



Sustainability & Contamination Control in hospitals

Sustainability vs. patient safety







R.J.R. Noor MSc.

- Maximuse B.V.
- Dutch Society on Contamination Control
- Sint Maartenskliniek
- D2 ontwikkeling B.V.



Sint Maartenskliniek

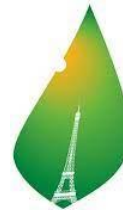
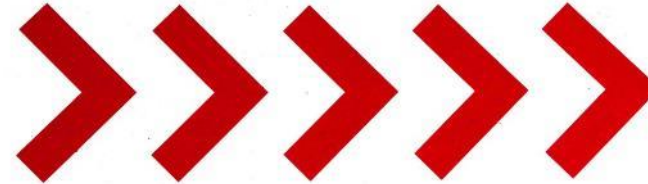


Dear to dream.
Challenge yourself.
Develop.





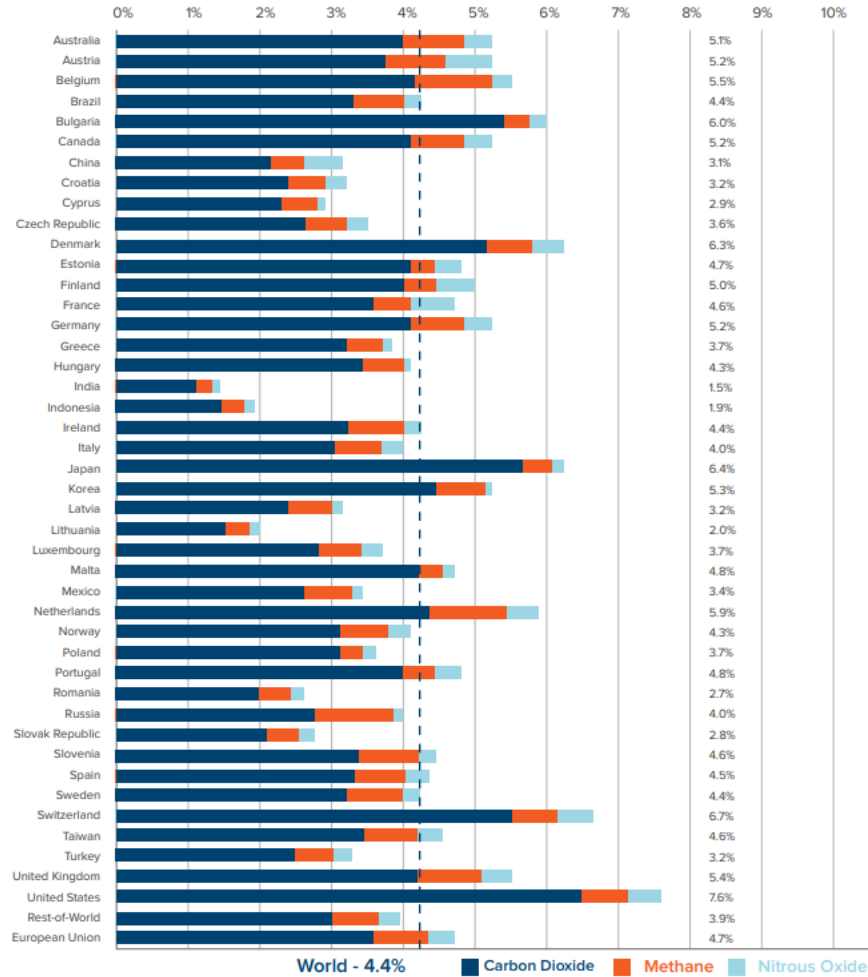
Climate change



PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21-CMP11



CO₂ footprint Healthcare sector

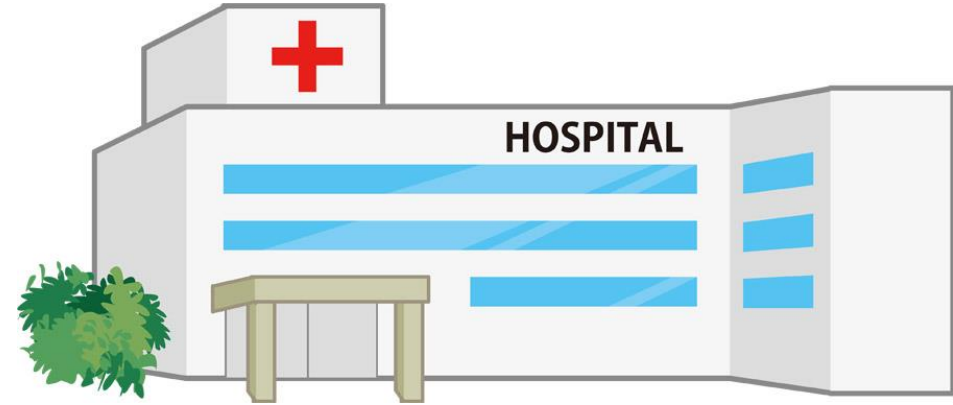


- World 4,4%
- European Union 4,7%
- The Netherlands 5,9 %
- Germany 5,2 %
- Sweden 4,4%
- Switzerland 6,7%
- USA 7,6%
- China 3,1%



