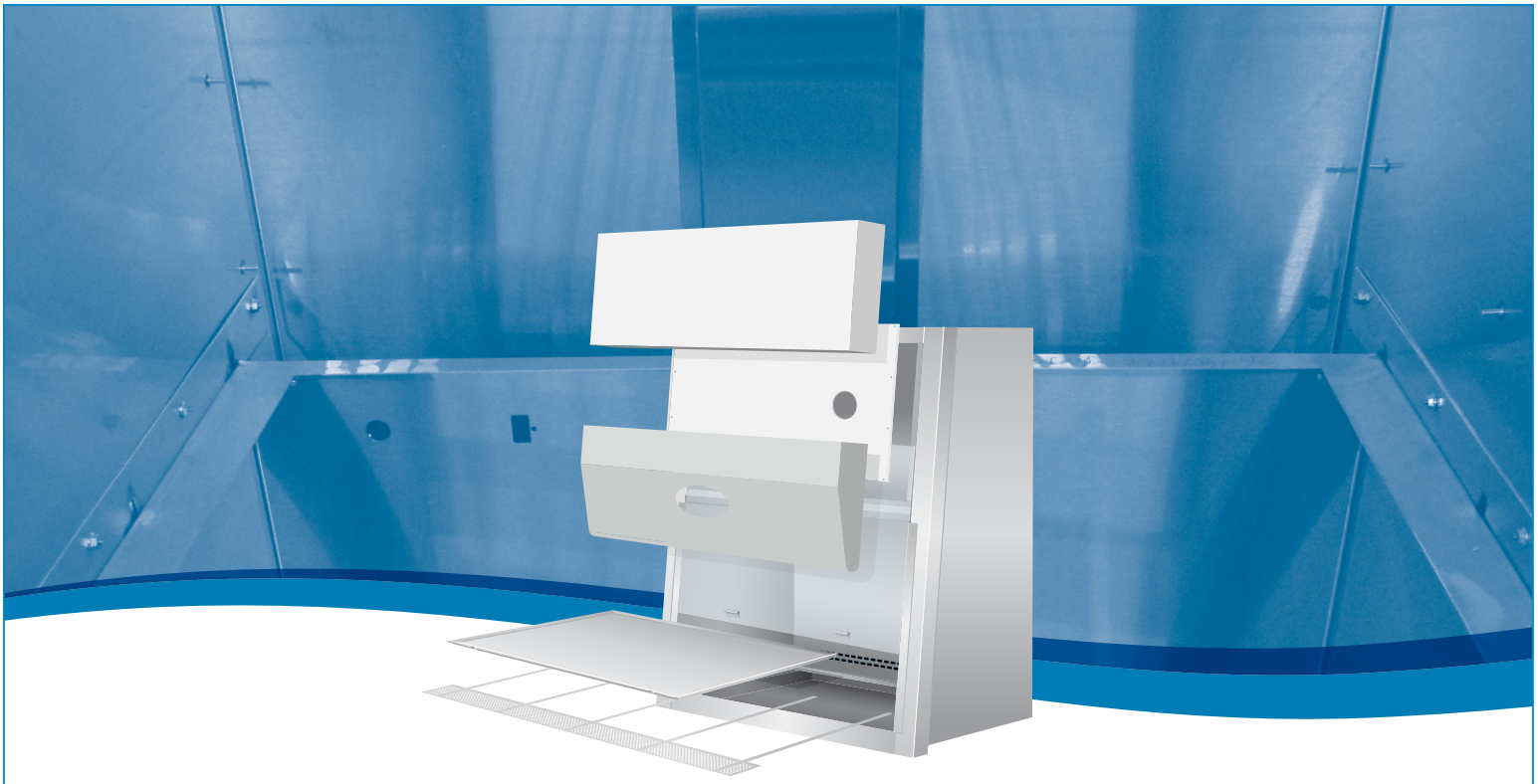

SAFELY DISPOSING
OF A BIOSAFETY CABINET

Authored By: Julianne L. Baron Ph.D., CPH, RBP

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SAFELY DISPOSING OF A BIOSAFETY CABINET

