

The Changing World of Cleanroom Standards: Updates to ISO 14644-1 and ISO 14644-2

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PRESENTER biography



Jason Kelly
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Over 20 Years Management positions in Environmental Monitoring Systems Service, Design, Installation, Validation and ongoing support. Jason has worked on many Projects for top Life-Science, Semi-conductor companies assisting in procurement, delivery and compliance to ensure regulatory acceptance. Worked across the World on many projects in the UK, Ireland, Europe, Australia and now resides in Oregon USA. Where he manages the Systems group. Jason can be contacted by email on jasonk@golighthouse.com or on LinkedIn and always welcomes queries and questions on Monitoring Systems connected to particle counters or environmental sensors.

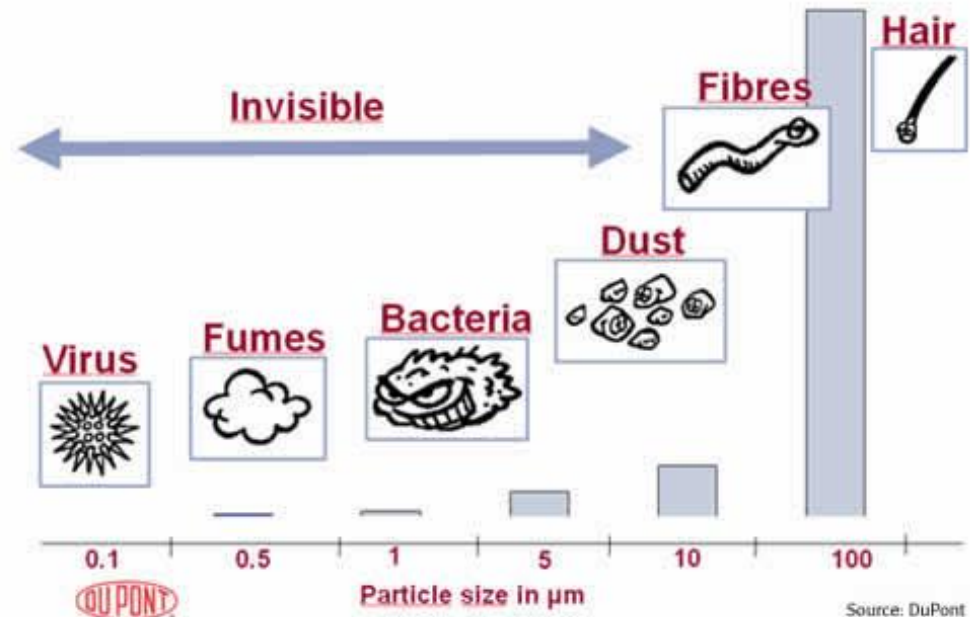
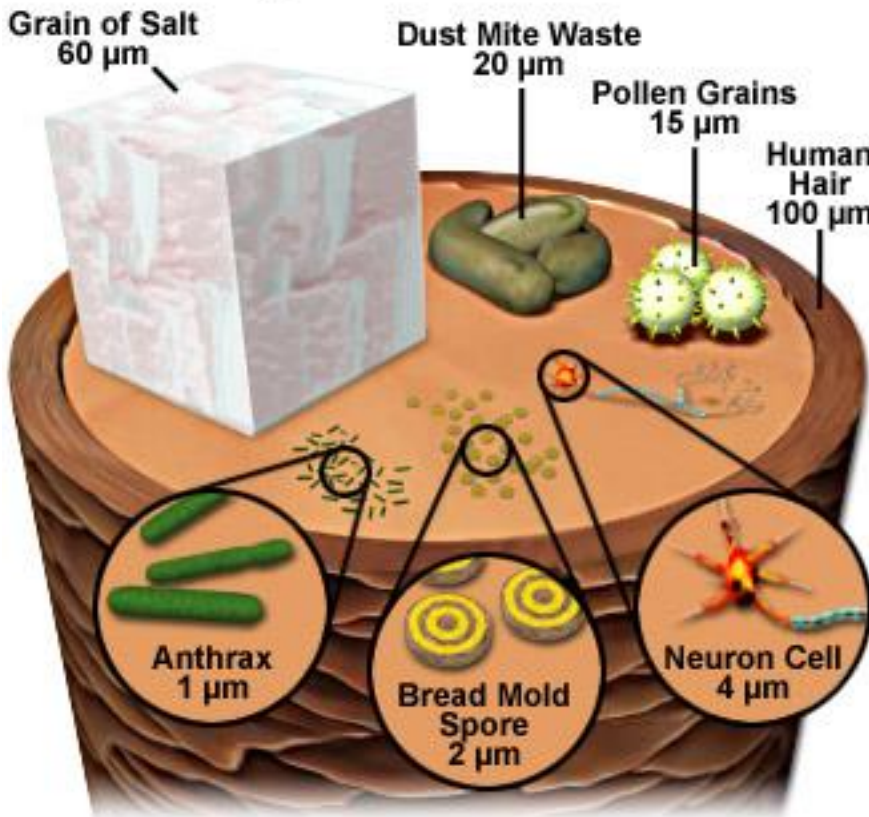
WHAT is a Particle?

