WELCOME!

Laboratory Ventilation Safety

J. Scott Ward

Protecting your laboratory environment

LABCONCO®

Labconco Corporation

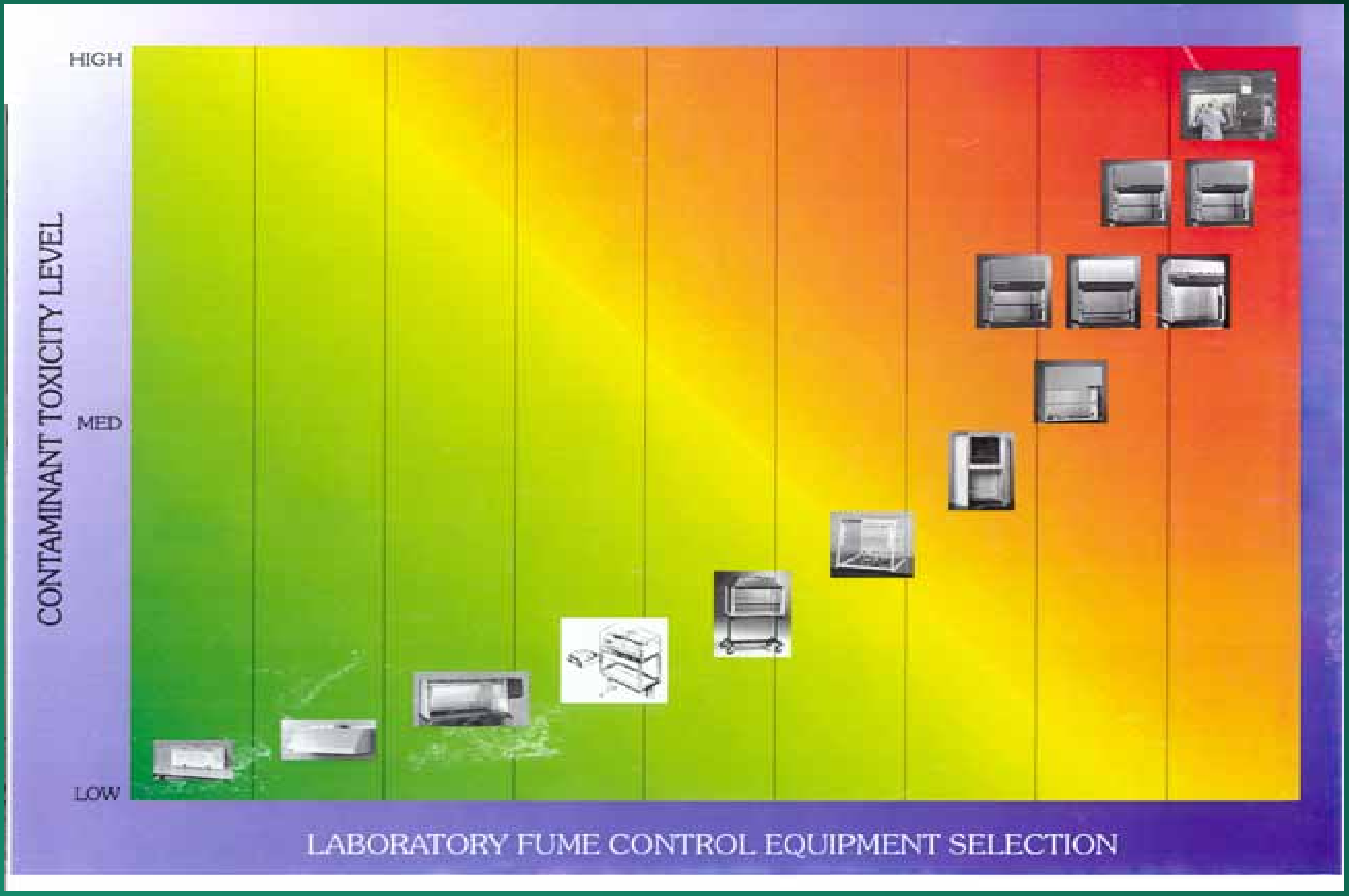
In 1925, Laboratory Construction Company was born. The first product was a Kjeldahl Nitrogen Determination Apparatus. We may have shortened our name, but we've expanded our horizons. We offer 16 different product lines to universities, research centers, hospitals, general laboratories and governmental agencies around the world.

LABCONCO

Laboratory Ventilation

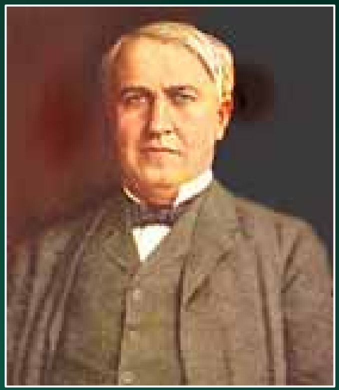
LABCONCO

Laboratory Ventilation Products

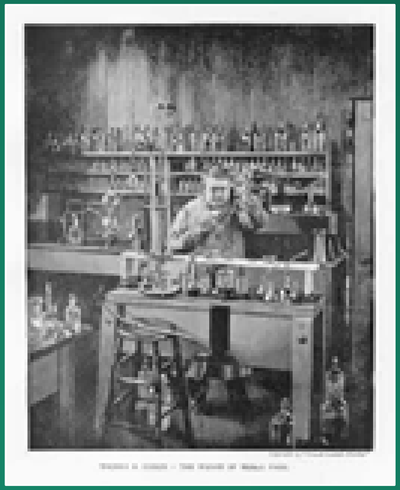


History of Fume Hoods

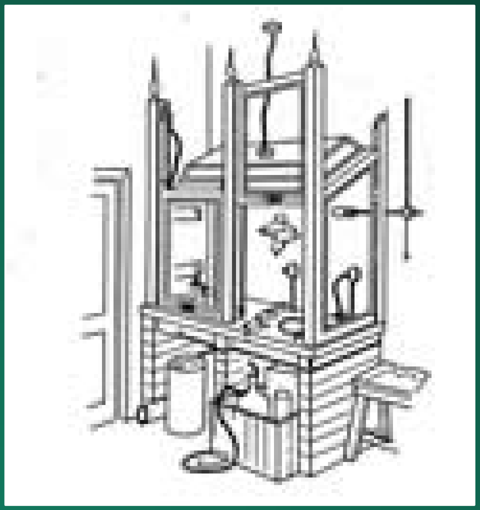
- Thomas Edison Laboratories
- Fireplace and chimney
- Shelves outside the window
- "fume cupboard" University of Leeds, England 1923



Thomas Edison invented the incandescent light bulb in 1879.



Thomas Edison, circa 1900



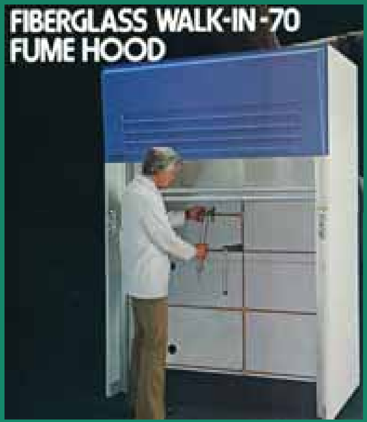
University of Leeds, England - 1923

Evolution Revolution

First Labconco Hood 1936

Fiberglass 28, circa 1960

Protector Hood Line, 2002



Fiberglass Walk-In, 1970’s

Radioisotope, 1980’s

Definition of a Fume Hood

A ventilated enclosure where harmful or toxic fumes or vapors can be safely handled while protecting the laboratory technician.

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Purpose of a Fume Hood

Video 9

The primary function of a fume hood is to *capture, contain* and *remove* airborne contaminants.

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Purpose of a Fume Hood

Video 11

Fume hoods provide operator safety by drawing air away from the operator and into the fume hood.

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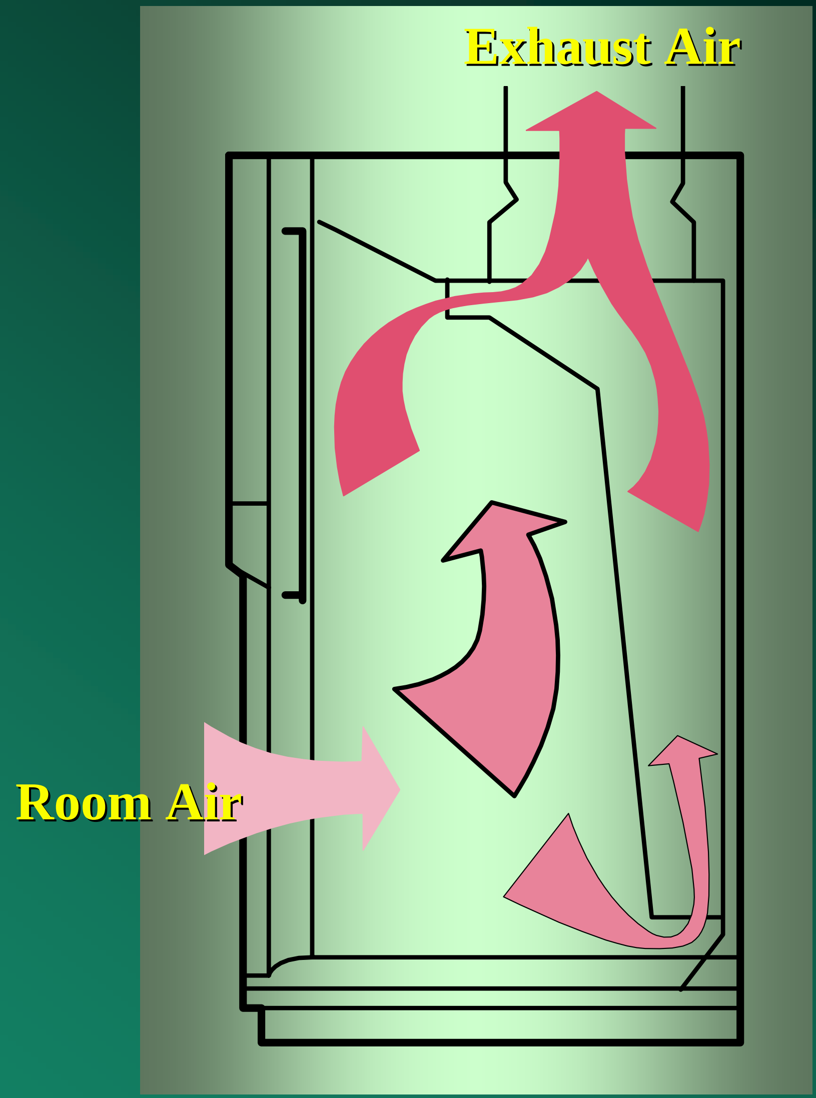
Face Velocity

Definition:

Airflow into a hood is achieved by an exhaust blower which "pulls" air from the laboratory room into and through the hood and exhaust system. This "pull" at the opening of the hood is measured as face velocity.



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Air Volume

Air volume passing through a fume hood is generally equal to the area of the sash opening multiplied by the average velocity desired. For example, if 100 feet per minute (fpm) is required and the hood has a sash opening of 7.5 square feet, then the hood's air volume is 750 (7.5 x 100) cubic feet per minute (CFM).

