Getting it Right from the Start…that's Optimization.

Clean Room

PV Vacuum Engineering Pte Ltd
(A member of Darco Water Technologies Limited)

puzair
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Housekeeping of Clean Room

Advanced production methods often require very clean air and in many cases these requirement are certain to increase driven by the desire of making things smaller & lighter.

For example the electronic industry needs a very clean manufacturing environment for their Very Large Scale Integrated (VLSI) circuit production. The pattern width on the circuits can be 1 micron or less. The need will be to control particle contamination down to 1/10 of this distance (0.1 micron).

The “Heart” of the Clean Room is the filter, but there are a number of considerations beside room classification, choice of filter, etc that are critical to ensure the sustainability or reliability of the Clean Environment Created for production.

Housekeeping happens to be one of them which sometime it’s important is overlook in the design of a Clean Room.

Contrary to popular thinking, Portable Hepa Vacuum Cleaner cannot be considered as an alternative solution of a Central Housekeeping Vacuum System.

Laminar Flow- Refer to Figure A

In the field of clean room technology is laminar flow, or the parallel streaming of air, an important factor for the effective removal of contaminants. When variations in laminar flow is non-unidirectional, there is a substantial risk that contaminated air will be inducted into the flow and that the movement of contaminants across the flow of air will increase. Most standards for laminar flow systems take this into account and impose definite requirement on velocity distribution.

What good is a high efficiency filter if its filtration capacity is ruined by uneven air distribution as a result of housekeeping?

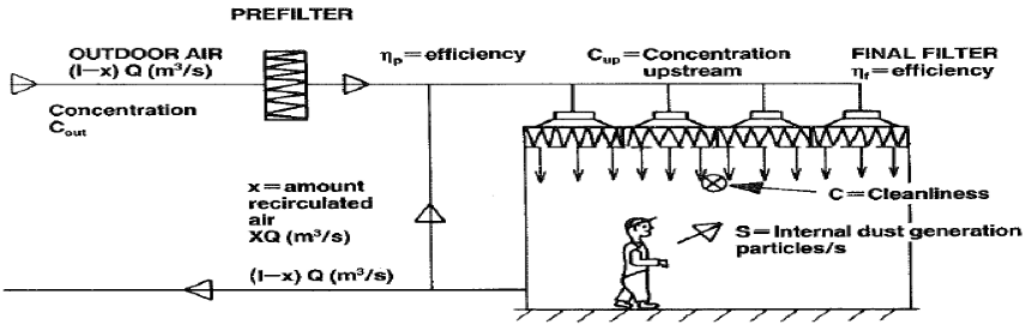
Portable Hepa Vacuum Cleaner discharge its exhaust together with particles that it cannot trap within the close proximity of the user within the Clean Room.

Such exhaust disturb the laminar flow condition in the clean room, create substantial risk. Risk that the contaminated air will be inducted into the flow. Movement of contaminants across the flow will increase.

Unlike a Portable Hepa Vacuum Cleaner, a Central Housekeeping Vacuum System pick up the dirty air & particles, removed it from the Clean Room and discharge it at a remote location after thorough filtering outside the Clean Room.

Hence, Central Housekeeping Vacuum System does not disturb the Laminar Flow condition within the Clean Room at all during cleaning.

Laminar Air Flow- Clean Room – Figure A



Concentration upstream FINAL FILTER

$C_{up} = x\ S/Q + (1-x)\ (1-\eta_p)\ C_{out}$

Cleanliness CLASS downstream FINAL FILTER

$C = [x\ S/Q + (1-x)\ (1-\eta_p)\ C_{out})]\ (1-\eta_F)$

Special Case

A. 100 % outdoor air: $x = O$

$C_{up} = C_{out}\ (1-\eta_p)$ (conc. upstream)

$C = C_{out}\ (1-\eta_p)\ (1-\eta_f)$ (Cleanliness Class)

B. 100 % recirculated air: $x = 1$

$C_{up} = S/Q$ (conc. upstream)

$C = (1-\eta_f)\ S/Q$ (Cleanliness Class)

Effective Cleaning

The Main Design Criterion for a Portable Hepa Vacuum Cleaner is **"Portable"**, not "Cleaning". Why?

