Technical Note: TNBSCTCONA

Thermo Scientific Biological Safety Cabinets

Managing a Facility's Total Cost of Operation

Key Words

Total Cost of Operation (TCO), Biological Safety Cabinets (BSCs), Hoods, Fume Hoods, Energy Efficiency

Goal

Managing groups of biological safety cabinets (BSCs) in a biomedical research, healthcare or academic facility requires three strategies to optimize the total cost of operation. These strategies address both performance and cost. An inexpensive BSC that does not provide the needed cleanliness and containment has no value; conversely, a BSC that provides unneeded or unused protection is a waste of important resources that could be better utilized elsewhere.

Strategy One: The right protection for your application

Biological safety cabinets (BSCs), clean benches, chemical fume hoods and additional airflow cabinetry are commonly called "hoods." Although laboratory hoods are often lumped together, each provides very different types of protection with different cost structures.

Biological safety cabinets, laminar flow clean benches and cleanrooms capture and control "particles" including biological agents through HEPA filtration. With proper maintenance, most of these filtration-based devices can last five to ten years between filter changes.

Chemical fume hoods use airflow to capture, dilute and expel hazardous gases and fumes from the laboratory or work area. Chemical fume hoods tend to be simpler in construction and do not have internal fans or filters. The major operating cost associated with fume hoods is heating, cooling and conditioning the air required to replace the expelled laboratory air. A Mills and Sartor[1] study on fume hoods estimated the annual cost of external exhaust at $4.50 per cfm per year. A typical fume hood with an opening 3 ft wide and 18 inches tall requires approximately 450 cfm and costs over $2,000 per year in energy.

If biological containment or protection is required, then HEPA-filtered, non-exhausted hoods or Type A2 BSCs are necessary. If the containment or protection required is from volatile chemicals or gas, then externally-exhausted chemical hoods or Type B2 BSCs are necessary. Figure 1 illustrates the level of protection required for the various types of airflow cabinets.

From a cost standpoint, the decision that a BSC must provide protection from gases and volatile chemicals, in addition to biological hazards, increases the overall cost of the BSC significantly. For safety and efficiency, it becomes vital to determine precisely what type of protection is needed.

Airflow Cabinets & Protection Level

Protection Level	Airflow Cabinet Type				
	Open Air Lab Bench	Laminar Flow Clean Bench (HEPA-Filtered)	Class II, Type A2 BSC (Non-Exhausted, HEPA-Filtered)	Class II, Type B2 BSC (Externally Exhausted, HEPA-Filtered)	Chemical Fume Hood (Externally Exhausted)
Personal			*	*	*
Environment			*	*	*
Product		*	*	*	
Cross-contamination			*	*	

Figure 1: Select the type of airflow product required based on whether or not biohazards or toxic chemicals are used in the application.

* Based on internal data, 2011. Data on file.

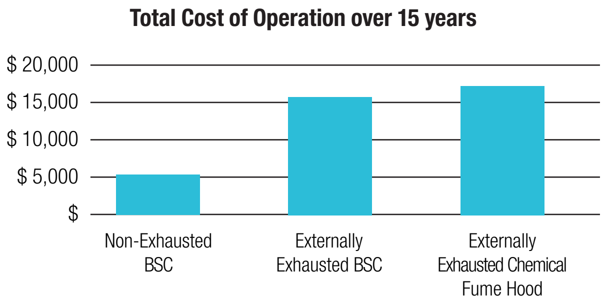

Figure 2: Estimated equipment costs for energy and maintenance over 15 years. Externally exhausted models double costs.*

Figure 2 provides a rough comparison of total costs in energy and upkeep for the three types of containment equipment discussed: Non-Exhausted BSCs, Externally Exhausted BSCs, Externally Exhausted Chemical Fume Hood. Note how the decision to provide protection from both biological hazards and volatile toxic chemicals, which requires the equipment to be externally exhausted, more than doubles the total cost of operating the BSC.

