

THE WORLD LEADER IN CLEAN AIR SOLUTIONS

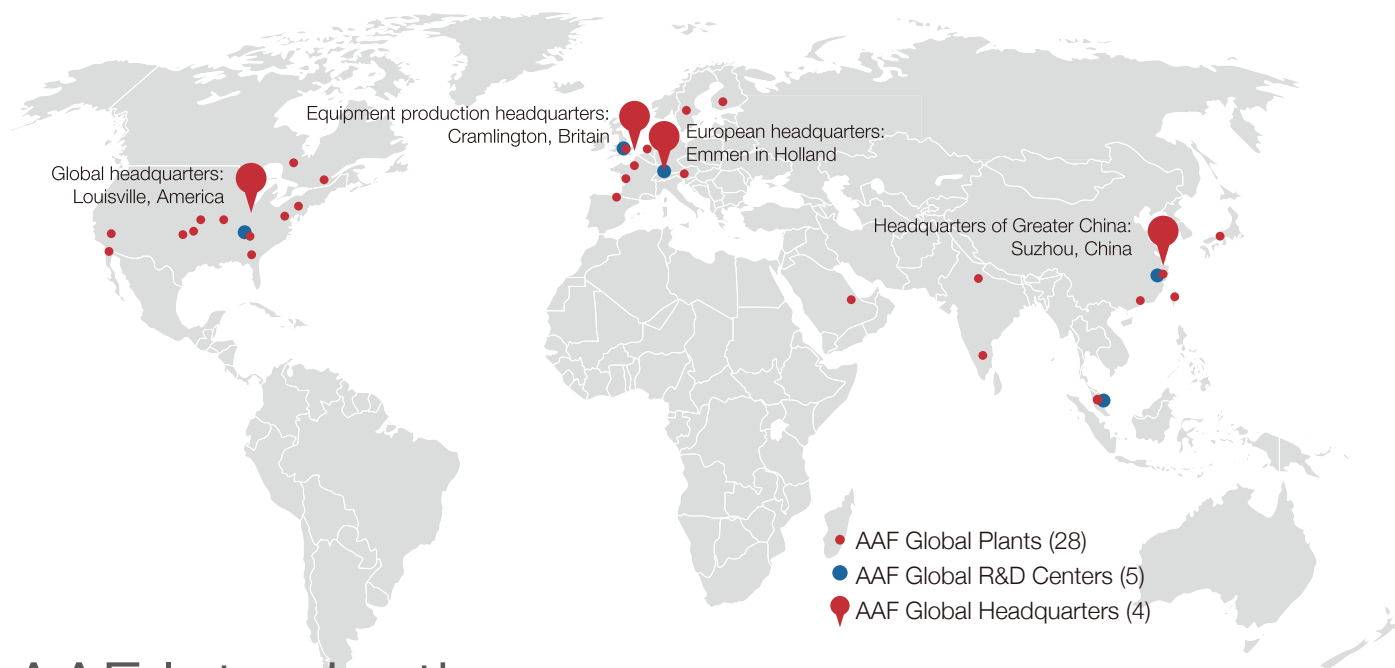


## Microelectronics Clean Air Solutions

PARTICULATE AND GASEOUS FILTRATION



Bringing clean air to life.™



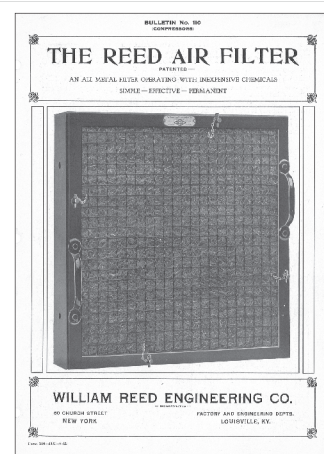
# AAF Introduction

## International

AAF International, the world's largest manufacturer of air filtration solutions, operates production, warehousing and distribution facilities in 22 countries across four continents. With its global headquarters in Louisville, Kentucky, AAF International is committed to protecting people, processes and systems through the development and manufacturing of the highest quality air filters, filtration equipment and contaminant housings available today. Our company offers comprehensive, innovative air filtration solutions designed to remove and control airborne particulates and gaseous contaminants in residential, commercial, industrial, clean room, transportation and nuclear power applications. AAF International is supported in our international ventures through the resources of our parent company, Daikin Industries Ltd., based in Osaka, Japan, a diversified international manufacturing company and a global leader in air conditioning.

## AAF Asia

AAF Asia was first established in 1972, Singapore. The headquarters is in Malaysia with three hundred employees, production office and Research & Development Center. AAF Asia is composed of Malaysia, Thailand, Singapore, Australia, Indonesia, India, Middle East and distributors from New Zealand, Pakistan, Bangladesh, Vietnam and Philippines. AAF Asia has occupied an advantageous position in Asian market and has maintained the leading position in the filter industry.



Reed Air Filter in 1921

## Our Rich history

While AAF is an international company, our global headquarters remain in Louisville, where it was founded in 1920. Bill Reed, a skilled engineer and entrepreneur, developed the Reed Air Filter in 1921. This creative filter solution for the automobile industry would establish the foundation for what is today a global leader in air filtration. His concept was so successful, Reed joined forces with seven other firms to create American Air Filter Co. in 1929.

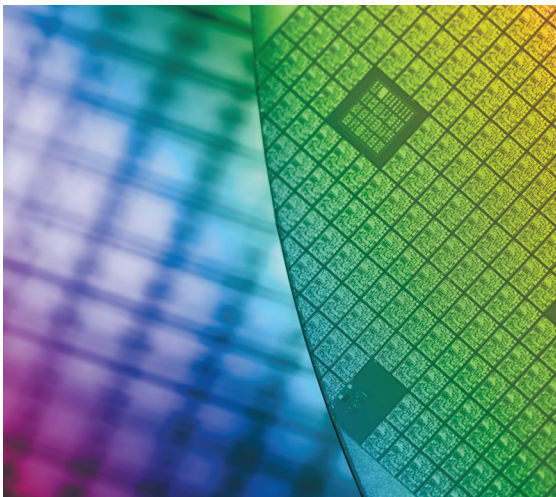
## Looking to the Future

In September 2016, AAF further demonstrated our commitment to revolutionizing air filtration with the opening of our Clean Air Innovation & Research Center in Jeffersonville, Indiana. The center represents a significant advancement in research, development and testing efforts for both AAF and the global air filtration industry. Our Clean AIR Center engineers and scientists are bringing the next generation of high-performance air filtration products and equipment to market.

A pioneer in clean air innovation for nearly 100 years, AAF is just getting started. With our combined resources and expertise, we'll continue to lead global initiatives that increase productivity, improve processes and protect public health for the next 100 years.



# AAF — Microelectronics Industry



AAF International has made continuous efforts in developing its innovative products for more than 90 years. We always stand at the forefront to meet all kinds of needs of air filtration development for microelectronics industry, and constantly improve process quality, protect equipment environment and personnel. Our filters are known to maintain high efficiency, low pressure loss and minimum maintenance requirements for a long time. Moreover, its lower energy consumption also reduces the overall operation cost and provides sustainable development solutions for the enterprise, and has provided reliable performance products with the rapid development of the semiconductor industry in the past decades. We have always set high standard requirements for ourselves and never stuck to the usual standard solutions. Therefore, we have maintained a leading position in the global market. The unique overall clean air idea can help you cope with the severe challenges in the production in the semiconductor manufacturing industry.

The quality inspection of the HEPA/ULPA filter can fully ensure that it complies with clean room air quality standards. It can successfully apply its rich experience in the AMC filter in the semiconductor manufacturing industry to FPD, wafer manufacturing, and new energy fields, and its solutions are for a variety of gas molecular contaminants in many processes.

We serve the leading semiconductor, microelectronics, flat panel display, hard disk storage and photovoltaic equipment enterprises in the world. In the past 20 years, AAF Asia has also provided a large number of filtration products and technology supports for the development of Asia's microelectronics industry.

## Global Partners

Intel	BOE	WMS/Murata	Hanenergy	IBM	M+W
TSMC	Tianma Microelectronics	DMS/Tonsail/Sineva	GCL	Motorola	CESE
Samsung Semiconductor	AUO	Seagate	BYD	Huawei	EDRI
Henan Honliv Group	Truly	Hitachi	First	Philips	Hentane
SMIC	Panda Electronics	Western Digital	YOFC	Corning\3M\Foxconn	L & K
ST	Royole		Sony		
ASE Group	IVO		Panasonic		
Hynix	Caihong Group				
Huahong NEC	LG				



# Clean Air Solutions in Microelectronics Industry

## Industry Introduction

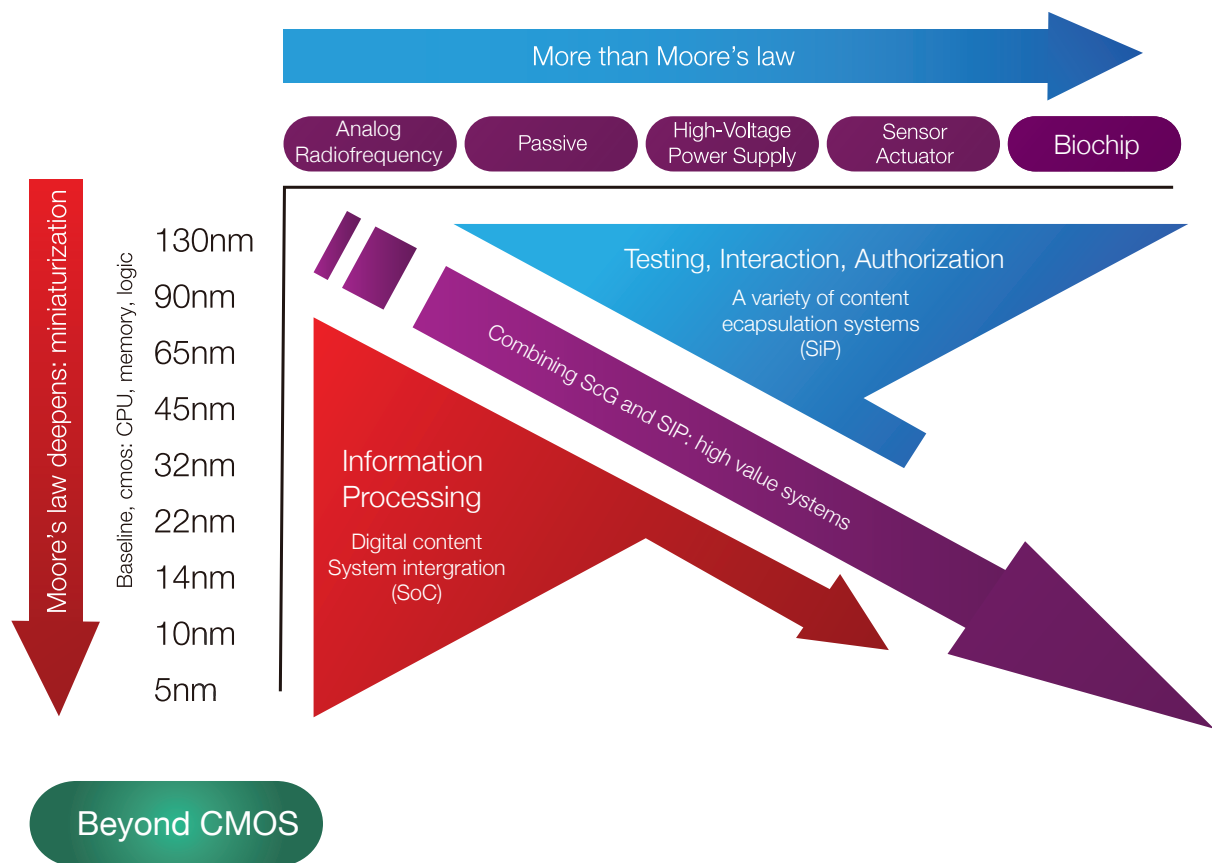
With the continuous development of science and technology, the production of electronic products is changing rapidly. Modern electronic products require miniaturization, precision, integration, precision and high reliability. Let's take the mobile phone and personal computer as an example, the production of the used integrated circuits, electronic components and the assembly process require strict controlled conditions, especially the production of integrated circuits. Microelectronic technology is the key technology in the field of information technology, and it is the technical basis for the development of the electronic information industry and all kinds of high technology.

### • Integrated Circuit (IC)

China's integrated circuit has a market scale of USD 182 billion, which accounts for half of the global semiconductor market. In the semiconductor industry, advanced manufacturing technology is undoubtedly a magic weapon. Every OEM and chip factory will always pursue new technologies at all costs. When the 10nm process is mass produced and popularized, all manufacturers are working on 7nm and several major wafer manufacturing enterprises in the world will comprehensively achieve the mass production of it in 2018.

The manufacturing process of IC is varied, complex and difficult technically. A series of key technologies and processes must be completed in the dust-free workshop with constant temperature, constant humidity and super cleanliness. The production of integrated circuit has very critical requirements for the cleanliness of the environment. Meanwhile, AMC has become the most concerned pollution problem in the integrated circuit manufacturing process. Its control will directly affect the yield of products.

The increasing cost of Flawless shading film used in the process of DUV (deep UV) lithography and even EUV (extreme ultraviolet lithography) puts pressure on the inspection equipment or pusher and other facilities and critical microenvironment, air particulate matter and AMC pollution control.





## • Flat Panel Display (FDP)

Flat panel display (FPD) has become the mainstream of the future television, representing the general trend. There are many types of flat panel displays, by which display medium and work principle, can be classified into liquid crystal display (LCD), plasma display panel (PDP), light emitting diode (LED), organic light emitting diode (OLED), field emission display (FED), projection display, etc.

Under the new market structure, global panel manufacturers have new enthusiasm for the investment in the production of high-generation LCD panels. Especially the 10th generation and above ultra-high-generation LCD panel production line has become the new investment target for many panel makers. Active Matrix/Organic Light Emitting Diode (AMOLED) is known as the next generation display technology; TFT-LCD panel production needs to be carried out in highly clean environment, and the air cleanliness of most production areas is ISO5 level, and the local part is required to be controlled according to ISO4 level. Due to the large scale of the clean workshop for the production of TFT-LCD (3370mm x 2940mm), and the relevant operation air volume is very large. Therefore, pollution control optimization and energy saving has become a priority in the TFT industry.

