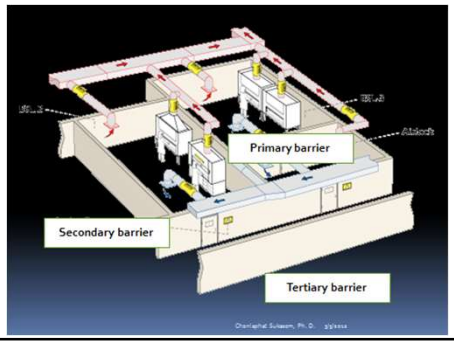
Biosafety Cabinet (BSC): What you need to know?

4 Primary controls for Biosafety

- **Engineering Controls: BSC**
- Administrative Controls: Training, Proficiency test, Maintenance
- Practices and Procedures: SOP
- Personal Protective Equipment: PPE

Engineering Controls

- Technology based, reduce or eliminate exposure to hazards by changes at the source of the hazard.
- Containment:
  - Primary vs Secondary
  - Containment levels

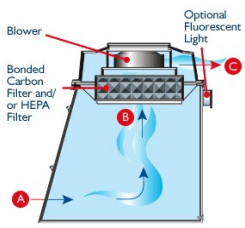


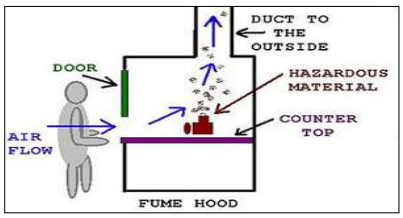
PRIMARY BARRIER
(BSC and PPE)

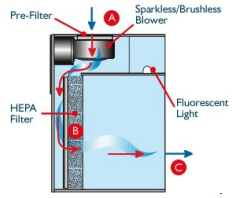
BSL-2 laboratory

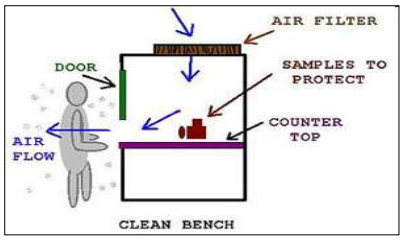
Types of Cabinets

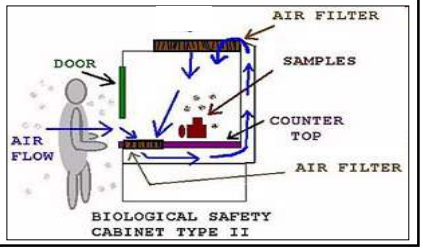
- Biohazard Safety Cabinet (BSC)
- Laminar Flow Cabinet (LFC)
- Fume Hood





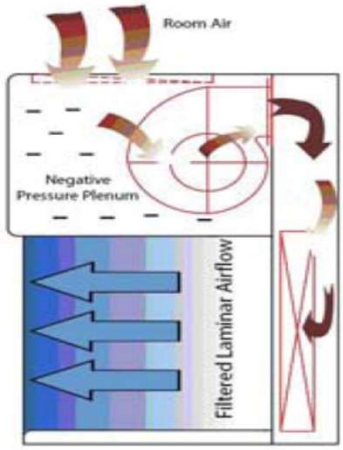




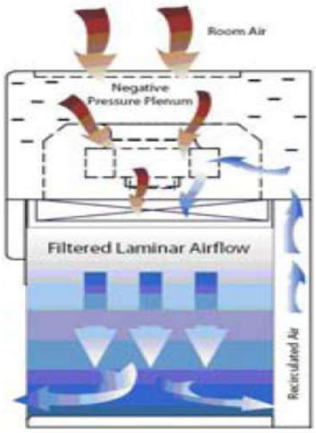


Laminar Flow Cabinets: LFC

- Product protection (no personnel protection)
- Not for biohazard agents or chemical fumes



