



MANN+HUMMEL  
Innovative LTF  
ceiling systems  
(Laminar Flow  
systems) for  
operating theatres



## MANN+HUMMEL – your partner for standard solutions and custom-made products

Through the perfection of our products and their implementation, we have become the largest and most experienced supplier of sterile air systems in clinical settings. Every installation is unique - with its own challenges and objectives. But our application know-how means that no solution is too complex when it comes to meeting your individual requirements. And we expand this expertise through continuous development and innovation.

## INNOVATIVE LTF CEILING SYSTEMS (LAMINAR FLOW SYSTEMS) FOR OPERATING THEATRES

<b>OUR STANDARDS</b>	Page 5
<b>TECHNOLOGY CG DISTRIBUTOR</b>	
CG distributor vs. perforated plate	Page 6
Screen printing mesh and stretching technology	Page 7
<b>LTF CEILING SYSTEMS CG<sup>3</sup>-P/CG<sup>3</sup>-N</b>	<b>Page 10</b>
<b>LIGHTING</b>	
Priming and peripheral illumination	Page 12
<b>SPECIAL INSTALLATION PARTS</b>	
Testing port	Page 14
Flow stabilisers	Page 14
HEPA filter	Page 15
<b>CG DISTRIBUTOR WITH MOTIF PRINT</b>	<b>Page 16</b>
<b>LTF CEILING SYSTEMS OPTIMA CG-P/CG-N</b>	<b>Page 18</b>
<b>COMBINATION WITH RECIRCULATION MODULES</b>	
Ceiling recirculation modules	Page 20
Wall recirculation modules	Page 22
<b>SPECIAL APPLICATIONS FOR HYBRID ORs</b>	Page 24
<b>LTF CEILING SYSTEM FM<sup>3</sup> FOR INSTRUMENT PREPARATION</b>	<b>Page 28</b>
<b>STANDARD SIZES AND CUSTOMISATION</b>	
Design and customisation	Page 30
Technical data for standard sizes	Page 31
<b>COMPLETE CEILING SYSTEM TMS 3000</b>	<b>Page 32</b>
<b>TEST METHOD FOR PARTICULATE AIR FILTER (EN 1822)</b>	Page 34
<b>ASSEMBLY AND SERVICES</b>	Page 36
<b>CONTACT</b>	Page 38

**Every day, MANN+HUMMEL  
products enhance the safety  
of patients undergoing  
complicated operations.**



# We set ourselves the highest possible standards

MANN+HUMMEL has been a specialist in LTF ceiling systems (Laminar Flow systems) for more than 40 years. Over this time we have reduced the germ load in thousands of operating theaters, preparation rooms and intensive care units - delivering the highest levels of air cleanliness while maintaining all the required comfort criteria.

## CURRENT MAIN REQUIREMENTS FOR LTF CEILING SYSTEMS

- Reduction of the germ load of indoor air
- Surgical smoke removal in the protected area
- Occupational safety and protection of the surgical staff
- Compliance with the required air cleanliness class in the protected area
- Discharge of cooling loads
- Maintenance of the required room pressure (protective pressure maintenance)
- Compliance with the ventilation comfort parameters such as air speed, temperature, degree of turbulence, humidity and sound pressure level
- Adherence to the defined illuminance of the priming illumination in LTF ceilings
- Complete ceiling solution for jointless connection to the rest of the ceiling and integration of the room lighting and optionally the ceiling pendants or media bridges

**The effectiveness and functionality of LTF ceiling systems have meanwhile been proved by numerous studies and confirmed by independent hospital hygiene committees!**

Continuous development of LTF ceilings, knowledge transfer as experts in national and international standards committees and **more than 5,000 references worldwide** result in high product quality and reliability for our customers.

Our LTF ceilings achieve the required particle and germ counts in accordance with all international standards, including DIN 1946-4, ÖNORM H6020, SWKI VA 105-01, HTM 03-01.

# The CG distributor for more than just filtered air

MANN+HUMMEL has developed its own market standard with the innovative CG distributor technology – for low-turbulence displacement flow (LTF) and a stable sterile zone in the surgical field.

## CG DISTRIBUTOR VS. PERFORATED PLATE

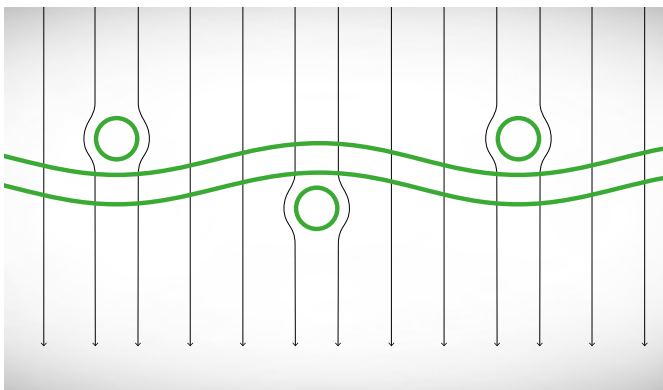
A CG distributor creates a low-turbulence displacement flow (LTF) and therefore a stable sterile zone in the surgical field. The low-turbulence displacement flow prevents particles and germs from being drawn into the sterile zone (cross-contamination).

In contrast, a perforated plate produces turbulent mixing ventilation, which draws particles and germs from the impure adjacent areas into the sterile zone.

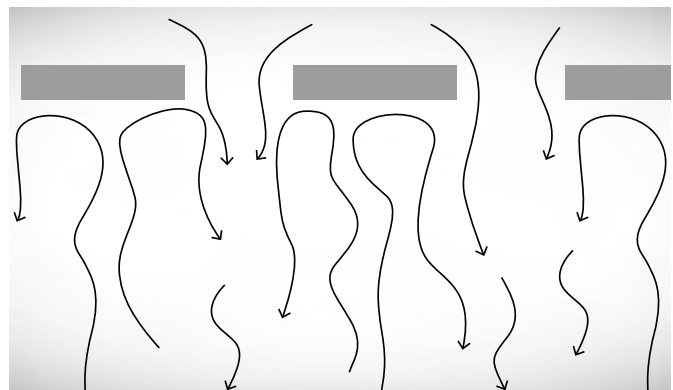
Particular attention should be paid to the mesh thickness and mesh size of the special fabric (DIN 16611). The very specific fabric combinations ensure the achievement of the optimal low-turbulence displacement flow. The differences between individual fabrics can only be seen under the microscope.