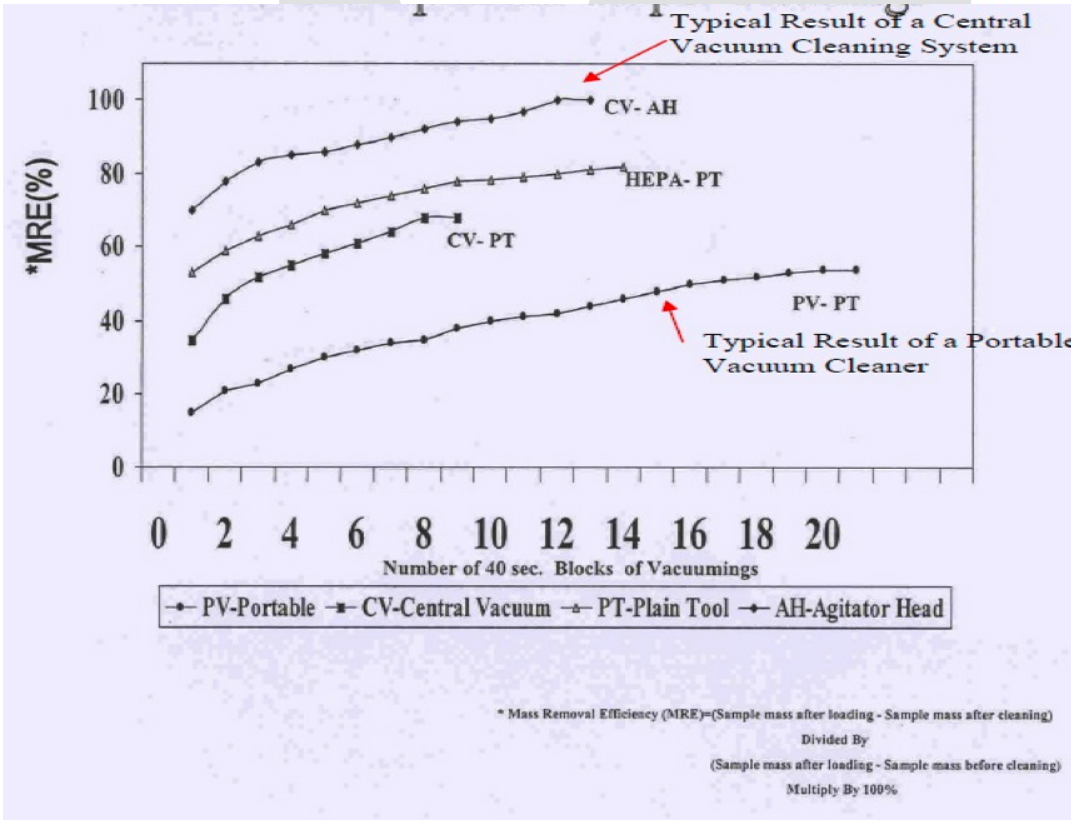
Because, without portability, it cannot fulfil its function to clean.

All the conventions has told us that it is impossible to have both; Portability and Effective Cleaning. Portability means less effective vacuum cleaning. Portable Vacuum Exhauster (motor) is small, it does not have enough suction power. Portable filter has small areas for trapping dirt, it will not trap all dirt pickups. It is that simple.

Many such Portable Vacuum Cleaner are rated and sold according to their no-load vacuum capability. Rating a machine when it's essentially at rest, moving no air and performing no work, is unrealistic. While the machine may be able to pick up and hold a bowling ball or lifting a water column, that feat is meaningless if cleaning is the desired function. As soon as the intake of the machine is opened, air rushes in and hits the vacuum fan (motor), slowing it down and drastically reducing the suction.

A true vacuum rating must relate suction to a specific volume of airflow. It's only when air is moving that dirt can be picked up and removed.

