

Microcontamination Control

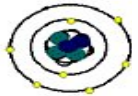
Microcontamination is any micro foreign material or energy that has a detrimental effect on a product or process. For example,



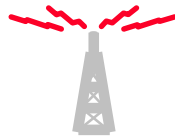
Particles (Solids)



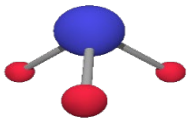
Vibration (Energy)



Ions (in Liquids)



Electromagnetic Interference or Radiation (Energy)



Molecular (Gases)



Electrostatic Discharge (Energy)

Microcontamination control measures in Wafer Fabrication:

- Clean Room
- Ultra Pure Water
- ESD Control

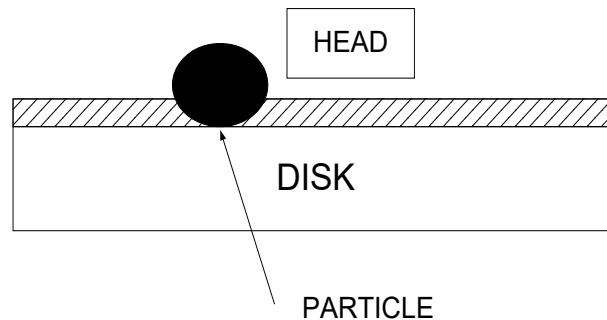
Microcontamination Effects

Product or Process:

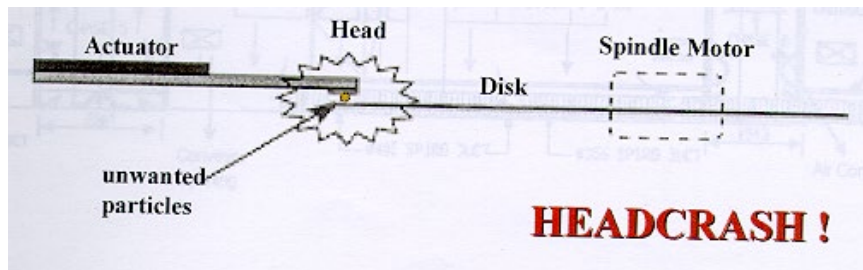
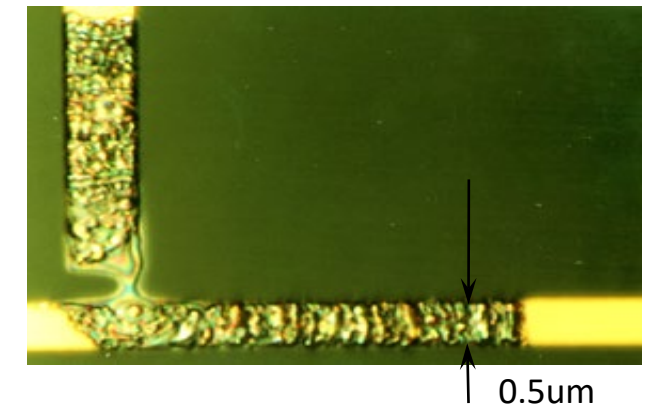
- Yield
- Performance
- Reliability



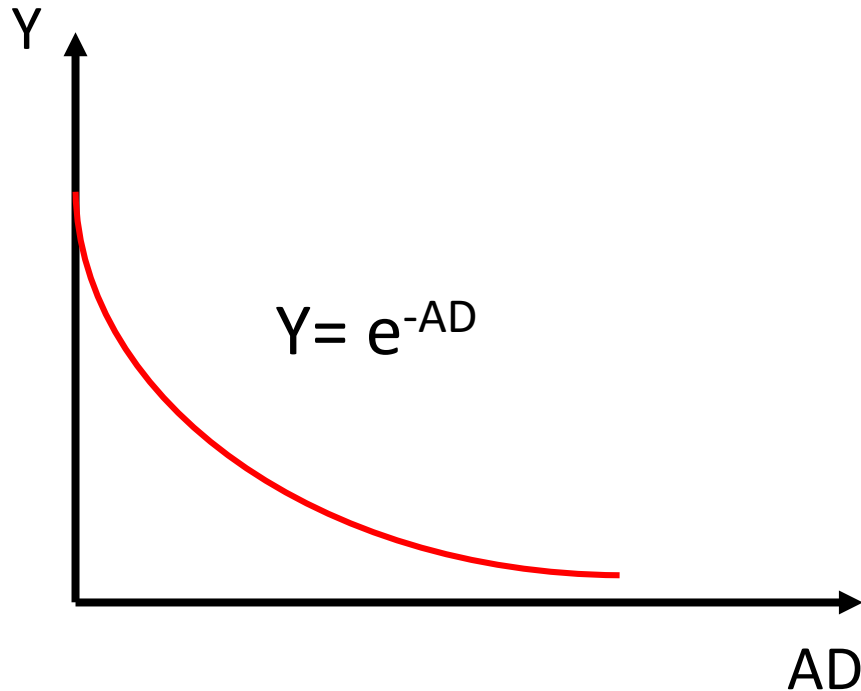
Particle Related Failures



Short circuits &/or ESD damaged devices



Microcontamination and Yield (Y)