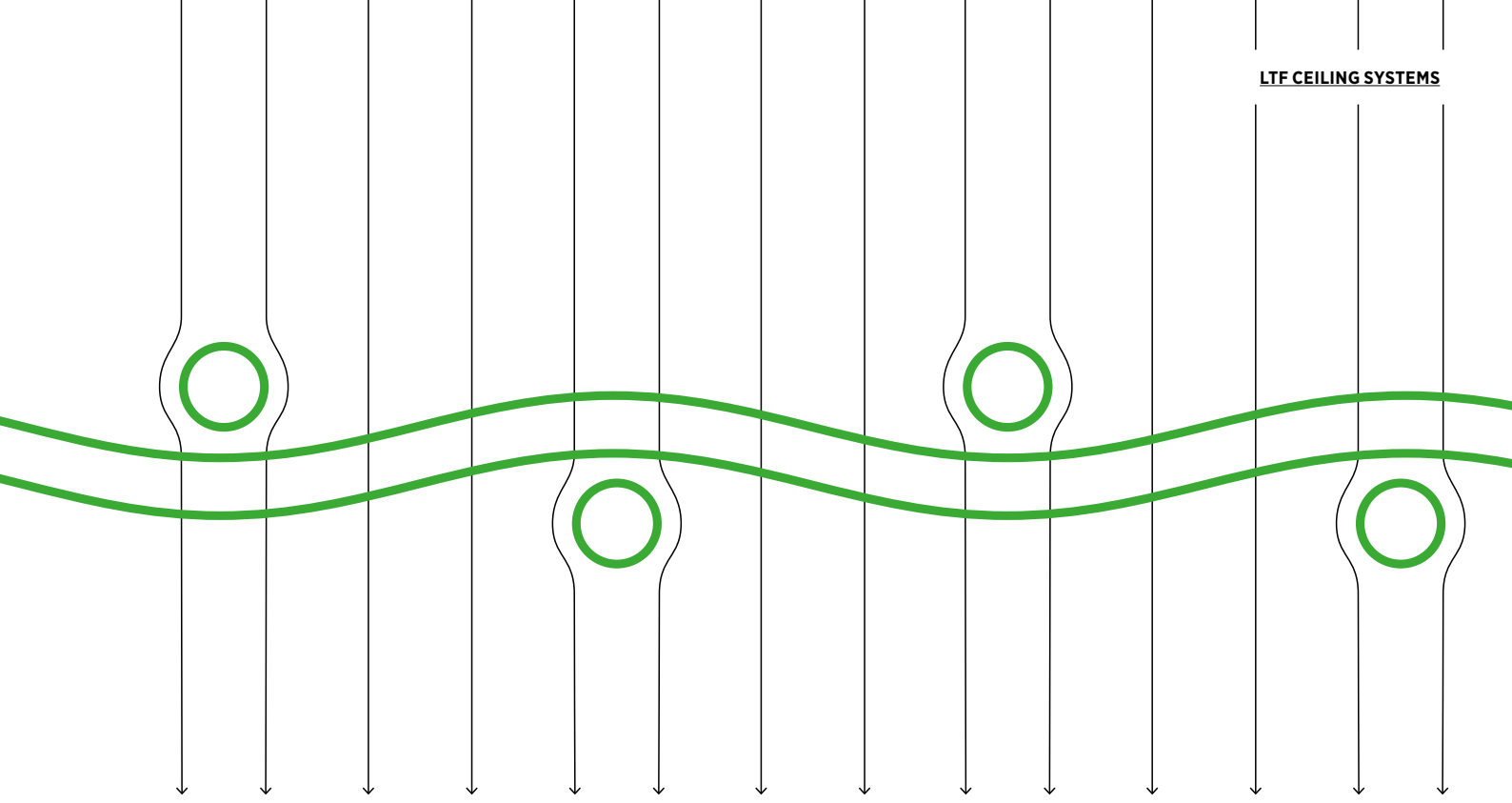
Special applications, such as differential flows, are custom built to meet different air velocities and standards requirements. Commercially available cleaning agents are used to clean the CG distributor.

Function CG distributor



Function perforated plate





### THE SCREEN PRINTING MESH

The screen printing mesh of the CG distribution frames is made of a high quality, precise polyester fabric. It meets all the requirements for detail reproduction, homogeneity of face printing, print run consistency and registration accuracy. The surface treatment of these special fabrics optimises the stencil adhesion, the wettability and the antistatic behaviour. These features ensure high quality and efficient processing.

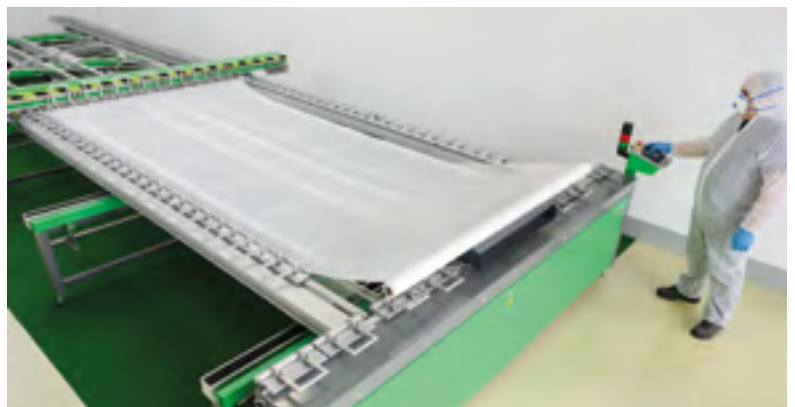
### THE STRETCHING TECHNOLOGY

The stretching technology requires high precision, fully automatic stretching machines and a great deal of experience on the part of the technicians in order to achieve the required quality goals. The stretching machines must allow large stretching surfaces, infinitely variable stretching speeds, sliding clamps on stainless steel guideways, no contact between frame and mesh during stretching and simultaneous processing of multiple frames.

The measurement of fabric tension



Stretching a CG distributor



## MANN+HUMMEL AS AN INNOVATION DRIVER

CG distributor technology was developed in the late 1970s and has proven its worth thousands of times in cleanroom technology ever since. Double covering of the air distribution frame is still the standard version today. This technique was developed by us in collaboration with a leading pharmaceutical manufacturer.





# LTF ceiling systems

## CG<sup>3</sup>-P/CG<sup>3</sup>-N

### LTF CEILING SYSTEMS

Type CG<sup>3</sup>-P/CG<sup>3</sup>-N

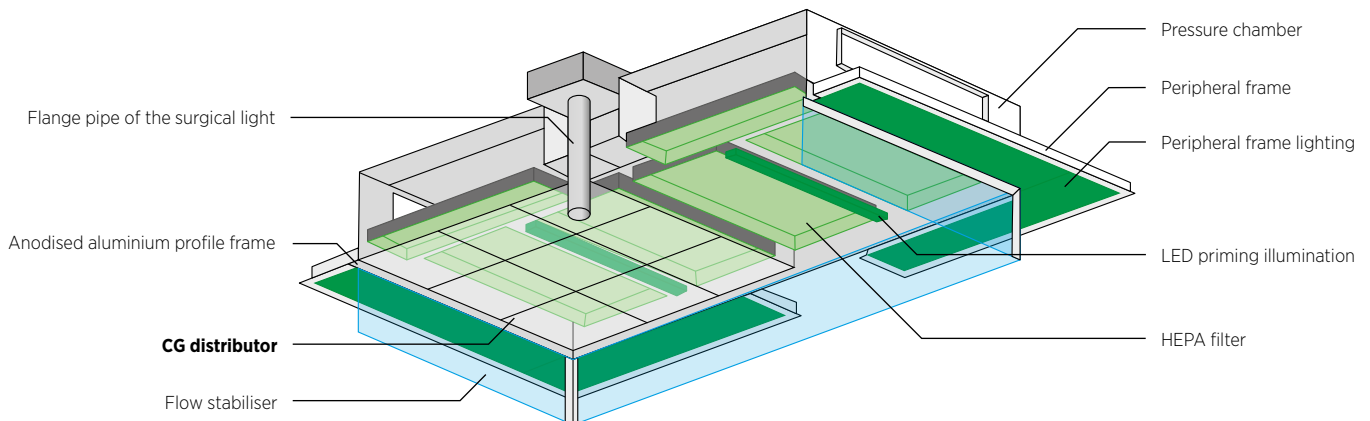
### AIR CLEANLINESS

Highest air cleanliness ISO class 5  
acc. to DIN EN ISO 14644-1

### AREA OF APPLICATION

Operating rooms and for special  
applications such as burn units





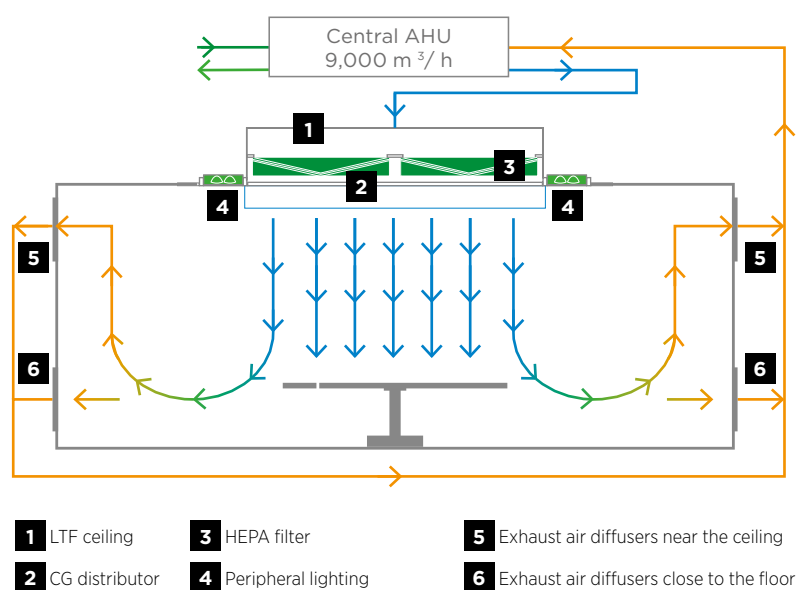
### PRODUCT ADVANTAGES

- Lowest germs counts  $<10 \text{ cfu/m}^3$  acc. to valid standards
- Optimum low-turbulence displacement (LTF) ensures rapid removal of airborne contaminants (particles and germs) from the protection zone
- Perfect and gap-free integration of the surrounding sub-disciplines and false ceiling
- Very low sound pressure level  $\leq 45 \text{ dB (A)}$
- Wide product range with modular assembly
- Minimised pressure drops and low energy consumption through the use of HEPA filters from our in-house production
- All acceptance tests met; leak test with test aerosol (DEHS test), protection zone determination (at rest), determination of the degree of protection, determination of the degree of turbulence
- Draft-free, comfortable indoor climate
- Disinfectant-proof design

