WG 19 - CEN TC 156

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Revision EN 15251 - Indoor environmental input parameters for the design and assessment of energy performance of buildings.

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STANDARDS

- ISO EN 7730-2005
  - Ergonomics of the thermal environment – Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort effects

INTERNATIONAL STANDARDS INDOOR ENVIRONMENTAL QUALITY

- **prEN15251-1 and ISO CD 17772:**
  - Indoor environmental input parameters for the design and assessment of energy performance of buildings.
- **TR15251-2 and ISO NWI TR 17772:**

INDOOR ENVIRONMENTAL INPUT PARAMETERS FOR THE DESIGN AND ASSESSMENT OF ENERGY PERFORMANCE OF BUILDINGS

- This International Standard deals with the indoor environmental parameters for thermal environment, indoor air quality, lighting and acoustic.
- This standard specifies how to establish indoor environmental input parameters for building system design and energy performance calculations.

CATEGORIES

Category	Explanation
I	High level of expectation and also recommended for spaces occupied by very sensitive and fragile persons with special requirements like some disabilities, sick, very young children and elderly persons, to increase accessibility.
II	Normal level of expectation
III	An acceptable, moderate level of expectation
IV	Low level of expectation. This category should only be accepted for a limited part of the year

MODERATE THERMAL ENVIRONMENTS

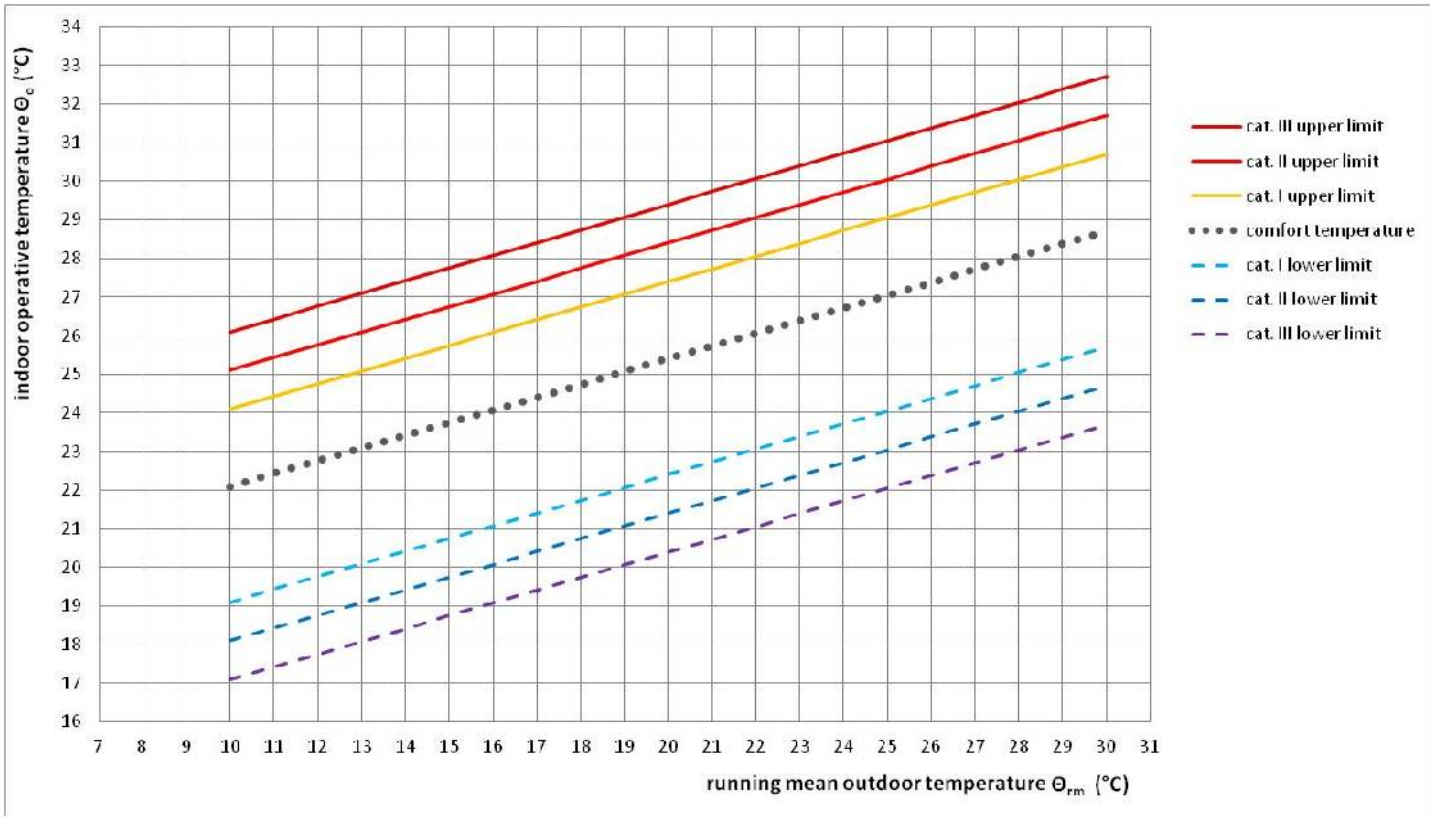
- **GENERAL THERMAL COMFORT**
  - PMV / PPD, OPERATIVE TEMPERATURE
- **LOCAL THERMAL DISCOMFORT**
  - Radiant temperature asymmetry
  - Draught
  - Vertical air temperature difference
  - Floor surface temperature

