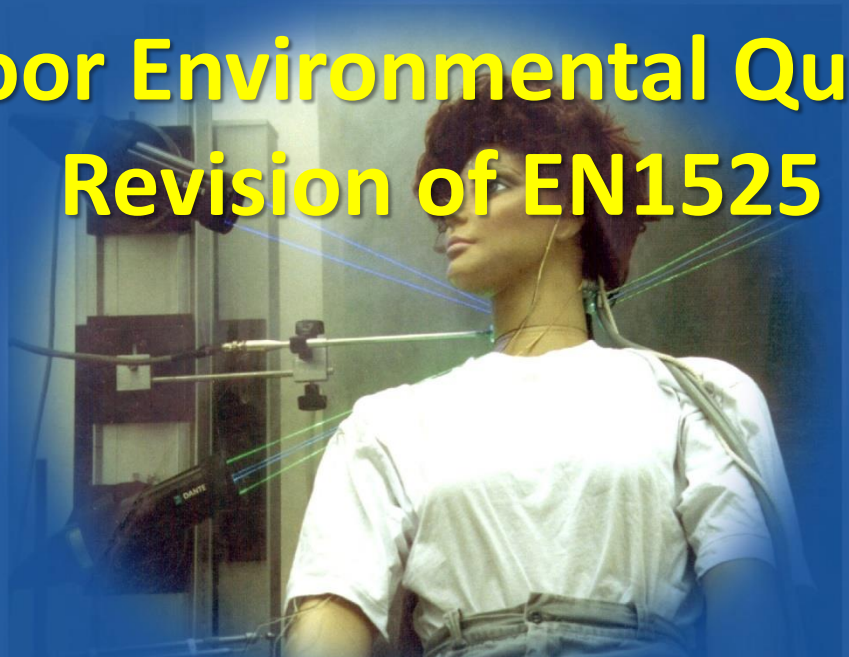
International Centre for Indoor Environment and Energy

Indoor Environmental Quality. Revision of EN1525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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:
  - Guideline for using indoor environmental input parameters for the design and assessment of energy performance of buildings.