Comparison of the cutting slices between Generation 8.5 and Generation 10.5 LCD panel

Gen Glass Size	G8.5 2200x2500	G10.5 2940x3370
55"	6	8
65"	3	8
70"	2	6
75"	2	6
85"	2	3

## • New Energy

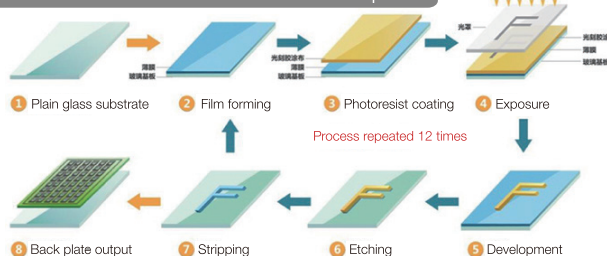


Photovoltaic is the abbreviated form of solar power system. It is a new type of power generation system of using the photovoltaic effect of solar cell semiconductor materials to directly convert the solar radiation energy into electric power. It operates in two ways, independent operation and grid-connected operation.

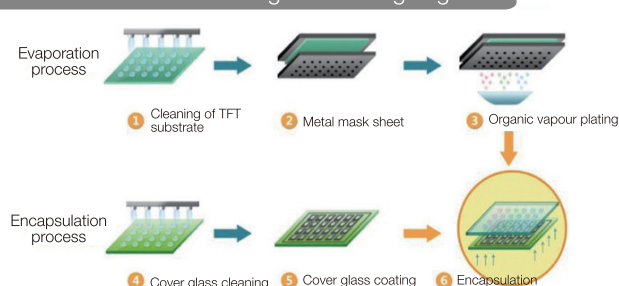
The industrial chain of photovoltaic power generation, from upstream to downstream, mainly includes polysilicon chips, silicon chips, battery chips and battery components. In the industrial chain, from polysilicon to battery components, the technical threshold for production is getting lower and lower, especially in the production of high purity polysilicon chips, the industrial high purity polysilicon chips produced with the silane method will generate a large amount of hydrofluoric acid. How to ensure the normal operation of the filtration system in hydrofluoric acid conditions is a key factor in improving the yield of the product. At the same time, a large number of corrosive gases are produced in the photovoltaic industry. To ensure the normal operation of the filtration system and eliminate the corrosive acids (hydrogen chloride, hydrofluoric acid, etc.), AAF can provide the corresponding solutions, the filtration system and corrosion detection system, measurement with the gas analyser to ensure the corrosion level is maintained within the acceptable range of the industry.

There are mainly three processes for the production of AMOLED, back plate segment, front plate segment and module segment:

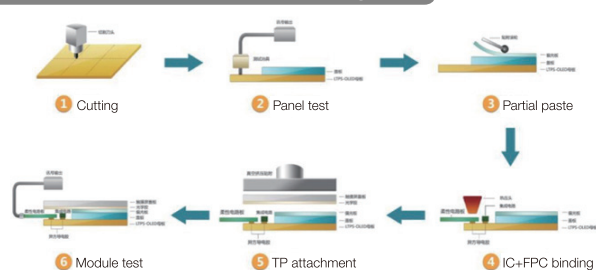
### 1. Process flow chart of drive back plate



### 2. Process flow chart of organic coating segment



### 3. Process flow chart of module segment



For high concentration particles and chemical substances released by the large process equipment in the production of AMOLED, AAF can provide comprehensive solutions, optimizing the particle filtering scheme and helping the owner achieve the best total ownership cost; AAF provides BOE with 100,000 FFU's, saving USD 20 million energy cost and reducing 200,000 tons of CO2 emission annually.

# Control of Pollutants

## Particulate Matters

The size of integrated circuit components produced in the semiconductor industry has become increasingly small, and many components are integrated into a small chip. Therefore, in the manufacturing process, the introduced contamination sources (including dust, metal ions, various organic compounds, etc.) must be prevented because these contamination sources can lead to the deterioration of the performance of components and the reduced product yield and reliability. So the manufacturing of integrated circuits must be carried out in a clean environment in order to isolate contamination sources and silicon chips as much as possible.

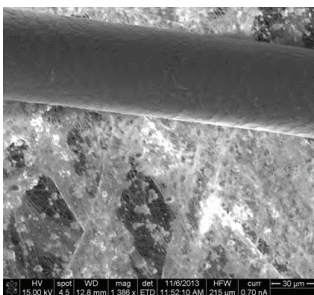
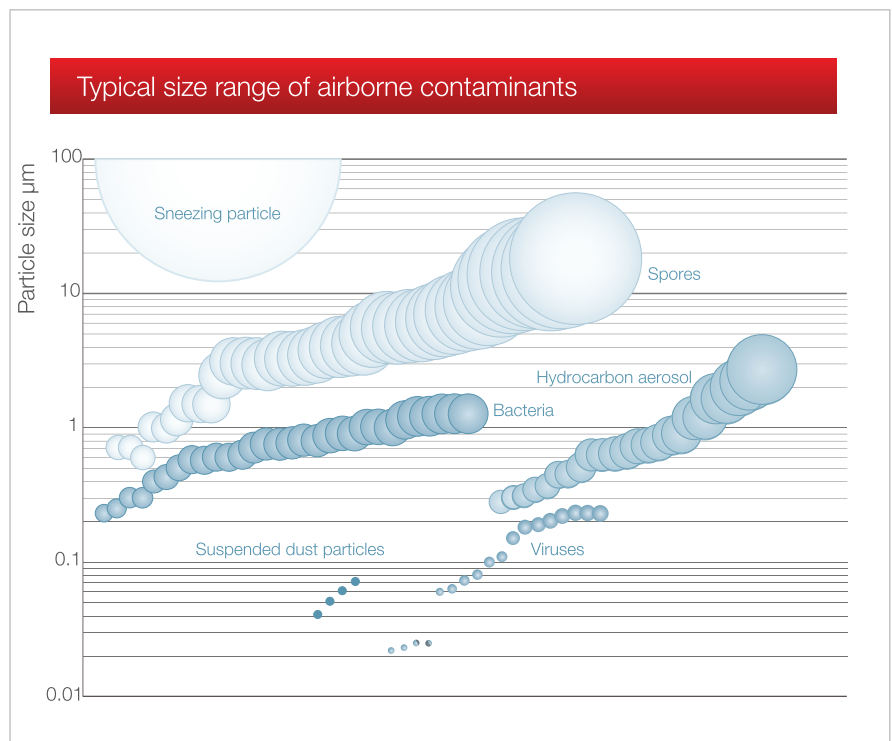


- **Contaminants**

Substances introduced in the manufacturing of microelectronics that reduce the yield and electrical performance of the chips and are not expected to exist. They include particles, metal ions, chemicals, bacteria and static electricity.

- **Particles**

Particle contamination is a major contributor to the yield loss. The size of particulates must be smaller than 1/10 of the minimum feature size on the component particle per wafer per pass (PWP): the number of the particles introduced into the silicon that exceed a certain key dimension. For the particle detection, the laser beams are widely used to scan the silicon surface and detect the light intensity position of the particle scattering.



The cross section of human hair is about 60 to 90μm

$$\frac{90\mu\text{m}}{0.18\mu\text{m}} = 500$$

The diameter of the hair is about 500 times the feature size of the smallest integrated circuit.

Feature size of minimum integrated circuit = 0.18μm



- **Metal Ions** Movable Ionic Contaminants (MIC)

The metal ions present in the materials have a strong mobility in the semiconductor materials that can harm the chip. Even if the components passed the electric performance test and are transported, MIC can still move in the components, affecting electric performance and long-term reliability. The MIC problem is most seriously manifested in MOS components. It will cause structural defects of oxide, polysilicon gate, increase of leakage current of PN junction, decrease of the lifetime of minority carriers, and change of threshold voltage.

**Sources of Metal Ions:**

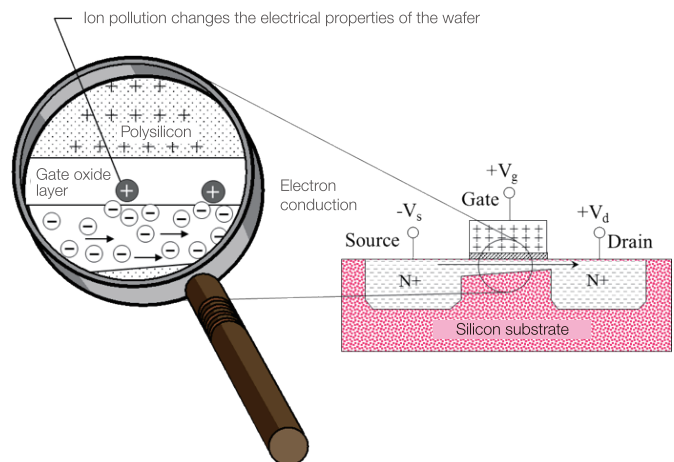
- Chemical solution:** they exist in the vast majority of chemical substances.
- The process of microelectronics manufacturing:** metal ion pollution caused by ion implantation, between 1,012 and 1,013 atoms/cm<sup>2</sup>.
- The reaction between chemicals and transmission pipelines and containers:** carbon monoxide can react with other elements in stainless steel, nickel gasket and gas transmission system, and generate tetracarbonyl particles of nickel, which are distributed on the surface of silicon wafer.

**The Way to Attach to The Silicon Wafer:**

They exchange charge with the hydrogen atom on the surface of the silicon wafer and are bound to the surface of the silicon wafer. It is difficult to eliminate this kind of metal impurities. When the surface of the silicon wafer is oxidized, the metal impurities will enter the oxide layer.

In metal ions, Na is the most common and most mobile. It must be the primary focus to control and must be  $\leq 10^{10}$  atoms/cm<sup>2</sup>.

Heavy Metal	Alkali Metal
Ferrum (Fe)	Natrum (Na)
Cuprum (Cu)	Kalium (K)
Aluminum (Al)	Lithium (Li)
Chromium (Cr)	
Wolfram (W)	
Titanium (Ti)	



- **Chemical Substances**

The chemical reagents and water used in the process may be contaminated with trace substances that affect the chip process. They may lead to the unwanted etching of the wafer surface, the formation of compounds that cannot be removed on the surface of the components, or the uneven process. They are the third main pollutants in the field of microelectronics.

- **Bacteria**

Organic substances formed in the water system or on the unregularly cleaned surface. Once they are formed on the surface of components, they will become granular contaminants or introduce metal ions that are not expected to exist to the surface of the device.

- **Static Electricity**

Electro-Static Discharged (ESD) is also a kind of contamination. Static charge is delivered without control between two objects, which may damage the chip. More importantly, the electric field generated by the charge accumulation will attract charged particles or polarize and attract neutral particles to the surface of the silicon wafer.

# Definition of the Contamination Source of AMC (Airborne Molecular Contaminants)

## • SEMI F21-1102

For the microelectronics manufacturing industry, the chemicals in the air that harm production process and products and reduce the product yield are called “airborne molecular contaminants”, AMC for short. AMCs are much, several orders of magnitude, smaller than particles. They cannot be removed by HEPA and ULPA at all. Semiconductor Equipment and Materials International (SEMI) officially released SEMI F21-95 Standard (1996 Edition), and the revised version of the SEMI F21-1102 Standard (2002 Edition) for Classification of Airborne Molecular Contaminants in the Purified Environment. In the standard, the AMCs are classified into four categories, acids, alkalis, condensable materials and dopants. The magnitude combination of each category produces a classification of the description environment. The name of each category begins with the letter “M”, followed by the first capital letter of the category name, A, B, C, and D.

No.	Category	Contaminants	Source	Adverse Effect	Bad Results	Countermeasure	Test Analysis
1	MA	Acid gas (HF, HCl, H <sub>2</sub> SO <sub>4</sub> , H <sub>3</sub> PO <sub>4</sub> , Cl <sub>2</sub> , NO <sub>x</sub> , SO <sub>x</sub> )	External air, chemicals in dust-free room, etc.	Commonly contaminated metals, hard disks, wafer surface contamination, chemical photoresist resolution of bad salt particles, Haze phenomenon	Abnormal welding of aluminum/copper wiring, element impedance anomaly	Installation of acid removing chemical filter	IC
2	MB	Base gas (NH <sub>3</sub> , organic amines, ammonia compounds)	NH <sub>4</sub> OH-H <sub>2</sub> O <sub>2</sub> can easily hydrolyze and separate out NH <sub>4</sub> <sup>+</sup> .	Easy to have neutralization reaction with H <sup>+</sup> in chemical photoresist	Bad lithography	Installation of alkali removing chemical filter	IC
3	MC	Condensables: VOCs, Siloxane Gas	Sealant, polymer	Easy to attach to the CVD film on the surface of wafer/glass, and the occurrence of Haze phenomenon	Abnormal LCD display, foreign body, and defective Gate oxide film with poor voltage withstanding	Installation of VOCs removing chemical filter, sealing reagent-free operation outside the dust-free room	ATD-GC-MS ICP-MS
4	MD	Dopant (B, P) boron particle (B <sub>2</sub> O <sub>3</sub> ), BF <sub>3</sub> Gas	Release of boron and HF reaction in the glass fiber filter, release of reaction between BPSG-related materials and HF	Wafer surface contamination, impedance change	Abnormal critical voltage	Use an activated carbon filter, or a boron-free HEPA filter	ICP-MS

\*AMC Classification Lin Compliance with SEMI F21-1102 Standard

Acid AMC (MA), Alkaline AMC (MB), Condensable AMC (MC) and Dopant AMC (MD)

- MA acid corrosiveness materials: Their chemical reaction produces positive charge, such as HF, SO<sub>2</sub>, HCl, HBr, Cl<sub>2</sub> and so on.
- MB alkali corrosiveness materials: Their chemical reaction produces negative charge, such as NH<sub>3</sub>, CH<sub>3</sub>NH<sub>2</sub>, [(CH<sub>3</sub>)<sub>3</sub>N], morpholine, etc.
- MC condensables is a kind of chemical substances that can be deposited on clean surfaces (excluding water, such as silane, esters, di-tert-butyl-m-cresol and macromolecular hydrocarbons).
- MD dopants, a kind of chemical element, that can change the electrical properties of semiconductors, such as boron (Be), phosphorus (P), arsenic (As) and other compounds.

The name of each category should represent the maximum gas phase concentration, which is expressed as an integer of pptM (pptM 1x10<sup>-12</sup>).

