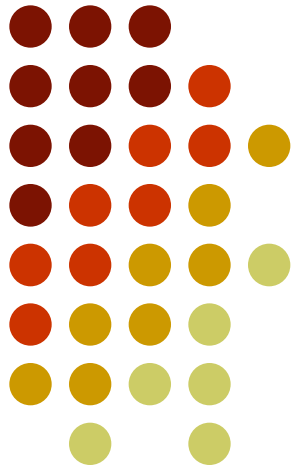
IAQ
Indoor air quality



2014. 09. 24.

Indoor climate requirements

- Thermal comfort
- Indoor air quality
- Noise
- Light

Indoor Air Quality (IAQ)

- Health risk should be minimal
- Air should be perceived as fresh rather than stale, stuffy or irritating

- Control of indoor air quality:
  - Source control
  - Ventilation

IAQ - Ventilation

- Ventilation to remove air pollutants that cause health risks
- Ventilation required for the desired perceived indoor air quality

- Chose the one which is higher for design!

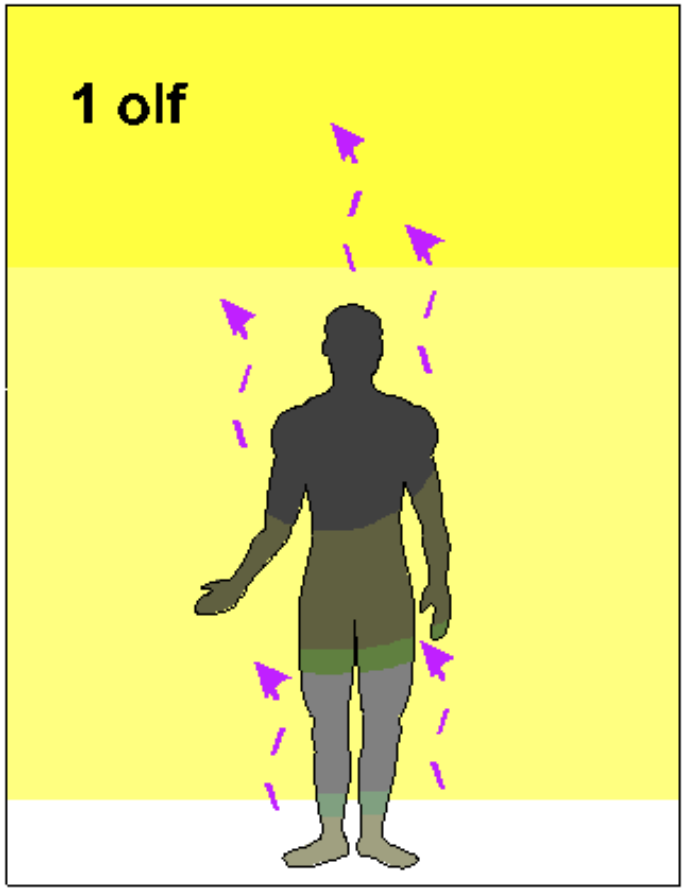
Perceived air quality

- Humans perceive the air by two senses:
  - Olfactory sense (in the nasal cavity)
  - Chemical sense (on the mucous membranes of the nose and eyes)
- Perceived air quality: Percentage of dissatisfied – persons predicted to perceive the air as unacceptable just after entering a space.

