Creating a Biosafety Cabinet Training Program

Expert Guidance on Training Users to Work Safely Inside a Biological Safety Cabinet (BSC)

Sponsored by: NUAIRE

Authored By:

Julianne L. Baron

Ph.D., CPH, RBP

President of Science and Safety Consulting. She has a background in infectious diseases, biosafety, and public health and consults on laboratory safety and design, pandemic preparedness, and scientific communication.

Why Should I Conduct BSC Training?

While working in clinical, pharmaceutical, research, and/or other laboratory settings individuals may work with hazardous materials, including potentially infectious biological materials. National and international guidelines including The Centers for Disease Control and Prevention (CDC) and National Institutes of Health (NIH)'s Biosafety in Microbiological and Biomedical Laboratories (BMBL) 6th edition[1], The NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules[2], The World Health Organization (WHO)'s Laboratory Biosafety Manual 4th Edition[3], The WHO's Biosafety Programme Management monograph[4], and The Occupational Safety and Health Administration (OSHA)'s Bloodborne Pathogens Standard[5] address the needs and importance of training users to work safely with biohazards. These documents recommend or require worker training be about job-specific topics including potential hazards, manipulations of infectious agents, precautions for minimizing exposure, aseptic technique, and standard microbiological practices or good microbiological practices and procedures[1-5]. These resources will also describe the importance of conducting a risk assessment for this work, which should review worker training and their familiarity with safe practices and procedures.

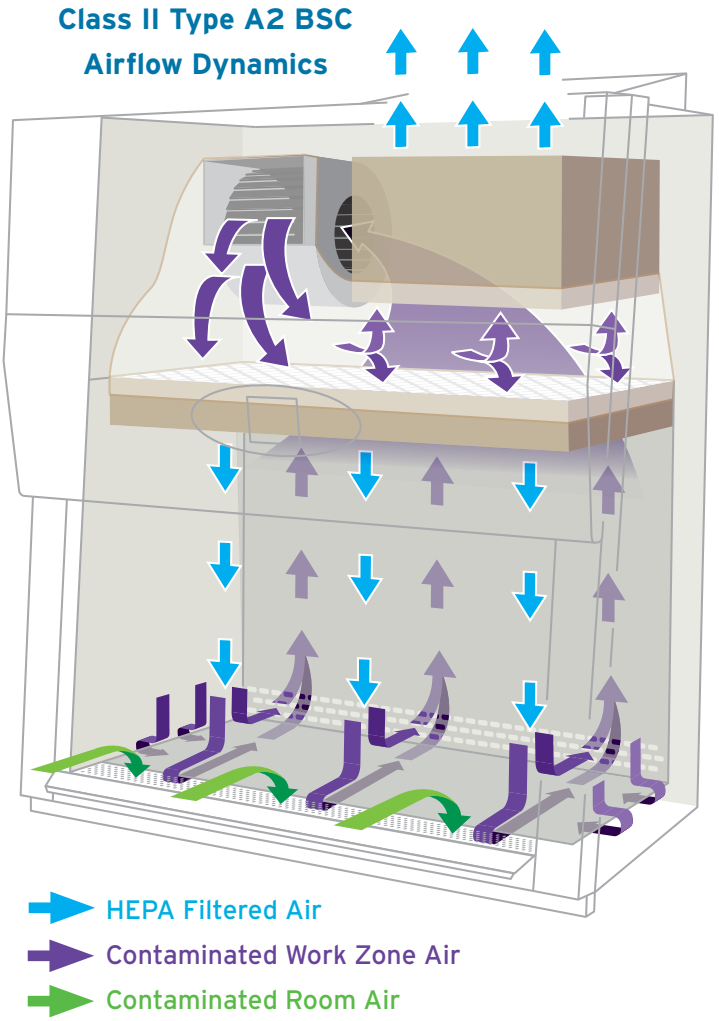
Work with biological agents, especially work with unknown specimens[1,3], work that may generate aerosols, droplets, or splashes[1-3,5], or work with high concentrations or large volumes of materials[1-3,5], should be conducted within a primary containment device, often a Biological Safety Cabinet (BSC). Therefore, the BSC is a critical engineering control used to minimize exposure to biohazardous materials. However, users may or may not be trained specifically to use it - especially those working at lower levels of containment. Within the context of a larger biosafety training program, inclusion of specific information and hands-on training on the appropriate practices and procedures for working within a BSC can assist workers in safely handling or manipulating biological materials. The WHO's monograph on Biological Safety Cabinets and Other Primary Containment Devices[6] and the NSF/ANSI 49-2020 Annex I-1[7] recommend that protocols, plans, and training be developed specifically relating to proper BSC use. This article provides information for creating your BSC training program including why proper BSC use is important, how to facilitate learning transfer, an annotated list of BSC resources and videos, and discusses situations when your BSC manufacturer could provide additional helpful resources.

