Safety in the Laboratory

First in a series of five
Advanced Laboratory Safety Training

"A safe, healthful, and secure environment for scholarship and research."

Key Concepts

- Safety Requirements
- Hazards
- Equipment
- Controls
- When and how to use each piece of equipment

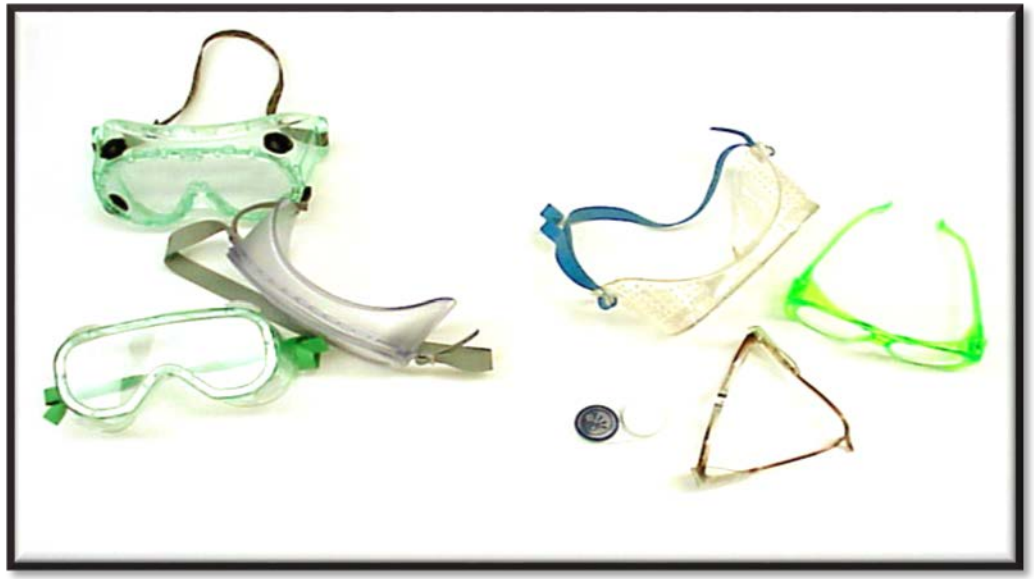
Safety regulations are established for each laboratory by Federal and State mandates and TAMU rules.

Personal Safety Requirements

- It is mandatory that **NO FOOD or DRINK** items be taken into the laboratory
- In addition to not eating, drinking or smoking in the laboratory, each person working in a chemistry laboratory needs to observe **ALL RELEVANT SAFETY REGUIREMENTS**

PPE: Eye Protection

- Whenever anyone is working with chemicals or apparatus in the laboratory, safety eyewear is required for ALL persons in the laboratory
- Chemical Safety Goggles are preferred, not glasses
- Goggles must be imprinted with “Z87” to indicate that the goggles meet flammability and chemical resistance requirements
- Goggles cannot have any type of open perforations
- In addition, contact lenses should not be worn in the laboratory, even while wearing goggles



Proper Clothing

- Wearing correct attire is essential to help avoid laboratory accidents
  - Floppy sleeves are not acceptable
  - Shoes that cover the entire foot are required
  - Shorts are not acceptable in the laboratory
  - Long hair should be tied back
  - Lab coats are recommended but not required
  - All backpacks, book bags, and coats should be placed on the coat rack and shelves provided or stored in a drawer
    - **NOT ON THE WORK BENCHES**

PPE: Gloves

- Whenever handling corrosive or toxic materials, protective gloves must be worn
- Protective gloves made of vinyl, latex, and nitrile are available
- Be sure to wear the proper type of glove for the specific chemical hazards encountered in each experimental situation
- Gloves should never be worn outside the lab

Washing Hands

Always wash your hands thoroughly to remove any potential chemical residues before you leave the laboratory.

Lab Safety Equipment

- In case of an emergency, you should know the location and proper use of ALL the safety equipment provided in the laboratory
- Always immediately inform the instructor of any accident or injury

Fire Extinguishers

- Carbon dioxide or dry powder fire extinguishers are suitable for many of the potential fire hazards in the general chemistry laboratories
- To operate this type of fire extinguisher, aim the nozzle at the base of the fire, pull out the locking key and depress the handles together
- This will release a discharge of CO_2 or powder that will smother the fire
- Always inform the instructor of the use of a fire extinguisher so that it can be recharged

Fire Blanket

- In case of a clothing fire, a fire blanket should be used
- Remove the fire blanket from its container using the straps
- Wrap it around the person to completely cover the person and smother the fire

Safety Eyewash

Any chemical contacting your eyes should be immediately and thoroughly rinsed out using the safety eyewash found in/near every laboratory.

Safety Eyewash

- Position the head between the spigots, with eyes open (indicate on picture)
- Push the handle to start the flow of water
- Flushing for 15 minutes is the standard (minimum) procedure

Safety Shower

- Remove all contaminated clothing and stand under the shower
- Pull the chain to start the flow of water
- Washing should continue long enough to insure complete removal of the chemical, at least 15-20 minutes
- Any chemical spill on a person should be washed off immediately and thoroughly, using the safety shower

Emergency Gas/Electrical Shut Off

- Locate the utility controls in your laboratory
- Be sure to understand how they operate
- In most laboratories a single valve and circuit breaker assembly will allow for the complete shut off of gas to all outlets and power to most outlets
- Locate the controls in your laboratory and be sure that you understand how they operate

Bicarbonate, Sand & Ansul

- Containers of sodium bicarbonate to neutralize acid spills, plus sand and Ansul containers should be available in chemical labs for extinguishing small fires
- These work by covering either the spill of acid or the fire with a solid
- Each needs to be cleaned up and disposed of in a specific manner
- Be sure that the instructor is notified if any of these materials have been used

ECI Safety Card

Post current Emergency Contact Information (ECI) at the entry door(s) to all laboratories and other hazardous locations.

Contact the Engineering Safety Officer for an ECI standard template 845-2132

Summoning Help in an Emergency

- Dial 911 on the campus phone to contact TAMU Emergency Services and summon police, fire department, HazMat Team, paramedics, and/or the emergency ambulance
- Dial 911 on your cell phone
- Be prepared to give the operator your name, building name & room number
- There is a campus phone located in or near each laboratory
  - Locate the one for your laboratory

Waste Disposal

- Discard waste as needed, during and at the end of each laboratory period
- Broken glass or single-use glassware must be placed in a designated broken glassware containers after any disposable contents have been removed
- Paper products that do not contain chemicals can be placed in the waste baskets
- Specific guidelines must be observed for waste disposal

Solid and Liquid Chemicals

- Solid and liquid chemicals need to be placed in appropriate containers
- The exact means will be given in the written lab procedure (SOP) or specified by the instructor
- SDS information for chemicals must be readily accessible in the work area!
- **Never dump chemicals down the drain!**

Reduce Your Risk

- Do not work unsupervised in the laboratory without the instructor's permission
- Do not conduct unattended experiments or procedures
- Do not initiate your experiment until the instructor has evaluated and approved your apparatus, procedures, and SOP's
- When in doubt, always use

  "Prudent Practices in the Laboratory"

Who is Responsible for Safety?

You are !!!

Your Safety Responsibilities

- A safe work environment depends on your active support and commitment
- Each Faculty/PI is responsible for ensuring that appropriate safety information and training is provided to their staff, students, and visitors
- Staff, students and visitors are responsible for following safe working practices and procedures as specified in written rules, protocols and policies

Hazard Communication Standards

- Established by 1983 Hazard Communication Standard CFR 1910.1200 **and** 1990 Occupational Exposure to Hazardous Chemicals, 1910.1400 aka “Lab Standard”
- Both require a written plan
  - Employers must
    - Inform workers of work hazards
    - Provide labels and other forms of warning, and Safety Data Sheets (SDS)
    - Provide information and training
    - Define minimum requirements

Laboratory Standard Definitions

Hazardous Chemical

- Chemical for which there is statistically significant evidence based on at least one study (following scientific principals) that acute or chronic health effects may occur in exposed employees
  - Includes: carcinogens, toxics, reproductive toxins, irritants, sensitizers; agents that act on the blood, lungs, skin eyes, mucus membranes; hepato-, nephro, or neurotoxins

Physical Hazards

- Material that is flammable, combustible, compressed gas, explosive, water reactive, an oxidizer, an organic peroxide, pyrophoric, or unstable

Safety Standards

Why do we need Laboratory Safety Standards in an Academic setting?

- The estimated accident rate in academic settings is 50-100 times higher than in industry
- Research scientists have little formal safety training
- Colleges and universities tend to be less litigious than industries, little lost time injuries are not reported, etc.

Fundamental Lab Standard Requirements

- Requires a Chemical Hygiene Officer (CHO)
- Development of a Chemical Hygiene Plan (CHP)
  - CHP protects employees from health hazards associated with hazardous chemicals in the laboratory
  - CHP should be capable of keeping exposure levels below the Personal Exposure Levels (PEL) as listed in the General Industry Standards
  - CHP is readily available to all employees, visitors, and upon request by Occupational Safety and Health Administration (OSHA) during inspections

Chemical Hygiene Plan (CHP) Requirements

- All CHPs must identify specific measures the employer will take to ensure laboratory employee protection, including
  - Standard Operating Procedures (SOP's) to be followed when working with hazardous chemicals
  - Criteria the employer will use to select chemicals and procedures that will be implemented to reduce exposures
    - Includes the uses of engineering controls
    - Personal Protective Equipment (PPE)
    - Hygiene practices

Chemical Hygiene Plan (CHP)

Training Requirements

- Applicable details of the CHP and where to find it
- The physical and health hazards of the chemicals found in the lab
- Methods and observations to detect presence of releases of chemicals in the lab (odor, physical symptoms, monitoring)
- Measures employees can take to protect themselves (SOPs, engineering controls, PPE)
- Labeling
- SDS

Additional Lab Standard Requirements

- Safe performance levels for fume hoods and other protective equipment must be identified
  - Program must exist to maintain the equipment to standard's level
- Employee safety information and training must be provided
- Circumstances must be identified for reviewing procedures where the use of extremely toxic or hazardous substances is required
- Provisions for medical consultation and medical surveillance for employees who have been exposed above the PELs or action levels
- Designation of personnel responsible for the implementation of the CHP (CHO vs. committee)
- Special provisions for “particularly hazardous chemicals”

Hazardous Chemical

A hazardous chemical is one for which there is significant evidence based on at least one scientific study, that acute or chronic health effects may occur in exposed individuals.