Energy consumption in hospitals

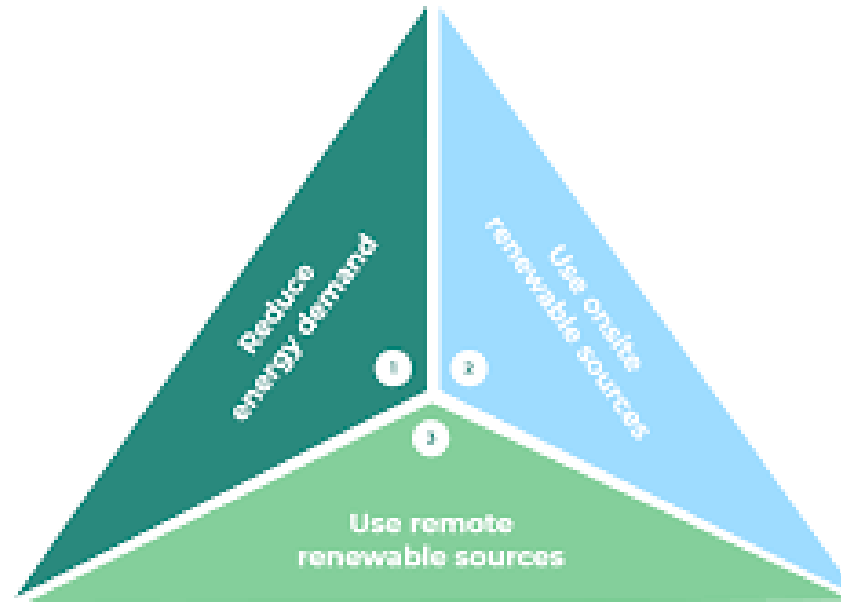
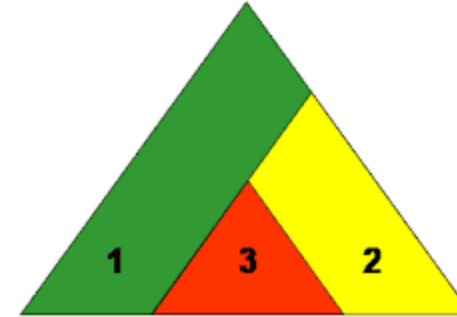
- Nursing department
- Imaging department
- ICU / CCU
- Pharmacy
- Isolation units
- Central Sterilization Department
- OR complex





Trias Energetica

1. Reduce energy demand
2. Use onsite renewable sources
3. Use remote renewable sources



Energy reduction

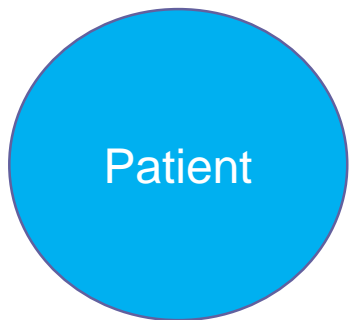
- Dimensions & design
- Insulation
- High efficiency insulation glass
- Temperature
- Humidity
- Lighting
- Uninterrupted power supply (UPS)
- Equipment





Behaviour by design

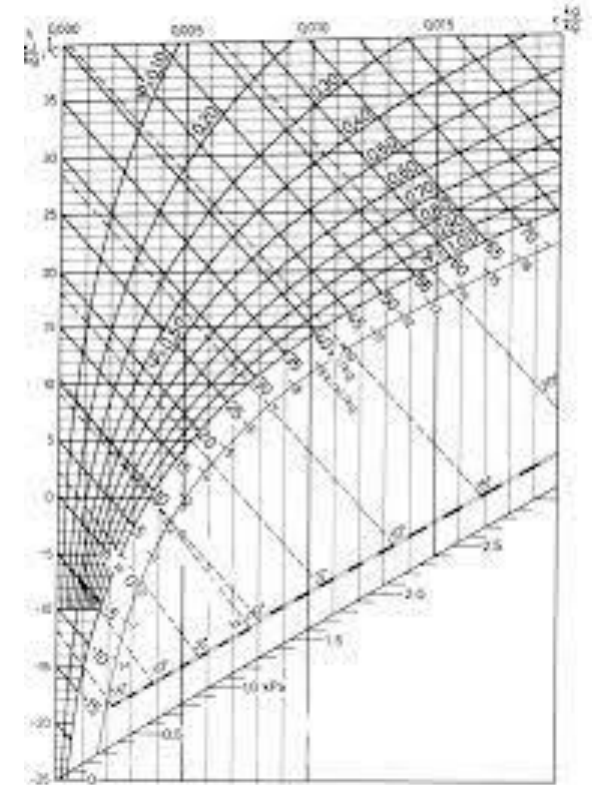
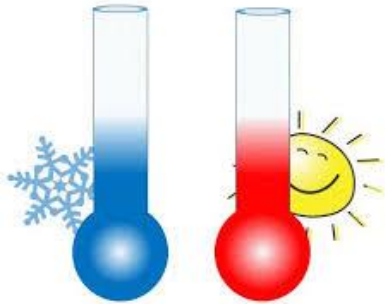
- Lay-out and design of hospital, departments, floors, etc.
 - Separation of flows
 - Combining function
- Different colour of carpeting.
- Automatic closing doors.
- Detection of presence for lights and indoor climate.





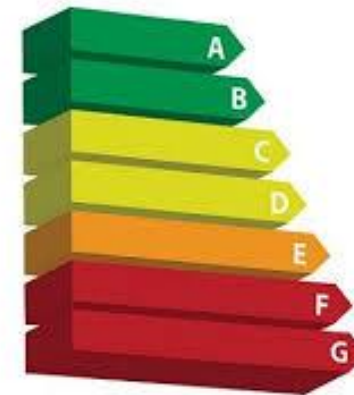
Temperature & humidity Control

- Low Temperature Heating (maximum temperature 50 °C)
- High Temperature Cooling (minimum temperature 10 °C)
- Heat Recovery Systems
- Insulation of pipes and ducts
- Minimum humidification (minimum relative humidity 30%)
- Minimum dehumidification (maximum relative humidity 80%)



Electricity reduction

- Programmable systems
- LED light fixtures
- Detection of presence of lights and climate control
- Day and night program
- Minimum light level (average level of 300 lux)
- Minimum light level in OR (average level of 600 lux)
- Limitation of light level of surgical lights
- Preference in electrical systems





Medical equipment

- Only power supply during use
- Stand by ≠ switched off
- Combination of equipment