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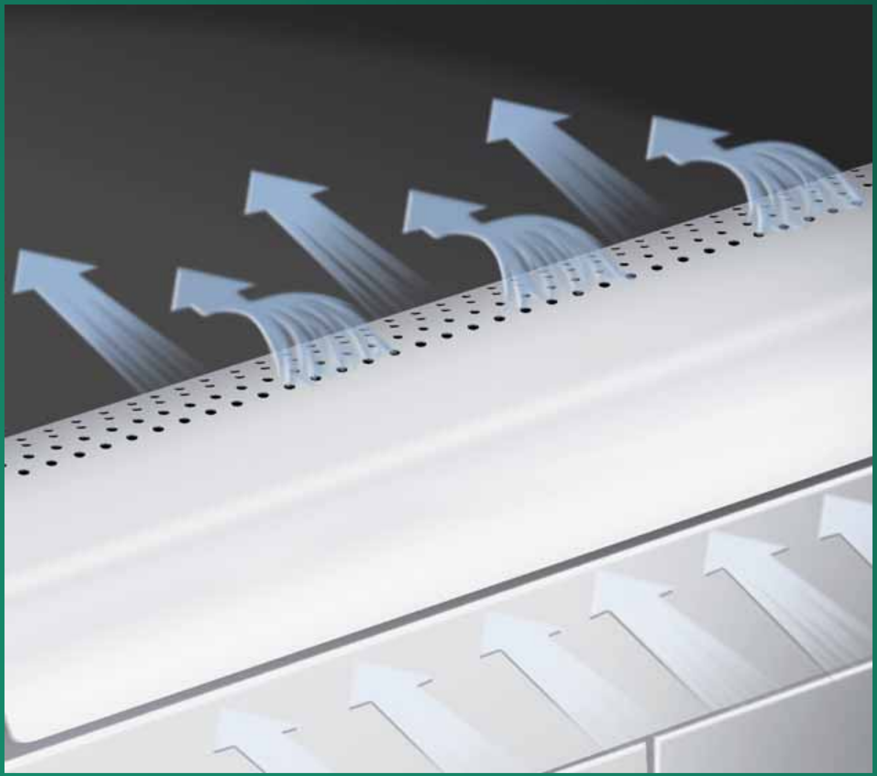
Design Components



Air Foil

Aerodynamic sash opening directs airflow into hood and across work surface with minimum turbulence helping to ensure fume containment.

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Design Components

The **SASH** controls the area of the fume hood which is open. It protects the operator and controls hood face velocities. Glass options include tempered or laminated.

Sash

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Safety Sash: Physical Barrier

Vertical-rising sash

Horizontal-sliding sashes

Combination (vertical and horizontal sashes)

Design Components

The BAFFLE controls the pattern of the air moving into and through the fume hood Baffles are either fixed (left photo) or adjustable (right photo).

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Types of Fume Hoods

- **Conventional**
- **By-Pass**
- **Auxiliary-Air**
- **Reduced Air Volume**
- **Variable Air Volume**
- **High Performance**

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Conventional Fume Hood

- Most basic hood design
- Operates at constant exhaust volume
- Face velocity increases as sash is lowered

Fiberglass 28 Hood on Acid Storage Cabinet

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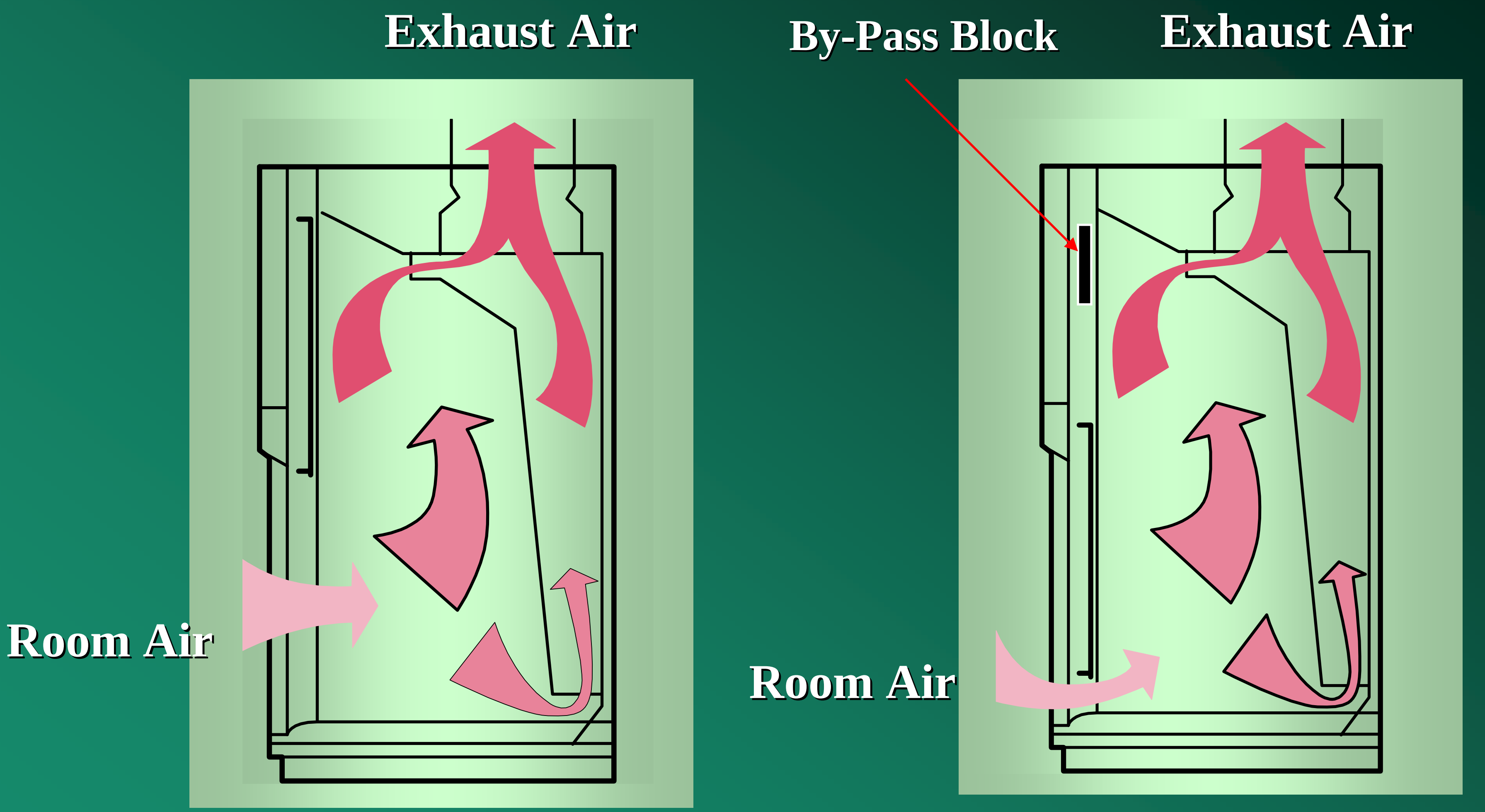
Conventional Fume Hood



With Sash Open | **With Sash Nearly Closed**

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By-Pass Fume Hood

- **Relatively constant face velocity**
- **As sash is closed, hood draws air through bypass openings, maintaining excellent containment**

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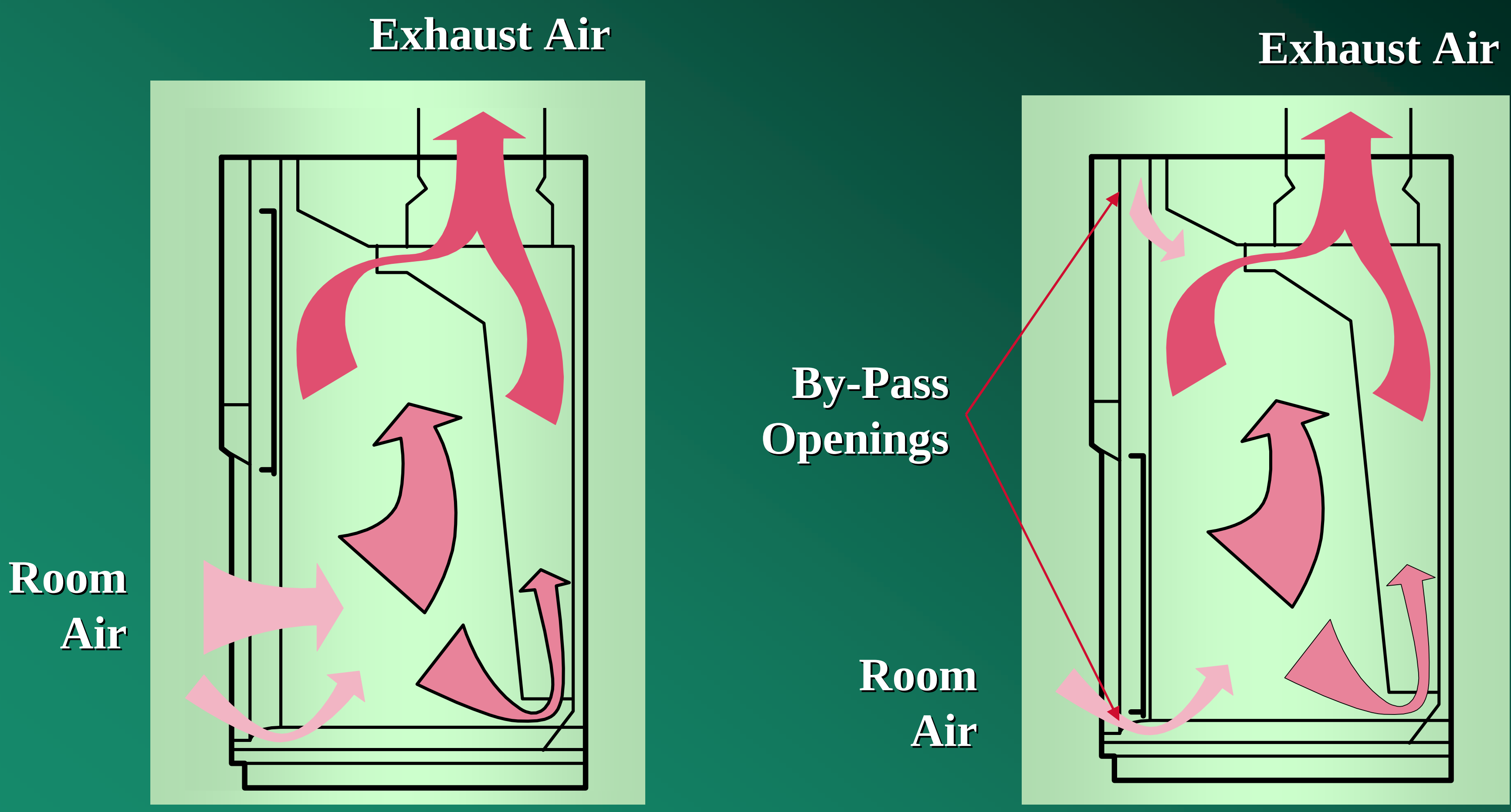
By-Pass Fume Hood



With Sash Open

With Sash Nearly Closed

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Auxiliary-Air Fume Hood

- **Brings in between 50-70% of air volume from outside laboratory**
- **May be used to augment insufficient room air**
- **Reduces consumption of fully tempered room air**
- **Requires two duct and blower systems**
- **Balance between air systems essential**