As per ISO 14644-1 Definition (2.2.1)

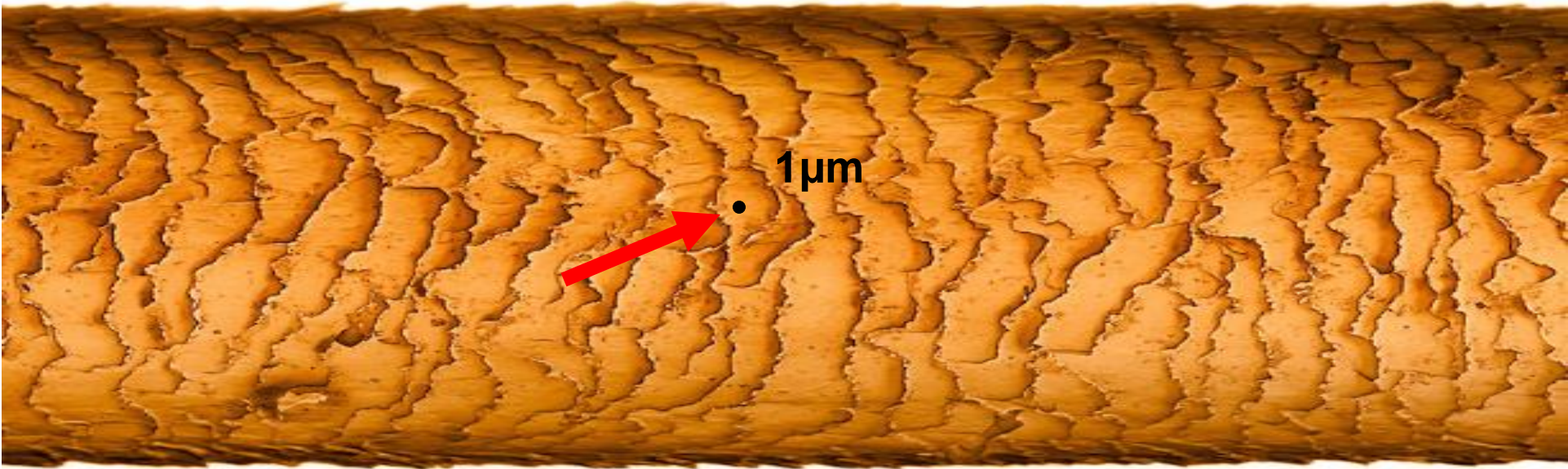
Solid or liquid object which, for purposes of classification of air cleanliness, falls within a cumulative distribution that is base upon a threshold (lower limit) size in the range from 0,1 micron to 5 micron.

HOW big is one micron?

Objects at Micron Scale



HOW big is one micron?



