Cleanroom Constructs to Boost Your Bottom Line

By Michael Bruce, Filtration Group, HVAC

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Most experts agree that cleanroom design, operation and maintenance is complicated. If your design doesn't support your processes, you will likely experience lower than expected uptime. When problems don't surface until after the room is in operation, they are more difficult and costlier to correct.

Understanding best practices for meeting the specific requirements for a cleanroom application goes well beyond complying with ISO standards. Making prudent operational and financial decisions while considering a variety of variables can be challenging - but it doesn't have to be. Breaking down the steps and learning "cleanroom language" are good places to start. Working with filtration solution experts who can help you consider your Total Cost of Ownership (TCO) can have a positive impact on your bottom line.

LOOKING BACK TO LOOK AHEAD

Cleanroom technology became relevant in the early 1960s, with aerospace innovations. The first cleanroom standardizations occurred in 1963 and were not heavily regulated. Today, an increasing number of industries rely on cleanroom technology and adhere to requirements and standards set in place by the Institute of Environmental Sciences and Technology.

Innovations are constantly evolving, and national and international standards help companies regulate practices – an integral part of effective, and consistent, cleanroom technology. The challenge is to operate cleanrooms that

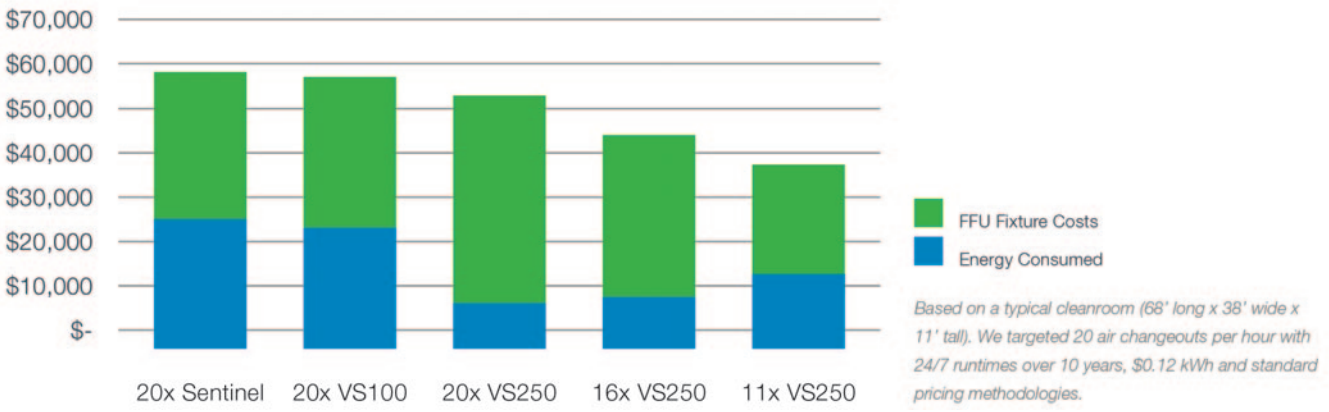
Table 1: Abbreviated list of ISO 14644-1 Classifications with Recommended Air Changeouts per Hour (ACH) requirements.

	Maximum Particles/m^3				
ISO Classification	0.2 micron	0.3 micron	0.5 micron	Common Airflow Pattern	*Recommended* ACH
1	2	1	-	Unidirectional Flow	500-750
2	24	10	4	Unidirectional Flow	500-750
3	237	102	35	Unidirectional Flow	500-750
4	2,370	1,020	352	Unidirectional Flow	400-750
5	23,700	10,200	3,520	Unidirectional Flow	240-600
6	237,000	102,000	35,200	Mixed Flow	150-240
7	2,370,000	1,020,000	352,000	Mixed Flow	60-150
8	23,700,000	10,200,000	3,520,000	Mixed Flow	5-60

The VS250 Filter Lowers The Total Cost of Ownership (TCO)

Purchasing a high-performing FFU such as the Flowstar® VS250, reduces TCO over time. For less critical ISO classifications, fewer VS250 models are required which reduces upfront costs.

In the graph below, we compare energy consumption and fixture costs. In the first three examples, we incorporated 20 units of different FFUs and then decreased the quantity of the Flowstar® VS250 to reduce the TCO while maintaining the CR ISO 7 classification. The more efficient your system is, the likelihood for contamination is lessened, and the lower your total cost will be.



achieve the particulate concentration goals without breaking the bank. When asked to explain their successful cleanroom operations, experts point to TCO.

DECIPHERING THE TERMINOLOGY

The International Standards Organization (ISO) provides classifications for cleanroom standards. Nine ISO classes help discern the levels of cleanliness which equate to the number of contaminants in the room. The most common classifications of cleanrooms are ISO 7 and ISO 8, which generally require between 5 and 150 changeouts per hour. [As a point of reference, a conventional HVAC system makes 2 to 4 changeouts per hour.]