Hazardous Chemicals Include

- **Carcinogens**
- **Toxics**
- **Reproductive Toxins**
- **Irritants**
- **Sensitizers**
- **Agents that act on the blood, lungs, skin, eyes, mucus membranes**
- **Hepatotoxins**
- **Nephrotoxins**
- **Neurotoxins**

Laboratory Supervisor Responsibilities

- Develop and implement safe SOP's for the lab activities to be incorporated into the CHP
  - These must be updated as processes change
- Conduct annual training for all lab personnel on the contents of the CHP, including lab specific hazards and SOP's
- Retrain staff on all new or revised SOP's
- Ensure chemicals are handled, stored, and disposed of properly

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Chemical Hygiene Officer (CHO)

Responsibilities

- Develop a CHP covering the entire organization, containing basic policies for chemical procurement, storage and handling, waste disposal, facility standards, availability of SDS, PPE guidelines, and emergency planning for the organization
- CHO's assist the lab supervisor to develop their own CHP by providing consultation and guidance, they are not expected to be familiar with the operations of each laboratory
- Conduct train-the-trainer programs so supervisors can provide appropriate training for their personnel
- Conduct inspections of the laboratory to insure compliance with the CHP
- Administer the medical consultation and medical surveillance programs

Organization Responsibilities

- The Unit or Department Head is responsible for insuring the safety and health of individuals within that unit
- Senior person (President, CEO) in the organization is charged with the overall responsibility of health and safety program at the institution
- Health and Safety Department(s) are responsible for implementation of the plan

Medical Requirements

Medical consultation must be provided at no cost to the employee in the following circumstances.

- Whenever employees develop signs or symptoms associated with exposure
- Where monitoring reveals exposure above action levels or PELs
- Where regulation requires medical surveillance or examinations
- Following an event where there is the likelihood a hazardous exposure (spill) occurred
- Physician must provide a written opinion, exam, recommendation, or test results

Recordkeeping

- Employees must be able to examine their personal exposure monitoring records and their medical examination records (including all accident reports)
- They must be maintained for duration of employment plus thirty years

Working Safely with Laboratory Glassware

“A safe, healthful, and secure environment for scholarship and research.”

Key Concepts

- Types of Lab Glass
- Glass Hazards
- Glass handling techniques
- Tubing
- Apparatus & Fittings
- Hazards of Pressure or Vacuum

Glass Types

- Glass contains silica, an element found in sand
- Three primary glass types found in laboratories:
  - Soda lime (soft) – working temperature up to 110° degrees Celsius
  - Borosilicate (hard) – working temperature up to 230° degrees Celsius
  - Pure fused quartz (99% silica) - working temperature up to 1000° degrees Celsius
- Pyrex™ is a brand of hard glass
- Soft, hard and quartz glass have working temperatures of up to 110°, 230°, and 1000° C, respectively

Hot Glass

- Hot glass looks the same as cool glass
- Establish routines that allow hot glass to cool in out-of-the-way locations
  - For example, before removing glassware from an autoclave, crack the door and allow the glass to cool for several minutes before handling
- Use gloves and tongs to prevent burns (Note: Gloves & tongs may make handling items awkward)

Hot Glass Will Burn Unprotected Hands & Fingers

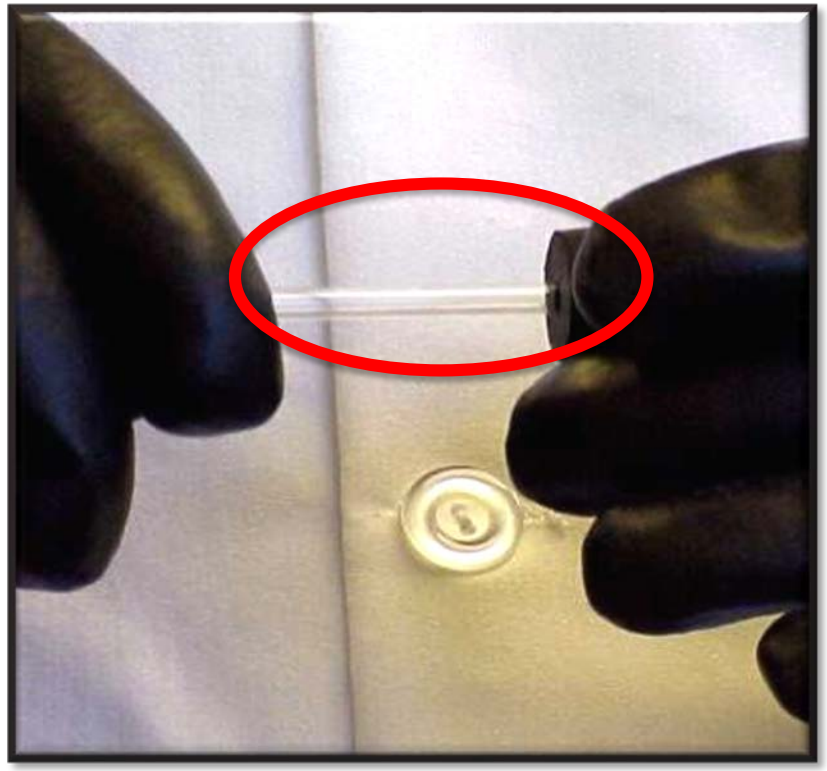
Wear Protective Gloves to Prevent Hand Injury

Preventing Cuts

- Heavy gloves should be worn when washing glassware by hand
- Glassware cuts are more common than you might expect and can be serious
- In one accident, an employee at a public university laboratory suffered cuts to five wrist tendons
  - Fortunately, the cuts were shallow and the injury did not result in permanent impairment

Inserting Glass

- Inserting a glass stem into a rubber stopper can be dangerous without proper precautions
- The task can be made safer and easier by first lubricating the glass
  - Laboratory grease works well, but even deionized water is better than nothing
- Protect hands with gloves, rags, or a shield fashioned from wood or plastic

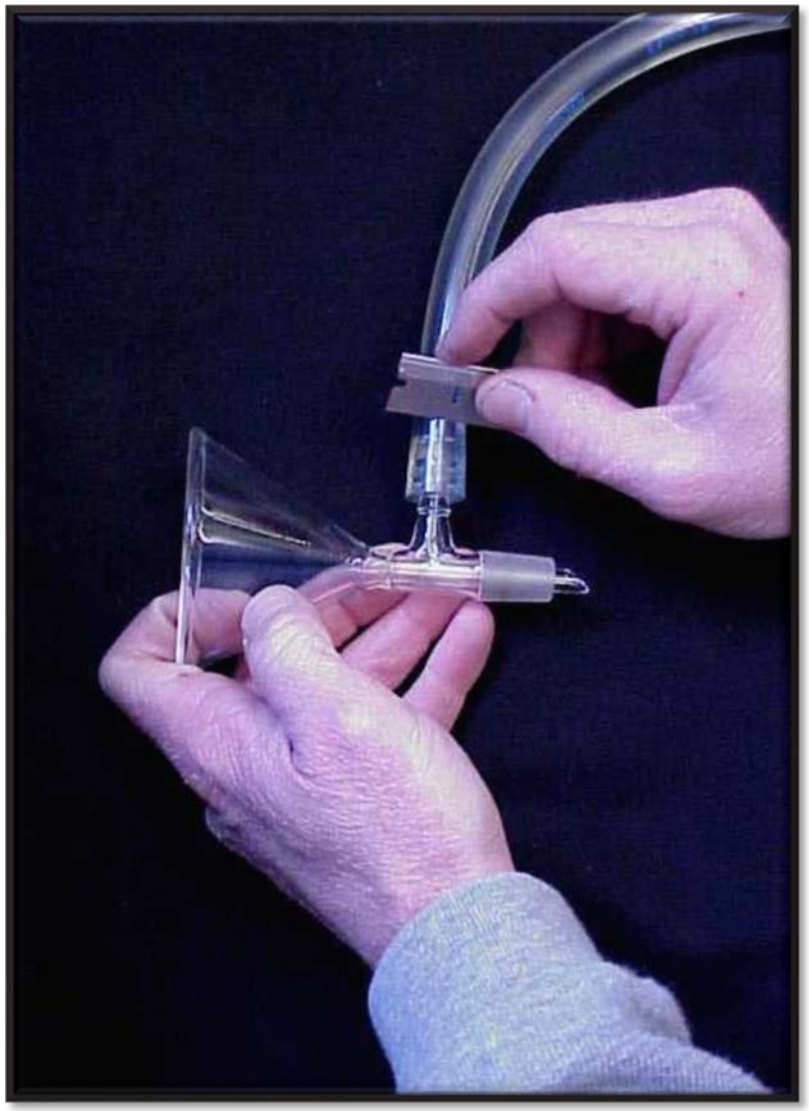


Making Connections

- When connecting plastic tubing to the side arm of a flask, condenser, etc., grease or wet the tubing (acetone works well on vinyl tubing)
- Then, with some type of hand protection, slowly work the tubing onto the glass nipple

Removing Tubing

- When removing tubing from glassware, do not attempt to pull it off
- First lay the item on the lab bench, if possible
  - Cut the tubing near the end of the glass
  - Always cut away from your body
- Next, slice the tubing lengthwise and slide the material off the glass nipple



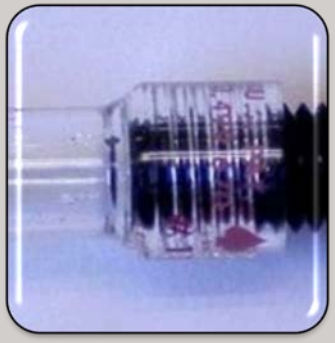
Tubing Properties

Understanding tubing material characteristics can reduce accident incidence and improve laboratory safety.

Plastic Properties	Low density polyethylene	High density polyethylene	Poly-propylene	Teflon® FEP	Poly-carbonate	Polymethyl-pentene
Temperature Limit °C	80	120	135	205	135	175
Tensile Strength, p.s.i.	2000	4000	5000	3000	8000	4000
Water Absorption, %	<0.01	<0.01	<0.02	<0.01	.035	<0.01
Flexibility	Excellent	Rigid	Rigid	Excellent	Rigid	Rigid
Transparency	Translucent	Translucent	Translucent	Translucent	Clear	Clear

Fittings

Ground-glass joints are the most common method of connecting laboratory glass. Typically these are round or tapered. Of the two types, round ground-glass joints are less likely to “freeze.



Threaded fittings are an alternative to barbed glass nipples.

Plastic tubing is typically connected via a screw cap with a plastic barb fitting and synthetic “rubber” gasket.