TEMPERATURE RANGES FOR HOURLY CALCULATION OF COOLING AND HEATING ENERGY IN THREE CATEGORIES OF INDOOR ENVIRONMENT

Type of building/ space	Category	Operative Temperature for Energy Calculations °C	
Offices and spaces with similar activity (single offices, open plan offices, conference rooms, auditorium, cafeteria, restaurants, class rooms, Sedentary activity ~1,2 met		Heating (winter season), ~ 1,0 clo	Cooling (summer season), ~ 0,5 clo
	I	21,0 – 23,0	23,5 - 25,5
	II	20,0 – 24,0	23,0 - 26,0
	III	19,0 – 25,0	22,0 - 27,0
	IV	17,0 – 26,0	21,0 - 28,0

ADAPTATION IN NATURAL VENTILATED BUILDINGS ?

- **Behavioural**
  - Clothing, activity, posture
- **Psychological**
  - Expectations



Θrm = (Θed -1 + 0,8 Θed -2 + 0,6 Θed -3 + 0,5 Θed -4 + 0,4 Θed -5 + 0,3 Θed -6 + 0,2 Θed -7)/3,8

CRITERIA FOR INDOOR AIR QUALITY ~VENTILATION RATES

- **COMFORT (Perceived Air Quality)**
- **HEALTH**
- **PRODUCTIVITY**
- **ENERGY**

HEALTH CRITERIA FOR VENTILATION

Minimum 4 l/s/person

CONCEPT FOR CALCULATION OF DESIGN VENTILATION RATE

People Component Building Component

Breathing Zone Outdoor Airflow

Vbz = RpPz + RsSd + RaAz

- RpPz: Minimum l/s/Person; Number of People
- RsSd: ~~Ventilation per Smoker~~; ~~Number of Smokers~~
- RaAz: Building Area; Minimum l/s/m²

TOTAL VENTILATION RATE

$$q_{tot} = n \times q_p + A_R \times q_B$$

$$qsupply = qtot / \hat{U}v$$

Where

- **Ûv = the ventilation effectiveness (EN13779)**
- **qsupply = ventilation rate supplied by the ventilation system**
- ***qtot*= total ventilation rate for the breathing zone, l/s**
- ***n* = design value for the number of the persons in the room,**
- ***qp* = ventilation rate for occupancy per person, l/s, pers**
- ***AR*= room floor area, m2**
- ***qB* = ventilation rate for emissions from building, l/s,m2**