Olf – pollution load

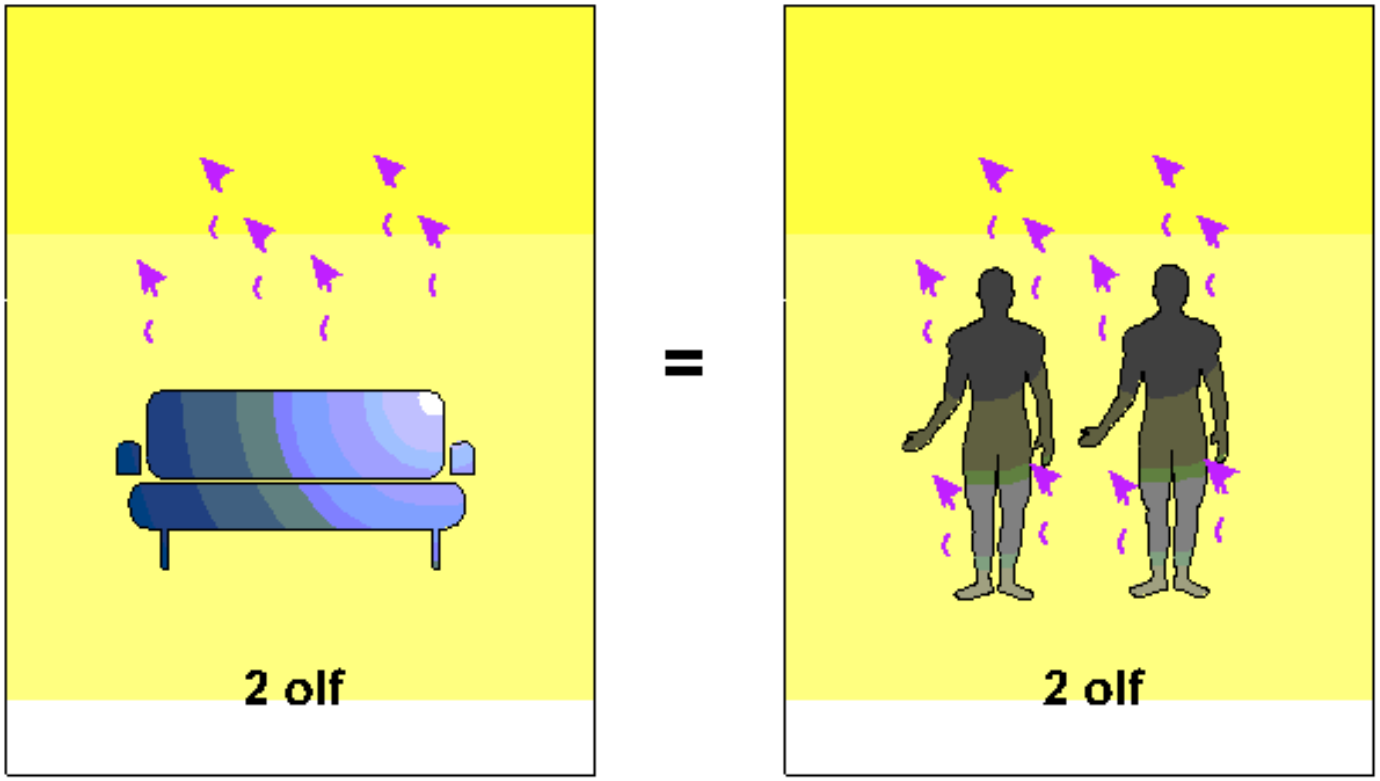
- Sensory pollution load in olf:

  1 olf is the sensory load on the air from an average sedentary adult in thermal neutrality



