

# Engineering Controls & Laboratory Equipment

*Instructor Guide – draft – November 2011*



 Sandia National Laboratories

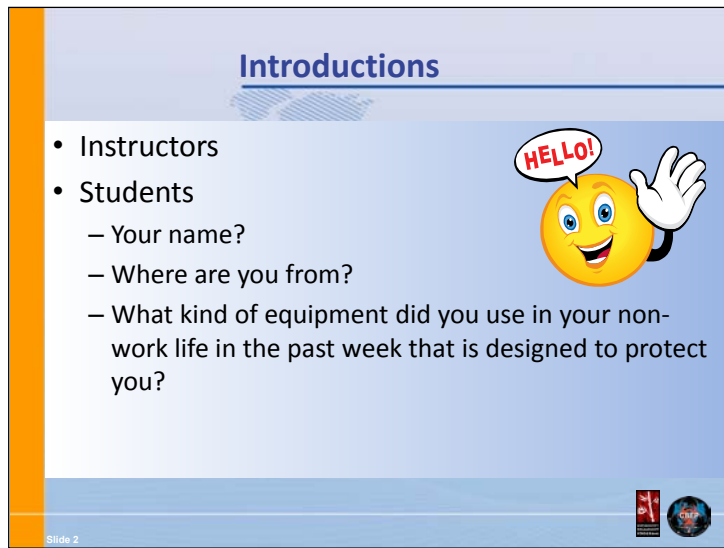


# Welcome & Introductions

Slide 1



Slide 2



Instructor(s): Introduce yourselves briefly, including name, organization, and brief background.

Ask each student to introduce themselves, by giving their name and where they are from. Ask each student to think of something engineered that they used to protect themselves over the past week (designed to start thinking about what engineering controls are)

# Welcome & Introductions

## Slide 3



Action Plan (pg X)			
By the end of this lesson, I would like to:			
KNOW		FEEL	BE ABLE TO DO
Your learning doesn't stop with this lesson. Use this space to think about what else you need to do or learn to put the information from this lesson into practice.			
What more do I need to know or do?	How will I acquire the knowledge or skills?	How will I know that I've succeeded?	How will I use this new learning in my job?

Use space on back, if needed

Insert standard Action Plan language



## Slide 4



Lesson Objectives
<ul style="list-style-type: none"><li>• Define, give examples, and demonstrate key features, functions, and proper operation and maintenance of laboratory engineering controls (equipment, etc.), per lab-specific SOPs.</li><li>• Describe engineering controls used in the laboratory to contain hazardous materials;</li><li>• Describe proper functioning of laboratory engineering controls</li><li>• Know how a HEPA filter works</li></ul>

Page 4

# Welcome & Introductions



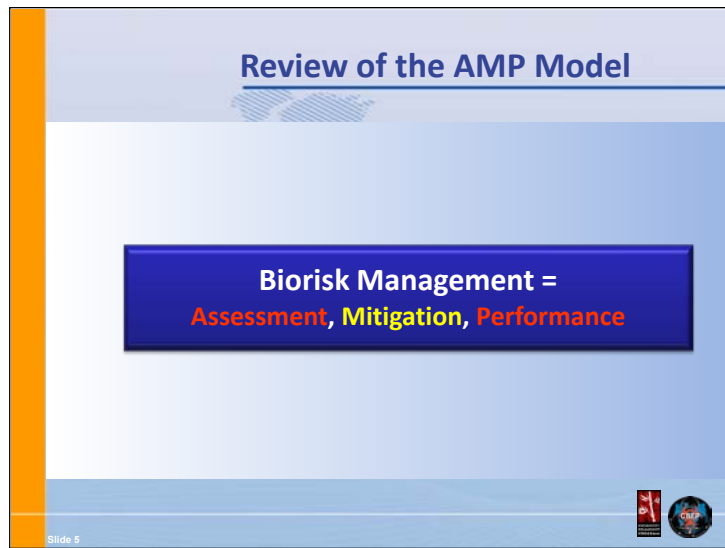
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The objectives of this course are to introduce the concepts of engineering controls and laboratory equipment as they apply to biorisk mitigation. It is important to remind the students that they each will have very specific engineering controls and laboratory equipment in their labs – each of these requires more specific training and should also have written SOPs associated with them. This training course is designed to help them explore the reasons why engineering controls are chosen and how to make the right choice and the factors to use in designing effective SOPs when it comes to engineering controls and laboratory equipment.