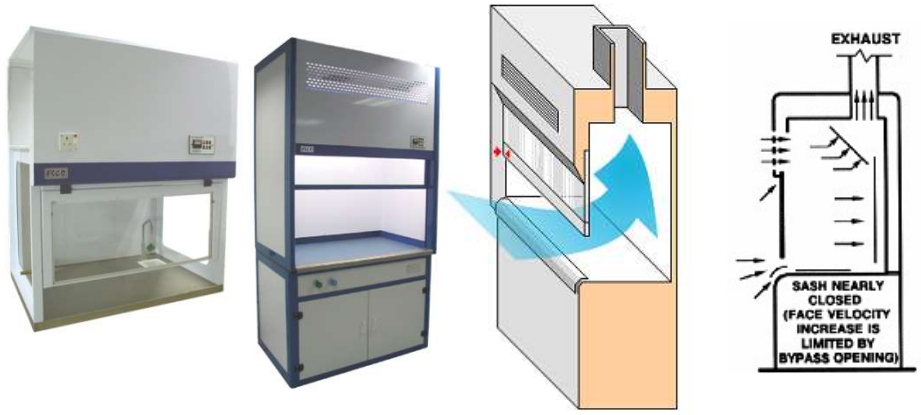
Horizontal Laminar Flow



Vertical Laminar Flow

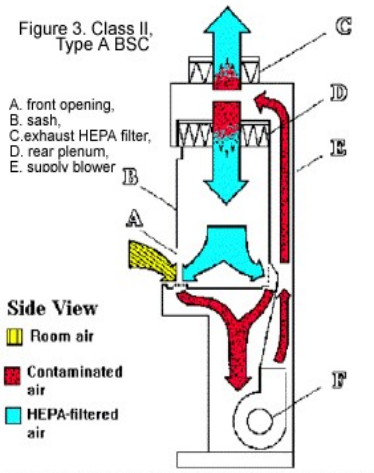
Fume Hoods

- **Removes toxic chemical (ducting sys./ductless)**
- **No HEPA filter -> not for biohazard agents**

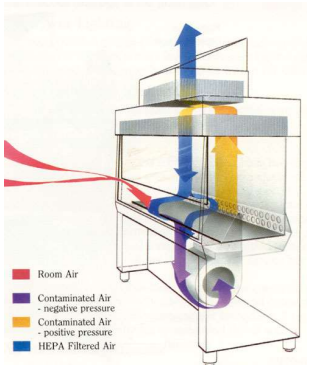


Biological Safety Cabinet (BSC)

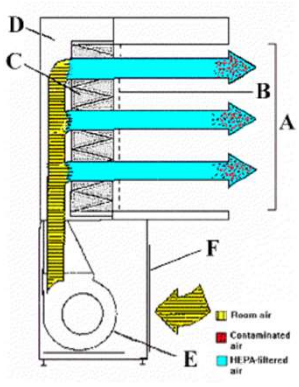
- **BSCs are designed to provide**
  - **–Personal Protection**
  - **–Product Protection**
  - **– Environmental Protection**



BSC vs. LFC



vs



Biological Safety Cabinet
- HEPA filtered laminar air flow and exhaust
- personnel, environment & often product protection

Laminar flow hoods
- **NOT** biological safety cabinets
- Vertical or horizontal laminar flow
- HEPA filtered air (intake)
- product protection only

BSC and the others

containment	operator	product	Environment
Laminar flow clean benches	-	✔	-
Chemical fume hoods	✔	-	-
Class I BSC	✔	-	✔
Class II BSC	✔	✔	✔
Class III BSC	✔	✔	✔

Biosafety Cabinets: BSC

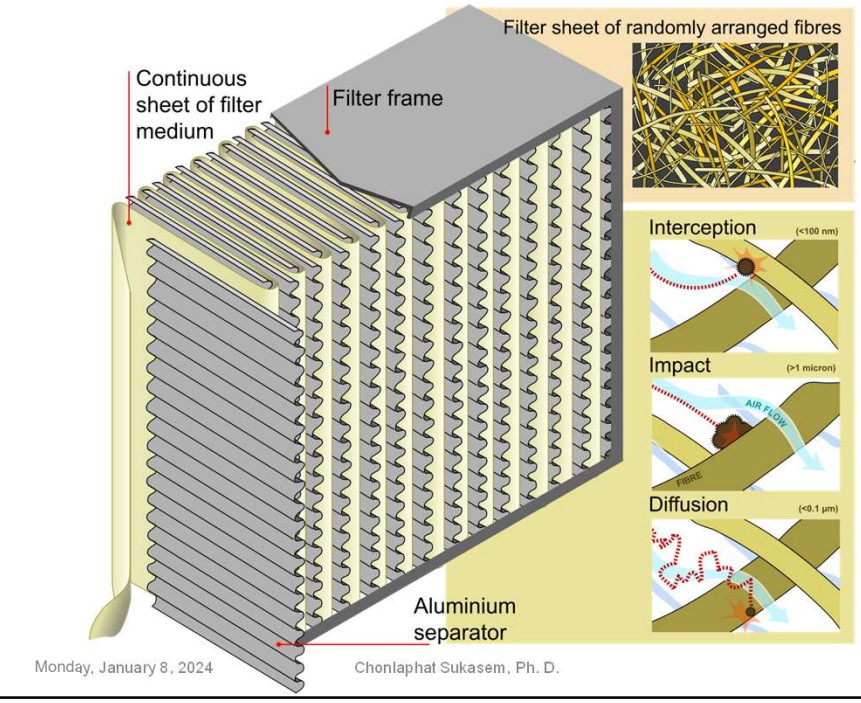
- **Class I BSC: Personnel and Environment Protection**
- **Class II & III BSC: Personnel, Product and Environment Protection**
- **HEPA filters (not for chemical vapours)**

