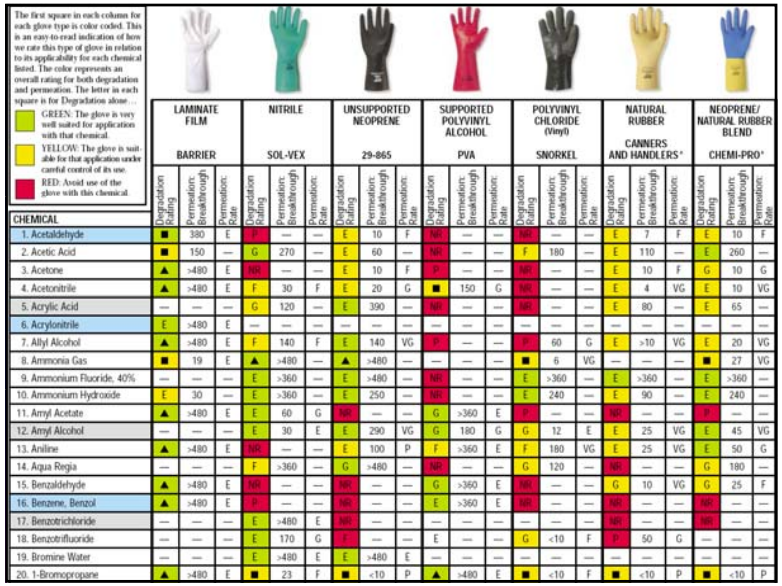
- Permeation ("silent killer")
  - Substances pass through intact material on a molecular level.
- Penetration
  - Substances pass through seams, zippers, stitches, pinholes, or damaged material.
- Degradation
  - Substance damages material making it less resist or resulting in physical breakdown.
- Contamination
  - Substances transferred inside material (improper doffing or decontamination).

Permeation Rate (PR)	Permeation Breakthrough (PB)	Permeation Degradation rate (DR)
E- Excellent; permeation rate of less than 0.9 mg/cm²/min	>Greater than (time - minutes)	E - Excellent; fluid has very little degrading effect.
VG - Very Good; permeation rate of less than 9 mg/cm²/min	< Less than (time - minutes)	G - Good; fluid has minor degrading effect.
G - Good; permeation rate of less than 90 mg/cm²/min		F - Fair; fluid has moderate degrading effect.
F - Fair; permeation rate of less than 900 mg/cm²/min		P - Poor; fluid has pronounced degrading effect.
P - Poor; permeation rate of less than 9000 mg/cm²/min		NR - Fluid is not recommended with this material.
NR - Not recommended; permeation rate greater than 9000 mg/cm²/min		† Not tested, but breakthrough time > 480 min DR expected to be Good to Excellent
		†† Not tested, but expected to be Good to Excellent based on similar tested materials

Gloves



- It's important to have the right glove for the job and know how long it will last.
- Glove Chart Examples:
  - Consider several glove manufactures data before final selection.
  - www.bestglove.com/site/chemrest/



The first square in each column for each glove type is color coded. This is an easy-to-read indication of how we rate this type of glove in relation to its applicability for each chemical listed. The color represents an overall rating for both degradation and permeation. The letter in each square is for Degradation alone...
GREEN: The glove is very well suited for application with that chemical.
YELLOW: The glove is suitable for that application under careful control of its use.
RED: Avoid use of the glove with this chemical.