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# Review of Biorisk Management and Mitigation

## Slide 5

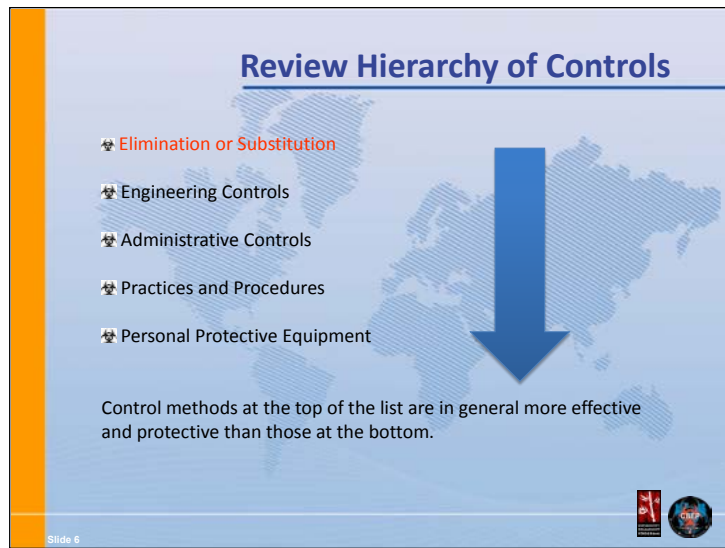


The first part of this course is a review of materials from previous lectures. Participants should have completed the Risk Mitigation Strategies course prior to taking this.

This should be a review for participants. Review by asking individuals to describe "Assessment", "Mitigation" and "Performance" to remind and verify that everyone remembers the AMP model

# Review of Biorisk Management and Mitigation

## Slide 6



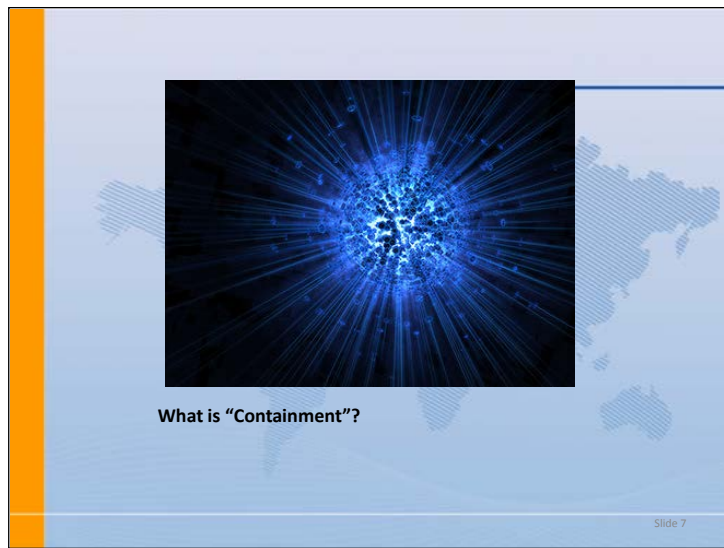
This should be a review for participants. Review by asking individuals why Engineering controls are considered more effective in general than PPE and the other controls.

Expected Answers: Engineering controls (if used properly) will remove the hazard from the environment and protect everyone in the lab (not just the wearer as in PPE)



# Biological Containment

## Slide 7



## Small group activity (10 minutes).



### Activity Instructions (to students)

1. Think about containment as it relates to biorisk management and
2. Work in groups to develop a definition for "containment" and write your definition in your workbook and
3. Ask a representative to write your group's definition on your flipchart.



**You have 5 minutes to complete this activity**

### *Directions for Instructor:*

- Have each group present their definitions and develop a working definition from input of the entire audience

# Biological Containment

## Expected Responses

A structure or system designed to prevent the accidental release of biohazardous materials from the laboratory

### New Responses from Students:

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## Slide 8



### Containment

How can we achieve containment

- Administrative controls?
- Practices and Procedures?
- Engineering controls?



# Biological Containment



**Plenary Discussion (5 minutes).** *(if this discussion is based on a projected slide, this block should follow the image of the slide)*

Question(s) to consider: How is containment achieved using:

- Administrative Controls?
- Practices & Procedures?

***Directions for Instructor:***

- Ask participants, in plenary, to discuss these mitigation strategies.
- Note: One of the reasons why we don't include PPE on this list is that PPE generally is not designed to achieve containment but acts as a barrier and protection to the user when containment is lost. That is one of the reasons why PPE is on the bottom of the hierarchy of controls.

## **Expected Responses**

New Responses from Students:

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# Biological Containment



**Small group activity (10 minutes).**



## **Activity Instructions (to students)**

1. Work in small groups for at least 5 minutes to list all of the different kinds of engineering controls found in the laboratory that help to achieve containment.
2. Capture each engineering control on a sticky note.
3. The instructor will collect the notes and make a master list as you generate the sticky notes.