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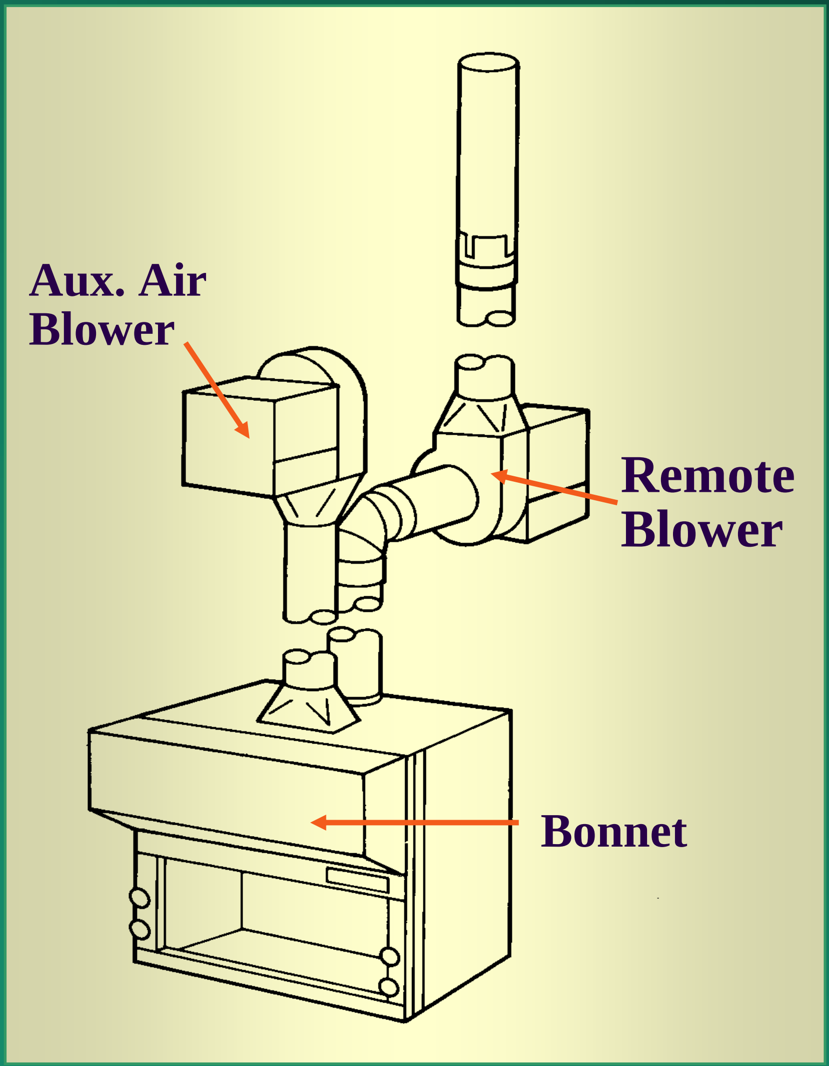
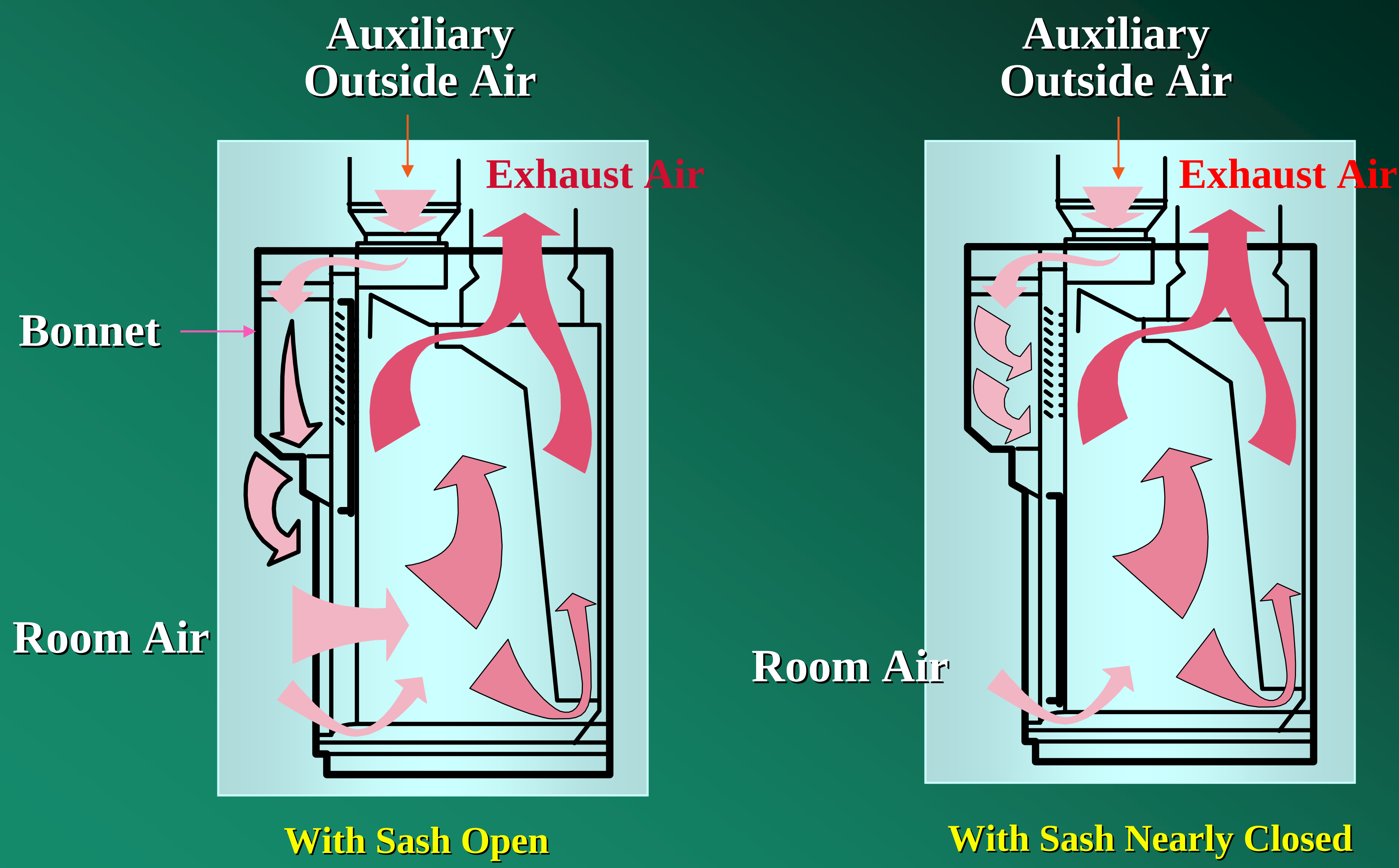
Auxiliary Air Fume Hood



- Requires two remote blowers– one to exhaust and one to supply air
- Bonnet directs uniform and continuous air flow
- Exhaust and Auxiliary Air blower systems must be I nter-locked

Auxiliary Air Fume Hood



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Special Purpose Hoods

- Perchloric Acid/Acid Digestion
- Radioisotope
- Floor-Mounted
- Canopy
- Educational
- HOPEC IV

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Stainless Steel Perchloric Acid Fume Hood

Wash Down
System Control

Seamless one
piece Type
316 stainless
steel liner
including
work surface

Requires dedicated
exhaust duct with
wash down system

Integral
drain trough

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PVC Perchloric Acid Fume Hood

Wash down system control

Seamless one piece liner including work surface

Requires dedicated exhaust duct with wash down system

Type I PVC liner

Integral drain trough

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Radioisotope Fume Hood

Type 304 stainless steel interior

***Work Surface with integral cupsink**

Dedicated exhaust system is recommended*

**** Consult local regulatory agencies for usage recommendations***

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Canopy Hood

- **Vents non-toxic materials such as steam, heat and noxious odors**
- **May be mounted on a wall or suspended from ceiling**
- **Install less than 12" above equipment to be ventilated**

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Floor-Mounted Fume Hoods

- By-pass airflow design
- Mount on floor permitting roll-in loading of heavy or bulk apparatus
- Additional interior height to accommodate large apparatus
- Aerodynamic sash foil

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* Operator should never stand inside hood while fumes are being generated.

XVS Ventilation Stations

Applications:

- Student work station
- Balance enclosure
- Light duty fume hood
- Solvent cleaning bay
- Veterinary pathology/cytology hood
- Forensics/ latent fingerprint hood

VS Station atop accessory work surface

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Carbon Filtered Enclosures

A portable, self-contained enclosure for vapors and fumes, which requires no ducting.

- **Applications include processes involving odors and unsafe concentrations of:**
  - ✓ **Organic solvents**
  - ✓ **Formaldehyde**
  - ✓ **Acid gases**
  - ✓ **Ammonia**

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Planning Laboratory Space

- Location
- Identify airflow configurations
- Adequate supply air
- Supply air diffuser location
- Balanced HVAC system
- Air changes (4-12 or 16 per hour for high risk)
- Energy conservation varies geographically
- * 300 CFM = 1 ton of air conditioning or $4 to $7 dollars/CFM

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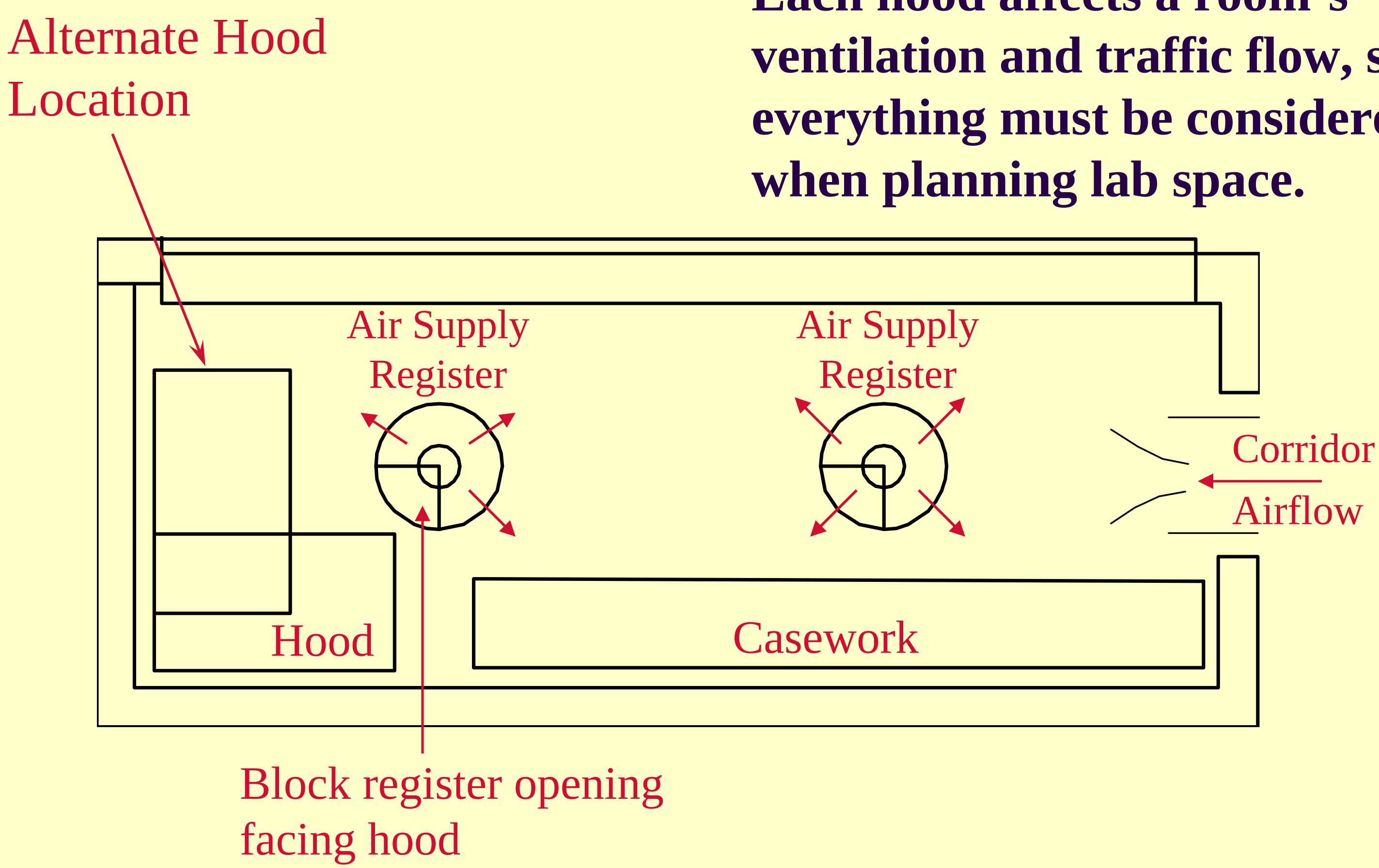
Planning Laboratory Space

Each hood affects a room's ventilation and traffic flow, so everything must be considered when planning lab space.