Several manufacturers also offer “quick-connect” fittings

One piece of the connector is threaded semi-permanently into glass. The other side attaches to tubing

Threaded compression fitting with a Teflon® seal is another connection option

O-ring or ferrule-type compression fittings are available in several material types including Viton® , silicone, and Teflon®

Apparatus Set-up

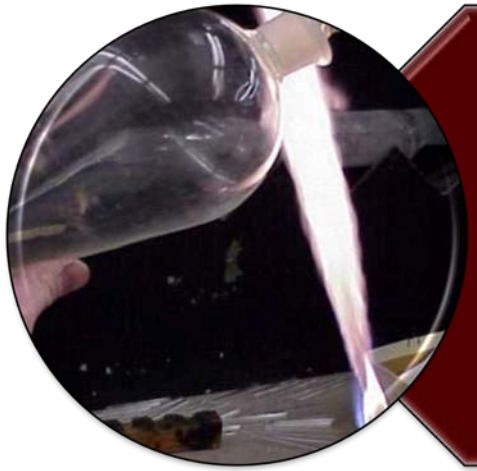
- When connecting lab apparatus, it may be necessary to clamp glass to ring stands or other supports
- Care should be taken to avoid over-tightening glassware clamps as this may induce mechanical strain

Preventing Frozen Joints

- When taper joints are used, the likelihood of “freezing” can be reduced by applying grease
- If grease is not an option, or if solvents remove the grease, tetrafluoroethylene (Teflon®) sleeves (inset) can be used to eliminate “freezing
- Once a joint is frozen, try soaking it overnight
  - If it remains frozen, do not attempt to force it apart

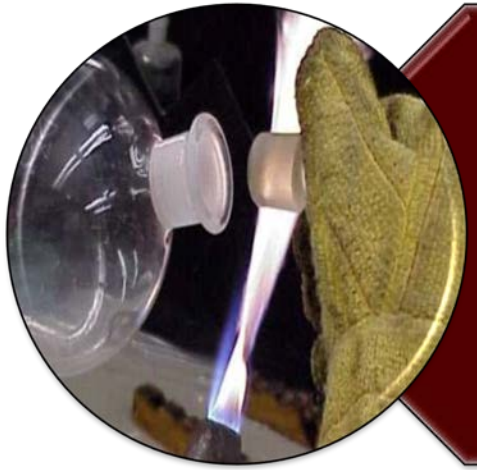
Teflon® sleeve

Unfreezing Joints Using Heat



It may be possible to loosen the joint with heat.

- A hot air gun may be tried, but a torch will likely result in better outcomes
- Once all flammable solvents are removed, and proper personal protective eyewear is donned, rapidly apply heat to the outer surface (try to keep the inner glass piece from heating)



Tapping lightly with a wooden stick may help.

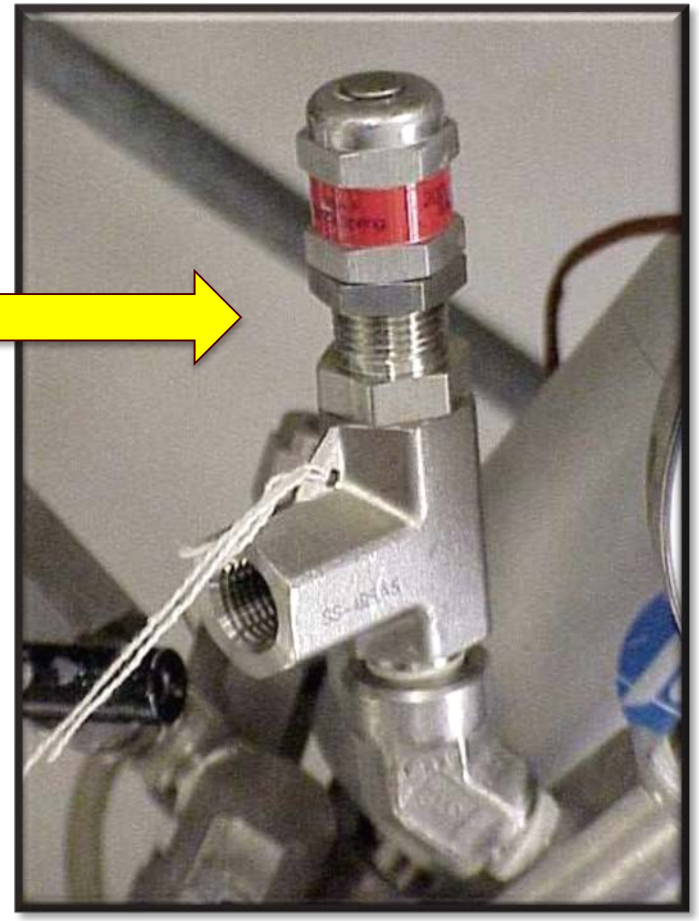
- If using a torch, do not heat longer than 30 seconds
- If you do not have a torch or are not interested in performing this procedure, a glass shop technician can provide this service for you

Using Glass Under Pressure or in Vacuum

- When glass is used under pressure or vacuum, taking extra precautions is advised
- Surface scratches are the most common defect causing weakness and breakage
- Be sure to inspect glassware for small defects before applying pressure or vacuum
- Use only glass containers that are rated for pressurization by the manufacturer
  - Install a pressure relief device

Using Glass Under Pressure or in Vacuum

- If possible, mechanically pressurized or vacuum pump systems should be operated in a fume hood with the sash down (Clamps are cheap insurance!)
- Pressure-relief (at right) and vacuum-relief devices can reduce hazards and improve research outcomes by reducing the chance of glass breakage
- If an experiment is designed, or has the potential, to generate positive system pressure, check to see that tubing is clamped securely to the apparatus
- Poorly clamped tubing could slip off the supply nozzle due to low pressure and spray the researcher in the face with liquid nitrogen

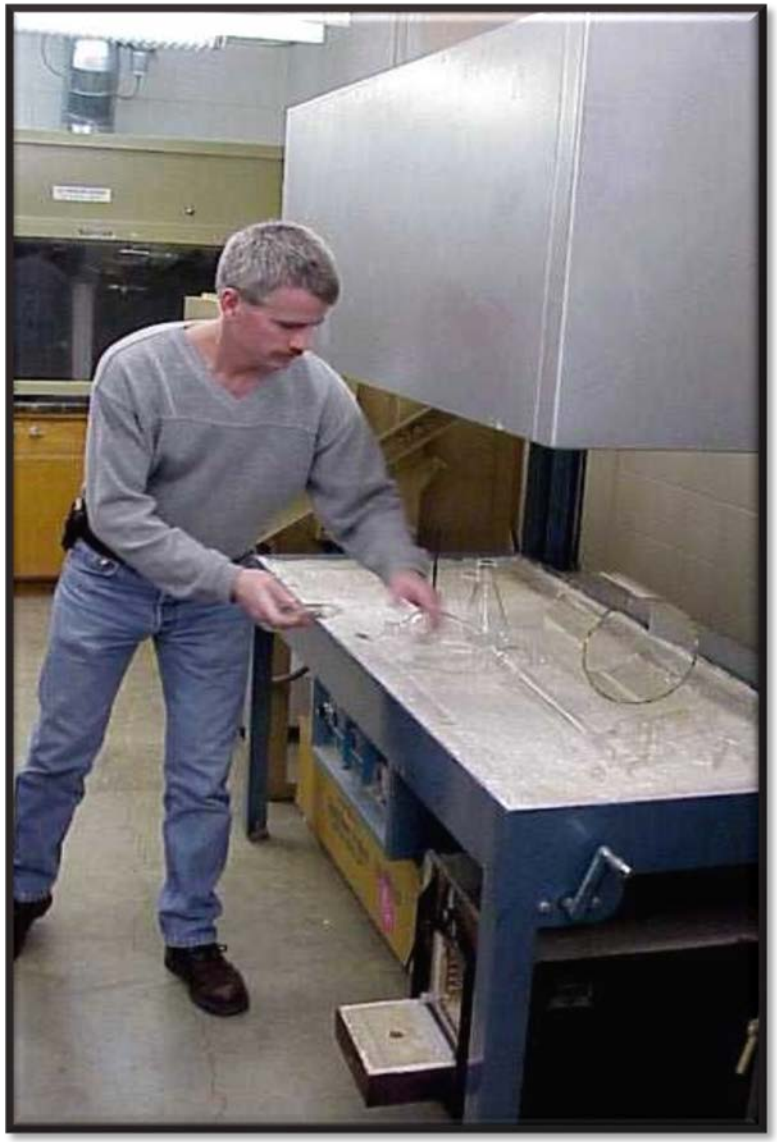


Using Vacuum Systems

- When working with vacuum systems outside of a fume hood, use epoxy-coated apparatus or tape the vessel to help contain glass in the event of failure
- Where practical, use a bench-top shield
- Keep in mind that round vessels will tolerate more pressure or vacuum than flat-sided vessels of similar construction
- **Never use glass as a pressure vessel unless approved by your safety officer !**

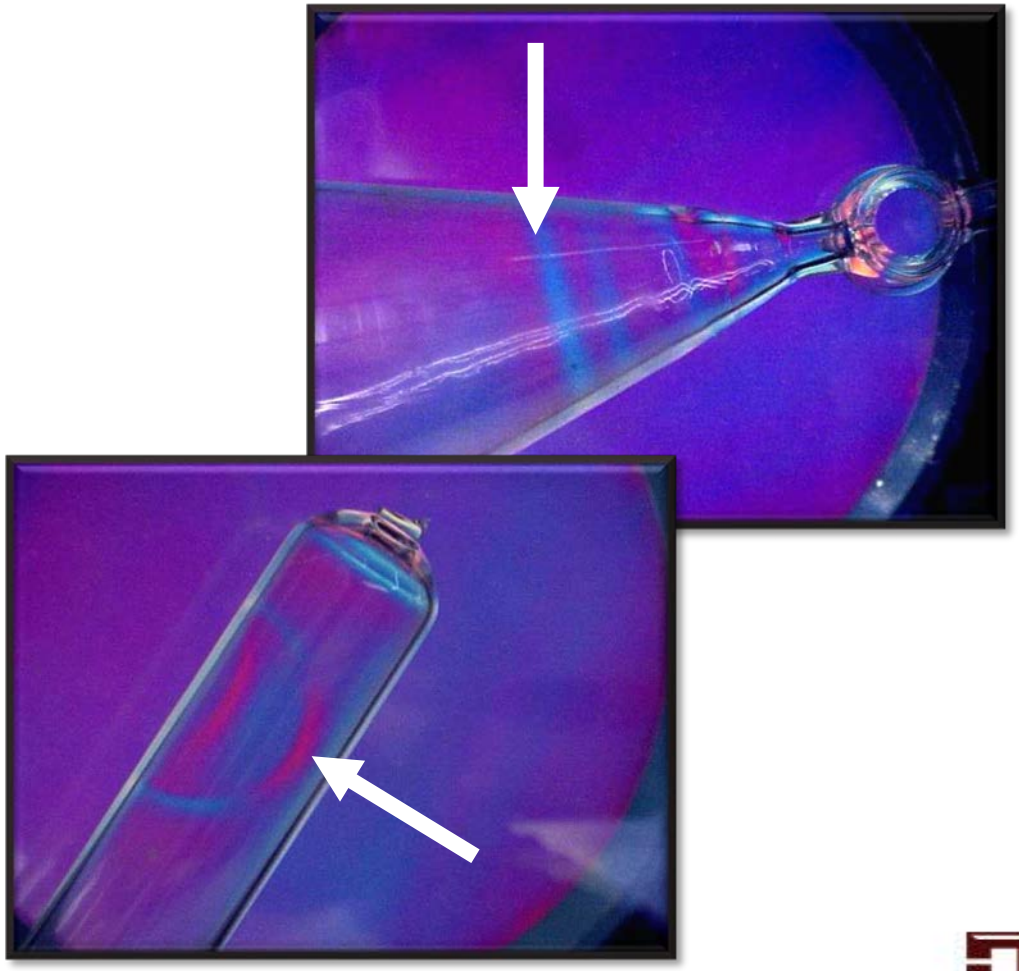
Glass Repair

- Star cracks and other small defects can be “repaired” at a glass shop, by annealing
- Annealing is a process of heating glass to a specified temperature followed by slow cooling
- The “harder” the glass, the higher the applied temperature



