NUAIRE CLASS II BIOSAFETY CABINETS THE BASICS

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NUAIRE CLASS II
BIOSAFETY CABINETS

To run a modern healthcare, biological, chemical, medical research, pharmacy, or pharmaceutical lab, a manager should understand the capital equipment employed regularly. The more thorough the knowledge of each device, the more efficiently the lab manager can plan for the implications of deployment, maintenance, repair, and replacement.

Most equipment in a laboratory performs an active function. For example, a centrifuge separates liquids, and CO_2 incubators grow tissue cultures. In comparison, role of a biosafety cabinet, while critical, might seem passive. A biosafety cabinet (BSC) does not perform any one direct function, but rather it prevents adverse conditions from occurring. BSCs cabinets are meant to prevent harm to employee health and contamination of the environment. Some also prevent contamination of the product in the work zone.

Biosafety cabinets function by causing air to move in precise patterns, as well as filtering air to eliminate particulate matter. This ability requires sophisticated engineering in such areas as the fluid dynamics of airflow, ergonomics of usability, design of the enclosure, and electrical design of motors, blowers, and control systems.

This e-book focuses on the common types and structures of BSCs, particularly Class II units, and what lab managers should know about the physics governing BSC functions, construction, specifications, and practical implications of these properties.

Biosafety Cabinet History

Development of BSCs was a lengthy process, as the 1991 Clinical Microbiology Reviews paper, Biological Safety Cabinetry makes clear.[1] The first report of an infection that was the result of exposure to materials in a lab came in 1893. The first survey of a laboratory-acquired disease, typhoid fever, primarily the result of pipette use, began in 1915.

By the middle of the 1900s, the link between laboratory practices and potential contamination and infection was more fully understood. A 1950 survey reported at the annual meeting of the American Public Health Association noted that 5,000 laboratories recorded 1,342 instances of laboratory-acquired infections. Thirty-nine deaths resulted. Of the 1,342 infections, only 467 had previously been made public. This pattern of infection continued in the following decades, as reported by the Centers for Disease Control and Prevention (CDC) and National Animal Disease Center. Such reports may not have addressed the full scope of harm. Focusing only on human infection may overlook adverse affects of poor contamination control on the work product of the labs involved.

The forerunner of the biosafety cabinet appeared in 1909 when a company offered a ventilated hood to prevent infection with tuberculosis when preparing tuberculin. An enclosed cabinet was first mentioned in scientific literature in 1943. By the early 1950s, the U.S. Army Biological Laboratories at Fort Detrick, Maryland developed and implemented sophisticated containment cabinet technology.[2]

Use of containment cabinets began to spread, continuing to the present. Currently BSCs are considered standard in laboratories to prevent a broad range of potential contaminants.

Although BSCs must provide safety for personnel and improved accuracy in testing and production through controlling airborne contamination, the terms "safety" and "control of airborne contamination" are relative terms. Is there an acceptable degree of exposure in a particular instance? Does a standard exist by which the effectiveness of BSCs from different manufactures can be measured?

1) Kruse, RH, et. al.; "Biological safety cabinetry"; Clinical Microbiology Reviews; April 1991; pp. 207-241

2) Barbeito, Manuel S. and Kruse, Richard H.; "A History of the American Biological Safety Association Part I: The First 10 Biological Safety Conferences 1955-1965"; American Biological Safety Association; https://www.absa.org/abohist1.html

For those reasons and others, NSF International, a standards development organization, helped create standards and classifications of BSCs, according to the amount of protection they are supposed to deliver. What satisfies the needs of one lab might be overkill or insufficient for another. Minimum standards allow lab managers and safety officers to know, at the very least, what they can count on. To understand BSCs in the light of a lab's safety requirements, an extended look at BSCs is necessary.

Biosafety Cabinet Standards and Types

There are 3 major types of BSCs in common use:[3]

Class I
Biosafety Cabinet Airflow

Class I

A cabinet that can be recirculated back into the laboratory or be exhausted through a facility's HVAC system. It uses negative pressure from an interior blower motor or the external exhaust system, creating an air barrier at the front of the cabinet at a minimum speed of 75 linear feet per minute with the air then circulating through the cabinet. Negative pressure prevents air from spilling back into the lab environment. The cabinet draws in air from a supply opening typically at the front of the cabinet. Exhausted air from the cabinet is passed through a HEPA filter. Class I cabinets are designed for low-to-moderate-risk biological substances. They protect personnel and the lab environment but not the work product in the cabinet.

Class II
Biosafety Cabinet Airflow

Class II

A cabinet with a partially open front for worker access. The Class II is similar to a Class I in that it uses negative pressure to keep air from moving through a supply opening and the access panel. The primary difference between Class I and Class II cabinets is that a Class II cabinet creates an air barrier at the front of the cabinet by creating a vacuum using an airfoil that directs air under the work surface instead of over the work area. It also filters the air supply to the internal work area and uses laminar airflow to eliminate turbulence, and the possibility of cross-contamination within the cabinet. The air splits on the work surface and is pulled into grills located on the front and back of the cabinet. A portion of air will be drawn from the side of the work area and under the work surface where it is directed up a channel located on the back of the cabinet then either re-circulated back into the work zone, exhausted, or a combination of the two depending on a cabinet's subtype. There are four subtypes of Class II cabinets. Air is drawn through the cabinet's front opening at a minimum speed of either 75 linear feet per minute or 100 linear feet per minute, depending on the subtype. Some portion or all of the air is either reintroduced into the cabinet's work area through a supply HEPA filter or discharged back into the laboratory or building's exhaust system through an exhaust HEPA filter. Class II BSCs are designed for low-to-moderate-risk biological substances.

