

## **DIF-OT Ceiling Filter**

*The optimized laminar airflow*



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**FläktWoods**

## When hygiene is crucial

The operating room is the most critical zone of the hospital. The operating theatre must be a clean room to protect the patient. The ventilation and the filtration system must ensure an ultra clean air environment to keep the patient alive and healthy.

The infections are caused by various contaminants. The main risks of contamination are coming from the staff and the equipments (direct contamination or from the indoor air (indirect contamination)). The air is the most important source of infection therefore it must be controlled to limit the risk.



## What are the requirements in an operating theatre

Further the quality air indoor, an easy maintenance and a comfortable air indoor are required.

The maintenance must require minimal operation costs and minimal tasks number. The cleaning and the readjustement between two operations must be faster as possible since the operating room are

used uninterrupted by all the different surgeons of the hospital.

The thermal environment must be comfortable for all the staff (surgeons, anaesthetist, nurses). They must be able to work without additional constraints caused by the ventilation and filtration system.

## How to design the HVAC system

First of all the risk analysis must be made for the operating room to estimate the level of risk including the pathogenicity of all the agents in the room, the possible consequences of an exposure, ways of transmission, duration of the operation, etc. Then the type of surgeries, the maximum crowdies and the uses frequency will be the additional parameters which will lead to the specifications of the operating room.

The standards are the guidelines which define exactly the level risk of the room and the requirements of the ventilation and filtration system.

The raised parameters are :

- type of air diffusion, mixing or laminar airflow
- dimensions of the diffusers, airflow and air velocity
- cleanroom classification according to EN ISO14644/1, recovery time or bio-contamination class
- comfort criteria: air temperature, humidity and noise level



### Standards

- EN ISO 14644/1, classification of air cleanliness, number of particles in the air

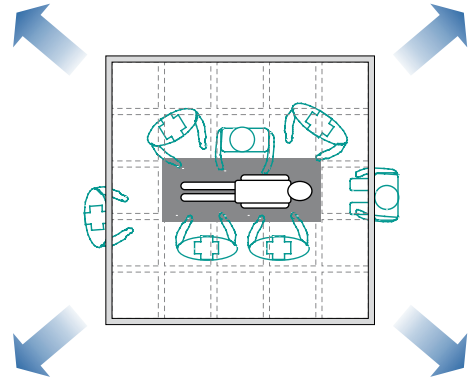
CLASS	Number of Particles per Cubic Meter by Micrometer Size					
	0.1 µm	0.2 µm	0.3 µm	0.5 µm	1 µm	5 µm
ISO 5	100 000	23 700	10 200	3 520	832	29
ISO 6	1000 000	237 000	102 000	35 200	8 320	293
ISO 7				352 000	83 200	2 930

# Ceiling filtration system

It supplies the clean air in the operating room. The air diffusion will be an unidirectional airflow or laminar airflow for the highest risky room (ISO5 class is required) whereas it will be a turbulent diffusion for the room with a low risk (ISO7 is required).

The laminar airflow prevents contaminated air entering the operating area in order to achieve ISO5 class under the ceiling. the supply clean air pushes the contaminated air outside the area which must be cleaned.

It's composed by a structure in stainless steel and HEPA filters.



# Exhaust grilles

It enables to have an air movement everywhere in the room. The combination with supply air movement coming from the ceiling will clean the protected area and remove the contaminants created in the operating area.

Filter panel or/and high efficiency filters in the exhaust grilles are required depending on the standards.

# Operating area

The most critical area of the operating room. The contaminants must be pushed out from this area.

It can be splitted in two different areas:

- the surgery bed (core zone): the patient must be absolutely protected against all the infection by creating an overpressure with the neighbored zone.
- the peripheral zone wich contains the surgical staff: the air movement must prevent the contaminants from going to the core zone and guarantee the comfort for the surgeons

# Transfer grille

An overpressure must be maintained with the neighbored room (from 15 to 25 Pa).