Glass Stress

- Glass stress results when glass is heated unevenly above its strain point, weakening the glass and increasing risk of breakage
- Glass shop technicians use polarized light to identify glass stress lines (right)
- It is difficult to stress quartz glass, but relatively easy to stress borosilicate (Pyrex™) glass, which has a strain point of 510° C
- Thermal strain is most severe in thick glass

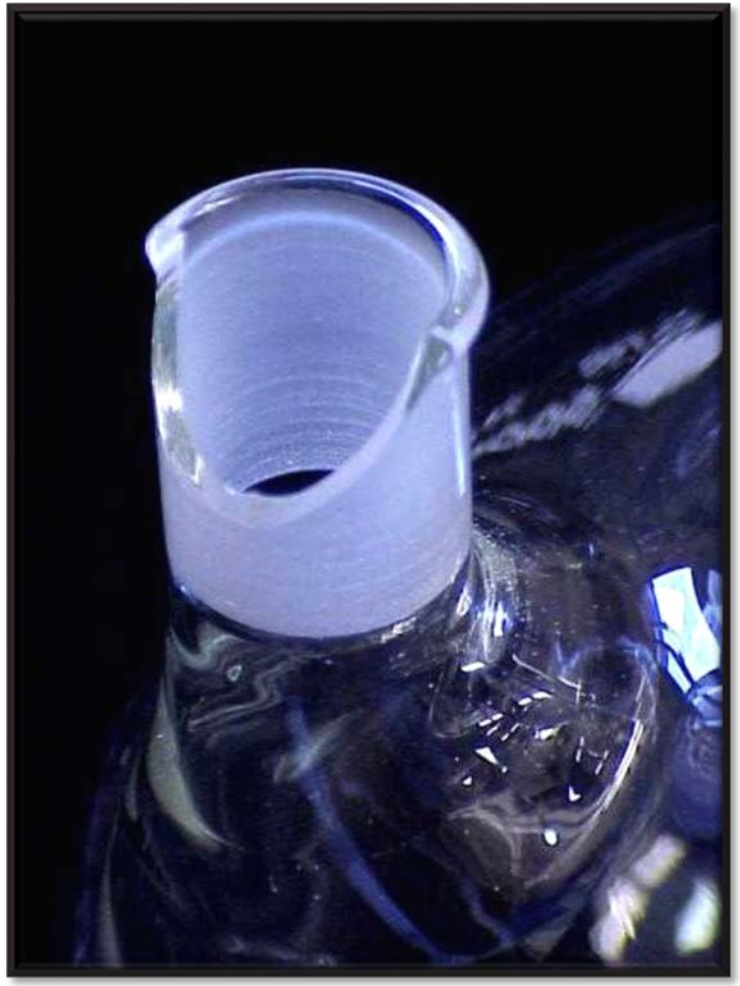


Polariscope

- If you have borosilicate glass that is routinely heated (e.g., distillation equipment), you may wish to purchase a light polarizer (polariscope) for your laboratory
- Annealing (right) removes the stress, making the glassware safer and more reliable

Chipped Glassware

- Chips weaken glassware and increase the risk of injury
- Chips and major breaks (reaction vessel, right) can be taken to a glass shop for economical repair, if one is available
- Before taking glassware in for repair, be sure to empty and clean each item
- If acetone or other flammable solvents are used, rinse glassware with water and allow to dry



Glass & Sharps Disposal

- Used and/or broken glassware should be free of chemical and biological hazards prior to disposal
- Wear gloves and safety googles when handling broken glass
- Place uncontaminated glass in a puncture-resistant box, lined with a plastic bag, label “BROKEN GLASS,” and secure with tape
- When the container is 2/3 full, tape it securely shut, and take it to an outside solid waste dumpster for safe disposal
- Custodians do **NOT** remove **YOUR** broken glass!
- For more information on glass disposal, contact the Office of Engineering Safety

What Are Sharps?


Hypodermic needles


Scalpels

Razor blades


Broken glass items


X-acto knife blades

If these sharps are uncontaminated, they go into a separate collection.

Disposing Sharps

For disposal purposes, there are four kinds of sharps:

1. Non-contaminated
2. Biohazardous (biologically contaminated)
3. Chemically contaminated
4. Radioactive

Keeping used sharps segregated by type of contamination is required by law, and will make disposal less expensive and less complicated.

Sharps Container

- Always use an approved sharps container to dispose of contaminated sharps!
- When 2/3 full, dispose of in compliance with the university's Hazardous Waste Management Plan
- For more information on sharps disposal, contact the Office of Engineering Safety

Footwear

- Finally, open-toed shoes are not allowed in laboratories (not while on feet, that is)
- Toes in open shoes are more vulnerable to cuts from dropped glassware, chemical attack, and a variety of impact injuries
- Only close-toe, solid shoes are allowed in laboratories
- Specialized protective footwear may be necessary

Foot Injury - Burns From Laboratory Acid Spill

Result of Improper Footwear in a Laboratory
Northwestern University, Evanston, IL
July 2003

Laboratory Waste Management

“A safe, healthful, and secure environment for scholarship and research.”

Key Concepts

- Hazardous Waste
- Hazardous Waste Regulations
- Characteristic Wastes vs. Listed Wastes
- Waste Generator Categories
- TAMU Hazardous Waste Management Program
- Hazardous Waste Accumulation
- Hazardous Waste Collection & Disposal
- Spill Cleanup & Control

Waste Regulations

1976 Resource Conservation and Recovery Act (RCRA)

- Defined hazardous waste as a solid waste or combination of solid wastes
- Which because of its quantity, concentration, chemical or infectious characteristics may cause, or significantly contribute to
  - An increase in mortality
  - An increase in serious incapacitating reversible illness
  - Pose a substantial present or potential hazard to human health
  - Pose a threat to the environment when improperly treated, stored, transported, disposed of, or otherwise managed
- RCRA had cradle-to-grave control that regulated the generation, transportation, treatment, storage and disposal of hazardous waste
- RCRA also provided the framework for handling non-hazardous waste

Waste Regulations - EPA

- Congress defined waste and gave statutory authority to the Environmental Protection Agency (EPA) to regulate it
- 1980, CERCLA (Comprehensive, Environmental Response Compensation and Liability act), allowed EPA to identify and clean-up abandoned or uncontrolled hazardous waste sites
- It established a Federal “Superfund” to finance these costs and generator liability to recover clean-up costs
- It also created a priority listing of active sites and established Reportable Quantities (RQs) for releases of hazardous substances that must be reported to the National Response Center

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Waste Regulations, 1984 - Amendment to RCRA

- RCRA was amended to include HSWA (hazardous and solid waste amendments), requiring generators to:
  - Certify that they have a waste minimization program in place
  - Identify efforts to taken to reduce the quantity and toxicity of the waste

Characteristic Wastes

- Hazardous waste definitions are separated into two categories:
  - "Characteristic" hazards
    - Ignitable
    - Corrosive
    - Reactive
    - Toxic
  - "Listed" hazards
    - ± 400 chemicals & chemical wastes are "Listed" by EPA
    - They have codes that begin with P, U, F, or K

Types of Characteristic Wastes

Ignitable (D001): If the waste is a liquid and has a flashpoint less than 140° degrees F.

Corrosive (D002): If the waste has a pH of 2 or less, or 12.5 or more, or if it corrodes steel at a certain rate.

Reactive (D003): If the material reacts with water, forms explosive mixtures with water, generates toxic fumes or vapors when mixed with water, is a cyanide or sulfide bearing waste which generates hazardous fumes or vapors, or is explosive.

Toxic (D004-43): If the wastes contain more than a certain level of some toxic materials, includes heavy metals, organics, and pesticides.

Identifying Characteristic Wastes

- Toxic Characteristic Leaching Procedure (TCLP)
- Toxic Wastes are identified by a TCLP test
- A material fails the TCLP test if it contains any listed constituent above the regulatory concentration established by EPA

Types of Listed Wastes

About 400 chemicals and chemical wastes are listed wastes. They have codes that begin with P, U, F, or K:

- **P-code** wastes are acutely hazardous, containers that contain these wastes are also managed as hazardous waste unless triple rinsed
  - Many P-code wastes are pesticides
- **U-code** (non-acutely hazardous) They are not considered hazardous until they are discarded in its unused form
  - They can be stored indefinitely they are to be used
- **F-code** wastes are wastes that are listed from non-specific sources. Includes spent halogenated and non-halogenated solvents in (methylene chloride, CCL4, benzene, toluene, MEK etc.)
- **K-code** wastes includes wastes from specific industry sources

Waste Generator Categories

Conditionally Exempt Small Quantity Generator (CESQG)

- An organization or company that is not allowed to generate more than 220 lbs. of hazardous wastes and less than 2.2 lbs. of acutely hazardous waste per month
  - Must correctly identify all hazardous waste
  - Never store more than 2,200 lbs. on site
  - Ensure its waste is properly disposed of at an approved facility

Waste Generator Categories

Small Quantity Generator

- An organization or company that is allowed to generate 220 - 2,200 lbs. of hazardous waste and less than 2.2 lbs. of acute hazardous waste per month
  - Acquire an EPA I.D. number
  - Follow EPA storage facility requirements
  - Follow DOT packaging requirements
  - Prepare manifests to accompany shipments
  - Include certification with each shipment on the proper treatment method
  - Allowed to store waste longer than 90 days

Waste Generator Categories

Large Quantity Generator

- An organization or company that generates more than 2,200 lbs. of hazardous waste and 2.2 lbs. of acute hazardous waste per month
  - Prepare a written contingency plan and HAZWOPER training for all responders
  - Biennial reports to EPA regarding waste shipments, waste minimization efforts
  - Comply with land band restrictions

- HAZWOPER
  - Hazardous Waste Operations & Emergency Response
  - 29 CFR 1910.120

Hazardous Waste Accumulation Rules

- Keep no more than 10 gallons of flammable liquid and 1 qt of acutely hazardous waste in your laboratory
- Tag all wastes with TAMU Waste Tag
- Call for a pick-up whenever your container is full, or minimum every 3 months
- The university currently does not hold a TSD permit, so waste must be eliminated from site 90 days after it is received at the hazardous waste storage facility
- Store chemical waste in the designated area – especially not on the fume hood
- Keep containers closed
- Never leave funnels in the bottles
- Never leave lids unscrewed
- TSD - *Treatment, Storage & Disposal* of Hazardous Wastes

Hazardous Waste Accumulation Rules

- Stoppers or corks are unacceptable
- Containers must be compatible with the waste
- Must be properly labeled
- Must have completed TAMU Waste Tag
- Do not overfill
  - leave 2 inches headspace in all bottles
- Contact your Safety Officer if you have any questions or need waste tags

Hazardous Waste Accumulation Rules

Label all waste containers

- Put TAMU Waste Tags on all waste containers
- Identify the material
  - Disposal of unknown waste is very expensive, and you will be direct billed for special disposal fees
- Complete all information on the TAMU Waste Tag
- Do not date the tag
- Print clearly!
- Do not use formulas, symbols or abbreviations
- All components in a “Commingled Waste” must equal 100%, including water and trace chemicals
- Place only compatible materials together
- Call TAMU Waste Management (845-2132) or your Safety Officer if you have questions
- If more than one Waste Tag is needed, number them #1 of 2, etc.