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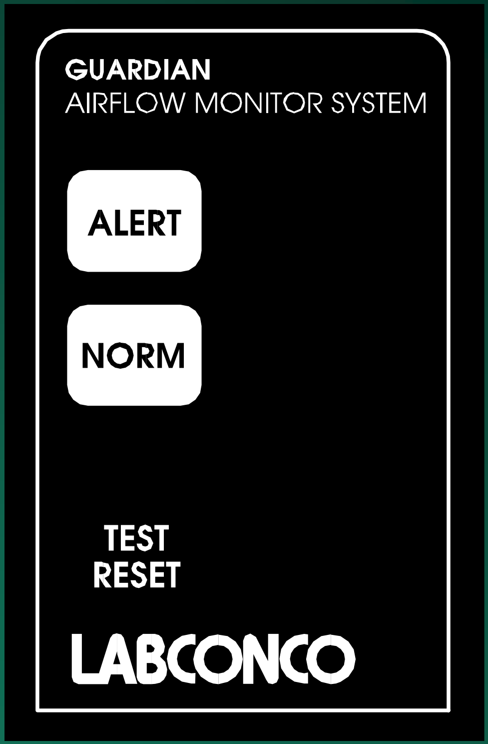
Monitors

Digital

American National Standards Institute (ANSI) Standard Z9.5 requires the use of an airflow monitor, a device that gives warning (by a visible or audible signal, or both) when the airflow through the hood has deviated from a predetermined level.

Analog



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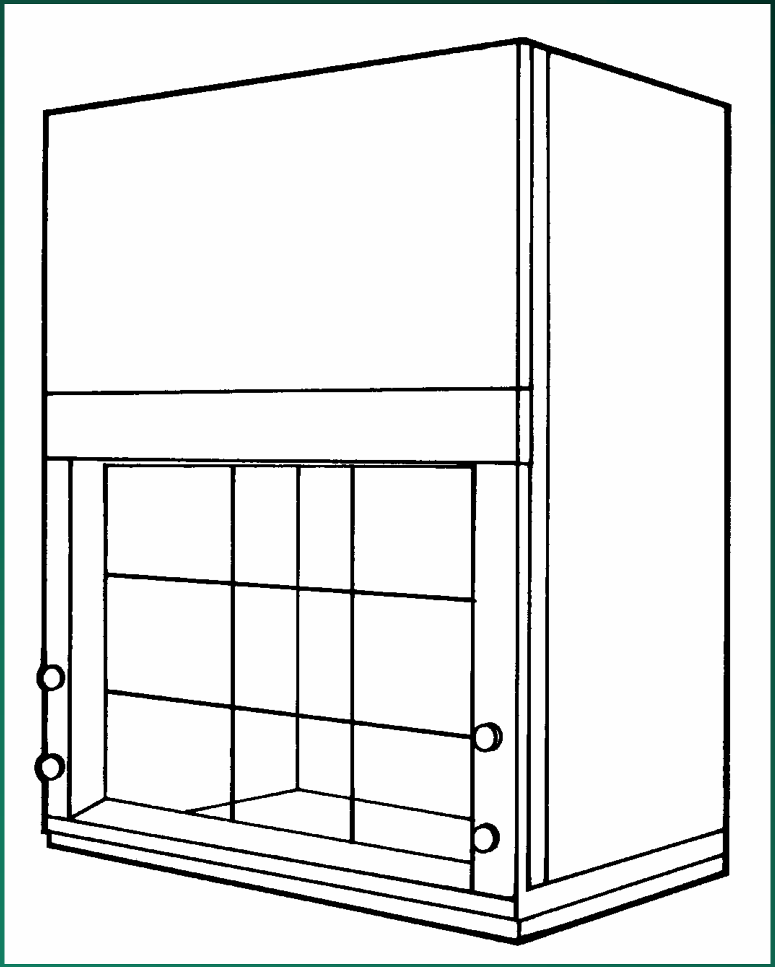
Fume Hood Performance Tests

- **Smoke**
- **Face Velocity**
- **ASHRAE 110-95**
- **SEFA**

Face Velocity

Average face velocity is calculated by dividing the sash opening into one-foot squares. Velocity readings are taken in each grid area and averaged.



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ASHRAE 110-95

Three part test – not a pass/fail

Face velocity profile

Smoke generation - Titanium tetrachloride

Tracer gas containment - Sulfur hexafluoride (released at 4 liters/min.)

ASHRAE Test on Floor Mounted Hood

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Laboratory Ventilation Standards

Federal Register 29 CFR Part 1910

Non-mandatory recommendation from "Prudent Practices"

- **Fume hoods should have a continuous monitoring device**
- **Face velocities should be between 60-100 linear feet per minute**
- **Average 2.5 linear feet of hood space per person**

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Laboratory Ventilation Standards

Industrial Ventilation - ACGIH

- **Fume hood face velocities between 60-100 fpm**
- **Maximum of 125 fpm for radioisotope hoods**
- **Duct velocities of 1000-2000 fpm for vapors, gasses and smoke**
- **Stack discharge height 1.3-2.0 x building height**
- **Well designed fume hood containment loss <0.10 ppm**

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BIOLOGICAL SAFETY CABINET OPERATION

Scott Ward

LABCONCO CORP.

Working in Biological Safety Cabinets

Planning

- Thoroughly understand procedures and equipment required before beginning work. Arrange for minimal disruptions, such as traffic in the room during work.
- Have disinfectant and spill cleanup materials prepared.

Biological Safety Cabinet

- **HEPA filtered**
  - **Contains biohazardous aerosols**
  - **Provides personnel protection**
- **May also provide product protection *(depends on class)***

Class II Biological Safety Cabinet

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How Are Biological Safety Cabinets Classified?

1) Airflow velocities and patterns
2) Exhaust system
3) Construction

Class I

Class II

Class III

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Defined by National Institutes of Health/Centers for Diseases Control and Prevention (NIH/CDC)

Theory of Operation
Biological Safety Cabinets

Major components:

- HEPA filters
- Motor/blower to force air through the cabinet
- Speed control for the motor/blower
- Appropriate air intakes, ductwork, and air balance controls

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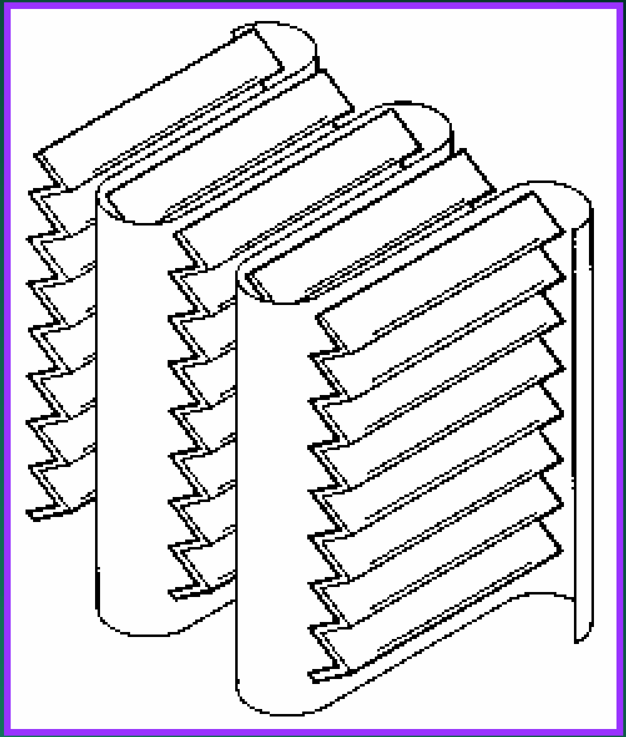
HEPA Filters

The HEPA filter is the heart of the biological safety cabinet. It is a disposable dry-type filter, constructed of boron silicate microfibers cast into a thin sheet. The filter media is folded to increase its surface area.



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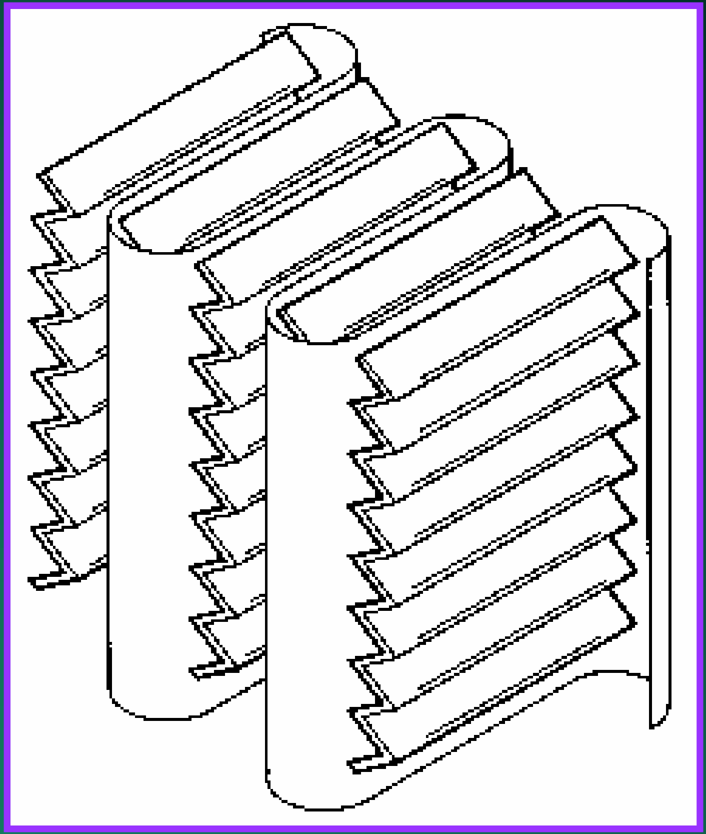
HEPA Filters

The HEPA filter is 99.99 efficient at removing particles 0.3 micron or larger in size. Gases pass freely through the filter.