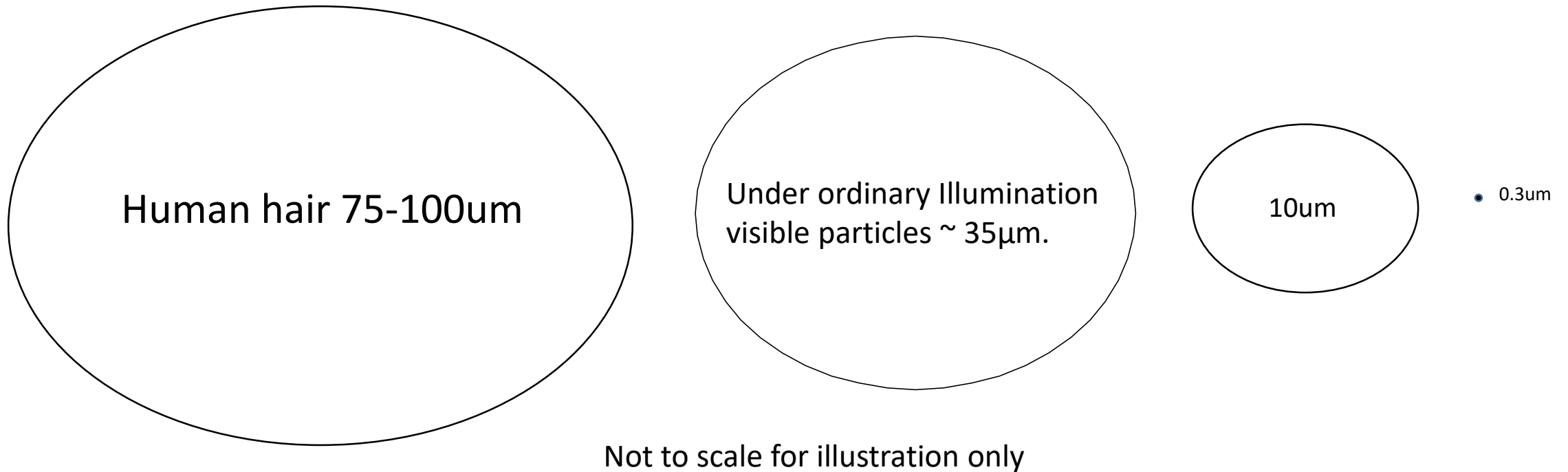


Poisson postulates that:

- Yield is exponentially inversely proportional to Area of Product.
- Yield is exponentially inversely proportional to Defect Density

The larger the size of a product the easier probabilistically it is subject to contamination by particles. Defect Density is a measure of the cleanliness of the environment. Both means that Yield is directly affected by Microcontamination Control. The smaller the size (the smaller the surface area, the more difficult probabilistically speaking to get contaminated by particles, notwithstanding technologically & machine capability) & the cleaner the environment, the higher the production yield. Device yield should improve as things get smaller according to Poisson, that's how important he attributes failures to contamination causes.

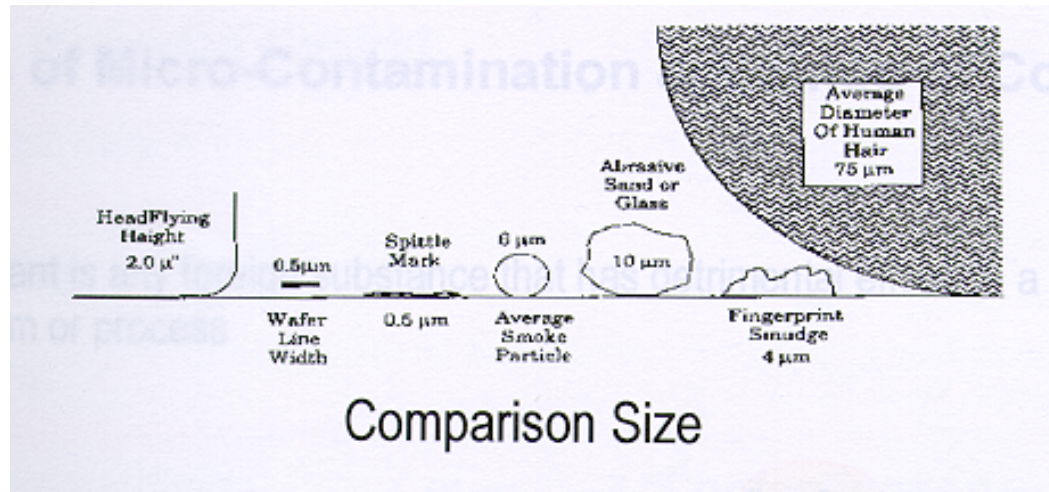
Particulate Contaminants Size & Characteristics



