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R.J.R. Noor MSc.



CEO Maximuse B.V.

- Consultancy Controlled Environments
- Develop and implement innovations in healthcare;
- Create turn-key solutions;
- Research about the effectiveness of new developments;



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Vice-president Dutch Contamination Control Society

- Chairman committee symposia & conferences VCCN;
- Member expert team air permeability;
- Member expert team CSSD;
- Member expert team OR ventilation.

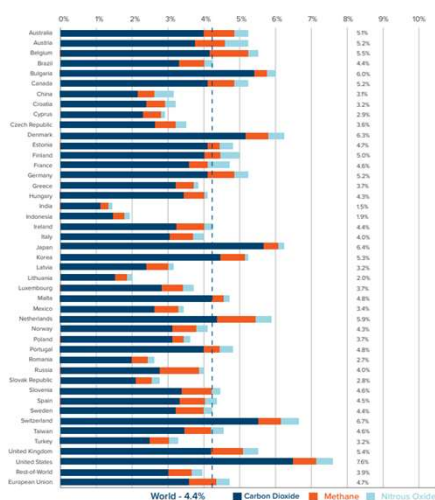


Dear to dream.
Challenge yourself.
Develop.



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CO₂ footprint Healthcare sector



- World 4,4 %
- European Union 4,7 %
- The Netherlands 5,9 %
- United Kingdom 5,4 %
- Germany 5,2 %
- Norway 4,3 %
- Sweden 4,4 %
- Finland 5,0 %
- Denmark 6,3 %
- USA 7,6 %
- China 3,1 %

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Sustainability

- Air permeability of the OR
- Limited fresh air supply
- Ventilation based on needs
- Temperature control based on needs
- No active humidity control

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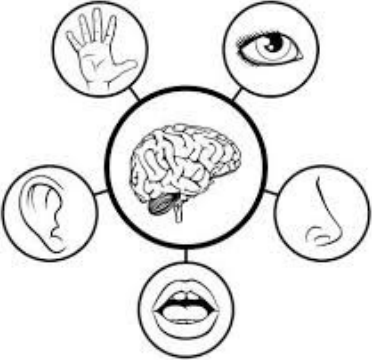
Patient safety

- Bacteria;
- Viruses (SARS, MERS, H1N1, etc.);
- Infections;
- Neuro / mycotoxin poisoning;
- Endotoxin poisoning;
- (Bio) chemical contamination;

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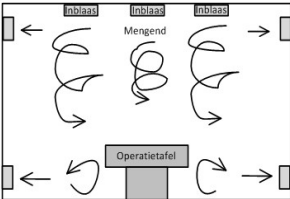
Comfort medical staff

4 Senses

- Hearing
- Smell
- Vision
- Touch

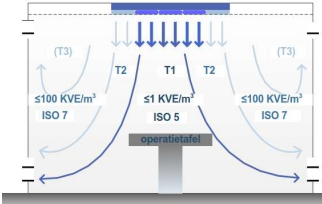
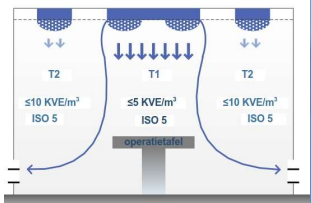
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OR ventilation

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Requirements the Netherlands

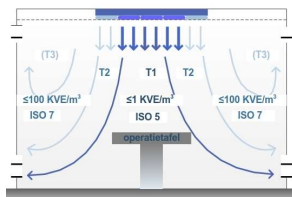
	Class 1+	Class 1	Class 2	Examination room
Air changes	$> 20 \text{ h}^{-1}$	$> 20 \text{ h}^{-1}$	$> 6 \text{ h}^{-1}$	$> 4 \text{ h}^{-1}$
Air quality	ISO 5	ISO 7	ISO 7	n.a
Recovery time (100:1)	$\leq 3 \text{ min}$	$\leq 20 \text{ min}$	n.a	n.a
Filters	HEPA 13	HEPA 13	HEPA 13	n.a
Temperature ($^{\circ}\text{C}$)	18 - 23 $^{\circ}\text{C}$	18 - 23 $^{\circ}\text{C}$	18 - 23 $^{\circ}\text{C}$	n.a
Humidity (%)	$< 65\%$	$< 65\%$	$< 65\%$	$< 65\%$
Classification	Ultraclean	Clean	n.a.	n.a