SEMI F21-1102 Classification System for Four Categories of Gas Phase Contaminants

AMC Classification	Concentration Grade				
	1pptM	10pptM	100pptM	1000pptM	10000pptM
Acids	MA-1	MA-10	MA-100	MA-1,000	MA-10,000
Alkalines	MB-1	MB-10	MB-100	MB-1,000	MB-10,000
Condensables	MC-1	MC-10	MC-100	MC-1,000	MC-10,000
Dopants	MD-1	MD-10	MD-100	MD-1,000	MD-10,000

\*pptM ((parts per trillion Molar) 10 to 12 trillionth mole) is used as the concentration unit



## ITRS International Technology Roadmap for Semiconductors

ITRS was initiated by five main chip manufacturing areas, Europe, Japan, Korea, Taiwan and the United States. The purpose of ITRS is to ensure the performance improvement of integrated circuit (IC) and IC products based on cost effectiveness, so as to sustain the health and success of the semiconductor industry.

	Acids		Alkalis	Organic compounds		
ITRS recommends AMC concentration for the semiconductor manufacturing industry, unit ppb (V). Technological level: flash 1/2 pitch 25nm line width, DRAM1/2 pitch 36nm line width, MPU physical grid 22nm line width (updated in 2012)	The total amount of inorganic acids, such as HCl, HF, H <sub>2</sub> SO <sub>4</sub> , HNO <sub>3</sub> . NOx& H <sub>2</sub> S are not considered.	Total organic acids (such as formic acid, acetic acid, lactic acid)	Total alkaloids (such as NH <sub>3</sub> , NMP, TMA)	Volatile organic compounds (GCMS retention time > benzene, fitted into hexadecane for calculation)	PGMEA and ethyl lactate	Condensable organic matters (boiling point defined by SEMI >150°C)
Clean room air: photolithography scanner	5	2	20	26	5	Unrelated
Wafer environment: photolithography scanner	0.05	0.02	0.2	0.26	0.05	Unrelated
Clean room air: coating developer and inspection tool	2	2	2	Unrelated	5	1
Wafer environment: coating developer and inspection tool	0.2	0.2	0.2	Unrelated	0.5	0.1
Mask storage area and exposure area	0.2	0.2	0.2	Unrelated	Unrelated	0.1
Self-aligned polycrystalline silicification	0.5		Unrelated	Unrelated	Unrelated	Unrelated
Exposure wafer processing (aluminum bonding) environment	0.5	0.5		Unrelated	Unrelated	Unrelated
Exposure wafer processing (aluminum bonding) environment		Unrelated	Unrelated	Unrelated	Unrelated	Unrelated
Grid, furnace tube wafer environment	Unrelated	Unrelated	Unrelated		Unrelated	Unrelated

Table 6: ppb (V) AMC concentration recommended by ITRS for semiconductor manufacturing industry

Table 6 (Continued)	Sulfur		Acids	Insoluble compounds	Metals	Dopants
ITRS recommends AMC concentration for the semiconductor manufacturing industry, unit ppb (V). Technological level: flash 1/2 pitch 25nm line width, DRAM1/2pitch 36nm line width, MPU physical grid 22nm line width (updated in 2012)	H <sub>2</sub> S	Total sulfur compounds	The total amount of other corrosive gases, such as O <sub>3</sub> and Cl <sub>2</sub>	Insoluble compounds (organic compounds with elements except C, N, O, etc. )	Total metal (atoms/cm <sup>2</sup> deposition per wafer per week)	Dopants (atoms/cm <sup>2</sup> deposited each wafer per week)
Clean room air: photolithography scanner	Undefined	Contained in acids and insoluble compounds	Undefined	0.1	Unrelated	Unrelated
Wafer environment: photolithography scanner	Undefined	Contained in acids and insoluble compounds	Undefined	0.1	Unrelated	Unrelated
Clean room air: coating developer and inspection tool	Undefined	Contained in acids and insoluble compounds	Undefined	Undefined	Unrelated	Unrelated
Wafer environment: coating developer and inspection tool	Undefined	Contained in acids and insoluble compounds	Undefined	Undefined	Unrelated	Unrelated
Mask storage area and exposure area	Undefined	Contained in acids and insoluble compounds	Undefined	Undefined	Unrelated	Unrelated
Self-aligned polycrystalline silicification	Undefined	Contained in acids and insoluble compounds	Undefined	Unrelated	Unrelated	Unrelated
Exposure wafer processing (aluminum bonding) environment	1	2.5	1	Unrelated	Unrelated	Unrelated
Exposure wafer processing (aluminum bonding) environment	Undefined	Undefined	1	Unrelated	Unrelated	Unrelated
Grid, furnace tube wafer environment	Unrelated	Unrelated	Unrelated	Unrelated	10	10

Table 6 (Continued): ppb (V) AMC concentration recommended by ITRS for semiconductor manufacturing industry

AAF's chemical filter products can be mainly applied to wafer manufacturing and intergrated circuit manufacturing. AAF can provide an overall solution for lithography process to meet the requirements of coating development process. Chemical filters can be matched with PTFE filters, which can be used in the lithography machine to provide maximum protection for core tehcnology production.

AAF's chemical filter can be applied to wafer, SOI, optical device, photomask, hard disk magnetic head, flat panel display and solar panel areas.

# Definition of the Contamination Source of AMC

## ISO 14644-8: 2013

ISO 14644-8 Air Cleanliness Classification by Concentration of Chemicals [ACC]: 2013-2-15. This version re-defines the classification of air cleanliness in the clean room and related controlled environments by the concentration of chemicals in the air. Meanwhile, it indicates the maximum allowable concentration of a particular chemical or a group of chemicals. In the classification of air cleanliness by the concentration of chemicals, the air cleanliness class is expressed with the hierarchical descriptor, "ISO-ACC", which replaces the previous ISO-AMC-Class N (X). The new standard is described as follows:

ISO-ACC	Class N	[X]
①	②	③

① Air Chemical Cleanliness

② Class according to ISO-ACC, logarithm of the concentration  $C_x$  ( $\text{g}/\text{m}^3$ ), ranging from 0 to -12 ( $1$  to  $10^{-12}\text{g}/\text{m}^3$ )  $N=\log_{10}[C_x]$

③ It is a chemical substance or a group of chemical substances, including acid (ac), alkali (ba), biotoxin (bt), condensable substance (cd), corrosive substance (cr), dopant (dp), organic matter or total organic matter (or), oxidant (ox), etc.

## The Application Area of AMC Control

The air conditioning unit used in the semiconductor manufacturing clean room is a large industrial unit that can handle a large amount of air for pressurization and circulation. The typical clean room HVAC system is composed of the fresh air unit, circulating fan unit or fan filter unit which supplies air to the clean room, the pipeline which is used to transport air, the plenum chamber which is used to distribute air, and the filtration system which is used to clean air entering the clean room.

No matter which air treatment system it is, chemical filters can be used in different locations. Basically, the characteristics and sources of contaminants, the layout and design of the clean room are all factors that determine the best location of the filter and equipment, such as fresh air, circulating air, fan filter unit/micro unit.

Fresh Air & Return Air							
Gas category (SEMI F21)	Concentration (Unit ppb)	HD/CG/MD Cassette	Canister	VariSorb XL	VariCel RF/C	VariSorb TY	VariSorb CE
Condensable volatile organic compounds VOC(b. $p>150^\circ\text{C}$ )	At low concentration $<40$	√	√	√	√	√	
	At high concentration $\geq 40$	√	√		√		
Acid gas tAcids	At low concentration $<10$	√	√	√	√	√	
	At high concentration $\geq 10$	√	√				
Alkaline gas $\text{NH}_3$	At low concentration $<10$	√	√	√	√	√	
	At high concentration $\geq 10$	√	√				

FFU & Cabinet							
Gas category (SEMI F21)	Concentration (Unit ppb)	HD/CG/MD Cassette	Canister	VariSorb XL	VariCel RF/C	VariSorb TY	VariSorb CE
Condensable volatile organic compounds VOC(b. $p>150^\circ\text{C}$ )	At low concentration $<40$			√	√	√	√
	At high concentration $\geq 40$				√	√	√
Acid gas tAcids	At low concentration $<10$			√	√	√	√
	At high concentration $\geq 10$				√	√	√
Alkaline gas $\text{NH}_3$	At low concentration $<10$			√	√	√	√
	At high concentration $\geq 10$				√	√	√



# Definition of Electronic Clean Room

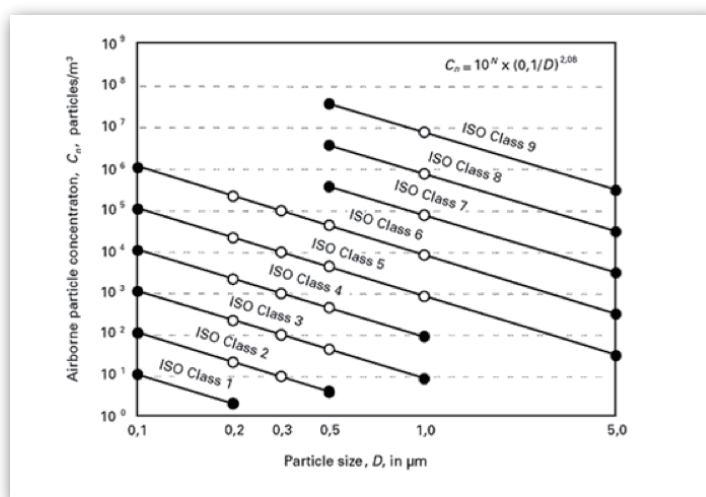
## The Importance of Clean Air

Clean Room is also known as dust-free room, clean workshop, cleanroom and so on. The key control in the clean room is the particle concentration of dust particles (cleanliness) followed by temperature, humidity, pressure gradient, noise, illumination, etc. The most important of all factors is cleanliness which is also the most related to the filter.

### Cleanliness classification of suspended particles selected from clean room and clean area

ISO Class No. (N)	Greater than or equal to the maximum concentration limit of the particle size considered in the table (pc/m3 air concentration limit is calculated according to the formula in 3. 2)					
	0.1µm	0.2µm	0.3µm	0.5µm	1µm	5µm
ISO Class 1	10	2				
ISO Class 2	100	24	10	4		
ISO Class 3	1000	237	102	35	8	
ISO Class 4	10000	2370	1020	352	83	
ISO Class 5	100 000	23700	10200	3520	832	29
ISO Class 6	1000000	237000	102000	35200	8320	293
ISO Class 7				352 000	83200	2930
ISO Class 8				3520000	832000	29300
ISO Class 9				35200000	8320000	293000

Note: As a result of the uncertainty of the measurement process, three effective data are required to determine the concentration level.



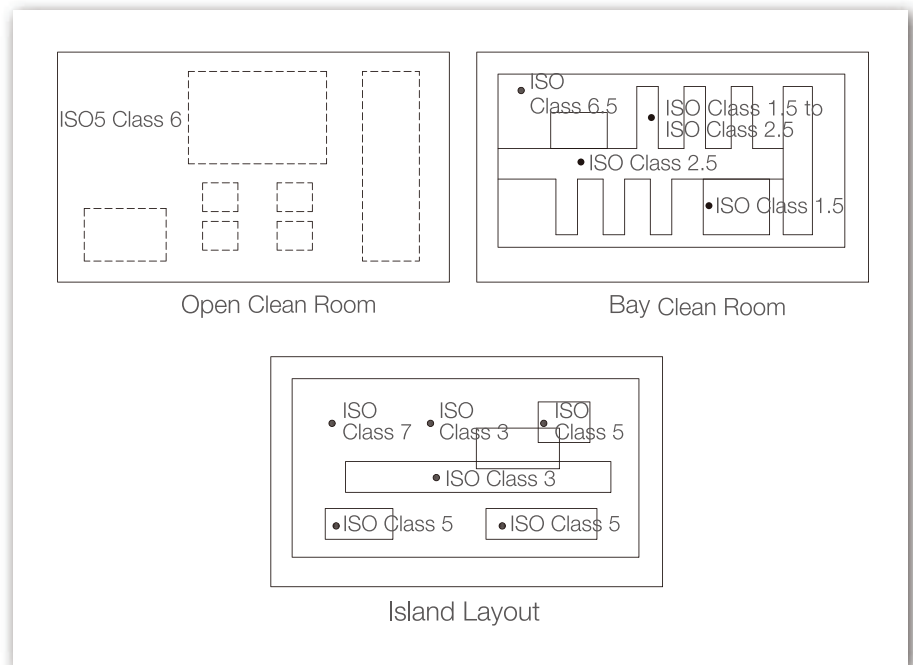
### Comparison of Various International Standards:

USA Federal Standard	USA Federal Standard	British Standard	Australian Standard	French Standard	German Standard	International Standard	Japanese Standard
Standard 209D	Standard 209E	BS5295	AS1386	AFNORX44101	VDI2083	14644-1	JACA24
						1	1
				—	0	2	2
1	M1.5	C	0.035	—	1	3	3
10	M2.5	D	0.35	—	2	4	4
100	M3.5	E	3.5	4000	3	5	5
1000	M4.5	G	35	—	4	6	6
10000	M5.5	J	350	400000	5	7	7
100000	M6.5	K	3500	4000000	6	8	8
		M			7	9	—

# Definition of Electronic Clean Room

## Form of Electronic Clean Room

1. According to the production process requirements of the electronic products, air cleanliness and plane or space layout requirements, the layout of the clean rooms in the microelectronics workshop usually includes the tunnel or harbor type, open type and island layout.



## 2. Clean room classification by airflow

- Unidirectional airflow clean room
- Non-unidirectional airflow clean room
- Mixed airflow clean room

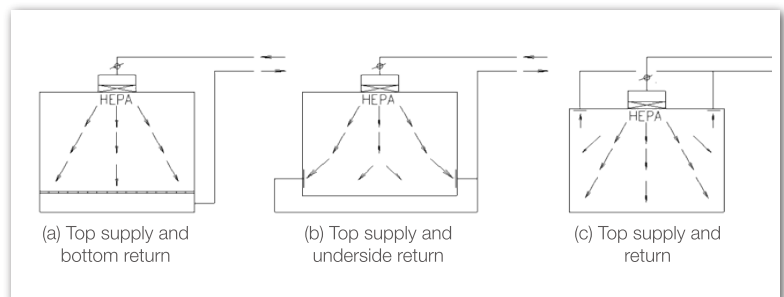
### • Vertical unidirectional airflow clean room

Air flows from the top to the ground at a certain speed (0. 25m/s to 0. 5m/s). Purification time of the vertical unidirectional air flow in general is only a few seconds. This type of airflow can create airflow of ISO14644 Class 5 and above. Vertical unidirectional airflow has high initial investment and operating costs, so its area is reduced as much as possible in the clean room engineering design and the vertical unidirectional airflow is used where it must be.