### FUNCTIONAL PRINCIPLE

The supply air is preconditioned via a central air handling unit (central AHU) directed via the ventilation ducts into the LTF ceiling pressure chamber and guided in via HEPA filters. The supply air is filtered and blown out at a speed of 0.25 (0.38) m/s towards the surgical protection zone via a flow-optimised, trapezoid profile (CG distributor) covered with a double-layered special fabric. The double-layered CG distributor produces this stable, low-turbulence displacement flow. Flow stabilisers reduce the constriction of the air flow.

The protection zone includes both the surgical team and the patient as well as the instrument and side tables. Impurities in the working/patient area are detected by the low-turbulence displacement flow and discharged via fluff separators near the floor.





# Everything clearly in view!

**For most projects, integration of lighting into the LTF ceiling system is carried out as a result of increasingly individualised and specialised solutions of operating theatres. Due to the required different illumination levels, the common standards (EN 12464-1, DIN 5035-3) differentiate between operation field lighting, operation peripheral lighting and general lighting.**

In order to limit adaptive dysfunctions due to excessively high differences in light intensity, an LED priming illumination is installed in the LTF ceiling. On its own, this can maintain a minimum luminance level of 1,000 lux and together with the LED periphery lighting positioned on the LTF ceiling, achieves a maintained illuminance of min. 2,000 lux (1 m above the ground in centre of operating field).

### PRIMING ILLUMINATION BUILT DIRECTLY INTO THE LTF CEILING

The priming illumination is installed in the air distribution box at the same height between the HEPA filters above the transparent CG distributor. Design as 3-sided LED continuous line luminaire with optimised lens cover and integrated electronically dimmable DALI operating devices (or 0-10 V), matched to the operating table control. Due to the 3-sided radiation by means of special lenses, the transparent CG distributor is illuminated homogeneously over the entire diffusion area.

#### SPECIFICATIONS

- Luminaire housing: made of sheet steel, powder-coated in white RAL 9016
- Luminous flux: 11,750 lm
- Electrical output: 95.6 watts
- Light colour: 4,000 K
- Colour rendition: Ra  $\geq$  90
- Life cycle: 55,000 h: L 80 / F 10
- AC/DC capable and suitable for emergency lighting
- EEI Class: A++

### PERIPHERAL LIGHTING INTEGRATED INTO THE LTF CEILING FRAME CONSTRUCTION

For peripheral lighting, direct luminaires for clean rooms are equipped with electronic multi-watt ballast units, which are wired ready-to-connect with heat-resistant cables and designed for mains operation at 230 V 50 Hz. In addition, these luminaires have permanently installed connection terminals for electrical connection with a conductor cross-section of up to 2.5 mm<sup>2</sup>.

#### SPECIFICATIONS

##### PERIPHERAL LIGHTING

- Made of sheet steel, white
- Antistatic powder-coated
- Resistant to oil vapours, disinfectants, cleaning agents and chemical agents
- With integrated mounting kit and system-specific IP65 seals

##### PRISMATIC DIFFUSER

- Clear, in pyramidal structure
- UV proof, light scattering and translucent
- Transmittance: 91%, corresponds to ISO 7823-2

##### SINGLE-PANE SAFETY GLASS (ESG) AND LAMINATED SAFETY GLASS (VSG)

- All-round IP65 gasket
- Internal spring closure technology

# Special installation parts



## TESTING PORT

*for testing the LTF system*

At the outer edge of the LTF ceiling, a testing port is attached for the following tests:

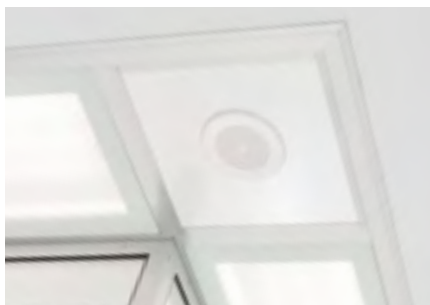
- Aerosol withdrawal (DEHS test)
- Aerosol feeding
- Differential pressure of filter
- Ambient pressure (false ceiling cavity)

White enameled panel (RAL 9016), nickel-plated brass bulkhead fittings with tight sealing plugs with O-ring gasket, disinfectant-proof inscriptions. The tubing is factory delivered by PUN tubing.



### Advantages during operation and the commissioning phase

The tests described above can be carried out in installed conditions, i.e. without removing the CG-distributor frame. This significantly reduces service times and servicing/commissioning costs.



## ADDITIONAL FRAME SYSTEM

*to increase flexibility of the system*

In order to be able to integrate the peripheral lighting as well as the ceiling pendants, an additional frame of extruded aluminium profiles is used. This special frame system, which is also used in the LTF ceiling, forms a self-contained, further expandable complete ceiling system that is adaptable to planning. Necessary facings between the luminaires and their fixing brackets are prefabricated in powder-coated aluminium according to the manufacturer and type of luminaire.



### Advantages in planning and installation

This additional frame system ensures that the complete construction is seamless and smooth. The delivery limits of the maintenance groups are clearly defined and the coordination tasks of the consultant or contractor with regard to subsections are far easier.



## FLOW STABILISERS

*for reduced constriction effects*

Flow stabilisers are used to reduce the constriction of the low-turbulence displacement flow, mainly with rectangular and square LTF ceilings, or with LTF ceilings with integrated recirculation modules. This prevents the air from short circuiting away from the adjacent exhausts and stabilises the air flow directly after the flow laminariser to the outside. Return flows of contaminated room air are also prevented and the planned protection zone is ensured. The laminated safety glass panes (VSG) a minimum thickness of 8 mm are held by an anodised aluminium frame. The installation situation and the configuration of the surrounding ceiling supply units must be taken into account when dimensioning the height of the stabilisers.



### Advantages during operation and during the commissioning phase

The CG distributor can be dismantled without disassembling the flow stabiliser. This reduces assembly and/or replacement costs. The standard heights of the stabilisers are 200, 400, 600 and 800 mm and they can also be made to any size.

## We know what you need!

As one of the leading manufacturers of HEPA filters, we know which aspects play a vital functional role, especially for LTF ceiling systems:

### Long lifetimes

Low initial pressure drops allow long-term use of the filters with low energy consumption. Our filters are generally not replaced for at least 4 years – which represents a significant reduction in operating costs for the operator.

### Reliable filtering effect

Our filters reliably protect against germs and particles. The commonly used H13 filters stop 99.95% of particles, while H14 filters stop 99.995% (at the most penetrating particle size, or MPPS).

### Low pressure drops

This ensures the energy-optimised operation of the system. Depending on the dimensions, the initial pressure drops of our H13 filters are  $\leq 60$  Pa with an air volume of  $1,000 \text{ m}^3/\text{h}$  per  $\text{m}^2$  filter surface.