Biosafety cabinets (BSCs) are critically important primary containment devices used to protect individuals from exposure to biohazardous materials while they are working in the laboratory. They are also heavy, large, built with a variety of types and materials of components, and will contain biologically contaminated internal parts, including HEPA filters, after they have been used. So once a BSC has reached the end of its lifespan, how do you safely and properly dispose of the device to avoid exposure to laboratory personnel, BSC maintenance personnel, and the community? This article will summarize how to conduct a risk assessment to determine what decontamination steps will be needed based on the BSC's previous uses to safely handle the retired BSC and relay important BSC disassembly information from the NSF/ANSI Standard 49 Informative Annex 1.

Industry guidance prohibits simply disposing of an intact biosafety cabinet at a waste dump.

Conducting a Risk Assessment Prior to BSC Retirement

Current biosafety cabinets will typically last for 15 years of use before they need to be retired[1]. Over that period of time, they may be used by many different individuals, in different laboratories and facilities, and with different biological, chemical, and/or radiological materials. Due to the potential for a variety of classes of hazards to be present in the cabinet, a risk assessment must be conducted to identify contamination that must be appropriately managed prior to withdrawing a BSC from service. A risk assessment is an evaluation of the likelihood and consequence of exposure to hazardous materials often performed in laboratories[2-4]. This BSC retirement risk assessment process should be conducted to evaluate what hazardous materials may be present in the cabinet's HEPA filter and internal components, what type of chemical or heat treatment will be required to effectively decontaminate the materials that have previously been used in the BSC, and how to safely handle the cabinet to prepare it for disposal. Wherever possible this risk assessment should be conducted with individuals who understand all of the hazards associated with the BSC retirement process[2-4]. This group could include the laboratory's BSC users, laboratory leadership, organizational health and safety experts, qualified BSC certifiers or maintenance personnel, and others. This article will only briefly cover the general steps of the risk assessment process in the context of evaluating the needs for safe BSC disposal, for additional information about how to conduct a risk assessment, consider reviewing Biosafety Cabinet Selection in

the Context of Risk Assessment. This article explains the principles of conducting a risk assessment in the context of selecting a new BSC but this risk assessment process can be used to evaluate how to safely retire a cabinet as well.

The first general step in conducting this risk assessment is to review the potential hazards[2-4]. Depending on the previous uses of the BSC these could include potentially infectious microbes, hazardous or toxic chemicals, and/or radiological materials. It is important to maintain a history of the BSC's hazardous materials use, whenever possible, so it can be properly assessed and treated before decommissioning. If the BSC was purchased with an unknown previous history, the lab's BSC use was not documented, or records are unavailable, the assessment group may choose to treat the cabinet with an abundance of caution. The second general step of the risk assessment process is to implement risk mitigation measures to reduce the risks associated with exposure[2-4] to potentially contaminated parts of the BSC during and after disposal. For BSC retirement, a main control measure to remove the potential for hazardous materials exposure from the BSC generally involves either

1) whole cabinet gas decontamination or

2) decontamination of all of the BSC's surfaces and components as well as directed chemical decontamination of the HEPA filters or HEPA filter incineration (described more below).

These processes are not without their own risks, however, and must be performed safely by a qualified individual (described more below). The final general step of the risk assessment process involves evaluating any remaining risks associated with the BSC identified for disposal and reviewing the effectiveness of the risk mitigation measures that were put into place[2-4]. To address some of these residual risks, appropriate PPE should be worn at all times when manipulating or handling the decommissioned BSC and its components as these materials may also present physical hazards due to their weight, sharp edges, shatter potential, etc.

Personal Protective Equipment (PPE) may be required while handling a decommissioned BSC.

Biosafety cabinets that have been used with infectious agents or biohazardous materials, and especially their HEPA filters, should be fumigated before retirement[1,2]. The NSF/ANSI Standard 49 (2022) details three common chemical sterilants that are used for BSC gas decontamination including formaldehyde, chlorine dioxide, and hydrogen peroxide[5].