HEPA & ULPA Filter

HEPA: High Efficiency Particulate Air
ULPA: Ultra Low Penetration Air

Important definitions:
- Modern "American-convention" HEPA: 99.99% at 0.3 microns (at MPPS)
- Modern "American-convention" ULPA: 99.999% at 0.12 microns (at MPPS)

Note: The "classical" definition of HEPA filter is 99.97% at 0.3 microns, but nowadays all BSC and LF in US use 99.99% at 0.3 μm



International Standards for BSC

- NSF Standard 49: USA
  (BSC Class II)
- EN12469 : 2000 : EU
  (BSC Class I, Class II, Class III)
- AS 2252 : Australia, Blower 2 set
  (BSC Class I, Class II)
- US Federal Standard 209E
  (Clean Air Classification)

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Class of BSC

1. BSC Class I: Person, Environment

2. BSC Class II: Person, Product, Environment
   Class II Type A (A1, A2)
   Class II Type B (B1, B2)

3. BSC Class III: Person, Product, Environment

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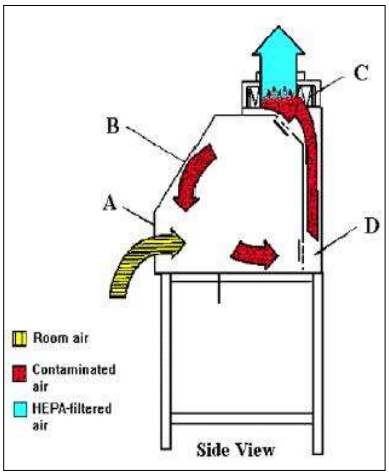
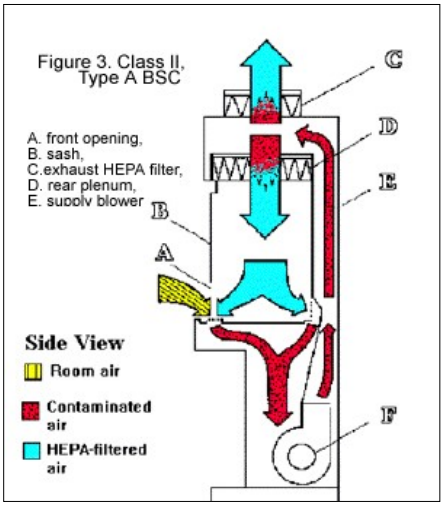
BSC: Personal, Product and Environmental Protection