3) "Biosafety in Microbiological and Biomedical Laboratories"; Centers for Disease Control; December 2009; https://www.cdc.gov/biosafety/publications/bmbl5/index.htm

Class III
Biosafety Cabinet Airflow

Class III

An enclosed cabinet that protects personnel and environment. Typically designed for biosafety level 4 pathogens. Users place their hands into mounted gloves that pass through a non-open window and manipulate all work in that fashion. Blowers create a negative pressure of at least 0.5 inches of water gauge. Air enters the cabinet through a HEPA filter. Exhaust air passes through two separate HEPA filters, or a HEPA filter and an air incinerator, and finally through ducting to discharge into an exhaust system separate from the general laboratory exhaust system. Class III BSCs typically do not offer laminar airflow within the internal work area. Materials pass into the workspace through a dunk tank on the floor of the cabinet or through a double-door pass-through box that can be decontaminated between uses. The cabinets are designed for high-risk biological substances.

The Class II BSC has the broadest use and is the most commonly found in labs.

Need for Class II BSCs

BSCs provide protection from airborne contamination by particulate matter. The most important need for protection is the lab technicians operating the BSC. The cabinets prevent viruses, spores, and bacteria from infecting these personnel. Not only does this prevent injury or illness among workers, but it reduces potential liability on the part of the organization that owns or runs the lab.

Cabinets protect the work being done. Without the protection provided by Class II technology, multiple samples, processes, or procedures that occur within a cabinet could potentially undergo cross-contamination, undermining time and energy already invested and disrupting schedules and completion times.

BSCs also help protect the environment of the lab. Potential contaminants are kept within the cabinet and filtered from discharged air, so they do not pose a risk for personnel or source of contamination for work located elsewhere in the lab.

To summarize, BSCs are a form of safety control and risk management that have become standard in virtually every lab handling biological materials, whether hospitals and other large healthcare providers, testing facilities, pharmaceutical manufacturers, or other organizations that handle particulate matter of low-to-moderate-risk.

This e-book focuses only on Class II BSCs. Class I cabinets have declined in popularity due to the additional benefits Class II versions provide. Class III cabinets are beyond what many labs need. From this point forward, if the terms "BSC" or "biosafety cabinet" appear without specified type, they refer to **Class II cabinets**.

Class II Biosafety Cabinets

BSCs are ingenious in their design. By using relatively simple mechanisms that rely on the physics of fluid dynamics, these devices maintain barriers to contamination while still allowing the physical access that allows people to do their work.

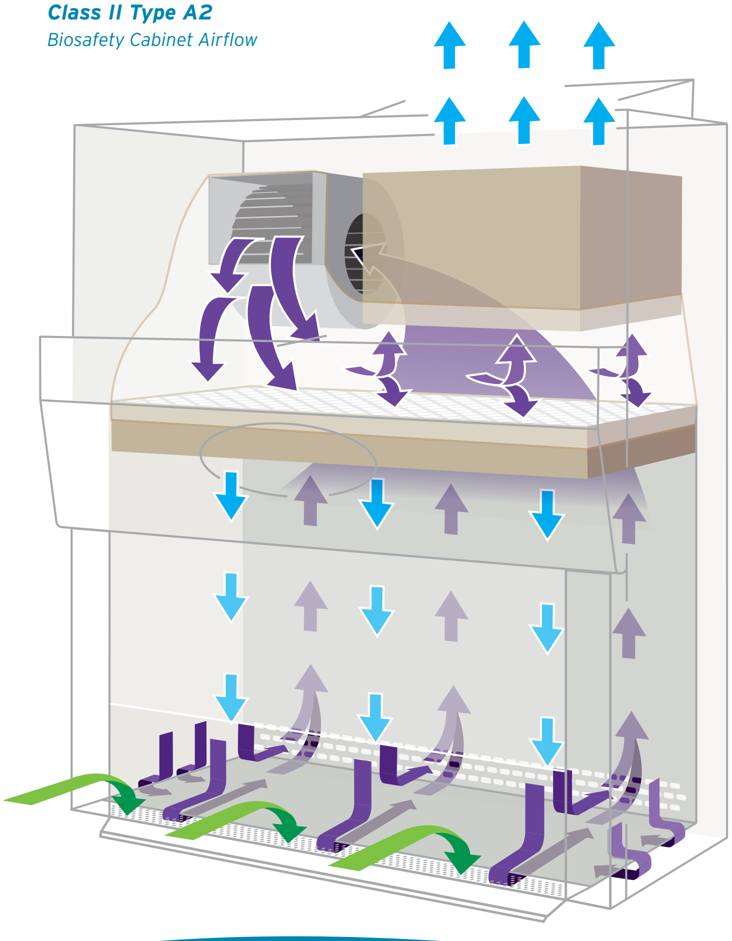
The Physics behind BSCs

BSCs can seem passive because of the most important tool of their effectiveness, air, is invisible. To better understand how Class II containment works takes a short review of some basic physics.

Fluids that are not under compression move without gaps through a channel or pipe. The fluid does not bunch up in some places or stretch thinner in others, even when the cross-section of the channel changes. The same volume of fluid must flow by each point. When the channel grows larger in cross-section, the fluid slows, because volume is directly proportional to both that cross-section and the speed at which fluid moves past the point. Similarly, when the cross-section shrinks, fluid moves more quickly, so the same volume per time flows past.

In the 18th century, Swiss mathematician and physicist Daniel Bernoulli applied the conservation of energy to fluid flow that led to the Bernoulli Equation and Bernoulli principle: When a fluid flows through a channel, fluid pressure, fluid speed, and channel cross-section are all directly related. So, when the channel size decreases, the fluid speed increases. Increase the channel size and the fluid speed decreases. Increase the speed and leave the channel size the same and the pressure decreases. The principle is what lets the airfoil of a plane create lift on the wing. It also lets a Class II biosafety cabinet operate and protect personnel, product, and the environment.

Class II Type A2
Biosafety Cabinet Airflow



How They Work

A BSC is essentially a box with a blower moving air within. A transparent panel on the front allows personnel to see inside. An opening at the bottom of the panel lets technicians reach in and perform work. This is known as the window sash.

