

CLEANROOMS

Air Filtration Products &
Systems for Cleanroom
Applications



B E T T E R A I R I S O U R B U S I N E S S ®

AAF®

Airborne Contamination Control

Many products have to be manufactured under cleanroom conditions, in which airborne contaminants are carefully controlled. For example:

- in the microelectronics industry, micro devices are produced under stringently controlled conditions to prevent defects
- in the pharmaceutical industry to stop cross-contamination
- in hospital operating theatres to inhibit the spread of infection.

The US Federal Standard 209E defines a cleanroom as a room in which the concentration of airborne particles is controlled and which contains one or more clean zones. Various classes of cleanroom are specified in terms of the maximum permissible number and size of particles per cubic foot or cubic metre. To meet these requirements, a cleanroom air filtration system has to be installed. While vital in maintaining air quality in a cleanroom, air filtration is not the only factor. Strict adherence to production procedures and personal hygiene is essential. When specifying a cleanroom it is important to define the facility. The US

Federal Standard 209E defines three types of cleanroom facility:

- An **as-built** cleanroom is complete and ready for operation, with all services connected and functional, but without equipment or operating personnel in the facility
- An **at-rest** cleanroom is complete, with all services functioning and with equipment installed and operable or operating, as specified, but without personnel in the facility
- An **operational** cleanroom is a facility in normal operation, with all services functioning and with equipment and personnel, if applicable, present and performing their normal tasks.

As a general guideline, the air quality in an operational cleanroom is ten times lower than that in an as-built cleanroom.

A cleanroom air filtration system normally also incorporates provisions to help remove contaminants originating from activities inside the cleanroom. Based on considerations of cost and energy conservation, a major part of the air volume

Guide to GMP

USA FS 209E 1992	EC Guide to GMP ¹⁾ 1989 viable micro-organisms			
metric	Class	max.CFU per m ³	velocity m/s	air- changes/h
M 3.5	A ²⁾	< 1	ver. 0.30 hor. 0.45	NA
M 3.5	B	5		> 20
M 5.5	C	100		> 20
M 6.5	D	500		> 20

Notes:

- 1) Refer to ‘ Rules Governing Medicinal Products in the European Community’, Volume IV, guide to Good Manufacturing Practice for more detailed information.
- 2) For laminar airflow workstations.

needed for cleanrooms is normally recirculated. The recirculated air is filtered in separate filter housings before remixing and recirculation or via the prefilter stages of the supply air. Where necessary, harmful emissions are filtered from the exhaust air before discharge to the atmosphere.

US Fed.Std 209E Class Name ²⁾		Class Limits ¹⁾					BS 5295 1989	VDI 2083 ⁴⁾ Part 3	AFNOR ⁴⁾ NFX 44-101
		0.1 µm	0.2 µm	0.3 µm	0.5 µm	5 µm			
SI	English ³⁾	(m ³)	(m ³)	(m ³)	(m ³)	(m ³)			
M 1		350	75.7	30.9	10.0	-	-	-	-
M 1.5	1	1,240	265	106	35.3	-	C	1	-
M 2		3,500	757	309	100	-	-	-	-
M 2.5	10	12,400	2,650	1,060	353	-	D	2	-
M 3		35,000	7,570	3,090	1,000	-	-	-	-
M 3.5	100	-	26,500	10,600	3,530	-	E,(F) ¹⁾	3	4,000
M 4		-	75,700	30,900	10,000	-	-	-	-
M 4.5	1,000	-	-	-	35,300	247	G,(H) ¹⁾	4	-
M 5		-	-	-	100,000	618	-	-	-
M 5.5	10,000	-	-	-	353,000	2,470	J	5	400,000
M 6		-	-	-	1,000,000	6,180	-	-	-
M 6.5	100,000	-	-	-	3,530,000	24,700	K	6	4,000,000
M 7		-	-	-	10,000,000	61,800	-	-	-