On-site renewable energy sources

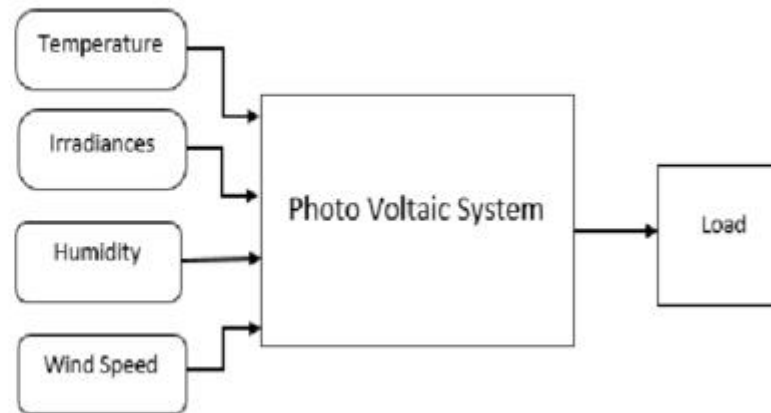
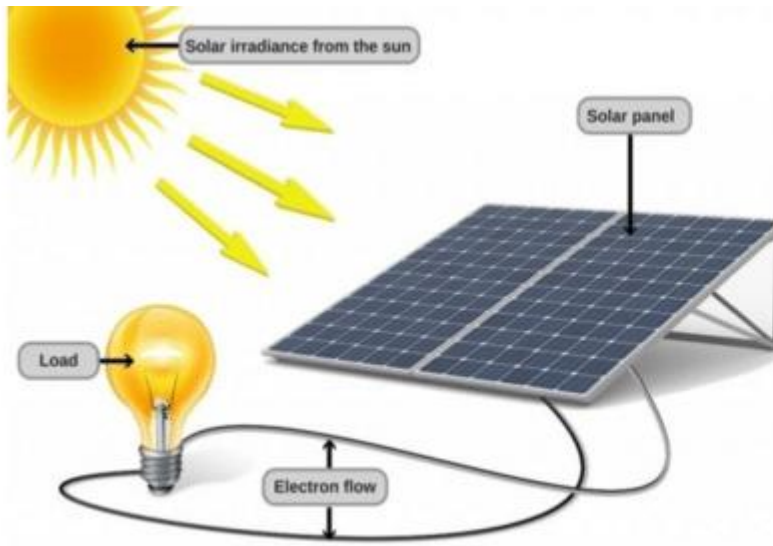
- Local wind turbines
- Solar panels
- Solar warm water supply
- Thermal energy storage





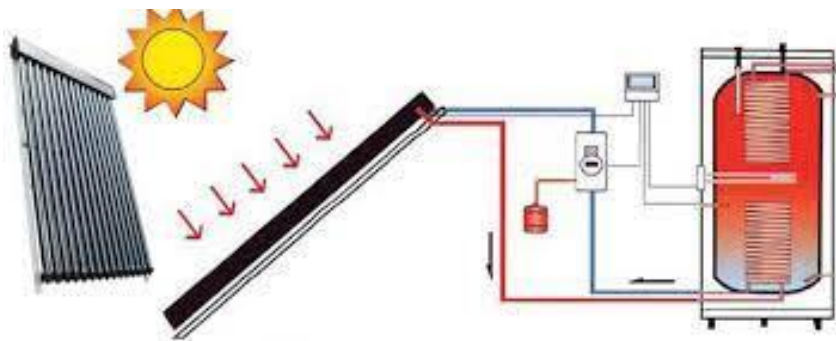
On-site solar panels

- Average output $\pm 3\%$ of total energy consumption
- Energy loss of computer monitors at night $\pm 3\%$

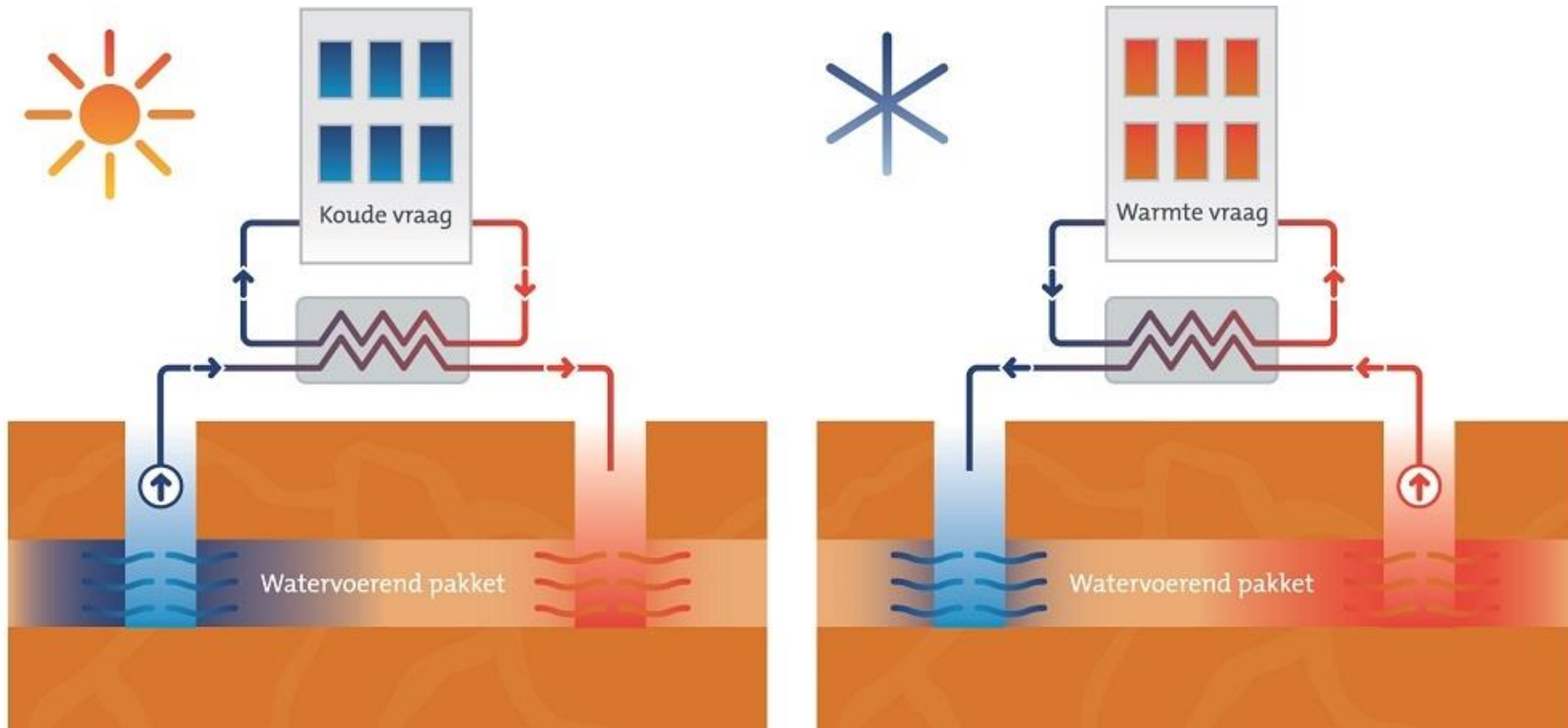




Solar warm water supply



Thermal Energy Storage





How do we transfer our planet to our grandchildren?