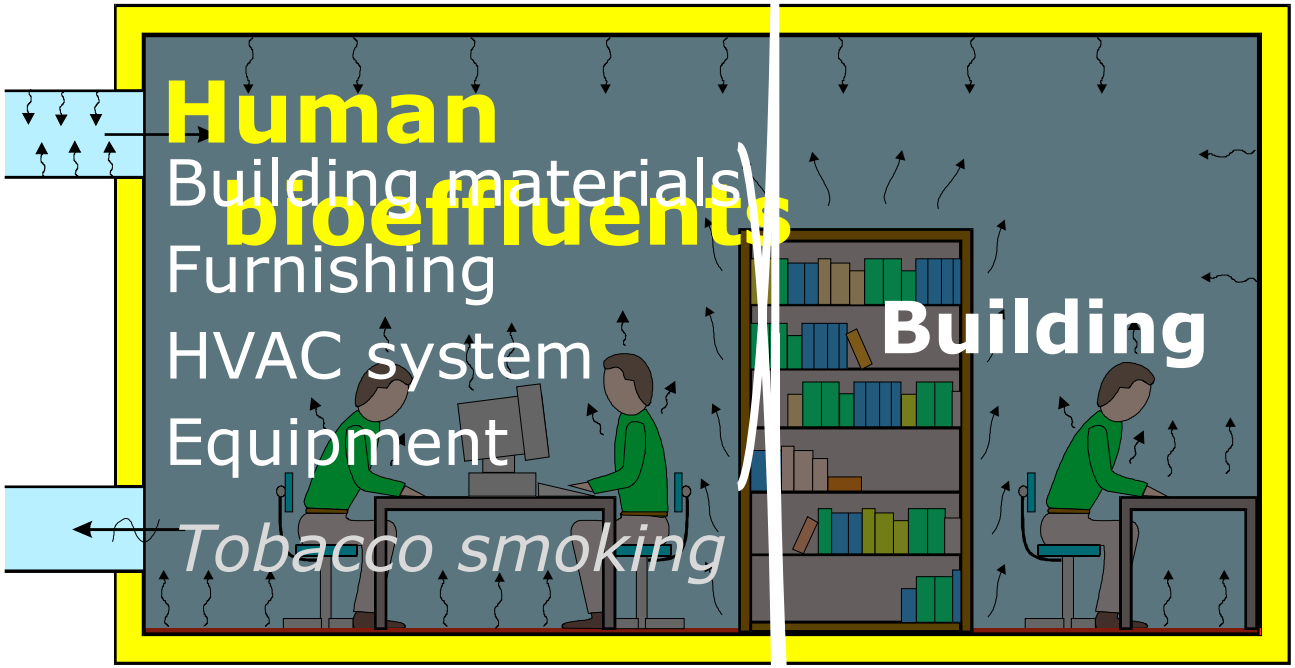
BASIC REQUIRED VENTILATION RATES FOR DILUTING EMISSIONS (BIO EFFLUENTS) FROM PEOPLE FOR DIFFERENT CATEGORIES

Category	Expected Percentage Dissatisfied	Airflow per non-adapted person l/(s.pers)
I	15	10
II	20	7
III	30	4
IV	40	2,5*

*The total ventilation rate must never be lower than 4 l/s per person

ASHRAE Standard 62.1 : Adapted persons 2,5 l/s person (Cat. II)

INDOOR POLLUTION SOURCES



DESIGN VENTILATION RATES FOR DILUTING EMISSIONS FROM BUILDINGS

Category	Very low polluting building l/(s m2)	Low polluting building l/(s m2)	Non low-polluting building l/(s m2)
I	0,5	1,0	2,0
II	0,35	0,7	1,4
III	0,2	0,4	0,8
IV	0,15	0,3	0,6
Minimum total ventilation rate for health	4 l/s person	4 l/s person	4 l/s person