Hazardous Waste Accumulation Rules

- Avoid excessive accumulation of waste
  - Less waste means safer conditions and more working space for you
- Inspect your accumulation areas to make sure they are clean, no leaks, lids on, labeled and segregated
- Post copies of the Waste Management Guide, labels and tags where they are readily accessible to all in the lab
- Maintain good housekeeping in the lab at all times
  - The condition of your lab reflects the quality of your research!!!
  - If it looks like a waste you may be cited during an inspection

Waste Collection

- A TAMU Waste Tag must be completed for every container of waste
  - A unique I.D. # is given to each bottle
  - You must certify you have done everything to minimize the waste i.e. microscale techniques, additional steps to neutralize or render the waste non-hazardous, etc.

Unknown Chemicals

- Hazardous waste not clearly identified by your laboratory are called “UNKNOWNS”
  - They are very expensive to dispose of
  - Departments/Divisions are charged for analysis, identification and special disposal of UNKNOWNS
  - If you share lab with someone who graduates or leaves, make sure they dispose of all their old chemicals or you may be stuck with the bill!!!
  - In FY-2008 one Engineering Department received a waste disposal invoice for $5,000, and another Department received a waste disposal invoice for $4,800
  - All Departments & Divisions must keep careful records of the identity, source and “owner” of each waste for accurate billing purposes

Who is Responsible?

for proper waste handling and disposal

- Faculty and/or PI's are responsible for ensuring all lab personnel handle their wastes according to:
  - Texas and Federal requirements
  - The TAMU Hazardous Waste Management Program
  - The Engineering Safety Policy
  - Pollution Prevention & Waste Minimization Guidelines
- If the responsible individual is unknown, the Department or Division will be charged for any waste disposal fees

Simple Spill

- Usually less than 4 liters or about 1 gal
- NOT something that spreads rapidly
- Is NOT classified as extremely toxic or rated 4 according to NFPA-704
- Can be cleaned up by laboratory personnel or contact:
  - TAMU Hazardous Materials Emergency Response Team
  - Call the Emergency Management Dispatcher at 911
  - Call EHSD at 845-2132
- Report ALL Mercury spills!

Complicated Spill or Large Spill

- Spill causing an IDLH condition (≥ 4 liters or one gal.)
  - Immediately call 9-911 or 911
  - Be specific about the material spilled
  - Evacuate the building
  - Bring the SDS
  - Requires a HazMat response team to clean up
  - If it is flammable turn off all ignition sources and open windows before leaving

- IDLH - *Immediately Dangerous to Life and Health*

Controlling and Cleaning Up a Spill

- Calcium bentonite can be used on most spills, except HF
- Non-clay kitty litter can also be used to clean spills
- Keep sodium bisulfate for base neutralization
- Keep sodium bicarbonate for acid neutralization
- Keep calcium gluconate gel on hand to treat HF exposures
- Keep a spill control & clean up kit in the lab, appropriate to clean up ≤ 4 liters of any chemical present in the laboratory

Controlling and Cleaning Up a Spill

- Keep trash bags on hand
  - All spill clean-up material must be placed in the bag and treated as hazardous waste
- Place contaminated broken glassware in a box then put it the bag
  - Properly label the bag
- Clean broken glassware should be place in a cardboard box and carried to the dumpster
- Do not place broken glass or discarded sharps in the laboratory trash can!
  - Use a proper broken glass container
- Know how to summon emergency help: Call 911
- Know how to report incidents & injuries

General Guidelines for Handling Waste Properly

- Read the Chemical Waste Management chapter of the Safety Manual
- When in doubt, call your safety officer for assistance
- Never clean a spill if you do not have proper PPE, smell strong odors, or are unsure
- Be prepared!

General Guidelines for Preventing Spills

- Always keep a clean, orderly lab!
  - Minimize exposures
  - Reduce potential for a spill
  - Reduce the risk of citations
  - Reduce your expenses
  - Improve the quality of your research

Good Housekeeping = Quality Research

Fire Safety in the Laboratory

"A safe, healthful, and secure environment for scholarship and research."

Key Concepts

- The Fire Tetrahedron: 4 things necessary for fire
- Stages of Combustion
- Chemistry of Fire
- Fire Extinction
- Classes of Fires
- Using a Fire Extinguisher
- TAMU Fire Extinguisher Training @ 845-7715

Objectives

- Identify the classification of types of fire as they relate to the use of portable extinguishers
- Identify the appropriate extinguishers and the application procedures for the various classes
- Extinguish Class A fires using the appropriate extinguisher

Goals of a Fire Prevention Program

- **Protect Life**
  - The primary goal of fire safety efforts is to protect building occupants from injury and to prevent loss of life
- **Protect Property**
  - The secondary goal of fire safety is to prevent property damage
- **Protect Operations**
  - By preventing fires and limiting damage we can assure that work operations will continue

Housekeeping

- Good housekeeping habits are an important part of a safe workplace
- Why is good housekeeping important?
  - To reduce amounts of flammable and combustible materials
  - To reduce ignition hazards
  - To ensure safe emergency evacuation of occupants
  - To allow for quick emergency response
- Work areas, aisles, walkways, stairways, and equipment should be kept clear of loose materials, trash, scraps, etc.

Housekeeping

- Never block aisles, fire exits, emergency equipment, or alarm pull stations with equipment or materials
- Avoid build-up of combustible trash and waste such as paper, wood, cardboard, etc.
- Keep use and storage of flammables and combustibles to a minimum
- Clean up all spills such as grease, oil, or water immediately
  - A delay could result in accidents

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 18 inches below sprinkler heads or smoke detectors
  - Storage that breaks this plane may prevent sprinkler heads from fully covering room during a fire

An example of how storage can protrude into the 18-inch plane below sprinkler heads.

Storage Guidelines

- All storage must be at least 3 ft from electrical panels
- In some emergency situations it will be necessary to access panels quickly

Improper Storage in front of Electrical Panel

- Maintain at least a 3 ft clearance from heating surfaces, air ducts, heaters, and lighting fixtures
- Storage of combustible materials in mechanical rooms is prohibited

Improper Mechanical Room Storage

How Do I Tell What's Flammable?

- National Fire Protection Agency (NFPA) 704 classification system
  - The NFPA diamond is an easy way to determine the safety risks associated with hazardous materials
  - To determine a materials flammability refer to the red section of the diamond
  - A number in this section will indicate the flammability rating of the material
- The following numbering system is used to indicate flammability

0 - will not burn

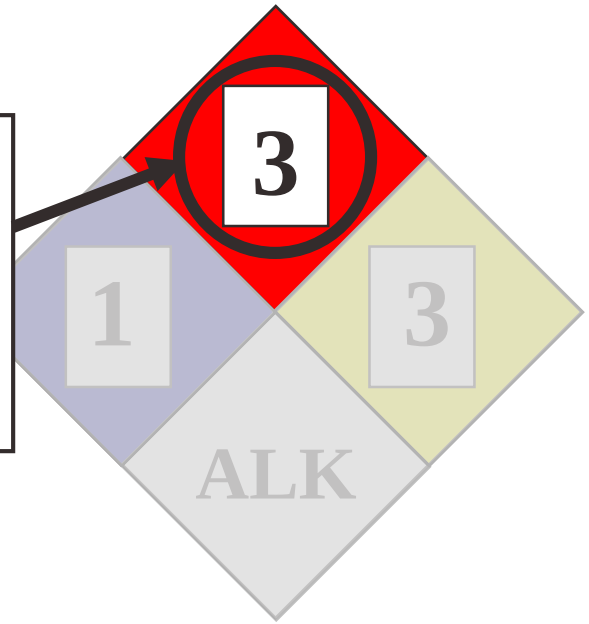
1 - must be preheated to burn

2 - ignites when moderately heated

3 - ignites at normal temperature

4 - extremely flammable

For example, an NFPA diamond on a can of gasoline would have a 3 in the red section indicating that gasoline could ignite at normal working temperatures.



