Risk Assessment: Biosafety Cabinet

Biosafety cabinets (BSCs) serve as primary containment devices for operations involving potential splashes, spills or aerosolization of hazardous biological materials. They are designed to provide personnel, environmental and product protection when appropriate practices and procedures are followed.

Three kinds of biosafety cabinets, designated as Class I, II and III, have been developed to meet varying research and clinical needs. They can effectively contain and capture microbial contaminants and infectious agents using HEPA (High Efficiency Particulate Air) filters. An overview is provided in Table 1-3 of the various classes of BSCs, the level of protection afforded by each and the appropriate risk assessment considerations.

BSCs should not be confused with laminar flow hood which only protect the material being worked with and are not suitable for work with infectious or toxic material.

BSCs should not be confused with conventional fume hoods that do not filter microorganisms.

Hazards

Occupational illness due to exposure of potentially hazardous biological agents (e.g. infectious organisms)

Occupational illness due to exposure of chemical (e.g. carcinogens) and radiological hazards as these are commonly used in microbial procedures.

Fire may occur when the vapour from volatile or toxic chemicals build up inside an unducted Class II, Type A cabinet.

Who is likely to be injured?

The laboratory workers, other people (public), and the environment are at potential risk if biosafety protective measures and regulations are not adhered to.

Control Measures

Biosafety Guidelines and Effective Use of Biosafety Cabinets

1. Purchase

The class of cabinet selected will depend on
a) the risk level of the agent to be used
b) the degree of protection required for the work
c) whether volatile chemicals or radioisotopes will be used in the cabinet
d) the type of procedure to be carried out in the cabinet

Other factors:
 a) cost
 b) the other uses of the room into which the cabinet will be installed
c) the amount of space available for installation of the cabinet.
d) size of doorways which cabinet must pass through to the final point of use.
e) adequate headspace for installation and for the maintenance of the filter boxes, exhaust ducts, alarm systems and fans. There should be, preferably, a 30 cm clearance from the walls and ceiling.
f) Availability of service connections, such as electricity

2. Certification/ Recertification

BSCs must be tested and certified/ recertified after each installation within the laboratory, after each relocation, and at least annually thereafter to ensure the effectiveness of the unit. They must be certified by an approved company and the contractor to provide a copy of their certification report to the laboratory contact.

3. Operation

3.1. Start-up Procedures:

a. Turn on the UV if appropriate for 15 minutes prior to use. UV irradiation is effective in killing many microorganisms. Ensure that the sash is in appropriate position.
b. Turn off UV lights and turn on fluorescent light and cabinet blower.
c. Check the air intake and exhaust grilles for obstructions.
d. If the cabinet is equipped with an alarm, test the alarm and switch it to the "on" position.
e. Confirm inward airflow by holding a tissue at the middle of the edge of the viewing panel and ensuring that it is drawn in.
f. Disinfect the interior surfaces with a suitable, non-corrosive disinfectant.
g. Wait 5 minutes to purge airborne contaminants from the work area.

3.2. Preparing work in the BSC:

a. Before using, wipe work surface with 70% alcohol or any other disinfectant suitable for the agent(s) in use. Wipe off each item you need for your procedures before placing it inside cabinet.
b. DO NOT place any objects over the front air intake grille. DO NOT block the rear exhaust grille.
c. Segregate contaminated and clean items. Work from "clean to dirty."
d. Place a pan with disinfectant and/or sharps container inside the BSC for pipette discard. DO NOT use vertical pipette discard canisters on the floor outside the cabinet.
e. It is not necessary to flame items. When deemed absolutely necessary, touch-plate microburners equipped with a pilot light to provide a flame on demand may be used. Alternatively, use aseptic techniques and sterilized labware.
f. Move arms slowly when removing or introducing new items into the BSC.
g. If you use a piece of equipment that creates air turbulence in the BSC (such as a microcentrifuge or vortex), place equipment in the back 1/3 of the cabinet; stop other work while equipment is operating.
h. Protect the building vacuum system from biohazards by placing a cartridge filter between the vacuum trap and the source valve in the cabinet.
i. Clean up spills in the cabinet immediately. Wait 10 minutes before resuming work.

3.3. Procedures upon completion of the work:
a. Close or cover open containers before removing them from the cabinet.
b. Surface disinfects objects in contact with contaminated material before removal from the cabinet.
c. Turn off the fluorescent light and cabinet blower when appropriate (some cabinets must be left on at all times; if you are unsure, check with your cabinet certifier or safety officer or building maintenance personnel).
d. When work is finished, remove all materials and wipe all interior surfaces with 70% alcohol or any other disinfectant suitable for the agent(s) in use.
e. Remove lab coat, gloves and other Personal Protective Equipment (PPE) and wash hands thoroughly before leaving the laboratory.