**Due to new media developed continuously by R&D engineers and tested in our own laboratories, we continually reduce the pressure drop of our filters. These energy and cost-optimising innovations will be used as soon as possible in the LTF ceilings.**



HEPA filter panel

### HEPA FILTER

*for the absolute purity of supply air*

The filter medium consists of finely pleated micro-glass fibre with thread spacers. The filter medium and frame are tightly interconnected by means of a 2-component PU casting. The filters have a frame optimised for huge filter surface and a correspondingly long service life as well as low pressure drops. The sturdy filter frame consists of an anodised aluminium profile and is equipped with a closed-cell EPDM profile dry seal, a foamed seal or gel seal.

A grip protection made of a synthetic-resin-coated aluminium expanded-metal grid (colour RAL 9016) is located on both sides of the filter medium. Each particulate air filter insert is individually tested for leaks by MANN+HUMMEL. The corresponding test certificates are issued and enclosed with the documentation. The HEPA filters have standard outer dimensions, but can also be individually made to measure. Depending on the required pressure difference, there are three filter heights to choose from. The HEPA filters for LTF ceilings are usually designed to class H13 due to the requirements in rooms for medical treatment, and the most efficient and economical operation. Naturally, the MANN+HUMMEL product range also includes all higher classes, such as H14.

# CG distributor with motif print

A pleasant atmosphere in the otherwise sterile operating room environment has a positive effect on the wellbeing of patients and staff. We therefore recommend printing the underside of the CG distribution fabric with friendly, detailed motifs.

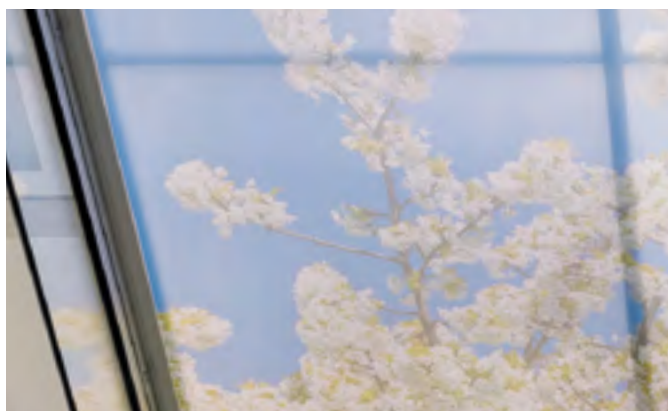
## THE PRINTING PROCESS

This is enabled by a new sublimation printing process that does not change the properties of the fabric. Similar to the requirements in sportswear, there must be no change in the fabric surface due to pressure or decorative colours used in the filter mesh. Therefore, a special organic ink is digitally printed on a transfer paper.

After a few pretreatment steps, the actual elastic fabric is fed through calander rolls along with the transfer paper, where it is subjected to pressure at a temperature of up to 160° C. In fractions of seconds, the colourant becomes gaseous and diffuses into the polyester fibre. This means the fabric is inked directly into the fibre and there is no colour binder to change the properties of the fabric. The printed CG distribution frame can be easily cleaned and disinfected.

## PRIMING ILLUMINATION SETS THE SCENE

The motif printing is created in photo quality by the special printing process. We recommend using a priming illumination to enable you to adjust and balance the different colour contrasts of the various pictures. Without a priming illumination, certain subjects can appear very dark and a little depressing. The pressure loss of the fabric due to the printing is negligible.



Detailed section of the motif





# LTF ceiling systems

## Optima CG-P/Optima CG-N

### LTF CEILING SYSTEM

Type Optima CG-P/CG-N

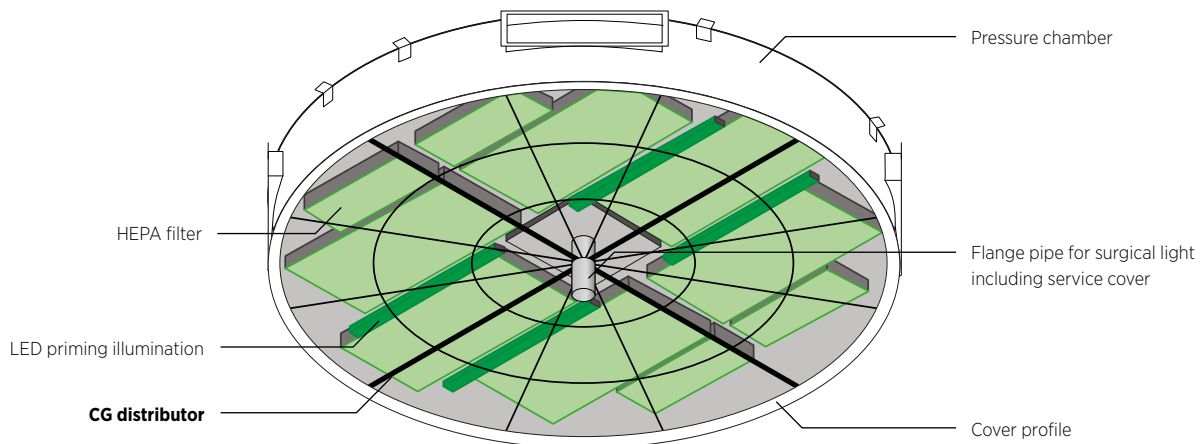
### AIR CLEANLINESS

Highest air cleanliness ISO class 5  
acc. to DIN EN ISO 14644-1

### AREA OF APPLICATION

Operating theatres





### PRODUCT ADVANTAGES

- Highest air cleanliness ISO class 5 in accordance with DIN EN ISO 14644-1
- Lowest germ counts <math><10\text{ cfu/m}^3</math> acc. to valid standards
- Reduced air flow: up to 25% in contrast to rectangular and square base forms
- Optimal low-turbulence displacement flow (LTF) ensures rapid removal of airborne contaminants (particles and germs) from the surgical zone
- Largest possible protection zone from a round design that does not need flow stabilizers
- Very low sound pressure level  $\leq 45$  dBA
- Minimised pressure drops and low energy consumption through the use of HEPA filters from our in-house production
- All acceptance tests met; leak test with test aerosol (DEHS test), protection zone determination (at rest), determination of the degree of protection, determination of the degree of turbulence
- Draft-free, comfortable indoor climate
- Disinfectant-proof design

### FUNCTIONAL PRINCIPLE

The supply air is preconditioned via a central air handling unit before being directed via the ventilation ducts into the pressure chamber of the LTF ceiling and guided in via HEPA filters. The supply air is filtered and blown out at a speed of 0.25 (0.38) m/s towards the surgical protection zone via a flow optimised, trapezoid profile (CG distributor) covered with a double-layered special fabric. The double-layered CG distributor creates this stable, low-turbulence displacement flow.

Impurities in the working/patient area are detected by the low-turbulence displacement flow and discharged via fluff separators near the floor.