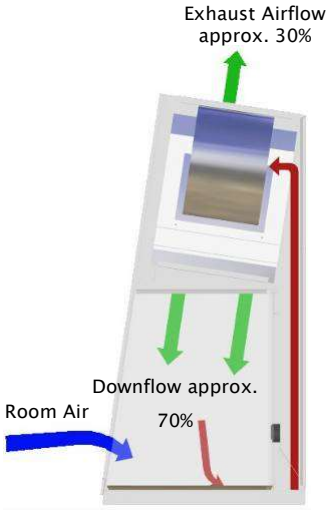
BSC Class I; BSL1, 2, 3



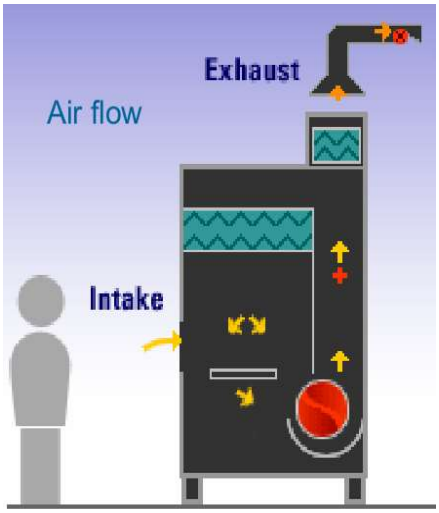
BSC Class II; BSL1, 2, 3

BSC Class IIA

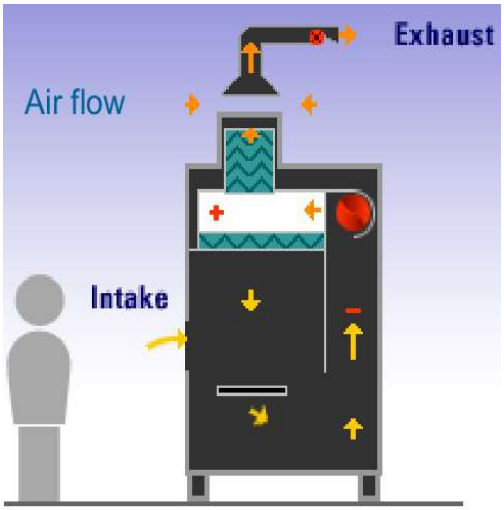
- Recirculating cabinet airflow
- No chemical / toxic vapours containment without ducting
- Approx. 70% recirculating and 30% exhaust



Class II Type A1



Class II Type A2



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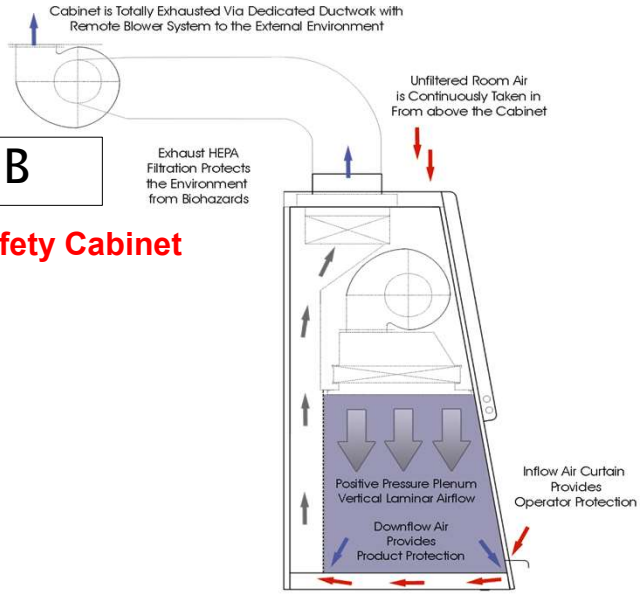
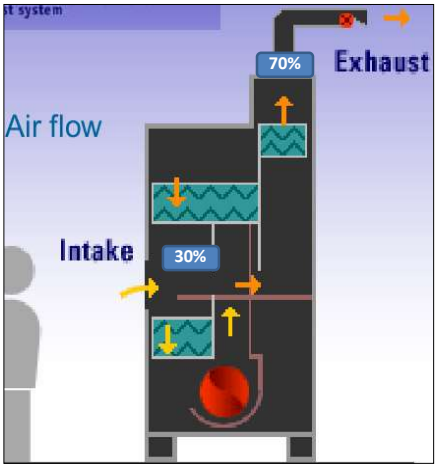
BSC Class IIB