**You have 5 minutes to complete this activity**

## *Directions for Instructor:*

- A master list can be collected and discussed at the front.
- Point out that engineering controls are generally the most significant means for achieving containment.
- Many of the practices and procedures revolve around the proper use of engineering controls

# Biological Containment

## Expected Responses

- Administrative controls –
- Practices & Procedures –
- Engineering Controls –
- Building ventilation system
- Laboratory separated from areas that are open to unrestricted access
- Engineered traffic flow patterns
- Sealable lab with ducting systems that allow for gaseous decon
- Hands free controls
- Backflow prevention devices
- Autoclave
- Sealed, unbreakable, leakproof containers
- Controlled access systems (locks, alarms, card readers, etc.)
- HEPA filters
- Plastic test tubes (vs. glass)
- BSCs
- Fume hood
- Doors
- Sealed (unopenable) windows with safety glass
- Directional airflow
- Locks
- Interlocks
- Airlocks
- Effluent decontamination systems
- Safety caps on centrifuge buckets
- Engineered self locking syringe. (all the engineered safety needles)
- Puncture proof sharps container
- Anterooms
- Coved flooring
- Gasketed seals

## New Responses from Students:

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# Biological Containment


## Slide 9



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### What are “Biosafety Levels”?

- Biosafety Levels are increasingly stringent combinations of:
  - Facility features
  - Safety Equipment
  - Work Practices
  - Administrative Controls
  - Personal Protective Equipment
- Designed to mitigate risk from pathogens having similar consequences of exposure.



Slide 9

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The concept of biosafety levels originated to group mitigation strategies in 4 consequence-based groupings. Notice that there is no such thing as a Biosafety Level X agent. BSLs encompass the mitigation strategies that should be effective for mitigating agents with similar consequences of exposure.

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**Plenary Discussion (5 minutes).** *(if this discussion is based on a projected slide, this block should follow the image of the slide)*

Question(s) to consider: What is the disadvantage to relying on the description of Biosafety Levels for mitigation strategies?

***Directions for Instructor:***

- Ask participants what might happen if BSLs are relied upon strictly for mitigation strategy assignments.
-

# Biological Containment

## Expected Responses

The descriptions of BSLs are designed to cover a range of pathogens with similar consequences. Different experimental scenarios might change the risk making the mitigation strategies inappropriate. Also the BSL criteria are designed to be a collection of possible mitigation strategies. Not every criteria is required to appropriately mitigate risk.

New Responses from Students:

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## Slide 10



### Containment Levels

- Biosafety guidelines provide four levels of increasing and additive protections
  - BSL1 – work with non-pathogens
  - BSL2 – Standard pathogen work
  - BSL3 – Containment laboratory
  - BSL4 – Maximum containment laboratory



# Biological Containment



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Talk briefly about Biosafety Levels. At each level there is increasing and additive protections from a combination of Administrative controls, practices and procedures, engineering controls and PPE.

This should be a quick pass through slide. Participants should already be familiar with Biosafety levels. Discuss further if warranted. Some standards such as the BMBL are more prescriptive in what combinations of controls are required for each level whereas other biosafety standards describe what needs to be achieved and allow the users to develop the controls necessary to achieve the standard.

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# Engineering Controls

## Slide 11



### Engineering Controls

- Primary Containment Barriers - contain the agent at the source
  - BSCs & other ventilation equipment
  - Animal isolation cages
  - Specialized laboratory equipment
- Secondary Containment Barriers – provide protection to personnel and the environment in case of a release from primary containment
  - Facility architectural features
  - Facility mechanical systems

Slide 11



# Engineering Controls

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Instructor presents this definition for “primary” and “secondary” containment barriers. If time permits, have participants separate their listed controls under the headings “Primary”, “Secondary”, or “both”. Instructor should also verify that participants are familiar with and understand the concepts of directional airflow, negative and positive pressure.

5 minutes

## Expected Answers

Primary: BSCs, Puncture proof sharps container, Engineered self locking syringe. (all the engineered safety needles), Fume hood, Plastic test tubes (vs. glass), Sealed, unbreakable, leakproof containers

Secondary: Coved flooring, Anterooms, Building ventilation system, Laboratory separated from areas that are open to unrestricted access, Directional airflow, Doors, Locks, Effluent decontamination systems, Engineered traffic flow patterns, Sealed (unopenable) windows with safety glass, Sealable lab with ducting systems that allow for gaseous decon, Controlled access systems (locks, alarms, card readers, etc.), Backflow prevention devices, Autoclave

Both: Gasketed seals, Safety caps on centrifuge buckets, Airlocks, Interlocks, HEPA filters, Hands free controls

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# Engineering Controls



**Small group activity (10 minutes).**



## Activity Instructions (to students)

1. Using the sticky notes that represent engineering controls, place each sticky note into a “primary” or “secondary” barrier or “both” category



**You have 5 minutes to complete this activity**

### *Directions for Instructor:*

- This exercise might work to use the floor or large space on a wall. Have each participant gather a handful of sticky notes and place them appropriately.