A well designed Central Housekeeping Vacuum System does not have such problem. This is because the Central Vacuum Exhauster (Producer) does not need to be portable. Hence, it is sized accordingly to meet its Main & Only Design Criterion, which is effective cleaning.



Enhance Filter Life-Saving in Operating Cost

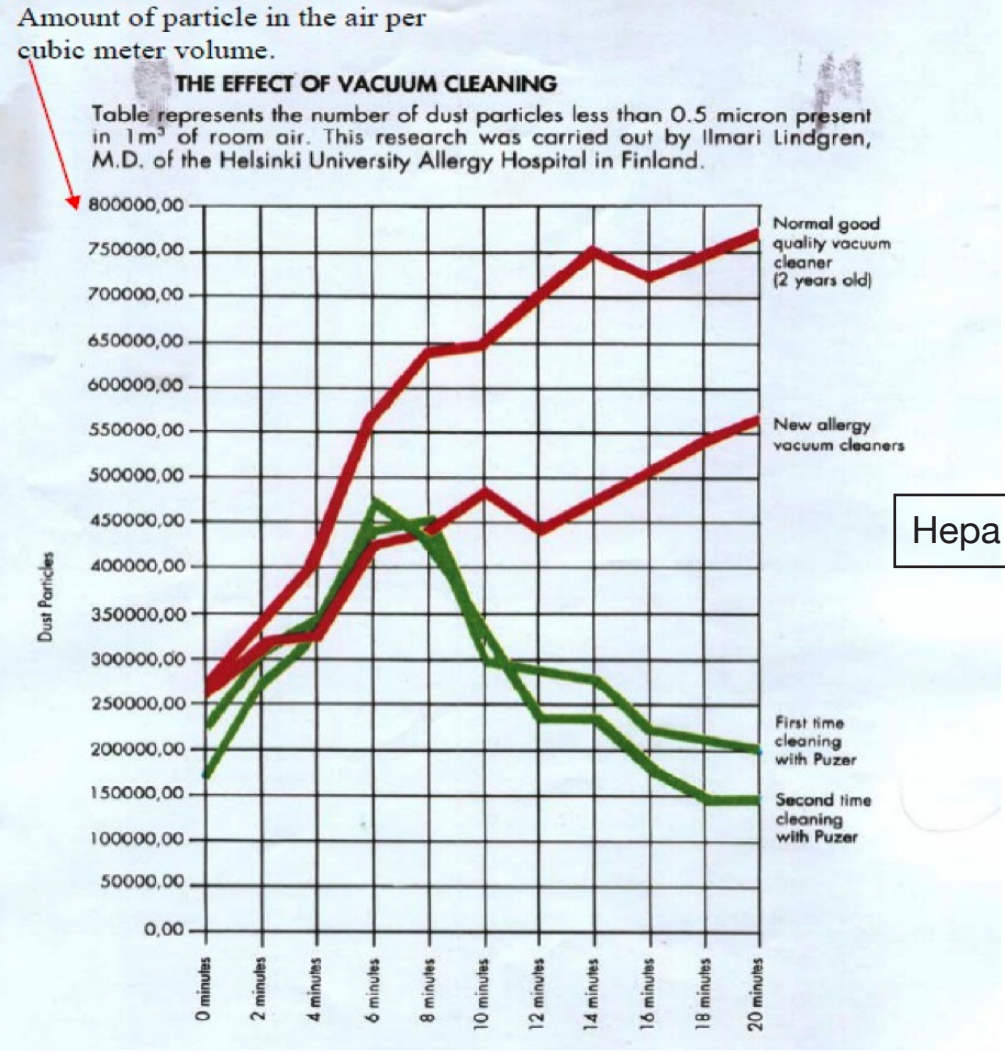
The “Heart” of a Clean Room is the filter, but similar to any other type of filters it has a definite life. A life that depend largely on the amount of dust particle it is exposed too constantly.

The use of better pre-filters can be a simple solution to enhance the final absolute filters life.