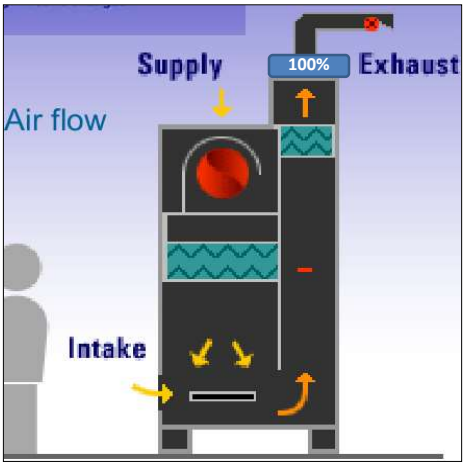
ducted Class II Safety Cabinet



Class II Type B1



Class II Type B2



BSC Class II Type B2 Biohazard Safety Cabinet
Class II

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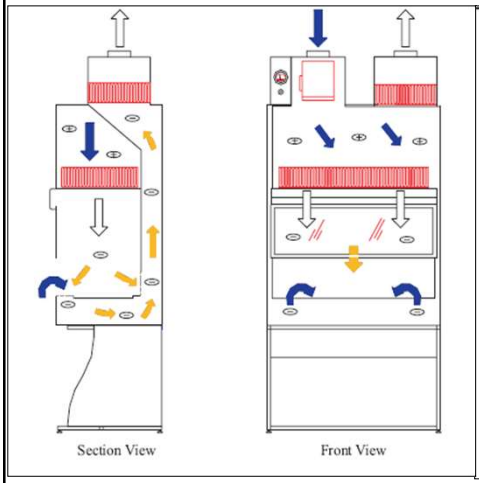
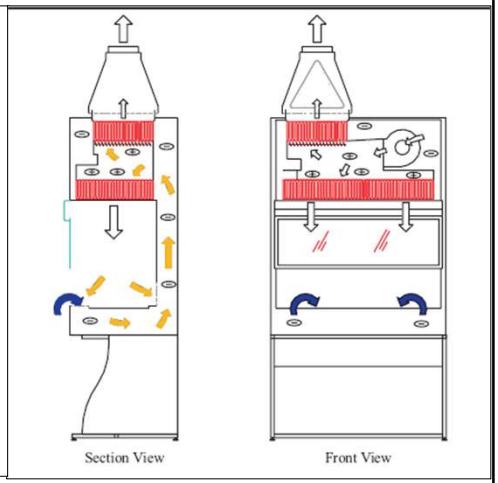
BSC II B

ducted Class II Safety Cabinet



microbiology with toxic chemicals
Cytotoxic drug

BSC II A



microbiology

Class III BSC

(Absolute level of safety)

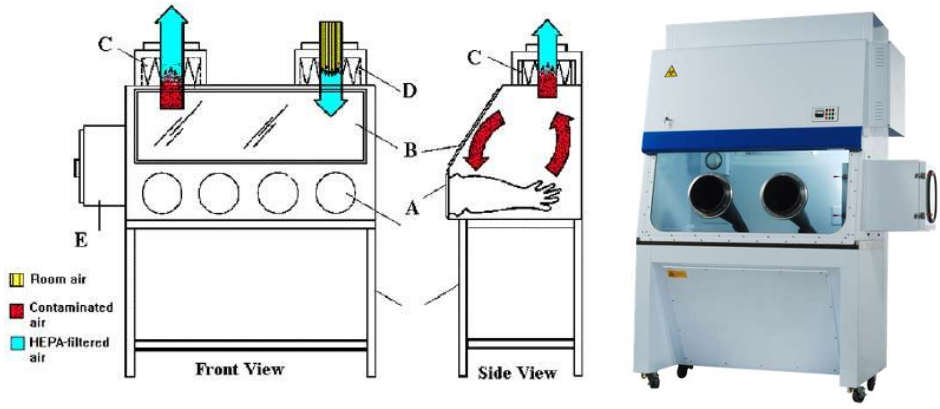


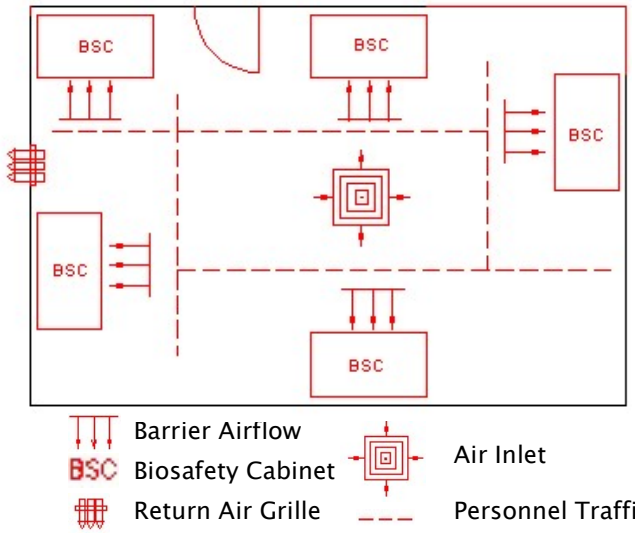
Table 9. ***Differences between Class I, II and III biological safety cabinets (BSCs)***

BSC	FACE VELOCITY (m/s)	AIRFLOW (%)		EXHAUST SYSTEM
		RECIRCULATED	EXHAUSTED	
Class I[a]	0.36	0	100	Hard duct
Class IIA1	0.38–0.51	70	30	Exhaust to room or thimble connection
Class IIA2 vented to the outside[a]	0.51	70	30	Exhaust to room or thimble connection
Class IIB1[a]	0.51	30	70	Hard duct
Class IIB2[a]	0.51	0	100	Hard duct
Class III[a]	NA	0	100	Hard duct

NA, not applicable.