The horizontal unidirectional airflow refers to the clean airflow flows from the air supply wall to the air returning wall at a certain speed (0. 25m/s to 0. 5m/s) this type of airflow can create airflow of ISO14644 Class 5. Initial investment and operating costs of horizontal unidirectional airflow are generally lower than those of the vertical unidirectional airflow. The important application fields are generally the horizontal unidirectional airflow which is used in the Stocker area in the Array, Cell and CF workshop of TFT-LCD in these areas, FFUs are installed vertically.

### • Non-unidirectional airflow clean room

The non-unidirectional airflow clean room, also known as mixed airflow clean room. According to the type of return air, the airflow is classified into the top supply and bottom return, the top supply and underside return, the top supply and return types.



### • Mixed airflow clean room

It is the flow pattern of combining vertical unidirectional airflow and non-unidirectional airflow in a clean room.



# Microenvironment

Microenvironment is used as physical barriers to isolate key production areas from contamination and provide the best quality air for them. The air quality requirements outside the isolated area are not as high as those for the microenvironment. Microenvironment is also an isolator, and is the specific application of isolation technology in engineering.

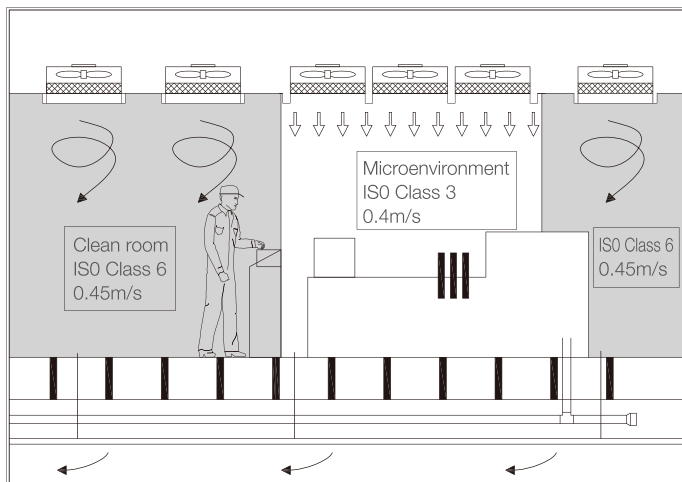
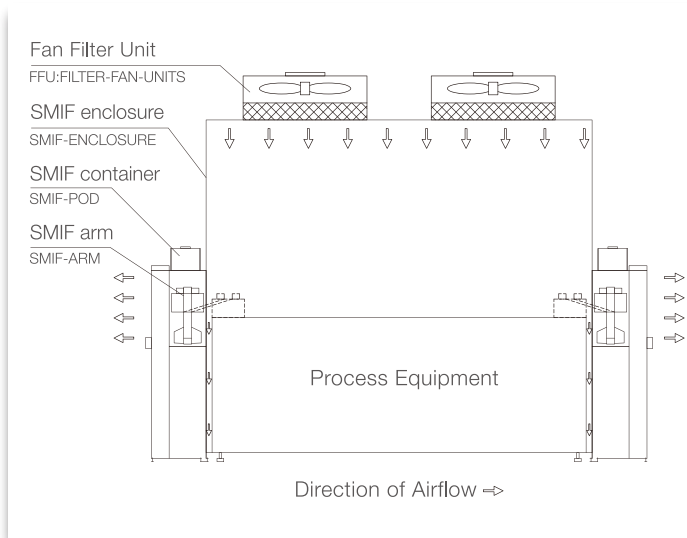


Diagram Showing Microenvironment

The requirement of microenvironment in the diagram is ISO Class 3. In the production area and service area, only ISO Class 6 or worse air is provided. It can be seen that the design of using the microenvironment can greatly reduce the air supply volume of the whole system, which not only ensures the air cleanliness of the process area, but also reduces the energy consumption. It may be the most important in terms of reduction in the volume of clean space and energy saving in the SMIF execution area of the entire semiconductor facility.

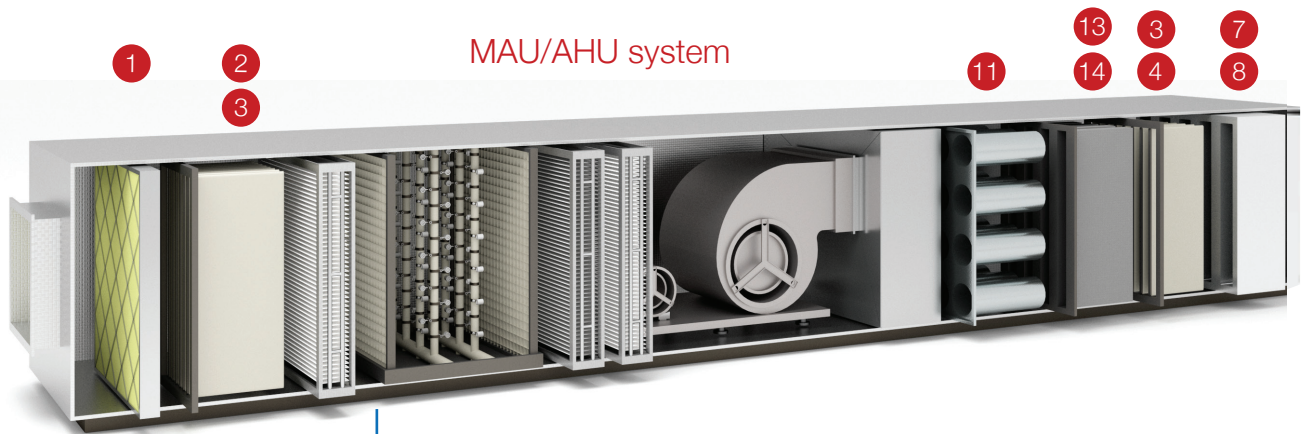


The use of the microenvironment is to isolate the processed objects such as silicon wafer from the exposed area to avoid contamination. A carrier can be particularly designed to transport the silicon wafers between the process equipment to prevent the silicon wafers from being contaminated by the external air in the transportation process. This kind of particularly designed carrier is "standard mechanical interface", SMIF for short. The SMIF/ microenvironment system is the combination of SMIF and microenvironment to form an independent work unit. It is composed of the SMIF system, the purification equipment and the enclosure structure.

The SMIF pod is a hard barrier that encloses the process equipment which is similar to a small clean island to isolate the processing equipment from the external environment. The isolation area of the processing equipment can reach a clean environment superior to ISO Class 3 (the ULPA filter is installed in the FFU). The SMIF arm provides a way for the wafer box to enter the isolation device environment through the SMIF access, and there is no pollution from the external environment that may affect the clean environment of the wafer or the isolation device. The SMIF pod is made up of FFU, structural frame and transparent panel.

# The Overall Solutions for the Microelectronics Industry

MAU/AHU system



① AmAir®  
Coarse panel filter

② DriPak 2000  
Medium efficiency bag filter

③ DriPak®NXM  
Medium efficiency high performance  
bag filter

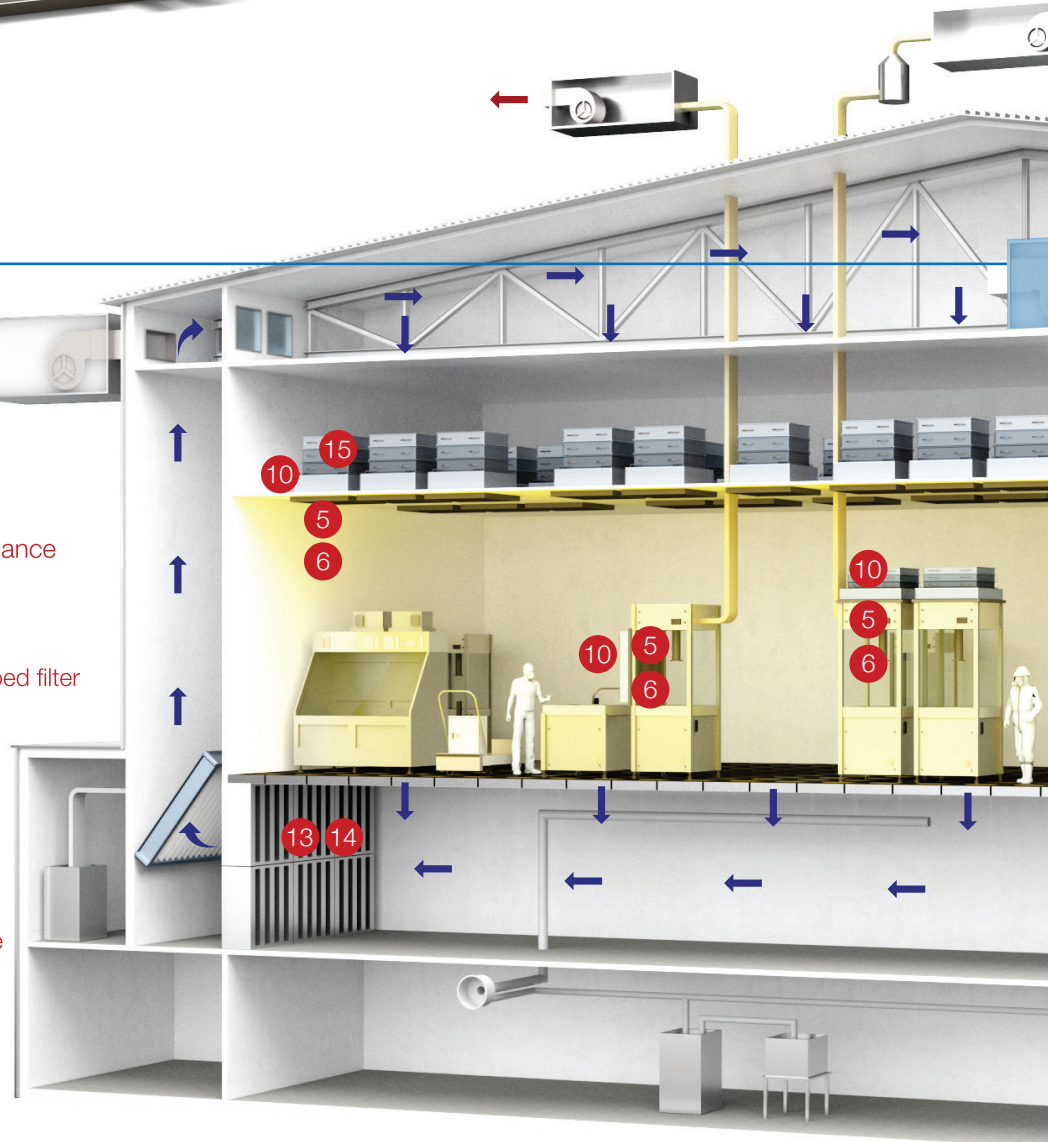
④ VariCel® VXL  
Medium efficiency pleated V-shaped filter

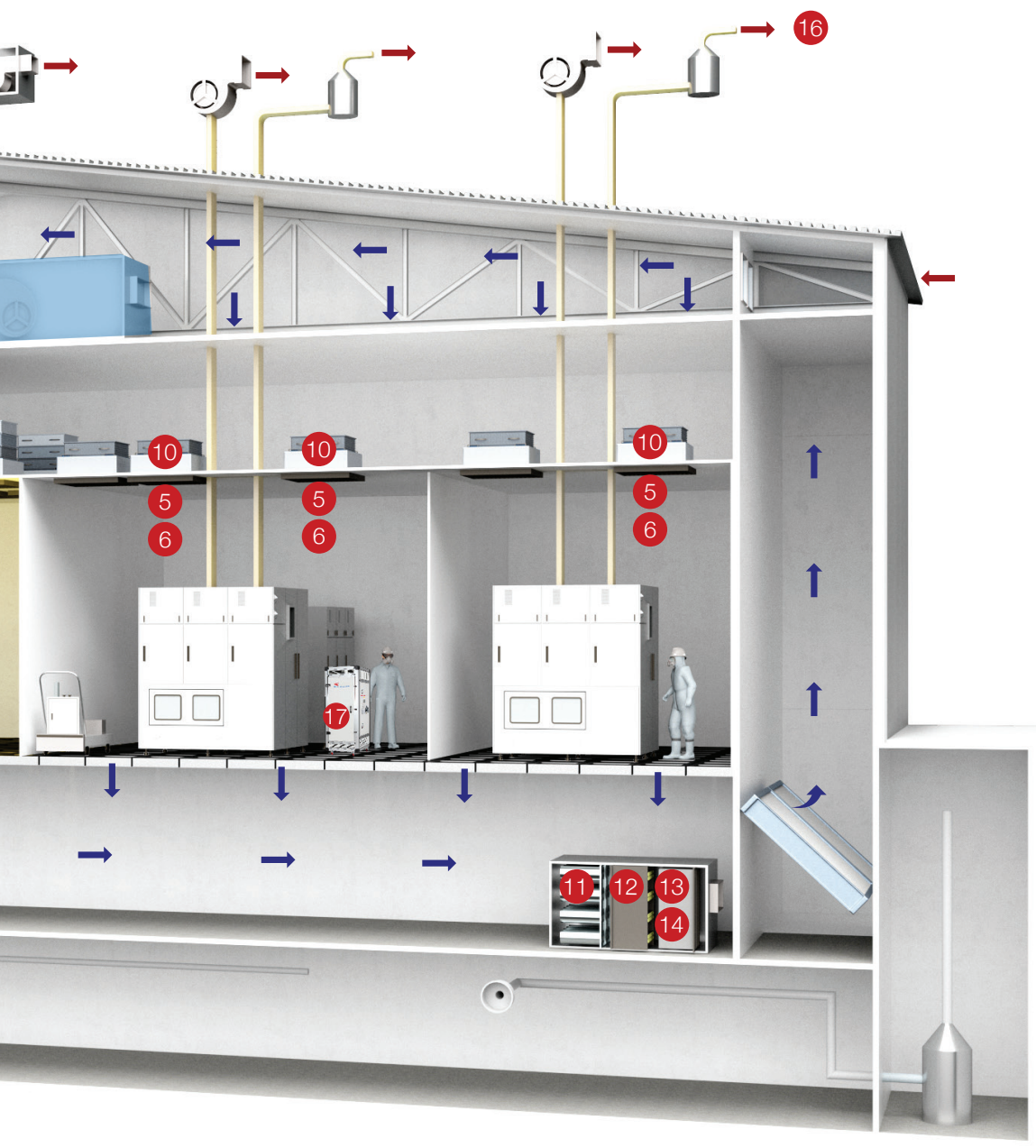
⑤ AstroCel® II  
Partition plate-free high  
efficiency filter

⑥ MEGAcel® II  
High efficiency and low resistance  
PTFE filter

⑦ AsrtoCel®III / MEGAcel®III  
Large air volume box type high  
efficiency filter

⑧ MEGAcel®I / AstroCel® I HC  
Large air volume partition plate high efficiency filter





- 9 AstroCel® TM  
Discardable ceiling filter set
- 10 FFU/EFU  
Intelligent control fan filter unit
- 11 Canister  
Cylinder chemical filter
- 12 SAAF™ Cassette  
Modular chemical filter
- 13 VariSorb XL/TY  
High performance densely pleated chemical filter
- 14 VariCel RF  
Pleated chemical filter
- 15 VariSorb CE  
High performance densely pleated chemical filter
- 16 DBS/SAH  
Filtrating equipment
- 17 RU  
Self-circulating filter system



# Product Introduction

## AAF Air Filter Solutions



- ① **AmAir®**  
**Coarse panel filter**  
Double-layer moisture-proof paper frame structure, synthetic fibre filter paper and other pleated design, uniform collection of dust, maximum improvement of filter paper utilization



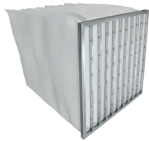
- ⑤ **AstroCel® II**  
**Partition plate-free high-efficiency filter**  
H13 to U16, ISO Class 1 to ISO Class 9 clean rooms, efficiency of HEPA or ULPA, the end filter at the air outlet.