Why is Correct BSC Usage Important?

As described in the BMBL[1] and the WHO's BSC monograph[6], biosafety cabinets are the primary barrier or primary containment that separates individuals from hazardous materials directly at the level of the hazard. Proper training can encourage appropriate use of the BSC, which provides:

- **Personnel Protection** - by maintaining the BSC's air curtain, so hazardous materials stay inside the work zone and do not contaminate the user.
- **Product Protection** - by providing HEPA-filtered air over the work products that assists with aseptic technique and avoidance of cross-contamination when the work zone is set up to allow individuals to work from "clean" to "dirty".
- **Environmental Protection** - by only allowing HEPA-filtered air to be released from the BSC into the lab space or out of the research building.

BSCs are critical engineering controls intended for preventing exposure to biological agents, however, their functionality and level of protection may be impacted by an untrained or poorly trained individual. While working, an improperly trained individual could easily disrupt the airflow within the BSC, breach the air curtain, or improperly manage materials or wastes leading to a reduction in the protections afforded by the BSC[1,6].



How Should I Conduct BSC Training?

When creating your training program, take into account different styles of learning along with adult learning principles to create the most effective biosafety cabinet training program possible. This could include a combination of oral lectures, visual presentations, and hands-on training opportunities, if possible. Adults often have more difficulty than children when it comes to learning new ideas and concepts, so including multiple mediums of information and repetition can help with education retention. Adult learning principles tell us that for learning transfer to occur, it must be supported at individual, instructional, and organizational levels.

At the level of the individual, their personal motivation, relevance of the information, and future applications are important factors in whether they absorb the information[8]. Consider incorporating messaging about ***why*** properly using a BSC is so important for the health and wellbeing of the individual, their community, and environment into your BSC training program.

At the instructional level, detailing the real-world applications of their training is the most critical factor in knowledge transfer[8]. This supports the idea of incorporating hands-on activities in the BSC training program to allow trainees to practice in a controlled environment before handling any hazardous materials. Trainees can learn appropriate techniques, practice specific SOPs, and get feedback from others, both on the technical and safety aspects of their hazardous material handling.

At the organizational level, the important factors in learning transfer are the perceptions of collective support and individual accountability[8]. Institutions or laboratories may outline specific requirements for completing training, refreshers, and mentoring periods while learning to manipulate biohazardous materials in a controlled environment. These efforts can demonstrate support for the training program as a whole and the health and safety of researchers performing this work.

Understanding these hierarchal support concepts can improve the development and retention of your BSC training program. These principles coincide with recommendations from the BMBL[1], the WHO[3], and OSHA[5], which encourage proficiency demonstrations or competency assessments for working with heightened control measures[3], bloodborne pathogens[5], or other hazardous biological materials, especially at higher levels of containment. Training, in these instances, must be repeated regularly and whenever equipment or procedures change; this encourages cabinet users to remember and practice the proper techniques for handling biological materials in a BSC and their responsibility for working safely. Additionally, proper cleaning and disinfection of BSCs, especially in the case of a liquid spill, can be incorporated into annual training to further instill this information into the memory of trainees to utilize in the event of an emergency.

Where Can I Find Training Resources?*

Many free resources exist around the web that can be referenced when creating biological safety cabinet training programs, such as informative documents, infographics, videos, and even virtual reality demonstrations. We outlined several of these resources below that were compiled by biocontainment and regulatory agencies to help you get started. These resources are completely free to use and are routinely updated to encompass cutting-edge BSC technology and hazardous material handling techniques.

Click on any of the resources below to get started.