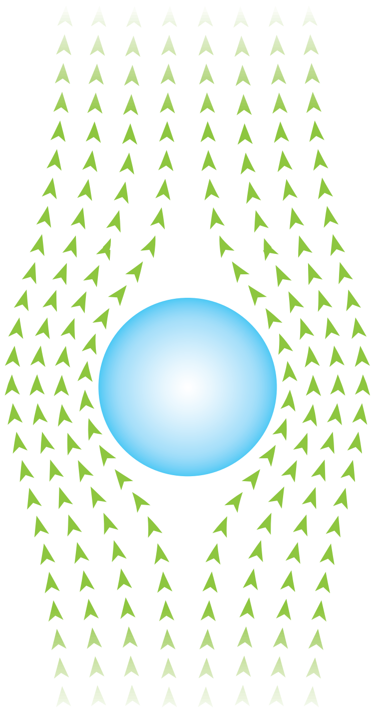
As the blower drives air through the box, the BSC becomes a study of fluid dynamics involving the Bernoulli principle. The moving air column lowers the pressure, creating a negative pressure area about air pressure in the lab.

Even as someone works with hands placed through the bottom of the window sash, air flows from the lab environment into the cabinet through that opening and into an air grill at the front of the cabinet. The air supply creates a moving air curtain in front of the work opening. Because of the negative pressure in the cabinet, air does not move outward through the opening into the lab so long as the person moves hands and arms slowly to avoid disruption of the air curtain.

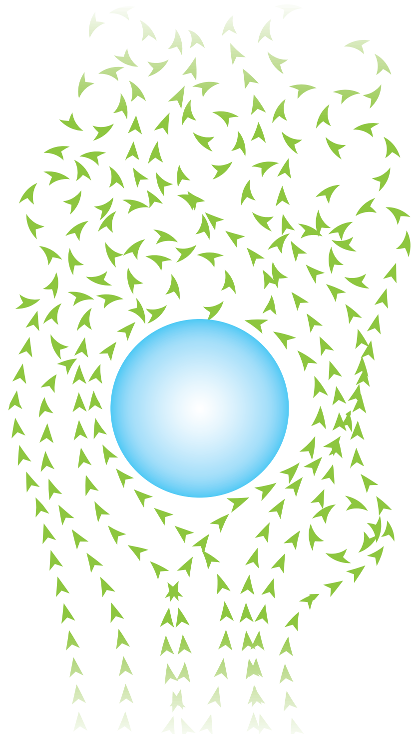
All or part of the air pulled through the cabinet may be vented out after passing through a HEPA filter. Depending on the BSC type and work being done, the filtered air may move into the lab or can be directed through venting to the building's exhaust system, eventually to be carried outside. Although they can screen particles from the air, the HEPA filters cannot remove volatile toxic chemical vapors or volatile radionuclides that might be generated.

Any air not discharged is recirculated by the blower that pushes it through the supply HEPA filter and into the workspace. Then the air is again drawn out, continuing the cycle.

HEPA Filtered Air
Contaminated Worksurface Air
Contaminated Room Air



Laminar Flow



Turbulent Flow

Protection and Laminar Flow

Contamination of work within a BSC, while rare, can still occur. The concept of laminar and turbulent flows explains the issue and the solution.

When a fluid, like air, flows past, over, or around an object, it can do so in one of two ways. One is in a turbulent flow, where eddies, whorls, swirls, and other disturbances tend to mix the fluid. If the air movement in the cabinet were a turbulent flow, airborne particulate matter or vapor could move between parts of the work area and contaminate other samples or processes.

The second way air can move around an object is called laminar flow. A laminar flow reduces to a minimum both turbulence and the potential cross-contamination it can cause as the air moves smoothly past objects it its path.

BSCs are designed to create and maintain laminar flow within the cabinet. The air moves smoothly around objects in the work area, minimizing the turbulence and the chance of cross-contamination. Any airborne contaminants move through the cabinet and are eventually trapped by a filter, whether the air is vented out or recycled to the work area.

To keep laminar flow intact, personnel must move their hands and arms slowly and carefully in the work area. A sudden movement can create turbulence, causing cross-contamination or disruption of the air barrier that prevents contamination of the lab environment.

Class II Types

There are four variations of Class II BSCs: A1, A2, B1, and B2. Here is an explanation of each:

Type A1

Class A1 cabinets are currently used infrequently. Class A1 BSCs are intended for routine microbiological work without generation of chemical vapors. The cabinet has a minimum inflow speed of 75 linear feet per minute at the access opening on its face.

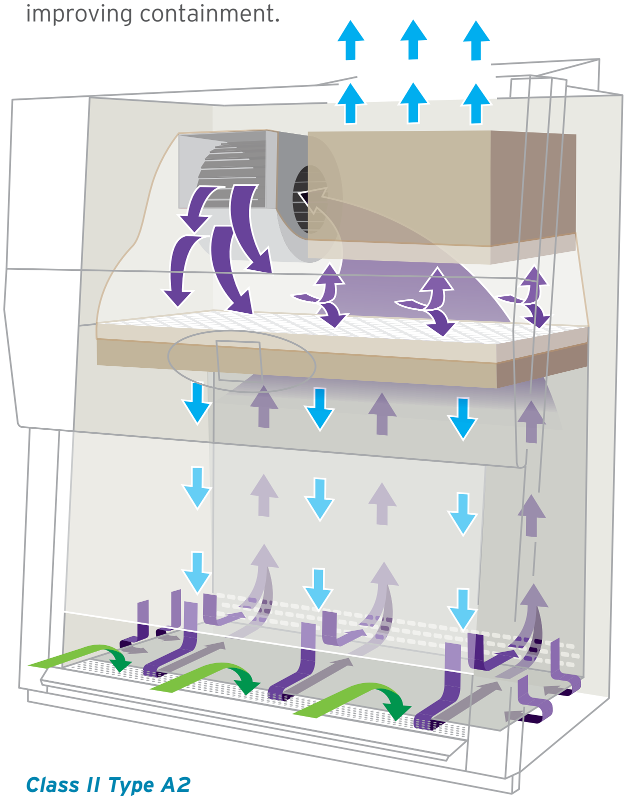
The air supply passes through one HEPA filter creating particulate-free air, drawn by a blower. 30 percent of the air circulated in the cabinet moves through a second HEPA filter and is vented out of the cabinet while the remaining 70 percent is directed through the first HEPA filter and recirculates through the cabinet. Laminar airflow prevents cross-contamination of items in the workspace. A Class II A1 BSC should not be used with volatile toxic chemicals because the build-up of vapors can create safety hazards.