However, the dust that escape the Hepa Filter of a Portable Hepa Filter Vacuum Cleaner together with its exhaust will usually be too small for such pre-filter to be effective. **These escape dust will add further load to the final absolute filter leading usually to a shorter lifespan of such filter.**

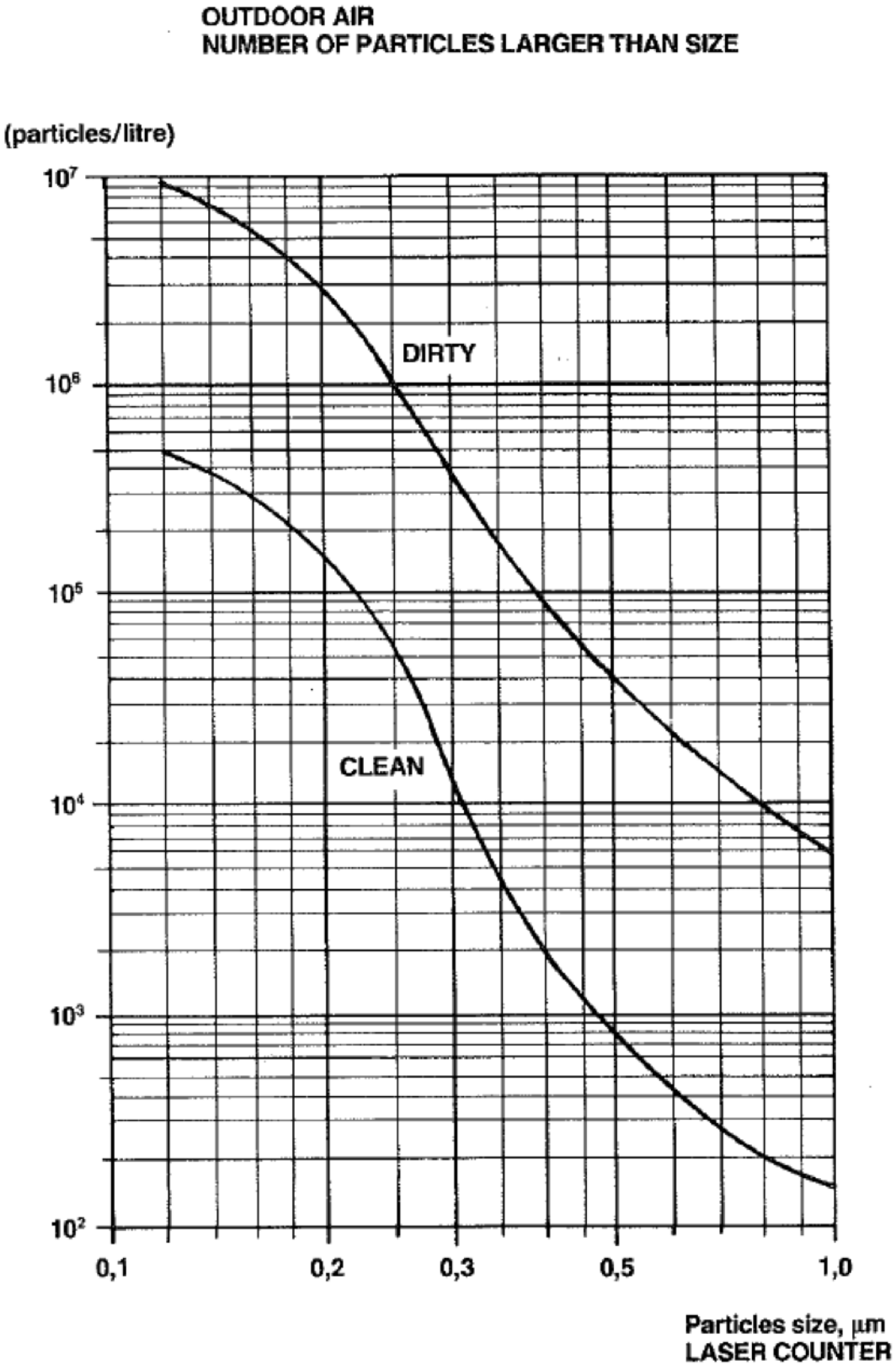
A Central Housekeeping Vacuum System does not create such a problem since its exhaust together with the dust it pick up is discharge at a remote location outside the Clean Room after its filter system.