- prCEN/TC 156, ventilation for hospitals, definition of protected operating zone

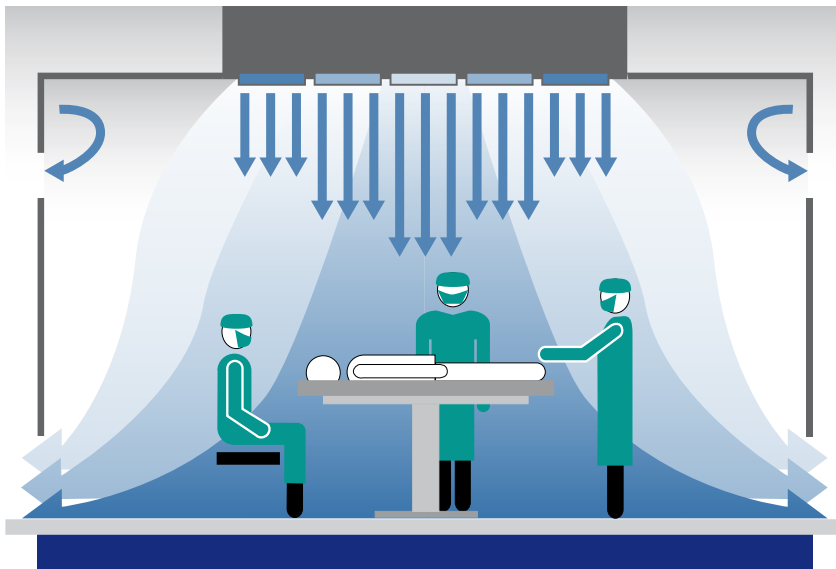
H1a	Protected operating zone within the operating room for orthopaedic and trauma surgery, neurosurgery, transplantations, cardiac and vascular surgery, gynaecology, general surgery	At least 9 m <sup>2</sup> by means laminar airflow	Slight overpressure in the operating room compared to adjacent rooms
H1b	No defined protected operating zone within the operating room for other operative interventions (e.g., insertion of small implants, invasive angiography, herat catheterisation, endoscopic examinations)	no defined protected zone	
H1c	reduced protected operating zone within the operating room, e.g., for abdominal surgery, eye surgery, urological surgery	6 m <sup>2</sup> to 9 m <sup>2</sup> by means of laminar airflow	

# DIF-OT, the optimized laminar airflow for high clean rooms classification

There are differential flow velocities decreasing from centre towards system's perimeter to provide a dynamic barrier between the operating table and the

outer zone. This differential air velocities optimizes the air treatment and the air cleaning in different operating areas : surgery bed (most critical area), surgi-

cal staff area and outer area (rest of the staff and equipments).



## Benefits of laminar airflow :

- ISO5 class at rest (acc. SWKI99-3)
- Short recovery time
- No draft in the comfort zone

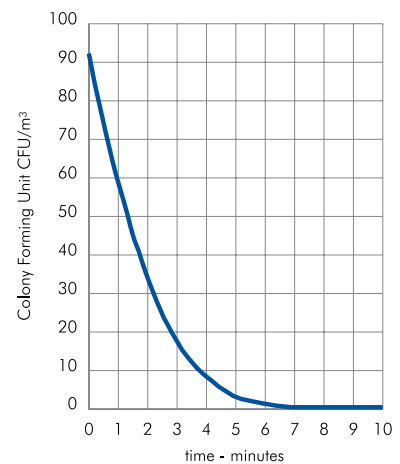
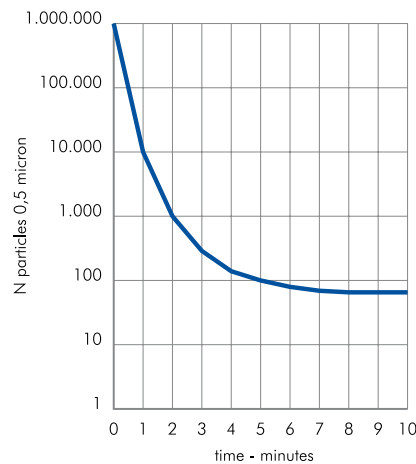
## Benefits of differential velocities :

- ISO5 class at rest and at operational simulated (acc. SWKI99-3)
- No induced air coming from the room into the unidirectional diffusion,
- no needs for air guide curtains
- Less required airflow to achieve ISO5 class than constant velocities (energy savings)
- ISO4 class over the surgery bed