Type A2

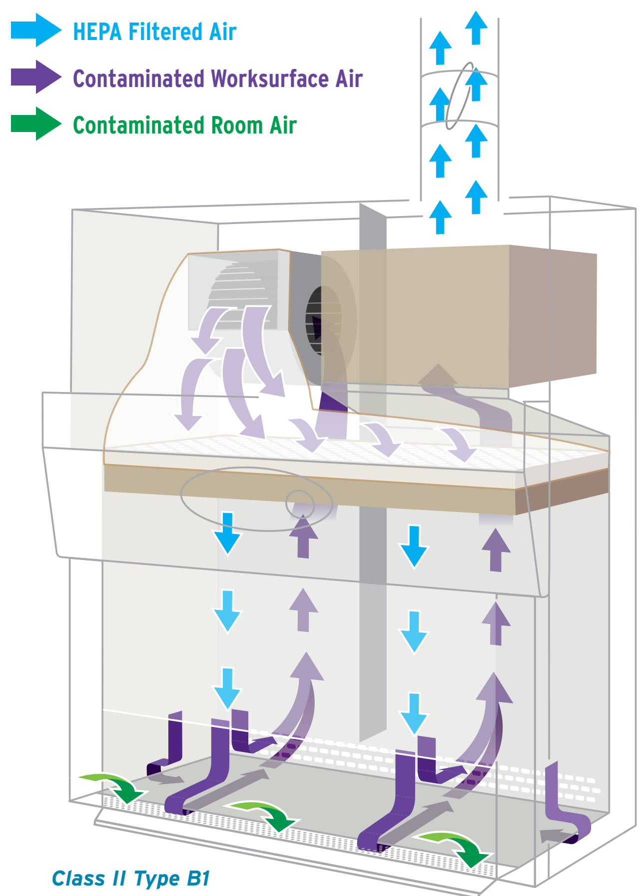
Intended for routine microbiological which either generates no chemical vapors. Applications that generate minute amounts of chemical vapors such as compounding chemotherapy drugs can be used with an A2 BSC if run with a canopy connection to an external exhaust. The A2 is similar to the A1 except with a minimum inflow speed of 100 linear feet per minute at the opening on its face, creating greater negative pressure and improving containment.

Type B1

Intended for routine microbiological work with generation of minute amounts of chemical vapors, so long as the generation does not interfere with the flow of air or the work is done at the rear of the cabinet, where the airflow is 100% exhausted. The cabinet has a minimum inflow speed of 100 linear feet per minute at the opening on its face. The air supply passes through a HEPA filter for particulate-free air, drawn by a blower. Of the air circulated in the cabinet, approximately 70 percent moves through an exhaust HEPA filter and is vented out of the cabinet while the remaining 30 percent passes through the supply HEPA filter and recirculates through the cabinet. Laminar airflow prevents cross-contamination of items in the workspace.



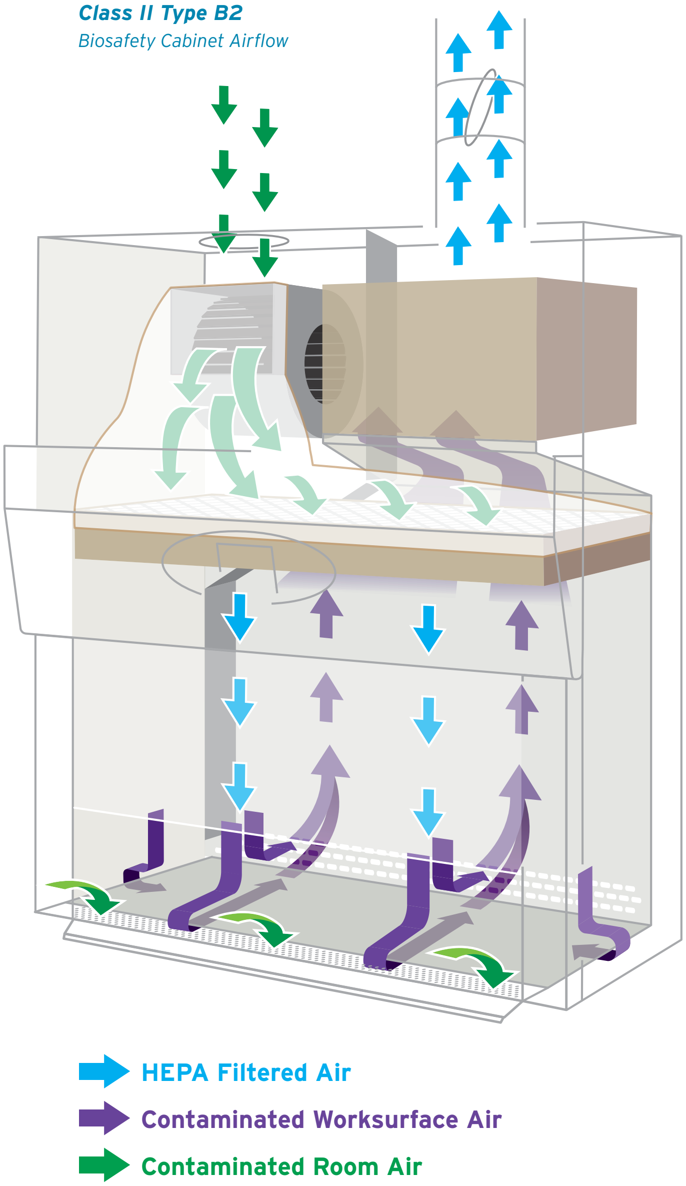
Class II Type A2
Biosafety Cabinet Airflow