# LTF ceiling systems with ceiling recirculation modules

## LTF CEILING SYSTEM

Typ CG<sup>3</sup>-US/CG<sup>3</sup>-UM

## AIR CLEANLINESS

Highest air cleanliness ISO class 5  
acc. to DIN EN ISO 14644-1

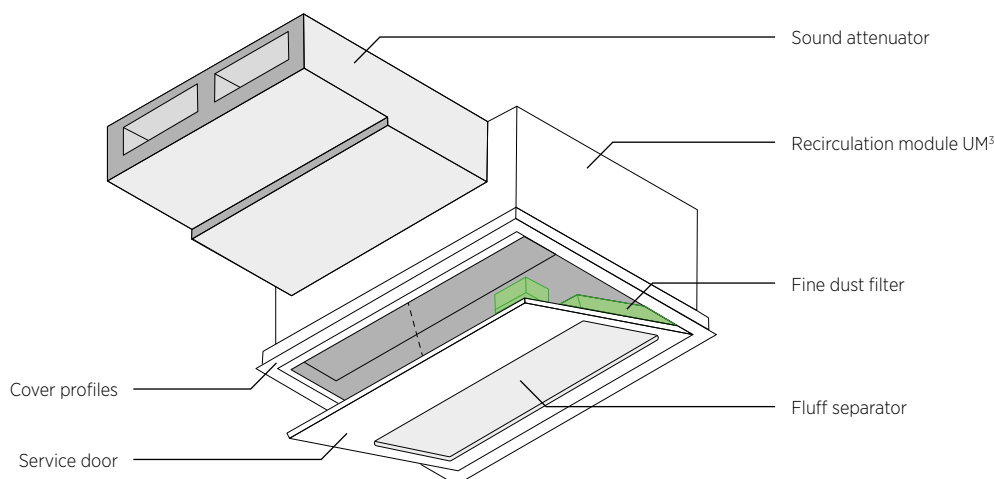
## AREA OF APPLICATION

Operating rooms and for  
special applications



## PRODUCT BENEFITS

- Reduced investment due to short conversion times
- Lower project costs - retrofit is limited to the operating room (and usually only the false ceiling), with no conversion work required to other disciplines or outside the theatre
- Lowest germ counts <math><10\text{ cfu/m}^3</math> acc. to valid standards
- Ensures rapid removal of airborne contaminants (particles and germs) from the surgical zone
- Very low sound pressure level  $\leq 48\text{ dBA}$
- Minimised pressure drops and low energy consumption through the use of HEPA filters from our in-house production
- Fulfills all acceptance tests; leak test with test aerosol (DEHS test), protection zone determination (at rest), determination of the degree of protection, determination of the degree of turbulence
- Draft-free, comfortable indoor climate
- Disinfectant-proof design

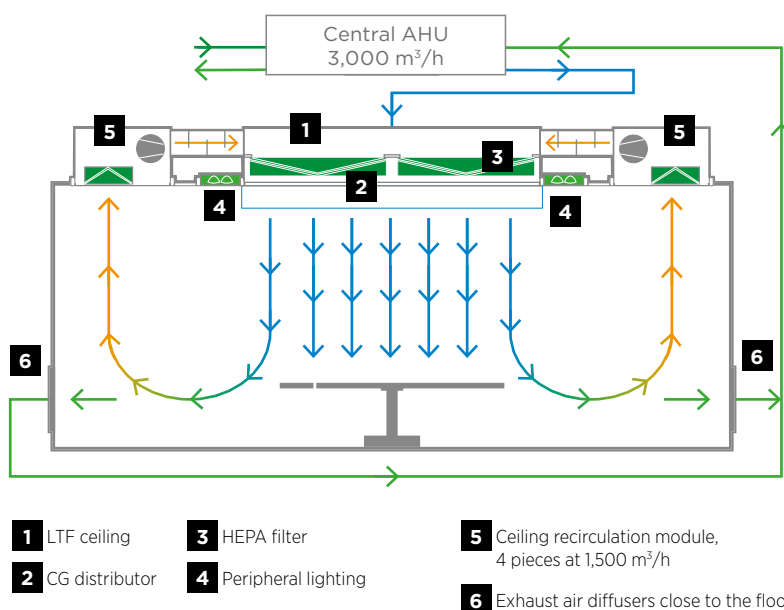


### PRODUCT CHARACTERISTICS

- Fluff separator as a single-layer micro-fabric
- Pre-filter ISO ePM1  $\geq 50\%$  acc. to DIN EN 16890-1; minimised pressure drop through our in-house produced fine dust filters
- Hinged maintenance opening with fall protection
- EC fans with low energy consumption and constant volume flow control integrated in the module
- Reduction of the central AHU and the total cost of installation
- Redundancy regulation; ensures uninterrupted operation
- Optional installation of coolers for dry cooling
- Low sound pressure level of  $\leq 48$  dBA due to self-developed sound attenuator and sound insulation/test in own sound laboratory
- Pressure side, self-closing backflow preventer
- Depending on the ceiling size different numbers of modules can be combined
- Integration into the LTF ceiling frame grid and seamless connection to the rest of the ceiling
- Visible side available in any RAL colour
- Use for new equipment and revitalisation of operating rooms

### FUNCTIONAL PRINCIPLE

Only a small part of the preconditioned supply air is passed into the pressure chamber of the LTF ceiling via a central air handling unit (central AHU), mixed with a larger part of the circulating air, which is conveyed through ceiling recirculation modules and guided over an in-built HEPA filter. The supply air is filtered and blown out at a speed of 0.25 (0.38) m/s in the direction of the surgical protection zone via a flow optimised, trapezoid profile covered with a double-layered special fabric (CG distributor). The double-layered CG distributor creates this stable low-turbulence displacement flow. The surgical zone includes both the surgical team and the patient as well as the instrument and side tables. Contaminants in the working/patient area are detected by the low-turbulence displacement flow and discharged via fluff separators near the floor and via exhaust of the recirculation modules close to the ceiling. Circumferentially-fitted flow stabilizers prevent lateral inductions. As a result, the integration of the recirculation LTF ceiling into a media bridge system is also possible.



# LTF ceiling systems with wall recirculation modules

## LTF CEILING SYSTEM

Type CG<sup>3</sup>-WU

## AIR CLEANLINESS

Highest air cleanliness ISO class 5  
acc. to DIN EN ISO 14644-1

## AREA OF APPLICATION

Operating rooms and for  
special applications

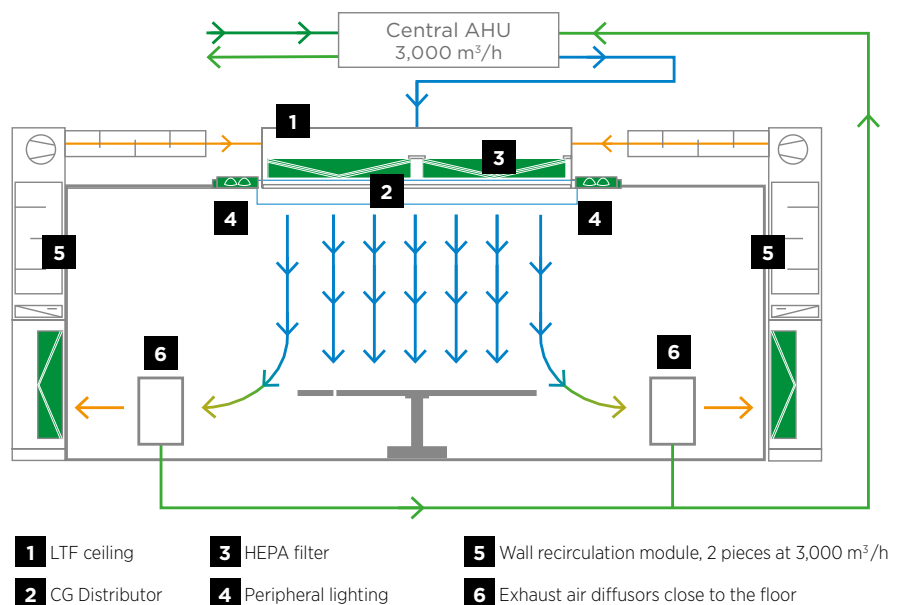
## PRODUCT CHARACTERISTICS

- Cabinet made of sheet steel, aluminium or stainless steel; all materials mentioned are available in powder coating
- Fluff separators as a single layer micro fabric in the suction door
- Pre-filter ISO ePM1  $\geq$  50% acc. to DIN EN 16890-1; minimised pressure drops through our in-house produced fine dust filters
- Single doors for the filter and sound attenuator, EC fans with low energy consumption and constant volume flow control integrated in the module
- Reduction of the central AHU and the total cost of installation
- Optional installation of cooling batteries for dry cooling
- Low sound pressure level of  $\leq$  48 dBA due to self-developed sound attenuators and sound insulation/test in own sound laboratory; Possible usage in rooms adjacent to operating theatre
- Flexible - can be combined in different module widths depending on the room size
- Easy integration into the operating theatre wall system
- Visible sides available in every RAL colour
- Use for new equipment and revitalisation of operating rooms

## FUNCTIONAL PRINCIPLE

A central air handling unit (central AHU) only mixes a small part of the preconditioned supply air with a larger part of the recirculated air, which is conveyed, via wall recirculation modules, into the pressure chamber of the LTF ceiling and has a built-in HEPA filter. The supply air is filtered and blown out at a speed of 0.25 (0.38) m/s towards the surgical protection zone via a flow optimised, trapezoid profile (CG distributor) covered with a double-layered special fabric. The double-layered CG distributor creates this stable low-turbulence displacement flow.