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Ultraclean OR Ventilation

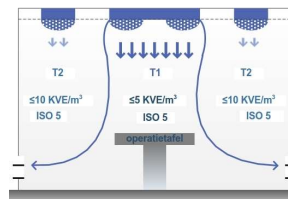


LAF system

- Plenum 3.4 x 3.4 m → sterile zone 3 x 3 m
- High and low exhaust
- 12,500 m³/h air supply
- Ach. = 85 h⁻¹

TcAF system

- Opragon 8 system with 12 external airshowers
- Low exhaust
- 6,800 m³/h air supply
- Ach. = 46 h⁻¹

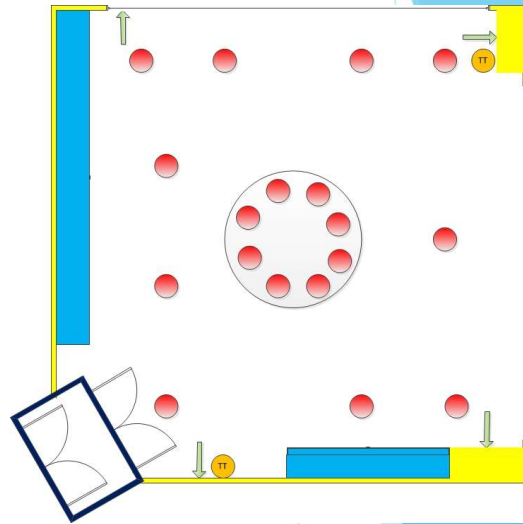


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Measurement Simulated procedures

- ▶ Opron 8 system
- ▶ 10 external airshower
- ▶ Outside temperature 27 °C
- ▶ Room temperature 21 °C
- ▶ Area is 54 m²
- ▶ In use with surgical clothing
- ▶ No separate preparation room
- ▶ Revolving doors without airlock system

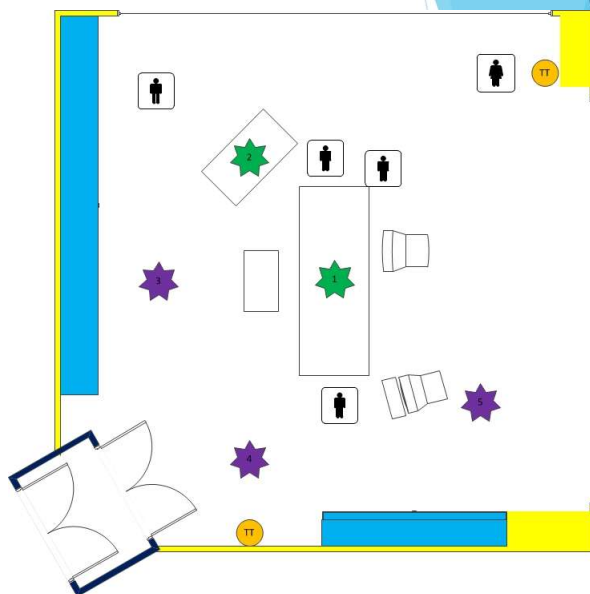


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Knee surgery

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



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Results 1 In Use

0,5 μm / m^3	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

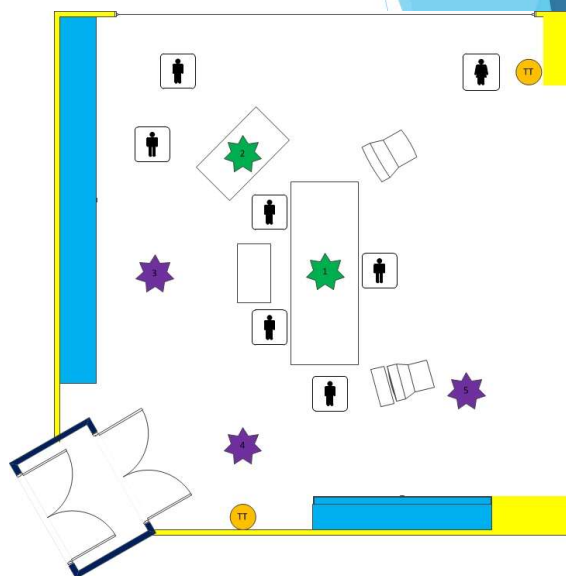
5,0 μm / m^3	Sterile zone		Periphery		
Level	1	2	3	4	5
High	0	2.407	1.412	1.765	353
Low	0	0	0	0	0
Average	0	360	360	507	7

