

# GERMFREE



## THEORETICAL AND TECHNICAL MANUAL FOR THE BENCHTOP BIOFUME HOOD (BTE)

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GERMFREE

# Theoretical and Technical Manual for the Benchtop Biofume Hood ( B T E )

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© Germfree Laboratories Incorporated  
11 Aviator Way • Ormond Beach, FL 32174  
Phone 800.888.5357 • Fax 386.677.1114  
[www.germfree.com](http://www.germfree.com)

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## Introduction

**D**uring the past few decades, there has been an increase in the use of Class II Laminar Flow Biological Safety Cabinets. These units were designed to contain low and moderate risk microorganisms, but did not provide for non-particulate materials that could pass through the supply HEPA filters. The Total Exhaust BENCHTOP BIOFUME HOOD differs from other Class II Laminar Flow Biological Safety Cabinets in that no air recirculates in the cabinet. Therefore, there is no possible buildup of any non-particulate material in the work area. In contrast, within a hood in which air recirculates, non-particulate matter passes through the HEPA supply filter into the work area. Thus, the BENCHTOP BIOFUME HOOD can be used for one or any combination of the following biohazards:

Carcinogens  
Radioactive gases  
Potentially infectious materials  
Volatiles  
Noxious fumes  
Subliming particulates

Besides ease of operation, the BENCHTOP BIOFUME HOOD provides personnel and environmental protection from the aforementioned potential hazards, and concurrently, offers product protection against cross-contamination.

Tissue culture and other sophisticated techniques frequently require that a variety of substances be used within the same hood at different times and, not infrequently, at the same time.

The inward air velocity required by various governmental agencies to handle the above classes of potentially hazardous materials has been reported as 100, 125 and 150 linear feet per minute (fpm). Because of the inability of available Class II cabinets to provide complete protection, particularly from carcinogens and

radioactive gases, it was apparent that a new concept in Biohazard Cabinetry was needed that would meet four basic requirements:

1. The protection of personnel and the environment from exposure to potentially contagious particulates such as bacteria, viruses, parasites, fungi, etc..
2. The protection of personnel and the environment from noxious fumes, potential carcinogens and radioactive materials, by totally exhausting air from the cabinet.
3. The establishment of a work area bathed with laminar flow, containment-free air for the protection of materials.
4. The provision of free ingress and egress of the operator's hands through a partially open front.

These features have been incorporated in GERMFREE's BENCHTOP BIOFUME HOOD. The BENCHTOP BIOFUME HOOD is a vertical downflow, unidirectional, laminar flow unit that differs from other Class II units because **THERE IS NO RECIRCULATION OF AIR. All air is totally exhausted.** Technologists now can have a far greater sense of security knowing that air passing over their hands and forearms is not contaminated.

The BENCHTOP BIOFUME HOOD has dual capabilities. It may be used as a BIOFLOW CHAMBER when working with potentially contagious particulates such as bacteria, viruses, fungi, parasites etc., and/or it may be used for chemical carcinogens and radioactive materials, with the outstanding feature that the work area is bathed with laminar flow sterile air. This degree of personnel, product and environmental protection was not previously available for work with non-particulate materials.

The BENCHTOP BIOFUME HOOD exceeds the requirements for a Class 100 chamber as described in Federal Standard No. 209. This Standard outlines air cleanliness classes and certain other environmental conditions of air required for achieving and maintaining clean environmental levels. Federal Standard Class 100 is that class where particles 0.5 micron or larger must not exceed a total count of 100 particulates per cubic foot.

Biomedical engineering and technology have introduced safeguards into the design of laboratory equipment but these safeguards cannot prevent human error!

**Danger to personnel from carelessness or improperly used equipment cannot be over-emphasized. There is NO substitute for safe, proper technique.**

## Services

The BENCHTOP BIOFUME HOOD is shipped complete with the following accessories: variable speed blower motor control for supply blower (BFA-5); dual magnehelic gauges (BFA-14); metal diffuser below supply filter (BFA-15); and air exhaust failure alarm system. To make this hood operational, it must be hooked up to an exhaust fan and a venting system. The unit is provided with both supply and exhaust HEPA filters.

To move the unit through narrow doors, the light housing can be detached by removing four screws. Also, the viewing panel with the attached light housing can be removed by sliding the split hinges to the left after raising the panel until it is parallel to the floor. This reduces the width of the BIOFUME HOOD to 30 inches. An additional 3/4" clearance is required for the two clamps located below the viewing panel.

All controls are front-mounted, allowing the unit to be placed side-by-side with other laboratory equipment and flush against the wall. Do not place the unit within an area of excessive air turbulence or one subjected to high traffic. Test the selected area with cigarette or chemical smoke and observe the movement of air.

### ELECTRICAL:

All electrical components, except the supply motor and pressure switch, are mounted in the control panel affixed to the front of the hood. There are no electrical components in the biologically contaminated air stream. A nine-foot long power cord with a molded-grounded plug exits from the control panel on the right hand side as you face the cabinet. Electrical requirements for the hood are (one) 15 amp, 115-volt electrical outlet. Variations in line voltage may cause changes in blower performance.

### CONTROL PANEL:

Components located on the face of the control panel are as follows:

- 2 amp circuit breaker (light)
- 10 amp circuit breaker
- Audible alarm
- Pilot lights (2), red & green
- Start button

Stop button  
On-off rocker switches (2)  
Switch top-main/bottom-fluorescent lights  
Speed control for supply blower

The control panel can be removed by unscrewing the two acorn nuts located at each end. All components are mounted directly on the removable control panel. Located inside the control panel is the internal circuitry and the ballast for the fluorescent lights. Please note: wires leading to the supply motor and pressure switch are threaded into the control panel through grommets in the upper right hand corner. Care should be taken when removing this panel that these wires are not disconnected.