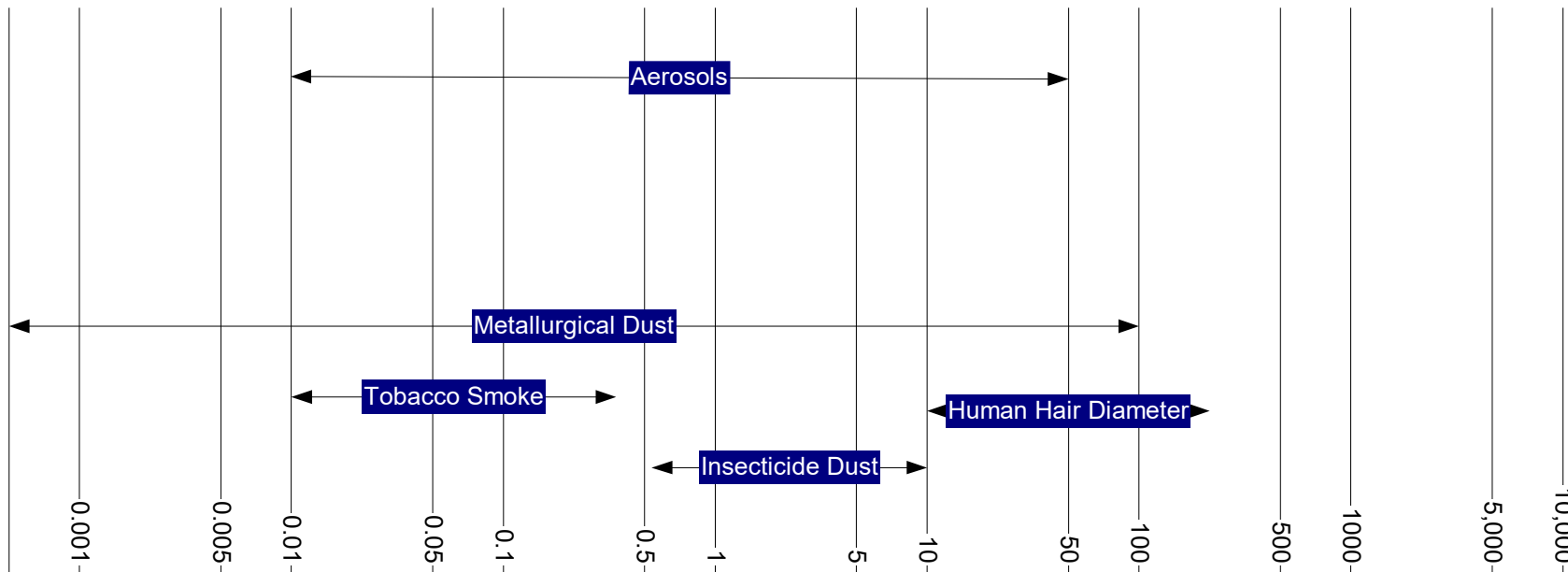
In microcontamination control of particulates, the contaminants size (0.01 to 100µm) & therefore their characteristics we are dealing with:

- Invisible
- Airborne (because of their weightlessness)

Contaminants Size Comparison & Chart



Spittle marks, Finger prints
& Smoke particles are all
Invisible



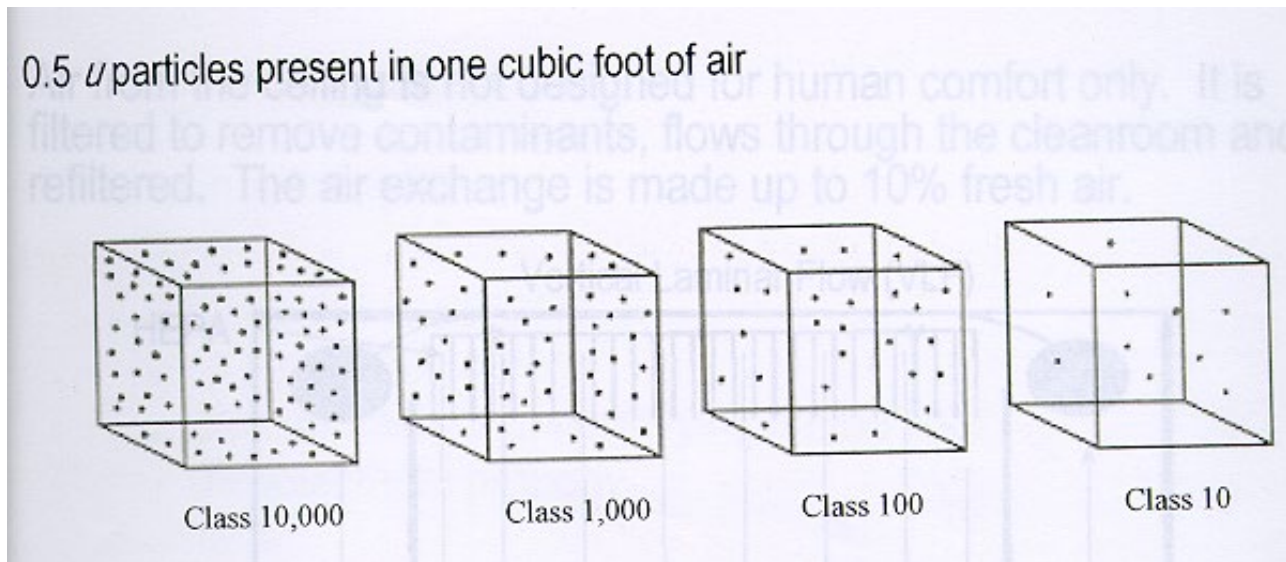
Smoke & Dust are
Invisible & Airborne
(Aerosols)