CH_2O *Formaldehyde*

ClO_2 *Chlorine Dioxide*

H_2O_2 *Hydrogen Peroxide*

The type of chemical that is used must be carefully selected to ensure it is

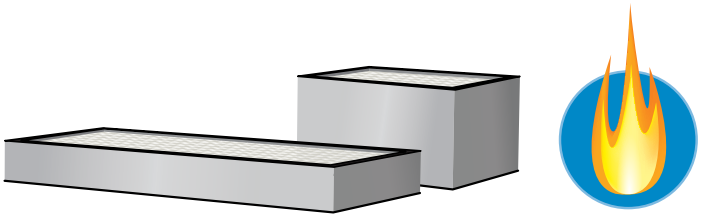
1) appropriate to inactivate hazardous materials previously worked with in the cabinet,

2) effective in penetrating and treating all the components of the intact device, and

3) that the process is being conducted safely for the individuals who are treating the BSC[5].

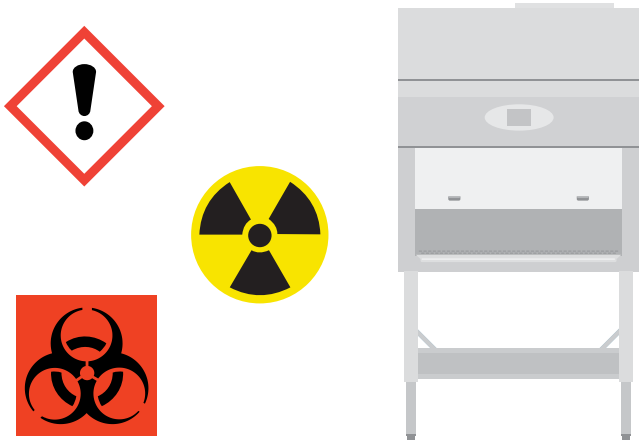
For more information about BSC gas decontamination methodologies, features, uses, and BSC location preparation, consider reviewing Biosafety Cabinet Gas Decontamination Considerations.

Certain biological materials that are handled in the BSC such as prions or toxins of biological origin can be resistant to inactivation by these typical gas decontamination methods[1]. The HEPA filters from these BSCs should be carefully removed and taken away for incineration[1]. Then, a disinfectant effective against the agents should be used to surface decontaminate all of the contaminated surfaces within the cabinet for the appropriate contact time while wearing suitable PPE[1].



Some contaminated HEPA filters require incineration.