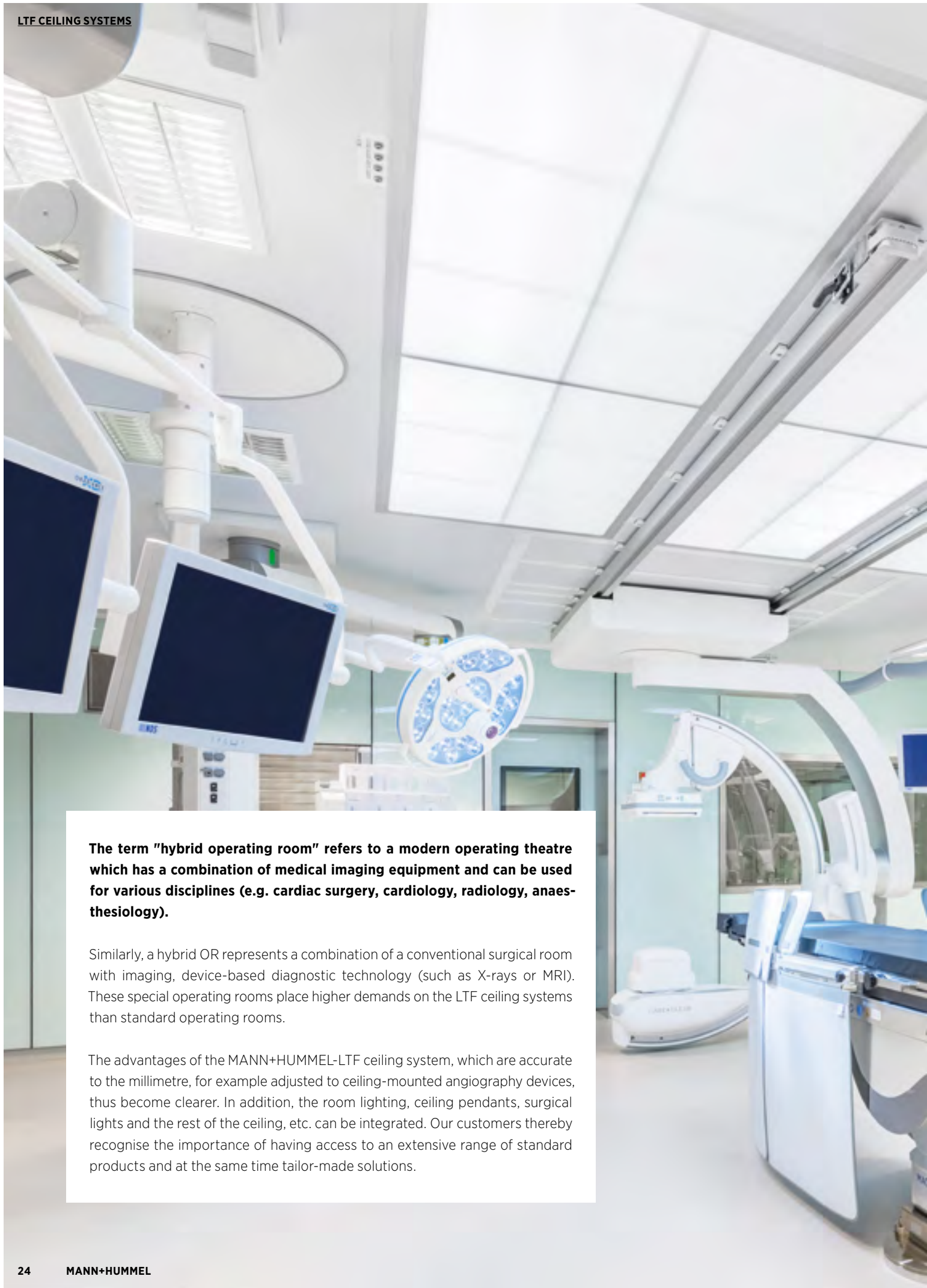
The surgical zone includes both the surgical team and the patient, as well as the instrument and side tables. Contaminants in the working/patient area are detected by the low-turbulence displacement flow and discharged via the fluff separator and the exhaust of the wall recirculation modules near the floor.



### PRODUCT ADVANTAGES WALL RECIRCULATION MODULES

- Reduced investments due to short retrofit times
- Lower project costs - retrofit is limited to the operating room (and usually only the false ceiling), with no conversion work required to other disciplines or outside the theatre
- Lowest germ counts  $<10 \text{ cfu/m}^3$  acc. to valid standards
- Ensures rapid removal of airborne contaminants (particles and germs) from the surgical zone
- Very low sound pressure level  $\leq 48 \text{ dBA}$
- Minimised pressure drops and low energy consumption through the use of HEPA filters from our in-house production
- All acceptance tests met; leak test with test aerosol (DEHS test), protection zone determination (at rest), determination of the degree of protection, determination of the degree of turbulence
- Draft-free, comfortable indoor climate
- Disinfectant-proof design





**The term "hybrid operating room" refers to a modern operating theatre which has a combination of medical imaging equipment and can be used for various disciplines (e.g. cardiac surgery, cardiology, radiology, anaesthesiology).**

Similarly, a hybrid OR represents a combination of a conventional surgical room with imaging, device-based diagnostic technology (such as X-rays or MRI). These special operating rooms place higher demands on the LTF ceiling systems than standard operating rooms.

The advantages of the MANN+HUMMEL-LTF ceiling system, which are accurate to the millimetre, for example adjusted to ceiling-mounted angiography devices, thus become clearer. In addition, the room lighting, ceiling pendants, surgical lights and the rest of the ceiling, etc. can be integrated. Our customers thereby recognise the importance of having access to an extensive range of standard products and at the same time tailor-made solutions.



# Special applications LTF ceiling systems for Hybrid operating theatres







# LTF ceiling system FM<sup>3</sup> for instrument preparation

---

## LTF CEILING SYSTEM

Type FM<sup>3</sup>

## AREA OF APPLICATION

For instrument preparation outside the OR with the same air cleanliness requirement as the OR