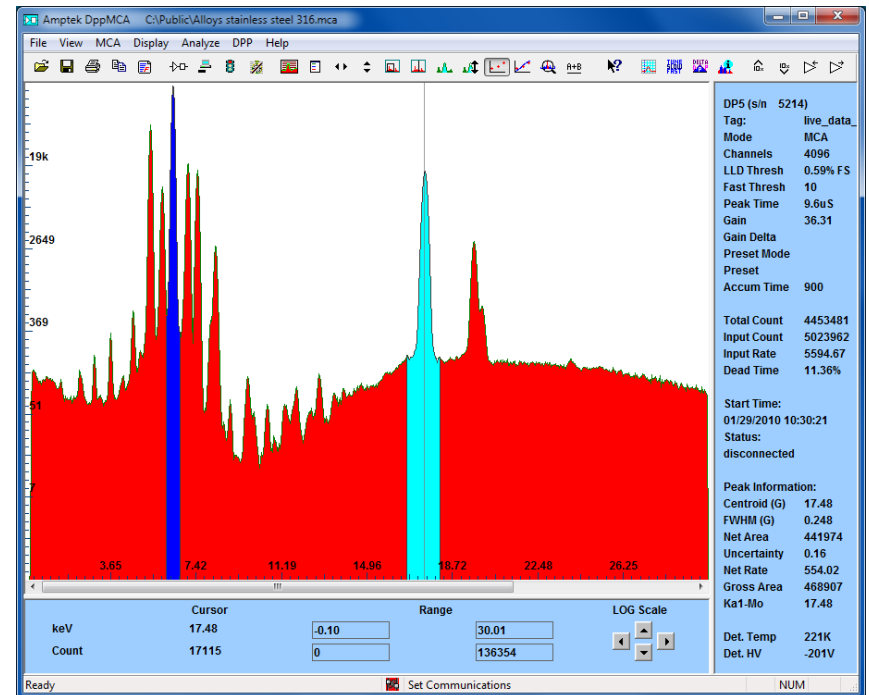
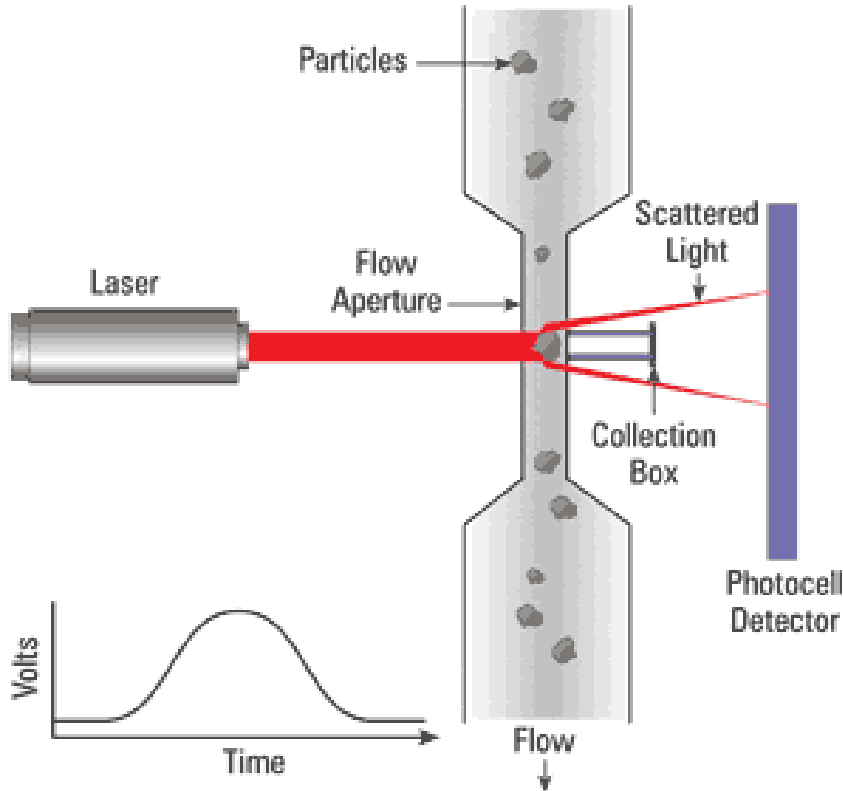
PARTICLE Counter

