CLEAN ROOM AS A KEY-FACILITY FOR TOMORROW'S HIGH TECHNOLOGICAL INDUSTRIES

A new age came after and as a result of some long history in the past days. However, in now-a-days, people are surprised at so remarkable and speedy improvement of daily living circumstances that they could hardly foresee. Seeing the development of electronics industry represented by VLSI, exotic materials, biotechnology in pharmaceutical and medical field or highly advanced communication network system, etc., we can name the very near future just before the 21st Century as an Age of Technical Innovation.

Clean Room Technology is an integrated technology which makes such high technological industries possible. Provision of super clean environment and its control technologies bring a precise production facility and contribute towards the technical research, development and experiment.

Takasago, with its technical know-how and capability, systematizes and controls every factors related to Air and Heat, such as, cooling, heating, humidity control, drying, dust elimination, energy saving, etc., and has greatly contributed to the development of industries and society in every age as a pioneer of Clean Room with many experiences more than a quarter of a century in the field of HVAC system's design and installation.

Takasago is pleased to meet any requirement of Clean Room from its basic plan to the design, installation and maintenance as a Turn-Key project.

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REASON WHY CLEAN ROOM IS NECESSARY

In the high technological industries such as electronics, optical and biological industries, the newly developed commodities are manufactured with precise fabrication as a basic process. Both production yield and product quality are, therefore, affected by invisible airborne particles or dust. For example in manufacturing of Semiconductor, the design rule of ULSI is now minimized to the line width of submicron. In this case, the size of particle to be eliminated in the clean room is smaller than 0.05 micron meter, namely, 1/5 ~ 1/10 of the design rule, which means that only a super clean environment can be accepted for its production process.
Also, in food processing, medical or pharmaceuticals, how to control the micro-organism is a key point to maintain the quality, which can be performed by clean room.

WHAT IS CLEAN ROOM

Clean Room is defined as "a specially constructed room in which the air supply, air distribution, dust and airborne particle, room pressure, temperature and humidity are environmentally regulated to meet appropriate cleanliness level".

Particle referred here means a particle as small as 1/1000 of human hair in diameter, which is equivalent to 1/100 of the smallest visible limit. These small particles affect to production yield and product quality to a great extent.

Air filters being used in common HVAC system can never collect these particles. Also many factors other than air supply are to be carefully managed to make clean environment condition. Clean Room is what solves these subjects.

Clean Room is divided into two kinds by application; one is Industrial Clean Room and the other Biological Clean Room. The latter, together with clean room function, controls contamination density of micro-organism and plays an important role in clinical research and examination, development of medicines, research and improvement of cultivation cycle and plant breeding, etc.

The clean air technology development has taken further steps with the progress of APOLO Program by NASA. During this progress, a high efficient filter has put into practical use, and its development has now advanced from 0.3 micron meter HEPA Filter (High Efficient Particulates Air Filter) to ULPA Filter (Ultra Low Penetration Air Filter) which can eliminate 0.1-0.2 micron meter particles in diameter at so high efficiency as 99.999%.

Not only visible dust but also invisible airborne particles are kind of enemy for quality control.

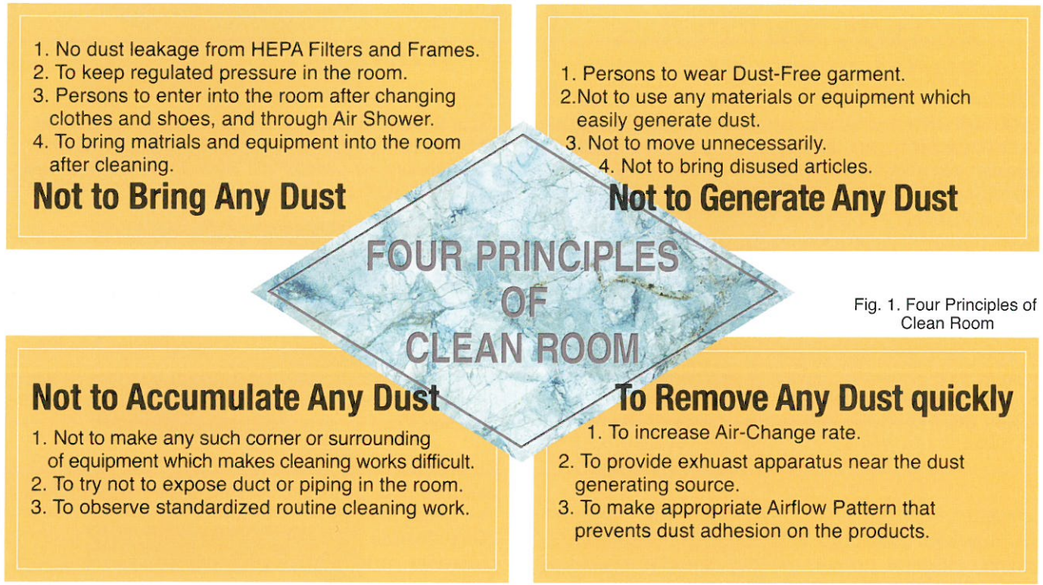
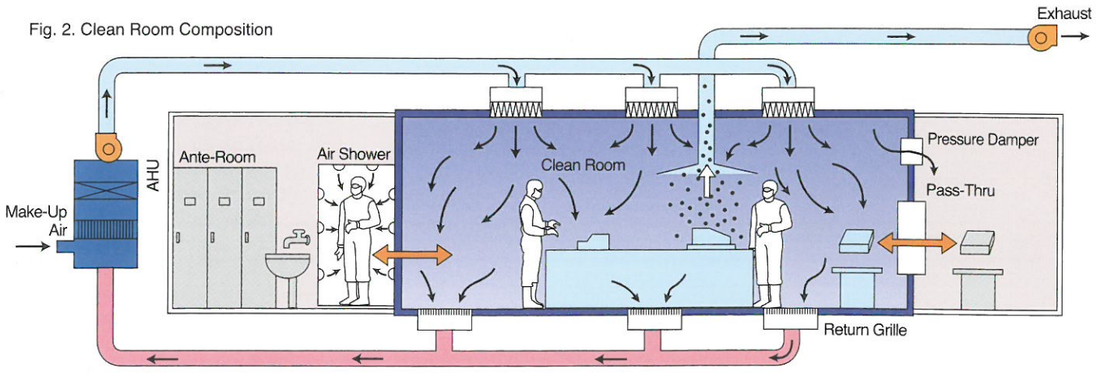


Fig. 1. Four Principles of Clean Room

In order to maintain cleanliness in Clean Room, "FOUR PRINCIPLES" shown in Fig. 1 must be observed. Namely, "Not to Bring", "Not to Generate", "Not to Accumulate" and "To Remove quickly" any dust. Fig. 2 illustrates Clean Room composition. The part enclosed by thick line shows Clean Room.