source: www.deparia.com, Vergoni, C

Olf – pollution load

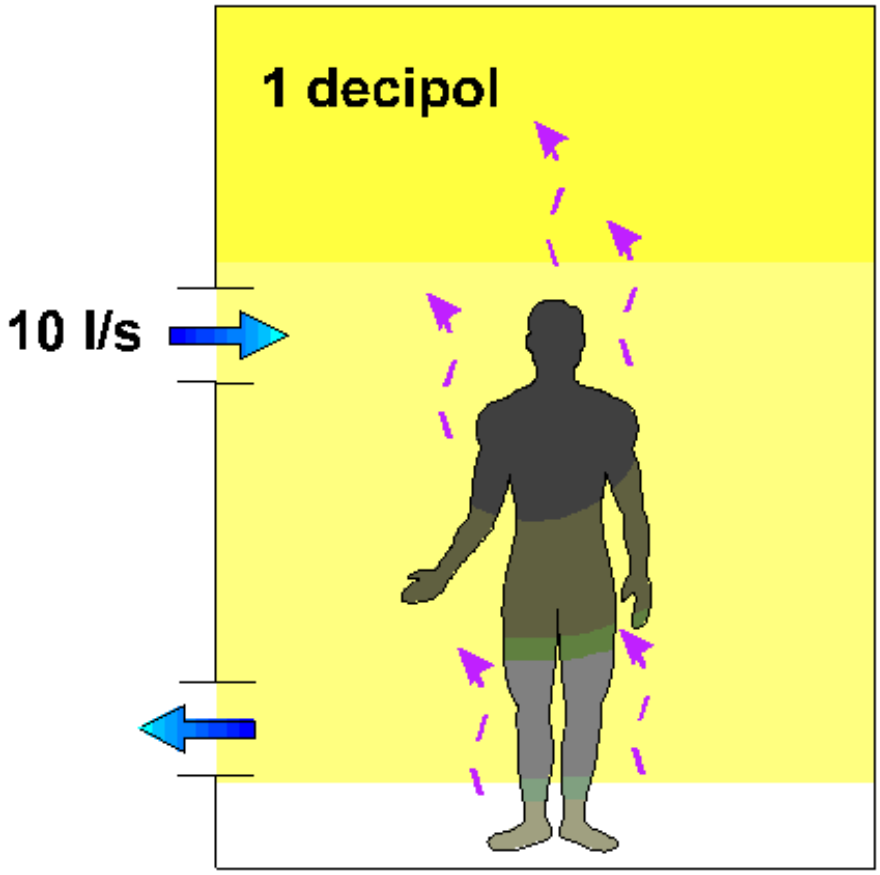


(source: www.deparia.com, Vergoni, C)

Decipol

- Perceived air pollution:

1 decipol (dp) is the air quality in a space with the pollution source strength of 1 olf, ventilated by 10 l/s of clean air.



source: www.deparia.com, Vergoni, C

CR 1752 and IAQ

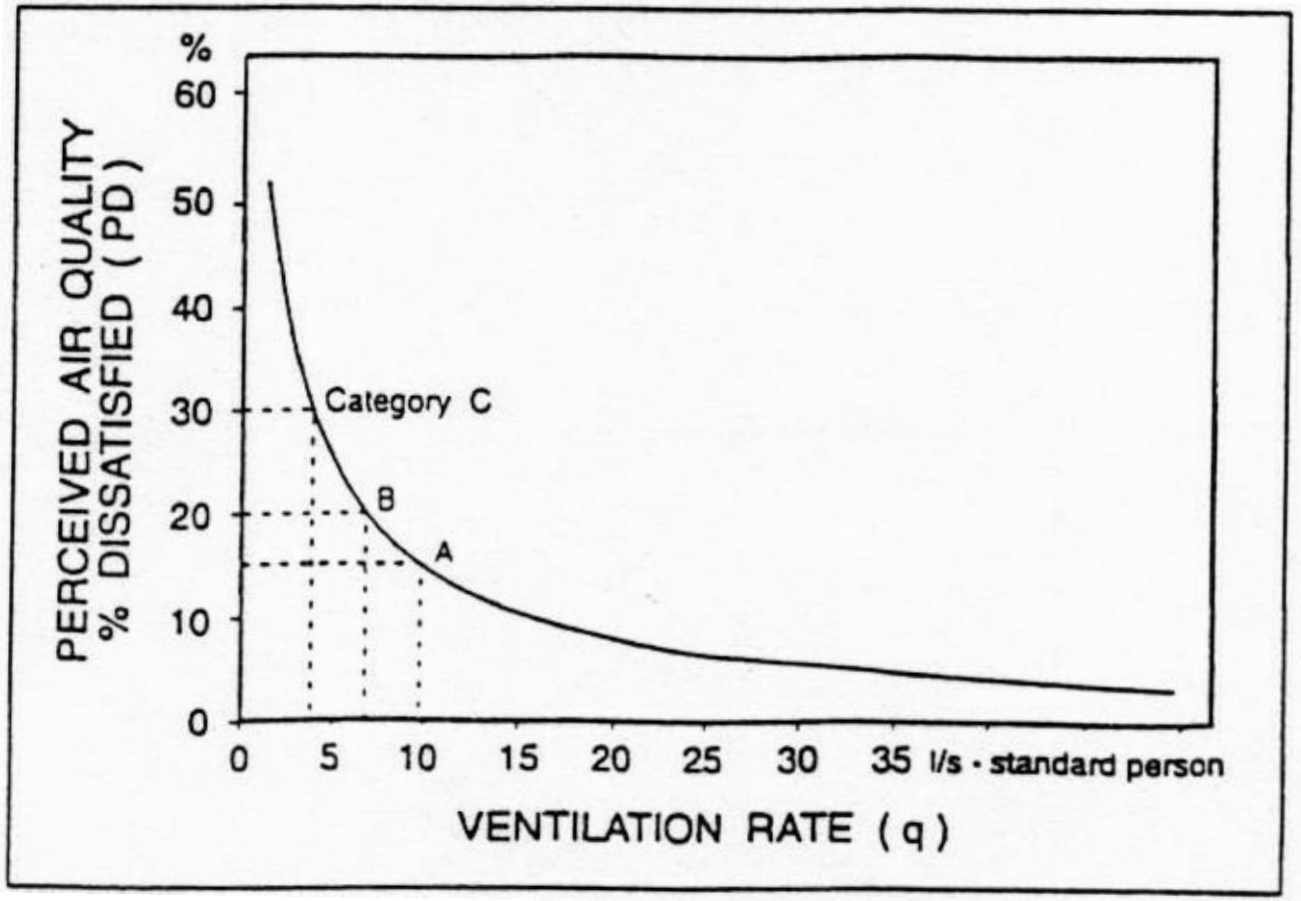
Table A.5 — Three categories of perceived indoor air quality