## DIF-OT, high performances

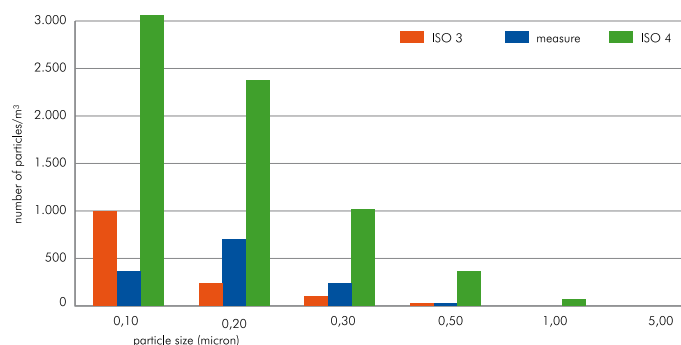
### Fast recovery time

A DIF-O.T. fitted in a mock-up room was tested by specialized people using an OPC (Optical Particle Counter) and a biological concentration counter. The diagrams shows the test results in terms of 0.5  $\mu\text{m}$  diameter particles and CFU (Colony Forming Units). These datas were confirmed then during the tests carried out on site and certified by independent laboratories.



### Low particle concentration

The diagrams shows the results of the particle count above the surgery bed. The test has been performed using an OPC following the ISO 14644/1 procedures. The results refers to tests in "at rest" situation in operating theatres for real operating conditions. The particle count concentration values has been measured between ISO 3 and ISO 4 class.



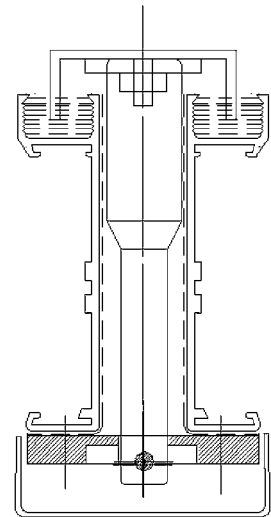
# DIF-OT, ceiling structure and filters



- Holding structure, filters frames and plenum box made of AISI 304 in stainless steel.
- HEPA filters with different performance and colours (V1, V2, LV) designed to obtain a decreasing air velocity from the centre towards the perimeter of the surgical theatre.
- Patented flow equaliser to achieve uniform and constant air distribution over the whole surface even low velocities.
- Perfect tightness guaranteed by a reverse liquid seal around the edge of the filters.

## Filters

- HEPA filters H14 efficiency, individually scan tested, according to EN1822.
- Uniform air flow over the whole surface (+-5% compared to the average flow velocity) thanks to the integrated equalizer in synthetic cloth.
- No additional flow stabilisers are required.  
Very low pressure drop through the clean air distributor.
- No micro-turbulence in the laminar flow area as with conventional filter outlets or perforated plates.



## Study case: Hospital “Riuniti di Ancona”

A survey about the surgery infections has been performed according to “National Healthcare Safety Network US” method by an independent company. 15 operating units has been studied. At the end 2003 they have refurbished the 18 operating rooms by exchanging the old ventilation system with differential flow velocities laminar airflow.

Period A April 2001 – March 2004		Period B April 2004 – March 2007	
21.759 Operations		19.608 Operations	
N° INF	% INF	N° INF	% INF
650	3,0	353	1,8

- The whole cost for each surgery room with unidirectional flow has been 50 000 €.
- The total invest for all the operating units has been 900 000 €.
- The cost of a post-operative infection is estimated at 9 000 € and the number of infections has been reduced of 300.
- Thus the hospital has saved 2 700 k€ in 3 years.

**Pay back = 1 year**

## DIF-OT, technical data

Model	DIF-OT 5/610	DIF-OT 6/555	DIF-OT 5/555	DIF-OT 6/435
ISO CLASS "at rest" (2)	≥ ISO 5	≥ ISO 5	≥ ISO 5	≥ ISO 5
ISO CLASS "operational simulation" (3)	≥ ISO 5	≥ ISO 5	-	-
Dimension	3,2 x 3,2 m	3 x 3,5 m	3 x 3 m	2,4 x 2,8 m
O.T. crowd	High	High	Normal	Low
Nominal airflow (m <sup>3</sup> /h)	9 500	9 000	7 400	5 600
Initial pressure drop (Pa)	80	80	80	80
Final pressure drop (Pa)	250	250	250	250
Mean velocity (m/s)	0,24	0,24	0,24	0,24
Velocity over surgery bed (m/s)	0,4	0,4	0,4	0,4
ΔT (K), between supply air and temperature in comfort zone	2÷3	2÷3	2÷3	2÷3