Fig. 2. Clean Room Composition

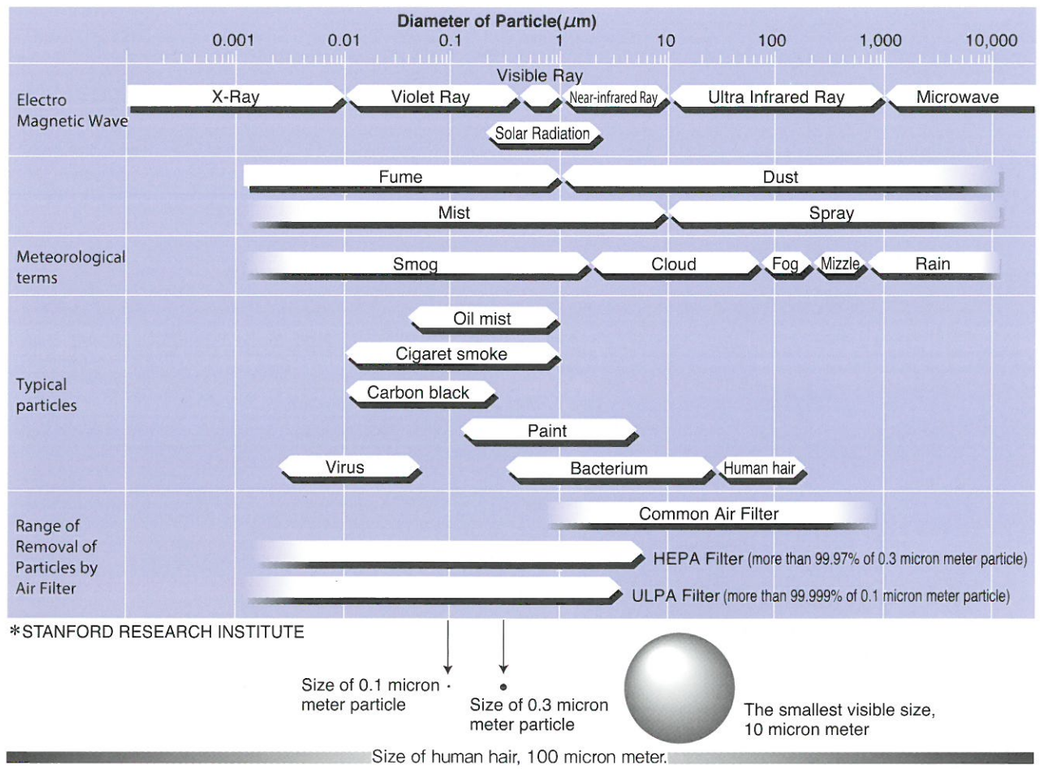


Dust and Particles to be controlled in Clean Room

The dust and particles controlled in Clean Room are very small and invisible as shown in Fig. 3. Visible particle is generally larger than 10 micron meter, which is removed out at the stage of Pre-Filter. In case of Clean Room, socalled submicron particle, smaller than 1 micron meter, is the subject to control. According to the United States Federal Standard the cleanliness is defined on the basis of 0.5 micron meter particle in diameter.In Fig. 3, around 0.5 micron meter particles are smog, oil mist, cigaret smoke, etc. These are in sight only when they are condense, but not discretely. Like this, in Clean Room, the subjects are such small particles that they can not be visible without using microscope.

HEPA Filter used in Clean Room can remove particles larger than 0.3 micron meter in diameter with more than 99.97% collection efficiency. ULPA Filter now being used in Super Clean Room for semiconductor industries has more than 99.999% for 0.1 micron meter particle, and is able to make the supply air free from particle.

Fig. 3. Comparison of Particles



"Class" of Clean Room is expressed by the value of X of $10^X/M^3$ which shows the concentration of Particle of 0.1 micron meter and larger in diameter contained in one cubic meter of the air.

Standards of Clean Room

Clean Room technology was introduced to Japan from the United States, and therefore, American standards have mainly been applied in Japan.
In recent years, however, through a work of international standardization of various standards by ISO, Clean Room is also discussed and JIS Class (JIS B 9920 '89) tends to be its standards. Not exception in the American Standards, the recent Federal Standards 209E ('92/09) applies the value of X of $10^X/M^3$ to expression of Class of Clean Room, same as in JIS, although the size of objective particle still remains unchanged as 0.5 micron meter and larger in diameter.

Table 1 shows the comparison of Class in JIS B 9920 and U.S. Federal Standards 209E, both of which are most applied in Industrial Clean Room.
Fig. 4 shows the distribution of particle size by each Class in JIS B9920.
It must be added, however, that, for expression of Class of cleanliness, the concentration of particle of 0.1 micron meter and larger in diameter in one cubic foot of the air is still applied by usage in Japan. Also main items to control Clean Room function, such as temperature, humidity, room pressure, supply air velocity etc., are freely set up according to the needs.
For Class of Biological Clean Room of pharmaceuticals, hospitals or test animal breeding facilities, NASA Standard, only in which micro organism is regulated, is used. Table 2 shows the outline of U.S. NASA Standard (NHB-5340-2).

Table 1. Comparison of Class cleanliness betwen JIS and Fed. std. 209E

JIS B 9920 Maximum Particle Concentration (Nos/M³)				Fed.std. 209E Maximum							
Class	0.1μm	0.5μm	5.0μm	Class SI	Class British Unit	0.1μm (Nos/M³)	0.1μm (Nos/ft³)	0.5μm (Nos/M³)	0.5μm (Nos/ft³)	5.0μm (Nos/M³)	5.0μm (Nos/ft³)
1	10^1	(0.35)									
2	10^2	(3.5)									
3	10^3	35		M1.5	1	1240	35	35.3	1		
4	10^4	350		M2.5	10	12400	350	353	10		
5	10^5	3500	29	M3.5	100			3530	100		
6	(10^6)	35000	290	M4.5	1000			35300	1000	247	7
7	(10^7)	350000	2900	M5.5	10000			353000	10000	2470	70
8	(10^8)	3500000	29000	M6.5	100000			3530000	100000	24700	700

Remarks : Only typical sizes of particle are stated in the above table. For other sizes of particle, refer each standards. As the trend of particle distribution differs a little in each other between JIS and Fed.std., correct comparison of Class is not available.

In JIS, $N = 10M(0.1/d)^{2.08}$ / In Fed.std. $N = 10M(0.5/d)^{2.2}$
N : Max. concentration (Nos/M³) of particle of size d and larger
M : Class of Cleanliness (-) / d : Particle size (micron meter)

Fig. 4. JIS Standard B9920-'89

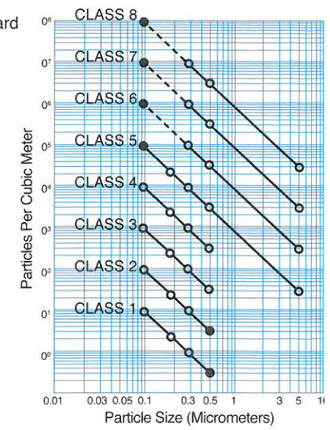


Table 2. Outline of NASA Standard (NHB-5340-2)

Bio-Clean Room Class	Particle		Bacteria	
	Diameter (μm)	Accumulated Numbers per ft3 (per litre)	Floating Quantity per ft3 (per litre)	Sedimentation per ft2/week (per M2/week)
100	≧ 0.5	≦ 100 (≦ 3.5)	≦ 0.1 (0.0035)	1,200 (12,900)
10,000	≧ 0.5	≦ 10,000 (≦ 350)	≦ 0.5 (0.0176)	6,000 (64,600)
	≧ 5.0	≦ 65 (≦ 2.3)		
100,000	≧ 0.5	≦ 100,000 (≦ 3,500)	≦ 2.5 (0.0884)	30,000 (323,000)
	≧ 5.0	≦ 700 (≦ 25)		

CLEAN ROOM

COMPARISON OF CONTAMINATION DENSITY

Let us compare the numbers of airborne particle or microorganism in Clean Room with our surrounding environment.

The numbers of particle in general environment vary time to time so that any fixed number can not be determined, but roughly classified as shown in Fig.5. From this Figure, you will see that such a clean condition in the highest class Clean Room can not be found in the natural world, even in the upper area of stratosphere. Also, even in the center of Pacific Ocean, the cleanliness level of the air is lower than that of middle class of Clean Room. In other words, Clean Room is an ultra clean space where airborne particles or microorganism are extremely eliminated so much as we can never experience in our normal life.

DUST GENERATION FROM HUMAN BODY AND ITS QUANTITY

Human body is one of the biggest sources of dust generation, and its quantity are different each other depending upon the person, kind of his movement, kind of his garment and others, and can hardly be determined, but the rough figures are shown in Table 3.

Table 3. Dust Generation from Human Body and Quantity *

(1) Particles (over 0.3μm)

Kind of Movement	Nos. of Particles/ per minute (≧ 0.3μm)
Sitting or standing (on movement)	100,000
Sitting (slightly moving head, arm and hands)	500,000
Sitting (slightly moving body and foot)	1,000,000
Standing up from a sitting position	2,500,000
Walking about 1 meter/per second	5,000,000
Walking about 1.5 meters/per second	7,500,000
Walking quickly	10,000,000
Climbing stairs	10,000,000
Gymnastic exercise	15,000,000 – 30,000,000

(2) Bacteria

Kind of Movement	Nos. of Bacteria/ per minute
In operation	
Under strict bacterial control	5,000
On average	10,000
Without bacterial control	50,000
In Laboratory:	
Heavy movement	15,000
Medium movement	8,000
Slight movement	4,000

* P.R. AUSTIN : DESIGN & Operation of Clean Room

Fig. 5.