A three-piece stainless steel shroud is attached to the unit to conceal the supply blower-motor, exhaust filter, etc. It is attached to the sides on the top with studs and nuts. The front piece houses the Magnehelic gauges and is key locked to the sides. This can be lifted off the unit for servicing once the control panel is removed by raising it up and out.

#### MAGNEHELIC GAUGES

Magnehelic gauges measure differential pressures across the supply and exhaust filter. This information is to help determine filter loading. Each filter has its own gauge because of differential pressures and the possibility of differential loading. They are marked "SUPPLY" and "EXHAUST". The "SUPPLY" is connected to the high-pressure side and usually reads greater than .50 inch. The "EXHAUST" is connected to the low-pressure side and usually reads approximately .25 inch. The connection on the exhaust gauge takes its reading from the contaminated air stream. Disconnection of the exhaust should only be undertaken after the unit has been decontaminated. Readings in the Magnehelic gauges vary with each individual set of filters and therefore is not a finite number. It is recommended that you take note of this setting once the hood has been initially certified and monitor it (monthly readings are frequent enough for most applications).

#### VARIABLE SPEED MOTOR CONTROL

The variable speed motor control for the supply blower is located beneath the hole plug. **Casual adjustment should not be done.** The control has been set in the factory according to our remote exhaust system, based on a total exhaust

volume of 525 cfm for the BTE 3SS, 700 cfm for the BTE 4SS and 1050 cfm for the BTE 6SS.

Upon completion of installation, it is strongly recommended that certification by a qualified in-house technician or independent agent be carried out. This is also recommended as an annual service requirement and any time the unit is moved. **DO NOT ADJUST THE SPEED CONTROL WITHOUT GOOD REASON.** In addition, we recommend that the airflow pattern be periodically checked using the Airflow Smoke Test (page 14) as a guideline. This will insure that proper airflow pattern is present.

### FLUORESCENT LIGHTS

The ballast for the fluorescent lamps is located inside the control panel. The bottom rocker switch in the control panel turns on the fluorescent lights that are mounted in a separate special housing outside the viewing panel. The cable, which exits from the upper right hand corner of the light housing, must be connected to its plug located in the right hand side of the control panel.

The stainless steel housing provided for the fluorescent lights is attached to the top of the viewing panel outside of the work area. This location provides the best glare-free view for the operator and also prevents heat build-up within the cabinet. The electric circuit for the lamps is independent of the wiring to the motor-blower. When the viewing panel is raised the ensuing safety shutdown does not interrupt the power to the fluorescent lights, providing good visibility within the work area at all times.

To change the fluorescent tubes or when other work must be performed, turn off the light switch, disconnect the electric cord to the chamber (receptacle located on right side) and remove the four screws that attach the light housing to the viewing panel frame. The light housing is now completely disconnected and can be carried to the appropriate work area. Standard fluorescent components are used.

### UV LIGHT OPTION

1. Fluorescent lights and UV lights cannot be on at the time.
2. **DANGER – Ultraviolet radiation emitted from this product. Avoid exposure. ALWAYS WEAR PROTECTIVE CLOTHING. EXPOSURE MAY CAUSE PREMATURE AGING OF THE SKIN**

AND CANCER. ALWAYS WEAR PROTECTIVE EYEWEAR; FAILURE TO DO SO MAY RESULT IN SEVERE BURNS OR LONG TERM INJURY TO THE EYE. Never look directly into the lamp. Exposure can cause eye and skin allergy and allergic reactions. Medications or cosmetics may increase your sensitivity to ultraviolet radiation. Consult physician before operating this product if you are using medications or have a history of skin problems or believe yourself especially sensitive to sunlight.”

3. WARNING – Do not operate without protective shield on UV light bulb.
4. WARNING – Do not work in the biofume hood while the UV light is on.

#### STOPCOCK (VALVE) OPTION

1. Warning: Do Not connect flammable fluids, gases or substances to the optional valves (stopcocks) if provided.
2. The maximum pressure is 30psi.
3. Overpressure safety device must be installed to limit pressure of substances coming into the fumehood.

#### FILTERS

In the BENCHTOP BIOFUME HOOD the supply HEPA filter is located immediately over the work area; the exhaust HEPA filter is placed at the final point of air discharge. These filters are sized to provide optimal safety and performance. All filters were integrity tested with dioctylphthalate (DOP) or equivalent and scanned with a photometer by their manufacturer and again in our factory. They are certified to be 99.99% effective for DOP particles 0.3 micron in size. As is the nature of HEPA filters they are even more effective for both larger and smaller particles.

Loading time for both filters will depend primarily on the number of particles generated within the chamber. Under normal laboratory conditions, the life of the filters should be four to five years. Occasionally they may become obstructed in three years or less. In a very clean environment, HEPA filters may remain effective for six or more years.

### VIEWING PANEL

The viewing panel is fabricated of polycarbonate plastic. A number of chemicals have an adverse effect on polycarbonates plastics. Never use gritty soaps or household cleansers such as Comet or Ajax.

Polycarbonate is unaffected by most inorganic solvents, mineral and animal oils, low concentrations of alcohols, paraffinic and olefinic hydrocarbons, amines, alkyl monhalides, esters containing more than ten carbon atoms, alkalies, non-oxidizing acids, salt water, photographic solutions and chemicals petroleum oils and grease, household cleaning products and chemicals used in treating water.

