Laboratory Health and Safety

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Introduction

- Presenters
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Agenda

- 8:00-8:15-Welcome
- 8:15-8:30-Introductions
- 8:30-9:00-Needs Assessment
- 9:00-9:30-Chemical Hygiene Plan
- 9:30-9:45-Break
- 9:45-11:00-
  - Tab A: Lab Safety Institute (LSI)
  - Tab B: Accidents
  - Tab C: Biological and Animal Hazards
  - Tab D: Chemical Storage
  - Tab E: Compressed Gases
  - Tab F: Waste Disposal
- 11:00-12:00-Lunch

Agenda (cont.)

- 12:00-1:30
  - Tab G: Electrical Safety
  - Tab H: Eye and Face Protection
  - Tab I: Fire Control
  - Tab J: Handling Chemical Reagents
  - Tab K: Handling Glassware
  - Tab M: Labeling
- 1:30-1:45-Break
- 1:45-2:45
  - Tab N: Legal Aspects of Safety
  - Tab P: OSHA Laboratory Standards
  - Tab Q: Planning for Emergencies
  - Tab R: Radiation
  - Tab S: Recordkeeping
  - Tab T: Safety Program Planning
  - Tab V: Student/Faculty Involvement
  - Tab W: Ventilation
- 2:45-3:00- Where are we now?

Needs Assessment

- Survey of 500 science teachers:
  - 17% knew what a GFI was.
  - 12% knew the best type of fire extinguisher for a science lab.
  - 4% knew ANSI standard for eyes.
  - 1% could identify the OSHA Lab Standard.
  - 14% knew the use of MSDSs.
  - 25% knew chemicals should not be stored alphabetically.

Answer the following questions:

1. Who is responsible for lab safety at your school?

2. Who is responsible for conducting a needs assessment at your school?

3. How do you or would you do your needs assessment?

What is wrong with this picture?

In your book, there is a picture of a lab, how many violations of lab safety can you find? There is a prize for the person who can find the most violations.

Needs Assessment

- The best way to assess your facility is by inspections.
- Why inspections:
  - Protect employees/students
  - Reduce liability
  - Protect environment
  - Insure rules are followed
  - Insure facility is operating within the law
- How often?
  - Minimum-quarterly
  - Ideally-monthly

- Who is responsible for making sure safety inspections are done?
  - CEO/president/principal who is ultimately responsible for safety.
  - Safety committee
- Who does the inspections?
  - Group of 2 to 4 appointed by the safety committee.
- Safety Committee
  - Be familiar with local, state, and federal laws
  - Fire protection representative
  - Industry representative
  - Member of administrative staff at facility
  - Person who is from a similar facility

- What can employees do to assist safety inspections:
  - Report safety problems ASAP
  - Perform routine safety inspections using a standard checklist that includes:
    - Personal protection equipment
    - Chemical storage practices
    - Waste collection and storage practices
    - Laboratory ventilation
    - Emergency safety equipment
    - Housekeeping and maintenance
    - Electrical safety
    - Gas cylinders and cryogenics
    - Biosafety and chemical handling practices

Is your lab a safe place to work?

- Throughout the day, when you have a few minutes, please look at the assessment provided in your book.
- If you can, begin to evaluate your laboratory facility.
- Instructions are provided for scoring.
- Note: anything below 100% indicates that your lab is potentially unsafe.

Chemical Hygiene Plan

- OSHA and related state regulations require almost all schools to have a chemical hygiene officer and a chemical hygiene plan.
- Florida does not follow OSHA state plan.
- However we do have a plan that directly mimics the OSHA plan.
- State plan is to be as strict or stricter than the OSHA plan.
- OSHA cannot visit the state unless it is clear that violations are present.
- In Florida, OSHA cannot go into a school or state facility.
- OSHA's plan does not include students.
- OCSD Chemical Hygiene Plan-S.Tallman

The Laboratory Safety Institute
LSI
Tab A

- Founded in 1978 by Dr.James Kaufman.
- Over 50,000 teachers and scientists have attended training programs.
- LSI's Goals:
  - Learn to care about your health and safety
  - Learn to recognize hazards and how to protect yourself.
  - Create a safe and healthy learning and working environment.
- Website: http://www.labsafety.org/

Action Ideas

On p. A-5, you will find a page for making notes as we go through the presentation. This page is for you to write down inexpensive ideas that you can do tomorrow to improve lab safety in your classroom and at your school.