Air Handling

- Minimize fresh air supply
- Limited air circulation
- Air tightness of rooms
- Ventilation when needed
- During nights ventilation “Switched Off” when no patients and staff are present.

ISO	FS209	Certification Particle Size (µm)					
Class	Class	0.1	0.2	0.3	0.5	1.0	5.0
1	---	10	2	---	---	---	---
2	---	100	24	10	4	---	---
3	1	1,000	237	102	35	8	---
4	10	10,000	2,370	1,020	352	83	---
5	100	100,000	23,700	10,200	3,520	832	29
6	1,000	1,000,000	237,000	102,000	35,200	8,320	293
7	10,000	---	---	---	352,000	83,200	2,930
8	100,000	---	---	---	3,520,000	832,000	29,300
9	---	---	---	---	35,200,000	8,320,000	293,000



OR ventilation

- Patient Safety
- Limited Surgical Site Infections (SSI)
- Create a safe and comfortable environment for medical staff
- Minimize airborne contamination
- Protection against contamination from outside
- Removal contamination which is generate in the surgical area



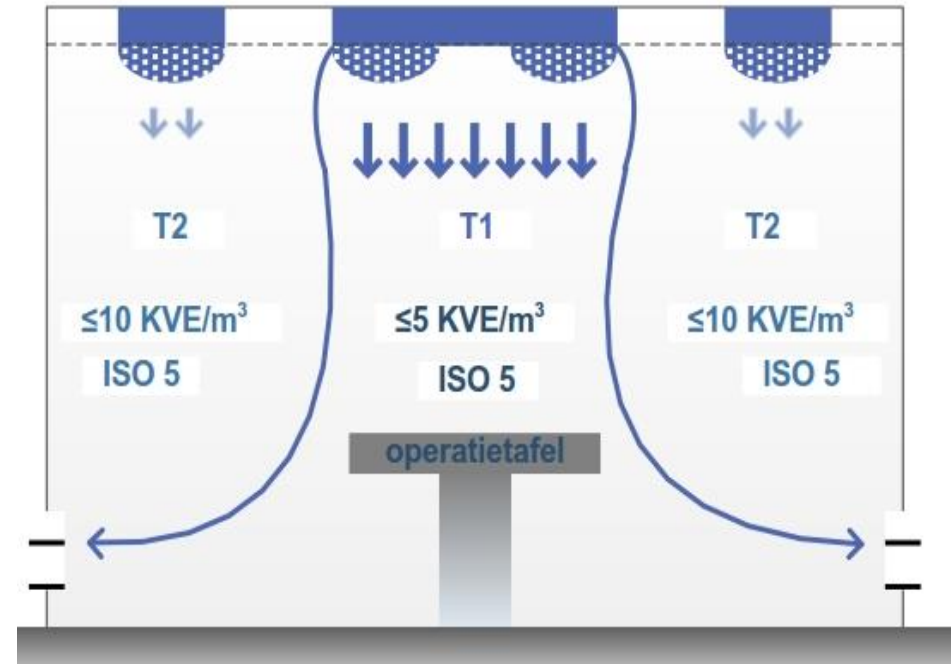
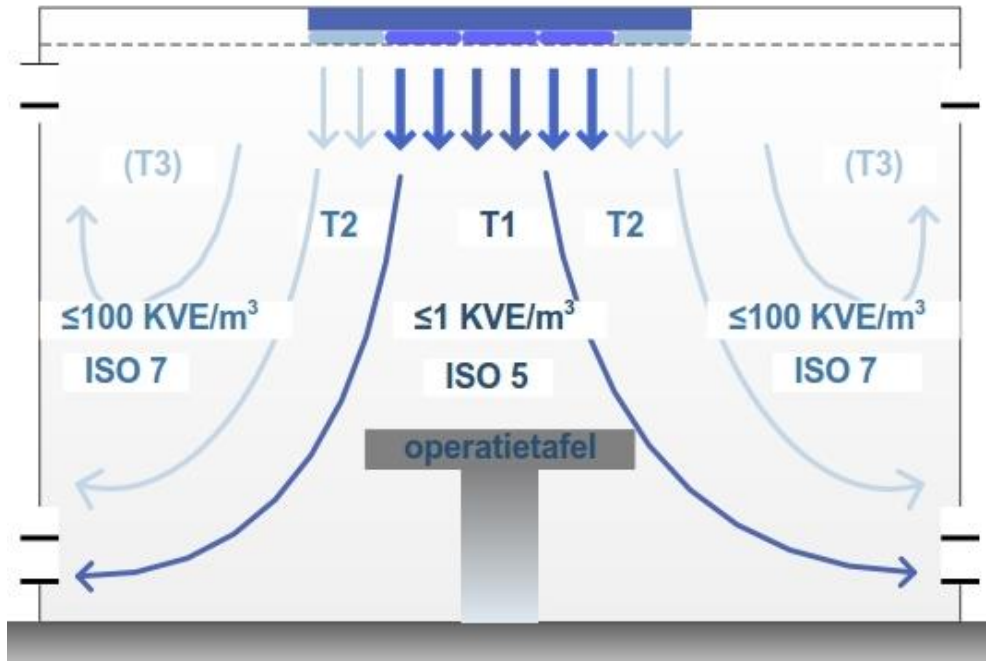