- ② **DriPak 2000**  
**Medium efficiency bag filter**  
It can be used in humid, high airflow and large dust load and widely used in the microelectronics, auto, food processing, commercial building industry, various industries and ventilation systems.



- ⑥ **MEGAcel® II**  
**High efficiency and low resistance PTFE filter**  
Individually tested microelectronic mini-pleat filter with an extremely low resistance and superior mechanical media strength.



- ③ **DriPak®NXM**  
**Medium efficiency high performance bag filter**  
AAF design has a stable tapered pockets for optimum airflow, with exceptionally low pressure drop for extremely low energy use.



- ⑦ **AstroCel®III / MEGAcel®III**  
**Large air volume box type high efficiency filter**  
The end filter using the optimized glass fibre filter paper /ePTFE air conditioning box.



- ④ **VariCel®V**  
**Medium efficiency pleated V-shaped filter**  
A light and compact filter composed of multiple partition plate-free cartridges; the maximum efficiency filter paper can provide stronger airflow, low resistance, high dust holding capacity and long service life. Specially designed for industrial and commercial HVAC applications.



- ⑧ **MEGAcel®I / AstroCel®I HC**  
**Large air volume partition plate high efficiency filter**  
High dust containing capacity partition plate filter used in large air volume places.



- 9 AstroCel <sup>®</sup>TM**  
**Discardable ceiling filter set**  
 Hermetically sealed and light weight filter module individually factory tested for guaranteed high filtration performance.



- 10 FFU/EFU**  
**Intelligent control fan filter unit**  
 Air filter system with fan. It has been widely used in semiconductors, electronics, flat panel display and other places with extremely strict requirements for air pollutants.



- 11 Canister**  
**Cylindrical chemical filter**  
 Mainly used in the industrial air condition box, widely used in semiconductors, liquid crystal panels, airports, commercial buildings, electronic clean rooms and other ventilation systems. A variety of chemical filter materials can be filled in the cylinder filter to remove the corresponding gaseous molecular contaminants.



- 12 SAAF<sup>TM</sup> Cassette**  
**Modular chemical filter**  
 Mainly used in industrial and commercial air conditioning unit; thanks to its special design, it is widely used in the semiconductor, LCD panel, paper pulp, sewage treatment, museums, metallurgy, petrochemical and other industries; combined with aluminum alloy rail groove profiles, with no gas leakage, it can achieve the perfect application.



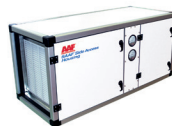
- 13 VariSorb XL/TY**  
**High performance densely pleated chemical filter**  
 The chemical filter is made of professional filter material for different chemical gases. It can remove acid, alkaline, condensable volatile organic matters and dopant gases. It can be widely used in the fresh air system in the semiconductor and liquid crystal panel industry, and it can also be used in return air conditioning unit and HVAC in buildings, schools, theatres.



- 14 VariCel<sup>®</sup>RF/C or VariCel<sup>®</sup>RF/C Plus**  
**Pleated chemical filter**  
 It is mainly used in industrial and commercial air conditioning units. It can eliminate odor, odor gases, volatile VOC organic gases, and ensure the indoor air quality. It can be widely applied to offices, office buildings, business centers, high-grade buildings and residential fresh air systems.



- 15 VariSorb CE**  
**High performance densely pleated chemical filter**  
 It is made of professional filter material for different chemical gases. It can remove acid, alkaline, condensable volatile organic compounds and dopant gases. It can be widely installed in FFU, EFU, special equipment, and lithography equipment.



- 16 DBS/SAH**  
**Filtrating equipment**  
 The DBS deep bed filtration system is mainly used to filter the high concentration harmful gases in the air. It is used in industrial fields of heavy air pollution, such as electronic factories.



- 17 RU**  
**Self-circulating filter system**  
 Self-circulating filter system is used to filter the corrosive gas and dust in the circulating air and it can also provide the clean positive pressure air through the external air duct to maintain the indoor positive pressure. It is used in the electronic instrument workshop of the pulp and paper plant, the refinery and the chemical plant, the central control room, the cupboard room and other places.

# Definition of Air Filter

## The role of air filtration

The control of pollutants is extremely strict in the microelectronics and pharmaceutical industries. To ensure the normal operation of the clean room, a reliable and stable filter system is needed. The performance of the air filtration system directly determines the efficiency of the removal of air pollutants. For the air that enters the key area, the high performance leakless HEPA filter is needed as the end filtration device to ensure the required air quality of the clean room. As such, air filtration represents a vital link in the overall industry value chain. The selection of the “total cost of ownership” filter products can not only reduce the operating cost, but also is energy saving.

## Classification of Filters

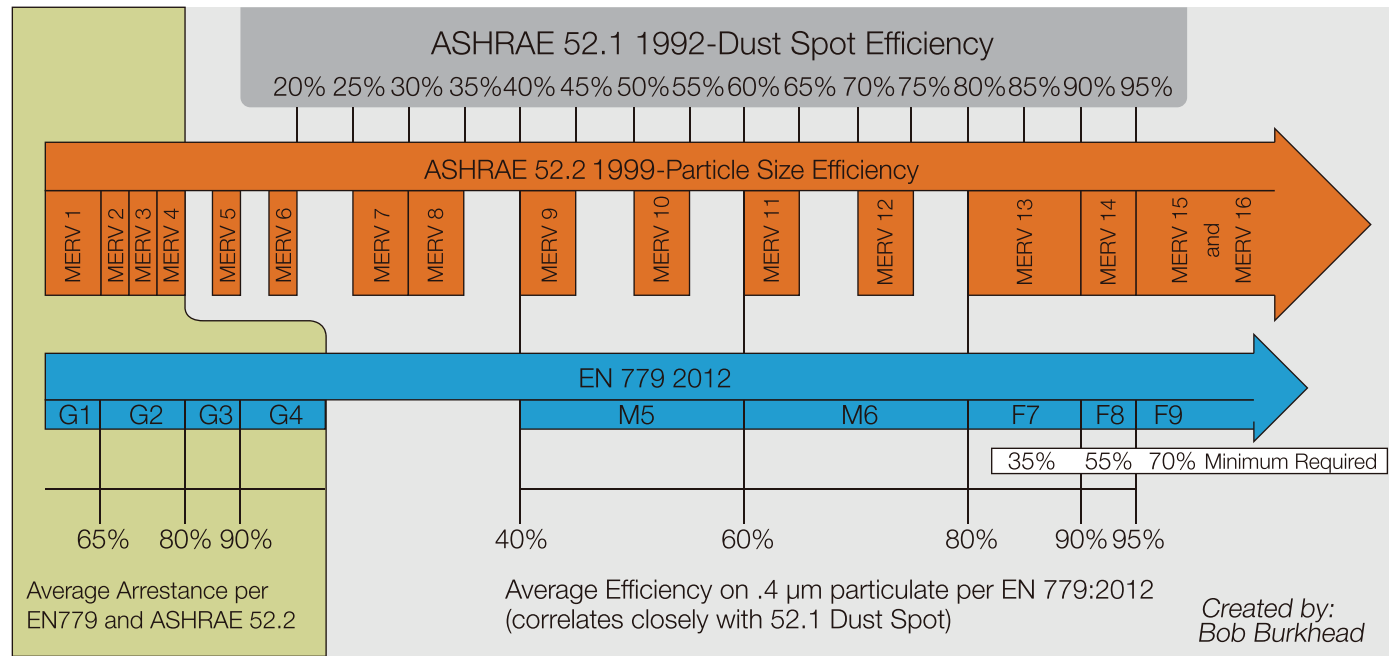
The type of activities within a particular electronics processing environment will determine the level of cleanliness that is required. To ensure that stringent air quality levels for safely manufacturing integrated circuit products are met, a carefully designed air filtration system is vital. Based on their performance efficiency, air filters are classified according to two widely accepted standards, ASHRAE 52. 2 and the Institute of Environmental Sciences and Technology (IEST) Recommended Practice (RP) IEST-RP-CC001. European Standard EN1822 and ISO Standard 29463 are used as a reference for classification.

### ASHRAE 52.2

ASHRAE Standard 52. 2 is the standard for measuring the performance of general ventilation filters in HVAC, and a laboratory test method is developed. The test method is used to measure the performance of air filters in removing particles of specific sizes as the filters become loaded by standard loading dust. The dust is sent in to simulate the actual conditions of use. The standard defines the experimental aerosol. It also provides the efficiency test method for calculating the particles within the interval of 0. 3-10  $\mu\text{m}$ , and the removal efficiency is calculated according to the particle size. The performance of the filter is expressed with the minimum efficiency report value (MERV).

AAF offers a broad range of ASHRAE 52. 2 compliant and primary air filters as prefiltration to terminal HEPA filters. Choosing the appropriate coarse filter will prolong the service life of the high efficiency filter.

## Performance level regulations and comparison of the European Standard EN779 ASHRAE 52.2 and American Standard





## IEST-RP-CC001

To ensure the highest level of air cleanliness, integrated circuits need to rely on high efficiency particulate air filters as terminal filters. These air filters are subject to classification according to IEST-RP-CC001 (HEPA and ULPA filters). This standard covers basic provisions for HEPA and ULPA filter units as a basis for agreement between customers and suppliers.

The filters that meet the requirements of IEST-RP-CC001 are suitable for the clean air equipment and clean rooms in the ISO 14644 range. These filters have higher requirements and the efficiency is 99.97% or higher.

In IEST-RP-CC001 the HEPA filters are classified and the structural levels of the filters are also divided.



### Comparison of the filter performance level and the specified capability stipulated in IEST-RP-CC001 and EN1822

IEST-RP-CC001							EN1822						
Filter performance levels	Particle size of test particles	Gross value		Local value			Filter performance levels	Particle size of test particles	Gross value		Local value		
		Efficiency %	Transmissivity %	Efficiency %	Transmissivity %	Local multiplier			Efficiency %	Transmissivity %	Efficiency %	Transmissivity %	Local multiplier
							H10	MPPS	85	15	-	-	-
							H11	MPPS	95	5	-	-	-
							H12	MPPS	99.5	0.5	-	-	-
							H13	MPPS	99.95	0.05	99.75	0.25	5
A	0.3µm	99.97	0.03	-	-	-							
B	0.3µm	99.97	0.03	Double air volume penetration test									
E	0.3µm	99.97	0.03	Double air volume penetration test									
H	0.1-0.2µm or 0.2-0.3µm	99.97	0.03	-	-	-							
I	0.1-0.2µm or 0.2-0.3µm	99.97	0.03	Double air volume penetration test									
C	0.3µm	99.99	0.01	99.99	0.01	1	H14	MPPS	99.995	0.005	99.975	0.025	5
J	0.1-0.2µm or 0.2-0.3µm	99.99	0.01	99.99	0.01	1							
K	0.1-0.2µm or 0.2-0.3µm	99.995	0.005	99.992	0.0008	1.6							
D	0.3µm	99.999	0.001	99.99	0.01	10	U15	MPPS	99.9995	0.0005	99.9975	0.0025	5
F	0.1-0.2µm or 0.2-0.3µm	99.999	0.001	99.995	0.0005	5							
G	0.1-0.2µm	>99.9999	0.0001	99.999	0.001	10	U16	MPPS	99.99995	0.00005	99.9998	0.00025	5

### Subefficiency and High Efficiency Comparison

ISO29463 filter level	Efficiency	IEST-RP-CC001	EN1822
ISO 15E	>95%	-	H11
ISO 20E	>99%	-	
ISO 25E	>99.5%	-	H12
ISO 30E	>99.9%	-	
ISO 35H	>99.95%	-	H13
-	>99.97%	A,B,E,H,I	-
ISO 40H	>99.99%	C,J(K)	
ISO 45H	>99.995%	K	H14
ISO 50U	>99.999%	D	
ISO 55U	>99.9995%	F	U15
ISO 60U	>99.9999%	G	
ISO 65U	>99.99995%	G	U16
ISO 70U	>99.99999%	G	

# Classification of Air Filters for General Ventilation

Different areas have different standards for classifying the air filters for general ventilation. In the United States ASHRAE 52.2 is the dominant standard in Europe EN779 is implemented in Asia and the Middle East, both standards are used.