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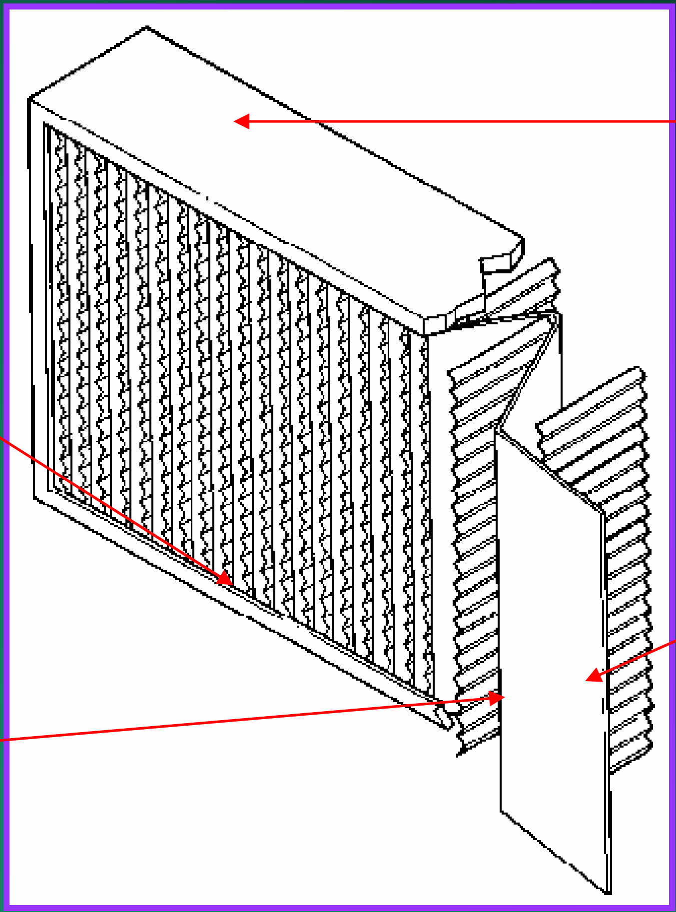
HEPA Filters



Filter Frame

Gasket Seal

Continuous sheet of flat filter medium

Adhesive bond between filter pack and integral frame

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Theory of Operation
Biological Safety Cabinets

Major principles:

- **Filtration and retention of particulates by the HEPA filter(s)**
- **Directional airflow**
- **Laminar airflow**

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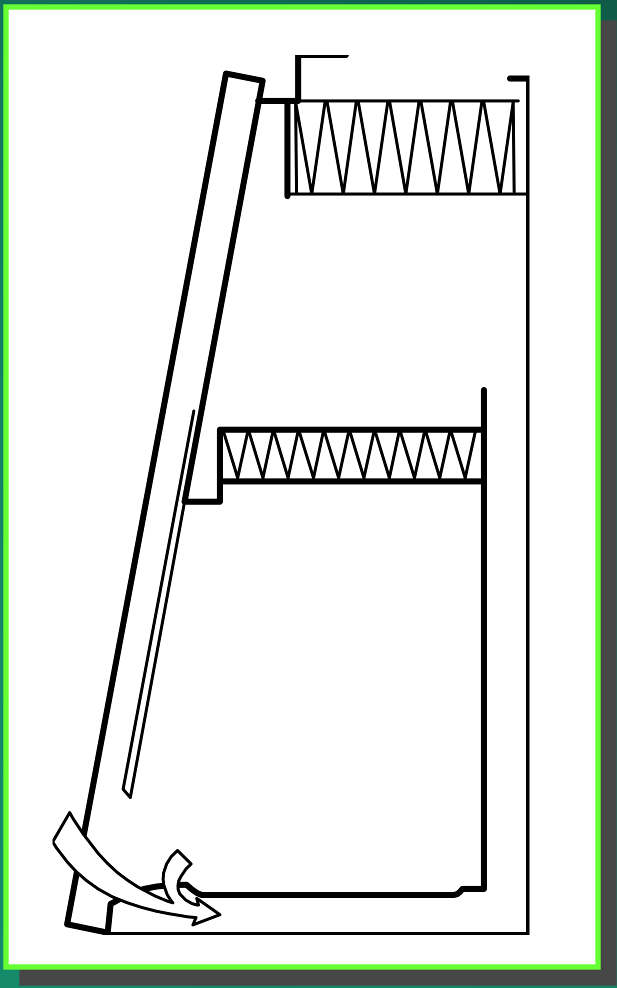
Theory of Operation

Directional Airflow



- Air is drawn in from the front of the cabinet. Directional airflow into the cabinet face prevents aerosols escaping from the face of the cabinet.

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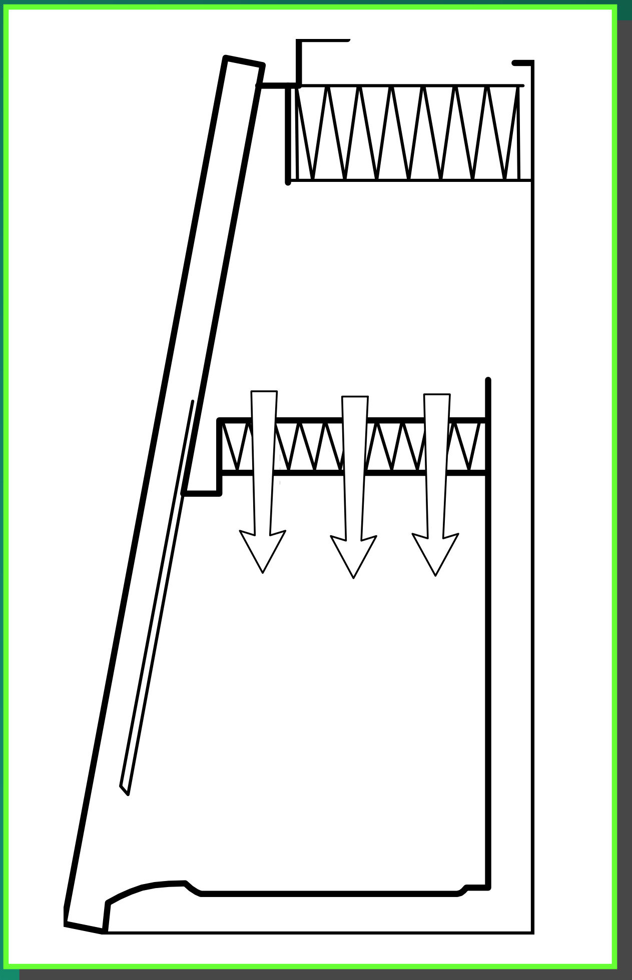
Theory of Operation

Laminar Airflow



- Vertical laminar airflow through the work area captures any aerosols generated in the work area of the cabinet.
- To be *true* laminar airflow, air velocities throughout the cabinet must be + or - 20% of overall average.

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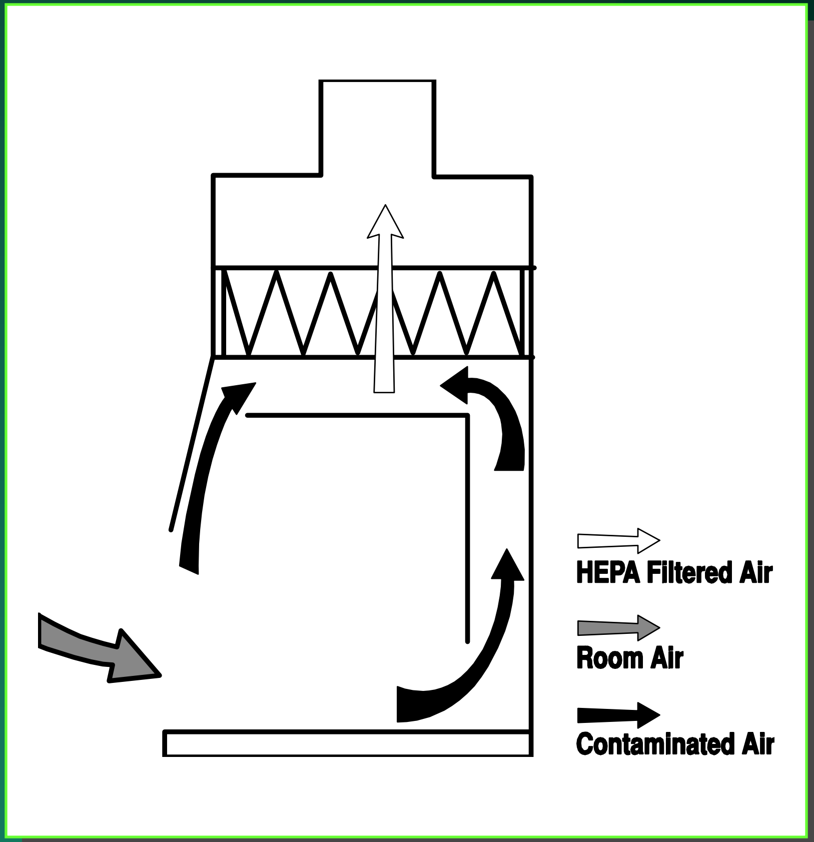
Class I Biological Safety Cabinet

- Open front with directional airflow
- Operates under negative pressure
- Face velocity of 75-100 fpm
- HEPA filtered exhaust
- Provides personnel and environmental protection only
- For work requiring Biosafety Level 1, 2, or 3 containment



Defined By NIH/CDC

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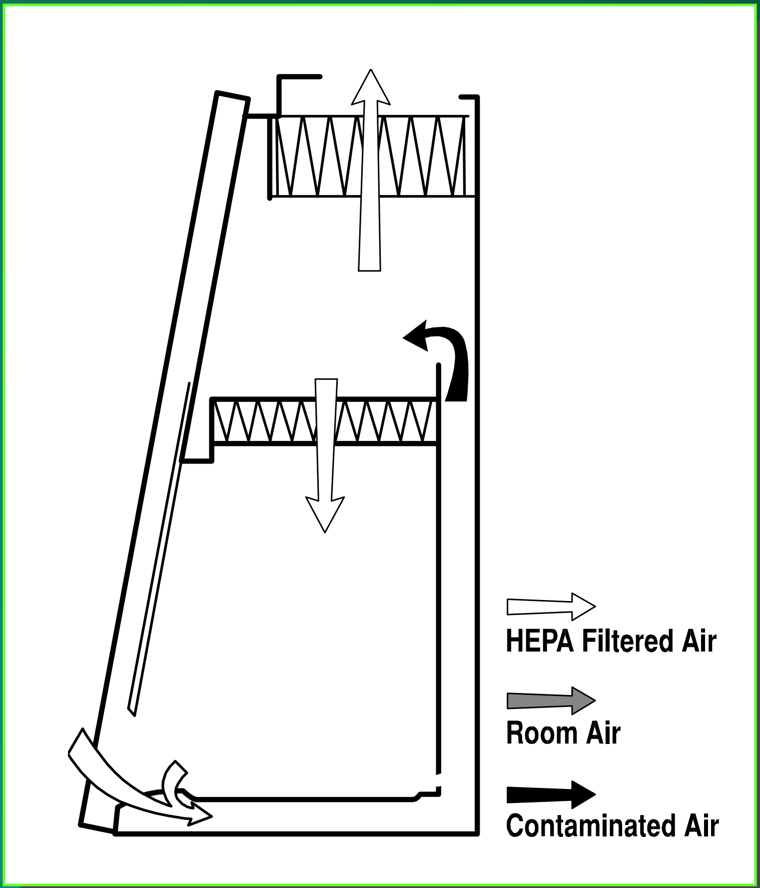
Class II Biological Safety Cabinet



- Open front with directional airflow for personnel protection
- HEPA-filtered laminar downflow for product protection
- HEPA-filtered exhaust
- Face velocity of 75-100 fpm
- For work requiring Biosafety Level 1, 2, or 3 containment

Defined By NIH/CDC

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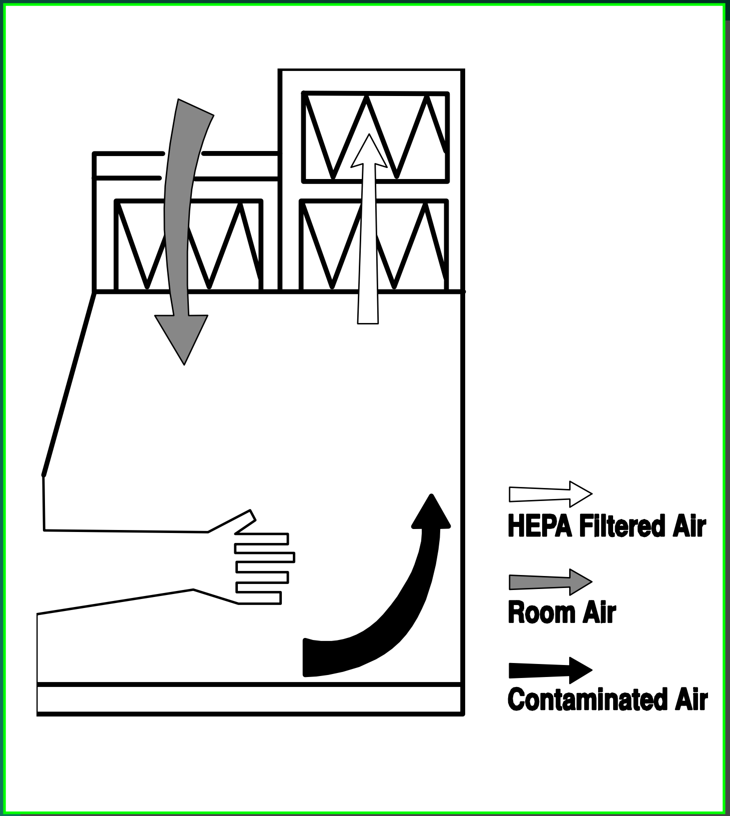
Class III Biological Safety Cabinets