Dust Particle Count during Cleaning

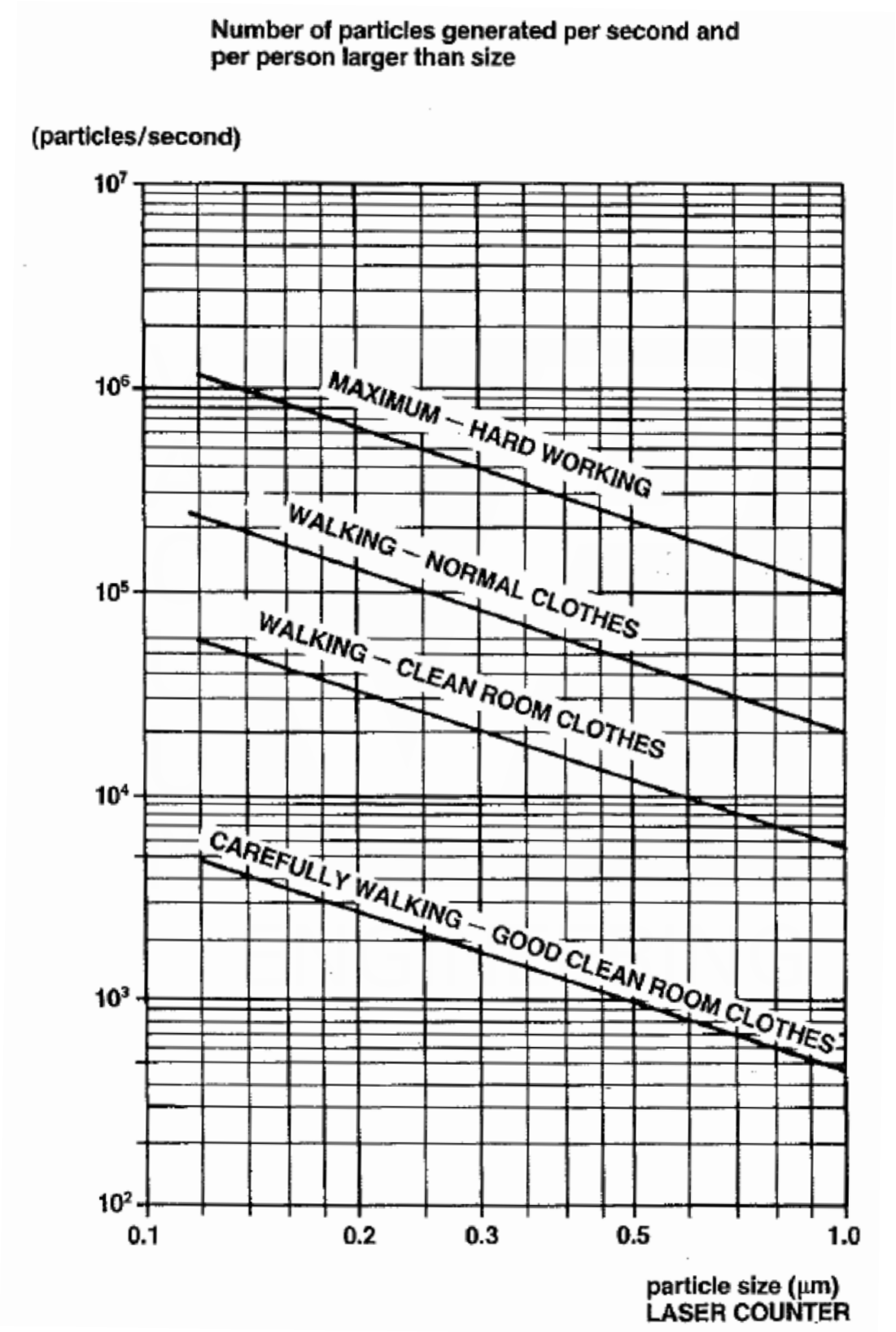


Hepa Type

Outdoor Air Particles Chart



Human Dust Generation



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THE MAGAZINE OF CONTAMINATION CONTROL TECHNOLOGY

Central Vacuum Systems—Effective Particulate Elimination for Cleanrooms

Contrary to popular thinking, the work performed by a vacuum cleaner is accomplished by pressure, not suction. Normal room air exerts a pressure of 14.7 pounds per square inch at sea level. Since reducing the pressure inside a vacuum cleaning hose creates a pressure differential, the air in the room will rush toward the low-pressure area and into the hose carrying with it any nearby solid objects. Dirt is therefore pushed through the vacuum system, not pulled.

Central vacuum cleaning systems scavenge particulate contaminants from cleanroom floors, walls and furnishings and, unlike portable vacuum cleaners, they evacuate particulates completely out of the cleanroom environment.

A cleanroom central vacuum cleaning system consists of a vacuum producer and separator located outside the room, connected to a metal tubing network within the cleanroom walls and/or beneath the floors. Vacuum inlet valves are located inside the cleanroom at convenient points along the tubing runs with vacuum hoses plugged into the inlet valves and fitted with a variety of tools for effective cleaning of walls, floors, ceilings, benches, work surfaces and equipment.