Accidents
Tab B

- How many of you have had a near miss in the laboratory?
- How many of you have known about a near miss in your school or district?
- How many of you would have been prepared if the near miss had been a hit?

Tab B

- What would you do in case of an accident?
  1. Do you have a written plan for emergency medical treatment?
  2. Where is the nearest telephone to the laboratory in which you work?
  3. Do you have a written accident reporting system?
  4. Did you examine the cause of the accident to help prevent similar accidents?

Tab B

- Problems include:
  - Instructors not using appropriate safety precautions when doing demos.
  - Unlabeled containers in stockroom/lab
  - Out-dated facility and chemical stock
  - Overcrowding lab with students
  - Not enough safety equipment for students
  - Lab ventilation problems; hoods that do not work.
- What is your worst, most serious problem?
  - Answer on B-3

Planning your Safety Program
B-4

- Please break into groups of 2-3 individuals. You may choose to work with teachers/support staff/administrators from your school or others in the district.
- Please brainstorm with your group and answer the 4 questions on B-4.
- You will have 5-10 minutes and then we will share.

Biological and Animal Hazards
Tab C

- Major causes of infections:
  - Oral aspiration through mouth pipetting
  - Accidental syringe injections
  - Animal contact and bites
  - Spray from syringes
  - Centrifuge accidents
- Hazards:
  - Broken containers
  - Inoculating loops
  - Microscopes mirrors
  - Blood typing not allowed in schools
  - Scalpels and other cutting devices
  - Allergic reactions
  - Animals are carriers of diseases

Tab C

- Methods of Decontamination
  - Autoclaving
  - Chemical decontamination
  - Incineration
- Field trip precautions:
  - Pre-visit the site
  - Permission slips
  - List of participants
  - Adult supervision
  - Buddy system
  - Plan for emergencies

Tab C

- Biosafety in the Laboratory
  - Biosafety Level 1
    - Basic level of protection for agents not known to cause disease in normal, healthy humans
  - Biosafety Level 2
    - For handling moderate risk agents that cause human disease by ingestion and other exposure.
  - Biosafety Level 3
    - Controlled access for handling agents with a potential for respiratory transmission and agents that may cause serious and potential lethal infections.
  - Biosafety Level 4
    - Sealed facilities for exotic agents that pose a high risk. Center for Disease Control
- Biosafety in the Laboratory Rules- C-3

Summary of practices for handling biohazardous materials.

1. Wear protective equipment.
2. Wash hands after handling hazardous materials.
3. Perform procedures carefully to reduce splashes.
4. Keep hazardous materials in a safety cabinet or hood.
5. Use mechanical pipetting devices
6. Never eat, drink, smoke, apply makeup, handle contact lens, or take meds in the lab.
7. Decontaminate lab surfaces before and after use
8. Be careful when using sharps; dispose of sharps properly.
9. Use secondary leak-proof containers when transferring hazardous materials.
10. Decontaminate hazardous waster before disposal.

Chemical Storage
Tab D

- Principles of Chemical Storage
  - To maintain control of chemical inventory.
  - To segregate mutually incompatible chemicals.
  - To insure safe storage of chemicals.
  - To provide protection against theft.
  - To protect the environment.
  - To protect the reagents from fire.

Storage Arrangements
Tab D

- Never store chemicals in alphabetical order.
- Fisher Scientific System
  - Red Flammable
  - Yellow Reactive or oxidizing agent
  - Blue Health hazard
  - White Corrosive
  - Gray General Chemical Storage

Laboratory Refrigerators
Tab D

- Never use a household refrigerator for flammable chemical storage.
- Dangers involve:
  - Internal thermostat, fans, lights
  - External compressor motor and electrical parts.
- Other storage suggestions
  - No top of the unit chemical storage
  - Minimize storage above eye level
  - Shelf assemblies secured firmly to the wall
  - Provide anti-roll lips on all shelves
  - Shelving should be of fixed wood construction or have non-corrosive metal supports.

Compressed Gases
Tab E

- Handling
  - Avoid dragging or sliding cylinders
  - Do not drop cylinders or let them strike each other
  - Keep valve protection cap in place
  - Never tamper with safety devices
  - Never permit oil, grease, or other combustible substances come in contact
  - Do not remove product ID label
  - When returning empty cylinders, close valves
  - Only allow qualified producers of the gas to refill the cylinder
  - Shipment without consent of the owner is a violation of Federal Law.
  - Never lift a cylinder by the cap.
  - See E-1 and E-2 for information on storage and use.