## Expected Responses

Primary: BSCs, Puncture proof sharps container, Engineered self locking syringe. (all the engineered safety needles), Fume hood, Plastic test tubes (vs. glass), Sealed, unbreakable, leakproof containers

Secondary: Coved flooring, Anterooms, Building ventilation system, Laboratory separated from areas that are open to unrestricted access, Directional airflow, Doors, Locks, Effluent decontamination systems, Engineered traffic flow patterns, Sealed (unopenable) windows with safety glass, Sealable lab with ducting systems that allow for gaseous decon, Controlled access systems (locks, alarms, card readers, etc.), Backflow prevention devices, Autoclave

Both: Gasketed seals, Safety caps on centrifuge buckets, Airlocks, Interlocks, HEPA filters, Hands free controls

### **New Responses from Students:**

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# HEPA Filtration

Slide 12



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## HEPA

- Almost all engineering controls involving ventilation employ a HEPA filter for primary or secondary containment, or both.

Slide 12

The slide features a blue background with a white border. The title "HEPA" is in blue. The text is in black. There are two logos in the bottom right corner: a red OSHA logo and a blue NIOSH logo.

One of the most important mitigation measure to understand and one of the most commonly misunderstood is the HEPA filter.

Slide 13



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## What is a HEPA filter?

- High Efficiency Particulate Air filter
- Filters **0.3 micron** particles at 99.97% efficiency
- Filters **all other particles**, bigger AND smaller, at an efficiency GREATER than 99.97%

Slide 13

The slide features a blue background with a white border. The title "What is a HEPA filter?" is in blue. The text is in black. There are two logos in the bottom right corner: a red OSHA logo and a blue NIOSH logo.

# HEPA Filtration





It is imperative to understand that HEPA filters are the LEAST efficient when filtering particles that are 0.3 microns. With bigger and smaller particles, they are much more efficient.

## Slide 14



**How do HEPA Filters Work?**

- Minimum efficiency of 99.97% removal of 0.3 micron particles
- HEPA filters do not filter out gases, vapors or volatile chemicals, they only filter out particulates (bacteria and viruses)

A photograph of a rectangular HEPA filter unit, likely from a laboratory or industrial setting.Two small logos are visible in the bottom right corner of the slide: a red one and a circular one.

Replace slide



It is also critical to understand that HEPA filters filter ONLY particulates. They have NO effect on gases, vapors, or volatile chemicals. While a HEPA filter will keep a bacteria or virus from re-entering the work space once filtered, it will not keep chemicals from entering the work space or building up within the biological safety cabinet.

# HEPA Filtration

## Slide 15



### How big is 0.3 microns

- This slide is reserved a chart with particle size comparisons

Slide 15



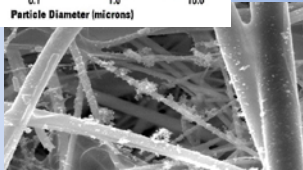
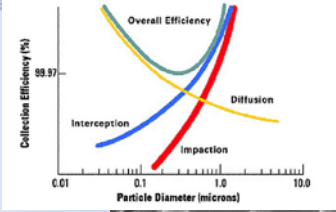
The important thing here is that viruses are smaller than 0.3 microns and therefore readily captured. Bacteria are larger than 0.3 microns and therefore also readily captured in a HEPA filter.

## Slide 16



### How do HEPA Filters Work?

- Straining
- Impaction
- Interception
- Diffusion
- Electrostatic



Slide 16

# HEPA Filtration



HEPA filters are one of the most important engineering controls in a biocontainment. Airflow into the workspace of the BSC is HEPA filtered as is exhaust air from the BSC. HEPA filters capture and remove particles from the air through the following five ways: Straining, Impaction, Interception, Diffusion and Electrostatic capture.

Instructor - this is a good point to do a “role play” where some students assume the role of fibers in the HEPA filter while other students play the various particles that might be filtered by various methods. The point is that all the particles are subject, due to their unique electrical or physical properties, to filtration.

## Slide 17



### True or False?

- A HEPA filter removes 5 micron particles at less than 95% efficiency?
- A HEPA filter removes 0.1 micron particles at greater than 99.97% efficiency?

Slide 17



Hopefully the answers are a resounding FALSE and TRUE. Ask the students to articulate why the first question is FALSE and the second is TRUE. They should be able to repeat back to you the concepts of the previous slides. Re-emphasize that they need to be ready to explain this to their co-workers. HEPA filters are not “typical” filters with a nominal filtration size.


# Biological Safety Cabinets

## Slide 18



### Ventilation Equipment

- Biological Safety Equipment, BSCs (vertical laminar flow)
- Chemical fume hoods
- Clean air benches (horizontal laminar flow)





There are three primary types of ventilation equipment, separate from facilities which is covered in a different course, to be addressed.


## Slide 19




### Biological Safety Cabinets (BSCs)

- Primary means of containment
- Three design types
  - Class I, Class II, and Class III
- Designed to provide protection for
  - Personnel
    - Directional flow of air into cabinet
  - Environment
    - HEPA filtered exhaust
  - Product (except Class I)
    - Laminar flow of HEPA filtered air

– But, how?