**The details and information provided in these third-party resources are the responsibility of the organization that has created them. The author and sponsor of this article are not responsible for the content provided therein.*

CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL) 6th Edition Appendix A

Click Here

This appendix to the BMBL, entitled "Primary Containment for Biohazards: Selection, Installation and Use of Biological Safety Cabinets", introduces HEPA filters and BSCs, describes the classes and types of BSCs and vertical/horizontal laminar airflow workbenches, provides information on conducting a risk assessment for working with chemical or radiological materials in a BSC, describes best work practices for preparing and working within a BSC, including how to decontaminate the device, provides additional information about facility and engineering requirements needed for proper BSC use and installation, details BSC certification and performance testing, and provides a number of diagrams for various containment devices.

CDC Fundamentals of Working Safely in a Biological Safety Cabinet

Click Here

The above training module focuses on Class II biosafety cabinets and provides an in-depth explanation on how they work and the importance of maintaining proper airflow, how to safely work within a BSC, and what to do in the case of an emergency. This training module contains the four videos described below:

Preparing for Work in a BSC: This short video describes items that you should have available for working inside the BSC, and how to check the BSC's certification, start the unit and ensure the switch for the alarm is turned on, read the magnehelic gauge, check the inward airflow, decontaminate the BSC before use, and properly adjust your seat.

Completing Work in a BSC: This short video explains how to surface decontaminate items used during work in the BSC, decontaminate the inside of the BSC, shutdown the BSC at the end of work, and provides information about lab cleaning or maintenance checklists for BSCs users.

Factors Affecting BSC Airflow: This short video shows the proper airflow within a BSC using a smoke generator and demonstrates factors that may affect the proper airflow including improper sash height, quick or sweeping hand movements out of a BSC, personnel walking too close to the BSC, overloading the BSC with materials or equipment, covering the front or rear grilles, and use of a flame inside the BSC.

Cleaning Up a Spill in a BSC: This short video demonstrates a general procedure for cleaning small spills on the work surface while working inside the biosafety cabinet.

CDC LabTrainingVR: Biosafety Cabinet Edition

Click Here

This virtual reality training supplements the Fundamentals of Working Safely in a Biological Safety Cabinet training course and allows learners to apply their knowledge of BSC use in virtual reality. The training outlines how to identify a BSC's parts, demonstrate proper airflow, prepare for work in the BSC, apply safe work practices, decontaminate and shut down a BSC, and conduct shutdown procedures in the event of an emergency.

NIH Biological Safety Cabinet (BSC): How it Works to Protect You

Click Here

This short video provides information on the personnel, environmental, and product protection BSCs provide, details the parts of a Class II Type A2 BSC and how the air flows through it, describes how to safely work from "clean" to "dirty" inside the BSC, suggestions on how to avoid disrupting airflow dynamics, and how to decontaminate items used inside the BSC.

OSHA FactSheet: Laboratory Safety Biosafety Cabinets (BSCs)

Click Here

This short document describes what employers should train workers to do before using a biosafety cabinet, including preparing a checklist of needed materials, turning off the UV lights, checking the certification and operation of the BSC, adjusting their seat position, and what employers should train workers to do while working inside the BSC. Training guidelines include proper use of PPE, aversion of placing large equipment inside the BSC, how to avoid disrupting the air curtain or blocking grilles, using proper aseptic techniques, how to perform spill cleanup, and how to decontaminate the BSC work surfaces.

WHO Biological Safety Cabinet (BSC) Video Series

Click Here

Introduction: This video provides information on the importance of conducting a risk assessment before working with biological materials in a biosafety cabinet, describes Class I, Class II, and Class III BSC specifics, what kinds of protection they offer, and what types of experiments should be performed in each class, and provides certification and installation recommendations.

Preparatory Steps: This video provides information on working safely in the BSC, including the need to develop a BSC use SOP detailing the risk assessment, required training, and proper use, how to verify the BSC's certification and performance between recertification, and how to turn on the BSC, visually observe proper airflow, disinfect the BSC, and place materials in the BSC to work from "clean" to "dirty".

Best Practices for Safe Usage: This short video provides recommended practices to include in the biosafety cabinet use SOP, including permitting only one person to work in a single BSC at a time, working towards the rear grille, keeping the front grille clear from the user's arms or elbows, avoiding rapid movement inside and outside of the BSC, setting up the work area from "clean" to "dirty", collecting biohazardous waste inside the work zone, avoiding the use of flames, decontaminating items and BSC work surfaces at the end of work, and avoiding equipment that can affect the airflow dynamics within the cabinet.