For cleaning 50% Ethyl alcohol, 70% Isopropyl alcohol, or a 5% Bleach solution can be used, **DO NOT use 95% or 70% Methyl alcohol or Windex.**

The viewing panel is held in place with toggle clamps. These are screwed in and can be removed if necessary for transportation into a room. The unit is not designed to be operated without its viewing panel. The viewing panel is hinged so it can be easily opened for placement of larger objects into the work area. It can be removed by releasing the snap ring, lifting the panel and moving it to the left. The snap ring prohibits accidental removal of the panel from its hinges.

### ALARM SYSTEM

The BENCHTOP BIOFUME HOOD has, as standard equipment, an Exhaust Failure Alarm System. The Alarm System consists of pilot lights, a sound alarm and pressure switch. This alarm system provides the user with added safety and also alerts the user if an airflow problem is present. Basically, should there be an exhaust fan failure, the supply blower will automatically shut off, the red pilot light will turn "ON" and the sound alarm will be activated.

This failure system eliminates the possibility of the supply fan operating without the exhaust fan, which could possibly discharge contaminated air into the room. If this situation occurred, personnel would be alerted. Conversely, should the supply fan fail, the sound alarm will ring and the exhaust fan would continue to operate, allowing the worker to complete his work.

The Alarm System consists of pilot lights, sound alarm and pressure switch. The pressure switch comes wrapped in plastic that is taped to the top of your unit. It must be mounted on the exhaust transition piece, which connects the exhaust HEPA filter to the in-house ductwork. This should be done by your maintenance department or the contractor installing the hood. The pressure switch comes complete with a quick electrical disconnect and junction box mounted on the top of the BENCHTOP BIOFUME HOOD.

#### D.O.P. PORTS

D.O.P. ports have been supplied for upstream concentration readings of both the supply and exhaust filter. The D.O.P. port located on the left-hand side of the rear area should not be opened without decontaminating the unit first.

# Installation

**NOTE:** The BENCHTOP BIOFUME HOOD has NO internal exhaust fan and requires hook-up to an external exhaust ventilation system.

Class II biohazard cabinetry should be located out of the traffic pattern and away from room air current which could disrupt the air containment barrier. If there is a window in the laboratory it should remain closed at all times. The cabinet should not be placed near room air vents. A smoke test to evaluate possible locations will assist in determining the cabinet's proper location.

The Total Exhaust BENCHTOP BIOFUME HOOD is a Class II, Type B2 Laminar Flow Biological Safety Cabinet. Type B2 cabinets are to be vented outside the building without recirculation. Venting should include an exhaust transition piece, leak-tight duct work, damper in the duct near the cabinet for flow adjustment and decontamination and an external exhaust blower at the duct's discharge. The exhaust fan should be sized to deliver the required exhaust airflow, as specified, taking into account the pressure losses in the duct and exhaust transition piece and allow at least 2 inches water gauge to compensate for a dirty, fully loaded HEPA filter. It is recommended each Type B2 cabinet have its own dedicated exhaust system and that an alarm system be provided (See Alarm System - BTE Series).

The exhaust transition piece should be removable from both the exhaust filter housing and the duct. Servicing and replacement of the HEPA filters requires this flexibility. (See venting recommendations on page 19 & 20 and the detail diagrams of Top View for the specified hood beginning on page 21.)

Once hook-up is complete, it is recommended that the hood be certified. If you do not have this service in-house, or know of an independent agent, please contact the factory, as we will be happy to supply names of independent qualified recertification organizations servicing your area.

# Test Mode

MAIN Switch turned “ON” (external exhaust fan and supply fan turned “OFF”); system is set for testing. Red light and alarm should be “ON”. This should be tested periodically to insure proper function of alarm system.

## OPERATION

1. Exhaust Fan OFF, Supply Fan OFF, Main Switch “ON” (Test Mode).
  - a) Red light “ON”
  - b) Sound alarm “ON”
  - c) Green light “OFF”
  
2. Exhaust Fan “OFF”
  - a) Supply fan will not start
  - b) Red light “ON”
  - c) Alarm “ON”
  - d) Green light “OFF”
  
3. Exhaust Fan “ON”.
  - a) Supply fan can be started
  - b) Green light “ON”
  - c) Alarm “ON”
  - d) Red light “OFF”
  
4. Exhaust Fan “ON” Supply Fan “ON”.
  - a) Green light “ON”
  - b) Red light “OFF”
  - c) Alarm “OFF”
  
5. Exhaust Fan Failure.  
Same as (2) above.

**NOTE:** IF EXHAUST FAN FAILURE HAS OCCURRED AND BEEN CORRECTED, THE START BUTTON WILL HAVE TO BE PUSHED TO SHUT THE ALARM OFF.

# Environmental Conditions

The BTE can be operated safely under the following conditions:

- A) Indoor Use
- B) Altitude up to 2000m
- C) Temperature 5°C to 40°C
- D) Maximum relative humidity: 80% for temperatures up to 31° decreasing linearly to 50% relative humidity at 40°C
- E) MAINS supply voltages fluctuations up to  $\pm 10\%$  of the nominal voltage
- F) Transient overvoltages typically present on the MAINS supply.  
(Note: The normal level of transient overvoltages is impulse withstand (overvoltage) category II of IEC 60364-4-443)
- G) Applicable RATED POLLUTION degree: 2

# Operation – BTE Series

To operate your BENCHTOP BIOFUME HOOD the following installation is required:

- 1) Connection to an external exhaust system, which consists of an exhaust transition piece, duct work and external exhaust fan. (See installation - BTE Series).
- 2) Installation of pressure switch (part of Exhaust Failure Alarm System) in exhaust transition piece.
- 3) Electrical receptacle; grounded, 20 or 15 amp (without outlet receptacle) for power cord.