OR ventilation systems

- UDAF system
- TcAF system
- Halton Vita system
- Mixing ventilation systems



LAF system vs. TcAF system





Methodology of testing

- Particle measurements

Requirements according Dutch guidelines VCCN guideline 7

Recovery time inside the sterile zone

Protection degree against contamination form outside the sterile zone

- Micro-organism measurements

Requirements according the Swedish standard SIS-TS39

Number of cfu at the wound area

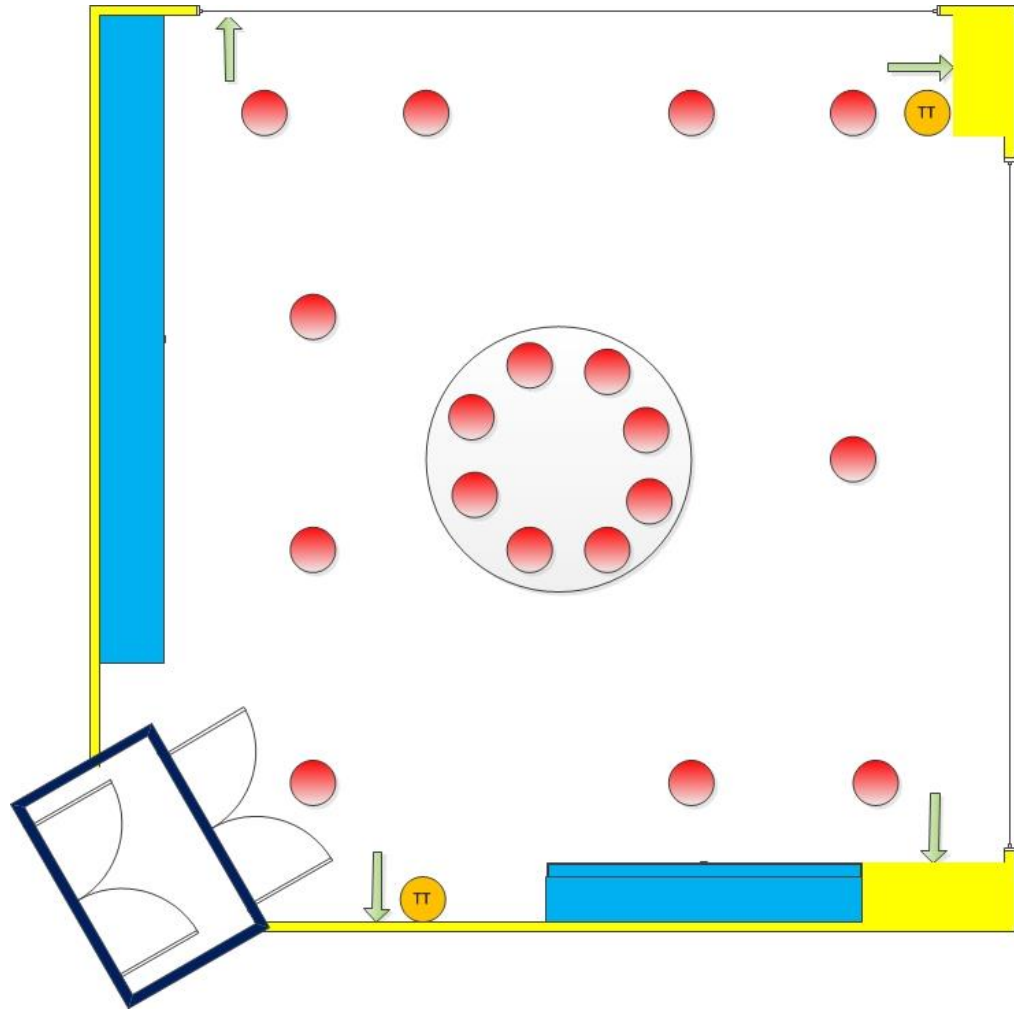
Number of cfu at the instruments

Number of cfu at the periphery



Test method

- Particle measurements
- Micro-organism measurements
- OR is 54 m²
- Outside temperature 27 °C
- Room temperature 21 °C
- Ventilation system Opragon 8 with 10 external airshowers





Particle measurements “At Rest”

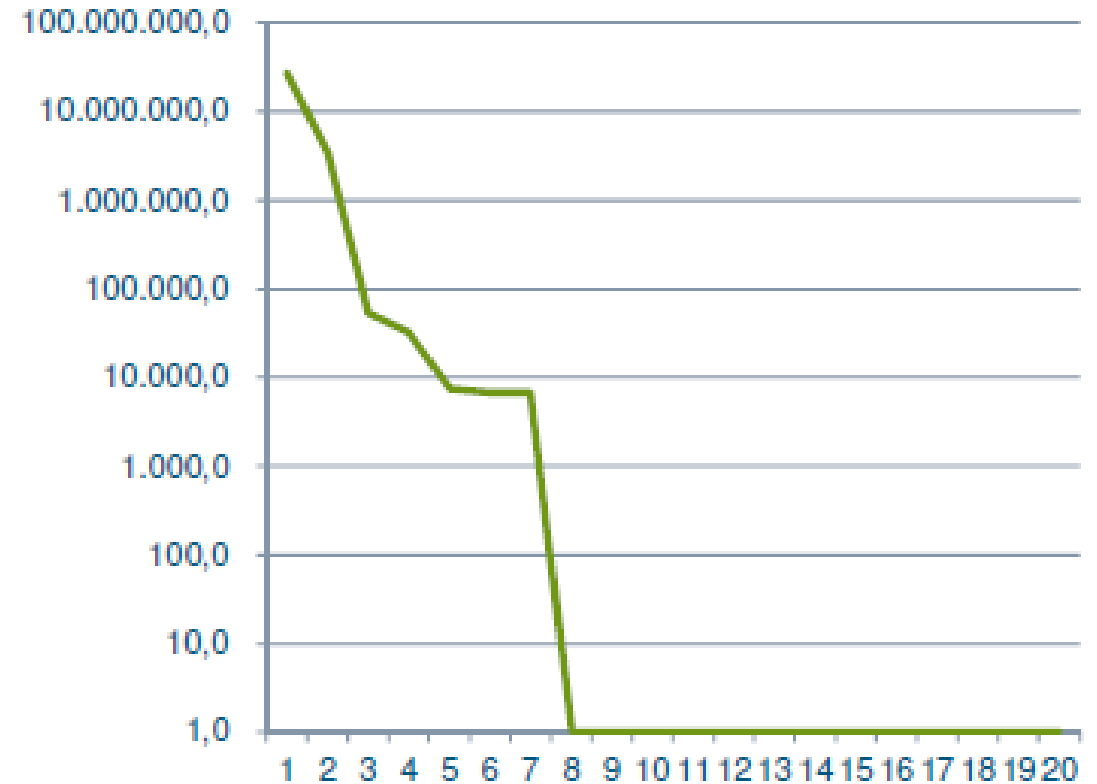
0,5 µm	1	2	3	5	4
High	0	0	706	0	287.108
Low	0	0	0	0	199.527
Average	0	0	78	0	254.266

