

# Understanding the differences between Class II, Type A2 and Type B2 Biological Safety Cabinets

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## Introduction

A Class II biological safety cabinet (BSC) is a ventilated containment device found in laboratories around the world. BSCs are used in many applications, including cell culture, pharmaceutical, clinical and microbiological work. Due to the critical nature accomplished inside these commonly used laboratory products, BSCs are regulated through rigorous standards and compliance. Engineered controls are built into the design of BSCs providing protection to the operator, product and environment.

Globally, different regions have their own standards applicable to BSCs, and manufacturers build and test to the criteria set out in these standards.

The two most common standards used globally are the NSF/ANSI 49<sup>1</sup>, which originated in



**Figure 1.** Image of a Class II, Type A2 BSC that accounts for approximately 95% of the global install base of any class or type of BSC (Thermo Scientific 1300 Series BSC pictured).

North America, and EN12469: 2000 Biotechnology—Performance criteria for microbiological safety cabinets<sup>2</sup>, which originated in Europe.

NSF currently recognizes four types of Class II BSCs. Another class is planned to be added in 2017. Classes include:

- A1
- A2
- B1
- B2
- C1 (not recognized until 2017)

The EN12469 standard recognizes one type of Class II BSC, which is generally equivalent to the Class II, Type A2 BSC as specified by NSF (Figure 1).

European Class II and NSF Class II, Type A2 BSC accounts for approximately 95% of the global install base of any class or type of BSC<sup>3</sup>. It is the most commonly used BSC, primarily due to the versatility and high levels of protection offered.

The Class II, Type B2 BSC (commonly known as a B2) is widely used and accepted in North America. B2 BSCs can also be found in the Middle East but rarely in China and other Asian Pacific countries. Toxicology is the main application for a B2. However, within Europe, it is extremely rare to see a Class II, Type B2 BSC used in a laboratory. Applications, such as toxicology work, would see a different approach regarding BSCs, mainly using a “thimble” Type A2 in place of a B2. European manufacturers produce what is known as a Cytotoxic Class II BSC, which is built to DIN12980<sup>4</sup> (Cytotoxic Standard) as well as conforming to EN12469. Ultimately the “European Cytotoxic BSC” is still an A2 type BSC.

Often there is confusion and misconception within the industry as to when to specify or use an A2 or B2 BSC. What type offers better biological containment? What applications can they be used for? Can a Type A2 BSC be used for work with chemicals? These are just some of the questions regularly posed by laboratory professionals when considering a BSC purchase. This application note will explain the differences between types of BSCs and the strengths and weaknesses of these types to educate and clarify some of the confusion surrounding A2 and B2 BSCs.

### Class II BSC similarities

All Class II BSCs provide four types of protection. First, they protect the BSC operator from airborne biological hazards from the BSC work area with an inward flow of air at the front

opening. Second, they protect the laboratory and external environment from hazards inside the BSC work area by filtering the air exhausted or drawn from the BSC. Third, they protect the samples in the BSC from airborne contamination in the laboratory with a downward flow of filtered air inside the cabinet onto the BSC work area. Finally, they help prevent cross contamination within the BSC work area through the use of a flowing and uniform downflow onto the BSC work area.

As we begin to look at the differences between the A2 and B2 types, we should first note that the airflow within the BSC work area is the same for all types of Class II BSCs. There is the inflow being drawn in the front opening but immediately captured into the front intake grille. This provides personal protection. There is the filtered flow of air inside the cabinet, flowing down from the top of the BSC

work area to the work surface, where it splits with half of the air going to the back grille and the other half going to the front intake grille. Smooth and clean downflow provides the product and cross-contamination protection.

Where the four or five types of Class II BSCs differ is in the source of the downflow air and where the air drawn from the BSC work area goes.