**NOW YOU ARE READY TO TURN YOUR HOOD “ON”**

- 1) Activate exhaust fan (this step varies from institution to institution).
- 2) Turn main switch “ON”; fluorescent lights can only be turned on after main switch has been engaged.
- 3) Press START button.

Allow 15 minutes to pass prior to undertaking any activities in the hood or prior to turning off the hood.

To shut down, carry out the same procedure in reverse.

## Performance Testing

Your BENCHTOP BIOFUME HOOD features one-piece welded construction. No access panels are required and there are no jointed segments that might loosen during shipment. This is a distinct advantage because many potential sources of leakage through gaskets are avoided. Your BENCHTOP BIOFUME HOOD has been tested at the factory. Dioctylphthalate (DOP) or equivalent was aerosolized and circulated by the supply fan and the integrity of the supply HEPA filter determined by scanning with a photometer to detect aerosol particles on the downstream side of the HEPA filter. The exhaust HEPA filter integrity was determined by scanning the filter and filter housing after vaporized DOP was introduced into the cabinet. If there was any penetration through the filter medium or perimeter filter seal, the leaks were repaired. Your BENCHTOP BIOFUME HOOD was certified to be leak-free when it left the factory.

Downward air velocity was determined to be uniform and unidirectional with a thermoanemometer. The probe was placed in the unit, 4" above the bottom edge of the viewing panel and readings were taken at 6" spaced intervals side to side and 5¼" front to back. Other tests for noise, vibration, and light intensity were performed. The BENCHTOP BIOFUME HOOD meets or exceeds recommended standards.

# Air Balance

It is extremely important that the air be balanced before the BENCHTOP BIOFUME HOOD is initially utilized, and from time to time thereafter, the frequency is dependent on the type of work. Air balancing is performed in the factory by adjusting the speed controls in the locked control panel. CAUTION: These settings may have been changed during or after delivery. It is imperative that the following procedures be carried out before the cabinet is used. Release chemical smoke inside the cabinet at various heights above the work tray. The smoke should be pulled through the perforations of the work tray support without escaping through the access opening of the viewing panel. Smoke from a source located outside the unit in front of this opening should be pulled down through the perforations in front of the work tray without passing over it.

The variable speed control for the blower is set so that the air downflow in the work area averages in the 55-65 fpm range. The speed control is adjusted to insure that smoke released within the work area is contained and smoke placed in front of the viewing panel does not pass over the work tray. To calculate the air inflow, first subtract the volume of air (cfm) passing through the supply filter from the total quantity of air passing through the exhaust filter. Dividing this remainder (cfm) by the access opening (measured in square feet) gives the inflow velocity in fpm.

$$\frac{(\text{value of air entering front window}) \text{ ft.}^3 / \text{min.}}{(\text{area of front window}) \text{ ft.}^2} = (\text{velocity of air through front window}) \text{ ft./min.}$$

The BENCHTOP BIOFUME HOOD has been tested under simulated work conditions. This testing was two-fold. Challenges were designed to prove the integrity of the unit in containing potentially hazardous materials and to demonstrate that work within the hood would be protected from outside air interference or contamination.

# Airflow Smoke Test

This basic test is used as a guide for balancing the airflow. A source of visible smoke is required.

The exhaust motor blower and the supply motor blower must be balanced. When the source of smoke is held outside the cabinet in front of the work access opening, the smoke should go into the front angled tray support, but not over the work tray. If the smoke goes over the work tray, then the motor blower should be rebalanced. When the source of smoke is held inside the cabinet above the work tray, the smoke should separate and go into the front and rear angled tray support. If the smoke goes outside the cabinet, then the motor blowers must be rebalanced.

# Working in the BTE

The successful use of the BENCHTOP BIOFUME HOOD as a safety tool depends upon two factors: advance planning and good technique. Even the most sophisticated and elaborate systems imaginable would be useless if proper technique were not employed. It is, therefore, the responsibility of the senior investigator or the head of the laboratory to train personnel who will be using the cabinet. If this is not done, a dangerous false sense of security might prevail.

## Advance Planning

To achieve maximum safety and utilization of your BENCHTOP BIOFUME HOOD, assemble equipment and materials needed for the particular operation or experiment.

The best way to accomplish this is with a checklist and/or protocol that includes equipment, apparatus, media, supplies, samples, specimens and other necessary items. This checklist should also indicate the order in which procedures will be carried out.

Advance planning should include a layout for arranging items in the work area. Contaminated items and clean items must be segregated and the movement of contaminated items over clean items should be minimized.

## Good Technique

When the planning phase is completed, place the clean equipment, supplies, etc., within the chamber. The viewing panel should only be opened when large items are required in the hood. Do not overload the work area. It is important that all materials for the complete procedure be in the chamber before starting to eliminate unnecessary movement in and out of the cabinet. **CAUTION:** Never block the perforations of the work tray support with paper, syringes, pipettes, etc. Work must be performed on or over the work tray.

