SELECTING LIFE SCIENCE ENCLOSURES

by David Wasescha

The importance of life-science research is at an all-time high. With the pandemic producing new research goals—and aided by new funding—labs are rapidly finding new ways to conduct science. Complicating the situation are inflationary pressures created by the pandemic, driving the cost of science to entirely new levels. Many of these costs are unavoidable.

Frequently, producing cutting-edge discoveries requires the use of costly facilities and instruments. Instruments such as analyzers and microscopes can cost more than a pandemic-priced home, and renovations of laboratory spaces to provide high flexibility have become the norm. Despite the high costs, these elements help to push forward our knowledge and understanding of science and human health.

Within the walls of these growing life-sciences laboratory spaces are not just million-dollar instruments and flexible seating, but critical enclosures and hoods that support scientists each day. The centerpiece of nearly any bioscience-focused laboratory is the biosafety cabinet, or BSC. As decision-makers consider biosafety cabinets for campus laboratories, they must keep long-term goals in mind. These goals may include a focus on sustainability, as well as maintaining a level of flexibility that ensures product relevance for current and future challenges.

Understanding the Science

By and large, the criteria for properly handling life-science samples have not significantly changed for the last several decades. Cells, viruses, and other biologically significant structures are often fragile and may be easily contaminated, so they must be handled in a sterile environment. If samples are not protected, the worst enemy of a life-science researcher is likely to occur: contamination. Even the slightest contamination of biological samples may create significant disruptions to a laboratory's research focus, potentially ruining years of findings with one simple mistake.

To protect sensitive life-science work, samples at risk for contamination are typically handled in laboratory hoods that produce High Efficiency Particulate Air (HEPA) filtered air into the hood's internal working area. Enclosures that provide only clean HEPA-filtered air are known as Laminar Flow Hoods or Clean Benches. Clean Benches provide a clean, sterile work area but offer no protection to researchers from hazardous samples, so therefore have limited use. These enclosures are regularly used for simple non-hazardous work, including polymerase chain reaction (PCR) experiments.

Because of the high interest in medically-significant research, investigators often utilize human cells to model biochemical or physiological behaviors and to evaluate drug candidates in vitro at a fraction of the cost of in vivo testing. Human cells are biohazardous and pathogenic in nature and must be handled in a sterile enclosure that simultaneously contains hazards to protect researchers. The most common enclosure offering both product and personnel protection is the Class II Biosafety Cabinet.

Class II biosafety cabinets are the workbench of the life scientist. They are safety devices, sterility devices, and benchtops, all contained in a large stainless steel enclosure. To provide user and sample protection, biosafety cabinets utilize an interior blower that draws air into the hood and purifies the air through HEPA filters before returning air to the work area of the hood or back into the lab. Because of the importance and prevalence of Class II biosafety cabinets in life-science laboratories, recognizing the impact these products can have towards meeting sustainability goals, accelerating science, and providing flexibility as research changes will ensure that campus research is well-supported.

Sustainable Operation

For some laboratory hoods, such as ducted chemical-fume hoods, operating costs are quite extreme because of their requirement to exhaust tempered air from the research facility. Due to high costs associated with chemical fume hoods, many cost-saving means have been generated, including the following: implementing high performance (low flow) models, reducing daily operating time where possible, installing intelligent exhaust control systems to limit air usage, and employing "shut the sash" energy-efficiency campaigns when high-density fume hoods are installed.

One clear challenge for sustainability concerns is that operational efficiencies are not as obvious with biosafety cabinets. Biosafety cabinets typically recirculate air back into the room, and this self-contained design consumes very little energy over the life of a cabinet. A typical non-ducted biosafety cabinet has zero impact to building HVAC costs. Operationally, a typical 4' biosafety cabinet consumes 200 watts, or 1.6 kWh in an eight-hour workday. Annually, a BSC costs around $50 if operated daily for eight hours. This cost is minimal when compared to a fume hood, which may cost thousands of dollars to run per year. But

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evaluating a biosafety cabinet's sustainability contributions goes beyond baseline energy consumption figures. With operational costs for biosafety cabinets so low, sustainable operation can be recognized not in energy savings, but in reducing the wastefulness of the biosafety cabinet's components and service requirements. Selecting biosafety cabinets with a cost-effective price point typically results in more frequent and costly HEPA filter replacements—a service that places a toxic sterilizing gas into the biosafety cabinet, generates biohazardous waste for incineration, and generates emissions from the visit of a servicer. These blind costs are difficult to record, yet they directly impact the sustainability impact of a cabinet at a facility.

Flexibility

Research is constantly changing and growing, and with those changes come shifting needs and expectations from equipment in the lab. Biosafety cabinets are no exception. As safety devices, biosafety cabinets have historically had limited flexibility. Many life-science laboratory employees have become frustrated with the process of identifying a singular Class II biosafety cabinet for their laboratory because BSCs come in multiple configurations, depending on application. Common questions asked during the selection of a biosafety cabinet include: Class I or a Class II? What is the difference between Class II Type A2 and Type B2 BSCs? Do I need to vent my biosafety cabinet at all? Can I convert my cabinet between recirculating and ducted designs? The questions go on and on.

Today, biosafety cabinets are designed to last multiple decades, so the decision to purchase a biosafety cabinet is an exceptionally long-term commitment. Fortunately, an easy choice exists: the Type C1 biosafety cabinet. Class II, Type C1 BSCs provide all of the safety and comfort of a standard biosafety cabinet. Personnel and product protection are provided. Furthermore, Type C1 BSCs are flexible and may be converted between recirculating A mode and B mode, which is a configuration that allows for safe handling with chemical fumes used in microbiological procedures. This flexibility can eliminate frustration when purchasing a biosafety cabinet, because the Type C1 is suitable for any application a researcher may encounter in the laboratory. Facilities personnel responsible for selecting biosafety cabinets can rest assured, knowing that providing Type C1 BSCs to their scientific community will satisfy all research needs.

Planning for Automation

The prevalence of automation systems in laboratories, particularly liquid handlers that eliminate laborious bench tasks, is increasing exponentially due to decreases in cost and increases in availability. With automation comes large instruments that carry out work previously performed by laboratory research associates, including work that is biohazardous in nature. The vast majority of automation systems are large and do not fit into standard biosafety cabinets, but larger automation-specific biosafety cabinets are available and must be considered when planning a facility's overall ability to support advanced scientific discovery. Decision-makers should consult with automated instrument manufacturers, biosafety cabinet manufacturers, and the campus safety office to ensure seamless integration of these complicated devices within the campus facilities.

Navigating Next Steps

Selecting biosafety cabinets requires careful planning prior to execution. With any safety product, planners need to engage their support networks before rushing to purchase, first by consulting with the campus biosafety office for guidance on specific requirements or configurations recommended for biosafety cabinets in the campus facility. Planners should also engage in-house and vendor technical resources to understand all available options, including those that best fit campus research interests. And most importantly, decision-makers should evaluate how a biosafety cabinet purchase will support not only current needs, but also important discoveries in the years to come.

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