** JB-1504

Pursuit of high quality starts from pursuit of Ultra Clean Space

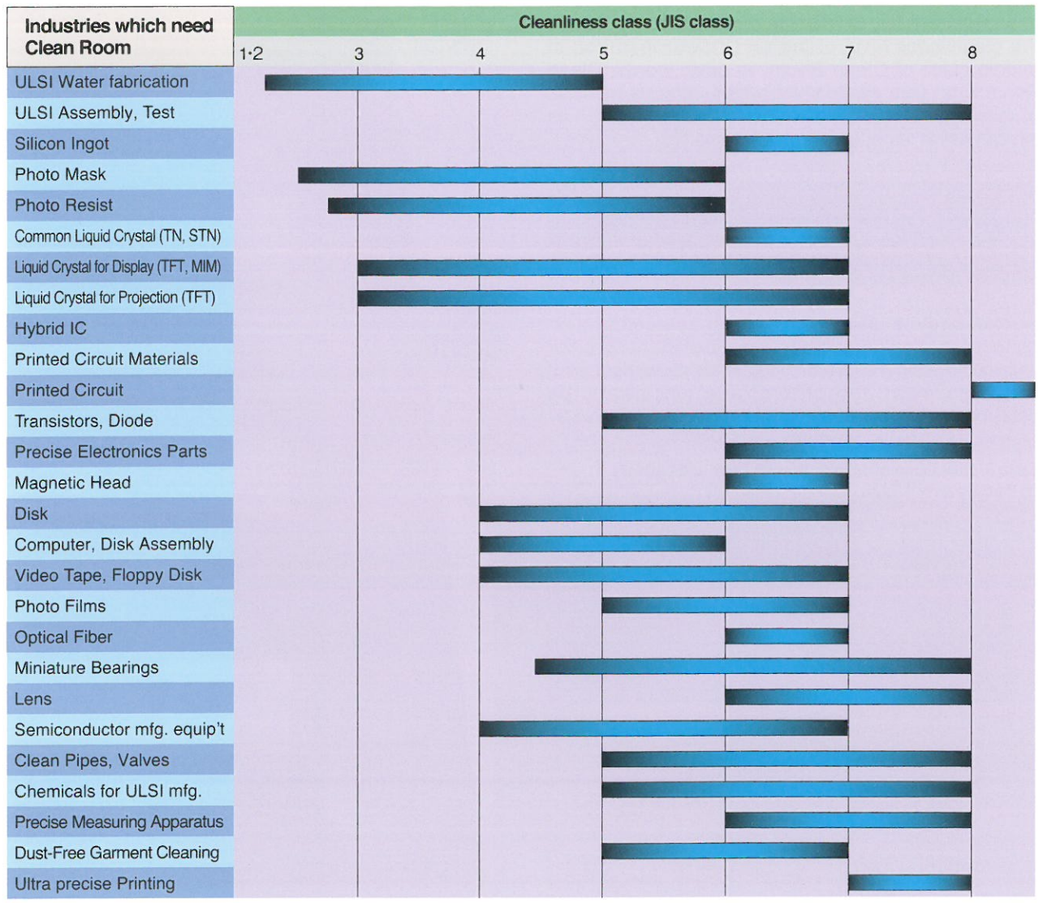
Industrial Clean Room is mainly applied in electronics industry standing for Semiconductor manufacturing represented by IC/LSI. Furthermore, now-a-day, it extends its application in new material developmenent and Fine Chemical industry.

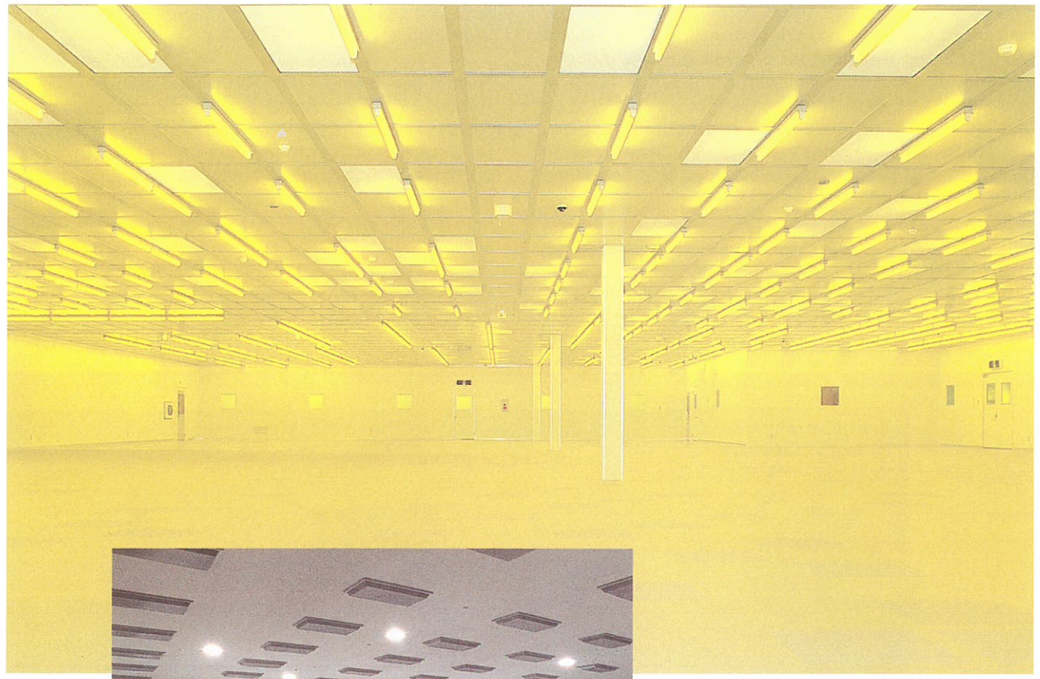
One of the Industrial Clean Room particulars is that its employment will get the investment capital returned with the improvement of quality and production yield of the products. In short, the investment for Industrial Clean Room is profitable. What level of Clean Room is necessary for what kind of product is well known through many experiences.

It is important to arrange as much as possible the higher cleanliness Clean Room for the more important production area and lower and economical Clean Room for other areas.

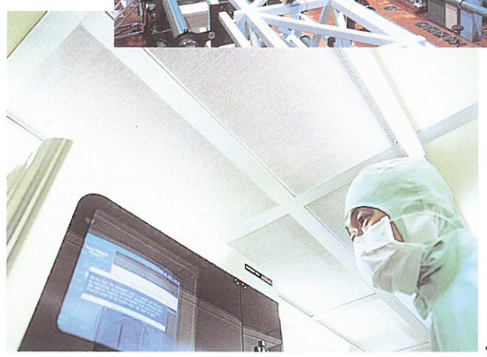
Fig.6 shows the industries which need Clean Room and the cleanliness class generally applied therein.

Fig.6. Fields of Application of Industrial Clean Room and desired Cleanliness class





Vertical Unidirectional Airflow Clean Room



JIS Class 4 Clean Room

TCR-MP (Multi Purpose Type Clean room)

Contributing towards development of future industries such as pharmaceutical, life science, genetic engineering, food processing, etc.