Incident Management: This video recommends best practices to include in the BSC use SOP for spill response, including a risk assessment depending on the amount of material spilled, the location of the spill, and the contamination of PPE. It also provides recommendations on how to respond to a power outage or fire alarm while working in the BSC, such as how to secure biohazardous materials in the BSC, remove PPE, contain materials inside the BSC, and how to re-approach materials upon return to the laboratory.

WHO monograph Biological Safety Cabinets and Other Primary Containment Devices

Click Here

This monograph accompanies the 4th edition of the WHO's Laboratory Biosafety Manual and introduces containment devices, including the different classes of BSCs and isolators, best practices for working in these devices, how to decontaminate them, information about directional airflow, HEPA filter functions, exhausting options, how to select a primary containment device with included diagrams, and information on containment isolators, ventilated workstations, and individually ventilated cages.

NSF/ANSI 49 - 2020 Biosafety Cabinetry: Design, Construction, Performance, and Field Certification Informative Annex 1

Click Here

This is an informative appendix to the NSF/ANSI 49 standard that is free to download upon registration on the website. It contains information on risk assessments, types and classes of BSCs, important questions to help readers select the proper BSC, how to assess BSC placement in the lab prior to purchase, information on arrival inspection and field certification of BSCs, how to clean and disinfect the BSC work zone, disinfectant chemical information, important practices and procedures relating to BSC use that includes ergonomics, probable BSC lifespan, and how to decommission a BSC when it is time to dispose of it.

Class II Type A2 Biosafety Cabinet

How Can My BSC Manufacturer Help?

When searching for resources to help compile your BSC training programs, consider contacting the manufacturer of the BSCs in your laboratory or institution. They may be able to provide helpful resources that apply specifically to the equipment in your lab. Utilizing materials created solely for your equipment can aide learners since they will be seeing items they are already familiar with and may have used in the past. Different BSCs may also have different features or quirks that can be incorporated into your training modules.

Consider asking the trainees if they currently use or plan to use large pieces of equipment in their BSCs and incorporating information about this topic. The size and shape of equipment inside the work zone may affect BSC airflow and could compromise the integrity of the BSC's primary containment. Consultation with its manufacturer can help provide clarity on size, shape, and weight limitations needed to maintain adequate airflow. The manufacturer should be able to suggest a different or specialized model or an alternative primary containment solution. If a customized unit is needed, the manufacturer should be able to provide any additional materials that can be required to train individuals on that new or custom piece of equipment.

When providing hands-on training and reviewing proficiency or competency, it may become evident that supplemental products can be purchased to help promote proper usage of the biosafety cabinet. These could include items like holders for pipettors that are mounted inside the BSC to encourage keeping hands inside the cabinet while working, elevated elbow or armrests that do not block the front air intake grilles, mounted shelves for raising stored items above the backwall grilles, rotating turntables to reduce reaching across the work zone, and more[7]. Encouraging trainees to share observed barriers to proper BSC use during training may identify relatively easy solutions that can improve containment.

Biological safety cabinets are often used as primary containment devices for working with hazardous biological materials, however, many factors can reduce the protection provided by the BSC that could be alleviated with thorough SOPs and user training. This training should incorporate adult learning principles and can be integrated into a larger biosafety training program.

Science and Safety Consulting

Science and Safety Consulting provides biosafety and biorisk guidance and training to facilitate safe and secure biological research and to prepare organizations for infectious diseases and pandemics. Science and Safety Consulting also facilitates successful scientific communication for technical and non-technical audiences.

Connect with an Expert: www.scienceandsafetyconsulting.com

References:

1. CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL) 6th Edition: https://www.cdc.gov/labs/BMBL.html
2. NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines): https://osp.od.nih.gov/biotechnology/nih-guidelines/
3. WHO Laboratory Biosafety Manual 4th Edition: https://www.who.int/publications/i/item/9789240011311
4. WHO Biosafety Programme Management monograph: https://www.who.int/publications/i/item/9789240011434
5. OSHA Bloodborne Pathogens Standard 29 CFR 1910.1030: https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1030
6. WHO Biological Safety Cabinets and Other Primary Containment Devices monograph: https://www.who.int/publications/i/item/9789240011335
7. NSF/ANSI 49 -2020 Biosafety Cabinetry: Design, Construction, Performance, and Field Certification Informative Annex 1: https://webstore.ansi.org/Standards/NSF/NSFANSI492020Annex
8. EA Roumell. (2019). Priming Adult Learners for Learning Transfer: Beyond Content and Delivery. Adult Learning 30 (1): 15-22