Strategy Two: Assess your usage needs

With the exception of external exhaust, the major ongoing costs of a BSC are associated with usage. When the BSC is operating; the fans are spinning, the fluorescent lights are on, the filters are loading up with captured particles and motors are wearing down. None of this happens when the BSC is completely turned off.

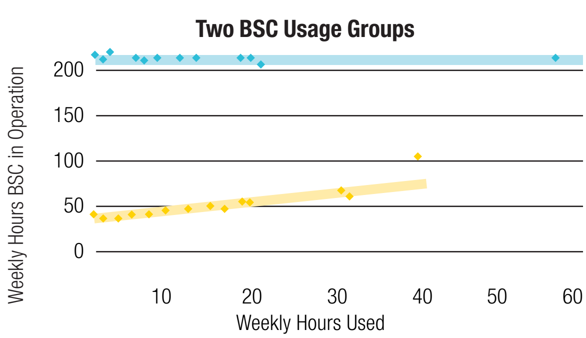

Figure 3: Results showing hours/week when users are working in BSCs (yellow) and hours BSC blowers were left operating regardless of active usage (blue). Average weekly use is 18 hours/week.*
Yellow = Only on when used   Blue = 24/7 'On' or "Power User"

Some BSCs are used only occasionally when the particular application requires the cleanliness and containment of a HEPA-filtered BSC. Other BSCs are constantly in use because of laboratory demands. Figure 3 shows the results of a BSC survey undertaken by Thermo Fisher Scientific to better understand BSC usage. The horizontal x-axis represents the hours per week the users reported physically working inside the BSC. The vertical y-axis represents the hours per week the users reported the BSC blowers were left in operating mode.

Notice that BSC usage falls into two distinct categories. The first category (yellow) are units where the BSC blowers are only on when the BSC is in use (i.e., the BSC is turned off when it is non-operational). The second category (blue) are units where the BSC blowers are on essentially 24/7, regardless of use. In surveys to date, we have found 27 to 30% of the BSCs fall into this blue category, which we call "Power Users." Regardless of the number of hours the BSCs were in operation, all users reported < 60 hours of use per week. The average use was < 18 hours.

A part of an overall strategy to maximize the cleanliness and containment provided by a facility's BSCs while optimizing the costs requires recognition that the usage and costs can vary significantly. Some energy efficient BSCs available on the market today operate at 75% lower energy consumption levels than commonly used, traditional BSCs. Therefore, "Power users" should consider upgrading to newer BSC technology for maximum reduction in their facility's overall operating costs.

Strategy Three: Timing is everything

The costs of operating a BSC are not evenly distributed over the 15 or 20 year lifespan of the unit. In the first year, electricity and cooling are the only additional costs. At some point, the filters and/or motors will need replacement. The cost for this is typically between $1,000 and $2,000 or even more. For the traditional BSC, filters and motor replacement are approximately 35% of the total cost of operation over 15 years.

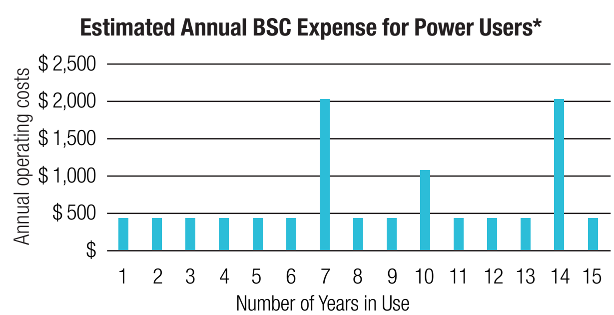

Figure 4: Estimated operating cost per year for "Power User" with cost being constant except for years when maintenance is required.*

Figure 4 shows a typical pattern of expenditure for a BSC Power User. Note the annual expenses are the same from year to year, unless the filters needs replacing (as in years seven and fourteen) or the motor needs replacing (as in year ten).

Replacing a BSC rather than spending the money to mend significant components may be the most cost effective way to transition from a costly, inefficient BSC to a newer, more cost effective BSC.