Flammable and Combustible Liquids

- Flammable and combustible liquids are potential fuel sources for fires and are present in almost every workplace
- It is actually the vapor created by flammable and combustible liquids that ignites and burns
- It is important to understand what materials in your work area are flammable and combustible so that you may properly store and isolate them from ignition sources

Flammable and Combustible Liquids

- Flammable liquids are considered flammable because their flashpoints are < 100º F.
  - This means that flammable liquids burn easily at normal working temperatures
- Combustible liquids have a flashpoint at or above 100º F.
  - These liquids are less hazardous than flammable liquids but still pose a risk
- The volatility of flammable and combustible liquids requires special storage and handling requirements

Storing Flammable and Combustible Liquids

- Flammable liquids must be stored away from ignition sources in cool, well ventilated areas away from incompatible materials
- Limit the amount of flammable and combustible liquids to the minimum amount necessary
- As a general rule, No more than 10 gallons of flammable materials should be outside of approved flammable liquid storage cabinets or approved storage rooms
- Room storage limits of flammable and combustible materials depend on various factors such as sprinklers, and storage cabinets
  - Refer to the table on the following slide for storage guidelines

NFPA Classification System

- Where can I find NFPA diamonds?
  - Product labels
  - Safety Data Sheets (ask your supervisor for them)
- How do I determine the flammability of chemicals that don't use the NFPA classification system?
  - The flashpoint of a chemical may be used to determine its flammability
  - Flashpoint information may be found on product labels or SDS sheets
    - The flashpoint of a liquid is the lowest temperature at which the liquid gives off enough vapor to be ignited
    - The lower the flashpoint, the greater the risk for ignition

I.S.U. Flammable Liquid Storage Limits

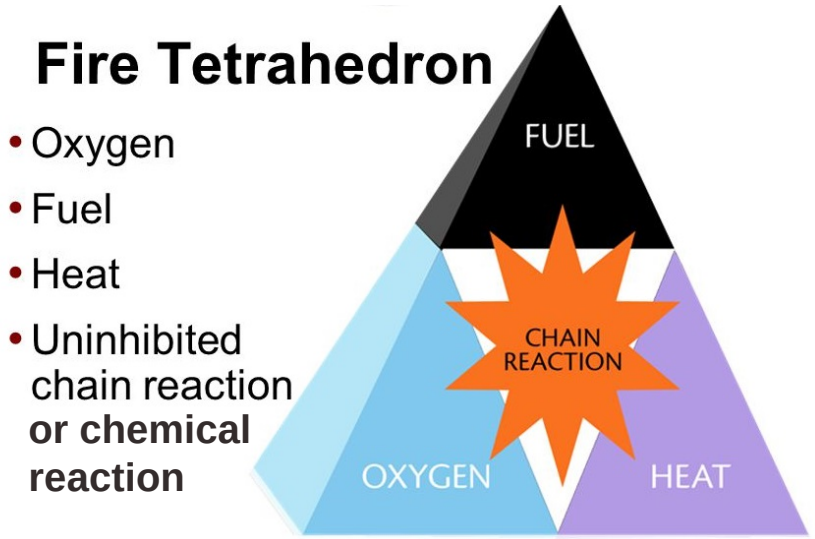
Table 1. Room Storage Limits for Flammable and Combustible Liquids

Class of Liquid	Flash point (°F)	Boiling point (°F)	Non Sprinkled Building	Non Sprinkled Bldg. & Flammable Liquid Storage Cabinet	Sprinkled Building	Sprinkled Bldg./Flammable Liquid Storage Cabinet
Class 1A, Flammables	<73 °F	<100 °F	10 gal.	20 gal.	10 gal	40 gal.
Class 1B Flammables	<73 °F	>100 °F	10 gal.	40 gal.	10 gal	80 gal.
Class 1C Flammable	> 73 & <100 °F	NA	10 gal.	60 gal.	10 gal	120 gal.
Class II Combustibles	>100 & <140 °F	NA	30 gal.	60 gal.	60 gal.	90 gal.
Class III-A Combustibles	>140& <200°F	NA	50 gal.	100 gal.	100 gal.	150 gal.

Note: Containers other than safety cans shall not be greater capacity than one (1) gallon. The number of two (2) gallon safety cans shall not exceed five (5). The number of one (1) gallon safety cans in use outside storage cabinets shall not exceed ten (10).

Chemistry of Fire: The Fire Tetrahedron

- In order for fire to occur four things must be present:
  - Oxygen
  - Fuel
  - Heat
  - Chemical Reaction
- When any of the four items are removed, the fire will go out
- Fire extinguishers function by removing one of the four components of the Fire Tetrahedron



The Four Stages Of Combustion

Explosions excepted, most fires have quite humble beginnings & grow through four stages

Incipient Stage - At this stage, decomposition is occurring at the surface of the fuel due to the influence of some form of heat. Products of combustion given off at this stage are invisible to the eye.

Smoldering Stage - At this stage, up to 10% of the decomposing products released at the surface of the fuel are visible.

Flaming Stage - Vapors from the decomposing fuel have ignited and are at the stage where flames are self-propagating.

Heat Stage - At this stage the burning has progressed to the point where the fire is still small but generating sufficient heat to warm the air immediately around the fire, sending warm products of combustion upwards by convection.

- The time required for a fire to develop through the first two stages is usually quite long when compared to the last two
- Depending on conditions, the time involved going through all stages may be anything from seconds to days

The Chemistry Of Fire Extinction

Eliminate or remove of one or more of the four elements of the fire tetrahedron by

Cooling - The most commonly used firefighting medium is water. Water absorbs heat from the fire and cools the fuel to a temperature where it no longer produces flammable vapors.

Smothering - By excluding the oxygen in the surrounding atmosphere, the fire will be extinguished.

Starvation - Starvation is achieved by removal of the fuel burning in the fire. Sometimes combustible material can be removed such as by shutting off gas valves or fuel flows.

Stop Chain Reaction - Stop or interrupt the chain reaction between the fuel, heat and oxygen the fire will be extinguished.

Specific methods of extinguishing fires often involves a combination of more than one of the four principles.

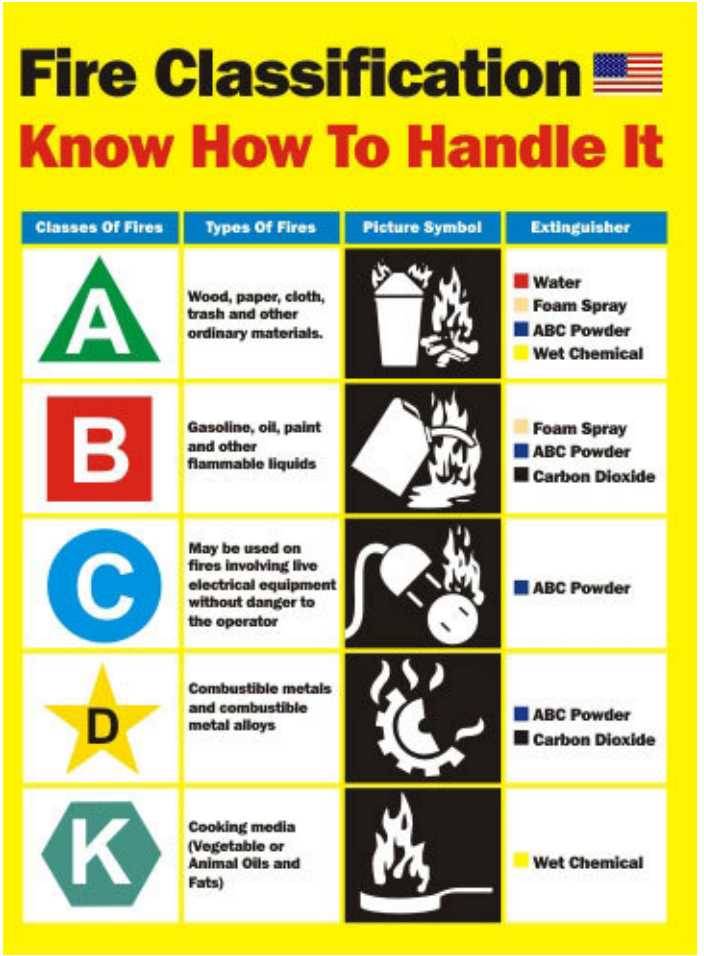
Classes of Fires

CLASS ‘A’ (Combustible Solids)
Fires involving solid material of an organic nature, namely carbon compounds such as wood, paper, cloth, etc. are the most common class of fire.

CLASS ‘B’ (Combustible Liquids)
Fires involving liquids or liquefiable solids such as, organic liquids, oil, paint, fat, thinners, etc.

CLASS ‘C’ (Combustible Gases)
Fires involving gases in either vapor or liquefied form, either as a spillage of the liquid or leak of vapor. Methane, hydrogen, acetylene, propane, butane, etc. are examples of likely fuels.

CLASS ‘D’ (Combustible Metals)
Fires involving metals such as magnesium, aluminum, sodium or potassium, certain organometallic compounds such as alkyl lithium and Grignard reagents.