CHEMICAL	LAMINATE FILM BARRIER			NITRILE SOL-VEX			UNSUPPORTED NEOPRENE 29-865			SUPPORTED POLYVINYL ALCOHOL PVA			POLYVINYL CHLORIDE (Vinyl) SNORKEL			NATURAL RUBBER CANNERS AND HANDLERS*			NEOPRENE/ NATURAL RUBBER BLEND CHEMI-PRO*		
	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate
1. Acetaldehyde	■	380	E	P	—	—	E	10	F	NR	—	—	NR	—	—	E	7	F	E	10	F
2. Acetic Acid	■	150	—	G	270	—	E	60	—	NR	—	—	F	180	—	E	110	—	E	260	—
3. Acetone	▲	>480	E	NR	—	—	E	10	F	P	—	—	NR	—	—	E	10	F	G	10	G
4. Acetonitrile	▲	>480	E	F	30	F	E	20	G	■	150	G	NR	—	—	E	4	VG	E	10	VG
5. Acrylic Acid	—	—	—	G	120	—	E	390	—	NR	—	—	NR	—	—	E	80	—	E	65	—
6. Acrylonitrile	E	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Allyl Alcohol	▲	>480	E	F	140	F	E	140	VG	P	—	—	P	60	G	E	>10	VG	E	20	VG
8. Ammonia Gas	■	19	E	▲	>480	—	▲	>480	—	—	—	—	■	6	VG	—	—	—	■	27	VG
9. Ammonium Fluoride, 40%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—
10. Ammonium Hydroxide	E	30	—	E	>360	—	E	250	—	NR	—	—	E	240	—	E	90	—	E	240	—
11. Amyl Acetate	▲	>480	E	E	60	G	NR	—	—	G	>360	E	P	—	—	NR	—	—	P	—	—
12. Amyl Alcohol	—	—	—	E	30	E	E	290	VG	G	180	G	G	12	E	E	25	VG	E	45	VG
13. Aniline	▲	>480	E	NR	—	—	E	100	P	F	>360	E	F	180	VG	E	25	VG	E	50	G
14. Aqua Regia	—	—	—	F	>360	—	G	>480	—	NR	—	—	G	120	—	NR	—	—	G	180	—
15. Benzaldehyde	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	G	10	VG	G	25	F
16. Benzene, Benzol	▲	>480	E	P	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
17. Benzotrichloride	—	—	—	E	>480	E	NR	—	—	—	—	—	—	—	—	NR	—	—	NR	—	—
18. Benzotrifluoride	—	—	—	E	170	G	F	—	—	E	—	—	G	<10	F	P	50	G	—	—	—
19. Bromine Water	—	—	—	E	>480	E	E	>480	E	—	—	—	—	—	—	—	—	—	—	—	—
20. 1-Bromopropane	▲	>480	E	■	23	F	■	<10	P	▲	>480	E	■	<10	F	■	<10	P	■	<10	P

Types of Gloves

Polyethylene/Ethylene-vinyl Alcohol {"Silver Shield®"}

- Resists permeation and breakthrough with chemicals.
- Uses: aromatics, esters, ketones, and chlorines.

Butyl

- Highest permeation resistance to gas or water vapors.
- Uses: ketones (MEK, acetone) and esters (amyl acetate, ethyl acetate).

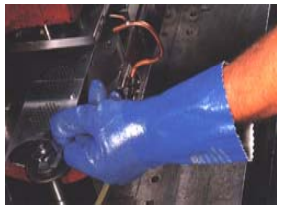
Types of Gloves

Viton®

- Highly resistant to permeation by chlorinated and aromatic solvents
- Can be used with water/water based solvents

Nitrile (acrylonitrile-butadiene rubber)

- Good replacement for latex
- Protects against acids, bases, oils, aliphatic hydrocarbon solvents and esters, grease, fats
- Resists cuts, snags, punctures and abrasions



Types of Gloves

Neoprene

- Protects against acids, caustics, DMSO.
- Resists amines, alcohols, glycols.
- Limited use for aldehydes and ketones.

Poly vinyl chloride (PVC)

- Protects against acids, caustics.
- Resists alcohols, glycols.
- Not useful for aromatics, aldehydes and ketones.

What is latex allergy?

- Natural rubber latex is from the rubber tree *Hevea brasiliensis.*
- The major route of occupational exposure is absorption of latex protein through the skin.
- Allergens in or on gloves can be transferred to the person's tissue.

