Biological Safety Cabinets (BSC) and High Efficiency Particulate Air (HEPA) Filters

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For BSL3 Laboratories
Nashville, TN
7 October 2007

www.biosecurity.sandia.gov

SAND No. 2005-3346C, 2004-3689C, 2005-3346C, & 2006-3688C.
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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Biological Safety Cabinets (BSCs)

- **Primary means of containment**
- **Designed to provide protection for**
  - Personnel
  - Product
  - Environment
- **Three design types**
  - Class I
  - Class II
  - Class III

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Primary Barriers – Ventilation Equipment

	Personnel	Product	Environment
Chemical Fume Hoods	X		
Laminar Flow Clean Benches		X	
Class I Biological Safety Cabinet	X		X
Class II Biological Safety Cabinet	X	X	X
Class III Biological Safety Cabinet	X	X	X
Isolators	X	X	X

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HEPA Filters

- **High Efficiency Particulate Air**
- **Components:**
  - Filter Media
    - Folded cellulose/borosilicate media
    - Very large surface area
  - Sealants
    - epoxy, polyurethane
  - Frames
    - metal
    - wood
  - Edge Sealant
    - gasket with clamp
    - gel seal with knife edge
- **Minimum efficiency of 99.97% removal of 0.3 micron particles**
- **HEPA filters do not filter out gases and vapors, they only filter out particulates**

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HEPA

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How does a HEPA filter work?

- **Inertial Impaction**
- **Interception**
- **Diffusion**
- **Electrostatic forces**
- **HEPA filters do not filter out gases and vapors, they only filter out particulates**

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Testing and Certification

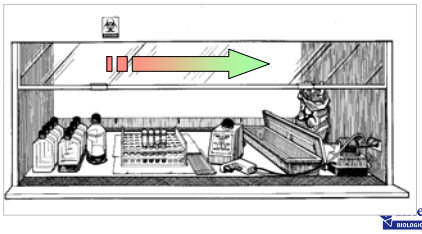
- **Field test (certification) is required**
  - Prior to service
  - After repairs or relocation
  - Annually
- **Certification reports kept in the equipment books**

Biosafety Cabinet Technique

- **Proper technique is critical to maintaining personnel and product protection!**
- **Elements**
  - Decontamination
  - Setup
  - Work flow
  - Locations of supplies and waste containers
  - Movement in and out
  - Others

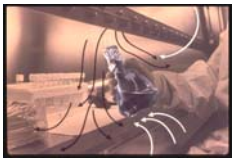
Operation in a Class II BSC

- **Class II BSC are designed to capture horizontally nebulized spores in the downward flowing air**
- **Workflow from clean to contaminated ("dirty")**



Operation in a Class II BSC

- After setup, allow a minimum of 2 minutes for air flow to stabilize
- Place hands in BSC and wait 30 seconds before beginning work
- Refrain from removing hands from BSC during operation so as not to disturb air-curtain
- Immediately clean up small spills
- Limit foot traffic near the BSC while it is in use



BSC Pitfalls

- Overloading
- Blocking airflow elements
- BSC location in lab
- Bunsen Burners
- UV Lamps….

Any comments?

Working in a Class III BSC

- **Advantages**
  - For work with emerging diseases, prions, and agents not found in nature
  - Can be used to separate PCR reagent and sample preparation steps to prevent contamination and augment QC
  - More forgiving of operator error
  - Closed system decreases chance of aerosol escape, accidental exposure and potential laboratory acquired illnesses
  - Chain of custody using Rapid Transfer Port containers
  - Provides superior operator protection in areas with limited reliable infrastructure
- **Disadvantages**
  - More limited range of motion than a Class II BSC.
  - Not as easy to move/remove large pieces of equipment (must remove front panel)
  - Must be able to purchase replacement gloves or bag-out supplies used in removing samples
  - Operations may take a little more time to conduct
  - Many operators are not familiar with the technology

Examples of Class III BSCs

- **Small Class III BSC for diagnostic samples with ergonomic improvements and rapid transfer port entry**
- **Class III BSC with pass-through chamber on right and bag-out for samples on the left**

Testing and Certification

- **National Sanitation Foundation (NSF) International Standard/American National Standard (Sept 29, 2004)**
- **Standard No. 49 - 2004**
  - Performance Criteria
  - Minimum Requirements for Design, Manufacture, and Testing
  - NSF 49 Seal
- **Testing is done by the manufacturer prior to shipping of cabinet**
- **Field test (certification) is required**
  - Prior to service
  - After repairs or relocation
  - Annually
- **Field test (certification) performance criteria:**
  - Down-flow air velocity and volume
  - In-flow air velocity
  - Air flow smoke pattern
  - HEPA filter leak test
  - Cabinet leak test
- **Certification reports kept in the equipment books**

Summary of Biosafety Level Requirements

Table 3. ***Summary of biosafety level requirements***

	BIOSAFETY LEVEL			
	1	2	3	4
Isolation[a] of laboratory	No	No	Yes	Yes
Room sealable for decontamination	No	No	Yes	Yes
Ventilation:				
— inward airflow	No	Desirable	Yes	Yes
— controlled ventilating system	No	Desirable	Yes	Yes
— HEPA-filtered air exhaust	No	No	Yes/No[b]	Yes
Double-door entry	No	No	Yes	Yes
Airlock	No	No	No	Yes
Airlock with shower	No	No	No	Yes
Anteroom	No	No	Yes	—
Anteroom with shower	No	No	Yes/No[c]	No
Effluent treatment	No	No	Yes/No[c]	Yes
Autoclave:				
— on site	No	Desirable	Yes	Yes
— in laboratory room	No	No	Desirable	Yes
— double-ended	No	No	Desirable	Yes
Biological safety cabinets	No	Desirable	Yes	Yes
Personnel safety monitoring capability[d]	No	No	Desirable	Yes

[a] Environmental and functional isolation from general traffic.
[b] Dependent on location of exhaust (see Chapter 4).
[c] Dependent on agent(s) used in the laboratory.
[d] For example, window, closed-circuit television, two-way communication.

From: WHO LBM 3rd edition

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