## References



### Italie

- Casa di cura S. Lucia General surgery DIF-OT/4  
S. Giuseppe Vesuviano (Na)
- Ospedale Fidenza General surgery DIF-OT DLS 5/43  
Fidenza
- Clinica Villa Fiorita General surgery DIF-OT DLS 6/43  
Prato
- Clinica Bernardini General surgery DIF-OT DLS 5/43  
Taranto
- Clinica S.Rita General surgery DIF-OT DLS 6/435  
Milano
- Mellino Mellini General surgery DIF-OT DLS 6/435  
Chiari
- Ospedale S. Chiara Heart surgery DIF-OT DLS 5/435  
Trento
- Istituti Clinici S. Donato Heart surgery DIF-OT DLS 5/435  
S. Donato Milanese

### Switzerland

- Ospedale Neuchatel General surgery DIF-OT/ 5  
Neuchatel
- Ospedale General surgery DIF-OT DLS 5/435  
Pontresina

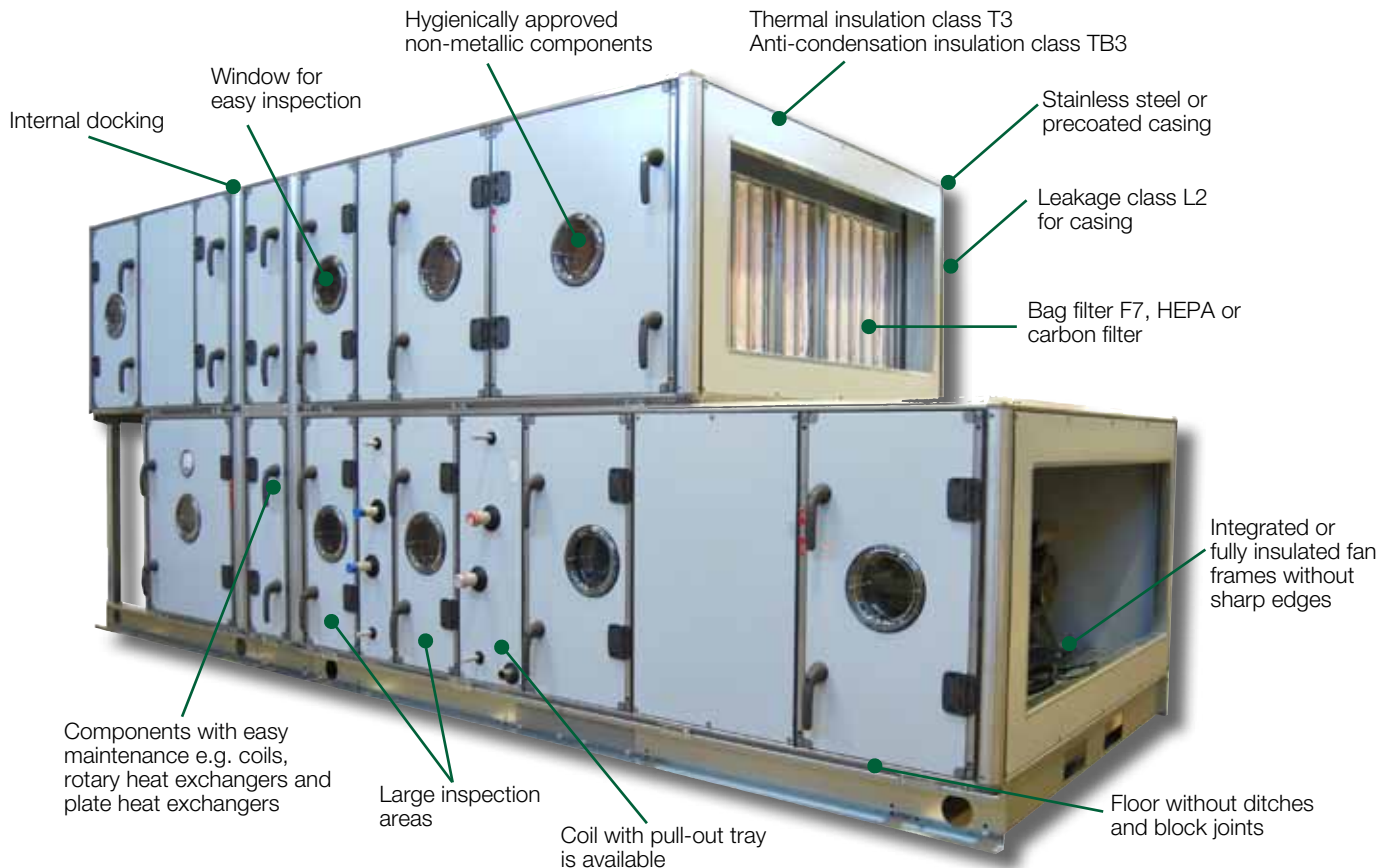
### Spain

- Ospedale Orthopedic surgery DIF-OT 6/43  
Zaragosse

# FWG is a global supplier for ventilation system in hospital market



Fläkt Woods hygiene appliances meets hygiene requirements according to VDI 6022, VDI 3803, ÖNORM H 6021, SWKI VA 104-01, DIN EN 13779, DIN 1946 Teil 4, SWKI 99-3 and ÖNORM H 6020-1.



## Heat recovery with ECONET® and ECOTERM®

In a hospital environment, no risk of leakage between the extract air and supply air is tolerated. To ensure secure ventilation, we offer the **ECONET®** and **ECOTERM®** liquid-coupled heat exchangers – a supply air and an extract air coil consisting of copper tubes and aluminium fins. **ECONET®** can be equipped with

a double pump for sites where ventilation is crucial to production, making it imperative that the **ECONET®** system never stops. If one of the pumps breaks down, the other pump takes over. Coils with maximum face area can be ordered for **ECONET®** and **ECOTERM®** to prevent high pressure drop and air flow.



# We Bring Air to Life

Fläkt Woods is a global leader in air management. We specialise in the design and manufacture of a wide range of air climate and air movement solutions. And our collective experience is unrivalled.

Our constant aim is to provide systems that precisely deliver required function and performance, as well as maximise energy efficiency.

## Solutions for all your air climate and air movement needs

Fläkt Woods is providing solutions for ventilation and air climate for buildings as well as fan solutions for Industry and Infrastructure.