# Biological Safety Cabinets



Instructor presents this class and asks participants to think about how a BSC provides the protections listed above. This question is just to get them thinking and answer is not sought. The function of BSCs will be described in further slides.

## Slide 20



(need to include the video in our folder)

BSCs provide protection through two key features: direction airflow and HEPA filtration. This video demonstrates the directional, laminar airflow in a BSC.

Key things during the video for the instructor to point out. . .

# Biological Safety Cabinets

## Slide 21



**Vertical laminar air flow in a BSC.**

- Reserved for photo showing vertical air curtain in BSC.

Slide 21



Use a photo or video to assure that the vertical laminar flow is shown if it is not shown effectively in the previous video.

## Slide 22



**Class I BSC**

- Unfiltered room air passes over the work area
- Exhaust air is HEPA filtered before returning to the room
- Personnel protection only

I need a picture and an airflow diagram of a Class I type cabinet

Slide 22

# Biological Safety Cabinets



Instructor should spend about five minutes discussing the purpose, function and use of a Class I Cabinet. The key is that the Class I cabinet provides personnel protection and environment protection, BUT NOT product protection. Ask the class to say why a Class I protects 1) personnel and 2) environment, but not 3) product.

## Slide 23



Source:  
Biological Safety  
Cabinets  
"A Web-based  
Training Program"  
Eagleson Institute  
www.eagleson.org

### Class II A2 BSC

Type A2 Cabinet with canopy

Type A2 Cabinet without canopy

- 100 fpm face velocity
- 70% recirculated air, 30% exhausted (thru HEPA)
- Exhaust to room or thimble connected to external exhaust duct
- Potentially contaminated ducts and plenums under negative pressure or surrounded by negative pressure ducts and plenums
- May be used for work with minute quantities of volatile toxic chemicals and tracer amounts of radionuclides if they are exhausted through properly functioning exhaust canopies



This is the type of BSC that most people think of when a BSC is referred to. Instructor should review the features of a Class II, Type A2 BSC and ask the class why this class protects all three components: personnel, environment and product.

# Biological Safety Cabinets

## Slide 24



### Thimble vs. Hard Duct

- This slide is an optional slide to discuss the difference between hard duct and thimble
- I will need diagrams

Slide 24



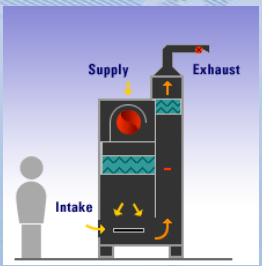
Reminder that cabinets that are hard ducted should not be turned off since their functioning is likely critical to the air balance that has been designed into the laboratory.

## Slide 25



### Class II B2 BSC

Source:  
Biological Safety Cabinets  
"A Web-based Training  
Program"  
Eagleson Institute  
[www.eagleson.org](http://www.eagleson.org)



- 100 fpm face velocity
- Exhaust 100% of the air to the outside after filtration through a HEPA filter
- Must be hard ducted to the outside
- Sometimes called "Total Exhaust"
- All contaminated ducts and plenums under negative pressure, or surrounded by (directly exhausted non-recirculated through the work area) negative pressure ducts and plenums
- May be used for work with volatile toxic chemicals and radionuclides

Slide 25

# Biological Safety Cabinets



The instructor should also mention the other Class II BSCs: Types B1 and B2 and the benefits and disadvantages of each (can use small amounts of chemicals, but must be hard-ducted and thus are much more expensive and harder to maintain).


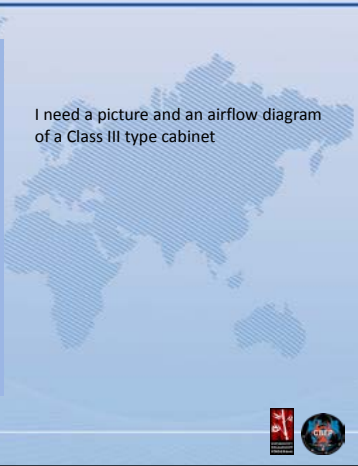
## Slide 26



### Class 3 BSC

- Maximum containment, gas tight enclosure with glove ports
- Air passes through HEPA in and out
- Usually only found in BSL4
- Can be joined in a "line" to provide larger work area
- Usually custom built