Cleanroom

A room in which the concentration of airborne particles is controlled and which has one or more clean zones.

Cleanroom Class

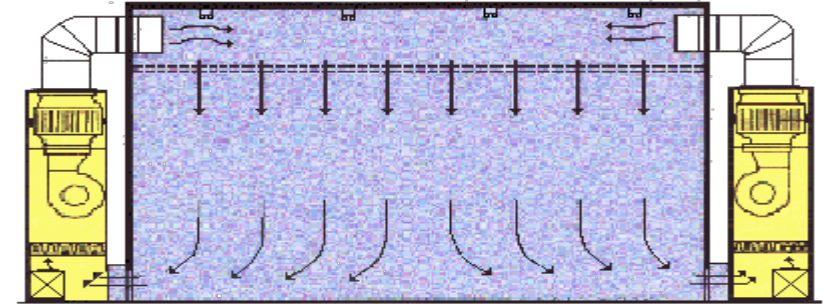
The number of particles $>0.5\mu\text{m}$ that can be found in 1 cubic foot. Class 1000 clean room will have less than 1000 particles $>0.5\mu\text{m}$ in 1 cubic foot.



Class Name		Class Limits									
		0.1		0.2		0.3		0.5		5	
		Volume Units		Volume Units		Volume Units		Volume Units		Volume Units	
SI	English	(m ³)	(ft ³)	(m ³)	(ft ³)	(m ³)	(ft ³)	(m ³)	(ft ³)	(m ³)	(ft ³)
M1		350	9.91	75.7	2.14	30.9	0.875	10	0.283	-	-
M1.5	1	1,240	35	265	7.5	16	3	35.3	1	-	-
M2		3,500	99.1	757	21.4	309	8.75	100	2.83	-	-
M2.5	10	12,400	350	2,650	75	1,060	30	353	10	-	-
M3		35,000	991	7,570	214	3,090	87.5	1,000	28.3	-	-
M3.5	100	-	-	26,500	750	10,600	300	3,530	100	-	-
M4		-	-	75,000	2,140	30,900	875	10,000	283	-	-
M4.5	1,000	-	-	-	-	-	-	35,300	1,000	247	7
M5		-	-	-	-	-	-	100,000	2,830	618	17.5
M5.5	10,000	-	-	-	-	-	-	353,000	10,000	2,470	70
M6		-	-	-	-	-	-	1,000,000	28,300	6,180	175
M6.5	100,000	-	-	-	-	-	-	3,530,000	100,000	24,700	700
M7		-	-	-	-	-	-	10,000,000	283,300	61,800	1,750

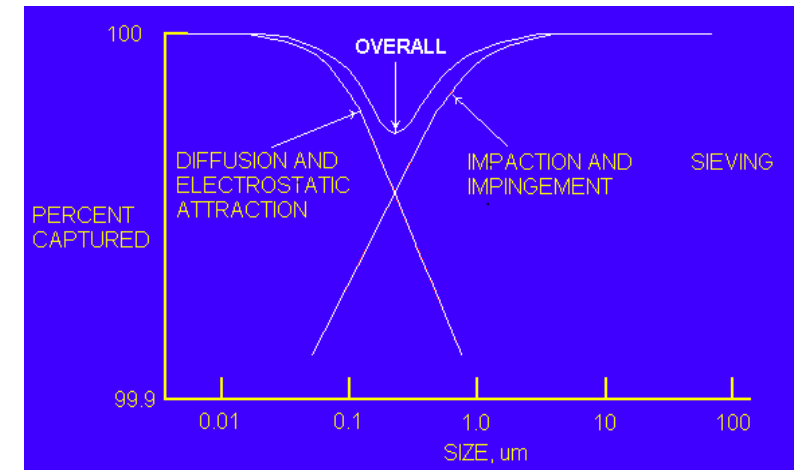
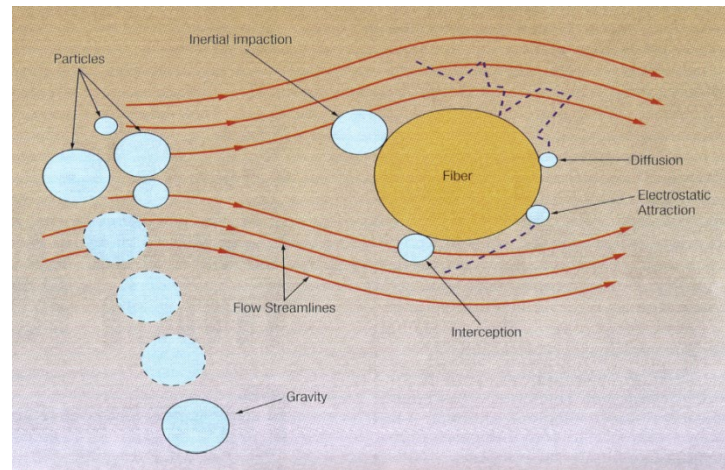
Cleanroom Operation