0,5 µm	1	2	3	4	5
Average start	145.002	8.573.270	34.842.297	56.231.083	22.261.306
High start	348.908	17.246.976	40.853.771	78.195.146	31.019.343
Low start	80.164	4.703.207	27.884.813	36.341.969	12.814.986
Average end	91.359	12.442.804	36.352.740	36.913.219	21.952.691
High end	183.636	23.067.540	47.582.981	47.456.201	33.929.271
Low end	38.846	4.878.014	21.983.026	30.628.763	13.067.485



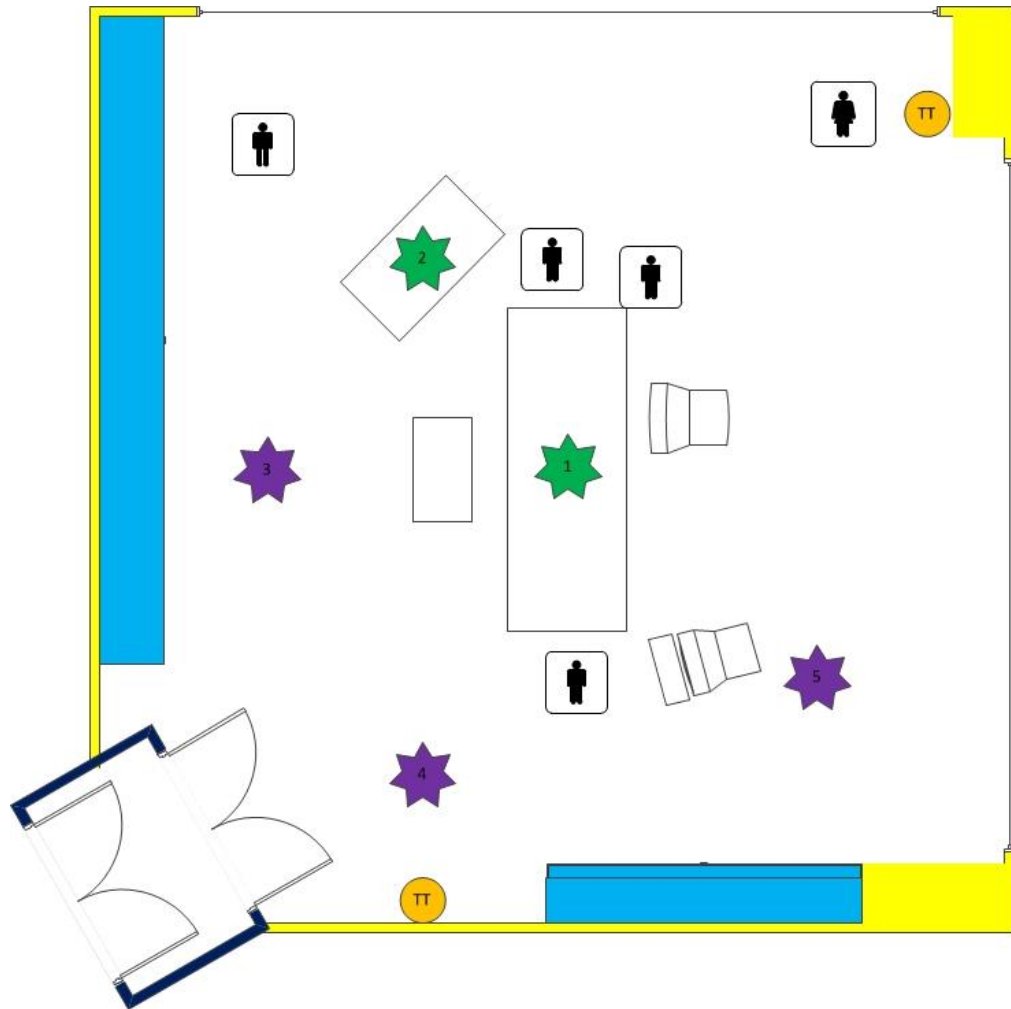
Recovery time “At Rest”

Measurement	
Number of particles	27.570.160
Log 2 reduction	< 2 minutes
Log 3 reduction	< 4 minutes
ISO class 5	< 7 minutes
Reduction to 0	< 7 minutes



1. Knee surgery

- 1 patient
- 5 medical staff
- 2 instrument tables
- Surgical equipment
- Anaesthesia equipment
- 6 door openings