A particle counter is an instrument that detects and counts particles not visible to the naked eye. Particle counters are specifically working on light scattering or light obscuration or direct imaging. A light source (typically a laser light) is used to illuminate the particle as it passes through the sensor orifice. As the Particle passes through the laser light It scattered or Block light



LIGHT Scattering

The proportion of light scattered is directly proportionate to the size of the particle.



Pulse Height Analyzer (PHA)

STANDARDS knowledge



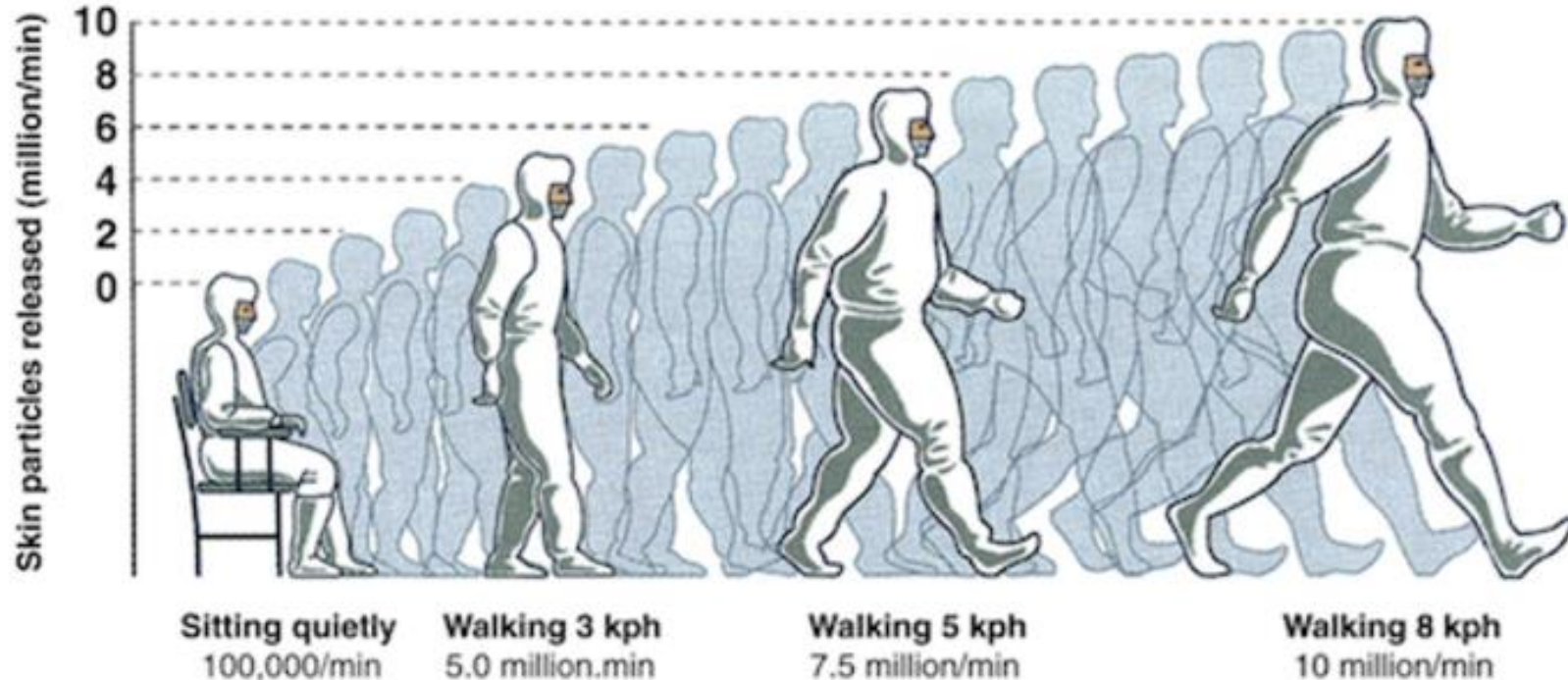
	07/02/2017 13:40:40	admin							Room 1
	μm	Σ	Δ	Limit / m^3		Location 001			
	0.3	0	0	10200		CR1 EU GMP			
	0.5	0	0	3520	ISO 14644-1: 2015 Class 5 In-Operation				
	1.0	0	0	832					
					Cycles: 0 / 1 Sample: 00:01:00 Recs: 10000 / 10000				
					IDLE				