EXAMPLE ON HOW TO DEFINE LOW AND VERY LOW POLLUTING BUILDINGS

SOURCE	Low emitting products for low polluted buildings	Very low emitting products for very low polluted buildings
Total VOCs TVOC (as in CEN/TS 16516)	< 1.000 µg/m³	< 300 µg/m³
Formaldehyde	< 100 µg/m³	< 30 µg/m³
Any C1A or C1B classified carcinogenic VOC	< 5 µg/m³	< 5 µg/m³
R value (as in CEN/TS16516)	< 1.0	< 1.0

EXAMPLE OF DESIGN VENTILATION AIR FLOW RATES FOR A SINGLE-PERSON OFFICE OF 10 M2 IN A LOW POLLUTING BUILDING (UN-ADAPTED PERSON)

Cate-gory	Low-pollutin g building l/(s*m2)	Airflow per non-adapted person l/(s*person)	Total design ventilation air flow rate for the room		
			l/s	l/(s*person)	l/(s* m2)
I	1,0	10	20	2	20
II	0,7	7	14	1,4	14
III	0,4	4	8	0,8	8
IV	0,3	2,5	5,5	0,55	5,5

DEFAULT DESIGN CO2 CONCENTRATIONS ABOVE OUTDOOR CONCENTRATION

ASSUMING A STANDARD CO2 EMISSION OF 20 L/(H/PERSON)

Category	Corresponding CO2 concentration above outdoors in PPM for non-adapted persons
I	550 (10)
II	800 (7)
III	1350 (4)
IV	1350 (4)

SPECIFIC POLLUTANS

The ventilation rate required to dilute a pollutant shall be calculated by this equation:

$$Q_h = \frac{G_h}{C_{h,i} - C_{h,o}} \cdot \frac{1}{\varepsilon_v} \qquad \text{Eq (2)}$$

where:

- Q_h is the ventilation rate required for dilution, in litre per second;
- G_h is the pollution load of a pollutant, in micrograms per second;
- $C_{h,i}$ is the guideline value of a pollutant, see Annex B6 , in micrograms per m^3;
- $C_{h,o}$ is the supply concentration of pollutants at the air intake, in micrograms per m^3;
- ε_v is the ventilation effectiveness

NOTE. $C_{h,i}$ and $C_{h,o}$ may also be expressed as ppm (vol/vol). In this case the pollution load G_h has to be expressed as l/s.

Pollutant	WHO Indoor Air Quality guidelines 2010	WHO Air Quality guidelines 2005
Benzene	No safe level can be determined	-
Carbon monoxide	15 min. mean: 100 mg/m3 1h mean: 35 mg/m3 8h mean: 10 mg/m3 24h mean: 7 mg/m3	-
Formaldehyde	30 min. mean: 100 µg/m3	-
Naphthalene	Annual mean: 10 µg/m3	-
Nitrogen dioxide	1h mean: 200 µg/m3 Annual mean: 40 mg/m3	-
Polyaromatic Hydrocarbons (e.g. Benzo Pyrene A B[a]P)	No safe level can be determined	-
Radon	100 Bq/m3 (sometimes 300 mg/m3, country-specific)	-
Trichlorethylene	No safe level can be determined	-
Tetrachloroethylene	Annual mean: 250 µg/m3	
Sulfure dioxide	-	10 min. mean: 500 µg/m3 24h mean: 20 mg/m3
Ozone	-	8h mean:100 µg/m3
Particulate Matter PM 2,5	-	24h mean: 25 µg/m3 Annual mean: 10 µg/m3
Particulate Matter PM 10	-	24h mean: 50 µg/m3 Annual mean: 20 µg/m3

WHO guidelines values for indoor and outdoor air pollutants

FILTRATION AND AIR CLEANING

- **The influence of position of outdoor air intakes, filtration and air cleaning shall be considered. (EN13779, TR15251)**

- **If filtration and air cleaning is used the following points shall be considered:**
  - Reducing the amount of airborne pollutants (pollens, molds, spores

EXAMPLE OF RECOMMENDED DESIGN CRITERIA FOR THE HUMIDITY IN OCCUPIED SPACES IF HUMIDIFICATION OR DEHUMIDIFICATION SYSTEMS ARE INSTALLED