Class II Type B1
Biosafety Cabinet Airflow

Type B2

Intended for routine microbiological work with generation of minute amounts of chemical vapors. The cabinet has a minimum inflow speed of 100 linear feet per minute at the opening on its face. The air supply passes through a HEPA filter for particulate-free air, drawn by a blower. Air circulates and is drawn through an exhaust HEPA filter to be vented out; 100 percent of air is exhausted. Laminar airflow prevents cross-contamination of items in the workspace.



Again, note that the preceding descriptions are for *minimum* configurations to meet the requirements of NSF standards. A cabinet from a particular manufacturer might include more blowers, larger blowers, higher air speed, or different sizes of filters.

Additionally, a given lab may want capabilities or capacities beyond standard requirements. Because each lab has unique needs and must determine on how much, if any, air can be vented to the lab environment versus the volume exhausted from the building, the lab safety officer's recommendations on the best type of BSC for the organization are important.

Class II BSCs are widely used in healthcare, chemistry and biochemistry, pharmaceuticals, and the life sciences. They may be employed at companies, healthcare providers, institutions of higher education research labs, or government facilities. Uses are typically the handling of microbiological materials with, at most, minimal chemical vapor creation. If creation of aerosols could be a byproduct of the work, it is recommended a BSC be exhausted into the facility's HVAC system. The choice depends on performing a proper risk assessment that includes the indemnifying the agent's risk group and Biosafety Level (BSL) of the laboratory. Every facility is different in how they are set up with their own recommended procedures. Work with your Environmental, Health, and Safety office to identify your facility's standard operating procedures.

The requirements for BSCs are set in NSF/ANSI Standard 49, *Biosafety Cabinetry: Design, Construction, Performance, and Field Certification*, which has undergone some revisions and addendums over the years. Each type of Class II BSC has a series of design and performance requirements, with the same pass or fails criteria.

Over time, NSF/ANSI standards have changed. For example, a configuration for a given type of cabinet that had been within specifications at one point may no longer meet current requirements. In that sense, use of a BSC is never static, and regular inspection and recertification from an accredited certifier are critical.

Standard NSF/ANSI 49 recommends your BSC be certified on an annual basis at minimum. Again, your facility may differ. In a compounding pharmacy setting standard USP 797 / USP 800 recommends your BSC be certified twice annually. Inspection and certification are also required when a unit is first installed, moved from one location to another, or has undergone a major repair.

There are some additional considerations:

- Cabinets have an estimated useful life expectancy of about 15 years but may vary from manufacturer.
- As with all equipment, the purchase price is not the final expense. Maintenance, repair, and recertification all contribute to a cost of ownership higher than the initial expense.
- Budget considerations are always an issue, as are trade-offs among price, capabilities, warranties, size, and features.
- Location requirements, configurations, or building restrictions may place constraints on which types and manufacturers' models are appropriate for a given application.

The next chapter will discuss the physical construction of a BSC.

Class II Construction

In one sense, it might not seem there should be much to building a box to fit inside a room and possibly connect to the ceiling through ducting. However, the simple description belies some inherent challenges in making a BSC that meets or exceeds category specifications.

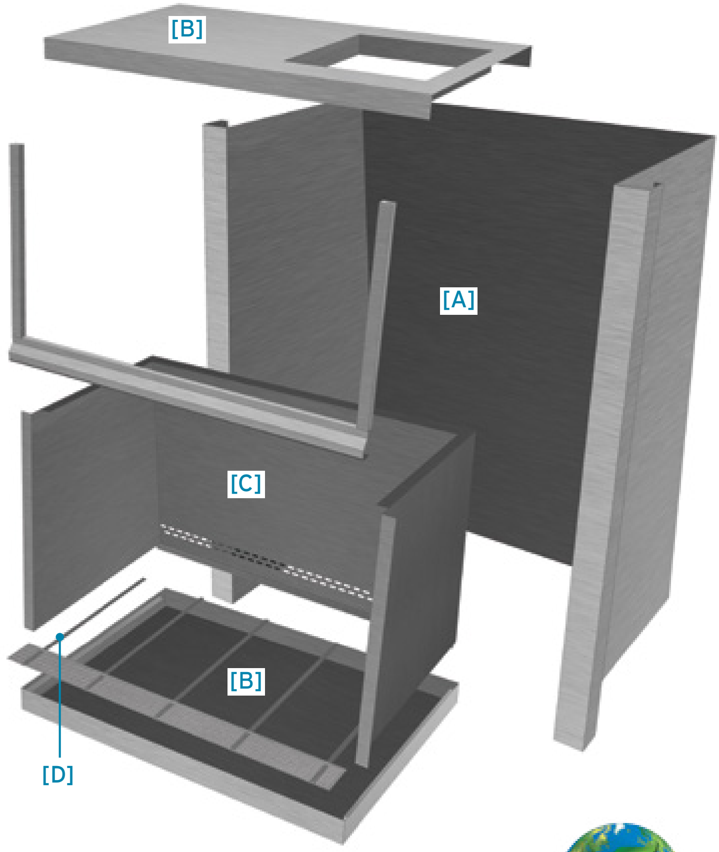
Durable, high-quality, BSC construction starts with a single piece of type 304 stainless steel. A stainless steel wrap **[A]** makes up the walls of the cabinet. Stainless steel sheets **[B]** are welded in place to make up the top and bottom of the cabinet. A smaller wrap **[C]** featuring coved interior corners is welded in place to make up the back wall of the cabinet. This improves the cabinet integrity by creating a double sidewall. New work tray supports **[D]** help minimize the vibration transfer from the shell of the cabinet to the work zone.