Notes:

- 1) The class limits shown in table 1 are defined for classification purposes only and do not necessarily represent the size distribution to be found in any particular situation.
- 2) Concentration limits for intermediate classes can be calculated, approximately, from the following equations:
$$\text{particles/m}^3 = 10^M (0.5/d)^{2.2}$$
 where M is the numerical designation of the class based on SI units, and d is the particle size in micrometers, or: $\text{particles/ft}^3 = N_c (0.5/d)^{2.2}$.
- 3) For naming and describing the classes, SI names and units are preferred; however, English (U.S.) customary units may be used.
- 4) VDI 2083 and AFNOR values are applicable for particle size 0.5 µm. These values deviate from the US Federal Standard 209E.
- 5) Scandinavian standards conform US Federal Standard 209E.
- 6) Always refer to complete standard for exact details.

Professional Cleanroom Solutions

AAF specializes in air filtration systems for cleanroom applications. A complete range of air filters is available, from economical prefilters to high efficiency particulate air (HEPA) and ultra low penetration air filters (ULPA). All filters are designed to comply with applicable international standards and practices.

In addition, AAF offers a full line of products enabling a complete air filtration system to be tailored to customer requirements. Whatever the type of airflow system, there is a full range of support products available, including ceiling grid systems, ceiling modules, crossflow frames and matrices, and duct housings.

Technical experts can be arranged to supervise installation and, if required, an entire air filtration system can be installed. Independent validation testing of filters and air filtration systems can also be arranged.

A worldwide organization with sales offices and representatives in most countries, AAF gives prompt, reliable after sales service to customers everywhere.

AAF has its own cleanroom facilities and conducts an intensive R & D program to keep abreast of rapidly changing developments in technical requirements and to spearhead new technologies.

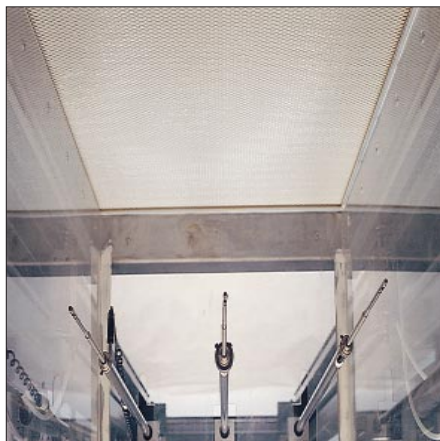
AAF is active in standardization committees in Europe and the USA and plays an important part in establishing advanced new standards and recommended practices.



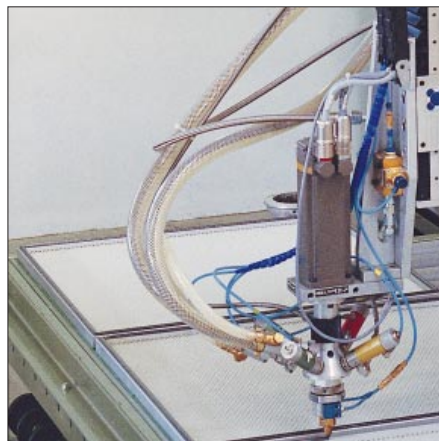
Automatic pleating technology



CNC scan testing in compliance with draft EN1822 (draft DIN 24.183)



Air distribution test



One-piece gasket production



Din 24184 leak test/pinhole repair

AstroCel Filters Designed for the Future

AAF has designed a range of high efficiency air filters (HEPA and ULPA) to meet the highest standard of particulate control required in cleanroom applications. All filters are tailor-made in the optimum configuration to provide the best solution for the customer, whatever the conditions and efficiency required.