### Class II, Type B2 BSC – How it works

For a B2 BSC, the air is pulled in at the front aperture creating an air barrier that gives the operator protection. Air is also pulled from an opening at the top of the cabinet that supplies the downflow fans with air (Figure 2). Then the air goes through a HEPA filter and is 100% exhausted through a dedicated duct with an exhaust fan motor. The air is then released into the atmosphere. The purpose of this is to remove toxic vapors that

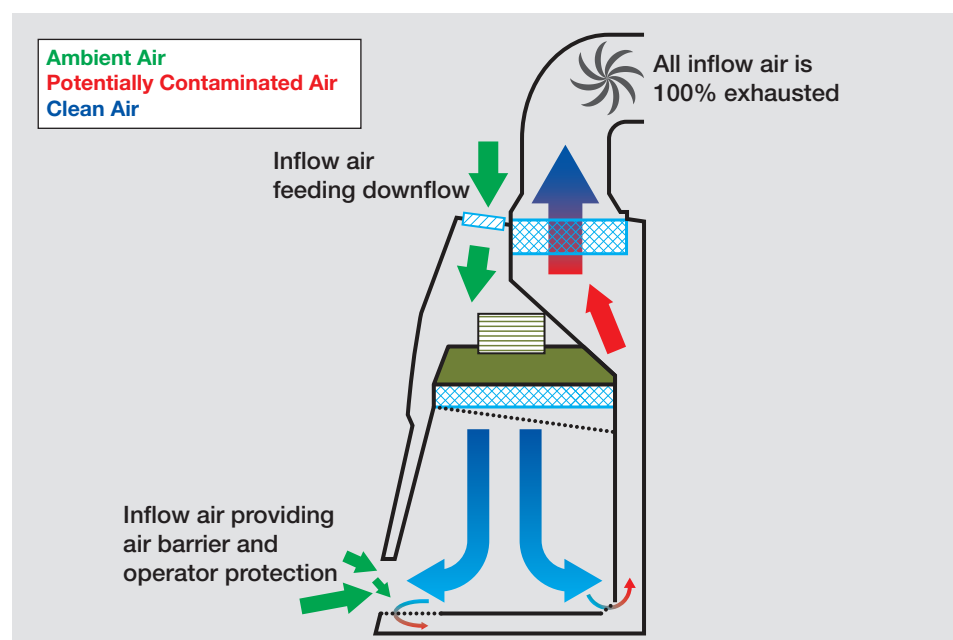


Figure 2. Demonstration on how a Thermo Scientific™ Class II, Type B2 BSC operates.

are generated in the cabinet with no recirculation within the BSC.

Airflow through a B2 is 100% externally exhausted which means the air that is drawn into the cabinet is 100% exhausted into the atmosphere. None of the air drawn into the B2 for either inflow or downflow is recycled within the airflow system. This is where an A2 differs as it does recycle a portion of its air after filtration – approximately 60% to 70%.

### Class II, Type A2 BSC – How it works

In a Class II, Type A2 BSC air is drawn in through the front aperture, which provides operator protection (Figure 3). The inflow air mixes with the downflow air as it enters the front intake grille and then passes through the plenum where the air splits. Approximately 60% to 70% of the air is recycled and pushed back into the BSC work area through the downflow