Waste Disposal
Tab F

- Regulations:
  - 1976 Congress passed the Resource Conservation and Recovery Act (RCRA)
  - 1980 EPA publishes regulations for large quantity generators
  - 1984 EPA publishes regulations for small quantity generators
  - 1987 Liquid Landfill Limits
  - 1990 Total list of Landfill Ban

Tab F

- Statutes
  - CCA Clean Air Act
  - CERCLA Superfund Act
  - CWA Clean Water Act
  - SWDA Safe Water Drinking Act
  - SARA Superfund Amendments
  - TSCA Toxic Substances Control Act
  - RCRA- Resource Conservation and Recovery Act.
- Regulatory Agencies
  - EPA Environmental Protection Agency
  - DOT Department of Transportation
  - NRC Nuclear Regulatory Commission
  - OSHA Occupational Safety and Health Administration
  - State agencies

RCRA
Resource Conservation and Recovery Act

- Functions of RCRA:
  - Gives EPA the responsibility to regulate solid waste including hazardous waste
  - Addresses solid waste mgmt in following categories- hazardous, waste oil, land disposal, and medical waste
  - Manages hazardous from “cradle to grave”- generation to disposal
  - Allows states to be more restrictive than RCRA.
- Laboratories must comply with the law.
- Laboratories can face future potential liabilities through SARA (Superfund). It is a trust fund with 8.5 Billion to clean up areas that have been designated as hazardous.

Tab F

- Assume responsibility by:
  - Establish a chemical materials management policy
  - Provide necessary funding
  - Appoint a coordinator
  - Operate as one site
  - Everyone shares in the responsibility
- Purchasing
  - Buy the smallest amount needed
  - Be certain the MSDS is available
  - Remember what comes in will go out as costly waste
- Inventory
  - Develop a system that works for your institution
  - Consider a computer based system
  - Keep it up to date
  - Avoid purchasing unnecessary and duplicate chemicals by using a one-site system.

Tab F

- Hazardous characteristics of waste:
  - Ignitability
    - Liquids with a flash point less than 60·C
  - Corrosivity
    - Acidic or basic wastes
  - Reactivity
    - Materials considered to be unstable, that generate toxic gases when mixed with water, that are capable of detonation at STP or when heated under confinement.
  - Toxicity
    - Wastes likely to leach hazardous concentration of particularly toxic materials in landfills
- Tab F-5 List of Chemical Disposal Companies
- What is the procedure for waste disposal in OCSD?

Tab F

- Other things to consider:
  - Toxicity Characteristics Constituent and Regulatory Levels p. F-7
  - Household Hazardous Waste Reference Chart p. F-8
  - The Golden Rules of Chemical Waste Disposal p. F-9 to F-10

Electrical Safety
Tab G

- What should you do to prevent electrical hazards (electrocution)?
  - Inspect all outlets and replace any that are broken, lost their grip, scorched, or not GFI near a ground.
  - Test all outlets with a circuit tester
  - Test GFI outlets with a GFI testing device regularly
  - Inspect all electrical cords and plugs once a year
  - Inspect three prong plugs to make sure the grounding plug in present.
  - Do not have flammable liquids near electrical equipment
  - Extension cords cannot be a permanent solution!

Tab G

- Know location of master switch to shut off power
- Know location and have access to circuit breaker
- Do not pull plug by cord to unplug
- Always use dry hands when unplugging cord
- Always look for broken plugs, frayed cords, burnt plugs, removed ground plugs, low tension outlets, improper building wiring, improper apparatus wiring, non GFI outlets near grounds and access to circuit breaker boxes.

Eye and Face Protection
Tab H

- The eye is the most vulnerable part of the body and must be protected.
- Three types of eye injury
  - Radiation damage
  - Particle impact
  - Liquid contact
- Eye protection must meet the minimum standards set by the American National Standards Institute (ANSI) Standard Z87.1a-1995.
- In a laboratory where chemicals are being used, the minimum eye protection provided should be impact-proof and splash-proof.