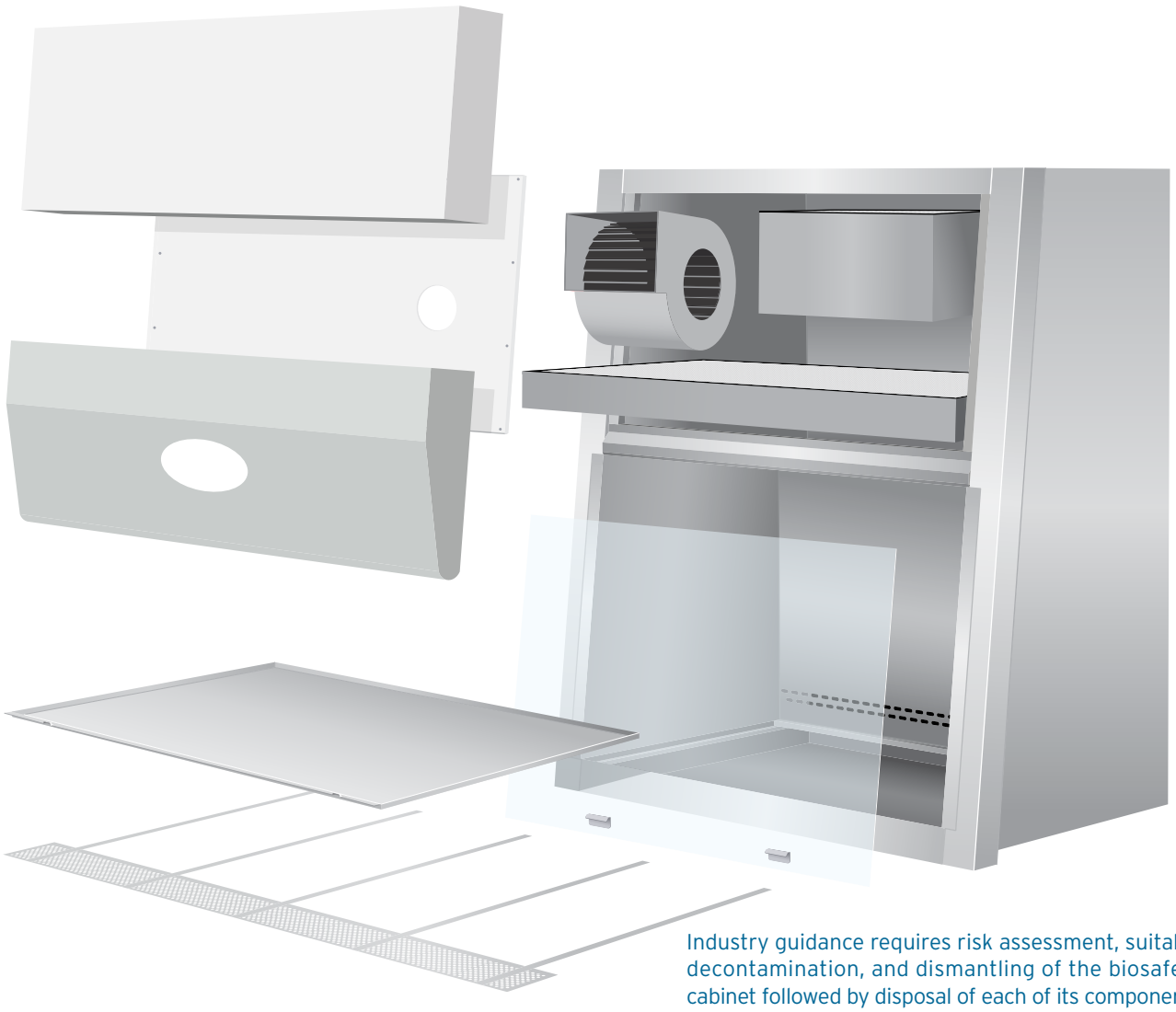
If, during the risk assessment process, the BSC has been determined to be chemically contaminated, a typical gaseous or vapor decontamination may not be sufficient to render the cabinet and its HEPA filters safe to handle, disassemble, and dispose of[1]. HEPA filters that are contaminated with toxic chemicals typically require careful removal and should be appropriately handled and disposed of while complying with applicable federal, state, and local regulations.



Biosafety cabinets can become contaminated with biological, chemical, and/or radiological materials.

If the biosafety cabinet is expected to be or known to be radiologically contaminated, consult with your organization's radiation safety experts to determine appropriate decontamination and radiation removal methodologies for the BSC's accessible surfaces, internal components, and HEPA filters.

Always work with a qualified BSC certification and maintenance professional to ensure adequate BSC decontamination and the disposal or incineration of your cabinet's HEPA filters based upon the type(s) of contamination identified in your risk assessment. This treatment process is critical to reduce the presence of existing hazardous materials in or on the cabinet and ensure that it is safe for disassembly and subsequent disposal.

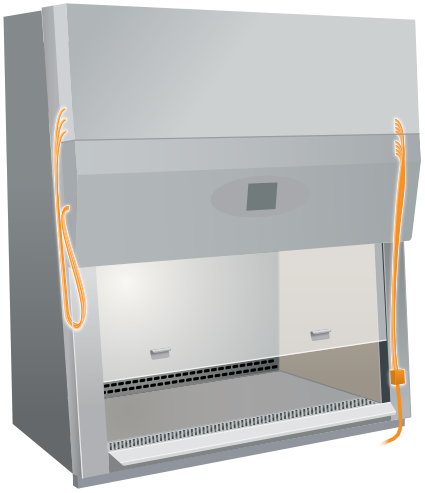


Industry guidance requires risk assessment, suitable decontamination, and dismantling of the biosafety cabinet followed by disposal of each of its components in a suitable manner.