cfu / m^3	1	2	3	4	5	Average
Wound	3	0	0	0	0	0,6
Instruments	1	1	1	2	1	1,2

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Abdominal surgery

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



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Results 2 In Use

0,5 µm / m ³	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

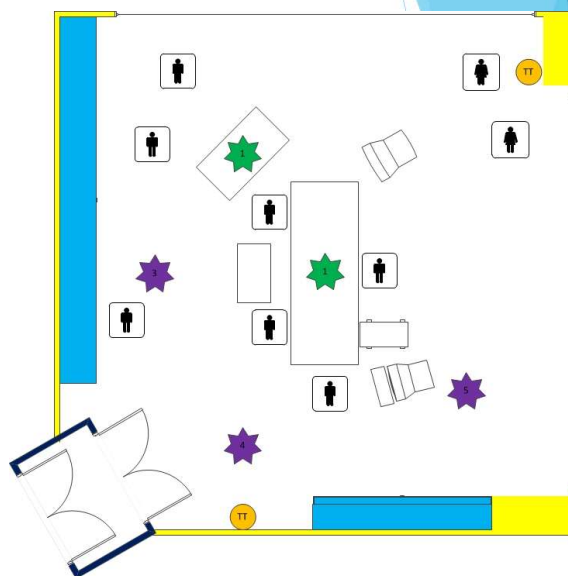
5,0 µm / m ³	Sterile zone		Periphery		
Level	1	2	3	4	5
High	0	2.118	2.825	2.472	706
Low	0	0	0	0	0
Average	0	286	743	669	51

cfu / m ³	1	2	3	4	5	Average
Wound	0	0	0	0	0	0
Instruments	1	0	1	0	1	0,6

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Caesarean section

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



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Results 3 In Use

0,5 μm / m^3	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

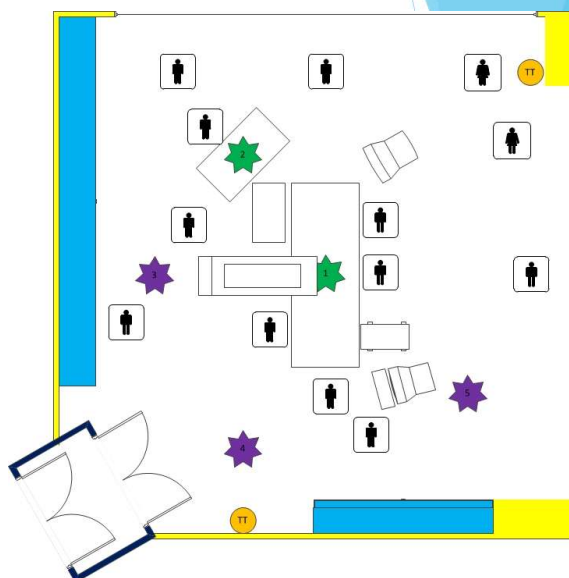
5,0 μm / m^3	Sterile zone		Periphery		
Level	1	2	3	4	5
High	353	1.412	6.709	2.118	1.059
Low	0	0	0	0	0
Average	7	162	618	669	88

cfu / m^3	1	2	3	4	5	Average
Wound	0	0	0	0	0	0
Instruments	2	2	1	1	2	1,6

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Trauma surgery

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



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Trauma surgery



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Results 4 In Use

0,5 $\mu\text{m} / \text{m}^3$	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 $\mu\text{m} / \text{m}^3$	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

cfu / m^3	1	2	3	4	5	Average
Wound	3	0	0	0	1	0,8
Instruments	6	7	5	7	9	6,8

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Conclusion

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

- Total OR ISO class 5 "At Rest"
- CFU-level centre < 5 cfu/m³
- CFU-level OR < 10 cfu/m³
- Noise level < 48 dB(A)
- No draft

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PURITAS OR ventilation Sint Maartenskliniek



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- Heat recovery system;
- Heat pump technology;
- HEPA filter;
- Variable Air Volume (0-50-100 %);
- Temperature controlled Air Flow;
- Max. 1200 m³/h fresh air supply
- Air permeability class L0 at ±50 Pa
- Energy saving > 37.000 kWh/year
- CO₂ footprint lowered > 21 ton/year
- Return on Investment < 2 years

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Take Home message

- Use only ultraclean ORs when needed
- Don't be afraid for innovation
- Use scientific research for your design
- Risk approach instead of Evidence Based

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Questions?

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