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Ergonomics And Safety In Biological Research Cabinets

by Dave Phillips

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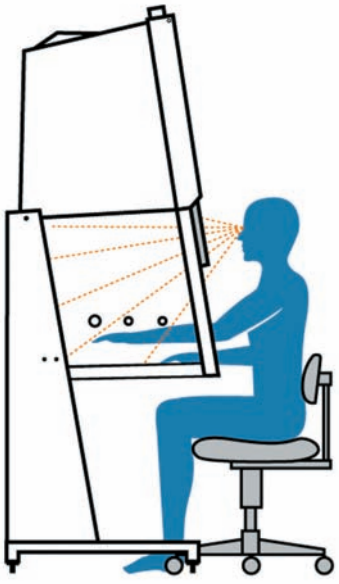

Figure 1. Choosing a biological safety cabinet with many ergonomic design features can improve operator comfort. An angled front promotes a more natural head and elbow working position, which allows the operator to get closer to their work, extend their reach and assume a comfortable and relaxed working environment.

From the earliest forms of lab-acquired infections to the hazards posed by today's antibiotic-resistant bacteria and rapidly-mutating viruses, laboratories have had to eliminate risk. Many techniques produce aerosols containing hazardous material such as infectious agents or carcinogens that can be inhaled by researchers. The additional hazards posed by working with animal tissue and cell cultures, the importance of maintaining the sterility of cell lines, and the efforts employed to minimize cross-contamination create the need for biological safety cabinets that provide maximum sample protection. To maximize productivity while assuring the highest level of safety, these cabinets have become critical to research, and are now among the most effective and most commonly used primary containment devices in laboratories.

A great amount of attention is also being given to ergonomic considerations. Repetitive tasks are inherent to research, and scientists spend long periods of time working in safety cabinets. It is imperative that every employee working in a biological safety cabinet (BSC) is trained in correct use and has an understanding of the different types of cabinets and how they work.

Cabinet classifications

There are three general classes of BSCs: Class I, Class II (of which there are four types) and Class III. Selection of the proper class of cabinet requires careful evaluation of the type of research to be performed, as cabinets can differ in the protection provided from non-particulate hazards, such as volatile chemicals.

As shown in Table 1, the Types of Class II BSCs differ according to the method by which air volumes are recirculated or exhausted, which has an impact on how they contain gases and vapors.

Type of Class II BSC	Recommended Use of Volatile Toxic Chemicals and Radionuclides	Type and Degree of Recirculation within Sample Chamber	External Exhaust Requirements
A1	Not suitable for work with volatile toxic chemicals and volatile radionuclides.	There is mixed recirculation into the downflow air from the inflow and downflow.	This does not require an external exhaust connection, if removal of nuisance fumes is desired, it can be exhausted through a canopy or thimble connection.
A2	Minute quantities of volatile toxic chemicals and tracer amounts of radionuclides, required as an adjunct to microbiological studies when exhausted through properly functioning exhaust canopy or thimble connection.	There is mixed recirculation into the downflow air from the inflow and downflow.	This does not require an external exhaust connection, if removal of volatile chemicals and radionuclides is desired, it can be exhausted through a canopy or thimble connection.
B1	Minute quantities of volatile toxic chemicals and tracer amounts of radionuclides, required as an adjunct to microbiological studies.	There is partial recirculation into the downflow air. Downflow air drawn into the front grill next to the window is mixed with the inflow and recirculated into the downflow. Downflow air drawn into the rear grill at the back of the work area is directly exhausted from the cabinet.	This type of Class II BSC requires a direct connection to an external exhaust to operate.
B2	Volatile toxic chemicals and radionuclides, required as an adjunct to microbiological studies	There is no recirculation into the downflow air. All downflow air drawn into the front and rear grills are directly exhausted from the cabinet.	This type of Class II BSC requires a direct connection to an external exhaust to operate.

Table 1. A guide to choosing the safest and most ergonomic cabinet for your research needs.

Figure 2. White back walls reduce glare.

In general, applications using larger amounts of volatile compounds and trace amounts of radionuclides are best served by Type B2 cabinets. More moderate amounts of volatile compounds and radionuclides are well served with a Class II, Type A2 BSC cabinet with a canopied exhaust system. Applications with only biological hazards can use the Class II, Type A2 BSC without a canopied exhaust system. The Class II, Type A1 BSC has been largely replaced by the Class II, Type A2 BSC, which will be the focus of this article.