I need a picture and an airflow diagram of a Class III type cabinet



# Biological Safety Cabinets



- The Class III biological safety cabinet (is sometimes referred to as a glove box) was designed for work at agents requiring biosafety level 4 (BSL-4) containment, and provides maximum protection to the environment and the worker. It is a gas-tight enclosure with a non-opening, completely sealed, viewing window. Access to the interior of the cabinet is through a double-door pass-through "interchange" box (such as an autoclave) that can be decontaminated between uses and/or a dunk tank that is accessible through the cabinet floor. Reversing that process allows for safe removal of materials from the Class III biosafety cabinet.
- Both supply and exhaust air are HEPA filtered. Exhaust air must pass through two HEPA filters, or a HEPA filter and an air incinerator, before discharge to the outdoors. Air Flow is maintained by a dedicated independent exhaust system exterior to the cabinet, which keeps the cabinet and all associated ducting under negative pressure.
- Long, heavy-duty rubber gloves are attached in a gas-tight manner to ports in the cabinet and should permit replacement without compromising containment. Although these gloves restrict movement for the manipulation of the materials isolated inside the cabinet, they prevent the user's direct contact with the hazardous materials. The trade-off is clearly on the side of maximizing personal safety.
- Depending on the design of the cabinet, the supply HEPA filter provides particulate-free, somewhat turbulent, Air Flow within the work environment. To minimize interior turbulence, however, the inflow air should be ducted to a distribution manifold located on the rear wall just above the work surface. The distribution manifold also provides the means to house an anti-static bar, bathing plastic materials with both positive and negative ions.
- Several Class III cabinets can be joined together in a "line" to provide a larger work area. Such cabinet lines are custom-built; the equipment installed within the cabinet line (e.g., refrigerators, small elevators, shelves to hold small animal cage racks, microscopes, centrifuges, incubators, etc.) is generally custom-built as well. Furthermore, Class III cabinets are usually only installed in maximum containment laboratories that have controlled access and require special ventilation or other support systems (such as steam for autoclaves). The reader should consult more definitive literature on these systems.

# Biological Safety Cabinets

## Slide 27



### Limitations of BSCs

- Only small quantities of volatile chemicals may be used in any type of BSC
  - Motors on standard BSCs are not sparkproof
- Should not use bunsen burners or alcohol lamps in BSCs
  - Over time, heat can damage the HEPA filter
  - Heat can create turbulent airflow, compromising protection
  - And, potential for fire to destroy BSC
    - Buildup of flammable vapors with 70% recirculation



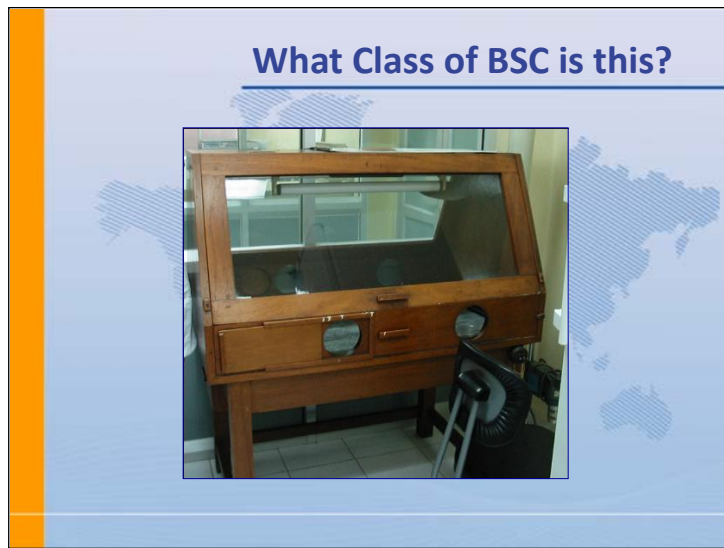
Ask students to use what they've learned about BSCs to determine what might have happened to cause this explosion and fire? Give them 5 minutes to discuss in small groups and then discuss the answer in plenary.

Expected answer: flammable chemicals or natural gas building up in the plenum of the cabinet, followed by ignition of a flame (and, unintentionally, the gas in the plenum) in the BSC. Or possibly ignition of the HEPA filter.



# Biological Safety Cabinets

Slide 28



## Ask students why this isn't considered a BSC?

This picture was taken in a laboratory where staff indicated that this was their Biological Safety Cabinet. You may get some splash and splatter protection but the wood surfaces will make decontamination difficult and there is not HEPA filtration, laminar air flow and therefore little product or personnel protection.

# Biological Safety Cabinets

## Slide 29



### Class Activity: Selecting a Biosafety Cabinet

- What cabinet would you select if you wanted to work with small amounts of volatile chemicals?
- What cabinet would you select if you wanted to be able to turn off the cabinet when it is not in use?
- What cabinet would you select for using to change the bedding in animal cages if you want to minimize the odors in the room?
- What happens to the cabinet function of a hard-ducted Class II B2 cabinet if the exhaust system fails?
- What happens to the cabinet function of a canopy-connected Class II A2 cabinet if the exhaust system fails?



**Ask each group to address one or two of these questions.**

(Need to have expected answers)

## Slide 30



### Limitations of BSCs

- Personnel and product protection depends on inward airflow through the work opening:
  - Requires proper placement of the BSC,
  - Requires proper set up, and
  - Requires proper techniques by user



# Biological Safety Cabinets



Ask in plenary: “What are some things that could disrupt the airflow at the front of the cabinet?”