The end result is a monolithic shell of 100% stainless steel without the use of silicone like many multi-piece cabinets. This provides you with a solid foundation for longer product life eliminating potential leaks.

Cabinet Shell

The first containment boxes were made of wood, but the material is subject to decay and is difficult to decontaminate thoroughly. In theory, any nonporous substance with sufficient strength – fiberglass, plastic, or metal – could be used as the basis of a BSC shell. The most common choice is stainless steel for strength; impermeability; longevity; and ease of formation, cleaning, maintenance.

There are different ways to form the shell. Separate pieces can be joined by various methods, including welding or riveting. In some cases, particularly with riveting, it might be necessary to add gaskets and silicon to make the seams gas-proof. Alternatively, a larger piece of steel can be bent into shape reducing the number of places that could present a weak spot for contamination. No matter how the sides are fashioned, tops and bottoms still must be joined to the walls. Some manufacturers weld the top and bottom pieces into place, creating single monolithic cabinets that eliminate potential leaks.



Seam construction is an important detail because over time gaskets and silicon can deteriorate, especially in the presence of some substances regularly used in lab work, so riveted joints may require additional inspection and maintenance.

Caption here?

Work Area and Size

The work area in the BSC is the reason the cabinet, ventilation, and control systems exist in the first place. Cabinets vary in size. The larger the work area, the larger the cabinet and air volume. The larger the volume, the more powerful the motor(s) which are necessary to move the air fast enough to create sufficient negative pressure. A larger BSC will likely be more expensive, but could increase productivity, aid work flow, and increase profitability.

Work areas are typically between three and six feet (0.9 to 1.8 meters) in width, usually with a removable work tray for ease of cleaning. The size depends on a lab's needs and the available space. It is wise to experiment before deciding on the work area size. Tape or mark off a rectangle approximating the size of the cabinet in question on a workbench to model the work area and perform common procedures (though without the introduction of material that is hazardous).

The work area will help determine the overall size of the BSC, although models with equal work areas from different manufacturers can vary significantly in size. For instance, the front air grill might extend farther into the work zone increasing the reach of the technician into the safe work area. The design of the workspace and finish of its interior surfaces are essential to creating and maintaining laminar flow. Everything within the workspace should be designed to avoid creating turbulence.

The window sash will have an opening through which users can place their hands and arms. Working for extended periods of time with arms held in place can be ergonomically challenging. Some BSCs have optional platforms that can be put into the cabinet to give room to rest arms and improve comfort. Platforms are typically placed on the air grill and raised to avoid interruption of the vacuum.

Venting on the work tray of the work area at the front and back allow the downward movement of air to maintain laminar flow. As mentioned earlier, any processes releasing small amounts of vapor should be performed at the back of the work area to avoid contamination when the air curtain is disrupted as hands and arms pass through the front opening.

Filtration

The entire operation of a BSC revolves around filtration. Below are a series of diagrams for the core ventilation design, by type, of Class II BSCs:

The configurations of the blower(s) and filters can differ, but all the ventilation systems work under the same general principle. A motor pushes air through the plenum; a chamber made either of a flexible material or metal. The plenum forces air through the supply HEPA filter. The air then moves through the workspace in a laminar flow. The airflow splits, passing through grills at the front and back of the work zone and into the bottom of the cabinet. The air moves up a channel at the back of the cabinet to the top. At that point the air either is recirculated, going through the same steps above or is exhausted through a HEPA filter either into the lab or through the facility's exhaust system. While all that happens, there is a flow of air through the air grill at the front of the cabinet. Air is pulled under the work surface to ensure sufficient airflow.

The HEPA filters used in a BSC remove particles larger than 0.3 microns, or micrometers, in diameter, which include bacteria, viruses, and spores. Any HEPA filter must have an efficiency of at least 99.97 percent. A typical life span for a filter is between five and 15 years, and a new filter will typically cost several hundred dollars. HEPA filters must be replaced in the event of damage, if an annual certification check finds a leak, or if the filter is sufficiently dirty that it cannot pass sufficient airflow.

Different manufacturers use different blower configurations. Some build cabinets with arrays of two or more blowers at a given spot rather than a single larger one. This approach increases the number of moving parts, increasing the possibility of a blower failure. Because such a cabinet is designed to use the full complement of blowers in an array, failure of one out of several means the cabinet can no longer offer reliable containment. Replacement of even one motor requires that the BSC be re-calibrated, resulting in lost productivity.

In general, a larger blower motor can move a larger amount of air at a higher velocity than a smaller motor. As more particulate matter is trapped by a HEPA filter, more pressure is necessary to move air through the filter. The more power a motor blower contains the more life one can get out of their HEPA filters lowering operating costs.

The plenum is directly connected to the supply and/or exhaust filters and can be either metal or flexible industrial cloth that can act like a balloon and help increase pressure.

Another important part of the system is venting. With work typically performed in an A1 or A2 cabinet, the exhaust from the BSC might be safe to release into the lab, having passed through a HEPA filter. A type B1 or B2 cabinet must be connected to an external exhaust system in order to contain vapors, or gases.