PARTICLES in the Cleanroom Personnel

Personnel are considered to be the biggest threat and the highest source for contaminant material, accounting for about 75% to 80% of particles found in cleanroom inspections. Personnel introduce particles through skin flakes, oil, hair, yeast and movement, while bringing in external particles from cosmetics, perfume, deodorants, lotions, and clothing (lint, fibers).



PARTICLES in the Cleanroom Personnel The Skin We Shed



Source: Dr. Ken Goldstein Cleanroom Consultants, and Mike Fitzpatrick, Lockwood Greene, Cleanrooms East 99

ISO 14644 consists of the following parts, under the general title Cleanrooms and associated controlled environments:

- **Part 1: Classification of air cleanliness by particle concentration**
- **Part 2: Monitoring to provide evidence of cleanroom performance related to air cleanliness by particle concentration**
- Part 3: Test methods
- Part 4: Design, construction and start-up
- Part 5: Operations
- Part 7: Separative devices (clean air hoods, gloveboxes, isolators and mini-environments)
- Part 8: Classification of air cleanliness by chemical concentration (ACC)
- Part 9: Classification of surface cleanliness by particle concentration
- Part 10: Classification of surface cleanliness by chemical concentration

Classification Testing

- Any Cleanroom Must be Tested or “Validated” to a Standard
- This is the Formal Testing to a Cleanroom Performance Standard
- GMP regulations are **NOT** Cleanroom Standards, they are regulations. They do not provide enough specifications for performance of Cleanrooms

GMP refers to ISO-14644_1&2
For Classification same as other industries



ISO 14644-1:2015 Class Table

Maximum concentration limits (particles M³ of air) for particles equal to and larger than the considered sizes shown below: (a)

ISO Classification Number(N)	0.1µm	0.2µm	0.3µm	0.5µm	1.0µm	5.0µm
ISO 1	b 10	d -2	d	d	d	e
ISO 2	100	24	10	d -4	d	e
ISO 3	1,000	237	102	35	d 8	e
ISO 4	10,000	2,370	1,020	352	83	e
ISO 5	100,000	23,700	10,200	3,520	832	d,e,f 29
ISO 6	1,000,000	237,000	102,000	35,200	8,320	293
ISO 7	c	c	c	352,000	83,200	2,930
ISO 8	c	c	c	3,520,000	832,000	29,300
ISO 9	c	c	c	35,200,000	8,320,000	293,000

5.0µm should be zero according to ISO/DIS 14644-1.2 Table 1 notes;

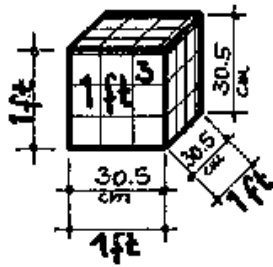
d) Sampling and statistical limitations for particles in low concentrations make classification inappropriate

e) ... Greater than 1 micron particles make classification at this particle size inappropriate due to potential particle losses in sampling system

f) Specify particle size in association with ISO Class 5, the marcoparticle descriptor M may be adapted.

