

Understanding airborne particle counter and interpretation of particle counts data

By Dylan Tan, Program Manager, Astic Pte. Ltd.

Airborne Particle Counter comes in different brands and function to suit various applications. This paper provides a general knowledge of particle counter/sensor, differences in measurement and interpretation of particle counts data.

1.0 Airborne Particle Counter/ Handheld Particle Counter

The three common ways for measuring particle counts within a cleanroom are;

- Airborne Particle Counter (Standalone/ sequential monitoring system)
- Hand-held Particle Counter
- Airborne Particle Sensor (Simultaneous Monitoring System)

The main differences between various airborne particle counter and handheld particle counter are the flow rate and particle size for measurement.

- Airborne Particle Counter flow rate: (28 l/min; 1ft³/min)
- Handheld Particle Counter (2.8 l/min; 1 ft³/min)
- Airborne Particle Sensor (28 l/min; 1ft³/min) or (2.8 l/min; 1 ft³/min)

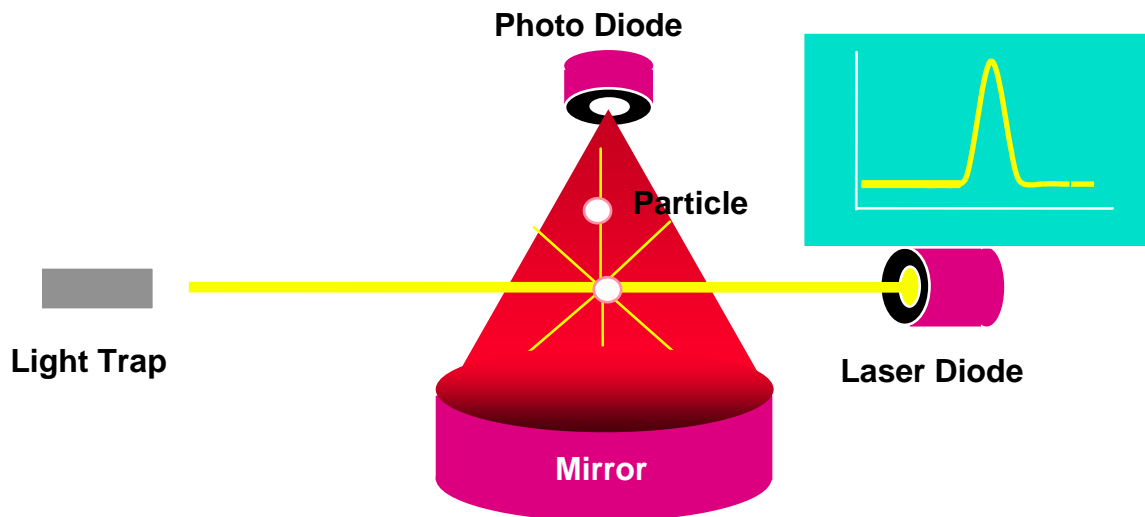


Figure 1: Particle Counter Principles

Shown in figure 1, as particle passes the laser beam, the scattered light provides an electrical pulse which determines the particle size. All airborne particle counter/sensors use this form of technology.

A HeNe laser Airborne Particle counter provides higher sensitivity particle count detection as compared to the Laser diode Airborne Particle counter/sensor. Airborne Particle sensor is used for simultaneous monitoring.

2.0 Airborne Particle Sensor

There is a common misunderstanding between “real-time” monitoring and simultaneous monitoring. Particle sensor is not able to provide “real-time” monitoring because it is based on sampling technology. Particle counts are collected and calculated based on time interval. Whyte, (2000) suggest that the ISO 14644-1 requires a minimum sampling rate of 1min based on a particle counter with a sampling rate of 28.3 l/min.

The correct practice of using any sampling time with a 2.83 l/min Airborne Particle sensor:

Normalize counts = Raw counts x 600 / Sampling interval(s)

This formula is usually being programmed into the Cleanroom Monitoring system software.

3.0 Cleanroom

A 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 (ISO 14644-1).

Understanding your cleanroom design is as important as measuring the amount of particle counts with an airborne particle counter. The complexity of the HVAC system shall not be explained in this paper. Generally, a cleanroom comes in laminar (unidirectional) flow or turbulently ventilated (non-unidirectional) flow. For ISO class 1-5, unidirectional flow cleanroom design is recommended. Non-unidirectional flow Cleanroom design is common in ISO class 6-9 Cleanroom.

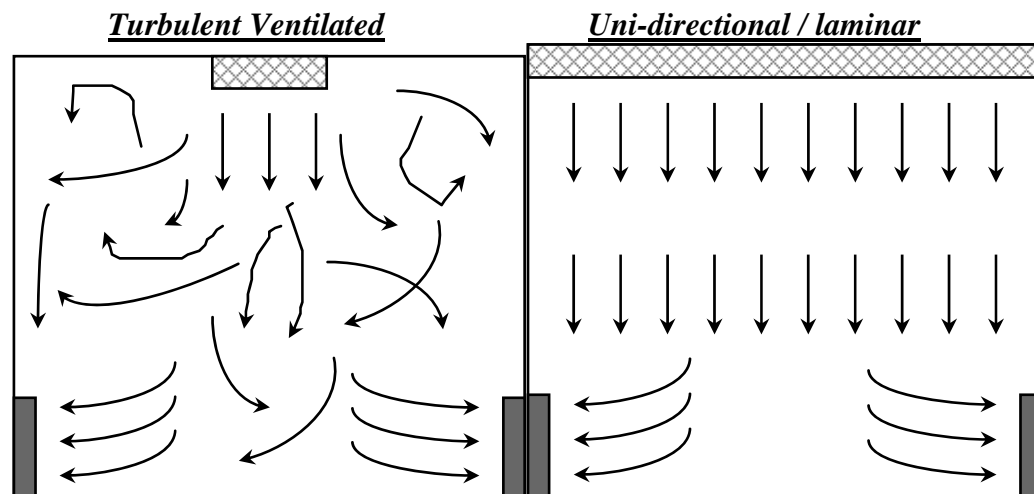


Figure 2: Cleanroom design

Figure 2 shows the difference between a Unidirectional and Non-unidirectional flow cleanroom design.