Type of building/space	Category	Design relative humidity for dehumidification, %	Design relative humidity for humidification, %
Spaces where humidity criteria are set by human occupancy. Special spaces (museums, churches etc) may require other limits	I	50	30
	II	60	25
	III	70	20
	IV	> 70	< 20

EXAMPLES OF LIGHTING CRITERIA FOR SOME BUILDINGS AND SPACES

Ref. no. acc. to EN 12464-1	Type of area, task or activity	$\bar{E}$m lx	UGRL –	Uo –	Ra –	Specific requirements
5.26.2 5.26.5	Offices - Writing, typing, reading, data processing. Conference and meeting rooms	500	19	0,60	80	DSE-work, see 4.9 Lighting should be controllable.
5.36.1-5.36.3	Educational buildings - Classrooms, tutorial rooms, Classroom for evening classes and adults education, Auditorium, lecture halls	500	19	0,60	80	Lighting should be controllable.
5.36.24	Educational premises – Educational buildings - Sports halls, gymnasiums, swimming pools	300	22	0,60	80	See EN 12193 for training conditions.

DAYLIGHT AVAILABILITY CLASSIFICATION AS A FUNCTION OF THE DAYLIGHT FACTOR DCA,J OF THE RAW BUILDING CARCASS OPENING AND DSNA 15193

Vertical Facades Daylight factor DCa,j	**Roof lights Daylight factor DSNA**	**Classification of daylight availability**
DCa,j ≥ 6 %	7 % < D**SNAa**	Strong
6 % > DCa,j ≥ 4 %	7 % > D**SNA** ≥ 4 %	Medium
4 % > DCa,j ≥ 2 %	4 % > D**SNA** ≥ 2 %	Low
DCa,j < 2 %	2 % > D**SNA** ≥ 0 %	None
a Values of DSNA > 10 % should be avoided due to danger of overheating		

NOISE

Building	Type of space	Equivalent Continuous Sound Level, Leq, nT,A [dB(A)]		
		I	II	III
Residential	Living room	≤30	≤34	≤38
	Bed room	≤26	≤30	≤34
Places of assembly	Auditoriums	≤20	≤24	≤28
	Libraries	≤24	≤28	≤32
	Cinemas	≤20	≤24	≤28
Hospitals	Bedrooms night-time	≤22	≤26	≤30
	Bedrooms daytime	≤24	≤28	≤32
Hotels	Hotel rooms (during night-time)	≤24	≤28	≤32
	Hotel rooms (during daytime)	≤26	≤30	≤34
Offices	Small offices	≤24	≤28	≤32
	Landscaped offices	≤26	≤30	≤34
Restaurants	Restaurants	≤28	≤32	≤36
Schools	Classrooms	≤24	≤28	≤32
	Teacher rooms	≤28	≤32	≤36

OCCUPANT SCHEDULES

Office, main

Parameters and setpoints

	Parameter	Value	Unit
Operation time	Hour at day, START	7	hour
	Hour at day, END	18	hour
	Breaks, inside range	0	hours
	days/week	5	days
	hours/day	11	hours
	hours/year	2868	hours
Internal gains	Occupants	17	m2/pers
	Occupants (Total)	8.3	W/m^2
	Occupants (Dry)	5	W/m^2
	Appliances	12	W/m^2
	Lighting		
	Moisture production	3.53	g/(m2, h)
	CO_2 production	1.10	l/(m2, h)
Setpoints	Min T,op in unoccupied hours	16	°C
	Max T,op in unoccupied hours	32	°C
	Min T,op	20	°C
	Max T,op	26	°C
	Ventilation rate (min.)	0.8	l/(s m^2)
	Ventilation rate for CO2 emission	0.53	l/(s m^2)
	Max CO_2 concentration (above outdoor)	500	ppm
	Min. relative humidity	25	%
	Max. relative humidity	60	%
	Lighting, illuminance in working areas	500	lux
Other	Domestic hot water use	100	l/(m2 year)