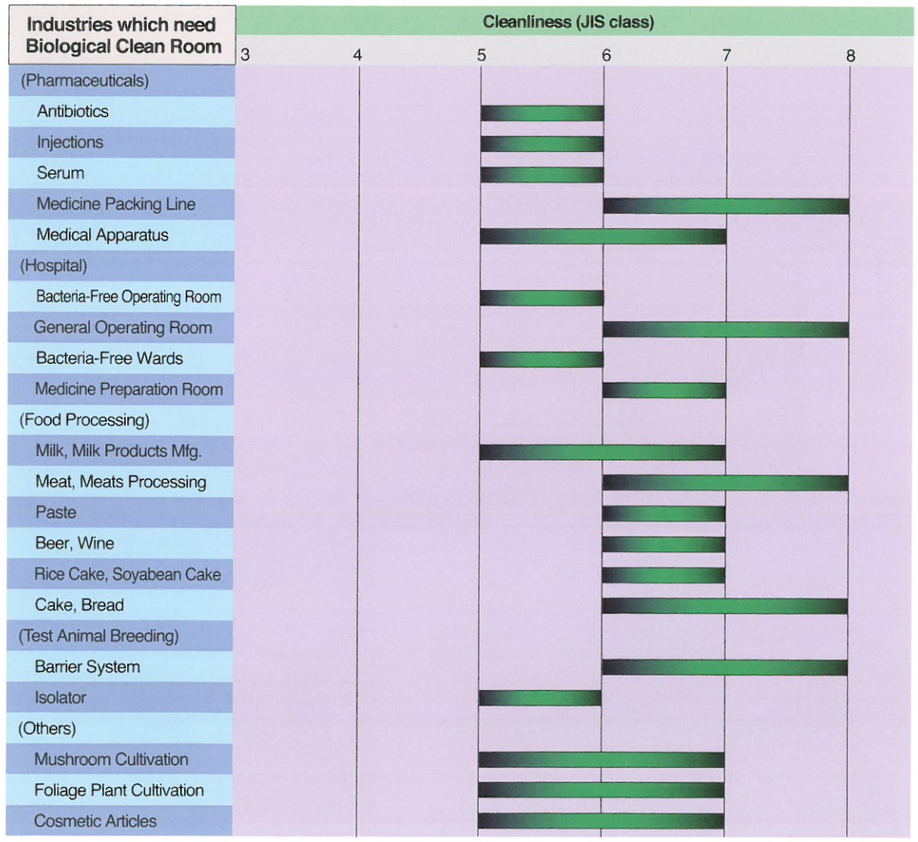
Biological Clean Room, which controls microorganism, has been widely demanded to meet GMP (Good Manufacturing Practice) for pharmaceuticals industry and also to provide a bioclean condition in hospital operating room. Also, because GMP is scheduled to be applied in food processing or cosmetic industries, Biological Clean Room has already been used in manufacturing process of Retort Food and Longlived Food or in filling process of drinks.

On the other hand, GLP (Good Laboratory Practice Regulations) has been enacted in force for Test Animal Breeding Chamber, essential facility for R&D and manufacturing of medicines, for which Clean Room technologies are required.

Recent development of biological technologies such as Recombinant DNA needs a precisely controlled Clean Room to protect experimentors against any infection or to prevent outside environment from being contaminated. Biological Clean Room will have much wider application in future with the advancement of high technologies.

Fig. 8 shows the industrial fields where Biological Clean Room is necessary and the cleanliness required.

Fig. 7. Field of Application of Biological Clean Room



High stability, low pressure difference control system LO-VST®

Offering reduced power consumption for operation control and securing stable room pressure for various operation mode changes

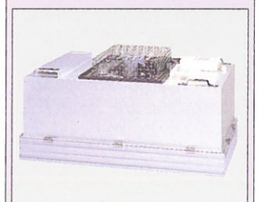
The LO-VST® system performs high precision control of the room pressure in highly airtight rooms, where stable control is considered to be difficult.
Even when the door is opened and closed or when the flow rate is reduced to reduce energy consumption, control is possible to ensure that there are no great variations in pressure inside the room by the system configuration of as following.

- Sudden changes in the room pressure when the door is opened and closed are suppressed with linked control of the doors and dampers.
- Variations in room pressure when the air flow rate changes are suppressed with the variable operation speed of the dampers.
- Start-ups in a short period of time are made possible with the use of a general purpose controller.

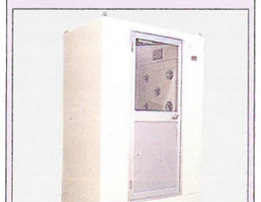
Fully-equipped with various accessories to eliminate causes of dust and bacteria generation in Clean Room

Even if the clean air is supplied by Clean Room system, there is still a big problem of contamination caused by movement of persons and operation of machines. Moreover, the Clean Room is all the time under risk of outside contamination because of coming in-and-out of persons and delivery of materials. In order to prevent this problem, importance is to provide completely various accessories with which Clean Room can perform its function, as well as strict observation of daily routines in accordance with "Four Principles". This is particularly important in Non Unidirectional Airflow Clean Room where affection of contamination is widely extended.

TFFU®(Fan Filter Unit)
Essential Part of TCR super MP.
Contributing to saving initial and running cost.



Air Shower
Air shower located at entrance to Clean Room blows high speed jets clean air on persons to dedust and to remove bacteria from their clothes. Airlock mechanism keeps Clean Room in positive pressure.



Pass Box
The pass-thru is an air-locked facility for the delivery of items. The doors on both sides cannot be opened simultaneously and are equipped with glass windows for viewing the inside.

Barometric Damper
This keeps inside pressure higher than that of outside, protecting Clean Room from outside contamination. Desired pressure adjustable.

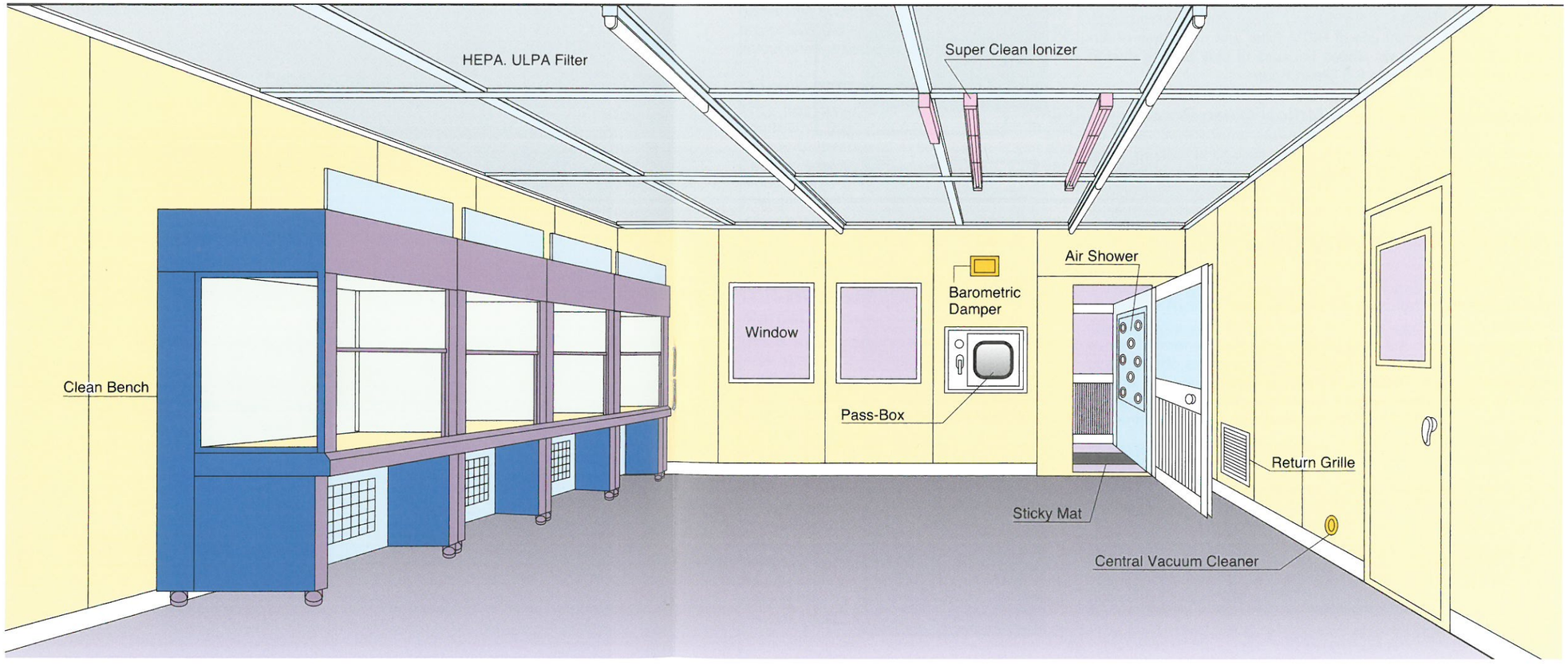
Dust-Free Garment
Nylon or Tetron material, and sometimes special thread is included for anti-electrostatic affect. Caps, masks, shoecovers, gloves, etc., in addition to garments.

Clean Air Dryer
It is not advisable to wipe hands by towel which generates dust. Recommend to use Clean Air Dryer.