Expected answers:

- Repeated and quick motions of hands in and out of the cabinet (especially side to side sweeping movements)
- Cabinets placed near door or window openings
- Walking past the cabinet (don’t locate cabinets near high traffic flow areas in the lab)
- HVAC supply vents

## Slide 31



The image on the right shows a poor placement for the BSC: next to the door and underneath a supply air exhaust. Breezes and gust near the cabinet could disrupt the airflow and leave product and personnel less protected. The picture on the lower left shows baffles (shielding) in place on the supply/exhaust vents to prevent disruption of airflow near the cabinet. This cabinet has also been properly located away from high traffic areas.

# Biological Safety Cabinets

## Slide 32



### Proper BSC set up



- Allow cabinet to run 5 minutes prior to use
- Disinfect work surfaces.
- Wipe off each item you place into the BSC to minimize potential contamination.
- Arrange materials in the BSC to segregate contaminated and clean items.



In addition to the above, make sure the sash height is set in the appropriate position. Too high or too low will result in improper airflow and can result in loss of product or personnel protection.

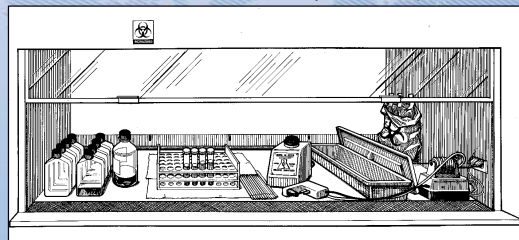
## Slide 33



### Class II Biosafety Cabinet Use

Layout of Equipment

Clean side → Dirty side



Neat, clean, organized, everything needed placed inside before beginning work

# Biological Safety Cabinets



Due to the down flow of air in the cabinet, passing dirty items back over the top of clean items in the cabinet can result in contamination. Always work from clean to dirty.

## Slide 34



**Ask students to address why the grilles must be kept clear?  
What is the outcome if they are not?**

Expected answers: obstructs air flow which might create an opportunity for particulates to escape into the breathing zone. Or contaminated air can be introduced into the work space which can affect the experiment or sample.

# Biological Safety Cabinets

## Slide 35



### Proper BSC Use

- Perform work at least four inches behind the front air intake grille.
- Avoid unnecessary movement in and around the cabinet.
- Collect waste, pipettes, and contaminated materials in the cabinet.
- Wipe down cabinet work surfaces when work is completed.



- Frequent in and out movements can compromise both personnel and product protection
- Never place your face below the sash opening while working (never put your head inside the cabinet) Example of SARS LAI?

## Slide 36



### UV Lights in a BSC

- Not recommended and limited effectiveness
- Must be cleaned weekly
- Bulbs usually need to be replaced regularly (every 90 days of use)
- Must be turned off while the room is occupied

Need pic here.



# Biological Safety Cabinets



UV lights are not recommended. If they are used, they must be cleaned weekly to remove any dust and dirt that may block the germicidal effectiveness of the light. UV intensity should be checked when the cabinet is recertified to ensure light emission is appropriate. UV must be turned off while the room is occupied to protect eyes and skin from inadvertent exposure

## Slide 37



### Limitations of BSCs

- BSCs need to be tested and certified regularly to have assurance getting expected protection
  - Prior to service
  - After repairs or relocation
  - Annually



How do you make sure that your BSC, which is a very complex piece of equipment, is functioning correctly?



# Biological Safety Cabinets

## Slide 38



- The functional operation and integrity of each BSC should be certified to national or international performance standards at the time of installation and regularly thereafter by qualified technicians, according to the manufacturer's instructions.
- Evaluation of the effectiveness of cabinet containment should include tests for cabinet integrity, HEPA filter leaks, downflow velocity profile, face velocity, negative pressure/ventilation rate, air-flow smoke pattern, and alarms and interlocks. Optional tests for electrical leaks, lighting intensity, ultraviolet light intensity, noise level and vibration may also be conducted.
- Special training, skills and equipment are required to perform these tests and it is highly recommended that they are undertaken by a qualified professional.
- Instructor should also mention decontamination: BSCs must be decontaminated before filter changes, before servicing, and before being moved. The most common method is by fumigation with formaldehyde gas. However, there are also other options including vapor phase hydrogen peroxide, and chlorine gas. Any of these methods should only be performed by qualified professionals.