[a] All biologically contaminated ducts are under negative pressure or are surrounded by negative pressure ducts and plenums.

Proper Installation / Location



Exhaust filter area: Especially susceptible to disruptive air currents. Clearance of 40 cm (minimum) is recommended between the highest point of the cabinet and the ceiling.

SOP (Standard Operating Procedures) for BSC
Proper Operation: Before work

- Remove all unnecessary supplies
- Turn on blower, wait for 3-5 min
- Wipe down surface with disinfectant
- Prepare check list of needed materials
- Place needed equipment
- Wipe the exterior of supplies

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SOP for BSC
Proper Operation: while working

- Work as far into the cabinet as possible (4 inches inside the front)
- Slow deliberate movements that will not disrupt airflow, minimize arm movement
- Move arms slowly and limit arm in and out of cabinet
- When an alarm is activated, do NOT use the cabinet
- Work starting from clean to “dirty” objects
- Do not block airflow perforations with objects/equipments

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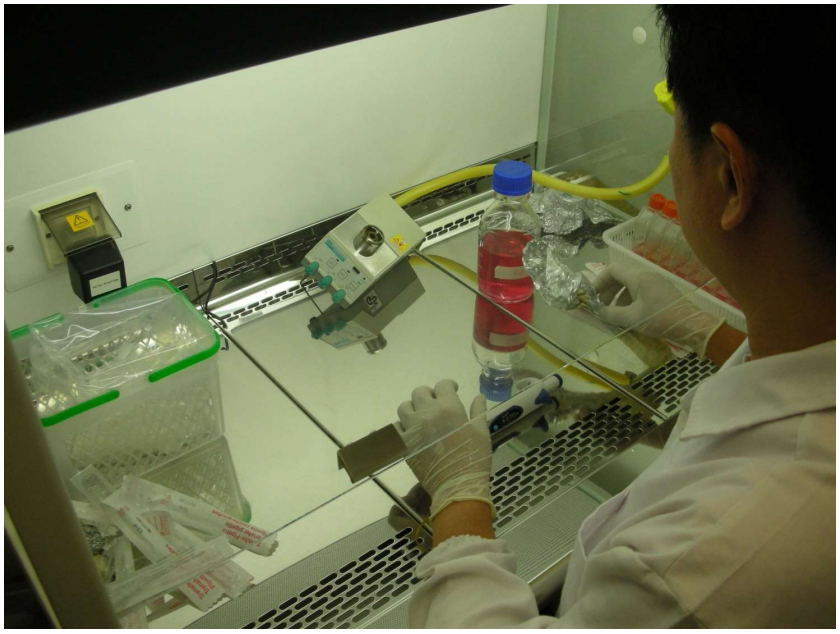
Blocking of airflow perforations with objects



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SOP for BSC
Proper Operation: after work

- After usage, wipe down the cabinet with cleaning agents
- Wipe down the surfaces of containers
- Leave blower on for several minutes

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SOP for BSC
Spill !!!

- Leave the cabinet running
- Cover spill area with paper towels and pour disinfectant (Spill kit)
- Let cabinet run for 10 min after cleanup

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Proficiency Testing

- Recommended recertification for BSC's:
  - Installed
  - Annually
  - Relocated
  - Repaired
  - HEPA has been changed

UV Lamps

- Germicidal UV lamps **are not substitutes** for proper cleaning of BSC workzone
- May cause **performance degradation**
- May compromise personnel safety when proper precautions are not taken

Bunsen Burners

- The use of Bunsen burners in LFC and BSC **is discouraged**
- Compromises cabinet's operator and cross-contamination protection when used

Filter damage due to bunsen burner usage within workzone

4 Primary controls for Biosafety

- Engineering Controls: BSC
- Administrative Controls: Training, Proficiency test, Maintenance
- Practices and Procedures: SOP
- Personal Protective Equipment: PPE