Usage schedule

	Energy calculation					
	Weekdays			Weekends		
h	Occupants	Appliances	Lighting	Occupants	Appliances	Lighting
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0.2	0.2	0.2	0	0	0
9	0.6	0.6	0.6	0	0	0
10	0.6	0.6	0.6	0	0	0
11	0.7	0.7	0.7	0	0	0
12	0.7	0.7	0.7	0	0	0
13	0.4	0.4	0.4	0	0	0
14	0.6	0.6	0.6	0	0	0
15	0.7	0.7	0.7	0	0	0
16	0.7	0.7	0.7	0	0	0
17	0.6	0.6	0.6	0	0	0
18	0.2	0.2	0.2	0	0	0
19	0	0	0	0	0	0
20	0	0	0	0	0	0
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
*u.r.	0.55	0.55	0.55	0.00	0.00	0.00

* u.r. : Usage rate, summed load factors/usage time

EXAMPLE OF EQUIVALENT INCREASE IN CO2 LEVELS INDOOR FOR THE TOTAL VENTILATION RATES SPECIFIED

Type of building or space	Category	occupancy	ΔCO2 [ppm]		
		person/m2	Very low-polluting	low-polluting	Not low-polluting
Single office	I	0,1	370	278	185
	II	0,1	529	397	265
	III	0,1	926	694	463
	IV	0,1	1389	1010	654
Land-scaped office	I	0,07	317	222	139
	II	0,07	454	317	198
	III	0,07	741	556	347
	IV	0,07	1235	794	483
Conference room	I	0,5	505	463	397
	II	0,5	722	661	567
	III	0,5	1263	1157	992
	IV	0,5	1462	1389	1502
Auditorium	I	1,33	535	517	483
	II	1,33	765	738	690
	III	1,33	1347	1300	1208
	IV	1,33	1576	1398	1576

ADAPTED OR UN-ADAPTED ?

- Conference rooms. Adapted?
- Classrooms. Adapted?
- Restaurants. Un-adapted?
- Department stores. Un-adapted

ADAPTED PERSONS. EXAMPLES OF RECOMMENDED VENTILATION RATES FOR NON-RESIDENTIAL BUILDINGS WITH DEFAULT OCCUPANT DENSITY FOR THREE CATEGORIES OF POLLUTION FROM BUILDING ITSELF

Type of building or space	Cate-gory	Floor area m2/per-son	*qp*		*qB*	*qtot*		*qB*	*qtot*	
			Adapted **qp** according to table B1							
			l/s, m2	l/s,person	l/s,m2	l/s,m2	l/s,person	l/s,m2	l/s,m2	l/s,person
			for occupancy		for very low-polluted building			for low-polluted building		
Conference Class room	I	2	1,75	3,5	0,5	**2,25**	**4,5**	1	**2,75**	**5,5**
	II	2	1,25	2,5	0,35	1,60	(3,2)4	0,7	1,95	(3,9)4
	III	2	0,75	1,5	0,3	1,05	(2,1)4	0,4	1,15	(2,3)4
	IV	2	0,50	1	0,25	0,75	(1,5)4	0,3	0,80	(1,6)4
Auditorium	I	0,75	4,67	3,5	0,5	5,17	(3,9)4	1	**5,67**	**4,3**
	II	0,75	3,33	2,5	0,35	3,68	(2,8)4	0,7	4,03	(3,0)4
	III	0,75	2,00	1,5	0,3	2,30	(1,7)4	0,4	2,40	(1,8)4
	IV	0,75	1,33	1	0,25	1,58	(1,2)4	0,3	1,63	(1,2)4

TRENDS REGARDING EMISSIONS FROM MATERIALS

- **Several national methods for material declarations and certification**
- **Work on establishing common EU concepts**
- **Will give incentives to manufacturer of building materials and furnishing**

TRENDS REGARDING VENTILATION

- **Increasing use of air cleaning**
  - Filtration
  - Gas phase air cleaning
- **Personalized systems for better comfort and energy savings**
- **Demand control ventilation**
  - Occupant precense
  - CO2 sensors
  - Artificial nose

THANK YOU FOR YOU ATTENTION

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