AstroCel II

AstroCel II is a high efficiency filter specially designed for cleanroom applications. Lightweight and easy to install, this filter is ideal for all types of airflow system:

- open plenum systems
- individually ducted systems
- in-line housing systems

AstroCel II is available with either a dry or liquid seal system to ensure leak-free installation in any type of grid system or frame. AAF specialists will assist in selecting the best sealing system for the specified application:

- dry seal, one piece foamed gasket
- knife-edge liquid seal system
- a fluid seal groove for individual modules

AstroCel II utilizes thermoplastic separators to maintain uniform spacing between the media pleats. The separators permit very dense packing of the filter media and provide a high ratio of media to face area which is essential for high efficiency filtration. Customers have a choice of pleating depth and spacing in combination with a variety of ultra high efficiency glass fibre filtration media.

AstroCel TM

AAF offers a filter hood, the AstroCel TM, which gives the same high performance as the AstroCel II. Made of extruded aluminium, the AstroCel TM filter hood is designed for individually ducted systems. It is available with either a dry seal or knife edge liquid seal system. The entire filter hood is factory sealed and tested to prevent leakage between hood inlet and air leaving side.

Testing

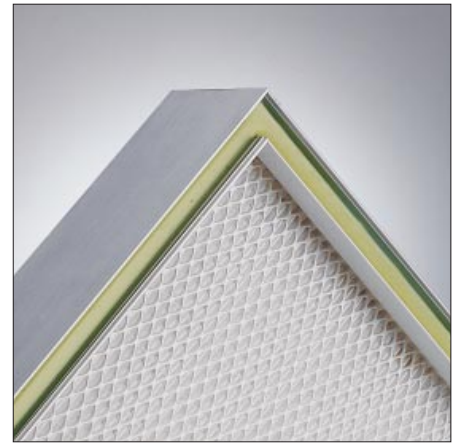
Each filter is individually factory tested to meet the criteria specified for its application. A test label, certifying the efficiency, rated airflow and initial resistance is supplied with each filter and an individual quality report is kept on file. All efficiency testing is carried out according to internationally accepted standards and practices. Individual leak testing and scanning is mandatory practice for all filters for cleanroom applications to ensure compliance with the minimum permissible level for local penetration.



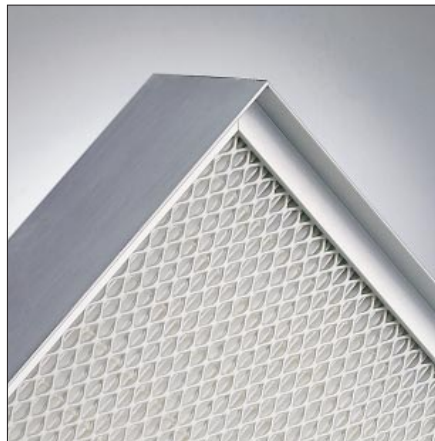
AstroCel II



AstroCel TM Hoods



AstroCel II fluid seal detail



AstroCel II knife edge detail



AstroCel II gasket detail

Ceiling Grid Systems and Accessories

As well as HEPA and ULPA filters, AAF offers a wide range of cleanroom products to meet all requirements of vertical airflow systems. The product range includes all essential accessories for laminar and non-laminar flow systems, such as ceiling grid systems, modules for replaceable filters, teardrop light and lay-in light fixtures.

Ceiling grid systems

The AstroGel ND grid system is the most advanced ceiling grid on the market today. The grid has provisions for individual sealing of each filter. The filter can be removed without affecting other filter seals. Designed to provide an airtight seal around all filters and blank panels, this grid system is truly leak-free under design conditions and, in addition, no mastic sealants are used at the joints.

The AstroGel ND grid system is suitable for different types of filter. For example:

- for applications with gel or vaseline for liquid seal using knife-edge filters
- for a dry seal using a unique dry seal clamping mechanism for non gasket filters

Furthermore, the AstroGel ND grid system is lightweight and quick and easy to assemble. It is also strong enough to walk on.

The grid system is so flexible that even after installation the design layout can be modified.