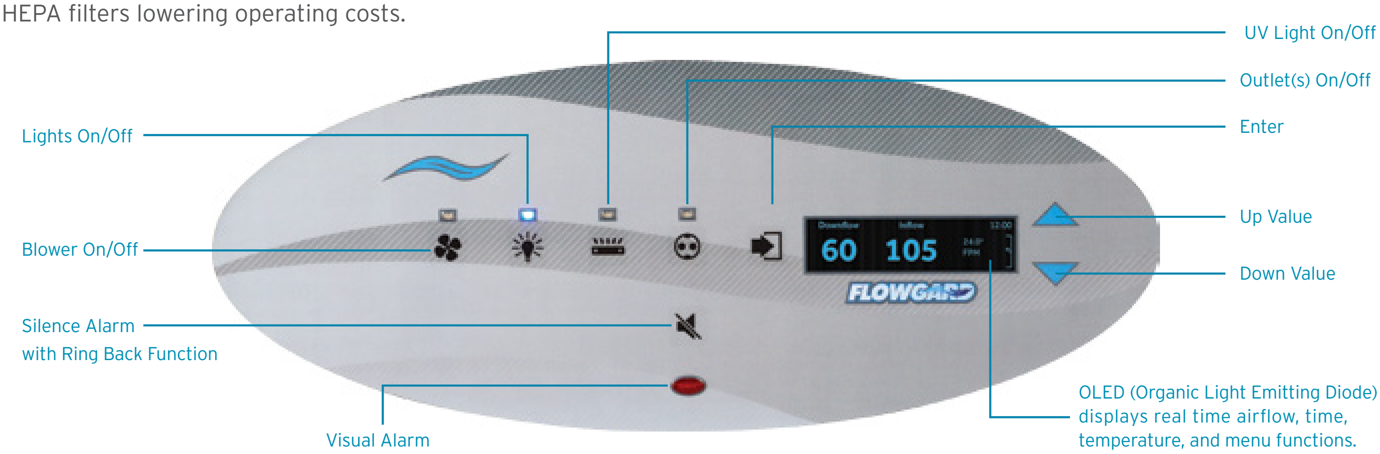
The construction and requirements of BSCs are necessary for personnel to understand. So are the operation and configuration considerations that the next chapter examines.

Operation and Configuration

Many aspects of a BSC's construction are determined by compliance with international specifications, the cabinet type, the particular size, and safety requirements of the work likely to be performed with the equipment. However, there are more considerations beyond the structure.

Control System

Although the functions of a BSC are simple, for example blower(s) are on during use, and off when not in use, with additional running time before and after to purge the chamber – the electrical systems controlling these functions can be quite complex.



The main control panel gives an operator the ability to start and stop the blower(s) and also to monitor two critical functions. One is the airflow. Technicians and lab managers must know that blowers are active. The protective properties of a BSC require an adequate volume of intake airflow to provide the necessary negative pressure, maintain the air barrier, and ensure laminar flow.

Hence, any BSC needs the ability to monitor the airflow and a way to present the information to the operator. Also necessary are alarm systems to indicate when something prevents the free flow of air, whether blower malfunction, unexpected power drop, obstructed filter, or constricted chamber or plenum.

Just as a variety of BSC models are available from various manufacturers, each with its specifics of construction, there are also different control and monitoring panels on the market. One model might offer a simplistic display of activity and alerts via lights. Another might provide more nuanced information through a digital display. Controls might be analog switches and knobbed dials or, instead, digital touch panels. There can also be differences in how the system measures operational performance. Directly monitoring plenum pressure does not necessarily offer enough information. A cabinet plenum can be at the right pressure and still have inadequate airflow to work properly. Airflow sensors provide a more direct indication of operational condition.

The choice of type of control and display depends on balancing operational needs and safety implications with budgetary considerations, both initial price and increased cost of ongoing maintenance.

Built-in Computer Monitor

Built-in Options

Many BSC manufacturers will make custom alterations to accommodate specific needs for a given lab. That might include any of the following:

- connections for electrical lines, gas inlets, or equipment cables
- monitoring equipment and associated mounts
- computer monitors on the back wall of the workspace
- changes to the work tray and front panel to accommodate a microscope
- bars and mounts to hang IV bags.

Built-in Microscope Window

Adding connectors, cables, hoses, electronic gear, or other equipment inside the working area can potentially increase turbulence and, as a result, reduce safety. Any modifications should be performed by the manufacturer, who will know if such alterations can be done without compromising function.

In general, authorities do not suggest the use of ultraviolet (UV) lamps inside the workspace, as they should be unnecessary. If a lab chooses to mount a UV light, it is necessary to clean bulbs and fixtures of dust, dirt, and grime weekly. Buildup of residue on the bulb surface could reduce the UV output decreasing the sanitation effects desired by the lab. UV Lights also need weekly calibration with a UV meter to ensure the necessary amount of UV light is emitted. When not in use, lamps should be turned off to avoid the potential for damage to the eyes or skin of lab personnel. Newer BSC models will feature a window sash interlock that will only allow the UV light to power on when the window sash is in the closed position.

