Tech Talk provides a medium for industry professionals to share ideas about trends, new methods, and cost-saving techniques. Tech Talk articles are not peer-reviewed, but are selected for general interest and timeliness.

Is There a Ticking Dust Bomb in Your Cleanroom?

Roger Diener and Morgan Polen

Selecting a non-cleanroom-approved vacuum cleaner may satisfy your budget, but the shortsighted choice brings substantial risk

Keywords

Cleanroom vacuum, HEPA-filter vacuum, cleanroom equipment suitability, cleanroom maintenance

Cleanrooms are an enormous expense for any company, but necessary to achieve increased levels of quality products. Those who take on the role of cleanroom manager or engineer find themselves responsible for all aspects of the operation. Unfortunately, daily maintenance of the cleanliness of the cleanroom environment is frequently perceived as a minor part of the overall responsibility. This perception often leads to the responsibility being delegated to personnel who, although they may be familiar with general housekeeping practices, can lack an understanding of contamination control protocols.

Without the understanding of how the cleaning process interacts with the products being manufactured in the cleanroom, serious mistakes can be made. One important aspect that can compromise the cleanroom is using inappropriate (household or commercial) vacuum cleaners to clean critical environments.

Proper Cleanroom Vacuum Cleaner Selection

Vacuum cleaners are needed throughout the cleanroom, not only for routine cleaning but also for unscheduled events that require cleanup. It is imperative that a proper cleanroom vacuum cleaner is used to avoid catastrophic results. Purchasing a non-cleanroom-approved vacuum cleaner may be a less expensive and easy choice that satisfies budgets and those responsible for reducing cleanroom operating expenses. But the risks imposed by such uninformed decisions will create a legion of potential contamination failures that can pose serious yield loss and, worse yet, field failure of products produced in the cleanroom.

Until recently, there wasn't an authoritative document to help the cleanroom manager or engineer understand the requirements for selecting a proper cleanroom vacuum cleaner. Those who correctly specified a proper cleanroom vacuum cleaner may have met resistance due to budget constraints and a lack of standardized information to support the decision. To foster the decision-making process, IEST experts developed Recommended Practice *IEST-RP-CC044.1: Vacuum Cleaners and Systems for Cleanrooms and Other Controlled Environments*. The

document fills the gap in enabling an informed decision to justify the expense of a proper cleanroom vacuum cleaner versus a risk-laden general-use machine.

All "HEPA" vacuum cleaners are not created equally

High-efficiency particulate air (HEPA) filters have been in use in military and industrial applications since the middle of the last century. The term came into more common consumer usage with the introduction of "HEPA" filtration in general household and office vacuum cleaners. The main purpose of HEPA filters in general consumer vacuum cleaners is to keep the majority of small dust particles, pollen, dander, and other allergens from being expelled into the environment being cleaned. Such allergens, if not controlled, can severely compromise human health. These types of HEPA-filter vacuum cleaners tend to command a premium compared to standard housekeeping vacuum cleaners.

However, general-use HEPA-filter vacuum cleaners do not meet the stringent technical and operational cleaning requirements for cleanrooms and critical environments. Vacuum cleaners required for cleanroom usage represent a level of performance well above that of household, commercial, or industrial HEPA-filter vacuum cleaners.

Recommended Practice *IEST-RP-CC001: HEPA and ULPA Filters*—widely used for cleanroom filtration specifications—defines a HEPA filter as having the proven efficiency of 99.97% at 0.3 microns. For a HEPA filter in a vacuum cleaner to be effective, the vacuum must be specifically designed so that all the air drawn into the vacuum is expelled through the filter; none of the air can leak past the filter or gaskets. General-use HEPA-filter vacuum cleaners may have a certified HEPA filter, but are not designed to ensure all airflow passes through the filter.

Cleanrooms not only require the control of exhaust air cleanliness but also air turbulence. Improperly controlled vacuum exhaust can disrupt the engineered cleanroom airflow, compromising critical manufacturing and product surfaces. The assurance of true HEPA or possibly an ultra-low particulate air (ULPA) filter is required in conjunction with diffusers to reduce exhaust air turbulence to minimize risk to the cleanroom.