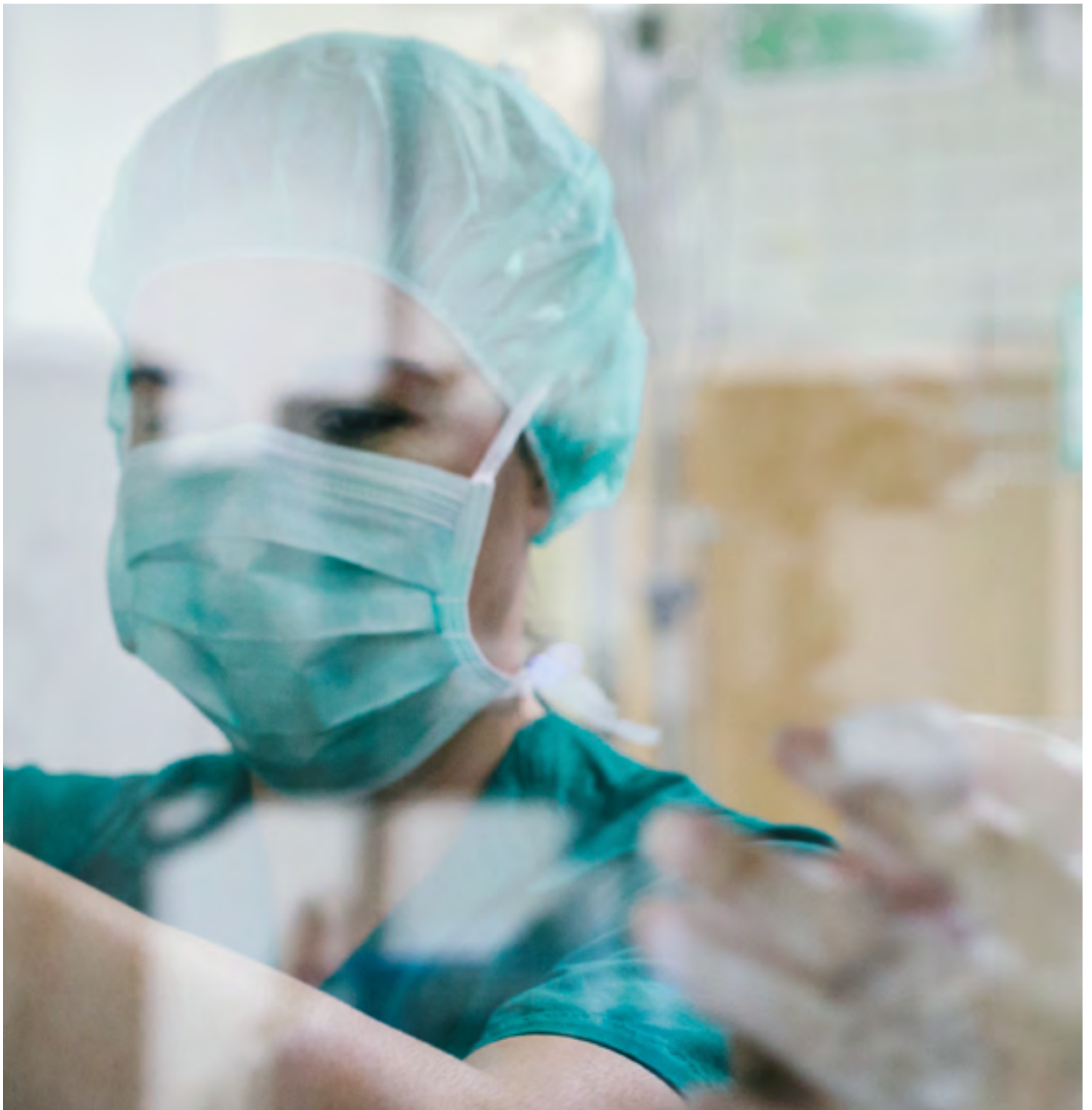
---

The special LTF outlet, adapted to the respective size and installation situation, is installed either in the intermediate wall or ceiling. In this special version of the LTF outlet, the preconditioned supply air can either be routed 100% via the central air handling unit or in recirculation mode via wall or ceiling recirculation modules into the pressure chamber of the LTF outlet and guided via built-in HEPA filters. The incoming air is filtered and blown out at a speed of 0.25 m/s towards the setup zone via a flow-optimised aluminium profile (CG distributor) covered with special fabric. The double-layered CG distributor generates this stable low-turbulence displacement flow.

Contaminants in the working/patient area are detected by the low-turbulence displacement flow and discharged via the fluff separator and the exhaust of the wall recirculation modules near the floor or ceiling. Circulating flow stabilisers prevent lateral inductions.







Due to the wide variety of applications and room architectures, MANN+HUMMEL manufactures to almost any size and design on customer request.

In general, the size of the surgical protection zone is defined by the operator in consultation with the responsible hygienist or hygiene expert. The respective disciplines that are planned for the operating room must be taken into account. After this, the size of the LTF ceiling outlet is determined, which must have a larger area than the surgical protection zone. In national and international operating practices, protection zones of 3,000 mm x 3,000 mm have proven successful, which are generally implemented using LTF 3,200 mm x 3,200 mm ceiling systems. For special applications of LTF ceiling systems, such as hybrid ORs, larger LTF ceiling panels are usually realised. For eye surgery or instrument preparation, smaller LTF ceiling panels are used.

# Proven standard sizes as the basis for your model

## TECHNICAL SPECIFICATIONS

Type	Page	Length (mm)	Width/depth (mm)	Height (mm)	Air volume (m <sup>3</sup> /h) DIN/ÖNORM - 0.25 m/s	Air volume (m <sup>3</sup> /h) HTM - 0.38 m/s	Weight (kg)
CG <sup>3</sup> -P/CG <sup>3</sup> -N	10	2,300	2,290	350 - 515	4,740	7,210	425
		2,600	2,590	350 - 515	6,060	9,210	525
		2,910	2,900	350 - 515	7,600	11,550	575
		3,150	3,170	350 - 515	8,990	13,660	650
Hybrid CG <sup>3</sup> -P	24	4,740	3,020	350 - 515	12,880	19,580	850
FM <sup>3</sup> - D - P/N	28	2,010	1,130	350 - 515	2,040	3,110	300
		1,990	2,010	350 - 515	3,600	5,470	375
FM <sup>3</sup> - W - P	28	2,190	440 - 490	640	1,260	1,920	100
		2,190	440 - 490	950	1,870	2,850	115
		2,840	440 - 490	640	1,640	2,490	125
		2,840	440 - 490	950	2,430	3,690	150
Optima-P/N	18	Ø 2,400		350 - 490	4,070	6,190	300
		Ø 2,600		350 - 490	4,780	7,260	325
		Ø 2,800		350 - 490	5,540	8,420	350
		Ø 3,000		350 - 490	6,360	9,670	375
		Ø 3,200		350 - 490	7,240	11,000	400
		Ø 3,400		350 - 490	8,170	12,420	425

## SPECIFICATION

	Description
Pressure chamber	Aluminium, material thickness min. 3 mm; for hygienic reasons produced in reversed housing wall production, without any tool marks
Base forms	rectangular, round, square, octagonal
Supply air connections	laterally or from above
HEPA filter	H13 or H14 (EN 1822)
Air diffuser	Aluminium frame with double-layered special plastic fabric or differential flow
Priming illumination	LED 1,000 lux without room lighting; adjustable to control technology, dimmable with room lighting

# Complete ceiling system TMS 3000

## COMPLETE CEILING SYSTEM

Type TMS 3000

## AIR CLEANLINESS

High air cleanliness ISO class 6  
acc. to DIN EN ISO 14644-1

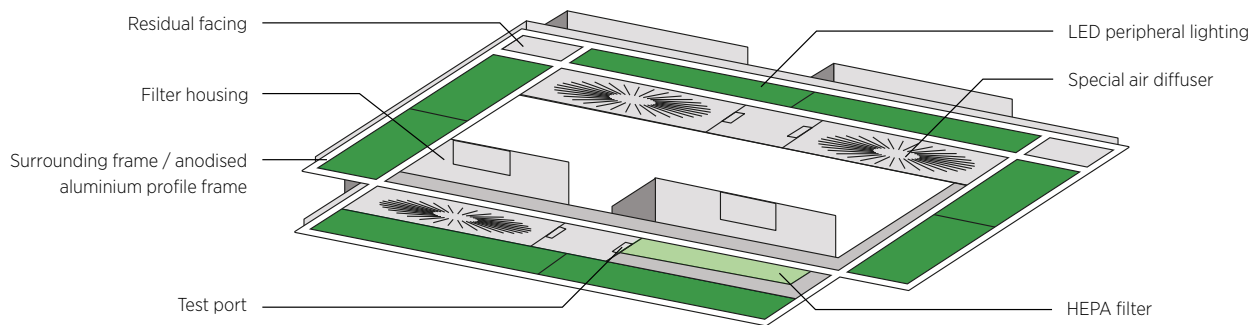
## AREA OF APPLICATION

Special HEPA filter air diffusers have been designed in accordance with DIN 1946-4 for class 1b operating rooms, rooms with special requirements in accordance with Austrian standard

H6020 class H2 or also interventions rooms with low hygiene and/or cleanliness requirements that, in combination with the peripheral lighting and the proven frame system, constitute a complete solution possible for the previously defined applications.







### PRODUCT ADVANTAGES

- A frame system, four special HEPA filter air diffusers with a constant air flow, integrated room lighting and ceiling pendants (or media bridges) for 99% of all 1b rooms
- Simple planning
- Modular design
- Certain successful acceptance according to DIN 1946-4 (recovery test) for room class 1b operating rooms due to sufficient air exchange and symmetrically planned exhaust air ducting
- Fast, cost effective installation without limiting or hindering building progress
- Stable, torsion-resistant construction with integrated peripheral lighting
- Fast, time-saving maintenance
- Low height and sufficient existing buildings for medical installations
- Suitable for retrofit/extensions of stock with low ceiling heights
- Minimised pressure drops and low energy consumption by using our in-house produced HEPA filters
- Perfect, low-interface integration of third-party sections and gap-free ceiling connectivity
- Optimal illumination of the surgical area through integration of illumination and media supply

### FUNCTIONAL PRINCIPLE

A preconditioned supply air volume is led via a central air handling unit and ventilation ducts into the HEPA filter air diffusers. From here, the air flow is guided into the room through the in-built HEPA filter. The supply air is filtered and blown out as a turbulent mixed flow (TMS) via a specially developed air diffuser. With a supply air volume of 3,000 m<sup>3</sup>/h, almost all air requirements of these rooms can be perfectly fulfilled. The exhaust air is discharged via fluff separator near the floor.