Table I-1.1
Characteristics of Type A1 and A2 BSCs

	Type A1 (Figure 35)	Type A2 (Figure 36)
intended purpose	Routine microbiological work. Work with volatile organic chemicals on the work surface permitted as an adjunct to microbiological research if the BSC is canopy-connected to external exhaust and permitted by risk analysis.	Routine microbiological work. Work with volatile organic chemicals on the work surface permitted as an adjunct to microbiological research if the BSC is canopy-connected to external exhaust and permitted by risk analysis.
airflow pattern	Room air is drawn in through the sash opening, protecting the operator. HEPA/ULPA filtered air flows down through the work area, protecting the product. Both bodies of air flow through a common plenum to the cabinet blower(s). A portion flows out of the cabinet via an Exhaust HEPA/ULPA filter, and the remainder recirculates through a Supply HEPA/ULPA filter before flowing down through the work area.	Room air is drawn in through the sash opening, protecting the operator. HEPA/ULPA filtered air flows down through the work area, protecting the product. Both bodies of air flow through a common plenum to the cabinet blower(s). A portion flows out of the cabinet via an Exhaust HEPA/ULPA filter, and the remainder recirculates through a Supply HEPA/ULPA filter before flowing down through the work area.
air recirculation	Varies by model.	Varies by model.
inflow	Minimum 75 ft/min (0.38 m/s) average.	Minimum 100 ft/min (0.51 m/s) average.
downflow	Varies by model, typically 50 to 80 ft/min (0.25 to 0.40 m/s) average.	Varies by model, typically 50 to 80 ft/min (0.25 to 0.40 m/s) average.
biological containment	All NSF-Listed BSCs must pass the same biological containment tests.	All NSF-Listed BSCs must pass the same biological containment tests.
exhaust system type	Canopy connection as needed.	Canopy connection as needed.
	system, if all BSCs are balanced properly.	system, if all BSCs are balanced properly.
exhaust system function	To convey the BSC exhaust air, plus an additional volume required by the canopy through the ductwork.	To convey the BSC exhaust air, plus an additional volume required by the canopy through the ductwork.
exhaust system volume	Greater than Type B1, less than Type B2.	Greater than Type B1, less than Type B2.
exhaust system negative static pressure at BSC	Typically, 0.25 inches w.g. (62 Pa).	Typically, 0.25 inches w.g. (62 Pa).
exhaust system reserve capacity	Static pressure requirements will not change as the cabinet filters load.	Static pressure requirements will not change as the cabinet filters load.
cabinet flexibility	Can be connected or disconnected from exhaust system as needs change.	Can be connected or disconnected from exhaust system as needs change.
cabinet cost	Less than Type B.	Less than Type B.
installation cost	Much less than Type B if recirculating; less than Type B if canopy-connected.	Much less than Type B if recirculating; less than Type B if canopy-connected.
electrical cost (BSC only)	Slightly more than Type B2.	Slightly more than Type B2.
tempered air loss	If recirculating in lab; none. If canopy-connected, typically 75 CFM/ft (7 m^3/m) of BSC width or less.	If recirculating in lab; none. If canopy-connected, typically 100 CFM/ft (9 m^3/m) of BSC width or less.