## EN779:2012

The EN779: 2012 Standard defines the performance of air filters for general ventilation. Air filters are classified into three categories: coarse, medium efficiency and high and medium efficiency filters. The average arrestance and the counting efficiency range of each filter level are set according to the different categories. In addition, the medium efficiency filters also need to meet the minimum efficiency (ME) requirement, namely, the lowest value of initial efficiency for 0.4µm dust particles, the efficiency of the whole test loading process and the efficiency of electrostatic elimination in the three different tests.

AAF provides a wide range of energy-saving air filters that conform to the EN779:2012 Standard, from coarse pre-filters to medium and high efficiency last stage filters. The selection of appropriate pre-filters will determine the cleanliness of the air that flows through the last stage filters and can prolong the service life of the filters.



All AAF filters are UL 900 Classified Filters.  
<http://www.ul.com/>

Air filter classification standard EN779:2012

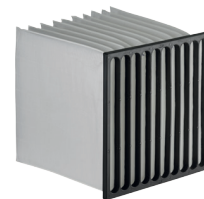
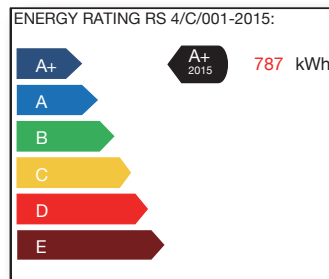
## AAF EUROVENT Certification

EUROVENT is an official authority in Europe. It certifies the performance level of medium efficiency and medium and high efficiency (filter level M5 – F9) air filters sold on the market. The filtration efficiency, operation resistance and energy efficiency filters have been certified by EUROVENT to ensure the performance of the delivered products is verified by third parties independently.

For more information about EUROVENT certification and an overview of the certification of AAF air filters, please login : [www.eurovent-certification.com](http://www.eurovent-certification.com)



## DriPak® NX detection report



DriPak® NX Medium Efficiency Bag Filter

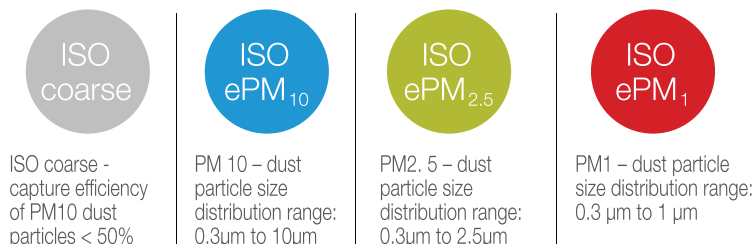
Initial resistance Anfangs-Druckverlust Perte de charge initiale	63 Pa	Initial efficiency Anfangs-Wirkungsgrad Rendement initial	50 %	Initial arrestance Anfangsabscheidegrad Rendement initial gravimétrique	>99 %
Final resistance Endwert des Druckverlustes Perte de charge finale	450 Pa	Average efficiency Mittlerer Wirkungsgrad Rendement moyen	84 %	Average synthetic dust weight arrestance Mittlerer Abscheidegrad gegenüber synth. Staubs Rendement moyen à la poussière synth.	>99 %
ENERGY RATING RS 4/C/001-2015:	A+ 2015 787 kWh	Efficiency of untreated media Wirkungsgrad des Mediums unbehandelt Rendement du médium non traité	50 %	Dust holding capacity Staubspeicherfähigkeit Capacité de rétention	779g
		Efficiency of discharged media Wirkungsgrad des Mediums entladen Rendement du médium déchargé	47 %	EN 779-2012 CLASS:	F7
		Minimum efficiency Minimum Wirkungsgrad Rendement minimum	47 %		

Category	Filter Level	Final Pressure Drop (Pa)	Average Arrestance (Am) % For Artificial Dust	Average Counting Efficiency (Em) % For 0.4µm Particles	Minimum Efficiency % For 0.4µm Particles
Coarse	G1	250	50 ≤ Am < 65	-	-
	G2	250	65 ≤ Am < 80	-	-
	G3	250	80 ≤ Am < 90	-	-
	G4	250	90 ≤ Am	-	-
Medium Efficiency	M5	450	-	40 ≤ Em < 60	-
	M6	450	-	60 ≤ Em < 80	-
Medium and High Efficiency	F7	450	-	80 ≤ Em < 90	35
	F8	450	-	90 ≤ Em < 95	55
	F9	450	-	95 ≤ Em	70

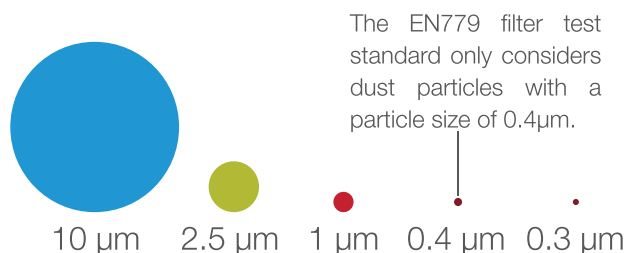
# Real Performance Measurement-ISO16890 Replacing EN779:2012



The International Organization for Standardization has developed a new standard for testing and grading air filters for general ventilation



## Main differences between EN779 and ISO 16890



The ISO16890 filter test standard considers the particle size range: 0.3µm to 10µm.

The exact definition of dust by PM10, PM2.5 and PM1 is rather complex and is not easy to measure. Therefore, the United States Environmental Protection Agency, the German Federal Environment Agency (Umweltbundesamt) and other government agencies have increasingly defined PM10 as the dust with the particle size  $\leq 10\mu\text{m}$  in publications. Although there is a deviation from the complex official definition, it has a small impact on the filter efficiency of dust filters, so ISO 16890 simplifies the definition of PM10, PM2.5 and PM1.

## More Reasonable - ISO Measures Real Performance!

The WHO believes that PM10, PM2.5 and PM1 are the most serious and dangerous dust particles for human beings. These PM levels are mentioned in the official literature. Therefore, it is more reasonable to use the grading of PM1, PM2.5 and PM10 for the filter test method and efficiency classification in the new standard.



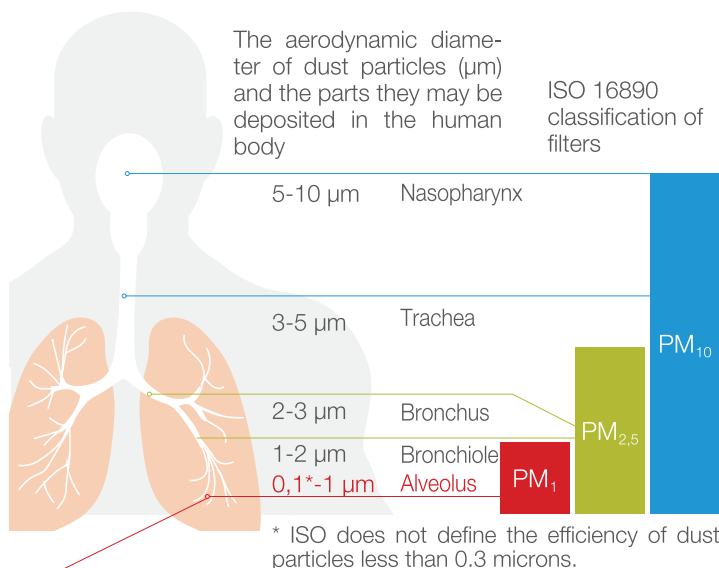
World Health Organization



United States Environmental Protection Agency



German Federal Environment Agency



The classification of ISO 16890 is based on the deposition of dust particles in different parts of the human lung.

“

Dust particles with a particle size less than  $1\mu\text{m}$  can pass through the cell membrane of the alveoli into the blood flow of the human body.

”

“

The 0.25 to  $0.5\mu\text{m}$  dust particles in the air are more closely related to human health, especially increasing the risk of cardiovascular disease.

”

“

Fine dust particles enter the human body, which may damage the regulation of the human central nervous system.

”

The smaller the PM<sub>1</sub> is, the more dangerous it is!

The findings of many studies have shown the effect of PM1 dust particles on health.

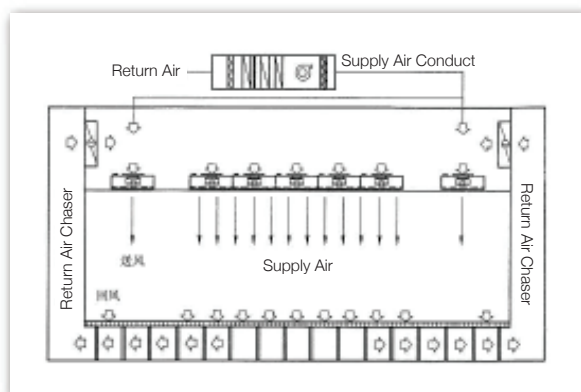
# Solutions for High Level Purification Areas - AstroFan® FFU




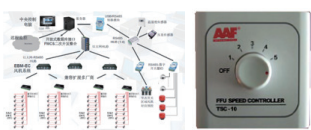
## Basic Introduction to FFU

FFU is the abbreviation of Fan Filter Unit. It is an air filter system with fan. It has been widely used in semiconductors, electronics, food, flat panel display, biopharmaceuticals and other fields with extremely strict requirements for air pollutants.

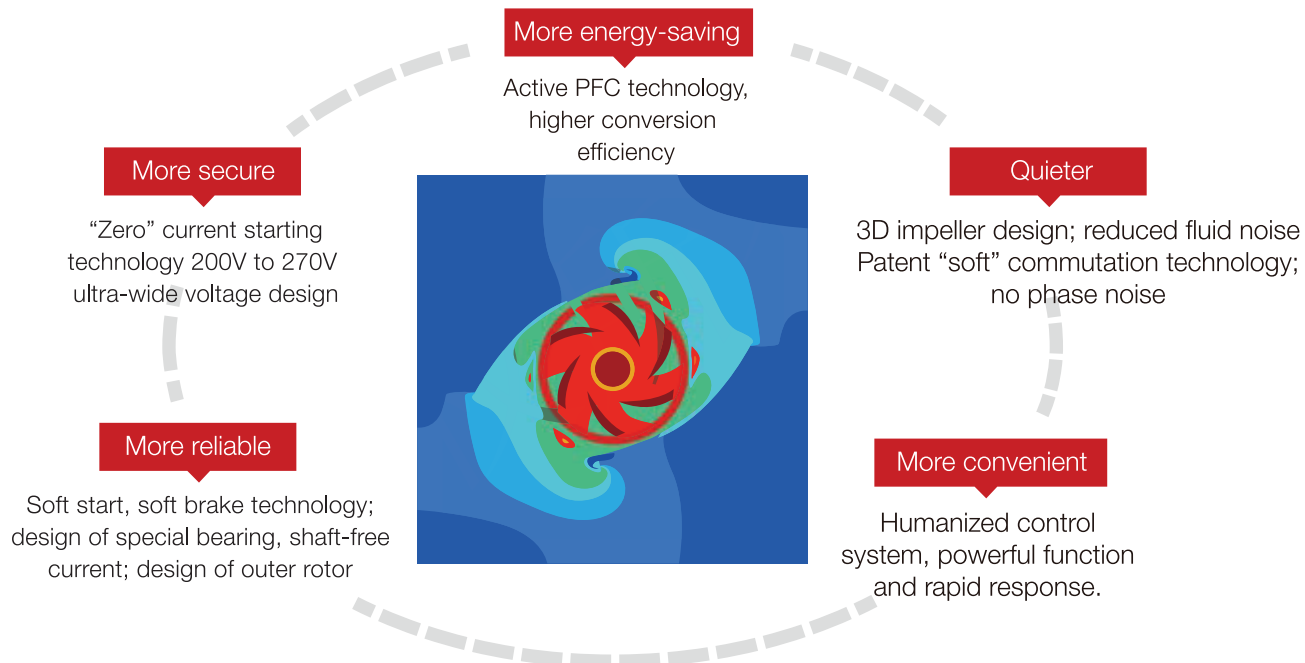
The clean room with above Cleanliness Class 1000 (FS209E Standard) or Class 6 (ISO14644 Standard) usually adopts FFU layout, and FFU is also adopted for the clean air supply in local environment.

AAF FFUs are exported to all parts of the world. Every day about 1.5 million FFUs produced by AAF provide clean air for human beings, and the performance of FFU is ranked first in the industry.



Fan	CASING	FILTER	Control System
			
Classification by Fan Type	Classification by Casing Material	Classification by Filter Material	Classification by Control Type
AC (AC system)	Galvanise	Low resistance ePTFE: MEGACel II	Local control: five-speed regulation
EC (DC system)	Aluminium	Traditional glass fibre: AstroCel II	Cluster control: E-Smart Control System
DC (DC system)	Stainless steel		EsiDrivers II AC Control System

## Characteristics of EC FFU





### AstroFAN FFU: Advantages of EC & DC/AC

- Excellent casing structure design, durable, reducing the resonance caused by multiple FFUs as much as possible.
- Revolutionary filter design, 40% more energy saving than traditional HEPA.
- Selected high performance fan with high static pressure under rated air volume, low vibration, low noise and high efficiency.
- Overall performance advantages: low energy consumption; less operating costs.
- The speed control system can realize local control and AAF's cluster control software can realize multi-function control.
- The pre-filter and the chemical filter that can remove AMC can be added according to the customers' needs.



### AstroCel EFU: Advantages

- The ultra-thin casing structure design is suitable for installing on the micro-environment equipment to meet the small installation environment in the equipment.
- It can be horizontally or vertically installed. The fixed mode of the filter and the casing can be applied to many kinds of microenvironment equipment to facilitate the installation, operation and maintenance.
- Revolutionary filter design, 40% more energy saving than traditional HEPA.
- Selected high performance fan with high static pressure under rated air volume, low vibration, low noise and high efficiency.
- The speed control system can realize local control and AAF's cluster control software can realize multi-function control.
- The pre-filter and the chemical filter that can remove AMC can be added according to the customers' needs.