### ● Air Handling Units (AHUs)

Modular, compact and small AHU units. Designed to ensure optimisation of indoor air quality, operational performance and service life.

### ● Air Terminal Devices and Ducts

Supply and exhaust diffusers and valves for installation on walls, ceiling or floor are all included in our large range and fit all types of applications.

### ● Chilled Beams

Active induction beams for ventilation, cooling and heating, and passive convection beams for cooling. For suspended or flush-mounted ceiling installation – and multi-service configuration. With unique Comfort Control and Flow Pattern Control features.

### ● Residential ventilation

A complete range of products for residential ventilation. Consists of ventilation units, exhaust air fans and cooker hoods designed to optimise indoor comfort and save energy.

### ● Energy recovery

Dessicant-based product and systems that recover energy, increase ventilation and control humidity.

### ● Fans

Advanced axial, centrifugal and boxed fans for general and specialist applications. Comprehensive range including high temperature and ATEX compliant options. Engineered for energy efficiency and minimised life cycle cost.

### ● Chillers

Air-cooled and water-cooled chillers with cooling capacity up to 1800kW. Designed to minimise annual energy consumption in all types of buildings.

### ● Controls and drives

Variable speed drives and control systems, all tested to ensure total compatibility with our products. Specialist team can advise on energy saving and overall system integration.

### ● Acoustical products

A complete line of sound attenuating products, including rectangular and round silencers. Media Free silencers, custom silencers and acoustic enclosure panels.

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See global website for international sales offices [www.flaktwoods.com](http://www.flaktwoods.com)

The logo for Fläkt Woods, featuring the company name in a bold, green, sans-serif font. A stylized green leaf-like graphic element is positioned above the 't' in 'Woods' and below the 'ä' in 'Fläkt'.