- Filtration
- Airflow Control



Filtration Mechanism:

- Gravity (large)
- Inertial Impaction (large)
- Direct Interception (large)
- Electrostatic (small)
- Diffusion (small)



Worst case overall efficiency occurs at a specific size for HEPA & ULPA:

- HEPA Filter: High Efficiency Particulate Air efficiency 99.997 % @0.3 μ m diameter.
- ULPA Filter: Ultra-Low Particulate Air efficiency 99.999997 % @ 0.12 μ m diameter.

Cleanroom Operation

Airflow Control:

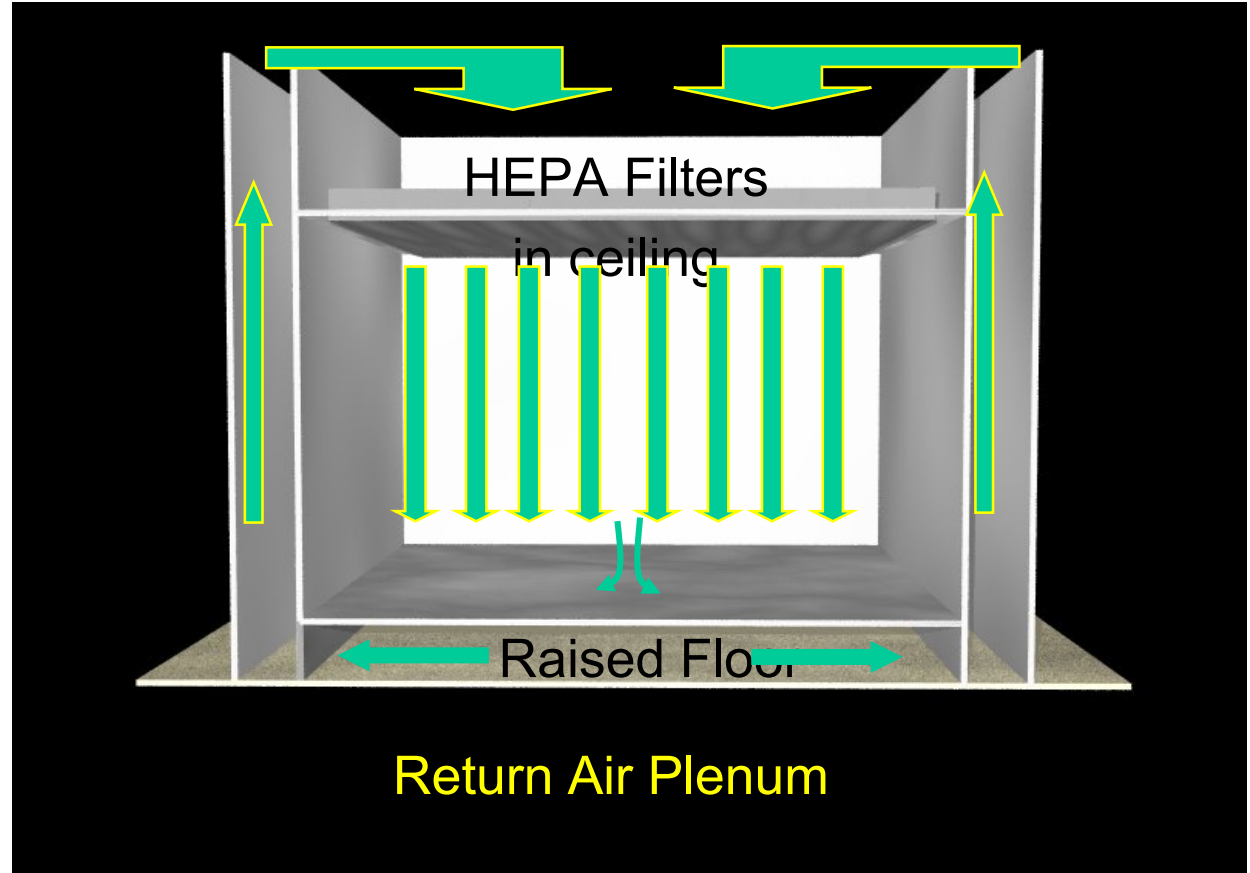
70 to 110ft/min or 0.35 to 0.45m/s

- Laminar Flow
- Raised Floor & Balancing

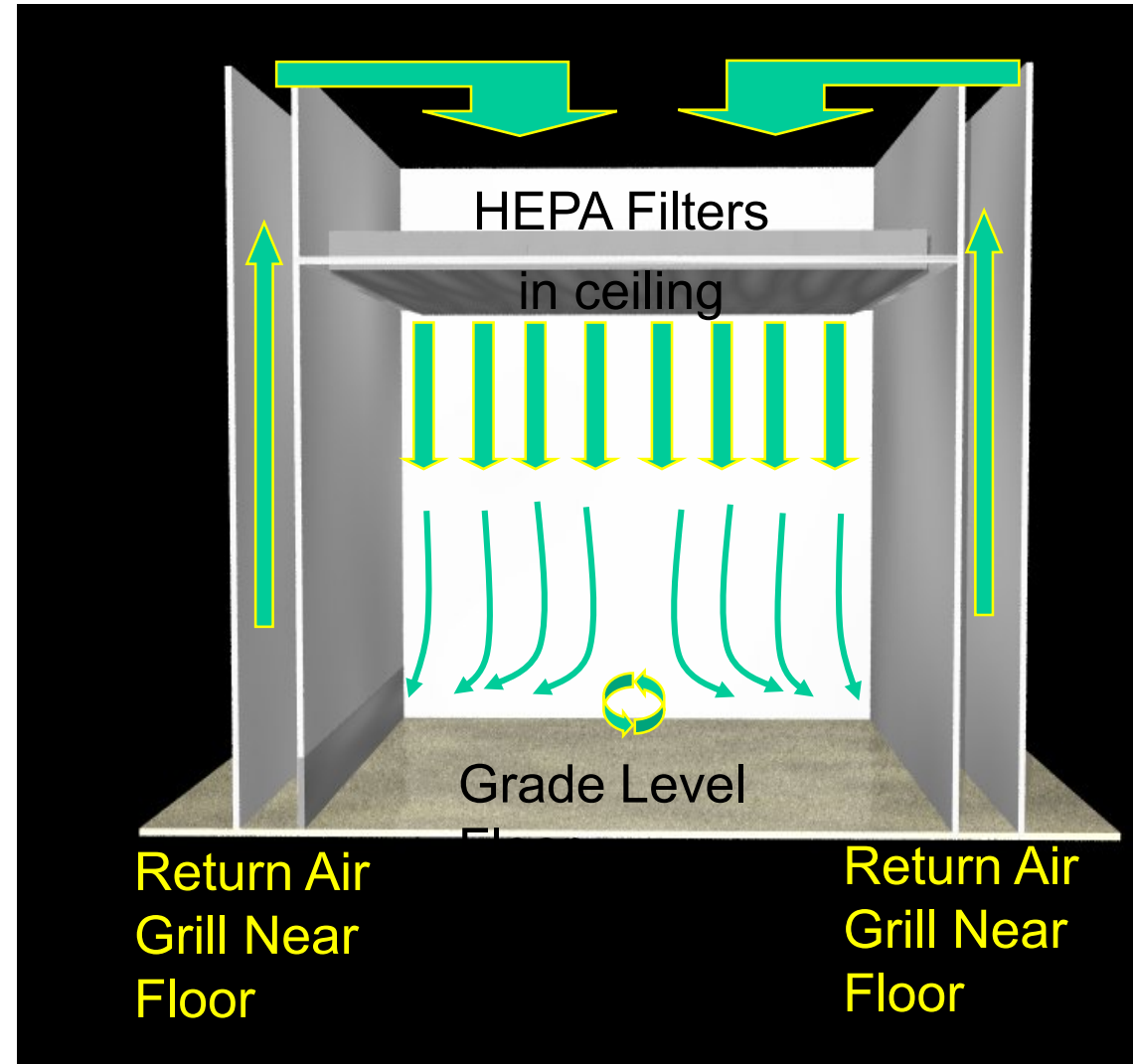
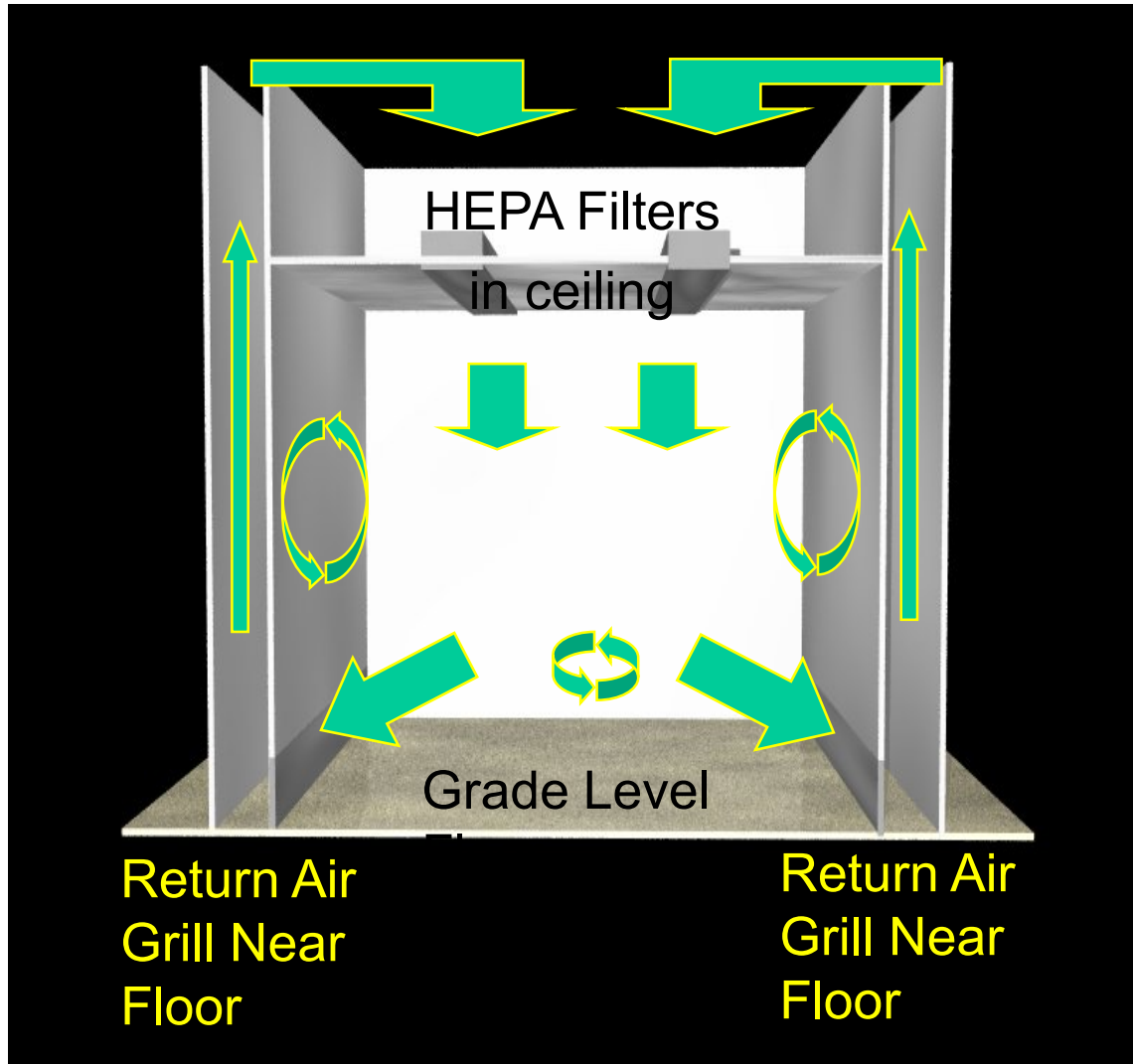
To remove Standing Recirculating Air
(see next slide)