Tab H

- Contacts- There is no published evidence to support the “dangers” with contacts. There is actually evidence that supports that contacts can be beneficial is some cases.
- Maximum distance from work station to eye wash/safety shower is not in distance but in time- 10 SECONDS
- Additional Eye Safety Rules
  - Never neutralize chemicals splashed in the eyes- always flush with water
  - Never use an emergency eye wash bottle
  - You must never work alone in the lab
- Goggles can be purchased from Flinn, Nasco, and Carolina.
- More information can be found www.flinnsci.com/Sections/Safety/eyeSafety/goggle.asp
- Please read First Aid for Eye Emergencies p. H-5

Fire Control
Tab I

- Prevention
- Detection
  - What kind of fire is it?
- Extinction
  - Which type of fire extinguisher to use?
- Why should you fight a fire?
- When should you fight a fire?

Tab I

- **Class A** extinguishers are for ordinary combustible materials such as paper, wood, cardboard, and most plastics. The numerical rating on these types of extinguishers indicates the amount of water it holds and the amount of fire it can extinguish.
- **Class B** fires involve flammable or combustible liquids such as gasoline, kerosene, grease and oil. The numerical rating for class B extinguishers indicates the approximate number of square feet of fire it can extinguish.
- **Class C** fires involve electrical equipment, such as appliances, wiring, circuit breakers and outlets. Never use water to extinguish class C fires - the risk of electrical shock is far too great! Class C extinguishers do not have a numerical rating. The C classification means the extinguishing agent is non-conductive.
- **Class D** fire extinguishers are commonly found in a chemical laboratory. They are for fires that involve combustible metals, such as magnesium, titanium, potassium and sodium. These types of extinguishers also have no numerical rating, nor are they given a multi-purpose rating - they are designed for class D fires only.

- Here are the **most common types of fire extinguishers:**
  - **Water extinguishers** or APW extinguishers (air-pressurized water) are suitable for **class A fires only**. Never use a water extinguisher on grease fires, electrical fires or class D fires - the flames will spread and make the fire bigger! Water extinguishers are filled with water and pressurized with oxygen. Again - water extinguishers can be very dangerous in the wrong type of situation. Only fight the fire if you're certain it contains ordinary combustible materials only.
  - **Dry chemical** extinguishers come in a variety of types and are suitable for a combination of **class A, B and C fires**. These are filled with foam or powder and pressurized with nitrogen.
    - **BC** - This is the regular type of dry chemical extinguisher. It is filled with sodium bicarbonate or potassium bicarbonate. The BC variety leaves a mildly corrosive residue which must be cleaned immediately to prevent any damage to materials.
    - **ABC** - This is the multipurpose dry chemical extinguisher. The ABC type is filled with monoammonium phosphate, a yellow powder that leaves a sticky residue that may be damaging to electrical appliances such as a computer.

Handling Chemical Reagents
Tab J

- Before handling ask yourself these questions:
  - What are the hazards?
  - Which materials have hazards?
- Four hazardous properties of chemical reagents are:
  - Flammable
  - Corrosive
  - Reactive
  - Toxic
- Improper handling may cause:
  - Explosions
  - Fires
  - Poisonings
  - Burns
  - Other bodily injury

Tab J

- Causes of problems with chemicals:
  - Improper purchasing
  - Improper record keeping
  - Improper storage
  - Improper labeling
  - Improper use
  - Improper disposal
- Three rules for lab safety with chemicals:
  - Avoid ingestion
  - Avoid inhalation
  - Avoid absorption
- Please read p. J-2 for more information regarding these rules.

Tab J

- ACS Online Videos
  - "Starting with Safety" with materials and Teachers guide
  - "Seeing the Light- Eye and Face Protection"
  - Access online at:
    - http://chemistry.org/elearning
    - Click on "Starting with Safety"
  - Appendix IIA- Substances with greater hazardous nature than potential usefulness. Pgs. J-4 and J-5

Handling Glassware
Tab K

- Types of glass:
  - Soda glass (soft glass)
  - Borosilicate glass (hard glass)
  - Quartz glass
- Only use borosilicate glass at all times except for reagent bottles, some measuring equipment, stirring rods, and some tubing applications.
- Never use glassware that is flawed.
- Dispose of glassware in heavy walled, vinyl lined boxed designed for broken glassware disposal. Can be purchased from Chemical supply companies.