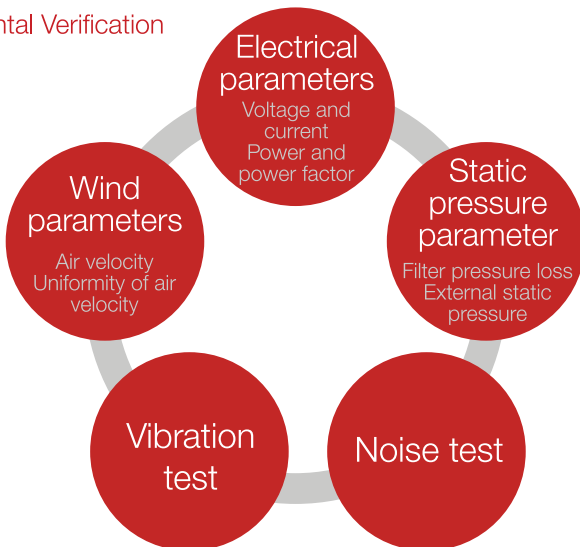


### FFU & EFU Chemical Filters

In the dust-free room, the FFU & EFU chemical filter can be used. According to the functional requirements for removing AMC, it can be combined with acid removal, alkali removal and VOCs organic gas removal chemical filter.



### Experimental Verification



We will provide each customer with a complete set of FFU test data reports on corresponding products.

In order to ensure the accuracy of the test, our testing instruments are all high-end products of well-known brands.

# Solutions for High Level Purification Areas-AstroCel® Fan FFU

## How to control AAF's FFU?

AstroDrive Control System

Superior System Architecture

Faster Scanning Speed

The software interface is more humanized.

Better Compatibility

Extensible OPC function and pressure difference monitoring

## Superior System Architecture

- The AstroDrive system architecture is based on a high-speed Ethernet switch.
- A single integrated gateway (MGW-S) is directly connected to 8 groups of FFUs, with 31 FFUs in each group, 248 FFUs in total.
- The maximum number of FFUs controllable by the AstroDrive system is:  $248 \times 254 = 62992$

The integrated gateway (MGW-S) may take place of the hardware of the original Elisa control system, Master Gateway1420 and Slave Gateway1421

## Faster Scanning Speed

- The scanning period of the AstroDrive control system is 8 seconds.

## The software interface is more humanized

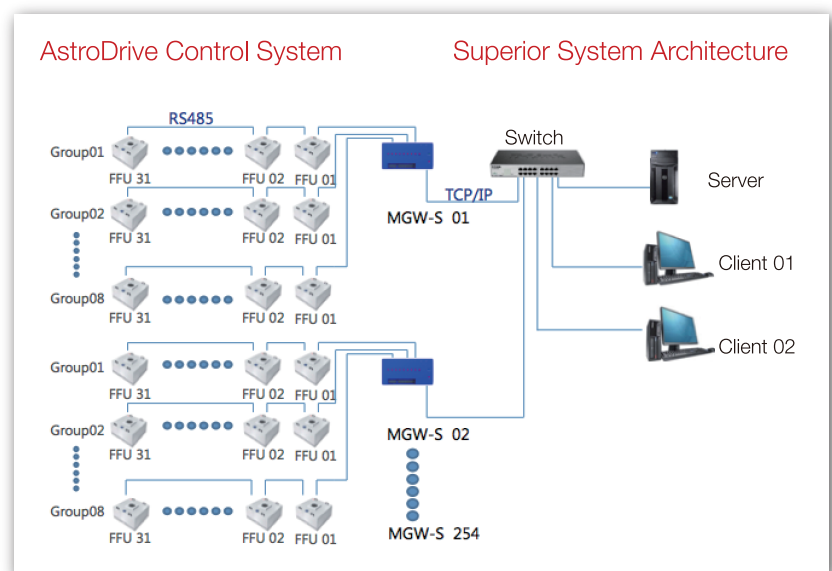
- With the CAD vector zooming function, zoom in and out can be realized at random by using the mouse wheel.
- Partition management is more optimized, with cross-area partition available.
- Quick-query function

## Better Compatibility

- Compatible with all EBM BUS protocol fans.
- Can run in most of mainstream versions of Windows.

## Extensible OPC function and pressure difference monitoring

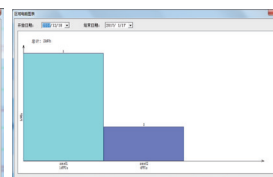
- The OPC Server can be added according to the customers' requirements to facilitate the integration of the information into the entire information system through the software.



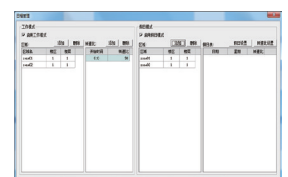
## Presentation of Software Functions



System parameter settings



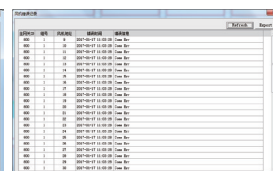
Energy consumption recording and analysis



Holiday energy saving



Multi-level user management



Logs



Firefighting linkage

# MEGAcel<sup>®</sup> Filter Material Introduction

## Secure

The pollution of the production process is minimized, and it does not contain B or P.

The harm to the operator is minimized.

## Reliable

Strong adaptability to the environment

Resistant to acids, alkalis, organic matters, water, etc.

## Energy Saving

Low initial resistance and long service life

20% to 30% more energy saving relative to traditional filter paper

## Performance

The filtration efficiency of particles is higher (H13-U17)

Performance reaches the standard under larger air volume

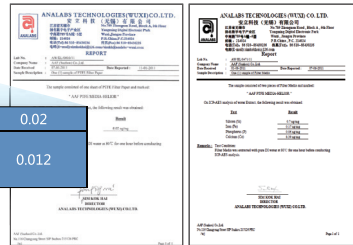
## Durable

Not easy to break in the process of transportation and installation

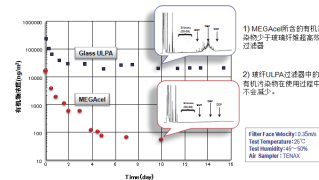
Not easy to break in daily use

### 1. Safest MEGAcel HEPA

Chemical composition	MEGAcel filter paper (wt.%)	Glass fiber filter paper (wt.%)	Low boron glass fiber filter paper (wt.%)
Si (Silicon)	$1 \times 10^{-7}$	72.0	74.0
B (Boron)	$2 \times 10^{-8}$	8.0	0.02
P (Phosphorus)	$1 \times 10^{-8}$	0.034	0.012
Na (Sodium)	<0.001	0.11	1.1
Ca (Calcium)	<0.001	4.1	1.2
Al (Aluminum)	<0.001	4.2	2.2
Fe (Iron)	<0.001	0.063	0.087
Zn (Zinc)	<0.001	2.1	0.31



There is almost no chemical volatilization in the MEGAcel filter.



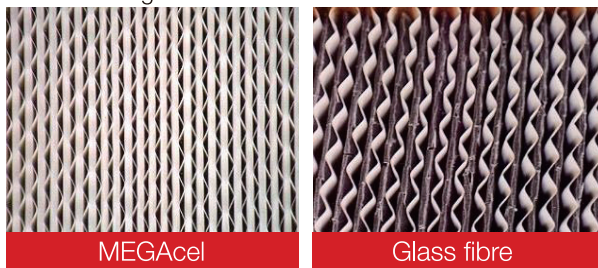
Test conditions:  
Air velocity: 0.35m/s  
Temperature: 25°C  
Humidity: 45% to 50%

FILTER	Chemical gas volatilization (ng/m3)
MEGAcel	<100
Glass fiber	20,000
Low boron glass fiber	20,000

The volatilization of chemical gases is less than 0.5% of the glass fiber filter paper.

### 2. Reliable MEGAcel HEPA

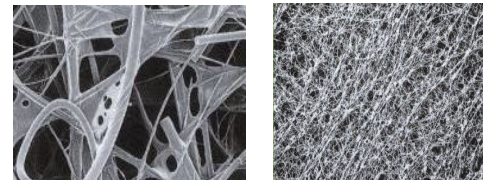
MEGAcel HEPA is resistant to the corrosion of acids, alkalis and organic matters.



The concentration of HF remains 0.2 ppm in two years. Manual of the Japanese Ministry of Health, Labor and Welfare stipulates the limit of the concentration of harmful and toxic materials to be at 3ppm.

### 3. Energy saving and Best performance MEGAcel HEPA

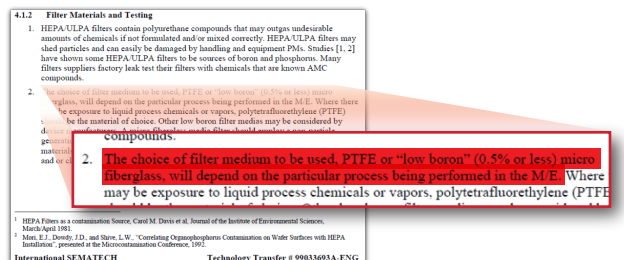
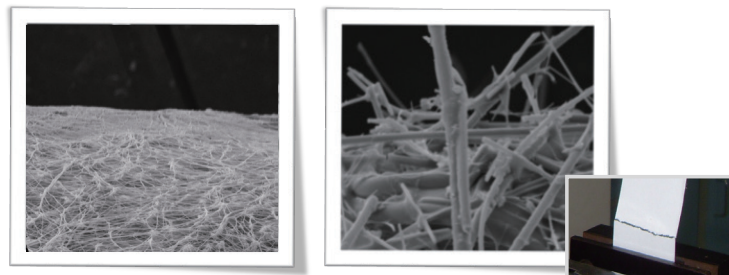
MEGAcel filter paper has smaller micropore diameter and more uniform fibre to achieve the effect of low resistance and super high efficiency



FILTER	MEGAcel filter paper	Glass fibre filter paper
Average pore size	0.7um	3.0um
Fibre diameter	0.05 - 0.2um	0.5 - 1.0um
Filter paper resistance (H13)	150Pa@5.3cm/s	300Pa@5.3cm/s

MEGAcel Media

The International SSL Alliance recommends the use of PTFE.



# MEGAcel<sup>®</sup> Filter Material Introduction

AAF MEGAcel<sup>®</sup> ePTFE filtering technology is applied to the microelectronics industry, which can bring the following advantages.



## Consistent Air Quality

Providing a reliable high air quality to optimize contamination control and meet the stringent conditions in clean environments.



## Environmental Savings

Reducing operating resistance and extending life expectancy to minimize energy consumption and reduce CO2 emissions.



## Improving Process Performance

Reducing risk of failures to enhance product quality and prevent negative effects from unnecessary interruptions.



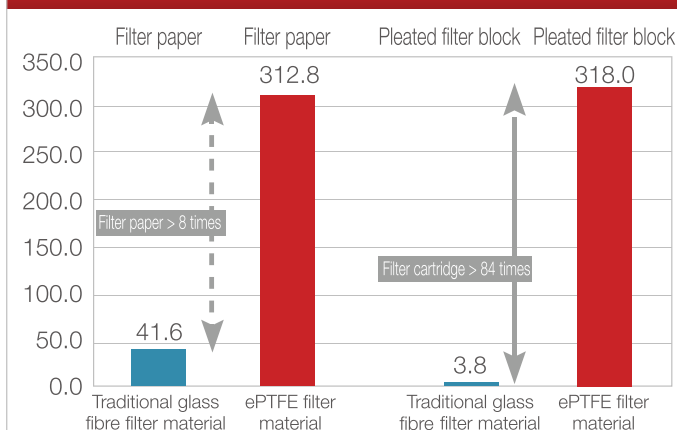
## Reducing TCO

Improving process reliability and overall efficiency to save life cycle costs and improve performance.

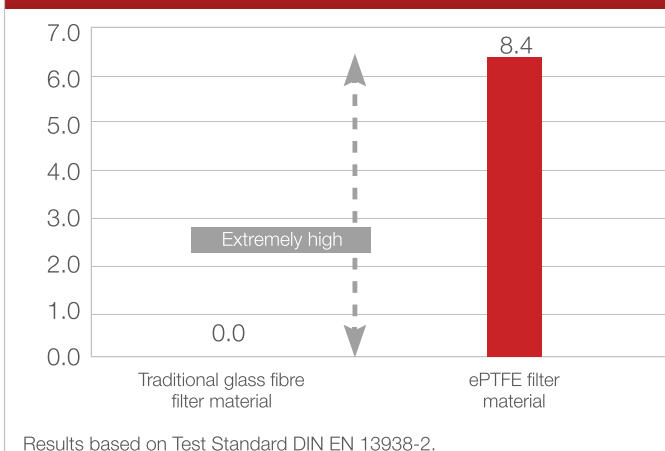
The life science industry needs dependable and persistent performance, reduced operational risk, low energy consumption, and considerable cost savings.

When a catastrophic accident occurs in the clean room, high strength, super high chemical resistance, extremely low chemical volatility of PTFE can greatly reduce the possibility of accidents, and reduce the loss caused by accidents.

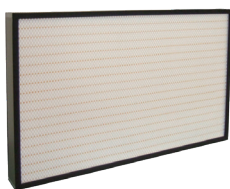
### Tensile Strength



### Burst Pressure (kg/cm²)



MEGAcel-I

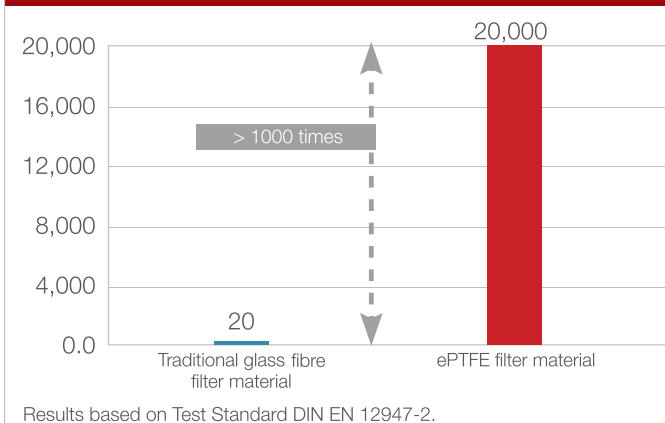


MEGAcel-II



MEGAcel-III

### Abrasion Resistance



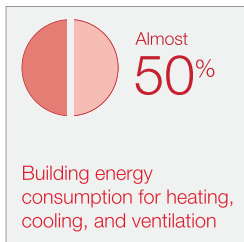


# TCO

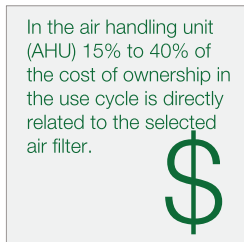
## TCO : Total Cost of Ownership

These costs mainly include the following aspects:

- Purchase cost of the filter
- Running energy consumption caused by filter resistance
- Expenses of labor of installing and replacing the filter
- Waste disposal costs of old filters
- Cleaning expenses of ventilation system



Sources: Department of Energy;  
2006 building energy data



Sources: Department of Energy;  
2006 building energy data

# TCO DIAGNOSTIC SM

Generally, the largest part in TCO of the filter is the cost of running energy consumption.