4. Training

a) Every employee working in a BSC must be trained in its correct use and always adhere to biosafety precautions when conducting experiments. This will effectively reduce or eliminate the risk of exposure to potentially hazardous agents used in research.
b) Have a good understanding of the different types of cabinets and how they work (attend a BSC seminar).

**Risk Remaining**

BSCs in which chemical and radiological materials are used require design modifications in the cabinet or building exhaust system to include charcoal filters, since HEPA filters do not retain agents which vapourize or sublimate. Evaluation of inherent chemicals must be part of assessment when selecting a BSC.

Table 1. Selection of a Safety Cabinet Through Risk Assessment

<table>
<thead>
<tr>
<th>Biological Risk Assessed</th>
<th>Protection Provided</th>
<th>BSC Class</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Personnel</td>
<td>Product</td>
<td>Environmental</td>
</tr>
<tr>
<td>BSL 1-3</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>BSL 1-3</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>BSL 4</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Biosafety level (BSL)</td>
<td>Agents</td>
<td>Practices</td>
<td>Safety Equipment (Primary Barriers)</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>1.</td>
<td>Not known to cause disease in healthy adult humans</td>
<td>Standard Microbiological Practices</td>
<td>None required</td>
</tr>
<tr>
<td>2.</td>
<td>Associated with human disease, hazard= autoinoculation, ingestion, mucous membrane exposure</td>
<td>BSL-1 practice plus: Limited access; Biohazard warning signs; “Sharps” precautions; Biosafety manual defining any needed waste decontamination or medical surveillance policies.</td>
<td>Primary barriers= Class I or II BSC or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials; laboratory coats; gloves; face protection as needed.</td>
</tr>
<tr>
<td>3.</td>
<td>Indigenous or exotic agents with potential for aerosol transmission; disease may have serious or lethal consequences</td>
<td>BSL-2 practice plus: Controlled access; Decontamination of all waste; Decontamination of lab clothing before laundering; Baseline serum.</td>
<td>Primary barriers=Class I or II BSCs or other physical containment devices used for all manipulations of agents; protective lab clothing; gloves; respiratory protection as needed</td>
</tr>
<tr>
<td>4.</td>
<td>Dangerous/exotic agents which pose high risk of life-threatening disease, aerosol-</td>
<td>BSL-3 practices plus: Clothing change before entering; Shower on exit;</td>
<td>Primary barriers= All procedures conducted in Class III BSCs</td>
</tr>
</tbody>
</table>
transmitted lab infections; or related agents with unknown risk of transmission
all material decontaminated on exit from facility.

or Class I or II BSCs in combination with full-body, air-supplied, positive pressure personnel suit.

supply/exhaust, vacuum, and Decon systems; requirements outlined in the reference1

Table 3. Types of Biohazard Safety Cabinets

<table>
<thead>
<tr>
<th>Type</th>
<th>Face Velocity (lfpm)</th>
<th>Airflow Pattern</th>
<th>Radionuclides/Toxic Chemicals</th>
<th>Biosafety Level (s)</th>
<th>Product Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I*, open front</td>
<td>75</td>
<td>In at front; out rear and top through HEPA** filter</td>
<td>No</td>
<td>2, 3</td>
<td>No</td>
</tr>
<tr>
<td>Class II: Type A</td>
<td>75</td>
<td>70% recirculated through HEPA; exhaust through HEPA</td>
<td>No</td>
<td>2, 3</td>
<td>Yes</td>
</tr>
<tr>
<td>Type B1</td>
<td>100</td>
<td>30% recirculated through HEPA; exhaust via HEPA and hard ducted</td>
<td>Yes (Low Levels/volatility)</td>
<td>2, 3</td>
<td>Yes</td>
</tr>
<tr>
<td>Type B2</td>
<td>100</td>
<td>No recirculation; total exhaust via HEPA and hard ducted</td>
<td>Yes</td>
<td>2, 3</td>
<td>Yes</td>
</tr>
<tr>
<td>Type B3</td>
<td>100</td>
<td>Same as IIA, but plus</td>
<td>Yes</td>
<td>2, 3</td>
<td>Yes</td>
</tr>
<tr>
<td>Class III</td>
<td>NA</td>
<td>Supply air inlets and exhaust through 2 HEPA filters</td>
<td>Yes</td>
<td>3, 4</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Glove panels may be added and will increase face velocity to 150 lfpm; gloves may be added with an inlet air pressure release that will allow work with chemicals/radionuclides

** HEPA: High Efficiency Particulate Airfilter

lfpm: linear flow per minute

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