Now that all the items on the checklist have been arranged in the work area, turn the power switch "ON" (Many institutions choose to continuously operate the unit). Wait approximately 15 minutes before starting to work. Smoke testing can be carried out during this interval. This allows sufficient time for the ultraclean air from the HEPA filter within the chamber to remove any airborne contamination

from the work area and particulate matter from newly introduced equipment and supplies.

The operator is the critical factor in the successful and safe operation of any safety cabinet. A properly balanced and properly utilized BENCHTOP BIOFUME HOOD will do an excellent job of preventing contamination. Gloves appropriate for the type of radioactive, biological or chemical material should be used.

It is recommended that operators wear long-sleeved gowns with knit cuffs under the rubber gloves. This minimizes the shedding of skin particles and flora into the work area and protects the hands and arms from contamination. Conventional laboratory coats with open cuffs that allow the entrapment of contaminated air around the technician's forearms should not be used. The hands and forearms should be inserted into and withdrawn from the work area slowly to prevent "dragging" of contaminants from the room into the work area or from the work area into the room. Abrupt movements of the arms and hands should be avoided. Excessive activity in the room may also create disruptive air currents. Obviously, the viewing panel should never be opened while work is in progress.

For loop sterilizing, a liquid petroleum (LP) burner or electrical sterilizer is recommended because it does not block the laminar flow pattern. If a flame is required, a microburner with a pilot light is preferred, which should be placed toward the back of the work area. Do not use a flame of such magnitude that it will damage the supply filter located above the work area. Ensure that the flame is extinguished and the gas turned off at the stopcock when not in use.

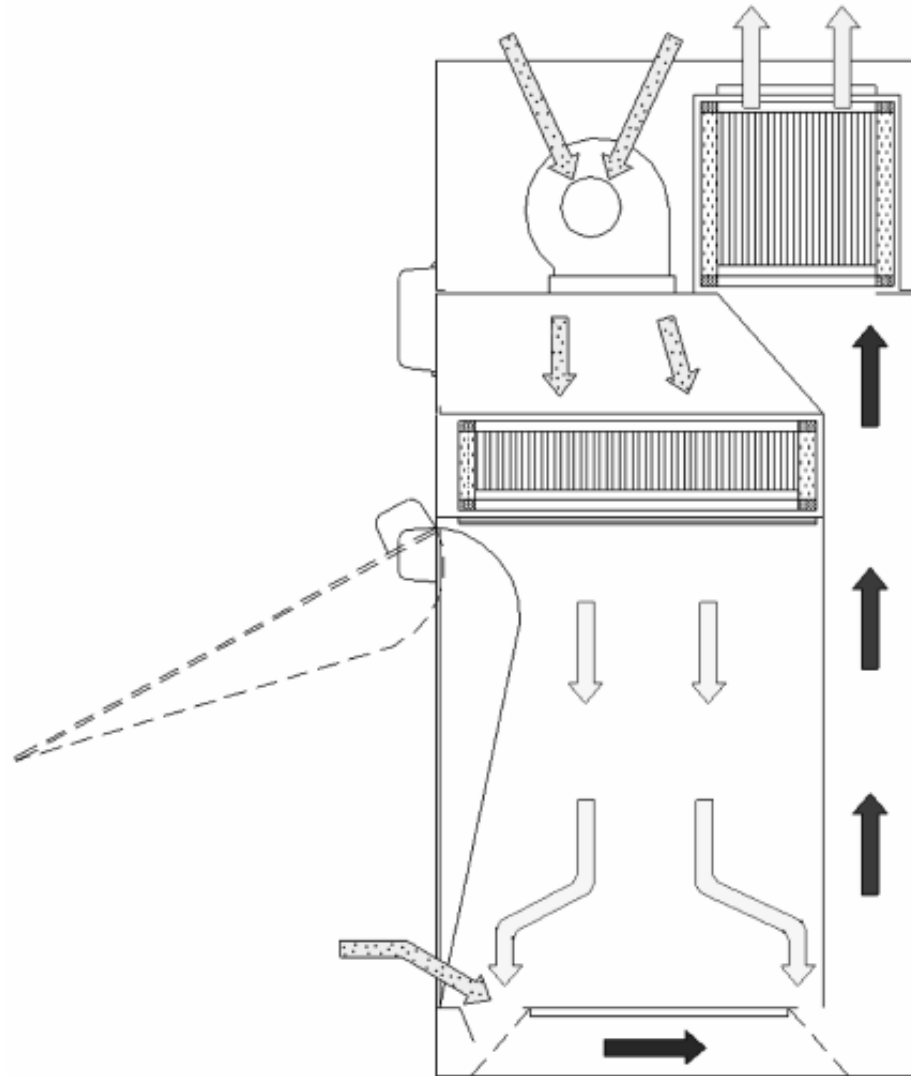
When work has been completed, cover the tray for discarded pipettes, planchettes, etc., with a towel soaked in the appropriate deactivating solution. The tray and other equipment (glassware, etc.) also can be wiped or sprayed with an appropriate solution. Wait approximately 15 minutes before removing any item from the chamber.