Fig. 8. Inside of Clean Room

Shoe Brush and Sticky Mat
For removal of dust not only from sole but also from shoe upper, shoe-brush better be combined with central vacuum cleaning system. A sticky mat is placed at the entrance.

Cleaner
Central vacuum cleaning system should be employed. Fans and dust-disposer are located in machine room. Only a hose connection is placed in Clean Room. A handy type with HEPA Filter is also availa



Three basic types of Clean Room classified by airflow pattern

Non unidirectional Airflow Clean Room

Horizontal Unidirectional Airflow Clean Room

Vertical Unidirectional Airflow Clean Room

Clean Room is generally classified by Cleanliness or by Air Flow Pattern. Classification by Cleanliness was explained in Page 4, and here Classification by Air Flow Pattern is described. It is roughly divided into three as basic types. Tunnel system, Open-Bay system and TCR-MP, as the combination of the basic types, are explained in the next page.

Basic Types

Non unidirectional Airflow Clean Room

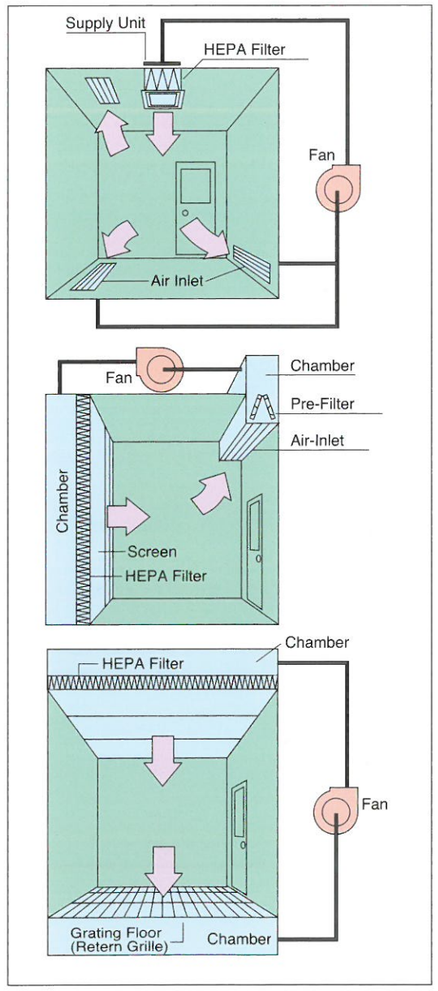
Air is supplied from Supply Units in the ceiling and returns to Return Grille at corner of the room. Almost same method as in common building, except use of HEPA Filter and more time of Air-Change. Cleanliness level limited because of only diluting dust in the air. Applied to JIS Class 6-8 Clean Room.

Horizontal Unidirectional Airflow Clean Room

Unidirectional air stream flowing uniformly from HEPA Filters on wall face to return grille of opposite side wall or ceiling. Dust exhausted with the air without falling down. More contamination in downsteam side, but JIS Class 3-4 level cleanliness obtainable in upper stream side. Bad affection by dusts detected only in downstream side. The highest level cleanliness expected depending way of use. Applied in bio-clean operating room or patient Isolator Room in hospital.

Vertical Unidirectional Airflow Clean Room

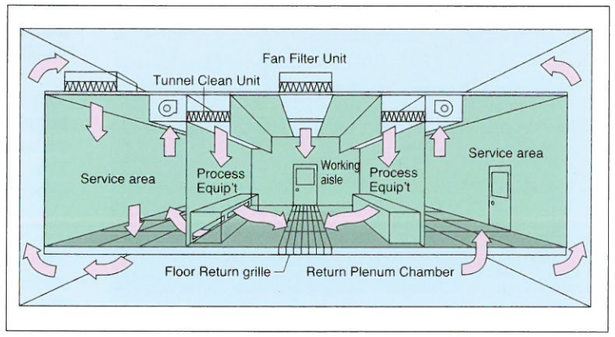
Unidirectional air flows vertically from ceiling fully covered with HEPA Filter down to the floor. Unless any dust generated above working area, JIS Class 4 or higher level cleanliness obtainable in whole working area. Even if any dust generated, they are inhaled quickly to floor surface without affecting to other working areas. Applied in many IC/ULSI industries. However, higher construction cost and wider space required.



Mixed Flow Clean Room (Combination of Basic Airflow Patterns)

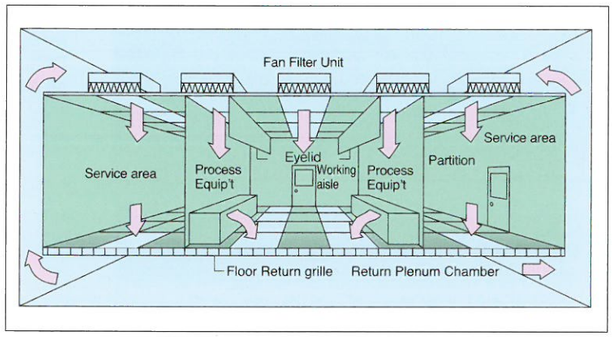
Tunnel Clean System

This system has been developed to save high running cost required in Vertical Unidirectional Airflow Clean Room. The room is divided into Process areas and Service or Maintenance areas. Only process areas are covered by the highest level cleanliness, by which saving of both energy and space is expected. It is much employed in Semiconductor manufacturing plant same as Vertical Unidirectional Airflow Clean Room. Disadvantages are that the cleanest area arrangement is limited depending upon the size and shape of process equipment and also that it has less flexibility for layout change and shift of equipment.



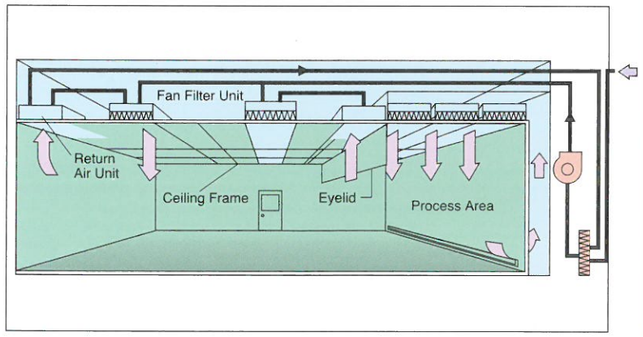
Open Bay System

This has been developed by Takasago employing the advantages of Flexibility of Vertical Unidirectional Airflow Clean Room and Energy saving of Tunnel Clean System. Process Area and Service Area can freely be arranged with partitions. Ceiling Filter System is composed of HEPA Filters and Blind Panels, by combination of which change of space and cleanliness level can be facilitated.



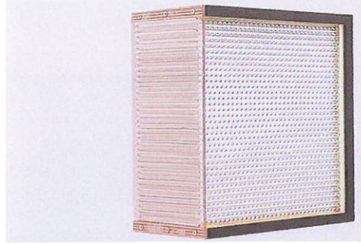
TCR-MP System (Partial Unidirectional Airflow)

This is a Takasago's own development clean room system. It is composed of a number of 1,200 X 600mm standard module units being equipped with Fan Filter Unit or Return Air Unit, which are placed on a ceiling module frame suspended from the ceiling of building, so that clean rooms with desired space and cleanliness can be provided. Without partition, JIS Class 5 or higher level of Unidirectional Airflow area can be partially arranged in a Nonunidirectional Airflow clean room with ceiling air supply and ceiling return air system. Design of the system according to the existing process lines or for more effective use of the existing floor or future expansion or reduction is easily made possible.



HEPA Filter is the key to Clean Room

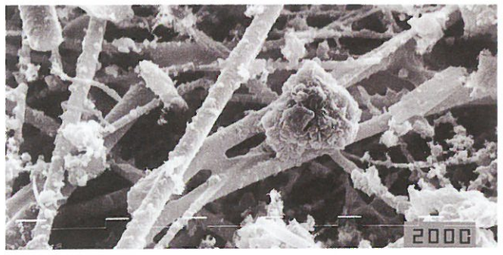
HEPA Filter



HEPA Filter stands for High Efficiency Particulate Air-Filter and is the most important item among those composing Clean Room. It is defined as "A throw-away extendedmedia dry-type filter in a rigid frame having minimum particle-collection efficiency of 99.97% for 0.3 micrometer thermally-generated dioctyl phthalate (DOP) particles or specified alternative aerosol, and maximum clean-filter pressure drop of 2.54 cm (1.0 in.) water gage, when tested at rated air-flow capacity".