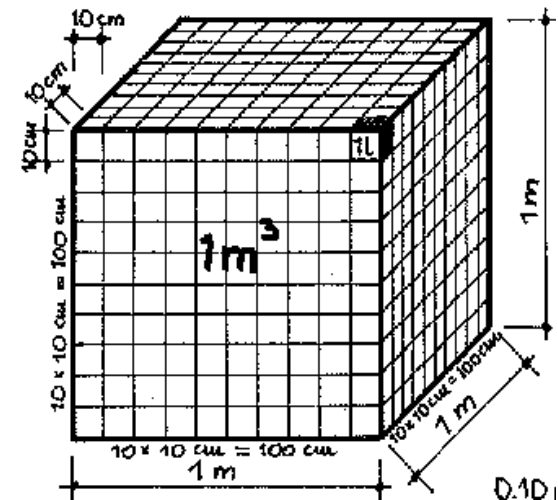
WHAT does Class Mean?

Maximum # Of Particles Greater than the Specified Size
Allowable In a Unit of Air



VS

$$1 \text{ Meter}^3 = 35.3 \text{ Feet}^3$$



Federal Standard
209

ISO 14644-1

WHAT is a Cleanroom?

Room in which the **concentration of airborne particles is controlled**, and which is constructed and used in a manner to minimize the introduction, generation, and retention of particles inside the room, and in which **other relevant parameters**, e.g. temperature, humidity, and pressure, are controlled as necessary.

STANDARDS knowledge



FDIS 14644-1 Update Summary

Exclusion of particles > 5 microns from the classification table for ISO Class 5

Determination of sample points required for classification of a cleanroom compared to the 1999 version

Locating sample points within a cleanroom

Removal of 95% Upper Confidence Limits

Risk based locations • Dealing with super huge cleanrooms

Instrument Calibration (ISO 21501-4)

ISO 21501-4 Calibration

- The requirement that all light scattering airborne particle counters be calibrated to ISO 21501-4:2007 criteria
 - Guidance on what to do if you cannot meet this

Removal of 5 micron particle at ISO 5

Removing the > 5 micron particle concentration in ISO 5

Note - In the old FS209E, Class 100 did not have a 5 micron testing requirement

Number of Sample Locations

Significant change in the standard

Adoption of a more consistent statistical approach to the selection and the number of sample locations and the evaluation of data collected

Approach allows for each location to be treated independently

Number of Sample Locations

The minimum number of sample locations compared to 1999 has changed – increased to give 95% confidence level

Table replaces the square root of the area of the room equation

Quick look-up table to define required number of samples

Dividing room into sectors and sampling at locations in each sector

Allows for additional sample locations to be selected for critical locations based on risk analysis

Removal of the 95% Upper Confidence Limit

The requirements to calculate the 95% upper confidence limit(s) for 2 to 9 sample locations was removed

Larger Cleanrooms

FDIS version says use the Table for cleanrooms up to 1000 m²

Use equation for larger cleanrooms

ISO 14644-2

Emphasizes the need to consider a monitoring strategy in addition to the execution of the classification of a cleanroom or clean zone

As you collect more data after initial classification, your on-going monitoring will help you better assess how your cleanroom operates

Benefits from Routine Monitoring

Faster response to adverse events and conditions

Ability to develop trends from data over time

Enhanced knowledge of installation and process allows for more effective risk analysis

Reduction in operation costs and product losses

Risk Assessment

ISO 14644-2 specifies the requirements of a monitoring plan, based on a risk assessment of the intended use

Data will provide evidence over time of continued cleanroom or clean zone performance related to air cleanliness by particle concentration

Regulatory

Relevant regulatory agencies may impose supplementary policies or restrictions

You must adapt the monitoring procedures to comply

Changes to Monitoring Plan

Significant changes require revisions to the monitoring plan

Periodic reviews of the monitoring plan should be conducted based on data and experience

Monitoring Plan

Guidance given for:

- Creation of the Plan
- Use of Risk Assessment
- Review and approval of your monitoring
- Implementing
- Data analysis
- Review the monitoring plan periodically

Periodic Classification

Periodic classification requirements

Use of risk assessment and data to help you determine frequency

Thank you!