1. Results

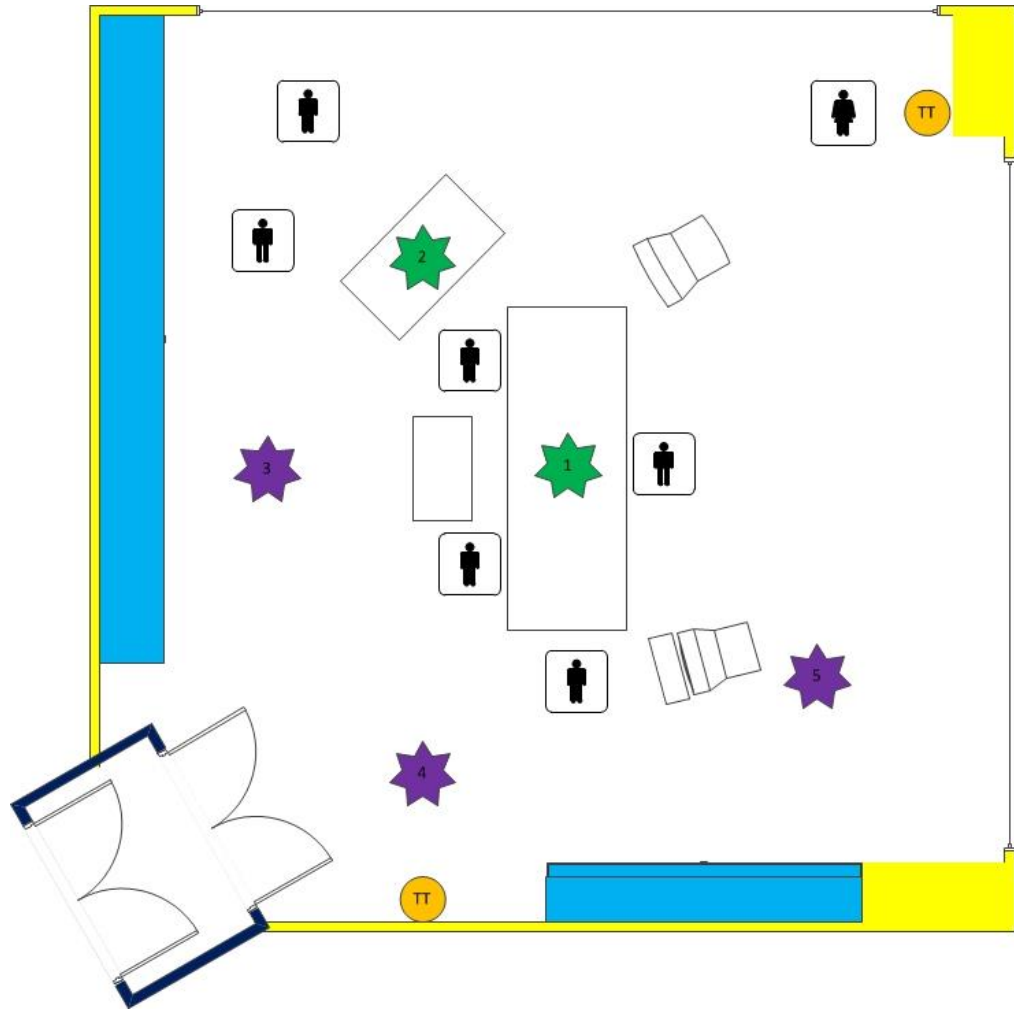
0,5 µm	Sterile zone		Periphery		
Level	1	2	3	4	5
High	0	14.125	15.538	15.891	1.059
Low	0	1.765	0	0	0
Average	0	5.841	3.391	3.009	37

5,0 µm	Sterile zone		Periphery		
Level	1	2	3	4	5
High	0	2.407	1.412	1.765	353
Low	0	0	0	0	0
Average	0	360	360	507	7

Area	1	2	3	4	5	Average
Wound	3	0	0	0	0	0,6
Instruments	1	1	1	2	1	1,2

2. Abdominal surgery

- 1 patient
- 7 medical staff
- 2 instrument tables
- Surgical equipment
- Anaesthesia equipment
- 12 door openings





2. Results

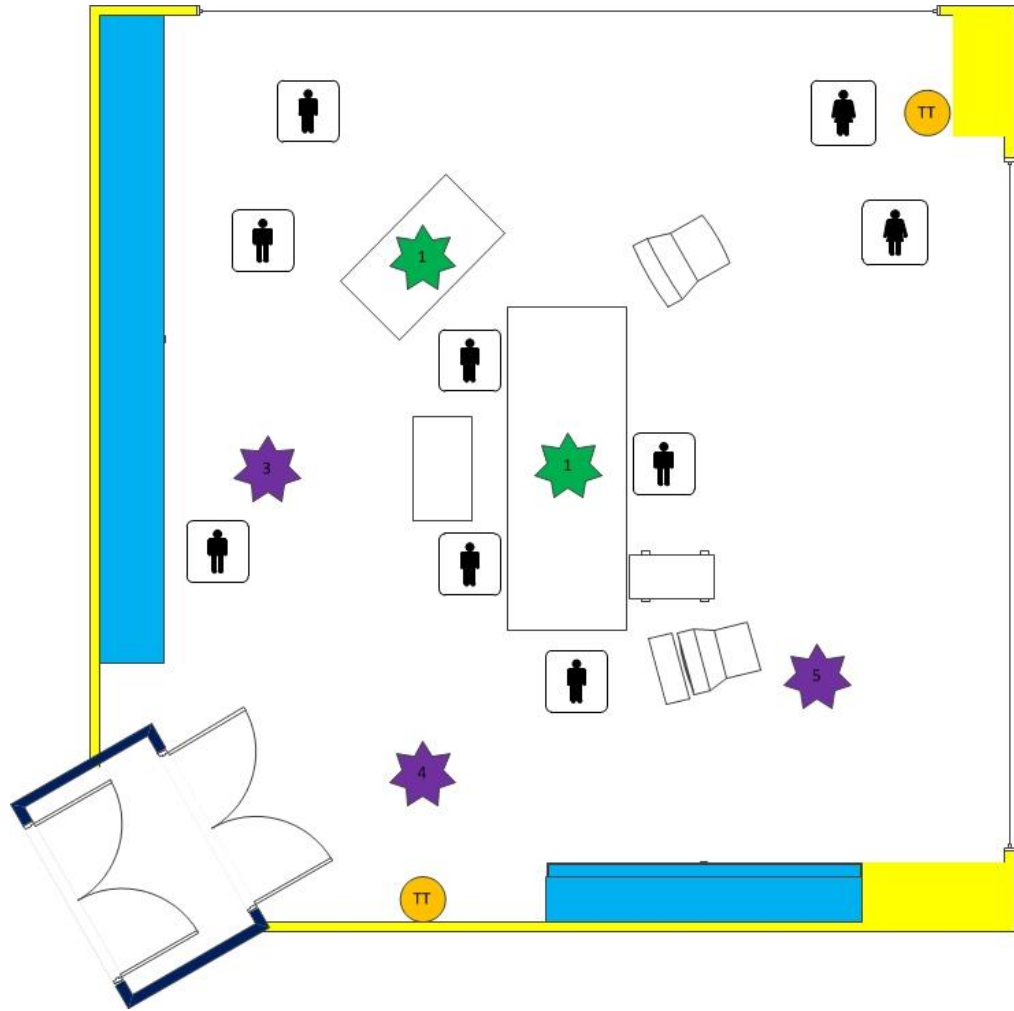
0,5 µm	Sterile zone		Periphery		
Level	1	2	3	4	5
High	0	18.010	178.339	145.143	16.951
Low	0	0	0	0	0
Average	0	2.600	13.200	10.203	808