# Other Ventilation Equipment


## Slide 39



### Chemical Fume Hoods

- Designed for use with chemicals
- Provides personnel protection through inward air flow
- Usually no HEPA filtration
- 100% exhaust through hard ducting to exterior of the building

I need a picture of a fume hood and a diagram of how they work





Instructor presents how a fume hood works and emphasizes the following points:

- Designed for use with large amounts of chemicals
- Provides personnel protection through inward airflow through the sash opening
- Does not provide any product protection since contaminated air from the laboratory is drawn directly over the work surface
- Does not provide any environment protection (typically no HEPA filtration of exhaust air)
- 100% of air is exhausted through a hard ducting usually to a tall stack on the roof of the building.

# Other Ventilation Equipment



## Slide 40



### Clean Bench or Laminar Flow Hood

- Outward air flow is directed toward the worker's breathing zone
- Provides a sterile environment
- Used primarily with non-hazardous material (media prep)

Need pics and/or diagram



Slide 41



Clean benches are engineering controls designed strictly to protect PRODUCT. There is no personnel or environmental protection.

Do not confuse “horizontal laminar flow” for “vertical laminar flow”

# Other Lab Equipment

## Slide 41



### Centrifuge Safety

- Follow recommended maintenance schedules.
- Balance rotors carefully.
- Never defeat safety interlocks.
- Wash rotors with mild detergent - never harsh or caustic cleaners.
- Never use abrasive or stiff brushes.
- Allow rotors to air dry (upside down) before placing in a cold room.



Ask students whether a centrifuge could be considered to be an engineering control. (Without certain safety devices, the answer is no). Why should centrifuge procedures use safety devices and what are they designed to protect against? (Due to high speed centrifugation, the possibility of aerosolization and pressurization of contents is high. If a tube or a rotor is damaged or if there is a significant malfunction of a centrifuge, unexpected and undetected aerosols may be released (see Sabia incident))


# Other Lab Equipment

Slide 42



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### Centrifuge Safety



- Routinely decontaminate rotors and centrifuge interiors appropriate disinfectant.
- Use secondary safety cups when spinning infectious materials.



Ask students to address why these are good practices to protect against undetected exposure to infectious agents.

Slide 43



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### Centrifuge Safety

- Load and unload rotors/safety cups containing infectious materials inside a BSC.
- Wipe off the outside of each secondary container with a suitable disinfectant.

## Other Lab Equipment



Ask students to address why these are good practices to protect against undetected exposure to infectious agents.

### Slide 44



**Vacuum Line Protection**

- Protect all vacuum lines with traps and hydrophobic filters
- Change high use filters every six months
- Direct fluid side toward vacuum flask
- Be sure inflow tube extends below the flask arm.

The diagram shows a vacuum line connected to a flask. The line passes through a 'Filter' and a 'Disinfectant Solution' trap before entering the 'Collection Flask'. The photograph shows a physical setup of a vacuum flask with a trap and filter in the line.

Slide 45



- Ask students what the risks are with unprotected vacuum lines (contamination of vacuum lines can result in an unknown and undetected aerosolization of infectious agents; also can contaminate a “house” vacuum system, if it exists)
- Disinfectant solutions need to be changed regularly depending on the disinfectant and should be defined by lab SOP. Note the concentration of disinfectant needs to be appropriate for a full container. (If using bleach, it should be changed at least weekly)

# Other Lab Equipment


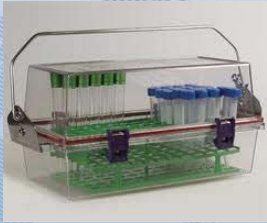
## Slide 45



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### Transport containers

- Robust, leak proof, unbreakable, autoclavable
- Used to transport infectious material within a lab facility
- Load and unload in a BSC
- Wipe of exterior with appropriate disinfectant
- Autoclave in between uses
- Sufficient absorbent should be present at the bottom



Slide 46

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Ask students why a transport container is considered an engineering control. Ask what risks a transport container is designed to mitigate. Also ask what advantage a clear container has over one that you can't see in?

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# Review & Wrap Up

## Slide 46



### Review & Wrap-Up


#### Review

To wrap-up, let's discuss what we learned about the types of engineering controls and the benefits and disadvantages to using them?

What did we learn?

What does it mean?

Where do we go from here?





Ask students to look at their list of engineering controls and to pick one primary and one secondary barrier. For each control, list the benefit (the risk that the control is designed to engineer out) and the disadvantages(s) to using that control.

As students report out, ask them to list one fact or practice about engineering controls or lab equipment that they will take back to their co-workers.




# Review and Wrap-Up

## Slide 47



Action Plan (pg X)			
By the end of this lesson, I would like to:			
KNOW		FEEL	BE ABLE TO DO
Your learning doesn't stop with this lesson. Use this space to think about what else you need to do or learn to put the information from this lesson into practice.			
What more do I need to know or do?	How will I acquire the knowledge or skills?	How will I know that I've succeeded?	How will I use this new learning in my job?

Use space on back, if needed



Remind students to look over their action plan and see if they need to add any new things to learn or next steps to take. Suggest that they put a date on each action item to give themselves a target to hit.

## Slide 48