The air filtered by HEPA Filter is so clean for being supplied into Clean Room as containing very little dust or bacteria. Recently, more efficient ULPA Filter (Ultra Low Penetration Air Filter) has been developed and used in VLSI manufacturing.

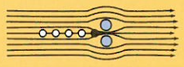
Construction of HEPA Filter



The filter media thickness is around 0.4mm (400 micron meter) made of unregularly overlapped glass fiber of about 0.5 micron meter in diameter. In the left photo, the thickest fiber is about 2 micron. The particle must travel through 400 micron thickness, during which not only large but also small particle is caught by the fiber media. Small particle does not always pass through the fiber media. It is apt to be caught by Diffusion Effect. Around 0.1 micron meter particle is said to be the most difficult one to collect.

Principles of Collection of Particlels

STRAINING

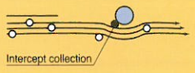


Particles are collected by fiber media same as by screen. Larger particles are caught easily by this principle.

INERTIA

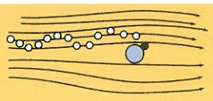
A massive particle approaching to fiber media will not follow the airflow but have a more direct path by inertia and strikes on fiber media and is caught. Effect is greater for more massive particle and for higher velocity.

INTERCEPTION



A particle approaching to fiber media touches its surface and is directly caught. Once the particle touches, it stays on the surface by Van Der Waals force.

DIFFUSION

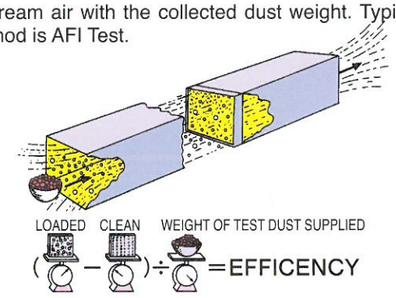


Particles move irregularly either by Brownian Motion or by a movement to make particle density uniform. By these irregular movement, particles are accessible to fiber media and adhere, resulting in increase of Interception Effect. Combination of Diffusion and Interception gives greater effects of collection particularly for smaller particle.

Expression of Filter Efficiency and Test

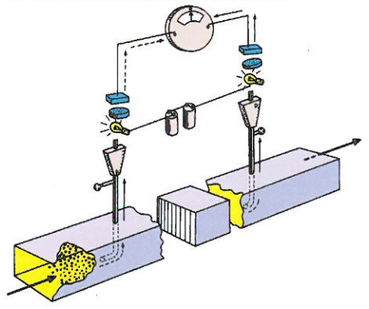
Weight Test

It is to obtain dust collecting efficiency by comparing contamination level between downstream air and upstream air with the collected dust weight. Typical method is AFI Test.



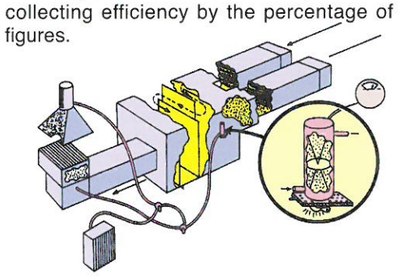
Discoloration Test

This is to compare the dirty conditions of two sheets of paper placed in each upstream and downstream. Typical one is ASHRAE 52/76 Standard.



DOP Test

This is to calculate the numbers of dust contained both in the upstream and downstream, and to obtain the collecting efficiency by the percentage of the two figures.



Bacteria Collecting Efficiency

Effectiveness of HEPA Filter in viological clean room depends on its bacteria collecting efficiency. However, there is no filter manufacturer who warrants such efficiency. On the other hand, according to the experiment reports by scholars in some countries, HEPA Filter's collecting efficiency for bacteria or virus is confirmed better than that for DOP.

Table 5. Virus Collecting Efficiency by HEPA Filter

Types of Filter	Filter Resistance mmAq	Penetration %		
		Virus	Bacteria	Dust
(A) HEPA Filter Glasswool, Plastic adhesion binder	26	3.9×10^{-3}	1.1×10^{-4}	0.011
(B) HEPA Filter Glasswool, Asbestos, Organism binder	17.5	8.5×10^{-4}	7.2×10^{-5}	0.02
(C) HEPA Filter Glasswool, Without Organism binder, 76mm Depth	13.5	8.5×10^{-3}	2.8×10^{-4}	0.006
(D) HEPA Filter Same as above 300mm Depth	19	1.1×10^{-3}	2.3×10^{-3}	0.002
(E) High Efficient Filter 12.5mm Thick, micro glasswool pad.	13	1.9	0.23	–

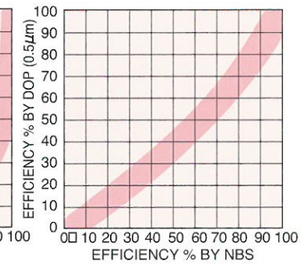
* Air Filtration of submicron Virus Aerosols, AACC Proc. 1967

Correlation between Measuring Test Methods

There is no definite correlation between the efficiency expressed by the aforesaid each test. However, since various types of filter are combined in actual use, an efficiency is to be calculated on a same basis. Fig. 10 and 11 show a converted efficiency line approximately obtained.