5,0 µm	Sterile zone		Periphery		
Level	1	2	3	4	5
High	0	2.118	2.825	2.472	706
Low	0	0	0	0	0
Average	0	286	743	669	51

Area	1	2	3	4	5	Average
Wound	0	0	0	0	0	0
Instruments	1	0	1	0	1	0,6

3. Caesarean section

- 1 patient
- 9 medical staff
- 2 instrument tables
- Surgical equipment
- Anaesthesia equipment
- Bair hugger
- 8 door openings





3. Results

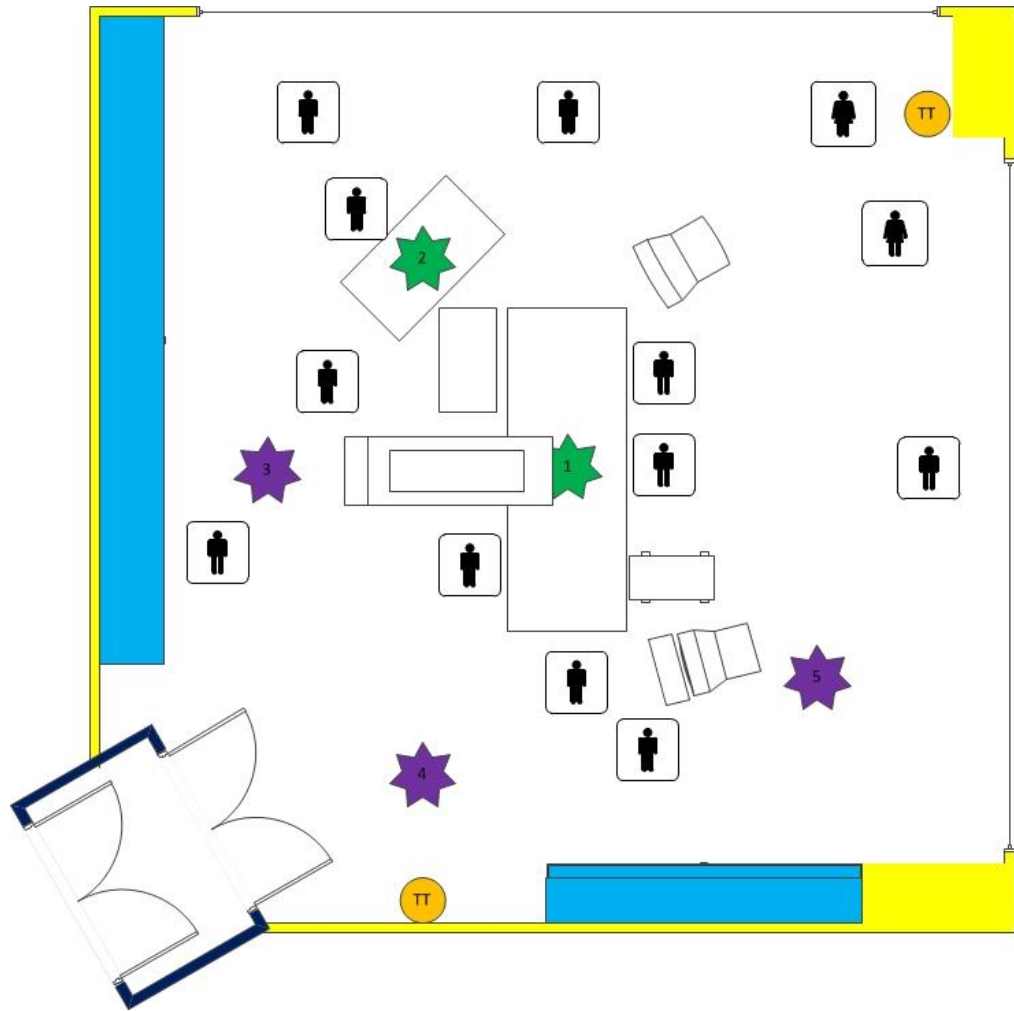
0,5 µm	Sterile zone		Periphery		
Level	1	2	3	4	5
High	706	9.535	12.007	19.423	5.297
Low	0	0	0	0	0
Average	21	1.681	3.905	6.427	974

5,0 µm	Sterile zone		Periphery		
Level	1	2	3	4	5
High	353	1.412	6.709	2.118	1.059
Low	0	0	0	0	0
Average	7	162	618	669	88

Area	1	2	3	4	5	Average
Wound	0	0	0	0	0	0
Instruments	2	2	1	1	2	1,6

4. Trauma surgery

- 1 patient
- 13 medical staff
- 2 instrument tables
- Surgical equipment
- Anaesthesia equipment
- Bair hugger
- Imaging equipment
- 36 door openings





4. Trauma surgery





4. Results

0,5 µm	Sterile zone		Periphery		
Level	1	2	3	4	5
High	5.660	13.066	7.062	12.007	3.884
Low	0	353	0	0	0
Average	1.195	5.426	5.589	5.623	944

5,0 µm	Sterile zone		Periphery		
Level	1	2	3	4	5
High	706	2.825	1.765	2.118	1.412
Low	0	0	0	0	0
Average	28	590	821	645	135

Area	1	2	3	4	5	Average
Wound	3	0	0	0	1	0,8
Instruments	6	7	5	7	9	6,8



Conclusion

- Particle measurements give a good overview of the functionality of the ventilation system.
- The LAF and TcAF system are capable of a fast reduction of contamination.
- TcAF ventilation is effective in extreme situations.
- TcAF is a good alternative ventilation system in OR's.
- TcAF is able to function with extreme heat loads and high temperatures.



Energy Savings

- Limitation of dimensions depends on total size
- Humidification savings
- Dehumidification savings
- Minimize fresh air supply
- Limited air circulation
- Different air handling system in OR
- Lower air circulation during nights in OR's
- No air circulation during nights in OR's



> 15 %

> 30 %

> 30 %

> 30 %

> 60 %

± 40 % per OR

± 30 % per OR

± 65 % per OR

Sustainability

- More than energy saving
- Way of life
- Sustainability need to be integrated in the hospital
- Smart design is sustainable
- Combinations and innovations are the key to the future
- Treatment, design and investment coordination





Thank you for your attention



Remko Noor
remko.noor@maximuse.on
e
+31(6) 5201 8656