In general, a cleanroom will require the same number of low air returns and HEPA filters. However, just like HEPA filters, air return models differ. It is important to be aware of the quality of the filter to determine its functionality – the number of air returns can be higher or lower than the number of HEPA filters, based on filter capacity.

Another important consideration is laminar air flow, commonly referred to as unidirectional. This refers to air that flows in an unimpeded trajectory with a steady velocity. When airflow is not unidirectional, a mixed flow, the movement of air is turbulent, the velocity fluctuates and will result in possible contamination in critical environments such as pharmaceutical manufacturing and medical testing, or lower yields in electronics manufacturing.

TOTAL COST OF OWNERSHIP (TCO)

Cleanrooms come in every conceivable configuration and there are multiple variables to consider. Ultimately, each variable will influence your bottom line. By taking a wholistic approach of all costs associated with meeting cleanroom standards it is possible to better balance the short and long-term financial goals of the operation. What may appear to be a cost-prohibitive Fan Filter Unit (FFU), could end up paying for itself within a few years and sometimes within months.

Calculating TCO leads to the optimization of cleanrooms and helps to optimize operational costs and maximize profits. It also gives you the ability to see the big picture by combining the costs of filtration solutions, installation labor, energy consumption and disposal. Accounting for all costs is the best method for designing cleanrooms and selecting filtration equipment.

TCO = Labor + Filter Solutions + Energy Consumption + Disposal

Deciding which filtration solution is best requires proficiency, data and a command of TCO. When it comes to filters, an upgrade in quality will typically increase upfront costs, yet the savings in lower energy consumption will result in greater dollar savings.

CONSIDERATIONS FOR PROPER PRODUCT SELECTION

The selection of a fan filter unit and accompanying filter is often driven by the lowest upfront price, but that decision unknowingly costs significantly more money over time. To ensure the proper balance of upfront and long term costs, four primary factors need to be considered when selecting an FFU for a cleanroom. These factors include the cost of energy, the required air changeouts per hour, the available percentage of ceiling space for proper installation, and the height of the cleanroom.

COST OF ENERGY

In the United States, energy costs vary greatly depending on the region. For example, energy in the Northeast and

on the West Coast can cost up to three times that of the Midwest. To optimize costs, cleanrooms that operate in locations with high energy costs must include an FFU and filter that are energy efficient, such as the Flowstar VS250 FFU. Compared to its sister products, the Sentinel and the VS100, the VS250 uses 50-67 percent less energy at 90 FPM air velocity.

AVAILABLE CEILING SPACE FOR FFU INSTALLATION
Sometimes, there are physical obstructions above the ceiling of a cleanroom such as the HVAC, electrical, and building structures that do not allow for FFUs to be installed. The lower the available amount of ceiling space for FFUs, a higher flowrate performance is needed from the installed FFUs. FFUs with built-in lighting options like the Flowstar VS100 and VS250 can help manage the ceiling space as well – as higher-end ISO class cleanrooms can require 100 percent of the ceiling to be covered with FFUs.

HEIGHT OF THE CLEANROOM
The higher the ceiling of a cleanroom, the harder the FFUs have to work. Let's target a 100 air changeout per hour rate in two separate 1,000 sq.ft. rooms, one with an 8-foot ceiling and another with a 12-foot ceiling. Because of the added volume in the second room, to achieve the same air changeout rate you would have to install 50 percent more FFUs or run the same amount of FFUs 50 percent harder, which is even more expensive and will not produce laminar air flow – a critical component in ISO classes 1-5.

AIR CHANGEOUTS PER HOUR
As you move from ISO Class 8 to ISO Class 1, a higher air changeout rate is needed to achieve the particulate concentrations required. This requires higher flowrates from the selected FFU, or more FFUs altogether.

MAKING SENSE (AND CENTS) OF IT ALL
The list of obstacles and challenges to maintaining a well-operated cleanroom can be lengthy. Inefficient placement of workstations, limitations to space and ceiling height, temperature and climate fluctuations, ventilation issues and financial hesitation all play a role in just how complex it can be. By organizing needs, partnering with quality filtration solution experts, and understanding the up-front costs compared to the payoff over time are essential to operating a successful cleanroom.

Focusing on quality and value will guide decisions regarding the products that are best-suited for cleanroom needs. Ultimately, experts agree – understanding TCO is paramount to long-term operational and financial success. Working with filtration solution experts who can help optimize TCO will have a positive impact on the bottom line.

Michael Bruce is the director of marketing and customer care for Filtration Group, HVAC. As part of the world's fastest growing filtration company, he oversees product development and management for the HVAC division. He has three granted patents with others pending. Previously, he has held roles in sales, operations, and engineering in various industries. Michael graduated Magna Cum Laude from the University of Maryland, Baltimore County, with a bachelor's degree in Engineering.