Latex Allergies

- Symptoms may occur within minutes of exposure or may take several hours depending on the individual.
  - Skin Redness
  - Hives
  - Itching
  - Respiratory Symptoms
    - Runny Nose
    - Itchy Eyes
    - Scratchy Throat
    - Asthma

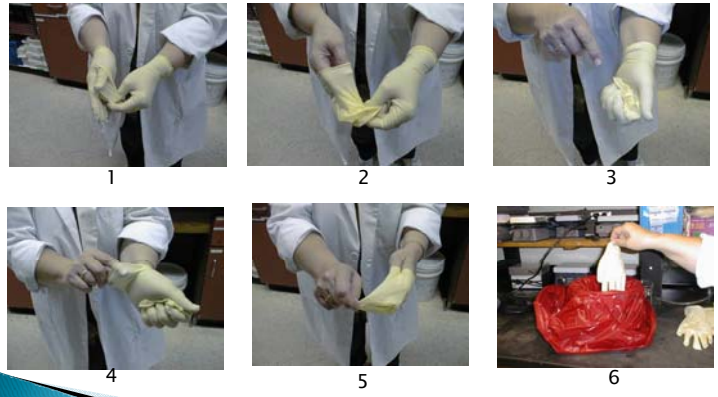
Latex Allergy

Latex Allergies

- To prevent latex allergies consider:
  - Using non-latex gloves.
  - If you choose latex gloves, use the powder-free version.
  - When using gloves, do not use oil-based hand cream or lotions (these cause glove deterioration).
  - Recognize the symptoms of latex allergy.
  - Always wash hands after removing gloves.

http://www.cdc.gov/niosh/topics/latex/
http://www.nursingworld.org/osh/latex.htm

Proper Steps for Removing Gloves



Respiratory Protection Program

- **Written program**
- **Administered by Safety Office**
- **Medical clearance**
  - **Respiratory Protection Questionnaire**
  - **No beards**
- **Fit testing**
- **Respirator selection**
  - **Air monitoring**
- **Training (annual refresher)**

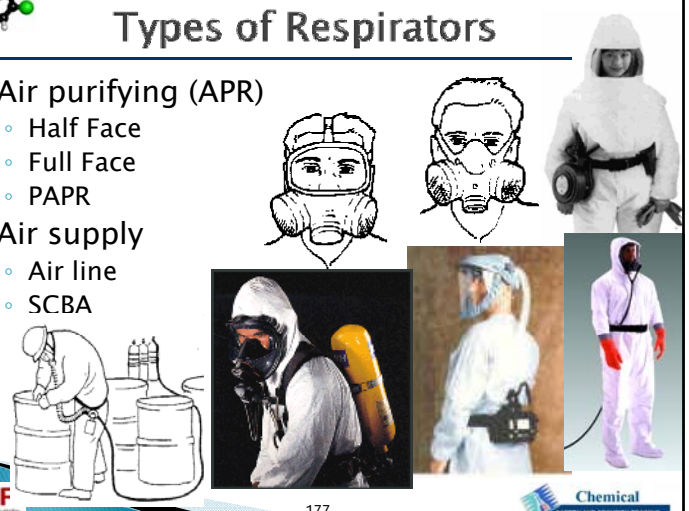
Respiratory Protection Standards

- 29 CFR 1910.134
  - OSHA Respiratory Protection Standard
  - New OSHA Assigned Protection Factors
- ANSI Z88.2-1992
  - ANSI Voluntary Consensus Standard

Conduct an Exposure Assessment:
www.osha.gov/SLTC/etools/respiratory/haz_expose/haz_expose.html

Types of Respirators

- Air purifying (APR)
  - Half Face
  - Full Face
  - PAPR
- Air supply
  - Air line
  - SCBA



177

Air Purifying Respirators

- *Must have at least 19.5% oxygen.*
  - Never use in O_2 deficient atmospheres
- *Only filters the air.*
  - Particulate filters
    - Removes aerosols
  - Chemical cartridges or canisters
    - Remove gases and vapors
- *Concentrations must not exceed limitations of filter/cartridge.*
- PAPR (Powered Air Purifying Respirator)
  - Uses a blower to force air through an air purifying element