Category	Perceived air quality		Required ventilation rate[1)]
	dissatisfied %	dp	l/s × olf
A	15	1,0	10
B	20	1,4	7
C	30	2,5	4

[1)] The ventilation rates given are examples referring exclusively to perceived air quality. They apply only to clean outdoor air and a ventilation effectiveness of one.

- Same categorisation, i.e. A, B, C categories
- Sources:
  - chemical pollution load
  - sensory pollution load

CR 1752 and IAQ

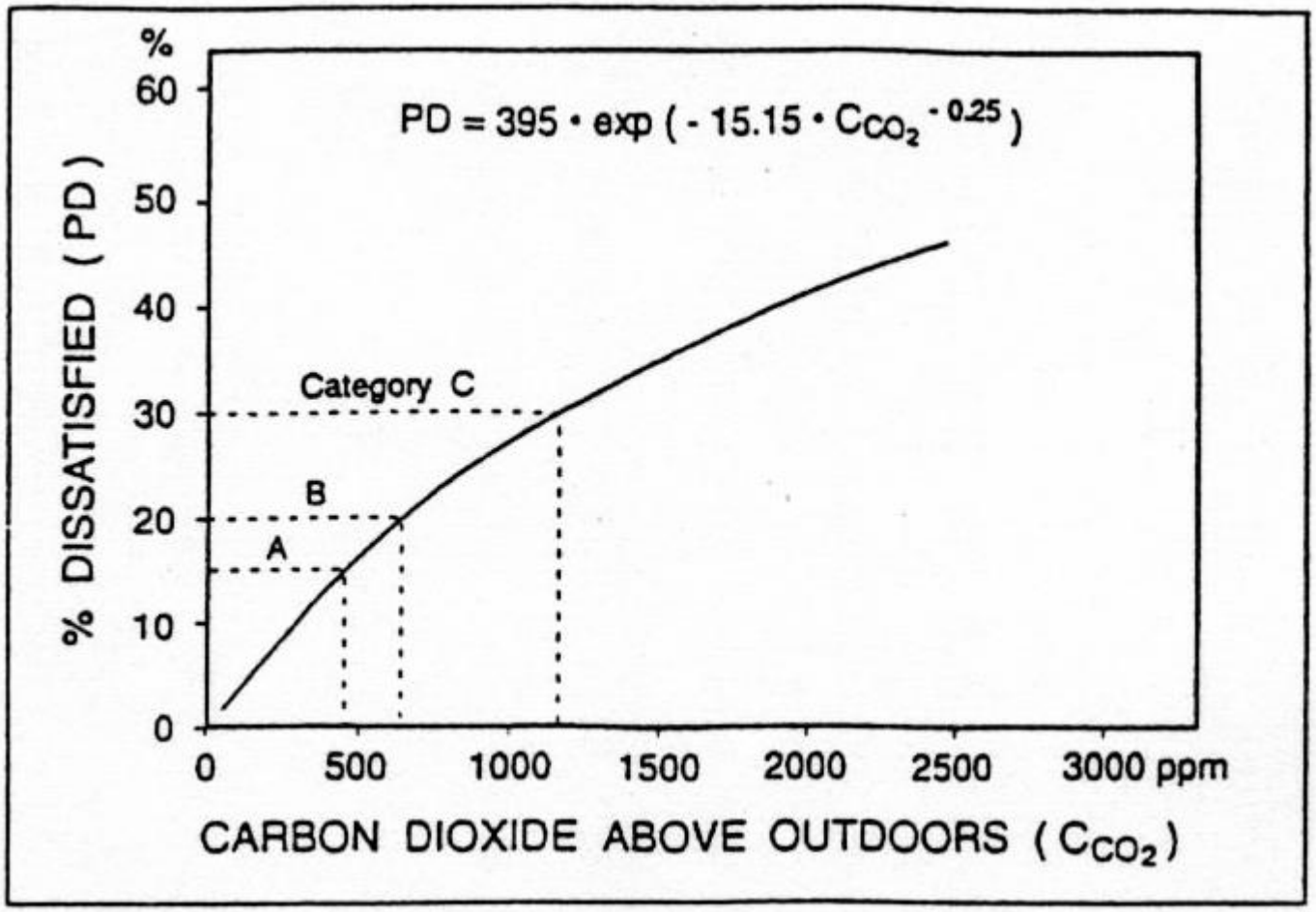


NOTE The curve is given by the following equations:

$PD = 395 \times \exp(-1{,}83 \times q^{0.25})$ for: $q \geq 0{,}32$ l/s × olf

$PD = 100$ for: $q < 0{,}32$ l/s × olf

CR 1752 and IAQ



Required ventilation rate

- From the comfort point of view:

$$Q_c = 10 \bullet \frac{G_c}{C_{c,i} - C_{c,o}} \bullet \frac{1}{\varepsilon_v}$$

where:

Q_c	is the ventilation rate required for comfort, in litres per second (l/s);
G_c	is the sensory pollution load, in olf (olf);
$C_{c,i}$	is the desired perceived indoor air quality, in decipol (decipol);
$C_{c,o}$	is the perceived outdoor air quality at air intake, in decipol (decipol);