Through biomedical engineering and advanced technology, we are providing the BENCHTOP BIOFUME HOOD as one of the key elements in the safe handling of hazardous materials. By utilizing good technique and following the procedures outlined, you can protect yourself, the environment and the integrity of your research. **YOU ARE THE KEY!**

## Some Biological Don'ts

1. DON'T neglect to test smoke pattern at fixed intervals.
2. DON'T cover the air intake area in front of the chamber with papers, notebooks, equipment, etc. Movement of air into the negative pressure section must not be impeded!
3. DON'T "turn up the air" under the mistaken impression that the faster the air flow the better the unit is operating.
4. DON'T obstruct the exhaust filter or supply blower opening.
5. DON'T perform maintenance in a contaminated hood.
6. DON'T overload the work area.
7. DON'T carry out procedures in front of work tray.
8. DON'T place items in a position that would interrupt the laminar airflow pattern.
9. DON'T introduce or remove your hands rapidly into or out of the unit.
10. DON'T allow spilled hazardous material to remain in your BENCHTOP BIOFUME HOOD.
11. DON'T move contaminated items over clean items.
12. DON'T work with open cuffs or other loose garments that might entrap hazardous material.

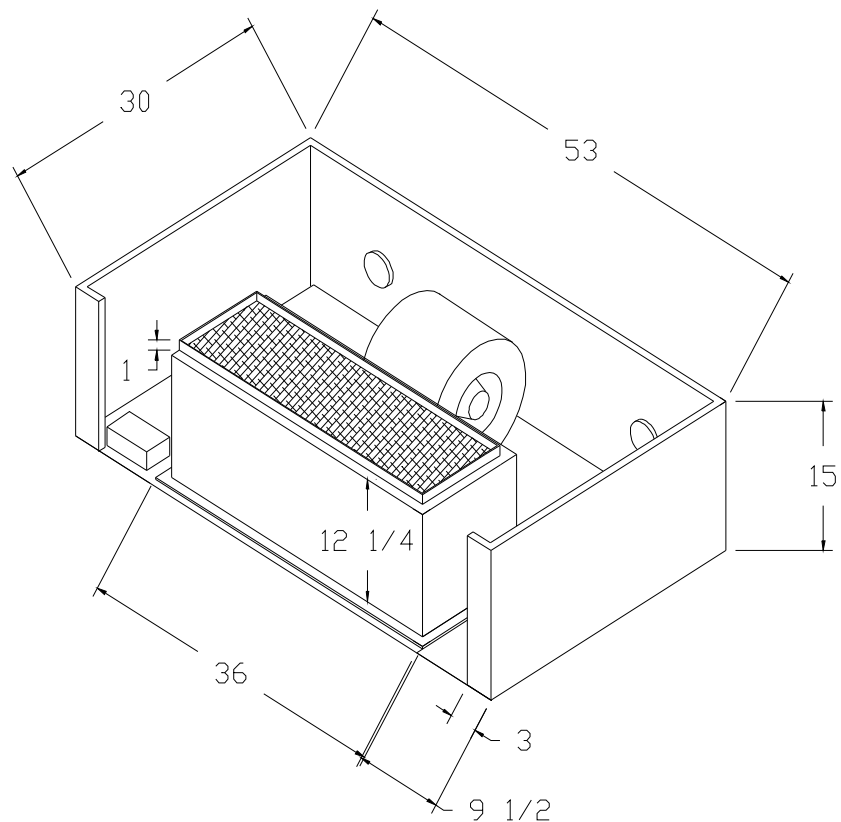
# Airflow Diagram



# Venting

## Recommendations for BTE 4SS

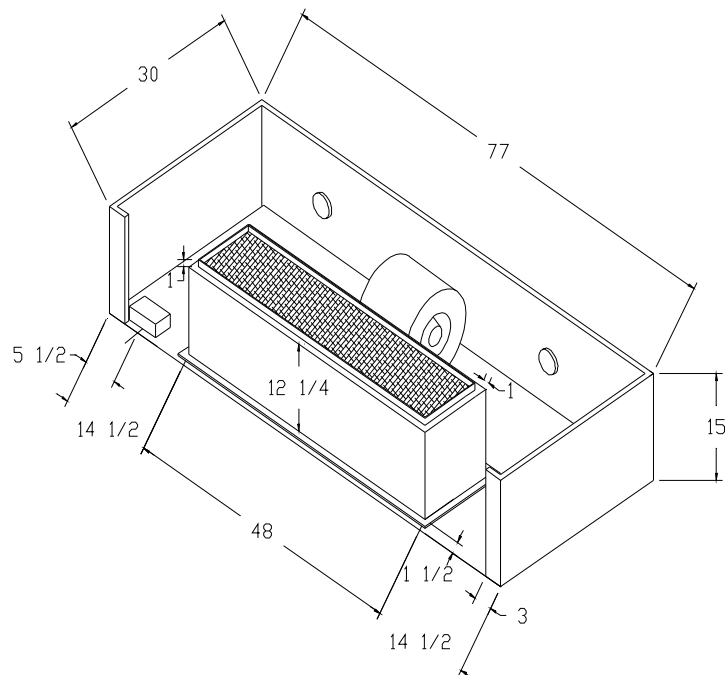
- 1) 8" to 10" round ductwork or equivalent in square.
- 2) Tapered exhaust transition to minimize static pressure.
- 3) Hard connected but removable with minimum 14" clearance for filter changing.
- 4) In-line adjustable damper (preferably in duct near cabinet).
- 5) Leak-tight duct.
- 6) Requires 700cfm of exhaust air with 2 -2½" of reserve static pressure for loaded HEPA filter.