178

APR Chemical Cartridge Selection

- Specific gases or vapors
- NIOSH or MSHA approval
- Adequate warning properties
- End of service life
- Mechanisms
  - adsorption
  - absorption
  - chemical reaction
- Breakthrough times
- *Proper maintenance and storage*

179

Cartridge Selection

Cartridge	Description
	**Organic Vapor**
	**Organic Vapor and acid gases**
	**Ammonia, methylamine and P100 any particulates filter 99.97% minimum filter efficiency**

180

End of Service Life Indicators (ESLI)

There are very few NIOSH-approved ESLI's:

- ammonia
- carbon monoxide
- ethylene oxide
- hydrogen chloride
- hydrogen fluoride
- hydrogen sulfide
- mercury
- sulfur dioxide
- toluene-2,4-diisocyanate
- vinyl chloride

Assigned Protection Factors (APF)

- Level of workplace respiratory protection that a respirator or class of respirators is expected to provide.
- Each specific *type* of respirator has an Assigned Protection Factor (APF).
- Select respirator based on the exposure limit of a contaminant and the level in the workplace.

Maximum Use Concentration (MUC)
= APF x Occupational Exposure Limit
(e.g.OEL, TLV)

Assigned Protection Factors

Type of Respirator	Half Face Mask	Full Facepiece	Helmet/ Hood	Loose-Fitting Facepiece
Air-Purifying	10	50	-	-
PAPR	50	1,000	25/1,000	25
Supplied-Air or Airline				
– Demand	10	50	-	-
– Continuous flow	50	1,000	25/1000	25
– Pressure demand	50	1,000	-	-
SCBA				
– Demand	10	50	50	-
– Pressure Demand	-	10,000	10,000	-

Assigned Protection Factors

Workplace air sampling indicates the exposure to benzene is 30 ppm. OEL is 1 ppm. What respirator should you choose?

Maximum Use Concentration (MUC) = OEL x APF
Half Face Mask: MUC = 1 ppm x 10 = 10 ppm
PAPR (LFF): MUC = 1 ppm x 25 = 25 ppm
Full Face Respirator: MUC = 1 ppm x 50 = 50 ppm

Dust Masks vs. Hospital Masks

High Efficiency Particulate Air Filter (HEPA) Respirator

Fit Testing

- Qualitative
  - Irritant smoke (stannic chloride)
  - Isoamyl acetate (banana oil)
  - Saccharin
  - Bitrex (bitter taste)
  - *Employees should perform a user seal check each time they put on a tight-fitting respirator*
- Quantitative
  - Portacount

Qualitative Fit Test

Pass/Fail Fit Test

- Assess the adequacy of respirator fit
- Relies on the individual's response to a test agent

Qualitative Fit Test

Positive / Negative pressure fit test

Supplied Air

- Supplies breathing air to employee
- Examples:
  - SCBA
  - Airline
- Grade D Air
- Limitations

Breathing Air Quality and Use

- Compressed breathing air must be at least Type 1 – Grade D [ANSI/CGA G-7.1-1989]:
  - Oxygen content = 19.5 – 23.5%
  - Hydrocarbon (condensed) = 5 mg/m^3 or less
  - CO ≤ 10 ppm or less
  - CO_2 of 1,000 ppm or less
  - Lack of noticeable odor
- Compressors equipped with in-line air-purifying sorbent beds and filters.