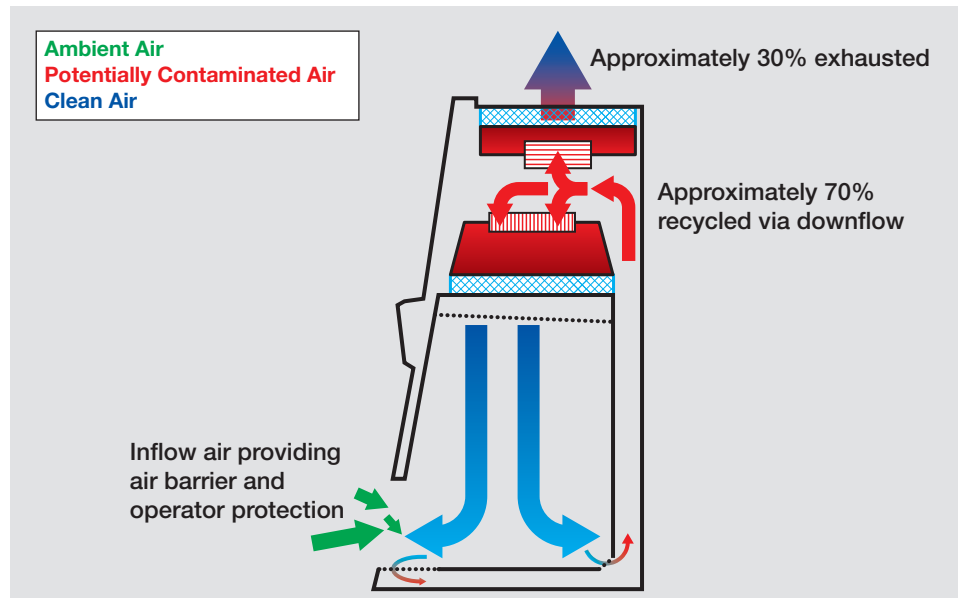


Figure 3. Demonstration on how a Thermo Scientific Class II, Type A2 BSC operates.

HEPA filter, and the remaining 30% to 40% is exhausted through the exhaust HEPA filter. This filtered exhaust air can be externally extracted with a thimble system, direct duct or simply extracted back into the laboratory. However, if volatile chemicals are used within the BSC as an adjunct to

microbiological work, exhaust must be released into the atmosphere through a thimble system or direct duct.

Alternatively, in Europe, if small amounts of chemicals are used in a recirculating BSC and if approved by safety personnel, a carbon filter may

### Comparison between Class II, Type B2 and Class II, Type A2 BSC

Characteristic	Class II, Type B2 BSC	Class II, Type A2 BSC
<b>Airflow pattern</b>	No recirculation within work area. 100% total flow is exhausted.	Approximately 70% of air is recycled and approx 30% exhausted
<b>Exhaust system type</b>	Must be direct ducted as per NSF	Can have three types of exhaust: <ol style="list-style-type: none"> <li>1. Recirculating — filtered exhaust into room</li> <li>2. Thimble-type duct</li> <li>3. Direct duct (only EN12469, NSF 49 does not allow direct duct for A2 type BSC)</li> </ol>
<b>Inflow velocity</b>	≥100 FPM (NSF 49)	≥ 100 FPM (NSF 49) ≥ 0.40 m/s (EN12469)
<b>Downflow velocity</b>	Not defined	Not defined (NSF 49) 0.25–0.50 m/s (EN12469)
<b>Recognized by EN12469</b>	No	EN12469 only recognizes 1 type of Class II BSC, which is very similar in design to an NSF 49 A2 type BSC

be installed after or as a part of the exhaust HEPA filter.

**IMPORTANT NOTE:** NSF/ANSI 49 allows for an A2 BSC to be connected to a thimble (canopy) system but does not allow for them to be connected to a direct duct system. EN12469 allows both thimble and direct duct A2 BSCs.

### Comparing A2 and B2 BSCs

There is a misconception that a B2 BSC is safer than an A2. They are both equally safe from a microbiological perspective and provide operator and product protection.

A B2 BSC may provide additional protection for the user when working with vapors and gases where aseptic conditions are required. The B2 provides greater dilution of any volatile chemicals within the BSC work area and eliminates even the diluted recirculation of volatile chemicals being used in the BSC. B2 cabinets are designed for work that involves volatile, toxic chemicals or radionuclides. This is in addition to the microbiological work being completed.

When an A2 BSC is connected to a thimble (canopy) system or direct duct exhaust system, it too can be used with volatile chemicals or radionuclides.

Although larger quantities of volatile chemicals and/or radionuclides may be used in a B2 BSC, given the greater dilution capability, restrictions will still apply. Flammable corrosive or explosive materials should not be used in either A2 or B2 BSC, and the user may need to consider using a traditional fume cupboard for these types of applications.

### Considerations

There are a number of important points to consider before deciding which type of BSC is right for your application. One of the biggest and often overlooked is the total cost of ownership for a BSC.