Categories

Cate-gory	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

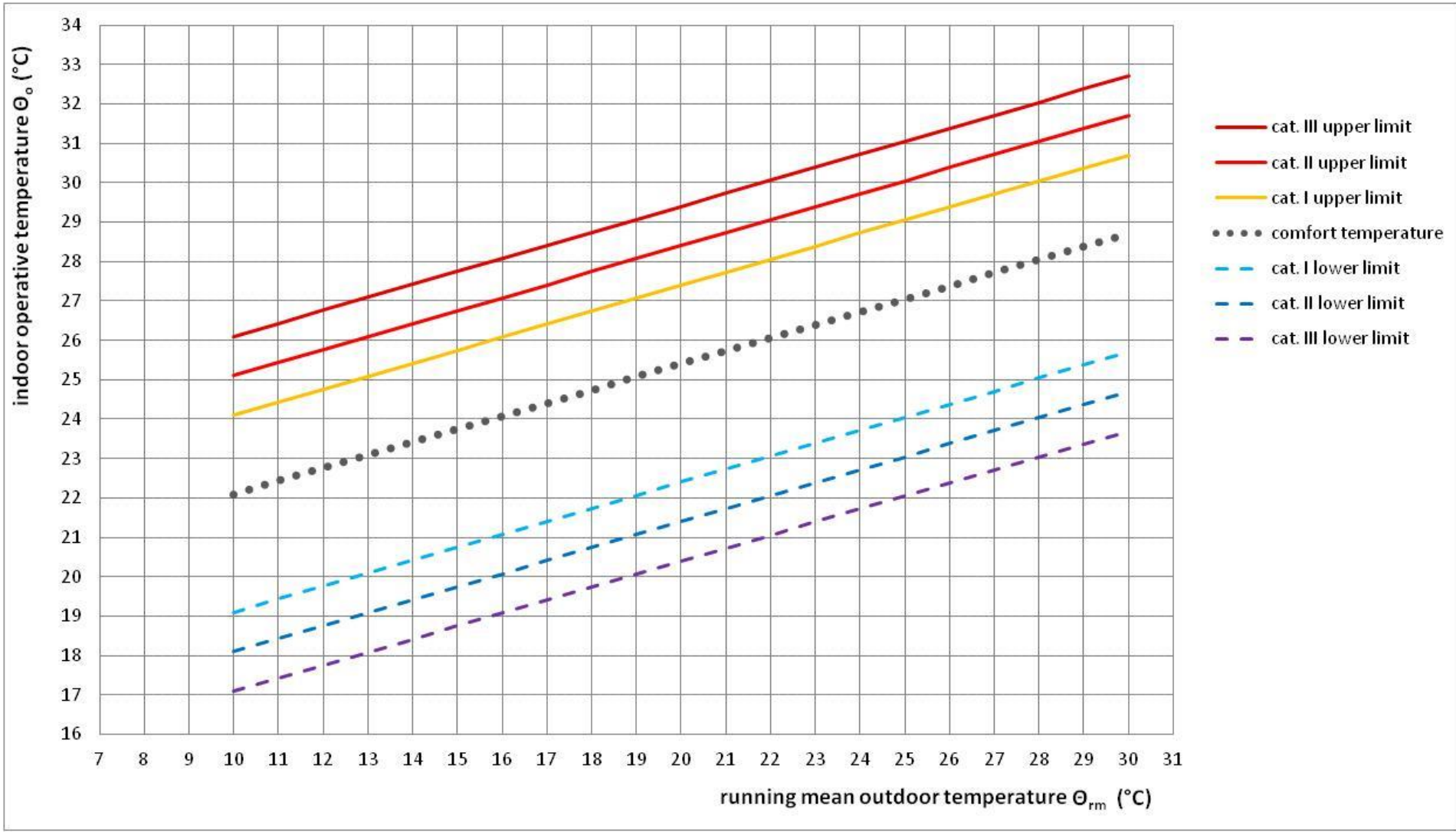
- GENERAL THERMAL COMFORT
  - PMV / PPD, OPERATIVE TEMPERATURE
- LOCAL THERMAL DISCOMFORT
  - Radiant temperature asymmetry
  - Draught
  - Vertical air temperature difference
  - Floor surface temperature

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** ^{o}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



$$\Theta_{rm} = (\Theta_{ed\ -1} + 0{,}8\ \Theta_{ed\ -2} + 0{,}6\ \Theta_{ed\ -3} + 0{,}5\ \Theta_{ed\ -4} + 0{,}4\ \Theta_{ed\ -5} + 0{,}3\ \Theta_{ed\ -6} + 0{,}2\ \Theta_{ed\ -7})/3{,}8$$

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

$$V_{bz} = R_p P_z + R_s S_d + R_a A_z$$

Minimum l/s/Person

Number of People

Ventilation per Smoker

Number of Smokers

Building Area

Minimum l/s/m²

Total ventilation rate

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

$$q_{supply} = q_{tot} / \varepsilon_v$$

- Where
- ε_v = the ventilation effectiveness (EN13779)
- q_{supply} = ventilation rate supplied by the ventilation system
- q_{tot}= total ventilation rate for the breathing zone, l/s
- n = design value for the number of the persons in the room,
- q_p = ventilation rate for occupancy per person, l/s, pers
- A_R= room floor area, m^2
- q_B = ventilation rate for emissions from building, l/s,m^2

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)

Design ventilation rates for diluting emissions from buildings

Category	Very low polluting building l/(s m^2)	Low polluting building l/(s m^2)	Non low-polluting building l/(s m^2)
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 m^2 in a low polluting building (un-adapted person)

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

Default design CO2 concentrations above outdoor concentration assuming a standard CO2 emission of 20 L/(h/person).