HEPA filters to be changed:

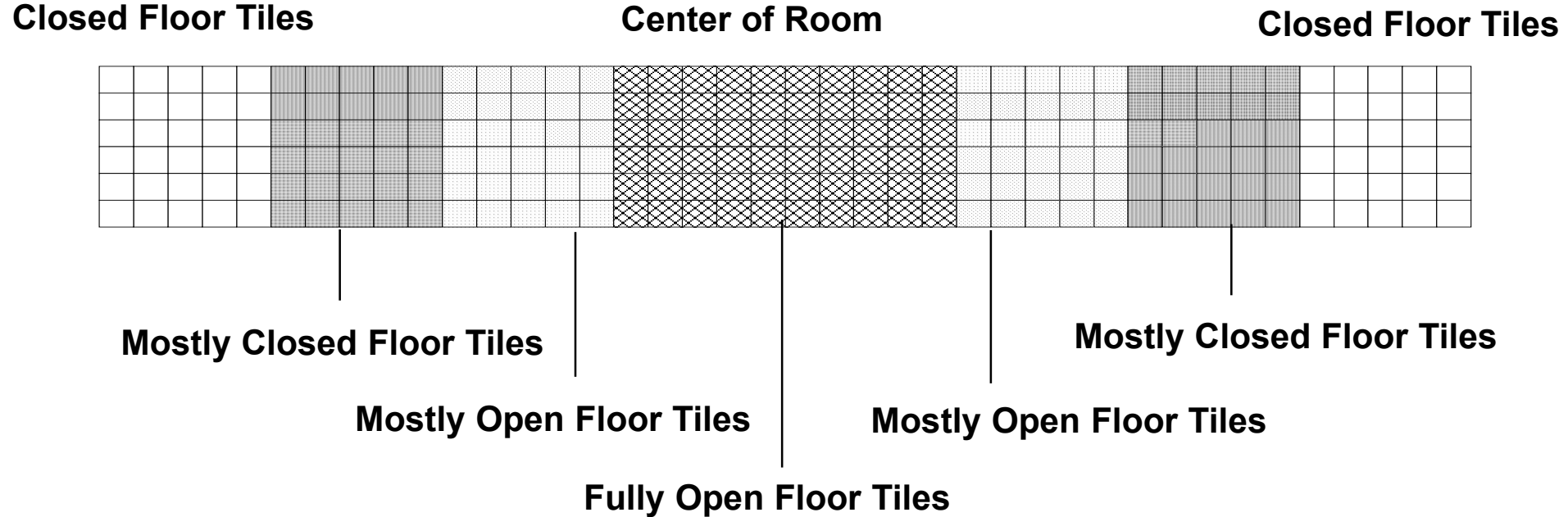
- When airflow speed decreases
- To minimize Energy Consumption