Central vacuum systems are effective for scavenging particulate contaminants from cleanroom floors, walls and furnishings. Unlike small portable vacuum cleaners, which collect and separate contaminants in situ, central systems evacuate particulates completely out of the cleanroom environment to a remotely located separator, preventing recontamination or cross-contamination of other areas. To function effectively, there must be an adequate pressure differential at the cleaning tool so that incoming air will have sufficient velocity to carry dirt particles with it. This pressure differential must also be maintained throughout the hose and tubing system to overcome the system resistance and sustain a conveying velocity.

System Design Criteria

There are four principle factors to consider when designing a central vacuum system: the size and layout of the facility to be cleaned, the location of the vacuum producer, the characteristics of the material to be handled, and the maximum number of simultaneous operators.

A single central vacuum cleaning system can service an individual cleanroom (**Figure 1**), a complex of cleanrooms or an entire facility with office, warehouse, manufacturing, processing and cleanroom areas. Larger cleaning loads, however, will naturally require larger systems with higher vacuum ratings. The vacuum requirement is also influenced by the length of the longest vacuum tubing run in the layout.

Equipment location is also important.

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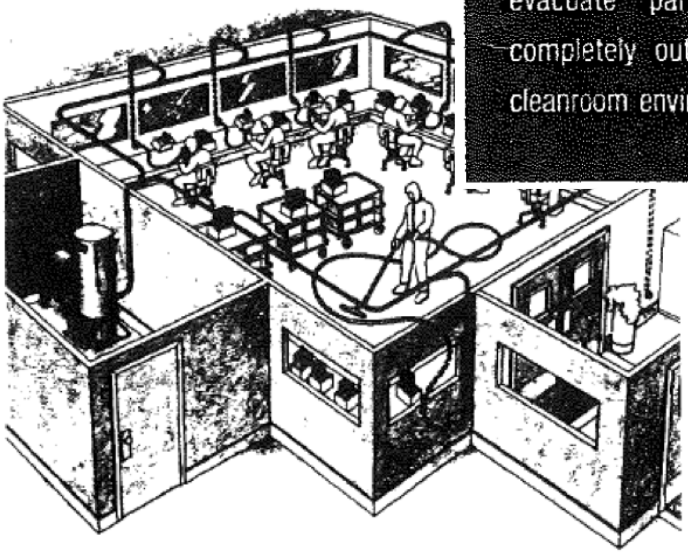

Figure 1. Cleanroom vacuum systems have a vacuum producer and a separator located in an adjacent room and connected via a tubing network to a wall-mounted inlet valve, serving both cleaning and processing applications within the room. Note that exhaust from the central unit is directed outdoors, avoiding chance of cleanroom recontamination.