- Totally enclosed
- Gas tight construction
- Work through gloves
- Negative pressure of at least 0.5" H_2O
- Provides personnel, product and environmental protection
- Double HEPA filter exhaust
- For work requiring Biosafety Level 1, 2, 3, or 4 containment



Defined By NIH/CDC

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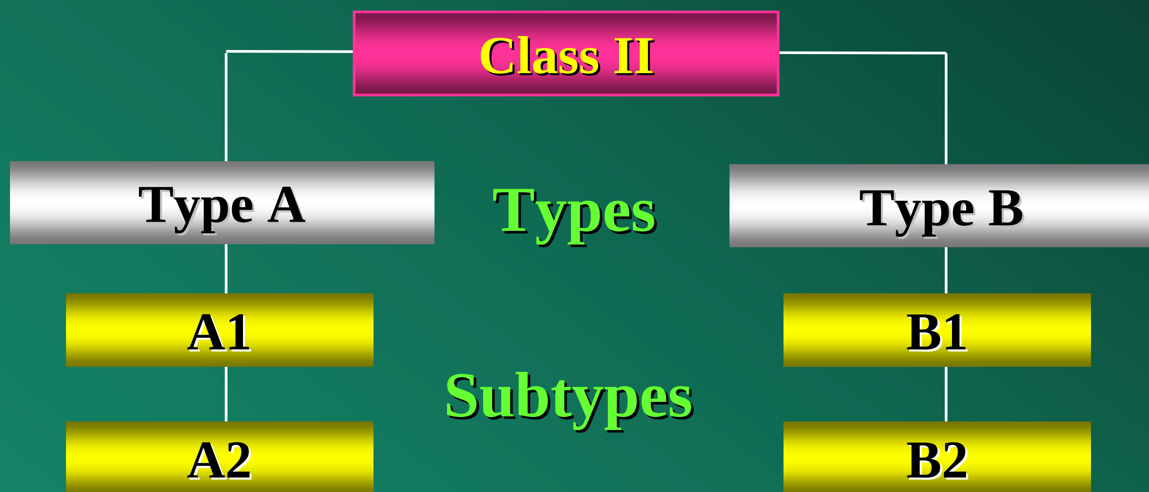
Types of Class II Biological Safety Cabinets



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Described by NSF Standard No. 49

Differences Between Type A and Type B Biological Safety Cabinets

Class II

Type A	Type B
May have "exposed" contaminated positive pressure plenums (A1 only)	No "exposed" contaminated positive pressure plenums allowed
Minimum average face velocity of 75 FPM (A1) or 100 fpm (A2)	Minimum average face velocity of 100 FPM
Exhaust into lab or outside via canopy	Must exhaust outside the lab via dedicated exhaust system with alarm

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Type A or Type B - Which to choose?

Type A

For routine microbiological work.

Type B

Offers containment and direct removal of volatile toxic gases and fumes used in conjunction with biological research.

The critical factor in choosing Type A or B is not biological containment, but whether the user works with volatile toxic chemicals, and the volumes required.

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Exhaust Options

- Re-circulate into room, Type A
- Canopy/thimble, Type A2
- Sealed connection, Type B1 or B2

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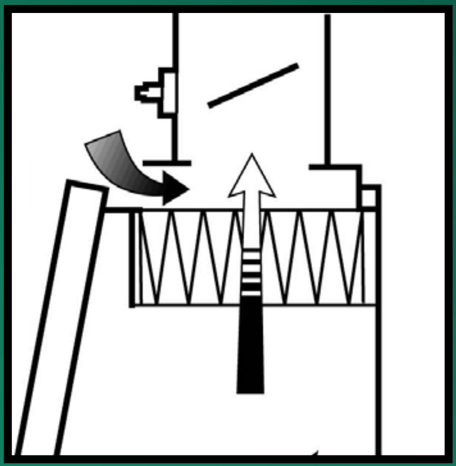
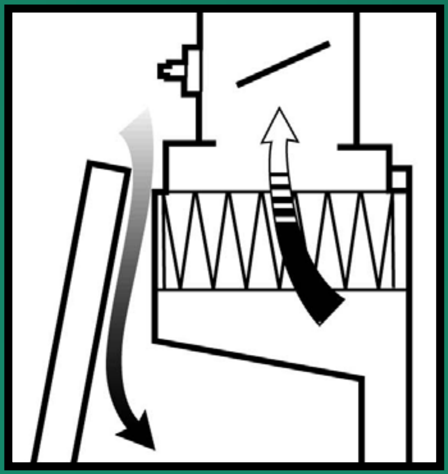
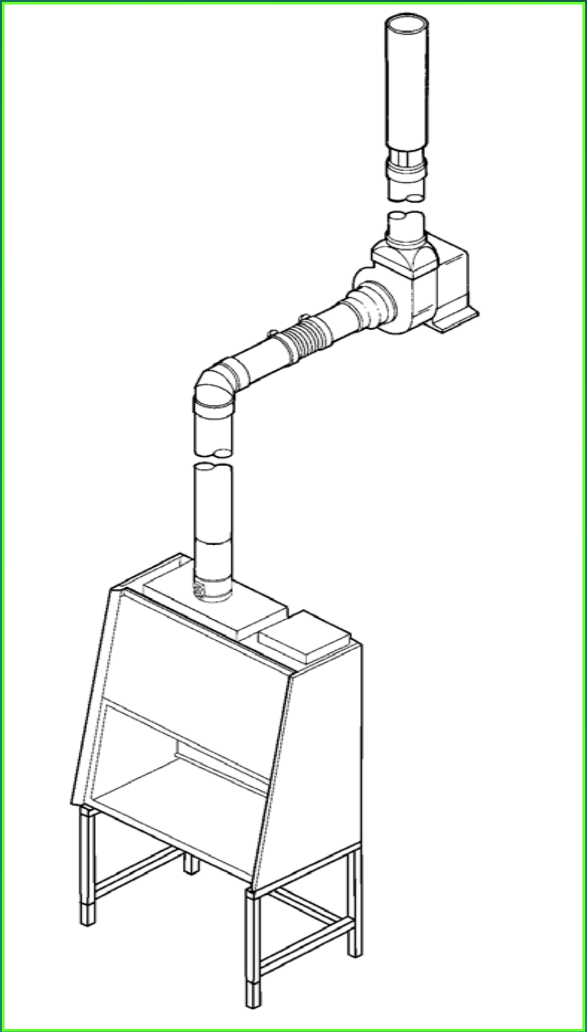
Exhaust Options





- A canopy, also known as a thimble, air-gap, or loose connection allows some room air to be drawn into the exhaust system, along with the cabinet's exhaust
- The sealed connection is an air-tight connection between the cabinet and the ductwork

Installation Considerations



The major components of a biological safety cabinet exhaust system are:

- The connection to the cabinet - canopy or sealed
- A remote blower
- A backdraft damper
- A ductwork system

With gas tight damper

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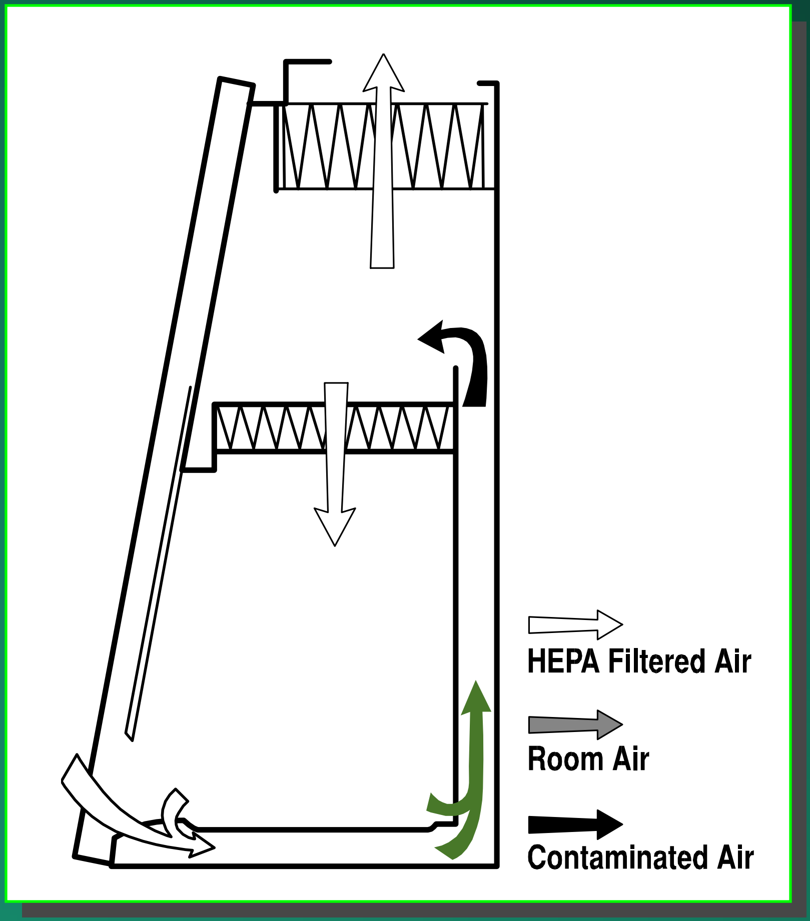
Class II Biological Safety Cabinets

Type A1
without Canopy



Minimum inflow 75 fpm

Biosafety Levels 1, 2, & 3

No radionuclides

No volatile toxic chemicals

Open flames not recommended

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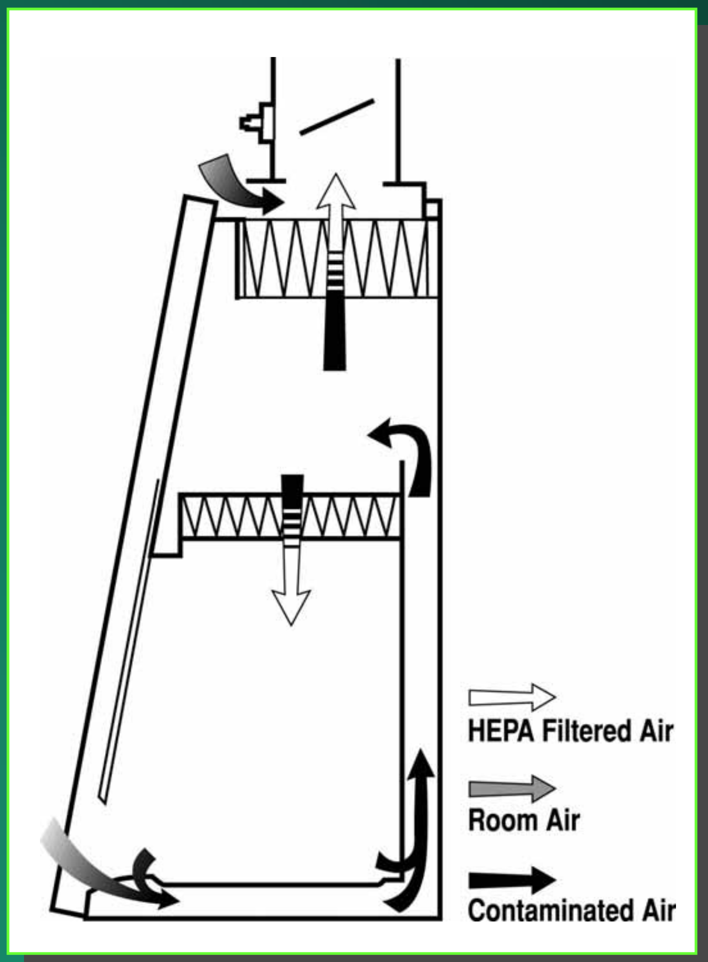
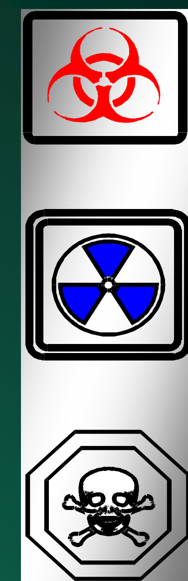
Defined by NSF Standard No. 49