Meeting new standards

Product design, airflow optimization and improved filters have all had a major impact on safety containment performance, as has the revision of NSF Standard 49. NSF International (www.nsf.org), formerly the National Sanitation Foundation, is a non-governmental organization that develops standards and certifies materials for a multitude of applications. Although NSF International is based in the U.S., it has influenced safety cabinet design worldwide with its emphasis on demonstrating containment of biological aerosols. Improvements have been made in design and manufacturing, in performance specifications, and with requirements for the protection of personnel, samples and the environment. The next step in the process is reducing accidents and laboratory-acquired infections through improved ergonomics.

Ergonomics — the new safety

Aside from working daily with hazardous substances, lab personnel are exposed to many ergonomic risk factors due to the nature of their work. Only in recent years has ergonomics moved to the forefront of scientists' awareness.

Although the National Institutes of Health has recognized lab work as an occupation with risk for musculoskeletal disorders and repetitive stress injuries (RSIs), ergonomics in the lab has not received the same level of attention as ergonomics in non-laboratory environments. Working in any form of containment cabinet requires personnel to perform repetitive tasks in a variety of postures. People who use BSCs can be at risk of RSIs, and since arm movements are restricted, the stress on joints of the upper limbs, neck and back can be significantly increased. It is thus imperative that issues such as cabinet shape and design, worker position, lighting and noise are all taken into consideration when choosing a BSC.

Creating a comfortable working environment

Poor posture and positioning are the most common problems encountered when using a BSC, and these can ultimately lead to mistakes. Working at a cabinet requires the operator to hold their head, shoulders and arms in a forward position (Figure 1). Choosing a cabinet with an ergonomically-angled front allows operators to extend their reach and assume a comfortable working position, effectively eliminating musculoskeletal strain and fatigue during extended procedures. An angled view-screen also promotes a more natural head position and minimizes light reflection and glare.

The height and size of the work surface is also important to operator comfort. Where labs are staffed by operators of varying heights, electronic support stands are available that can be automatically adjusted to a comfortable work-surface height for each individual. The work area must provide sufficient space while taking into account the maximum reach of operators. This prevents hunching of the shoulders and repetitive stretching, which can increase muscle strain and fatigue.

Figure 3. Transparent side walls introduce natural light into cabinets and reduce the sense of confinement associated with opaque side walls.

Arm and foot rests should be considered. Arm rests eliminate pressure points without disrupting the protective inward airflow of the cabinet. Foot rests allow operators to establish a comfortable position beneath the cabinet.

Quiet enough to think

Noise is the number one irritant for BSC users. It distracts and irritates the operator, which decreases performance and increases the likelihood of errors. Reducing noise levels permits users to work longer and allows them to hear and think more clearly. It is important to consider a BSC that operates as quietly as possible. While NSF International requires BSCs to operate at no more than 67 dBA, cabinets are available that operate at less than 61 dBA. As noise is measured on a logarithmic scale, a difference of 3 dBA below the NSF specification of 67 dBA is equivalent to a more than 50% decrease in sound levels.

Bright work space

Good lighting also makes for a safer and more comfortable environment. Cabinets with white back walls reduce glare and make it easier to see variations in texture and color (Figure 2). Some cabinets are available with transparent side walls which introduce more natural light into the unit and reduce the sense of confinement associated with opaque side walls (Figure 3). Glass side walls also simplify training and demonstrations by offering easy viewing from all angles.

Cost–effective UV lighting

Ultraviolet (UV) lights, common accessory in BSCs, are biocidal devices that protect personnel from exposure to infectious agents and samples from contamination. The effective life span of UV lights is relatively short and bulbs are expensive to replace. However, programmable UV lights allow overnight exposure times to be set precisely. As the intensity of the light striking the area to be decontaminated is a function of the distance, the UV light ideally should be mounted just above the work surface for optimum effectiveness.

About the author

Dave Phillips, a Technical Applications Specialist for Thermo Fisher Scientific, is on the Joint Committee for the NSF/ANSI 49 Standard on biosafety cabinets, NSF Steering Committee for Field Certifier Accreditation and is an active member of the Controlled Environment Testing Association.

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