4.0 Airborne particle Counter/sensor application

Two common application of particle counters/sensor are process monitoring and cleanroom monitoring.

In process monitoring, particle counts are sampled at critical area of the production or within a mini-environment. There are no common standards for this application as production equipments or process varies.

Table 1: Selected ISO 14644-1 airborne particulate cleanliness classes for cleanrooms and clean zones

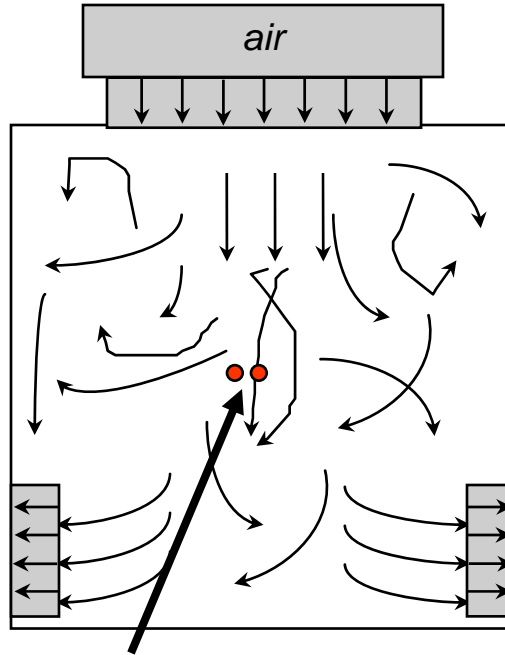
ISO Classification number	Maximum concentration limits (particles/m ³ of air) for particles equal to and larger than the considered sizes shown below					
	>=0.1µm	>=0.2µm	>=0.3µm	>=0.5µm	>=1µm	>=5.0µm
ISO Class 1	10	2				
ISO Class 2	100	24	10	4		
ISO Class 3	1 000	237	102	35	8	
ISO Class 4	10 000	2 370	1 020	352	83	
ISO Class 5	100 000	23 700	10 200	3 520	832	29
ISO Class 6	1 000 000	237 000	102 000	35 200	8 320	293
ISO Class 7				352 000	83 200	2 930
ISO Class 8				3 520 000	832 000	29 300
ISO Class 9				35 200 000	8 320 000	293 000

The information required for determining the air cleanliness within a room is to determine the number of sampling locations, the sampling volume and counting the number of airborne particles. The worked examples of classification calculations can be found in the ISO 14644-1 Annex D (informative).

5.0 Particle counter comparison test

With the understanding of Cleanroom and the Particle Counter, a simple test is being performed to enhance the understanding of its application.

Particle counter comparison test method is commonly practiced in various industries to justify the “functionality fitness” of a particle counter. Figure 3 shows two particle counter of the same brand sampling particle count data at the same location.



Particle Counter A & B placed very near each other.

Figure 3: Particle Count sampling test

The airflow pattern is shown in the diagram and it varies every second depending on the amount of personnel and machine movement. The air velocity of every Fan Filter Unit may vary every second.

Table 2: Particle count sampling test data

Time	Particle Counter A (0.5um)	Particle Counter B (0.5um)
14:00	20 Counts	10 Counts
14:01	80 Counts	150 Counts
14:02	10 Counts	16 Counts
14:03	90 Counts	10 Counts
14:05	150 Counts	300 Counts
14:05	600 Counts	200 Counts

Table 2 shows the test result and may suggest that one of the particle counters is not “functionally fit”. It is important to understand that no two particle counter will display the same particle count when sampling is perform at one location within a cleanroom. As the Cleanroom Class increase, the differences in particle count of two particle counter increases. A laminar flow cleanroom will provide better comparison representation.

The following variables should be considered while performing this test:

- cleanroom airflow pattern
- Fan Filter Unit's air velocity changes from time to time
- Particles generated by machines movements
- Particles generated by human movements
- Difference in flow rate of particle counter

However, such a test can be carried out using an aerosol particle generator or a zero count filter. The aerosol particle counter removes the above variables by injecting a controlled amount of particles. Therefore, yearly calibration is recommended for any particle counter to check and ensure that the particle counter is accurate.

6.0 Summary

This paper provides a general understanding and addresses the common misunderstanding in particle counter application and interpretation of particle count data.

The ISO 14644-1 standard common terms and calculation are used as it has replaced various federal standards. The ultimate aim of measuring the particle counts within a cleanroom is to check the integrity of the cleanroom. Control measures such as cleanroom disciplines and cleanroom protocol are important factors that contribute to the cleanliness of the cleanroom.

7.0 References

Whyte, W. 2001, *Cleanroom Technology*, John Wiley & Sons, Ltd, England, pp 162-163.

International Standard 1999, *ISO 14644-1*, International Organization for Standardization, Switzerland.