Fire Extinguishers

Examples Of Fire Extinguishers

Water

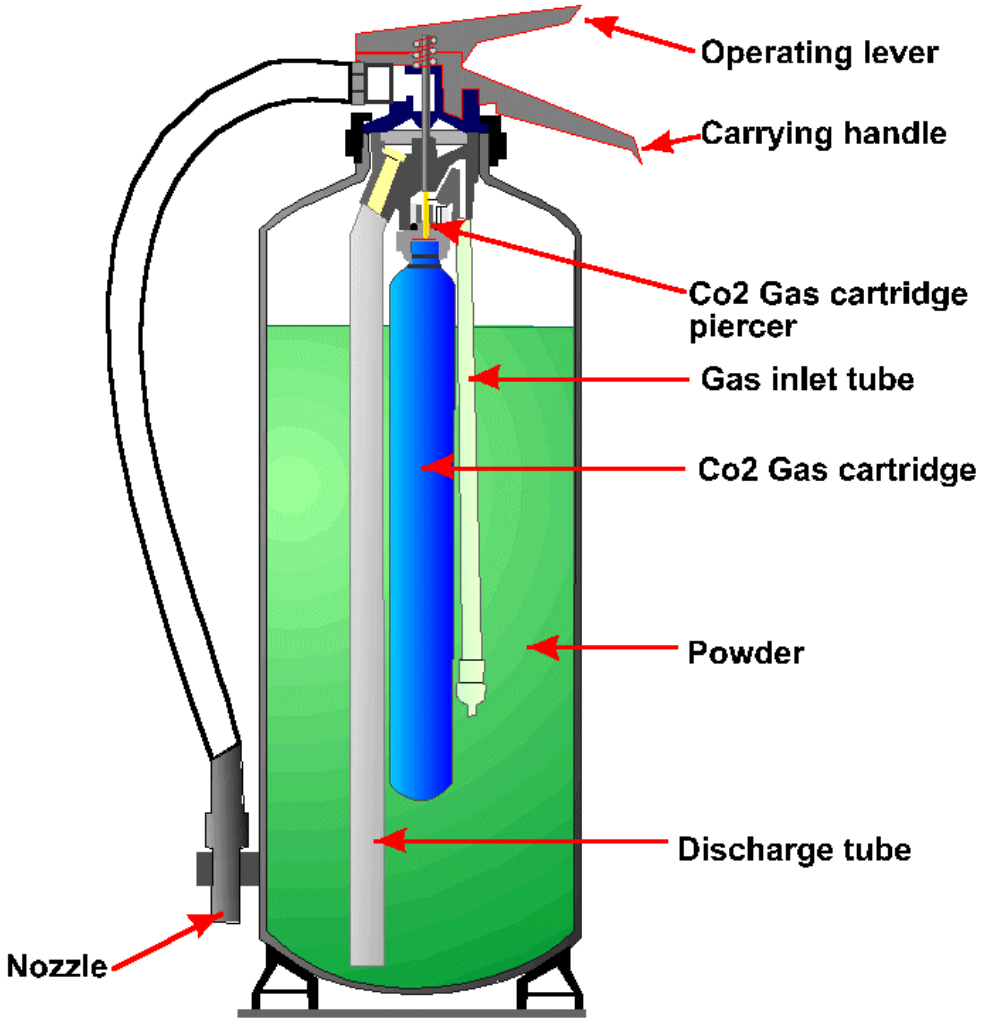
Foam

Halotron Gas

Carbon Dioxide

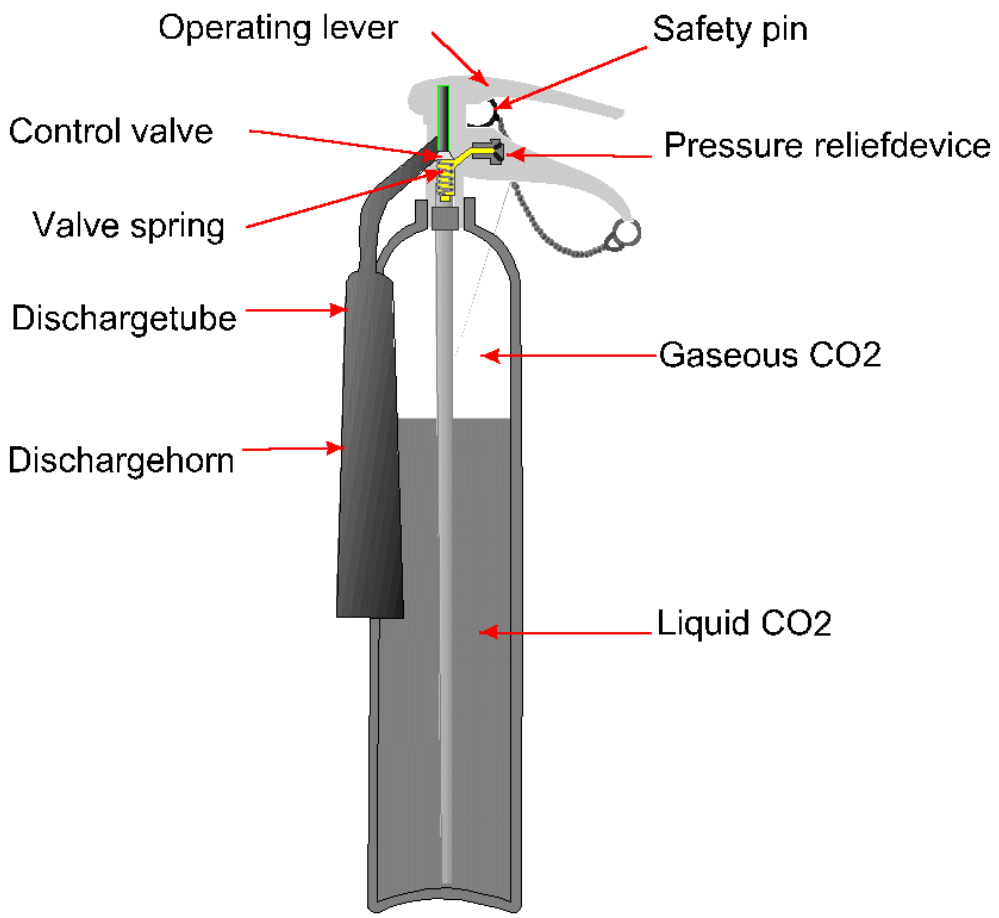
Dry Chemical

Inside the Dry Powder Fire Extinguisher



Inside the Carbon Dioxide Fire Extinguisher

Carbon dioxide extinguisher (small size)



Care of Your Extinguisher

Have it pressure checked every 6 years.

Fire extinguisher should be inspected at least monthly.

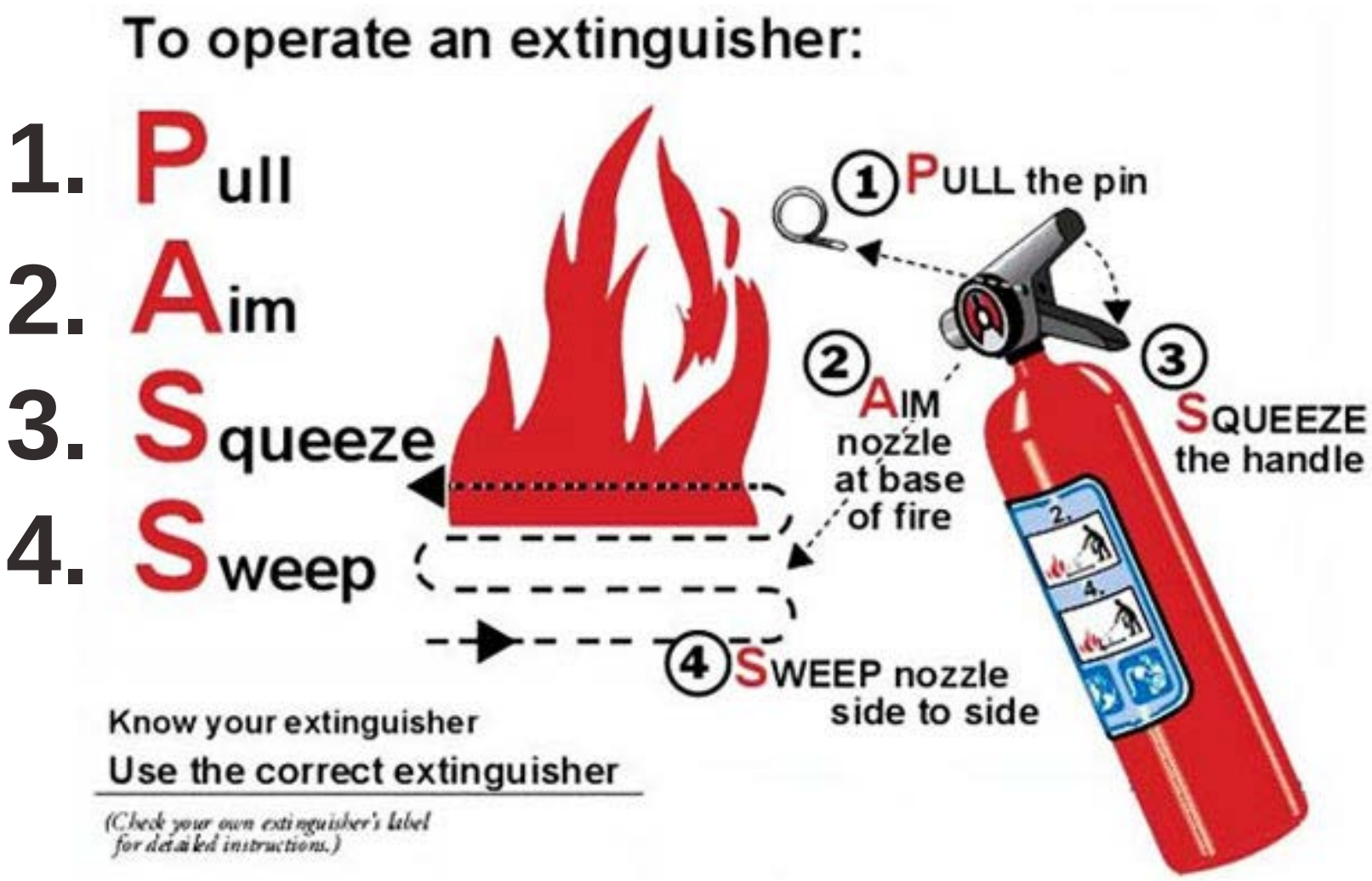
Using a Fire Extinguisher

- Keep your back to an unobstructed exit and stand six to eight feet away from the fire
- Follow the four-step procedure
  - Pull, Aim, Squeeze and Sweep (PASS)
- Pull the pin
  - This unlocks the operating lever and allows you to discharge the extinguisher
  - Some extinguishers may have other lever-release mechanisms
- Aim low
  - Point the extinguisher nozzle (or hose) at the base of the fire
  - Generally, you must be within 10’ of the fire, to use a hand-held fire extinguisher effectively

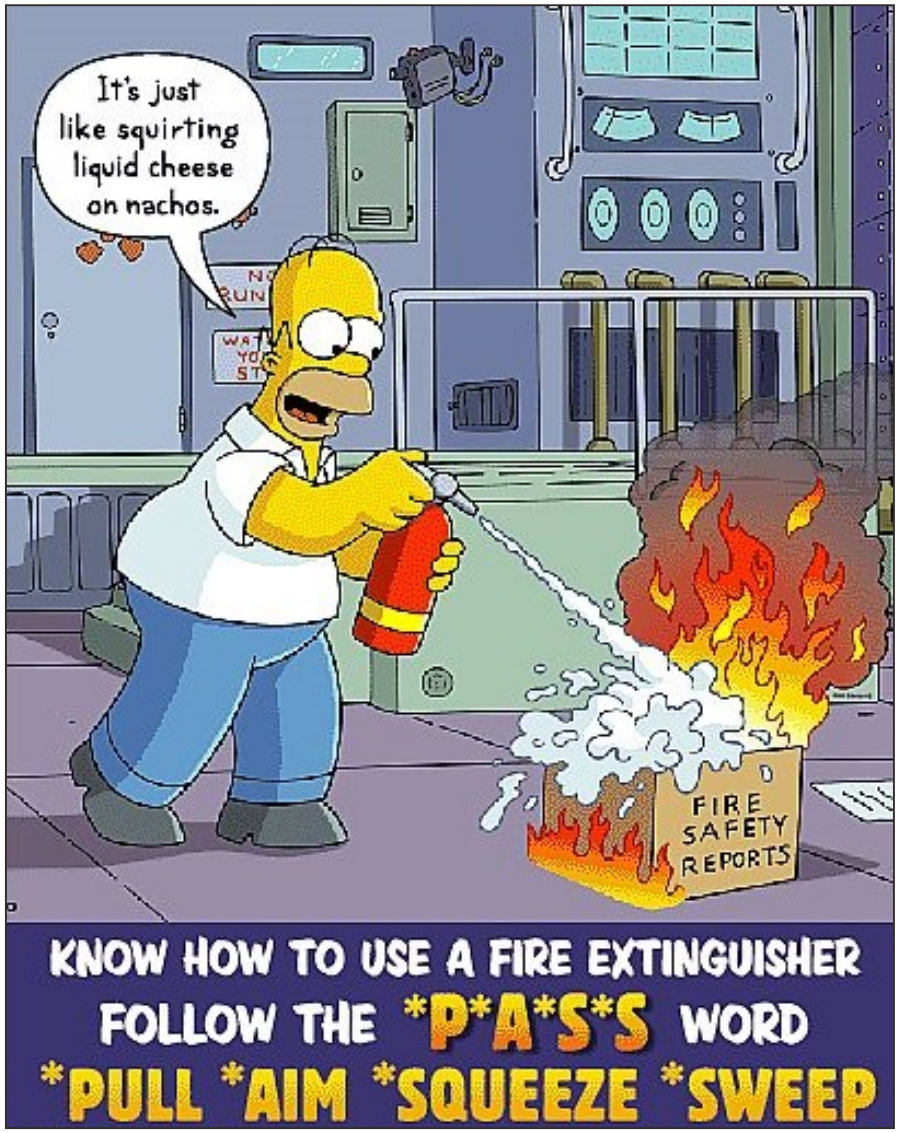
Using a Fire Extinguisher

- Squeeze the lever above the handle
  - This discharges the agent
  - Releasing the lever will stop the discharge
  - Some extinguishers have a button instead of a lever
- Sweep from side to side
  - Moving carefully toward the fire, keep the extinguisher aimed at the base of the fire and sweep back and forth until the flames appear to be out
  - Watch the fire area
  - If the fire re-ignites, repeat the process
- Always be sure the fire department inspects the fire site, even if you think you've extinguished the fire