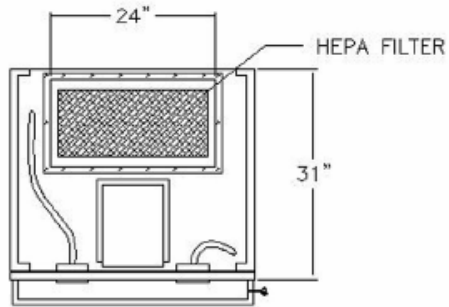
# Venting

## Recommendations for BTE 6SS

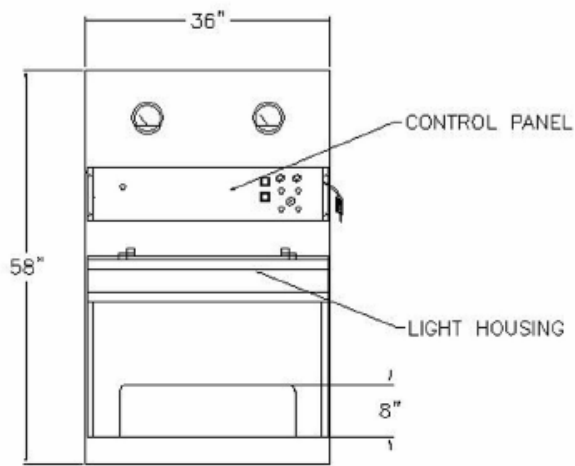
- 1) 10" round ductwork or equivalent in square.
- 2) Tapered exhaust transition to minimize static pressure.
- 3) Hard connected but removable with minimum 14" clearance for filter changing.
- 4) In-line adjustable damper (preferably in duct near cabinet).
- 5) Leak-tight duct.
- 6) Requires 1050cfm of exhaust air with 2 - 2½" of reserve static pressure for loaded HEPA filter.