# EN 1822 – The test method for particulate air filters

The European filter test standard is the most important basis for testing and classifying particulate filters.

## ENSURING THE QUALITY OF EPA, HEPA AND ULPA FILTERS

The European filter testing standard is the most important basis for testing and classifying absolute filters. The standard is based on state-of-the-art particle measurement technology and authorized procedures for determining the efficiencies. It has five parts. The filter is assigned to the relevant filter class using the results from sections 4 (local arrestance) and 5 (integral arrestance).

An individual test report and serial number are produced for filters in classes H13 and higher. Therefore each filter from H13 onwards can be assigned to its own individual test. Individual testing of EPA filters is not necessary according to the standard, and is possible with the testing procedure described. EPA filters are tested in the course of sample testing, whereby the arrestance is obtained as a mean value from individual, random measurements.

Filter Class	Integral Value		Local Value	
	Efficiency [%]	Penetration [%]	Efficiency [%]	Penetration [%]
<b>E10</b>	≥ 85	≤ 15		
<b>E11</b>	≥ 95	≤ 5		
<b>E12</b>	≥ 99.5	≤ 0,5		
<b>H13</b>	≥ 99.95	≤ 0.05	≥ 99.75	≤ 0.25
<b>H14</b>	≥99.995	≤ 0.005	≥ 99.975	≤ 0.025
<b>U15</b>	≥99.9995	≤ 0.0005	≥ 99.9975	≤ 0.0025
<b>U16</b>	≥99.99995	≤ 0.00005	≥99.99975	≤ 0.00025
<b>U17</b>	≥ 99.999995	≤ 0.000005	≥ 99.9999	≤ 0.0001

## PART 1: CLASSIFICATION, PERFORMANCE TEST AND IDENTIFICATION

EN 1822-1:2009 sets three groups:

- **Group E: EPA** – Efficient particulate air filter
- **Group H: HEPA** – High efficiency particulate air filter
- **Group U: ULPA** – Ultra low penetration air filter

Absolute filters are classified according to the local and integral arrestance values determined during testing.

## PART 2: AEROSOL PRODUCTION, MEASURING EQUIPMENT, PARTICLE COUNTING STATISTICS

This part describes the conditions for testing and the aerosol generators, the particle measuring technology and the statistical procedures to evaluate the counts.

## PART 3: TESTING FLAT SHEET FILTER MEDIA (DETERMINING MPPS)

Part 3 describes the determination of the fractional efficiency and determination of the most penetrating particle size (MPPS) of the flat sheet filter media.

A test aerosol is applied to the filter media at the nominal flow velocity specified for later use of the filter. Partial flows of the test aerosol are taken upstream and downstream of the filter sample. The particle counting method determines the particulate concentrations and calculates the fractional efficiency curve. The particle size at which the fractional efficiency curve reaches its minimum is called the MPPS. Put in simple terms, this is the particle size at which the filter medium performs worst for a defined flow velocity.



Entire scan test facility in the factory cleanroom

#### **PART 4: LEAK TESTING OF FILTER ELEMENTS (SCAN METHOD)**

This section addresses how to test filters for leaks. Leaks can occur due to faults in the filter media, improper sealing between the pleat pack and frame or irregularities when handling the components. On account of the high filtration efficiency expected of absolute filters, even the smallest leaks (that are hardly visible to the human eye) can produce increased local particle concentrations.

For the automated process (scan test), the filter element is set up in a test rig and a DEHS (Di-2-Ethylhexyl-Sebacat) test aerosol is applied. The mean particle size of the aerosol must lie in the range of the MPPS. The flow side of the filter is approached using probes on computer-controlled linear axis. At each point on the clean air side, the local aerosol concentrations are measured to determine the local degree of penetration. If the aerosol concentration does not exceed the required limit at any of the points, the filter is deemed to be leak free.

The necessity to determine the local efficiencies also implies the need for individual testing of each filter element upwards of filter class H13.

#### **PART 5: DETERMINING THE EFFICIENCY OF FILTER ELEMENTS**

Part 5 describes the determination of the integral filter efficiency. This value is usually calculated as the mean of the local individual efficiencies measured in Part 4. Alternatively, an individual measurement with fixed sampling probes is also permissible.

#### **LEAK TEST ALTERNATIVE: OIL THREAD TEST (H13 AND H14)**

In this fast, low cost, leak-testing method, the filter is positioned horizontally on a diffuser in front of a black background, in a brightly-lit room. An oil-drop aerosol (liquid paraffin) is applied and the filter is inspected visually for leaks. The test procedure depends highly on the training and attitude of the test personnel. Therefore the results cannot be exactly reproduced in repeated tests. The oil thread test only focuses on leaks and does not determine the filter efficiency.



HEPA filter panel during the scan test

# Assembly and Services

With our vast experience of thousands of cleanroom installations around the world, MANN+HUMMEL is able to offer a comprehensive solution, not just a product or system.

With more than 80 offices worldwide, we have the advantage of being on-site with our customers, or at least our supervisors can be close-by. This ensures the customer both short travel distances and access times and also the required execution quality at the agreed time.

**Our worldwide MANN+HUMMEL network facilitates the handling of special cases, since a specialist employee can come quickly to work on site.**

MANN+HUMMEL not only offers its customers the know-how for product development, manufacturing and installation, but also a complete range of cleanroom services to ensure quality, function and on-time delivery.

Due to our many years of experience, we can offer our customers the following cleanroom services:

- Complete installation of LTF ceiling systems and customised laminar flow systems
- Measurement and adjustment of all ventilation parameters: air velocity, temperature, humidity, room pressure, sound pressure level
- Cleanroom classification acc. to DIN EN ISO 14644-1
- Pressure drop measurements
- Microbiological germ determinations in the air and on surfaces
- Flow visualisation
- Leak test using test aerosol (DEHS test) acc. to EN ISO 14644-3
- Acceptance measurements of LTF ceiling systems in accordance with all valid standards (protection degree measurement, turbulence degree measurement according to DIN 1946-4, SWKI VA 105-01, protection zone measurement according to ÖNORM H6020, grid measurement according to HTM 03-01
- Recovery test in accordance with EN ISO 14644-3



MANN+HUMMEL has been a filtration specialist for more than 75 years. Leadership in filtration is our motivation.

**A FILTRATION MASTER**

As a global player, we contribute our expertise to the development of new standards and are represented in technical advisory boards in several sectors. The numerous awards as Supplier of the Year at renowned national and international companies show that we take our role as partners very seriously.





# Your direct line to us!

## Germany

MANN+HUMMEL  
Life Sciences & Environment Germany GmbH  
Honeywellstraße 18  
D-63477 Maintal

Tel: +49 6181 9082 01  
Fax: +49 6181 9082 110  
E-Mail: [medical.de-mt@mann-hummel.com](mailto:medical.de-mt@mann-hummel.com)

## Austria

MANN+HUMMEL  
Vokes Air GmbH  
Ortsstraße 18  
A-2331 Vösendorf

Tel: +43 1 698 66770  
Fax: +43 1 698 667734  
E-Mail: [medical.at-vd@mann-hummel.com](mailto:medical.at-vd@mann-hummel.com)

## Netherlands

MANN+HUMMEL  
VOKES AIR BV  
1e Garnizoensdok 7  
NL-3439 JA Nieuwegein

Tel: +31 30 686 8080  
E-Mail: [info-MANL@mann-hummel.com](mailto:info-MANL@mann-hummel.com)



0124\_en Printed in Germany © MANN+HUMMEL GmbH