Category	Corresponding CO_2 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/m^3 1h mean: 35 mg/m^3 8h mean: 10 mg/m^3 24h mean: 7 mg/m^3	-
Formaldehyde	30 min. mean: 100 µg/m^3	-
Naphthalene	Annual mean: 10 µg/m^3	-
Nitrogen dioxide	1h mean: 200 µg/m^3 Annual mean: 40 mg/m^3	-
Polyaromatic Hydrocarbons (e.g. Benzo Pyrene A B[a]P)	No safe level can be determined	-
Radon	100 Bq/m^3 (sometimes 300 mg/m^3, country-specific)	-
Trichlorethylene	No safe level can be determined	-
Tetrachloroethylene	Annual mean: 250 µg/m^3	
Sulfure dioxide	-	10 min. mean: 500 µg/m^3 24h mean: 20 mg/m^3
Ozone	-	8h mean:100 µg/m^3
Particulate Matter PM 2,5	-	24h mean: 25 µg/m^3 Annual mean: 10 µg/m^3
Particulate Matter PM 10	-	24h mean: 50 µg/m^3 Annual mean: 20 µg/m^3

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, particles, dust) from the outdoor air intake by circulating the air through a filter.
  - Circulating secondary air through a filter or other air cleaning technology to reduce the amount of pollutants in the air
  - Reduce the concentration of odors and gaseous contaminants by circulating the secondary air or recirculating the return air (gas phase air cleaning)

    - Note: Design guidelines on air cleaning and filtration are given in EN13779 and ISO DIS 16814. How to partially substitute outside air by air cleaning is described in TR15251

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

HEALTH CRITERIA FOR VENTILATION

Minimum 4 l/s/person

Table B2.1.4-1 Criteria based on pre-defined ventilation air flow rates: Total ventilation (1), Supply air flow (2) and (3) supplemented by exhaust air flow.

Category	Total ventilation including air infiltration (1)		Supply air flow per. person (2)	Supply air flow based on perceived IAQ for adapted persons (3)		Supply air flow for bedrooms (4)	Exhaust air flow peak or boost flow for high demand l/s		
	l/s,m^2	ach	l/s*per	q_p l/s*per	q_B l/s,m^2	l/s per person	Kitchen (3a)	Bath-rooms (3b)	Toilets (3c)
I	0,49	0,7	10	3,5	0,25	10	28	20	14
II	0,42	0,6	7	2,5	0,15	8	20	15	10
III	0,35	0,5	4	1,5	0,1	4	14	10	7
IV*	0,23	0,4				2,5*	10	6	4

NOTES

Column 3 and 4: The ventilation air flow rates must be available when the rooms are occupied. The design can take into account that not all bedrooms are occupied at the same time, e.g. during daytime

The number of persons in bedroom depends on the size according to design criteria and building regulations

RESIDENTIAL

Category	Supply air flow, l/s				Exhaust air flow, l/s (*)		
	Air change rate (1)	Ventilation per person (2)	Binominal (3)				
	ach (l/s/m^2)	l/s/ person	l/s/person (3a)	l/s/m^2 (3b)	Kitchen	Bathrooms	Toilets
I	0,7 (0,49)	10	3,5	0,25	28	20	14
II	0,6 (0,42)	7	2,5	0,15	20	15	10
III	0,5 (0,35)	4	1,5	0,1	14	10	7
IV	0,4 (0,23)				10	6	4

Notes:

- The values of column (1) refer to internal height of 2,5 m; for different height the coefficient shall be adjusted proportionally, as shown in Table B2.6
- The values of column (1) include the contribution of infiltration
- The ventilation system shall be in any case designed to supply fresh air in the bedrooms when occupied

Daylight availability classification as a function of the daylight factor $D_{Ca,j}$ of the raw building carcass opening and D_{SNA} 15193

Vertical Facades **Daylight factor $D_{Ca,j}$**	**Roof lights** **Daylight factor D_{SNA}**	**Classification of daylight availability**
$D_{Ca,j} \geq 6$ %	7 % < D_{SNA}[a]	Strong
6 % > $D_{Ca,j} \geq 4$ %	7 % > $D_{SNA} \geq 4$ %	Medium
4 % > $D_{Ca,j} \geq 2$ %	4 % > $D_{SNA} \geq 2$ %	Low
$D_{Ca,j} < 2$ %	2 % > $D_{SNA} \geq 0$ %	None
[a] Values of $D_{SNA} > 10$ % should be avoided due to danger of overheating		

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)

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

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

Schedule

- EN 15251rev
  - prEN enquiry May-September 2015
  - Final standard February 2016
- ISO 17772
  - DIS enquery June-October 2015
  - Final standard March 2016