There are penetration points in every connection joint with airtight covers and special auxiliaries for installing sprinklers, electrical conduits and smoke detectors. There are also provisions on the cleanroom side for:

- teardrop light fixtures
- connecting walls or glass panels
- curtains

Each grid system is prefabricated to fit the specific cleanroom requirements and is

supplied with all necessary hangers and wall connections for easy installation.

Special light diffuser

Narrow teardrop light diffusers which do not interfere with the airflow can be easily incorporated in the ceiling grid. Modular in construction, the teardrop fixture can be installed as a single unit or in continuous rows.

Lay-in light fixtures

If preferred, light units can be built into the grid. The light housings are factory sealed to prevent dust infiltration from the ceiling space above the grid.



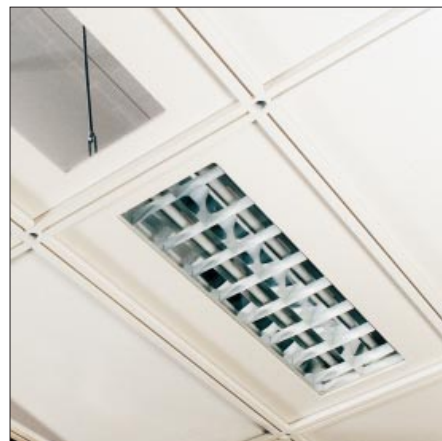
Penetrations and hanger



Teardrop light fixture



IBM Corbeil - Cleanroom (2)



Lay-in light fixture

Ceiling Modules

Ceiling modules are used in laminar and non-laminar cleanroom airflow systems to house replaceable terminal filters. AAF has three types of module available which comply with the most stringent cleanroom requirements and standards.

FM 2 Module

The FM 2 fan filter module comprises a fan and a replaceable ULPA filter encapsulated in a robust housing. As a self-contained and independent module, FM 2 can be suspended independently or included in a conventional grid system for non-ducted cleanroom applications. The module is designed to provide laminar localized Class 100 air, or better, to process equipment and control work zones.



FM 2 Application

CR II Module

The CR II ceiling module is designed to accommodate a high efficiency particulate air filter. This module can be used as a laminar ceiling for Class 1 areas, as defined in DIN 1946, Part 4 for hospital operating theatres, sterilization rooms and intensive care facilities. It can also be used in other cleanroom applications.

The module is made of passivated stainless steel to prevent oxidation. The housing contains no unnecessary troughs in which bacteria can accumulate. Each module has a perforated diffuser to optimize air distribution and protect the filter media.

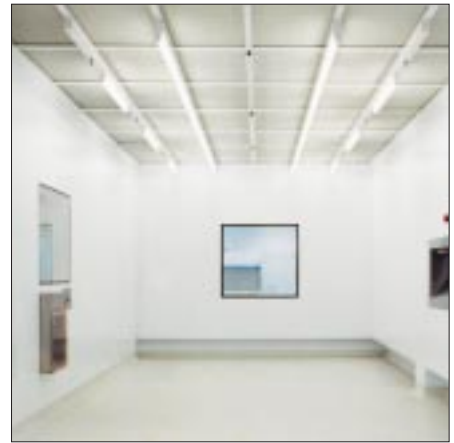


CR II Application

CM Hood

The CM Hood is a terminal filter module designed for non-laminar ceilings. The hood can accept a wide variety of HEPA and ULPA filters. Filters are mounted from the cleanroom side and sealed in the module by a clamping mechanism. Each unit is supplied with a testport for measuring pressure drop across the filter.

The unit can be supplied with an optional integral seal groove to test for gasket leakage in compliance with DIN 1946 requirements. Three types of air distribution device are available - 4.3.2.1-way, swirl or perforated, each of which can be removed from the module on the cleanroom side.