ε_v	is the ventilation effectiveness.

Required ventilation rate

- From the health point of view:

$$Q_h = \frac{G_h}{C_{h,i} - C_{h,o}} \bullet \frac{1}{\varepsilon_v}$$

where:

Q_h	is the ventilation rate required for health, in litres per second (l/s);
G_h	is the pollution load of a chemical, in micrograms per second (µg/s);
$C_{h,i}$	is the guideline value of a chemical, see annex E, in micrograms per litre (µg/l);
$C_{h,o}$	is the outdoor concentration of a chemical at air intake, in micrograms per litre (µg/l);
ε_v	is the ventilation effectiveness.

Ventilation effectiveness

$$\varepsilon_v = \frac{C_e - C_s}{C_i - C_s}$$

where:

ε_v	is the ventilation effectiveness;
C_e	is the pollution concentration in the exhaust air;
C_s	is the pollution concentration in the supply-air;
C_i	is the pollution concentration in the breathing zone.

Depends on

- Air distribution
- Location of the pollution source in the space

Ventilation effectiveness

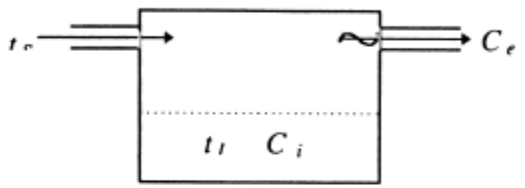
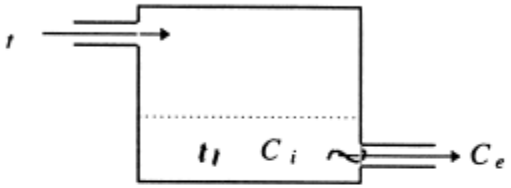
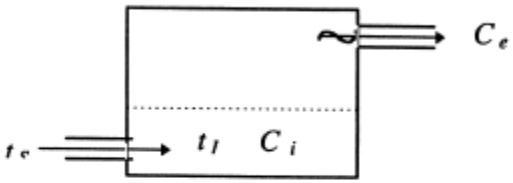
Table A.9 — Examples of outdoor levels of air quality