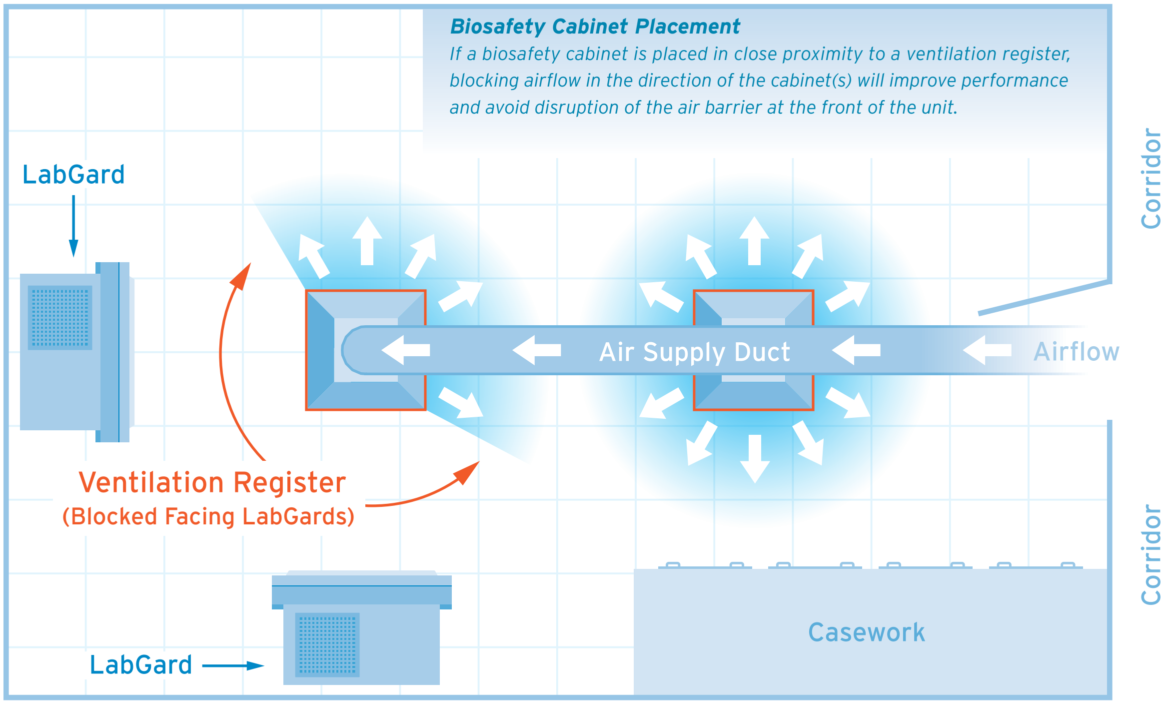
Similarly, adding fixtures to supply gas can be problematic because the cabinets are designed to contain particulate matter, not chemical vapors. Type B1 and B2 cabinets can only contain minute amounts of gas.

Installation

Location and power are two requirements for installation. The location is important for several reasons. Cabinets ideally should be placed in areas with minimal foot traffic and away from air registers. There must be sufficient floor space for the BSC to fit in the lab, but also a path having the proper dimensions to allow the BSC to be moved from an entrance into the lab. Measure in advance to ensure that the cabinet, can fit into elevators and through doorways so, once accepted and removed from the shipping crate, it can be put into place.

A BSC can be a heavy item, weighing hundreds of pounds. The floor of the lab must be strong enough to support the weight of the cabinet and any crating. The lab floor also needs to support the BSC indefinitely.

Ducting is often a consideration when installing a BSC. In the absence of volatile vapors, gases, or other substances that could cause health problems, exhaust can be returned back into the lab environment. Lab safety requirements and the nature of the work being performed might also require exhaust to be directed to the general building exhaust system or specialized treatment.



An A1 or A2 cabinet often feeds back into the lab, but either can be vented out to the building's exhaust system through a canopy. The canopy features gaps where an external fan located in the exhaust system pulls air from the laboratory and captures the BSC's exhausted airflow. The gaps also allow the BSC to functional properly if the facility's exhaust system fails by permitting the exhausted air from the BSC to exit into the laboratory offering biological and particulate containment only. An externally vented B1 or B2 should be permanently attached to the building's exhaust system through hard ducting. An additional location consideration then becomes whether there is clear access to the building exhaust system from where the cabinet will stand.

Your facility must be able to handle the power requirements of the BSC. The larger the cabinet the more power is needed to make it function properly (i.e. a 20 amp plug might be needed for larger cabinet widths). The lab manager should work with physical plant personnel to examine specs and determine what variations are possible or desirable for the building.

Operation

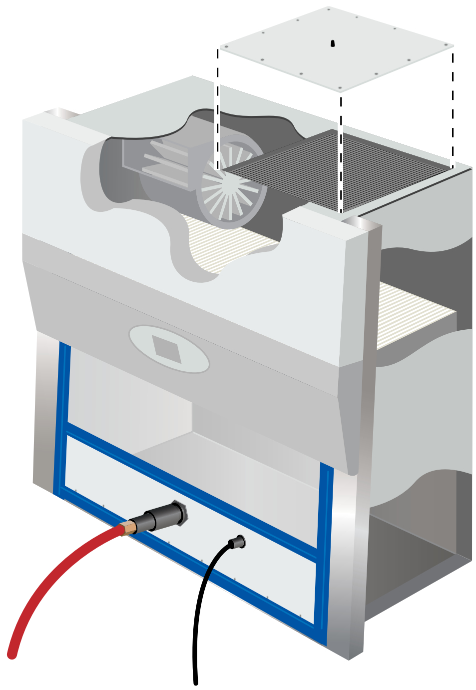
Part of the installation and operation of a BSC is deciding what specific steps should be taken to ensure safety for personnel and the environment – and for material in the cabinet if using a B1 or B2. The safety officer during their risk assessment will identify specific practices or configurations necessary.

Decontamination

Decontamination will be a necessity for any BSC, but the specific methods will depend on the materials in the cabinet and possibly its construction. The manufacturer will have recommendations of how to safely clean and maintain the equipment.

The DECON 101 system allows a biosafety cabinet to be isolated from the laboratory using gas-tight seals at the work access opening and exhaust port. A supply line allows for the introduction of aerosolized decontaminates, such as formaldehyde or H2O2. An exhaust line allows for the removal of remaining aerosols following decontamination.

Class II Type B2
Biosafety Cabinet with permanent exhaust duct



DECON101
Biosafety Cabinet decontamination system

Any new BSC will require training for all personnel who might use it. Aspects include set-up, operating the control panel, signs of problems, and procedures to use in case of a problem with either the cabinet or the building exhaust system.

The lab manager and safety officer should also adopt a routine operating sequence also need to develop materials to document operator responsibilities, schedules for regular maintenance, and cleaning procedures.

Conclusion

Understanding the structure, configuration, and deployment of Class II biosafety cabinets is important for labs that need to install and use them. An introduction like this one can help, but only so much.

The next step is to evaluate the lab's needs and plans in conjunction with all people at the organization who have responsibilities for or interests in the adoption and use of a BSC. Then speak with the technical experts from a manufacturer of biosafety cabinets. Ask about the specific solutions that are available, the likely maintenance requirements, and fully loaded lifetime costs.

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