Class II Biological Safety Cabinets

Type A1
with Canopy Connection



Minimum inflow 75 fpm



Biosafety Levels 1, 2, & 3

No radionuclides

No volatile toxic chemicals

Open flames not recommended

Defined by NSF Standard No. 49

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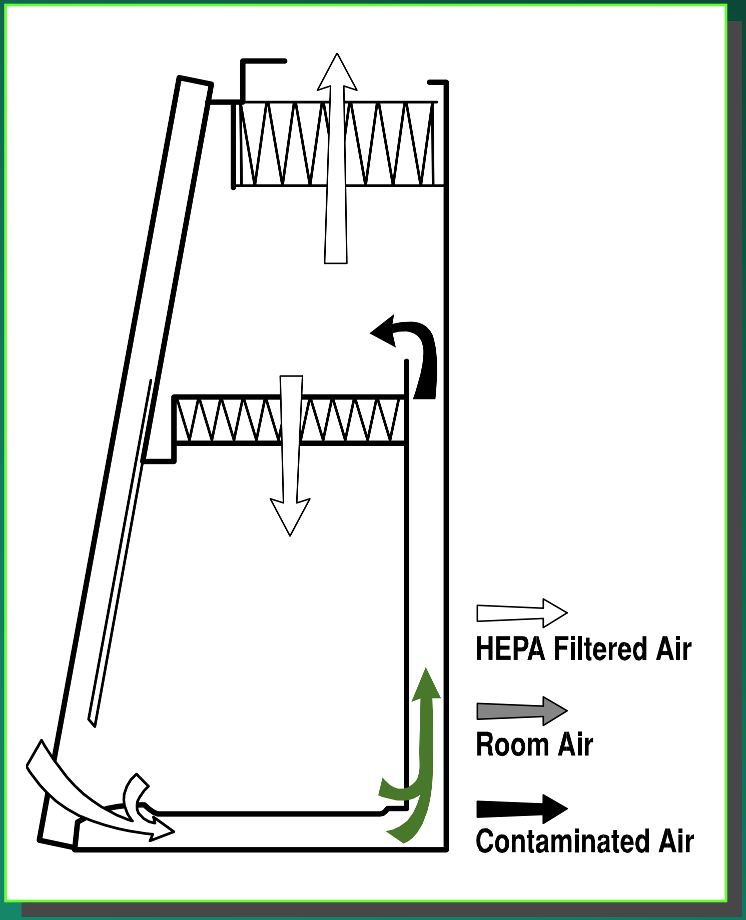
Class II Biological Safety Cabinets

Type A2
without Canopy Connection



Minimum inflow 100 fpm

Biosafety Levels 1, 2, & 3

No radionuclides

No volatile toxic chemicals

Open flames not recommended

Defined by NSF Standard No. 49

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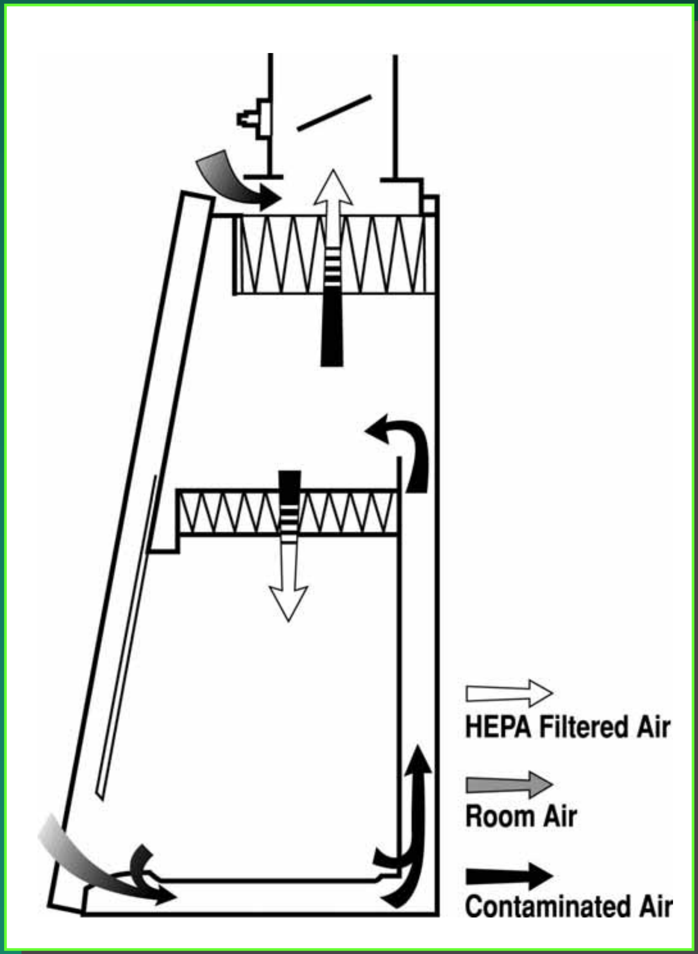
Class II Biological Safety Cabinets

Type A2
with Canopy Connection

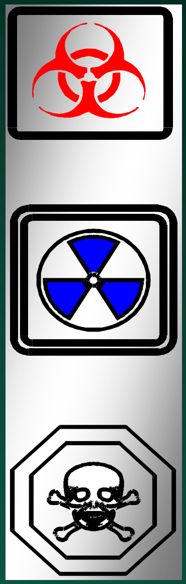


Minimum inflow 100 fpm

Biosafety Levels 1, 2, & 3

Suitable for trace amounts of radionuclides*

Suitable for minute quantities of volatile toxic chemicals*

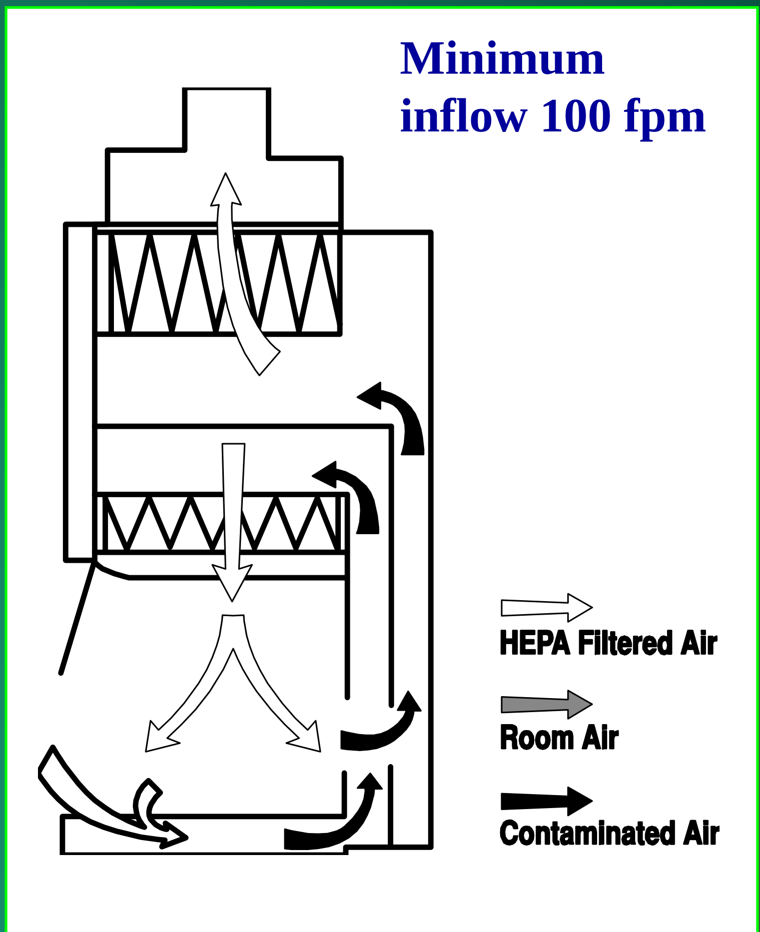


Open flames not recommended

** when used as an adjunct to microbiological research*

Defined by NSF Standard No. 49

Class II Biological Safety Cabinets

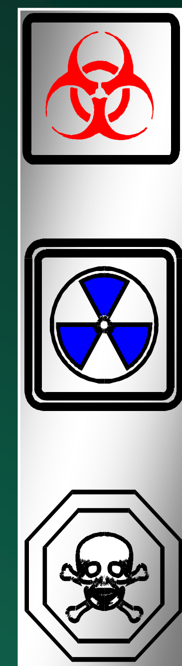


Type B1

Biosafety Levels 1 , 2, & 3

Minute quantities of radio-nuclides may be used in the rear of the work area.

Minute quantities of volatile toxic chemicals may be used in the rear of the work area.



Open flames not recommended.

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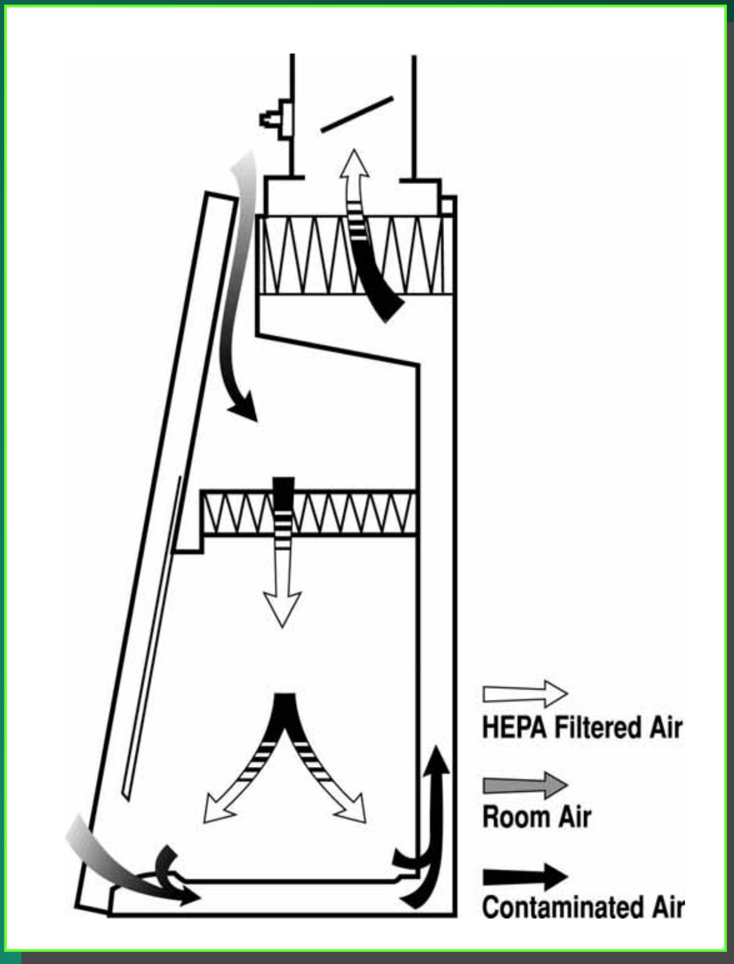
Defined by NSF Standard No. 49