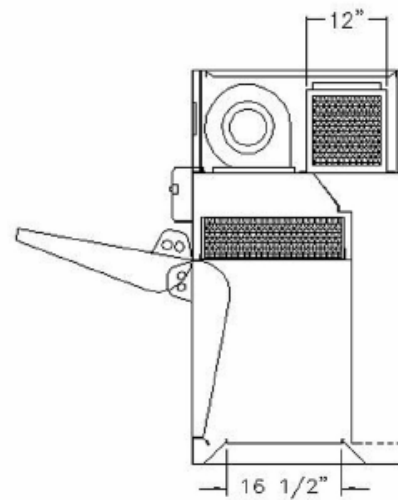
# BTE 3SS



Top View

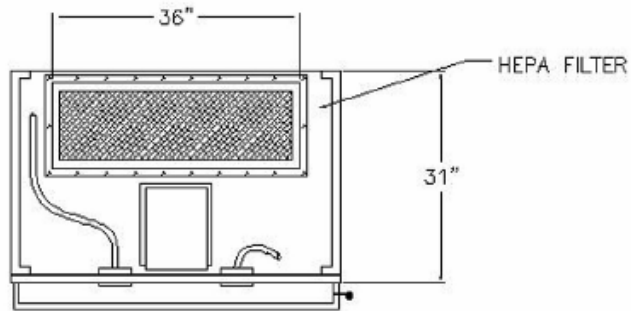


Front View

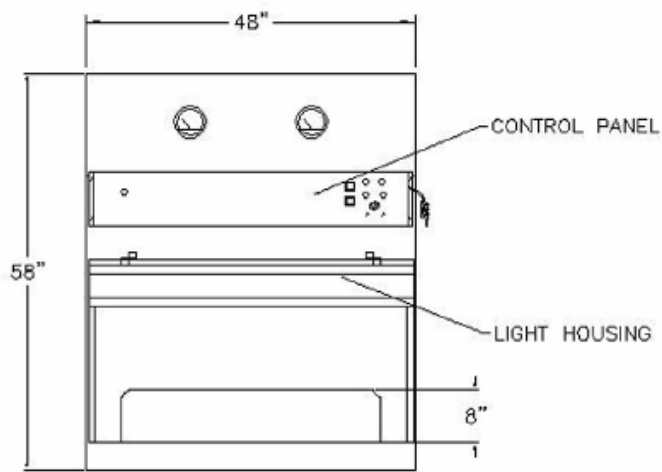


Side View

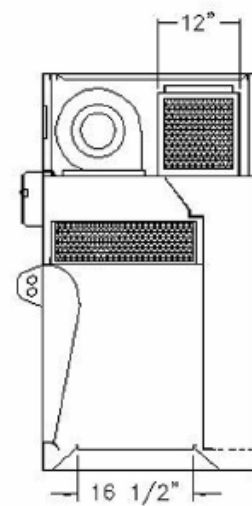
# BTE 4SS



Top View

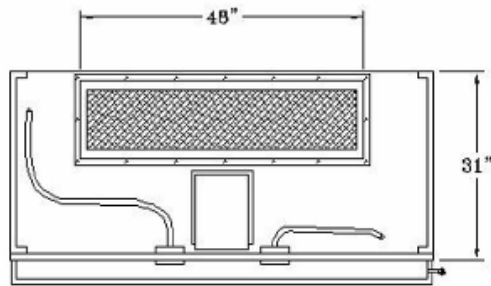


Front View

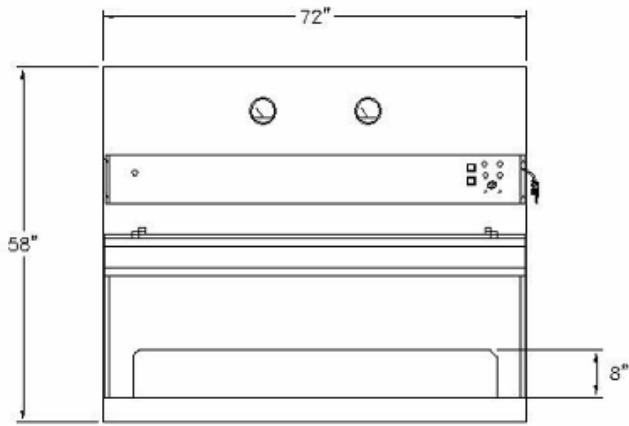


Side View

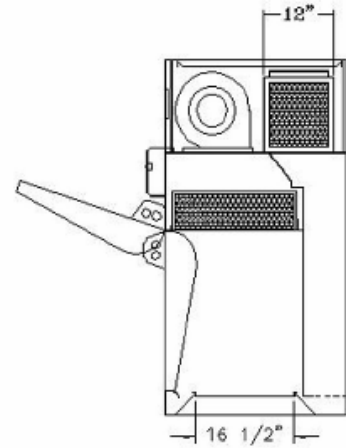
# BTE 6SS



TOP VIEW

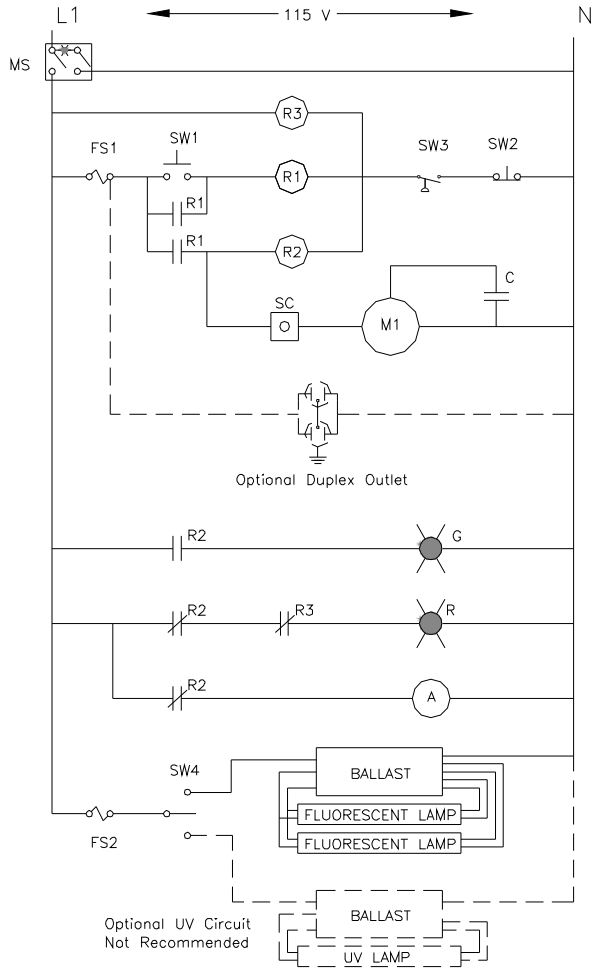


FRONT VIEW



SIDE VIEW

# Wiring Diagram



SW1	Start Switch, Push Button, n.o.
SW2	Stop Switch, Push Button, n.c.
SW3	Exhaust Alarm Pressure Switch
SW4	Light Switch SPDT (3 Position)
R1	Motor Start Relat DPST (Contractor)
R2	Alarm Relay DPDT
R3	Alarm Relay DPDT
M1	Blower Motor
SC	Speed Control
R	Red Light, Low Exhaust Pressure
G	Green Light, Exhaust Pressure OK
A	Alarm, Low Exhaust Pressure with Red
C	Capacitor, Motor Start
FS1	10 A Circuit Breaker, Main
FS2	2 A Circuit Beaker, Lights
MS	Main Switch with Internal Light
OUT	Optional Duplex Outlet (4 amps max)

# Parts List

**Filters:** HEPA (High Efficiency Particulate Air) 99.99% efficient probed

	<b>BTE 3SS</b>	<b>BTE 4SS</b>	<b>BTE 6SS</b>
<b>Supply:</b>	20 x 34 x 6 x 3	20 x 48 x 6 x 3	20 x 70 x 6 x 3
<b>Exhaust:</b>	12 x 24 x 6	12 x 36 x 6	12 x 48 x 6

**Blower, Supply** (1) Direct Drive forward curved DD9-7AT

**Motor Supply** (1) 2' and 3' —1/3 HP ; 1625 rpm; permanent split  
(2) 4' and 6' —1/2 HP ; 1625 rpm; permanent split

**Capacitor** 7.5 MFD G.E. # 6X655

**Electrical Light Connector** BEAU P-3302-CCT/S-332-AB

**Pressure Switch** Dwyer: Model 1910-1

**Switches (Rocker)** GE GX655D 97F9001

**Switches (Bottom)** (1) Start: N.O., microswitch; T11AJ20/233E/23E10  
(1) Stop: N.C., microswitch; T11AJ10/233E/23E01

**Relay D** (2) Relay + Socket OMRON LY2 110/120 Vac  
Relay CE-2039HP Max.15A - 240V  
(1) Contactor: PRD-11AYO-120 V

**Circuit Breakers** (1) 10 Amp. W58XB1A4A-10  
(1) 2 Amp. W58XB1A4A-2

**Speed Control** (1) 15 Amp. KBWC-115NS

**Magnehelic Gauge** (1) 0-2" water gauge, #2002 - Supply  
(1) 0-.5" water gauge, #2000-0 - Exhaust

**Sound Alarm** (1) Sonalert / Mallory, #SC110, 30-120V, 6-21mA, UL listed