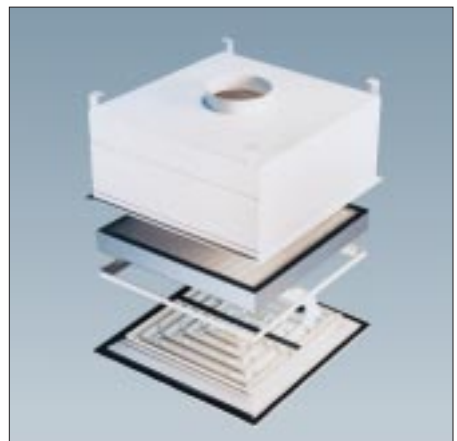
CM Hood Application (3)



FM 2 Module (exploded view)



CR II Module (exploded view)



CM Hood (exploded view)

Duct Housings and Frames

Crossflow Systems

In addition to its state-of-the-art ceiling grids and accessories for downflow systems, AAF offers a complete range of filter frames and products for crossflow systems (horizontal airflow). Basically, a crossflow system consists of two walls of filters situated opposite one another through which air is allowed to enter and exit. Close to the high efficiency wall, Class 100 or better air quality is achievable.

AAF's crossflow systems offer practical, cost effective solutions for cleanroom applications when space is limited, for example, a low ceiling. AAF has two types of modular frame systems available, both of which can be customized to meet customer requirements.



Crossflow system (4)

Frames

PC II

PC II frames are designed to accommodate HEPA and ULPA filters. This modular system can be quickly and easily bolted together in any configuration required. A unique clamping mechanism ensures that each filter is secured safely in place so that no contaminants are allowed to accumulate between frame and filter. A wide selection of frames is available, including galvanized steel, stainless steel, aluminium and coated steel to meet a wide variety of filter sizes.

Bevel Seal

As an alternative to PC II frames, AAF has developed a factory welded system to support banks of filters on cleanroom walls. Like PC II, the Bevel Seal System can be tailored to meet the requirements of the application. Installation is straightforward, filters being secured by way of spring-loaded mechanisms. The filters are flush with the frames on the clean air side.

Housings

RPT Safe Change Housing

The RPT Safe Change Housing is designed to enable smooth, safe removal of contaminated filters from exhaust systems in cleanrooms. Filters are changed in a fully enclosed bag system to ensure there is no physical contact between the operator and any hazardous substances. The unit is compact, takes up minimum space and is suitable for vertical downflow and horizontal airflow systems.



PC II Frame



Bevel Seal Frame Application (4)



RPT Housing Application (4)

Prefilters

A range of prefilters is available to protect air handling unit components, ducting and main filters from contamination.

AmAir

AmAir are pleated media type prefilters, designed to protect higher efficiency compact or pocket filters. The filters are either 45 mm or 94 mm deep.



AmAir



VariCel V

VariCel V

A compact, mini-pleat filter capable of providing high performance filtration in difficult operating conditions such as changes in air volume, repeated fan shut down, high humidity and intermittent exposure to water.

- (1) Page 1: Picture courtesy of TU Eindhoven
(2) Page 5: Pictures courtesy of IBM Corbeil
(3) Page 6: Pictures courtesy of Schering Plough
(4) Page 7: Pictures courtesy of Sulzer Infra and Pharmachemie B.V.

AAF-International B.V.
P.O. Box 7928
1008 AC Amsterdam
The Netherlands
Tel.: + 31 20 549 44 11
Fax: + 31 20 644 43 98