Labeling
Tab M

- No unlabeled containers!
- Violation of OSHA.
- Many labeling systems:
  - NFPA National Fire Protection Association
  - HMIS Hazardous Materials Identification System
  - DOT Department of Transportation
  - Vendor labels
  - In-house labels

Tab M

- ANSI Labeling recommendations:
  - Identify chemical using CAS number
  - Statement on hazards, Use signal words
  - List precautionary measures
  - Instructions in case of contact
  - Antidotes and notes to physician
  - Instructions in case of fire, spill, or leak
  - Instructions for handling and storage
- Signal words include danger, caution, carcinogen, inhalation hazard, corrosive, biohazard, warning, poison, toxic, oxidizer, flammable, and perioxide.

Tab M

- Facility Signs p. M-4
- Hazardous Materials Warning Labels p. M-6
- General Guidelines on Use of Warning Labels and Placards p. M-8

Legal Aspects of Safety
Tab N

- Standard of care means that the policies, regulations, and procedures of the employer may be considered by a court to be a binding part of the employment contract or condition of the employment even if not written in the contract.
- Assumption or risk means that a plaintiff may not be able to recover injuries caused by another's negligence if it can show that the plaintiff knew that the activity involved the taking of a risk and voluntarily assumed the risk.

- Assumption of risk may be difficult to show that a student or employee is knowledgeably informed since
  - The pressure of the grading system or employment may be seen as coercive.
  - The level of maturity and experience of the plantiff may be seen as low.
  - The ability to understand and appreciate the risks may be low.
- The teacher or employer should always fully explain the risks involved and make sure that they are fully understood.

- The Basic Duties
  1. Duty to supervise
     - Teacher is the person immediately responsible for safety.
     - Handing out a set of safety rules is not sufficient. There must be training and enforcement.
  2. Duty to use good judgement
     - Act as reasonably prudent person
     - If you know of a hazardous condition and you fail to train the students, you could be held negligent.

3. Duty to instruct
   - Teachers are experienced, students are not.
   - Instruction must be at the level to reach the most inexperienced person.
   - Must be more than handing out printed rules.
   - Must be a formal training process in the safety rules.
- Why should you follow these rules?
   - Few if any states provide immunity to the teacher, supervisor or employer.

Tab N

- Negligence
  - Failure to act as a reasonable and prudent person would act in similar circumstances to prevent harm to other persons.
  - Did the teacher show reasonable care?
- Types of Negligence
  1. Malfeasance- doing that which should be done, i.e forcing someone to assume an unnecessary risk.
  2. Misfeasance- improper performance or a lawful act, i.e improper instruction
  3. Nonfeasance-failure to perform a required act, i.e not enforcing the wearing of correct eye protection.

Tab N

- Liability Issues
  - Where do you store your chemicals? Are they easily accessible?
  - Do you only have chemicals for today's work?
  - Do you ever permit a person to work alone?
  - Do you require the use of Personal Protective Equipment?
  - Do you strictly enforce all safety rules?
  - Do you have written lab safety policies?
  - Is everyone trained in this policies?
  - Are you familiar with safety devices in your lab? Do they work?
  - Do you have an up-to-date inventory? Would you know if anything was missing?

Tab N

- Forms in Tab N
  - New Employee Safety Orientation N-5
  - Safety Maintenance Request Form N-6
  - Hazards Review Form N-7
  - Overcrowded/Unsafe Classroom or Laboratories Report Form N-8
  - Science Safety Rules and Procedures Agreement Form N-9 and N-10
  - Sample Letter to Students N-11

Complying with the OSHA Laboratory Standard Tab P

- While Florida is not an OSHA Plan state, please read the information included in Tab P.
- Under the OSHA plan, certain employers of laboratory workers are required to have a Chemical Hygiene Plan (CHP).
- Employees should comply with CHP.

Planning for Emergencies
Tab Q

- Please read the two emergency incidents on p. Q-1.
- Using the acronym (AID) on Q-2:
  - Assess the situation
  - Immediate action to be taken
  - Discuss preventive measures
- Apply these to each emergency incident.
- Also ask yourself “What would a reasonable prudent person do? Q-3
- Forms:
  - Q-5 through Q-11 Emergency Preparedness Review. Please use this at your school/facility to asses your preparedness for emergencies.