BSC: Five Steps to Managing TCO

These strategies can be implemented as part of an overall approach using these steps:

1. Conduct a BSC inventory survey, capturing:
   - unit model
   - location and identification
   - usage (hours per day, days per week)
   - electrical energy consumption
   - external exhaust volume
   - room exhaust volume
   - application (biohazards, volatile toxic chemicals, etc.)

* Based on external field study, 2011. Data on file.

- service history (age, last filter change, last motor change, current speed setting)

2. Identify the top 20% in terms of operating cost
3. Review application requirements with environmental health and safety
4. Identify cost/benefit for unit replacement
5. Identify cost/benefit for timed unit replacement

Figure 5 below ranks our surveyed BSCs in order of annual operating cost from least costly (on the left) to most costly (on the right).

Note that the most costly non-externally exhausted BSCs on the far right of the chart (shown in red) are all Class II, Type B2 BSCs; the next most costly BSCs (shown in yellow) are externally exhausted Class II, Type A2 and B1 BSCs. This supports the value of the first strategy. Taking the nominal 4 ft width as an example, a typical Class II, Type B2 BSC requires an external exhaust of 665 cfm and a non-exhausted Class II, Type A2 BSC of the same size requires 360 cfm.

The cost of the average externally exhausted BSC was more than fourteen times greater than the average of the non-externally exhausted BSC. External exhaust is needed to provide needed protection to BSC users also working with volatile toxic chemicals. Given that external exhaust cost is the single greatest contributor to the operational cost to this population of Class II BSCs, verifying the need and identifying the amount of external exhaust needed could make a tremendous difference to the bottom line of the organization.

As Figure 5 illustrates, 70% of the operating cost of the BSC population comes from the 20% most costly BSCs. By targeting the 20% most costly BSCs at an institution and reviewing the use and need for external exhaust, the energy efficiency of those high use units and the availability of more advanced features to reduce consumption on high use units, then significant savings can be achieved.

How Thermo Scientific BSCs Can Reduce Your Facility's TCO:

- Long life components – expected motor life >100,000 hours means fewer motor changes over the life of the cabinet
- Mini-pleat HEPA filters – more surface area equates to longer filter life
- Balanced filters – downflow and inflow load evenly eliminating premature replacement
- Energy efficient DC motors – reduce energy consumption by 75%
- Night Set-Back mode – energy saving mode for low usage periods

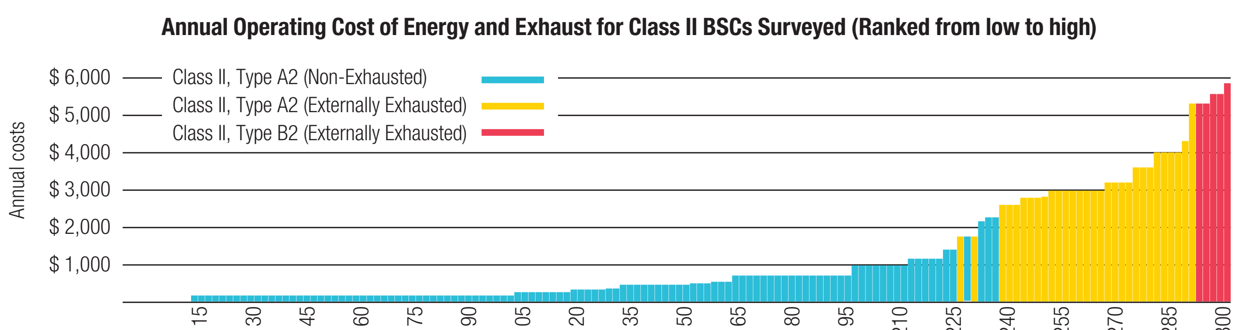

Figure 5: Annual total costs (energy and exhaust) for different types of BSCs. Non-exhausted Type A2 (blue) models are least expensive to operate while externally exhausted Type B2 for chemical protection (red) are highest. *

* Based on external field study, 2011. Data on file.

[1] Energy use and savings potential for laboratory fume hoods, Evan Mills, Dale Sartor, Lawrence Berkeley National Laboratory, Energy Analysis Department, University of California, 2003

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