Breathing Air Quality and Use

- Non-oil lubricated compressors
  - CO levels in the breathing air ≤ 10 ppm
- Oil-lubricated compressors
  - High-temperature or CO alarm, or both
  - If only high-temperature alarm, the air supply must be monitored to prevent CO levels from exceeding 10 ppm

Maintenance and Storage Procedures

- Disposable filtering face-piece:
  - Dispose after use
- Half-mask:
  - Write expiration date (current date +estimate) making sure to keep entire label legible
  - Discard cartridges based on expiration date, end-of-service life indicator or calculated service life
  - Clean
  - Dry
  - Place in sealable bag (write your name on bag)
  - Contact Safety Office for repairs

Maintenance and Storage Procedures

- Exclusive use of an employee:
  - Clean and disinfect as often as necessary to be maintained in a sanitary condition.
  - Discard cartridges based on expiration date, end-of-service life indicator or calculated service life.
- Respirators issued to more than one employee or maintained for emergency use:
  - Clean and disinfect before worn by different individuals or after each use.
- Respirators used in fit testing and training:
  - Clean and disinfect after each use
- All respirators *must* be stored in clean, dry bags

Hazards Requiring Body Protection

- *Hazardous chemicals.*
- Potentially infectious materials.
- Intense heat.
- Splashes of hot metals and hot liquids.

Body Protection for Emergency Response

Full suits:
- Class A
- Class B
- Class C
- Class D

Level A Protective Suits

Potential exposure to unknown:

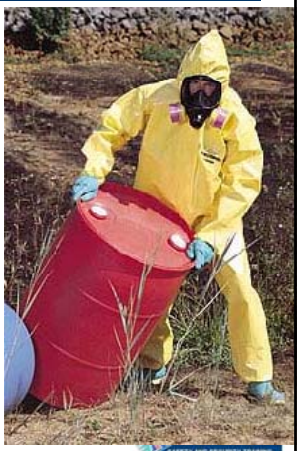
- Greatest level of skin, respiratory, and eye protection.
- Positive-pressure, full face-piece Self Contained Breathing Apparatus (SCBA) or positive pressure supplied air respirator with escape SCBA.
- Totally encapsulated (air-tight) chemical and vapor protective suit.
- Inner and outer chemical-resistant gloves, and boots.

Level B Protective Suits

- Atmospheric vapors or gas levels not sufficient to warrant level A protection.
- Highest level of respiratory protection, with lesser level of skin protection.
  - Positive-pressure, full face-piece self contained breathing apparatus (SCBA) or positive pressure supplied air respirator with escape SCBA
  - Hooded chemical resistant clothing or coveralls (non-totally-encapsulating suit), inner and outer chemical-resistant gloves, and boots

Level C Protective Suits

- Concentration or contaminant known
- Full-face air purifying respirator permitted with a lesser skin protection
- Inner and outer chemical-resistant gloves, hard hat, escape mask, disposable chemical-resistant outer boots
  - *Difference in Level C and level B is respiratory protection*



Level D Protective Suits

- Minimum protection.
- *No* respiratory or skin protection.
- Used only if no known or suspected airborne contaminants present.
- May include gloves, coveralls, safety glasses, face shield, and chemical-resistant, steel-toe boots or shoes.

Foot Protection

Should meet or exceed ANSI Standard.

Types:

- Impact,penetration, compression, steel toe, etc.
- Non-skid, with slip resistant soles.
- Chemical resistant (rubber, vinyl, plastic, with synthetic stitching to resist chemical penetration).
- Anti-static
- Temperature resistant (high or low extremes).
- Electrical protection (non-conducting).
- Water resistant
- Combination shoes

Personal Protective Equipment Foot Protection

Steel toe-safety shoes are not necessary for laboratory work *unless* there is a serious risk from transporting or handling heavy objects.

However,
open toe shoes
should NOT be worn in labs.

Head Protection

Should meet or exceed Z89.1-2003

Types:

- Bump caps - don't meet ANSI standard, provide minor protection
- Electrical protection 2200-22,000 v, depends on class)
- Mining protection
- Classic-- high impact general purpose protection.
- Impact 850-1000 pounds (386 - 454Kg)
- Penetration 3/8" (~1cm)

Any Questions?

Break

Lab Assessment Exercise

Part 5: Lab Assessment Presentations

Lab Assessment Exercise

Part 6: Lab Improvement Priorities

Questions?
Open Discussion
Homework