Radiation
Tab R

- Radiation ranked #1 in an public opinion poll for risk.
- If used properly, radiation is valuable research tool and beneficial.
- Radiation is mostly natural.
- Types of radioactive emissions:
  - Alpha- largest particles, cannot penetrate skin, but can be inhaled, ingested, or enter through a cut.
  - Beta- can travel in tissue so organs close to body surface can be injured.
  - Gamma- can penetrate deeply, shield with lead.
- Please read Tab R if radioactive materials are used in your facility.

Recordkeeping
Tab S

- Why keep records?
  - Reduce liability
  - Make safer labs/field investigations
  - Save money
  - Expenditure justification
  - Credibility
- Important records
  - Rules/agreements
  - Inspections
  - Emergency plans
  - Inventories
  - Repair requests
  - Accident reports

Safety Program Planning
Tab T

- What should you do?
  - Have an immediate goal upon returning to your school.
  - Read your CHP and learn who your CHO (Chemical Hygiene Officer) is.
  - Be certain all employees are properly safety trained.
  - Set up trainings.
  - Set up inspections
  - Showcase safety in your lab for others to see.
  - Check your chemical storage areas and practices
  - Establish or update chemical inventory lists.
  - Find and label all emergency shut off systems for gas, water and electricity.
  - Certify faculty and staff are CPR and First Aid trained.
- Use the Laboratory Safety Program Calendar on T-2 as a guideline for scheduling inspections, trainings, and safety evaluations.

Student/Faculty Involvement
Tab V

- Employee Involvement
  - Start at the top
  - Educate and train employees
  - Ask people to get involved
  - Create an environment that encourages involvement
  - Publish a Safety Newsletter
  - Develop a formal orientation for new employees
  - Celebrate a good safety record with a party or dinner.
  - Form a Safety Committee

Tab V

- Student Involvement
  - Grading system should include lab reports and safety quizzes
  - Safety inspections during labs should be part of grade
  - Post Safety-related signs in classroom
  - Pose periodic “What if” safety problems
  - Celebrate a good safety record with a reward for students
  - Create an environment that encourages safety
  - Discuss potential problems if safety is ignored
  - Have students and parents sign safety contract
  - Have clear consequences if safety rules are violated.
  - Bring in administration to show support for rules