Characteristics of Type B1 and Type B2 BSCs

	Type B1 (Figure 37)	Type B2 (Figure 38)
intended purpose	Type B1 cabinets may be used for routine microbiological work. Work with volatile organic chemicals on the work surface permitted as an adjunct to microbiological research if permitted by risk analysis. A majority of the downflow air is directly exhausted from the rear portion of the cabinet.	Type B2 cabinets may be used for routine microbiological work. Work with volatile organic chemicals on the work surface permitted as an adjunct to microbiological research if permitted by risk analysis. All downflow air is directly exhausted from the work area with no recirculation.
airflow pattern	Room air is drawn in through the sash opening, protecting the operator. HEPA/ULPA filtered air flows down through the work area, protecting the product. The room air, and a portion of downflow air in the front of the work area is recirculated through a supply HEPA/ULPA filter before flowing down through the work area. The air in the rear of the work area flows out of the cabinet via an Exhaust HEPA/ULPA filter.	Room air is drawn in through the sash opening, protecting the operator. HEPA/ULPA filtered room air flows down through the work area, protecting the product. Both bodies of air are drawn out of the cabinet via an Exhaust HEPA/ULPA filter.
air recirculation	Varies by model; less than 50%.	None.
inflow	Minimum 100 ft/min (0.51 m/s) average.	Minimum 100 ft/min (0.51 m/s) average.
downflow	Varies by model, typically 50 to 80 ft/min (0.25 to 0.40 m/s) average.	Varies by model, typically 50 to 80 ft/min (0.25 to 0.40 m/s) average.
biological containment	All NSF listed BSCs must pass the same biological containment tests.	All NSF listed BSCs must pass the same biological containment tests.
exhaust system	Required.	Required.
exhaust system type	Must have dedicated ductwork and exhaust blower for each BSC.	Must have dedicated ductwork and exhaust blower for each BSC.
exhaust system function	Must pull exhaust air through the Cabinet's Exhaust HEPA/ULPA filter and then through ductwork.	Must pull exhaust air through the Cabinet's Exhaust HEPA/ULPA filter and then through ductwork.
exhaust system volume	B1 is approximately 20% less than a Type A.	B2 exhausts 100% or more air than any other BSC Type.
exhaust system negative static pressure at BSC	Typically 0.7 inches w.g. H_2O (170 Pa) minimum.	Typically 1 to 2.5 inches w.g. (249 to 622 Pa) H_2O minimum.
exhaust system reserve capacity	Static pressure requirements may increase up to 0.3 inches w.g. H_2O (74 Pa) H_2O as exhaust HEPA/ULPA filter loads.	Static pressure requirements may increase up to 2.5 inches w.g. (622 Pa) as exhaust HEPA/ULPA filter loads.
cabinet flexibility	Must be permanently connected to an exhaust system to function properly.	Must be permanently connected to an exhaust system to function properly.
cabinet cost	More expensive than Type A.	More expensive than Type A.
installation cost	More expensive than a canopy-connected Type A and require a dedicated exhaust fan.	Most expensive. Higher exhaust volumes require larger ductwork and higher capacity dedicated exhaust fan.
electrical cost (BSC only)	Slightly more than a Type B2.	Typically lowest of any BSC.
tempered air loss	Equal to a canopy-connected Type A. Typically 50 to 100 CFM/ft (4.6 to 9.3 m^3/m) of BSC width.	Typically 175 CFM/ft (16.3 m^3/m) of BSC width.

	Type C1 (Figure 39)
intended purpose	Type C1 cabinets may be used for routine microbiological work. Work with volatile organic chemicals on the work surface is permitted as an adjunct to microbiological research if the cabinet is connected to an exhaust system, and is acceptable after performing a risk analysis. Typically, a majority of the downflow air is directly exhausted from the center portion of the cabinet.
airflow pattern	Room air is drawn in through the sash opening, protecting the operator. HEPA/ULPA filtered air flows down through the work area, protecting the product. The room air, and a portion of the downflow air in the work area is recirculated through a supply HEPA/ULPA filter before flowing down through the work area. Typically, the air in the center of the work area flows directly out of the cabinet via an Exhaust HEPA/ULPA filter.
air recirculation	Varies by model; typically less than 50%.
inflow	Minimum 100 ft/min (0.51m/s) average.
downflow	Varies by model, typically 50 to 80 ft/min (0.25 to 0.4 m/s) average.
biological containment	All NSF listed BSCs must pass the same biological containment tests.
exhaust system	Canopy connection as needed. If BSC exhaust is to be directed into the exhaust duct during a system failure, the ductwork must be sealed and tested for leakage.
exhaust system type	Canopy-connected Type C1 BSCs may be ganged into a multiple-cabinet exhaust system, if all BSCs are balanced properly.
exhaust system function	To convey the BSC exhaust air, plus an additional volume required by the canopy through the ductwork.
exhaust system volume	Greater than Type B1 Less than Type B2.
exhaust system negative static pressure at BSC	Typically 0.25 inches w.g. (62 Pa).
exhaust system reserve capacity	Static pressure requirements will not change as the cabinet filters load.
cabinet flexibility	Can be connected or disconnected from exhaust system as needs change.
cabinet cost	More expensive than Type A; similar to Type B.
installation cost	Much less than Type B if recirculating; less than B1 if connected to a ganged exhaust system; similar to Type B1 if connected to a dedicated system.
electrical cost (BSC only)	Similar to a Type A2.
tempered air loss	If recirculating in lab; none. If canopy-connected, typically 75 CFM/ft (7 m^3/m) of BSC width or less.