Design does matter

In addition to the control of captured surface and airborne particles, vacuum cleaners used in the cleanroom must avoid the generation or spread of contamination due to inadequate design. Plastics used in commercial vacuum cleaners may outgas and cause damaging organic films to condense on sensitive product surfaces. Electrostatic charge can build up on components that are not constructed of proper materials. The vacuum cleaner then becomes a source of uncontrolled discharge that can damage nearby products or interfere with sensitive processing equipment.

A lack of progressive filtration can cause premature failure of the vacuum motor. Any air that leaks past ill-fitting polymeric gaskets and seals can allow particulate-laden air to escape and contaminate the surrounding environment. Improperly protected and or un-filtered motors can allow submicron and metallic particles to escape the housing and be propelled into sensitive, critical processing areas. Commercial vacuum cleaners often utilize rotating polymeric belts that can shed particles into the environment. Improperly changed vacuum filter bags, filled with contaminants, can compromise the cleanliness of the cleanroom. Surface contours of commercial vacuum cleaners may be difficult to clean, leading to cross-contamination events. Vacuum cleaners transported between cleanrooms that are not thoroughly cleaned can present cross-contamination that can be extremely difficult to trace, correct, and remedy. Sensitive and critical

processing controls may be randomly compromised and shut down in ways that are nearly impossible to troubleshoot.

Establish (and stick to) a proper maintenance program

Improper maintenance of the cleanroom vacuum cleaner can also catastrophically compromise the cleanroom, both slowly and suddenly. Routine maintenance of cleanroom vacuum cleaners, including leak testing and certification, should be considered.

For those responsible for cleanroom operations, it is imperative that a thorough audit of the cleanroom cleaning program is performed to ensure a proper cleanroom vacuum cleaner is used (and maintained) in the general contamination control program as well as in maintenance functions. A thorough audit should determine if actions must be taken to correct shortcomings.

Pick the right tool for the job

Understanding these risks clearly illustrates how a poorly selected vacuum cleaner can become a dust bomb ready to wreak havoc, invisibly, in the cleanroom. Disable this ticking clock by not allowing a general-purpose HEPA-filter vacuum cleaner to be used in the cleanroom. Catastrophic events can be prevented through a rigorous selection process and use of a qualified vacuum cleaner that conforms to cleanroom requirements. *IEST-RP-CC044.1; Vacuum Cleaners and Systems for Cleanrooms and Other Controlled Environments* is an essential tool in the selection process. Such decisions can help avoid the occurrence of gradual or catastrophic failure of the cleanroom due to improper vacuum cleaner selection, and help cleanroom management personnel sleep better at night.

About the authors

Roger Diener is a Consultant and the current IEST Vice President of Planning. Diener has served as on the Executive Board in several roles, including President. He has been active on many IEST Working Groups and most recently served as Chair of IEST WG-CC044, Vacuum Cleaners and Systems for Cleanrooms and Other Controlled Environments. Diener led the development of ISO Standard 14644 Part 5: Operations. Diener retired after 40 years with Analog Devices. As Contamination Control Engineer, he was responsible for developing and maintaining the contamination control program and supporting wafer fabrication activities. Diener developed, documented, and implemented cleanroom and personnel protocols. As a manufacturing engineer, he supported clean manufacturing protocols including: wafer handling tooling, personnel methods for clean manufacturing, and applying clean techniques for resolving ergonomic and safety-related personnel issues.

Morgan Polen is the principal consultant for Microrite and the current IEST Membership Vice President. Polen has more than 30 years' experience working in cleanrooms and is a subject matter expert in particle monitoring. He has been involved in cleanroom projects in over 40 countries, working on cleanroom design, construction, validation, monitoring program development, particle counter design, and product management. He serves as a member of the US Technical Advisory Group to ISO/TC 209, Cleanrooms and associated controlled environments. Polen provides expertise for monitoring and control solutions in clean industries such as pharmaceutical, medical device, semiconductor, data storage, aerospace, defense, automotive, optical, food and beverage, and manufacturing.

Contact author: Roger Diener, rbd2050@icloud.com.

IEST is the leading global nonprofit contamination control society and Secretariat for ISO Technical Committee 209 (ISO/TC 209), the committee developing the ISO 14644 Standards. IEST has served as the Secretariat for ISO/TC 209 for more than 25 years with an established international leadership role based on more than 45 years of expertise in cleanrooms and controlled environments.