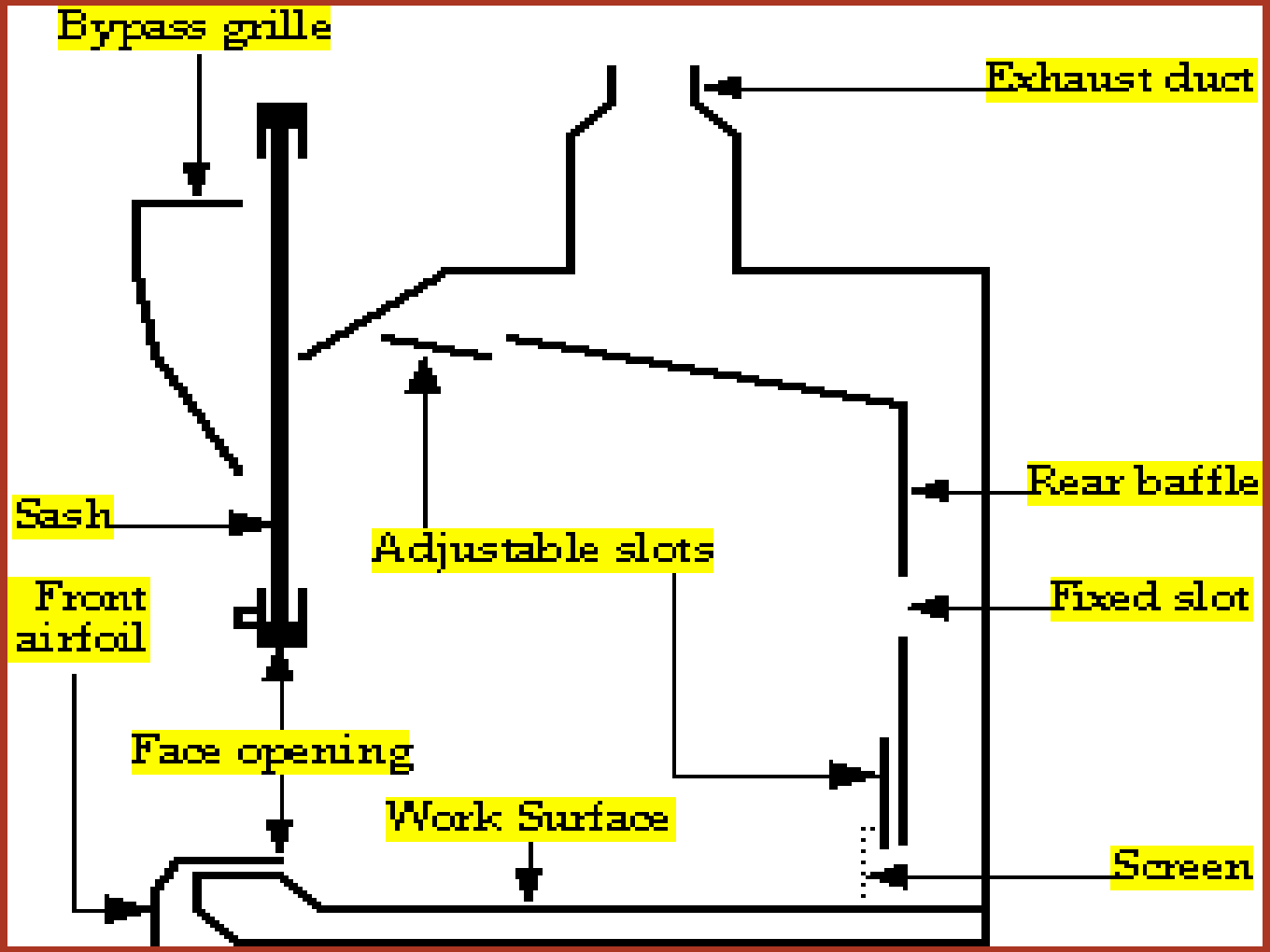
DiscussionTab V

- Please read the article “Snap, Crackle and Pop” on p. V-2.
  - Do you support this article? Why or why not?
  - Is this feasible in education?
  - How could this be enforced?
  - Who would be responsible for it? Administrators? Department Heads?
- Please read “101 Ways to Convince People That You Are Serious About Safety” V-4.
  - Brainstorm ideas with the group to finish out the list.

Ventilation
Tab W

- Ventilation includes:
  - Air circulation in building
  - Hazardous materials in Hoods
- Face Velocity
  - Average velocity of the air in feet per minute (fpm) in a direction perpendicular to the plane of the hood opening.
- Types of Hoods
  - Standard Hood
    - Face velocity increases as sash is lowered. May be modified to variable volume.
  - Bypass Hood
    - Venting keeps face velocity relatively constant as sash is raised or lowered.
- Auxilliary Air Hood
  - Outside air is used to minimize the exhausting of conditioned air

- Parts of a fume hood



Tab W

- A fume hood is a ventilated enclosure in which gases, vapors and fumes are contained.
- An exhaust fan on the top of the building pulls air and airborne contaminants in the hood through ductwork connected to the hood and exhausts them to the atmosphere.
- The typical fume hood is equipped with a movable front *sash* and an interior *baffle*.
- The sash may move vertically, horizontally or a combination of the two and provides some protection to the hood user by acting as a barrier between the worker and the experiment.

Tab W

- The slots and *baffles* direct the air being exhausted. In many hoods, they may be adjusted to allow the most even flow. It is important that the baffles are not closed or blocked since this blocks the exhaust path.
- The *airfoil* or beveled frame around the hood face allows more even airflow into the hood by avoiding sharp curves that can create turbulence.
- In most hood installations, the exhaust flowrate or quantity of air pulled through the hood is constant. Therefore, when the sash is lowered and the cross-sectional area of the hood opening decreases, the velocity of airflow (face velocity) through the hood increases proportionally. Thus, higher face velocities can be obtained by lowering the sash.

Tab W

- Other considerations for Hoods
  - Duct work must be straight and as vertical as possible with smooth elbow bends to promote laminar air flow.
  - Motor should be placed on roof to maintain negative pressure inside duct system.
  - Type of materials to be vented, especially flammables should be considered.
  - Air foil should allow air flow with the sash closed
  - Experiments should be 6-12 inches behind sash and 1-2 inches in front of back to minimize turbulent air flow.
  - Do not use hoods for both experiments and storage.
  - Inspect hoods regularly

Wrap Up

- Where can you start at your school?
- Evaluation

Thanks for participating!