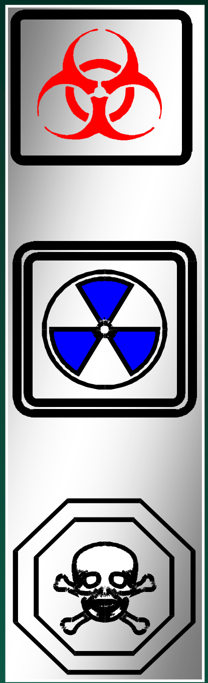
Class II Biological Safety Cabinets

Type B2
Total Exhaust



Minimum inflow 100 fpm

Biosafety Levels 1, 2, & 3



Suitable for radionuclides*

Suitable for volatile toxic chemicals*

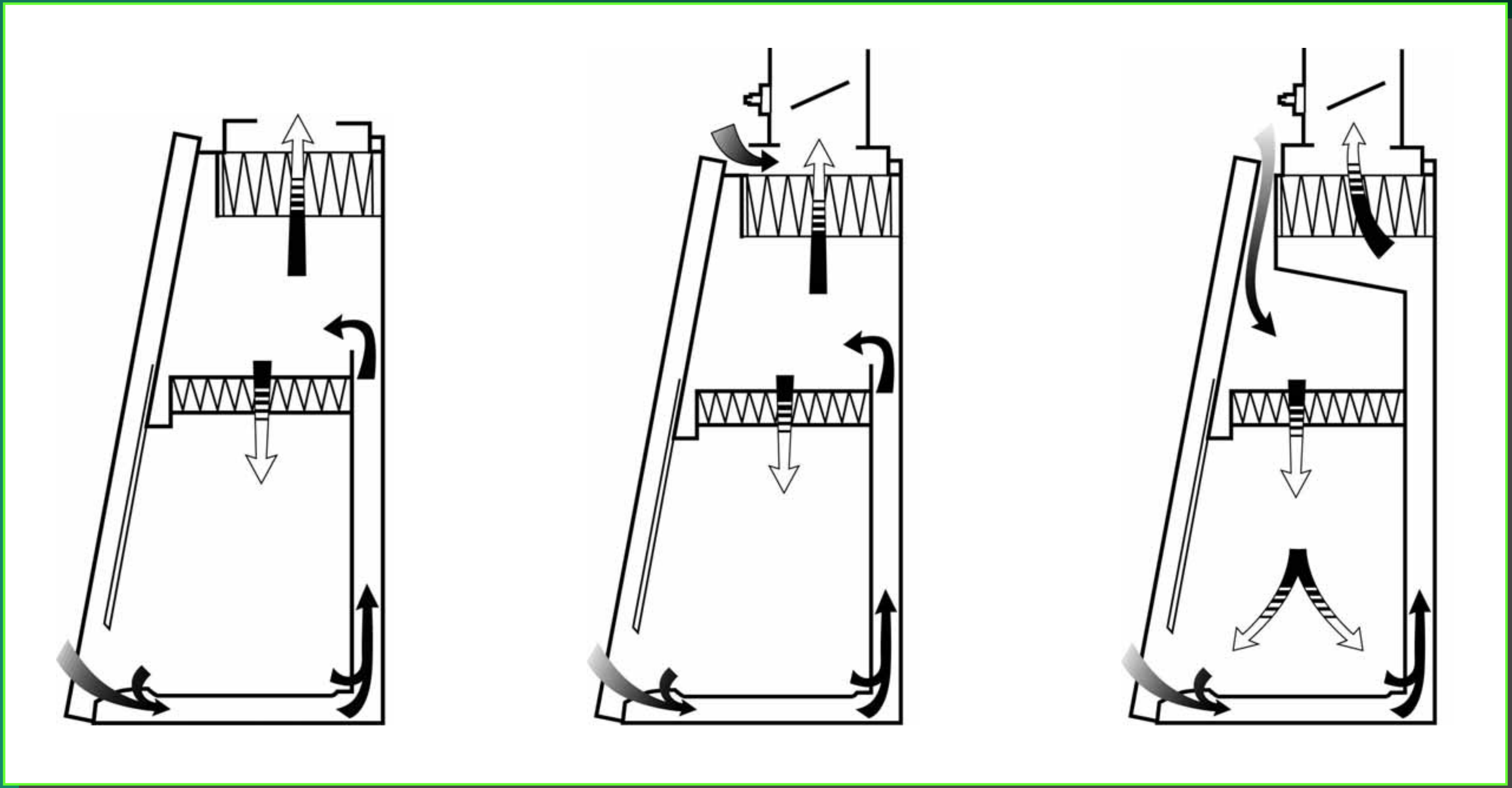
Open flames not recommended

Defined by NSF Standard No. 49

** when used as an adjunct to microbiological research*

Labconco Biological Safety Cabinet
Airflow Configurations

Without Canopy | Canopy Connection | Sealed Connection



Type A2 | Type A2 | Type B2

Working in Biological Safety Cabinets

Start Up

- Turn off UV light, open sash to its proper height, and turn on cabinet lights and blower.
- Check all grilles for obstructions and let the cabinet operate for 5 minutes.
- Wash hands and arms thoroughly with disinfectant soap; wear a long sleeved lab coat with knit cuffs and over-the-cuff gloves. Use eye protection.

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Working in Biological Safety Cabinets

Wipe-Down

Wipe down all interior surfaces of the work area with a solution of 70% ethanol or other suitable disinfectant.

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Working in Biological Safety Cabinets

Loading

- Load only the materials needed. Do not overload the cabinet or obstruct the grilles. Keep large objects separated.
- Lower the sash until it is in its proper position. Allow the unit to operate for 2 to 3 minutes to purge any airborne contaminants.

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Working in Biological Safety Cabinets

Work Techniques

- Keep all materials at least 4" inside the sash opening and perform all contaminated operations as far to the rear of the work area as possible.
- Segregate clean and contaminated materials. Arrange materials to minimize movement of contaminated materials into clean areas. Keep all contaminated material in the rear of the work area.
- Avoid excessive movement of arms or materials through the front opening during operation.

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Working in Biological Safety Cabinets

Work Techniques

- Use proper aseptic technique.
- Avoid techniques that disrupt airflow patterns in the cabinet, such as an open flame.
- If there is a spill or splatter during use, all objects must be decontaminated before removal. Thoroughly disinfect the interior surfaces of the cabinet while it is still in operation.

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Final Purging

After completing work, allow the cabinet to operate for 2 to 3 minutes undisturbed to purge airborne contaminants from the work area.

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Wipe-Down

- Periodically lift the work surface and clean underneath it. Clean the towel catch.
- Dispose of rubber gloves and have lab coat properly laundered. Wash arms and hands thoroughly with germicidal soap.
- Wipe down all interior surfaces of the work area with a solution of 70% ethanol or other suitable disinfectant.

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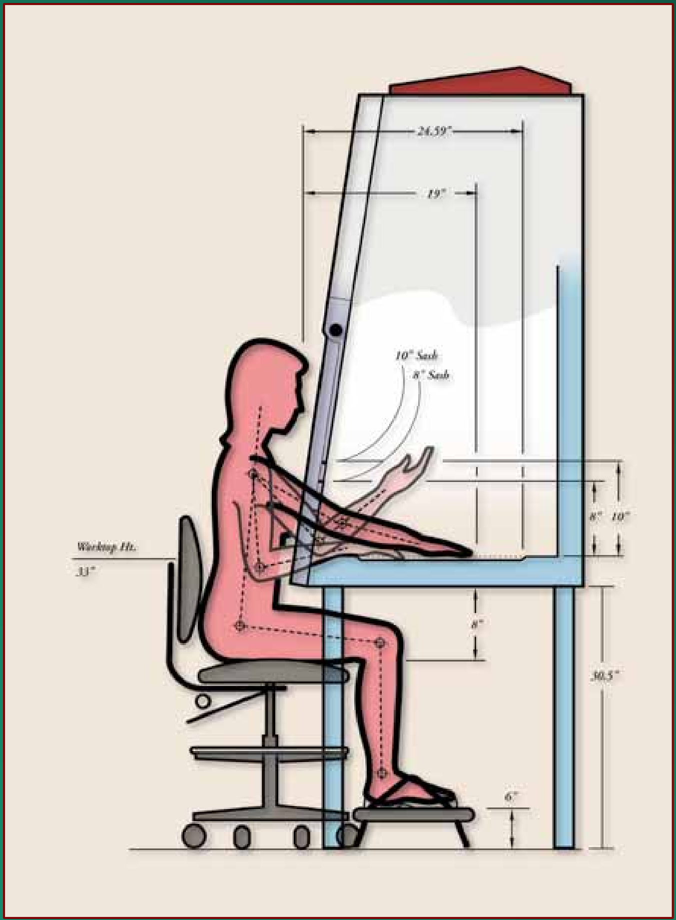
Shutdown

Turn off the fluorescent light and cabinet blower, close the sash and turn on the UV light if appropriate.

Ergonomic Considerations



Feet, Knees and Legs

- Make sure feet rest solidly on the floor or footrest. Don't dangle feet or compress thighs.
- Provide enough leg room under the cabinet to sit comfortably.
- Vary leg and foot positions throughout the day.
- Get up periodically and take brief walks.

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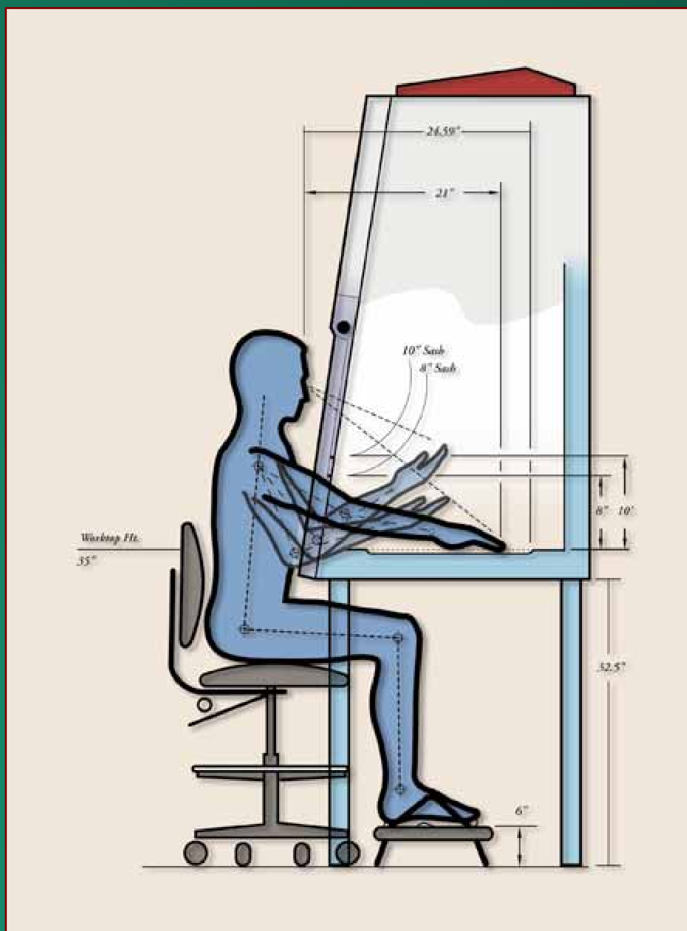
Ergonomic Considerations



Back

- Use chair to fully support your body. Make sure the lower back is supported. *Don't slouch forward.*
- If chair is adjustable, experiment with the adjustments to find several comfortable positions.

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Thank You!

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Questions?