The overall start up cost and lifetime cost of a B2 is far greater than an A2 cabinet. A B2 will have:

- Higher start up cost
  - Higher rated external exhaust fan
  - Dedicated ductwork
  - Installation

- Approximately 2.5 times more air exhausted than an A2 cabinet
- More conditioned supply of air required to replace a greater volume of exhausted air
- Higher energy consumption
- Larger carbon footprint
- Higher energy bills
- Higher total cost of ownership

Another point to consider before purchasing a B2 over an A2 BSC is the effect on the materials within the BSC. For example, if you use a relatively large amount of chemicals that pass through the BSC, the HEPA filter could be impacted. HEPA filters are made from one piece of continuous paper like media and a glue-like substance. Chemicals pose a risk to delicate HEPA filters. Some of the interior surfaces of the B2 BSC may also be susceptible to chemical use.

### Comparison of air volumes

Below is a schematic showing the airflow pattern and air volumes exhausted from an A2 thimble and B2 BSC (Figure 4).

The B2 is exhausting more than twice the amount of air directly out of the laboratory than the A2. The A2 is exhausting 358 CFM with 30% additional air from the room for the thimble and the B2 is exhausting 734 CFM. The large amount of air that a B2 requires is often overlooked. Also note the greater negative static pressure required by the B2. For the B2, the external extract system must draw this larger exhaust volume with no assistance from the cabinet while the filtered exhaust from the A2 BSC

### What Class II, Type A2 and Type B2 BSCs provide

Use HEPA filter technology

Contain and protect the user from biological agents

Protect the environment

Protect the samples inside the work area

Provide unidirectional (laminar) downflow

Can be used for Biosafety Levels 1, 2, 3

Thimble or direct ducted A2 and B2 can be used with volatile toxic chemicals required as an adjunct to microbiological work