International AAF Offices

Austria	AAF-Luftreinigungssysteme Gesellschaft m.b.H., Weyrgasse 8/7, A-1030 Vienna Tel.: + 43 1 712 59 11, Fax: + 43 1 712 59 111
Benelux	AAF-International B.V., P.O. Box 7928, 1008 AC Amsterdam Tel.: + 31 20 549 44 11, Fax: + 31 20 644 43 98
Canada	AAF-Canada, 225 Guthrie Street, Dorval, Quebec, H9P 2P5 Tel.: + 1 514 631 10 36, Fax: + 1 514 633 64 50
France	AAF-S.A., 124 bis, avenue de Villiers, 75017 Paris Tel.: + 33 1 44 29 93 30, Fax: + 33 1 42 67 26 66
Germany	AAF-Lufttechnik GmbH, P.O. Box 130618, 44316 Dortmund Tel.: + 49 231 921033-0, Fax: + 49 231 921033-23
Great Britain	AAF-Ltd., Bassington Lane, Cramlington, Northumberland NE23 8AF Tel.: + 44 1670 71 34 77, Fax: + 44 1670 71 43 70, Telex: 53491
Greece	AAF-Environmental Control Epe, 2 Papada street, 11525 Athens Tel.: + 30 1 692 35 78, Fax: + 30 1 691 16 50
Italy	AAF-S.r.l., Via Valassina 24, 20159 Milan Tel.: + 39 2 607 02 51 r.a., Fax: + 39 2 607 02 55, Telex: 332433 amfilt
Mexico	AAF-SA, Apartado postal no. 292, Tlalnepantla, edo. de Mexico, C.P. 54000 Mexico Tel.: + 52 5 5655200 Fax: + 52 5 3905814
Middle East	AAF-International B.V., P.O. Box 7928, 1008 AC Amsterdam Tel.: + 31 20 549 44 11, Fax: + 31 20 644 43 98, Telex: 12372 amfi nl
Saudi Arabia	AAF Saudi Arabia Ltd., P.O. Box 59336, Riyadh 11525 Tel.: + 966 1 498 4442, Fax: + 966 1 498 4441
Singapore	AAF Asia Pte Ltd., 8 Gul Circle, Singapore 2262 Tel.: + 65 861 36 96, Fax: + 65 861 10 91, Telex: RS 26953 amfil
Spain	AAF-S.A., C/Urarte, 11, P. Industrial Ali-Gobeo, 01010 Vitoria Tel.: + 34 45 24 18 00, Fax: + 34 45 24 80 86, Telex: 65235436
Turkey	AAF Hava Filtreleri ve Ticaret A.S., Esentepe Cad., Bildircin Sok. No. 8, 80300 Mecidiyekoy-Istanbul, Tel.: + 90 212 211 32 33, Fax: + 90 212 273 19 30
USA	American Air Filter, 215 Central Avenue, Louisville, KY 40232-5690 Tel.: + 1 502 637 00 11, Fax: + 1 502 637 05 20

Agents & Distributors

Denmark

Novenco A/S
Roskildevej 325A, 2630 Taastrup
Tel.: + 45 43 71 42 22, Fax: + 45 43 71 48 22

Finland

Oy Swegon AB
Munkinmaentie 1, 02400 Kirkkonummi
Tel.: + 358 0296 10 44, Fax: + 358 0298 93 59

India

Kirloskar AAF-Ltd.
No. 11, Niton Compound, Palace road
Bangalore 560 052
Tel.: + 91 80 2200226, Fax: + 91 80 2281212

Norway

American Air Filter A/S
Sonsterud VN. 2B, 1410 Kolbotn
Tel.: + 47 66 80 53 62, Fax: + 47 66 80 64 00

Portugal

Semortrade Import & Export LDA, Rua Nina
Marques Pereira, Lote 23-A, 1500 Lisboa
Tel.: + 351 1 714 55 39, Fax: + 351 1 714 16 09

Republic of South Africa

Gosair Filter Systems (PTY) Ltd.
6 Neutron Street, Chloorkop; Kempton Park
Tel.: + 27 11 393 19 24, Fax: + 27 11 393 10 17

Sweden

AB Ventilatorverken
Bronsyxegatan 9, S-21375 Malmö
Tel.: + 46 40 22 90 40, Fax: + 46 40 94 78 63

Mondial Filter AB
Box 128, S-516 22 Dalsjöfors
Tel.: + 46 33 27 01 00, Fax: + 46 33 27 01 10