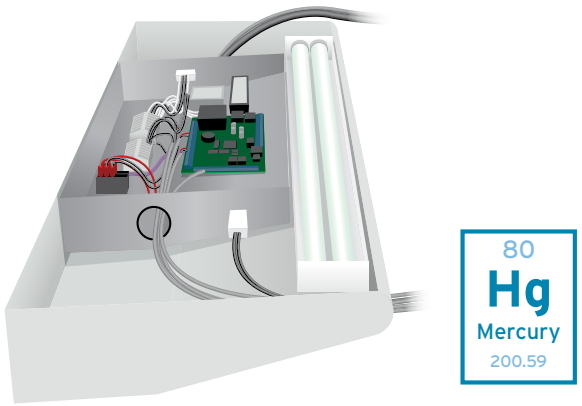
BSC Disassembly and Disposal

The NSF/ANSI Standard 49 (2022) states that no BSC should be sent for disposal to a landfill or recycling center as an intact unit but must be disassembled based on their specific recommendations which can be found in Informative Annex 1[1]. Any warning or hazard labels, identification, and field certification stickers should be removed from the device and destroyed before beginning the disassembly process[1]. The biosafety cabinet's metal components should be separated by weight, where those items under 30 pounds may be taken to a metal recycling container in the facility, and those items that are above 30 pounds, including the unit chassis, should be placed in a designated area for pick up by a commercial recycling vendor[1]. After successful decontamination, removed HEPA filters should be burned in an incinerator or buried in a sanitary landfill[1]. Proper HEPA filter incineration requires the consideration of many factors including the make-up of the waste, dwell time, combustion temperature, and more[1] so it is important to know that the company that is performing this service is familiar with the task and capable of effectively destroying the HEPA filters

while avoiding exposing individuals to the filters' contaminants. Safety glass windows and sashes should be recycled in the facility's glass recycling container[1]. Wiring that is accessible and lamp ballasts should be removed and taken to their appropriate recycling containers[1]. Fluorescent bulbs should be taken to an appropriate lamp disposal container in the facility, and if present, ultraviolet (UV) bulbs must be handled separately due to the presence of mercury in those waste items[1].



Remove user-accessible wiring for disposal.



Ultraviolet (UV) bulbs contain mercury and require separate disposal.

Conclusions

Since biosafety cabinets can regularly be used for over a decade before the end of their useful life, they may be exposed to and contaminated with different types of hazardous materials during that time. If possible, consider maintaining a list of what substances have been used in the device throughout your use of the cabinet to facilitate an easier retirement process. Before a BSC is retired, a risk assessment should be performed to identify how it must be treated to be rendered safe for disassembly and disposal. A biosafety cabinet that has been used with certain infectious agents (prions or biological toxins), chemicals, or radiological materials may require treatment beyond a typical BSC gaseous decontamination. Consult with your organization's biological, chemical, and/or radiation safety experts and a qualified BSC maintenance professional to determine the appropriate treatment method necessary for the specific biosafety cabinet, its internal components, and its HEPA filters based on its type or types of contamination prior to disassembly for disposal. Once the BSC has been appropriately decontaminated, the device must be disassembled into its component parts including metal items (by individual weight), HEPA filters, glass pieces, wiring, fluorescent or UV lamps, etc. and any labels or stickers should be removed prior to appropriate recycling and disposal.

References

1. NSF/ANSI 49 -2022 Biosafety Cabinetry: Design, Construction, Performance, and Field Certification Informative Annex 1: https://webstore.ansi.org/standards/nsf/nsfansi492022annex
2. CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL) 6th Edition: https://www.cdc.gov/labs/bmbl/
3. NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines): https://osp.od.nih.gov/policies/biosafety-and-biosecurity-policy#tab2/
4. WHO Laboratory Biosafety Manual: Risk Assessment monograph: https://www.who.int/publications/i/item/9789240011458
5. NSF/ANSI 49 – 2022 Biosafety Cabinetry: Design, Construction, Performance, and Field Certification Informative Annex 2 (formerly Annex G): pp 143-159.

About The Author:

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.

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