Using a Fire Extinguisher



Using an Extinguisher



- Always be sure the fire department inspects the fire site, even if you think you've extinguished the fire
- When finished, return the extinguisher to the Fire & Life Safety Officer to get inspected & refilled

EXAMPLE: Using a Fire Extinguisher

EXAMPLE: Using a Fire Extinguisher

EXAMPLE: Using a Fire Extinguisher

EXAMPLE: Using a Fire Extinguisher

Electricity

- Electricity presents a special hazard in a fire situation
- Electricity does not burn, it produces heat which may result in one of the classes of fire
- If the electricity is removed (e.g. by switching off the power), the heat source is removed and the remaining fire should be dealt with according to its class
- If the source of electricity cannot be eliminated, a non-conductive extinguishing agent should be used

Fire Extinction and Electricity

- Electricity presents a special hazard in a fire situation
- Electricity does not burn, it produces heat which may result in one of the classes of fire
- If the electricity is removed (e.g. by switching off the power), the heat source is removed and the remaining fire should be dealt with according to its class
- Learn where the breaker or emergency disconnect switch is for your work area
- Switch off the power in event of a fire or emergency
- If the source of electricity cannot be eliminated, a non-conductive extinguishing agent should be used

Preventing Electrical Fires

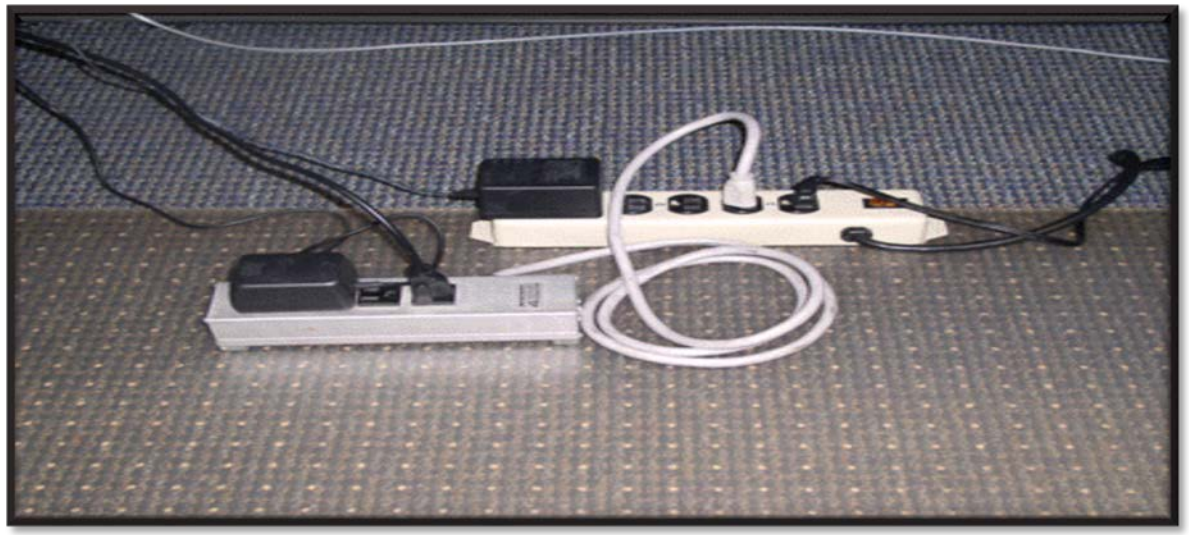
- Electrical hazards are the cause of numerous workplace fires each year
- Faulty electrical equipment or misuse of equipment produces heat and sparks that serve as ignition sources in the presence of flammable and combustible materials
- Examples of common ignition hazards
  - Overloading circuits
  - Use of unapproved electrical devices
  - Damaged or worn wiring

Extension Cords

- Extension cords are only approved for temporary use
  - They may only be used for a period of three days or less
  - Instead of using extension cords contact FP&M to install permanent wiring
- When using extension cords check for defaults such as frays, brittleness, or broken wires
- Never place extension cords in high traffic areas where they can be damaged by being stepped on or run over by equipment
- Extension cords and other temporary flexible cords must be used in compliance with the National Electrical Code (NEC), NFPA-70 & 70e

Multi-plug Strips

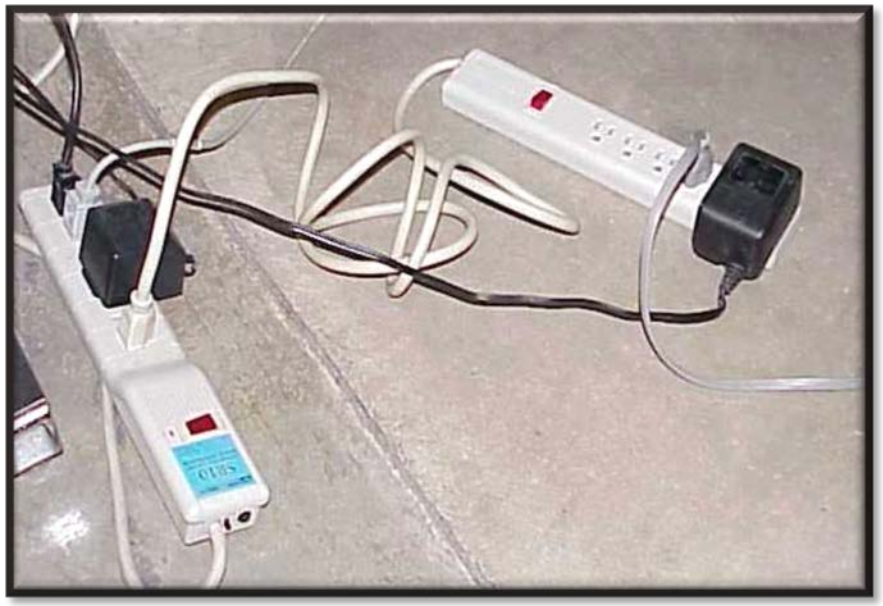
- Multi-plug strips should only be used for office equipment such as computers, printers, and fax machines
- Other common items such as microwaves, refrigerators, and copy machines must be plugged directly into wall outlets
  - **This is a requirement of the State Fire Marshal and the Fire Code**
- Multi-plug strips should have a fuse or circuit breaker and be UL approved
- Laboratory instruments must be plugged directly into a wall outlet



Do Not Do This!

Avoid Improper and Hazardous Practices

- Never use three prong adapters that allow a three pronged plug to plug into a two prong outlet
- Never use any item with a damaged or frayed electrical cord
- Space Heaters are not allowed in campus buildings
- Never daisy chain or piggy back multi-plug strips and electrical cords (plugging strips and cords into each other)



Do not use piggy-backed multi-plug strips

Compartmentalization

- Buildings are designed to prevent fire, heat, and smoke from spreading beyond locations of origination
  - Building elements such as fire walls, fire dampers, and fire doors, are designed to seal off one location from the next
  - This system is called compartmentalization
- Compartmentalization increases the safety of evacuating building occupants because smoke and fire are not able to escape into exit passageways
- Containment of fire and smoke reduces property damage and prevents small fires from growing into large fires
- In order for compartmentalization efforts to be effective fire barriers must be maintained

Fire Doors

- Fire doors are designed to withstand fire, heat and smoke for a period of 20-minutes to 3 hours
- Did you know that corridor office doors are fire doors and should have a 20 minute rating?
- Corridor laboratory doors should have a 60 minute rating
- Fire Doors are required to:
  - **Be Self Closing**: Fire doors should have a door closure that pulls doors completely shut after the door has been opened
  - **Have Positive Latching**: A positive latch locks a door in place so can open swing open freely
- **Never prop open a fire door!**

Maintaining Fire Barriers

- Fire doors need occasional maintenance and repairs to function properly and should be periodically checked
- To test a fire door:
  - Open the door fully and allow it to swing shut
  - The door should close and latch completely by itself
  - Give the door a push after it closes to ensure that the latch has engaged
  - If the door is not operating properly contact FP&M for repairs
- Ceiling, Floor, Wall Penetrations
  - All areas should be properly sealed to prevent the escape of fire, heat and smoke
  - Common penetrations include holes in walls, around ducts, pipes, etc. These types of penetrations should be sealed with appropriate fire-stopping material

Should You Attempt to Fight the Fire?

Before you begin to fight a fire, make sure to:

1. Evacuate the building
2. Call TAMU Emergency services 911
3. Make sure that the fire is confined to a small area and is not spreading
4. Make sure that you have an unobstructed escape route to which the fire will not spread
5. Make sure that the extinguisher is the right type for the fire
6. Make sure that you have read the instructions and know how to use the extinguisher
7. In all other circumstances, call 911, and clear the area

If You're On Fire? STOP! DROP! ROLL!

Listen to Sparky the Fire Dog
(http://www.sparky.org)

STOP

DROP

ROLL

A Good Rule of Thumb

- If you can’t get within 10 feet of the fire, it’s probably too big for a typical hand-held fire extinguisher

- Evacuate the area and call 911

Conclusions

- Safety is not a product, it is a process
- Over time, good practices will become good habits
- Learning to work safely in the laboratory is as important as learning the chemical concepts and techniques involved in each experiment


I attest that I have earnestly applied myself to learn all of the materials in this Engineering Laboratory Safety Course. Further I pledge to apply all controls and use protective equipment as put forth in this course in the pursuit of my Engineering work and studies here at Texas A&M University.

When finished, review and download a copy of your TrainTraq Transcript as documentation of completion of this training. Please note that the TrainTraq System does not provide a separate certificate.

- I agree
- I disagree

Acknowledgement

Quiz - 1 question

Last Modified: Sep 12, 2016 at 02:50 PM

PROPERTIES

On passing, 'Finish' button:	Close Window
On failing, 'Finish' button:	Goes to Previous Slide
Allow user to leave quiz:	At any time
User may view slides after quiz:	After passing quiz
Show in menu as:	Single item

Edit in Quizmaker

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