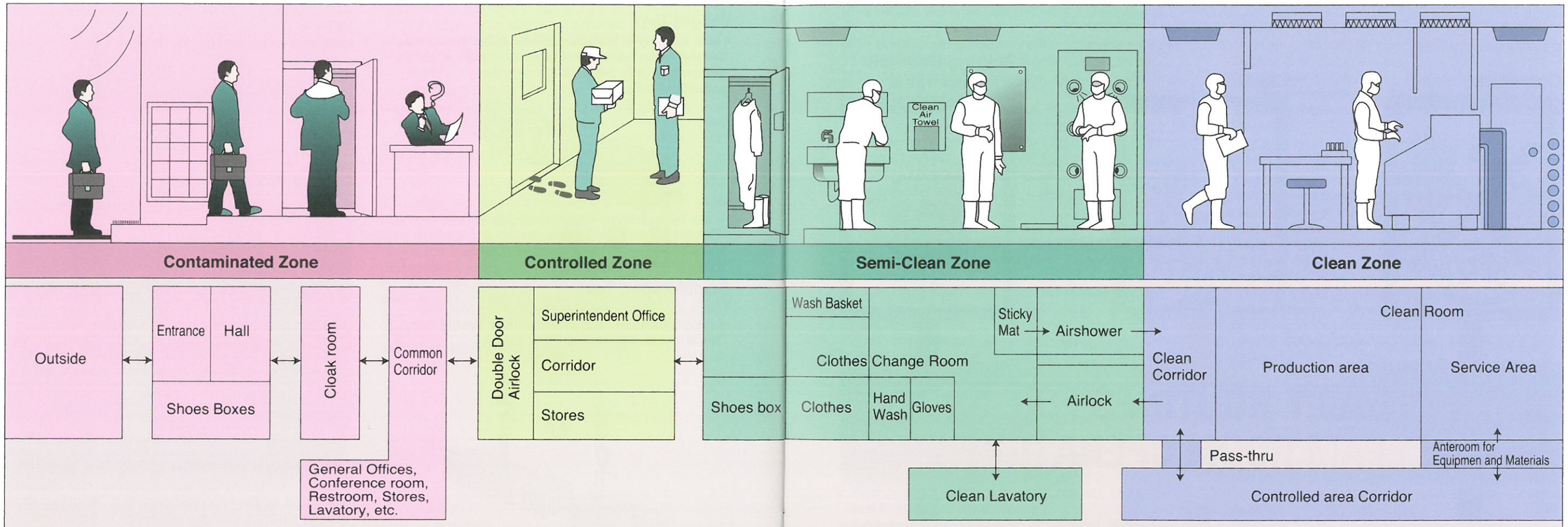
Fig.10

Fig. 11



To protect Clean Room against outside contamination

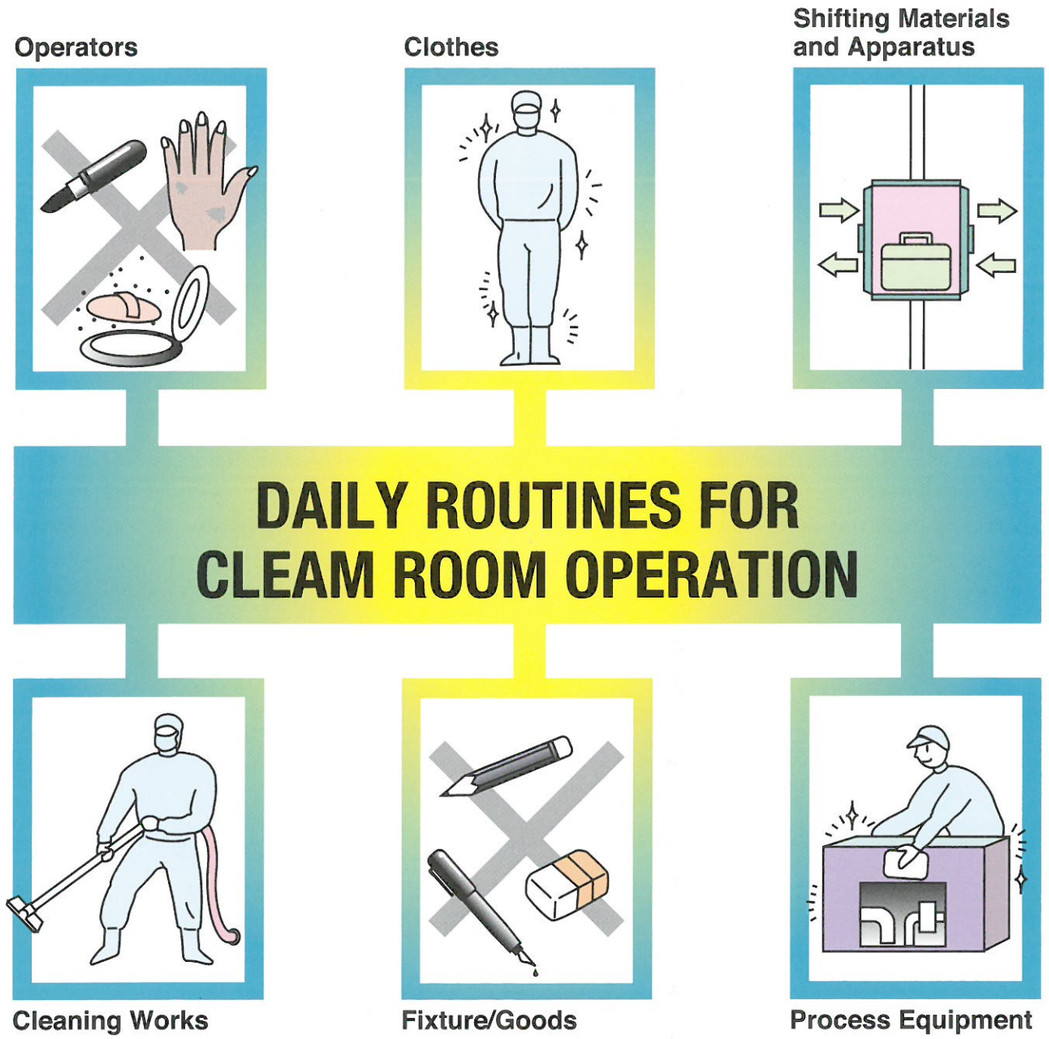
In order to prevent any outside contamination being brought into Clean Room, it is essential to provide Ante-Room as a buffer zone between Clean Room and outside contaminated area. Ante-Room itself functions as a big air-lock, which protects Clean Room against direct contact with outside environment. Shoes change room, Cloak-Room, Wash Stands, Air Shower, Sticky Mats etc. are provided in Ante-Room. All of these can prevent operators from bringing dust into Clean Room. For delivery of materials or equipment, it is better to prepare an another exclusive Ante-Room. The following chart shows a typical Ante-Room and a moving line of persons and materials.



Clothes	Clothes	Normal wear	Factory Uniform	Factory Uniform or White Garment	Facrory Uniform ↔	Dust-Free Garment, Hood, Mask	Dust-Free Garment (Mask, Gloves)	Dust-Free Garment, Hood (Mask, Gloves)
	Shoes	Outside Use	Rubber Shoes	Rubber Shoes or Exclusive Shoes	Robber Shoes ↔	Dust-Free Shoes	Dust-Free Shoes (Boots)	Dust-Free Shoes (Boots)
Action	Movement	Free	Free	Free		Moving as calmly as possible		Moving as calmly as possible
	Belongings	Free	Free	According to each Rules			Only Necessary Things	Only necessary Things
	Smoking	———	Free expect No-Smoking	Prohibited		Prohibited		Prohibited
Environ-ment	Structure	Not Specified	Not specified	No direct contact with Outside Air		No Contact with Air in Contaminated Zone, Easy Cleaning		Interrior materials to be less dust generating, Auto-Static, Chemical-Free
	Cleaning	General Cleaning	General Cleaning	Daily Routine Cleaning		Two to three times a day under Requlations		Conduct for each grade under Requlations
	Air	Not Specified	Common HVAC	Common HVAC		Circulating Clean Air supplied from HEPA Filter		Circulating Clean Air supplied from HEPA Filter or ULPA Filter

Problem is on invisible dust generation. Daily routine works very important.

The purpose of Clean Room is to improve the product quality and production yield and to prevent infection or crosscontamination in case of Biological Clean Room. Daily routines are, therefore, essential to achieve this purpose.Even if the air is cleaned, the surface of product is not alway clean. Dust generated during operation adhere and accumulate on work tables, process equipment, tools, floors, etc. If many quantity of dust are generated from operator, it greatly affects to the product quality as he approaches to the nearest place to the producs.
Clean Room can perform its function effectively only when the operators are so managed as to observe the regulations, rules or standards, and also that the clean room is well kept cleaned.



CLEAN ROOM

Operators

1. Education discipline and of operators for works in Clean Room.
2. To nominate a responsible person having a big power and right for Clean Room maintenance.
3. To limit as much as possible the numbers of person to enter into Clean Room.
4. To prohibit any person to enter when he sneezes, has cough, is allergy to solvent or has greasy hand.
5. To clean the body; mustache, long hair, scurf, dirt, long nails etc. are prohibited.
6. Cosmetics not allowed; Face Powder, Eye Shadow, Rouge or Lipstic are all dust generation sources.
7. Articles not to be brought into Clean Room; Personal belongings such as, common kind of paper, pensile, eraser, note-book, tissue paper, handkerchief, cosmetics, trinkets, etc., all of which are dust generation sources.

Clothes

1. Exclusive clean room garment prepared for each operator.
2. Cleaning of clean room garments in Clean Room.
3. Routine check for any tear, stain and life of garments.
4. Store of garments in some clean space.
5. Specifications of clean garment; Less dust generating quality, not passing dust but water, Anti static electrification, soft and comfortable, strong, and economical.

Shifting Materials and Apparatus

1. Delivery in-and-out of materials or apparatus through Pass-Thru.
2. Well cleaning before delivery to prevent any surface dust brought into Clean Room.
3. Better and safer to bring equipment, if big size, during non-operation time, to protect semi-fabricated products from contamination by turbulence of the air in the room.
4. Routine work of cleaning of Airlock, Pass-Thru and Semi-Clean zone to prevent dust accumulation.

Cleaning Works

Establishment of Standard or Rules for cleaning of following items;

1. Cleaning Tools; Vaccum Cleaner, Polisher, Clean Air Gun, Stainless or Plastic Basket.
2. Wipping Materials; Less dust generation wippers, Sponges, Mops and Rollers etc.
3. Cleaning Materials; Low residual neutral soap, Alcohol, Acetone, Freon etc.
4. Water; Use of City-Water, Primary purified water or D.I. Water depending on the level of Clean Room.
5. Cleaning Workers; By Process line's operators or specialists.
6. Frequency of Cleaning; For Process equipment, Work Tables, Floors, etc.

Fixture/Goods

Fewer numbers of fixtures or goods brought into Clean Room, and less dust generation materials thereof.