Cleanroom Operation



Cleanroom Operation



Air Flow Balancing of Raised Floor in Cleanroom

Cleanroom Practice

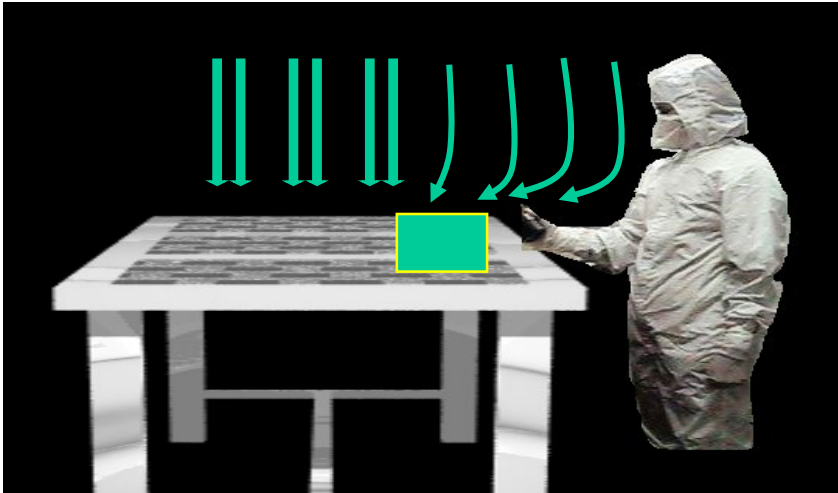
People are the major source of contaminants (Skin, Sweat & Saliva):

- Cleanroom Apparel (Gowning: Face Mask, Hairnet, Jumpsuit, Booties & Gloves).
- Cleanroom Skills (Education & Training)
- Personal Hygiene (Education & Training)

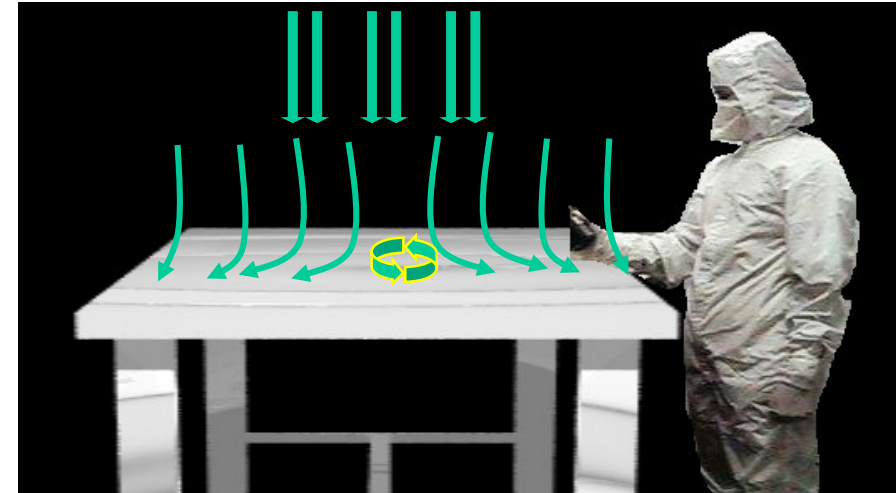
Tools are also sources of contaminants:

- Tables (Perforated or Not depending on how it affects the airflow).
 - ✓ Temporary storage (Perforated).
 - ✓ Work Table (Solid: Not perforated)
- Chairs (Always perforated).
- Machines & others (Cleaning schedule required).

Cleanroom Practice



Perforated table tops causes particles from the human body to move towards the product.



Horizontal obstructions force air to move horizontally on solid table. Take advantage of this and direct air flow toward operating personnel.

- Cleanroom Level (of Cleanliness): As defined in MIL STD 1246, the size in μm at which no more than one particle will be found per square foot of surface area (example for gloves, table or chairs).
- Not just Cleanroom Class compatibility when making decisions of purchase.