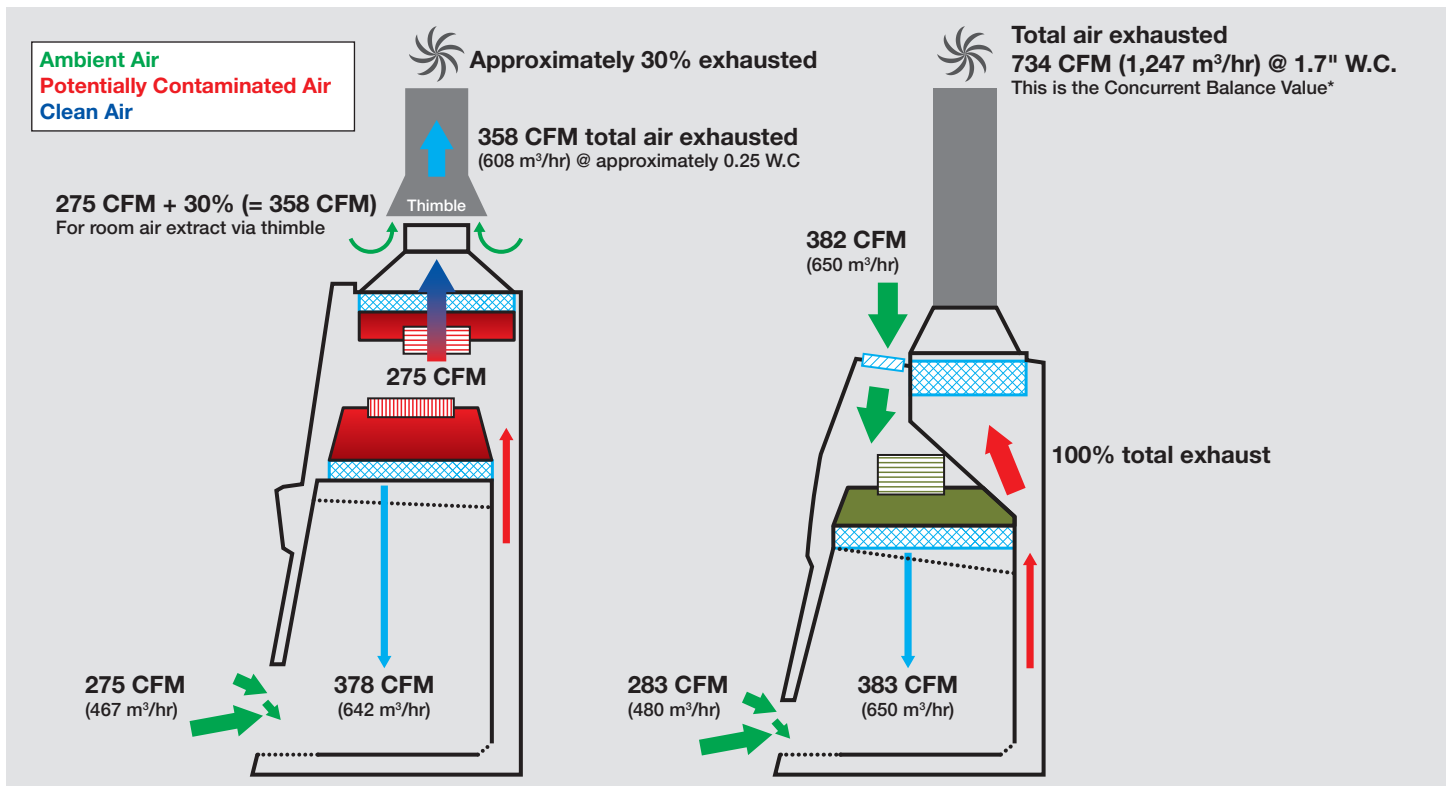


Figure 4. Thermo Scientific Type A2 BSC (thimble) and Thermo Scientific Type B2 BSC.

is pushed out the exhaust filter by the cabinet. In Figure 4 we see that while the A2 BSC requires up to 358 CFM exhaust at 0.25 inches w.c. negative static pressure, the B2 BSC requires 734 CFM at 1.7 inches negative static pressure. Not only does a B2 BSC require more exhaust volume, the extract system must work harder to draw this larger amount of air.

The A2 thimble type in this example is operating at an additional 30%. Manufacturers would normally recommend a thimble operates 5–30% above the cabinets exhaust volume. As a result, potentially the air volume of the A2 thimble could be even lower.

This difference in exhaust air has a direct affect on room pressures,

supply air and extract air volume, and a much larger rated external exhaust fan will be required for the B2 BSC.

### What is concurrent balance value for Type B2 BSCs?

The Concurrent Balance Value (CBV) was implemented by the NSF Joint Committee members to minimize confusion as to the exhaust airflow requirements of direct connected types such as the B2 BSC. There was variability in air volume measurements between field certifiers and HVAC designers.

**NSF DEFINITION:** This value is determined using the duct traverse measurement method as specified in ASHRAE 111-2008, a minimum of 7.5 duct diameters downstream of a direct connected BSC. Prior to determining

the concurrent balance value, it shall be confirmed that the cabinet is operating at its nominal setpoints for inflow and downflow velocity  $\pm 3$  fpm. The primary DIM method shall be used for setting the inflow velocity. The accuracy of the DIM shall be better than or equal to  $\pm 3\%$  and  $\pm 7$  CFM. The static pressure is also measured approximately two duct diameters from the cabinet exhaust connection. Appropriate filter load and tolerance values shall be added to the base static pressure value to accommodate filter loading: 0.3 in w.g. shall be added for Type B1 cabinets and 0.7 in w.g. shall be added for Type B2 cabinets.

The resulting values may be used for design and balance exhaust/supply HVAC requirements.

**AUTHORS NOTE:** Always use the CBV from the relevant manufacturer in planning the external exhaust system to meet the requirements of the B2 BSC.

## Summary

In most applications, a Class II, Type A2 BSC will be acceptable for your needs. Great consideration needs to be applied when specifying a Class II, Type B2 BSC. The substantial amount of air consumed by a B2 BSC is costly and must be replenished through the building's air handling units. It is important to remember that the air has already been conditioned before the B2 BSC draws it up discharging it into the atmosphere.

Finally, B2 BSCs must be ducted, and have an external fan. This adds additional costs, as well as lifetime costs such as power consumption.

Please contact your Thermo Fisher Scientific representative who can provide you with the understanding, technical expertise, and experience needed to help you choose which biological safety cabinet is required for your laboratory.

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