When most users choose air filters, they tend to consider only the cost of the purchase, which is actually incorrect.

What is the most economical and overall clean air solution?

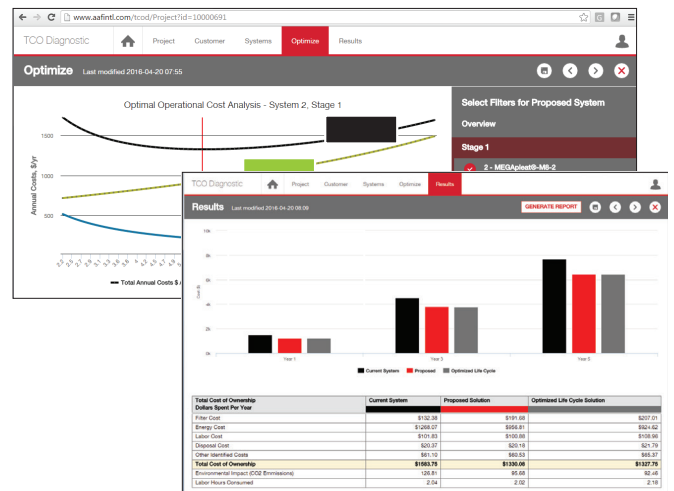
$$TCO = \text{direct cost} + \text{indirect cost} + \text{intangible cost}$$

Investment cost (10 to 20%)      Energy consumption cost (70 to 85%)      Maintenance cost (2 to 5%) + Waste disposal cost (2 to 5%)

As a global leader in clean air solutions, AAF has powerful software support to develop the most advanced analysis software in the filter industry.

## The most advanced filter analysis software in the filter industry

- TCO diagnosis and analysis of HVAC system are carried out online to determine the best solution, which is fast and convenient.
- Simulate the system environment, close to the actual operating environment.
- The most complete test report database.
- As many as 4 filtering schemes can be analyzed at the same time.
- The related costs of filters, energy consumption, and expenses of labor are described in stages.
- Energy use and cost calculation ensure consistency between methods and results.
- Dynamic adjustment to view the value of the total cost, the cost of energy consumption, and the change in the filter cost.
- Generate a written report that clearly illustrates the used assumptions and calculates the savings.



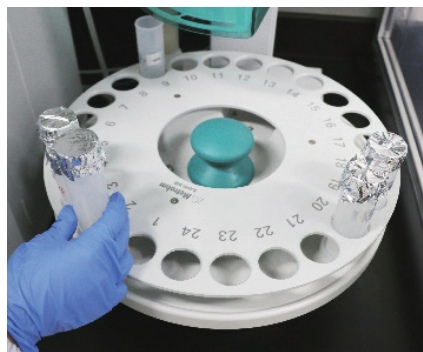
# Research and Development, Production and Testing Capabilities of AAF

## Research and Development Strength

AAF has a strong and experienced R&D team. Our R&D staff have many years of experience in the design and development of air filters and purification equipment and the research and development covers the purification equipment, filter materials, chemical gas analysis, pharmaceutical products and product design.

Since joining Daikin group, AAF has paid more attention to the open and long-term development. On the basis of the original development of the R&D department, greatly enhance the R&D strength of AAF. With the strong support of Daikin Group, we have constantly promoted the development of new products, comprehensively improved the quality control, constantly expanded the service fields, and successfully developed a variety of high value-added products. AAF has a strong R&D team and the world's leading R&D laboratory.

Boasting large high-end analytical and testing instruments such as GC-MS and ion chromatograph, we can directly collect gas samples and analyze the gas composition of samples on the customer's site. It not only greatly shortens the gas sampling and analysis time, but also helps us provide customers with follow-up tracking services so that AAF can serve customers more efficiently with better quality products and services and provide customers with better solutions.



**Ion chromatograph**  
It can test the filtration efficiency and the inorganic ion concentration in the customer's site environment



**TSI filter material testing equipment**  
It can test the filtration efficiency and resistance of filter materials



**GC-MS can be used for qualitative and quantitative analysis of TVOC and common organic compounds in the customer's site and in the use of filters**

## Production Environment

AAF has Class-10,000 e-PTFE clean rooms, HEPA filter clean rooms and FFU clean rooms, as well as industrial and commercial filter production lines. We use advanced equipment, standardized production processes and stringent quality standards for production. We have 3,000 square meters of storage space and all products have code and the whole process can be traced back.



High efficiency filter production line



FFU production clean room



Filter production line



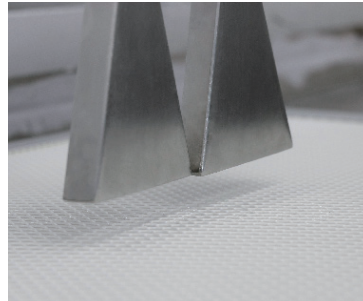
Gas phase filter media pleating machine

## Test System

AAF has a complete set of testing system from coarse filters, medium and fine filters to HEPA filters, ULPA filters, and even filtration equipment, AAF has conducted a comprehensive test to all the performance of products in accordance with the most advanced testing standards.

European standard: EN779-2012  
EN1822-2009

American standard: ASHRAE52.2  
IEST-RP-CC034.3



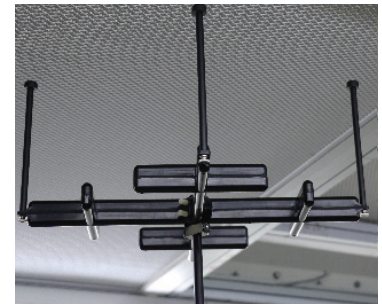
The test of EN1822 MPPS is based on particle counting method. It uses the aerosol probe to scan and move across the surface of the filter to obtain the local efficiency value of the filter. In addition, it uses computers to calculate the efficiency of the filter or the leakage rate of a certain area.



The test standard of EN779 is the basis of the design, production and detection of coarse, medium and fine filters.

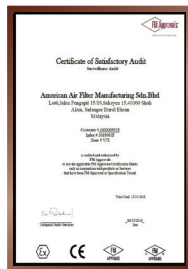


The performance test of high efficiency filter is to test the performance of high efficiency filter through PAO/PSL dust particles.

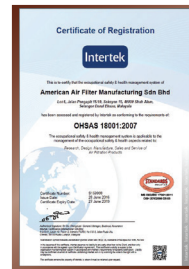


The FFU test can be used to detect noise, air velocity uniformity, power consumption and vibration.

## AAF Certification



FM Certificate



OHSAS 18001



ISO 9001



ISO 9001

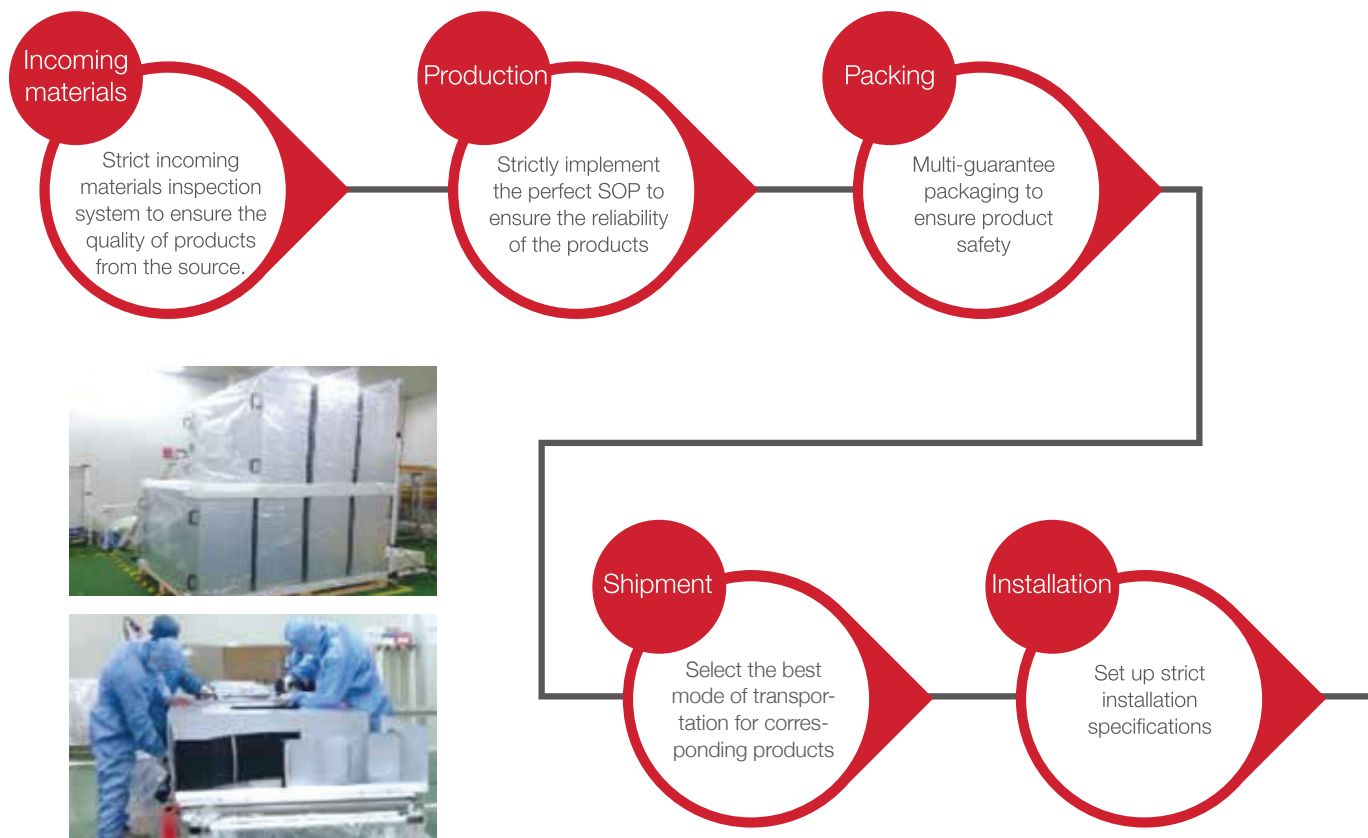


ISO 14001

# Advantages of AAF

## Strict Quality Control

The whole-process of quality control is provided to ensure the quality of the products.



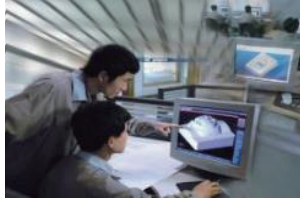
Complete Supply Chain	Sustainability	Integrity	Traceability	Testing	Maximum Yield
AAF is the only manufacturer in Asia capable of consistent production from raw materials to finished filter products.	Since the independent research and development of the first generation of PTFE filter materials 30 years ago, it has been updated to the sixth generation.	After twenty years of finished product verification, our products are safe and reliable.	From raw materials to finished products, the whole process can be traced and the quality is controlled.	The products are strictly tested before they leave the factory.	Our products have a huge output and are supplied to the whole world.



# AAF Service Projects

## Perfect Technical Services and After-Sales Team

AAF's FFU Technology R&D Center in Asia is located at AAF Malaysia. We have nearly twenty years of R&D and production experience, and a technology and R&D team of over 20 members. We have two technical customer offices all over the country in charge of areas covering most parts of the country.



The control of AMC is now fully combined with the requirements of the clean room management of the high-tech production workshop. The most suitable control is divided into three steps:

- The air quality inside and outside of the workshop is evaluated to identify the target pollutants and the substances that may affect the operation of the AMC control system.
- Select a set of qualified AMC control system.
- Continuously monitor the controlled environment and the operation of the AMC control system.

AAF can provide a wide range of AMC-related services to enable customers to focus on their core businesses. These services include the filter life analysis, real-time online measurement of pollutants and passive sampling to precisely determine the type and concentration of the problem mixture.

After completing the customer site analysis, our AMC experts can propose a comprehensive AMC scheme based on the minimum use cycle cost that meets customer needs. This kind of performance data is very important when determining the best scheme for specific AMC.

### Pre-Sale Services

Environmental Detection

- Suspension and collection of environmental corrosion testing pieces.
- Detection and analysis of AAF Laboratory.
- According to the test data, the existing environmental problems and potential risks in the machine room are analyzed and summarized, and relevant solutions are issued.
- Provide a feasibility analysis report on the installation, construction and operation of AAF solutions in combination with solutions and customer site conditions.

### Whole-Sales Services

Installation and Construction

- Installation, commissioning and trial operation of the machine room purifier.
- Regular monitoring of the normal operation of the purifier.
- Maintenance and inspection of air filter.
- Inspection of chemical module filter.
- Regular checking, repair and maintenance of electrical equipment such as electric motor in the equipment.
- Continuous monitoring of the environmental risk of the machine room after the normal operation of the purification equipment.
- Issue the acceptance report according to the comparison of the customer's environment before and after the installation.

### After-Sales Services

Risk Monitoring  
Maintenance Services

- During the maintenance period, technicians are sent to inspect the field equipment (at least) every three months and replace the filters.
- After the expiration of the maintenance period, perform maintenance services according to the sales contract.

## Proven Expertise of AAF

AAF offers the most comprehensive air filtration portfolio in the industry, including particulate and gas-phase filters, to provide a customized clean air solution. Each product is carefully designed, manufactured, and tested in full compliance with all applicable standards to meet the most challenging demands with the lowest Total Cost of Ownership.

### Asia Sales Office Air Filter

American Air Filter Manufacturing Sdn. Bhd. (Malaysia)  
AAF Australia Pty. Ltd. (NSW Sales Office)  
AAF Australia Pty. Ltd. (VIC Sales Office)  
AAF Australia Pty. Ltd. (QLD Sales Office)  
AAF India Private Limited (Noida)  
AAF India Private Limited (Bangalore)  
AAF International (Thailand) Co., Ltd.  
AAF International Air Filtration Systems L.L.C  
AAF Singapore Pte. Ltd.  
PT. AAF International Indonesia  
AAF Saudi Arabia Ltd.

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Tel : +04 339 7688  
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+96 61 265 2285



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AAF has a policy of continuous product research and improvement and reserves the right to change design and specifications without notice.

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