	Perceived air quality dp	Air pollutants				
		Carbon dioxide mg/m³	Carbon monoxide mg/m³	Nitrogen dioxide µg/m³	Sulfur dioxide µg/m³	Particulates µg/m³
Excellent	0	680	0–0,2	2	1	<30
In towns, good air quality	< 0,1	700	1–2	5–20	5–20	40–70
In towns, poor air quality	> 0,5	700–800	4–6	50–80	50–100	>100

NOTE There is no direct relation between perceived air quality and the pollutants listed in this table. The values for the perceived air quality are typical daily average values. The values for the four air pollutants are annual average concentrations.

Ventilation effectiveness

Table F.1 — Examples of ventilation effectiveness in the breathing zone of spaces ventilated in different ways

Mixing ventilation		Mixing ventilation		Displacement ventilation	
					
Temperature difference between supply air and air in breathing zone $t_s - t_i$ °C	**Ventilation effectiveness**	**Temperature difference between supply air and air in breathing zone** $t_s - t_i$ °C	**Ventilation effectiveness**	**Temperature difference between supply air and air in breathing zone** $t_s - t_i$ °C	**Ventilation effectiveness**
< 0	0,9 — 1,0	< -5	0,9	< 0	1,2 — 1,4
0 — 2	0,9	-5 — 0	0,9 — 1,0	0 — 2	0,7 — 0,9
2 — 5	0,8	> 0	1,0	> 2	0,2 — 0,7
> 5	0,4 - 0,7				

Pollution load caused by occupant

Table A.6 — Pollution load caused by occupants

	Sensory pollution load olf/occupant	Carbon dioxide l/(h × occupant)	Carbon monoxide[a] l/(h × occupant)	Water vapour[b] g/(h × occupant)
Sedentary, 1–1.2 met				
0 % smokers	1	19		50
20 % smokers [c]	2	19	11×10^{-3}	50
40 % smokers [c]	3	19	21×10^{-3}	50
Physical exercise				
low level, 3 met	4	50		200
medium level, 6 met	10	100		430
high level (athletes), 10 met	20	170		750
Children				
kindergarten, 3-6 years, 2,7 met	1.2	18		90
school, 14–16 years, 1–1,2 met	1.3	19		50

[a] From tobacco smoking.
[b] Applies for persons close to thermal neutrality.
[c] Average smoking rate 1,2 cigarettes/h per smoker, emission rate 44 ml CO/cigarette.

Pollution load caused by occupant

Table A.7 — Examples of occupancy in spaces

	Occupants/(m^2 floor)
Offices	0,07
Conference rooms	0,5
Assembly halls, theatres, auditoria	1,5
Schools (classrooms)	0,5
Kindergartens	0,5

Pollution load caused by building materials

Table A.8 — Pollution load caused by the building, including furnishing, carpets and ventilation system

	Sensory pollution load olf/(m² floor)	
	Mean	**Range**
Existing buildings		
Offices[a)]	0,3[d)]	0,02–0,95
Offices[b)]	0,6[c)]	0–3
Schools (classrooms)[a)]	0,3	0,12–0,54
Kindergartens[a)]	0,4	0,20–0,74
Assembly halls[a)]	0.3[d)]	0,13–1,32
New buildings (no tobacco smoking)		
Low-polluting buildings (see annex G)	0,1	
Non-low-polluting buildings	0,2	

[a)] Data based on more than 40 mechanically ventilated buildings in Denmark.

[b)] Data based on European Audit Project to Optimize Indoor Air Quality and Energy Consumption in Office Buildings, 1992–1995 [3].

[c)] Includes load caused by present and previous tobacco smoking.

[d)] Includes load caused by previous tobacco smoking.

NOTE Little information is usually available on the pollution load from many materials used in practice. Still it is essential to try to minimize the pollution load from the building. Work is in progress to provide information on and decrease the pollution load from materials. Annex G offers some guidelines for low-polluting buildings.

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