1. Tables, Chairs; Simple construction with plastic cups on legs. Stainless, Aluminum, Plastic or Resin Coated Steel Plate.
2. Carrier Case; Anti-wearing material of loading surface. Nylon or Synthetic Rubber Wheels. Case Cover.
3. Writing Goods; Dust-Free paper, Ball-Point, Plastic Cover, etc.

Process Equipment

1. To enclose or relocate such parts of belt or rotating and cooling equipment, if generating many dust.
2. Dismantling and well cleaning Process equipment before delivery.
3. Daily routine cleaning in Clean Room. To install Process equipment so as to facilitate easy cleaning work.
4. Well control for cleanliness of various gases, D.I. Water, Chemicals, same as for cleanliness of the air.

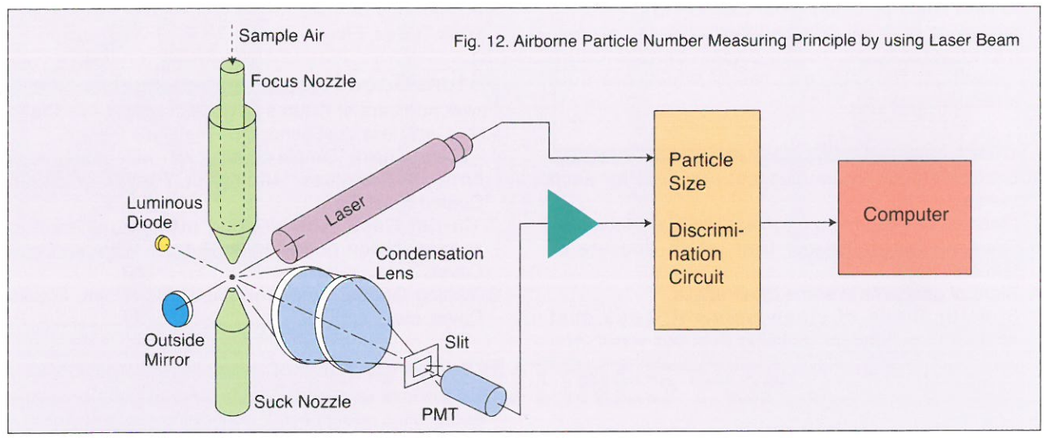
Quick measurement of larger than 0.1 micron particles in the air by Particle Counter.

Measurement of Particles

Laser Particle Counter has been developed to measure the numbers of airborne particle as they exist. The principle of this Counter is shown in Fig. 12. Test air is sucked into a small tube of 1-2mm in diameter. The tube has a small separated space, to which laser beam is emitted. If any particle goes through the space, it shines; called as Scattered Light. This scattered light is gathered to photoelectron multipular Tube (PMT), where the light pulse is converted to electric pulse. Numbers of particle is obtained from the numbers of the pulse, and the size of the particle is found by the scattered light strength as it represents a function of particle.

Laser Particle Counter can rapidly measure the numbers of airborne particle of larger than 0.1 micron meter, and is an important measuring apparatus for Clean Room. Recently, even around 0.05 micron meter particles can be measured with Condensation Nuclears Counter (CNC).

Fig. 12. Airborne Particle Number Measuring Principle by using Laser Beam

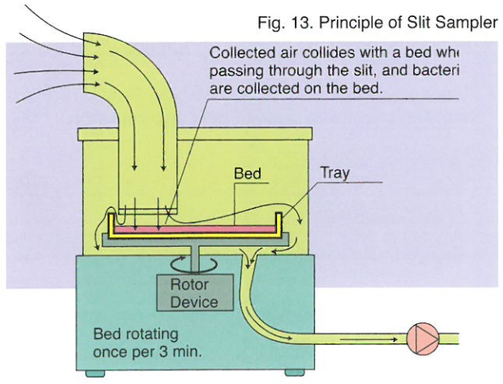


Measurement of Bacteria

The biggest problem in the measurement of bacteria is that its result can not come out immediately. Test bacteria requires 24 hours cultivation, and the test result varies in each case. Because the generation source of bacteria is mainly human body, a big difference appears depending upon the numbers of occupant, their position, kinds of movement, etc. Common method being generally applied are Drop Sampler, Slit Sampler or Pinhole Sampler. As Slit Sampler or Pinhole Sampler indicates the numbers of bacteria contained in an unit of air volume, this method is convenient in comparison of the result with the numbers of bacteria regulated by NASA Standard; for example 0.1/ft³ in Class 100.

In every method, it is important to obtain an average value by many times measurement for detecting the numbers of bacteria.

Fig. 13. Principle of Slit Sampler



TAKASAGO'S VARIOUS SYSTEMS AND APPARATUS RELATED TO CLEAN ROOM

TCR®-MP

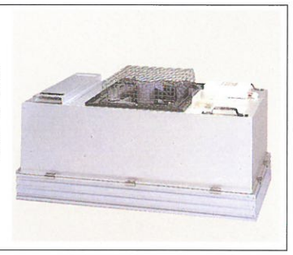
Prefabricated module type clean room composed of standardized equipment and materials. Suspended from ceiling beam of factory builiding, all the modular units are placed above ceilling, which makes process line layout free in a factory and installation period shorter.

TCR® Super MP

Supper Clean Room using FFU system which supports manufacturing process of the most advanced technical industries. By employing dry cooling coil for air-conditioning, machine room area greatly reduced and effective space more enlarged.

TFFU®
(Fan Filter Unit)

Many installation results with high appraisal.Essential part of FFU system demonstrating high efficiency and reliability. More than 50% of total fan efficiency has been achieved.

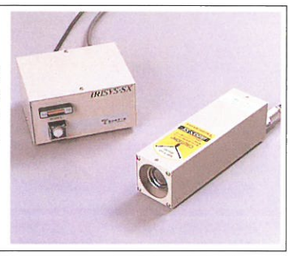


TSCI®
(Super Clean Ionizer)

Epochmaking Ionizer. No dust generation from emitter and controlling the balance between positive and negative ion density. Great effective for countermeasure against electrostatic charge problem in Clean Room.

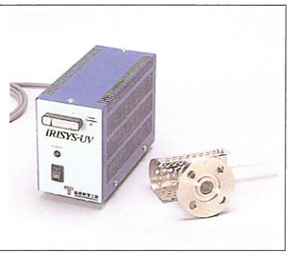
IRISYS®-SX
(Soft X-Ray Irradiation Neutralization System.)

It directly ionizes gas molecules in the air by Soft X-Ray with high energy. Capable of dielectrostatic to OV in a short time without affection by air flow.



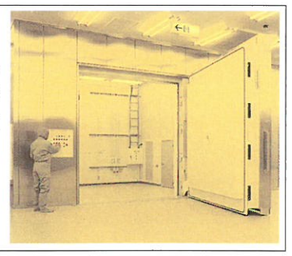
IRISYS®-UV
(Vacuum Ultra Violet Irradiation Neutralization System.)

Capable of neutralizing electrostatic potential to inert gas or OV in a vacuum space, which conventional technique could not achieve. An irradiation type neutralization systm to process equipment.



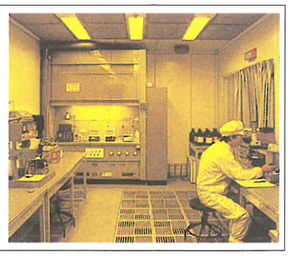
DELTAT®-5000

Control System precisely regulating atmospheric pressure in a complete air-tight space. Employed to Lithography process of ULSI



SECTAT®-CR

A contral systm to maintain the cleanliness and room pressure. It detects numbers of particle in Clean Room, computes necessary air volume to satisfy the set values and regulates the circular fan motors acccordingly.

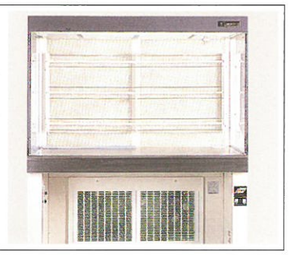


TCR®-MP Clean Booth

Ceiling panel, Fan Filter Unit, Frame etc., are all modular. The booth is enclosed by vinyl curtain. Various types are prepared for many different ways of use.

Apparatus

Air shower, Clean Bench, Pass-Box and other devices are available to maintain the cleanliness of Clean Room.



Clean Bench