Temperatūra

Siltuma enerģijas ietaupījums ir atkarīgs no iekštelpas temperatūras un līdz ar to nepamatoti augstas iekštelpu temperatūras uzturēšana palielinās ēkas kopējo siltumenerģijas un oglekļa dioksīda (CO_2) patēriņu.

Normatīvo iekštelpas temperatūru Latvijā regulē vairāki būvnormatīvi, piemēram,

- Ministru kabineta noteikumi Nr.596 „**Higiēnas prasības izglītības iestādēm, kas īsteno pirmsskolas izglītības programmas**.” Rīgā 2002.gada 27.decembrī (prot. Nr.60 66.§)
- Noteikumi par Latvijas būvnormatīvu **LBN 231-03 "Dzīvojamo un publisko ēku apkure un ventilācija"**

Normatīvajos aktos ir dotas atsauces uz valsts standartiem (LVS ISO), pēc kuriem ir iespējams precīzi noteikt normatīvo iekštelpu temperatūru. Normatīvā temperatūra svārstās robežās no 170C līdz 210C. Normatīvā temperatūra ir atkarīga ne tikai no telpu izmantošanas mērķiem (auditorija, sporta zāle, darbnīca), bet arī no cilvēku aktivitātes līmeņa un apģērba daudzuma. 1.pielikumā ir pievienota iekštelpu temperatūru klasifikācija saskaņā ar standartu LVS EN 15251.[1; 2]

Vairumā gadījumos, veicot enerģijas ietaupījumu, energouditos kā atskaites punkts tiek izmantoti 18^0C. No praktiskā aspekta tas nozīmē, ka faktiskais siltumenerģijas patēriņš ēkā būs lielāks, jo 18^0C vairumā gadījumos neatbilst komfortablai temperatūrai. Kā arī zemāka iekštelpas normatīvās temperatūras definēšana ir izdevīga ēkas apsaimniekotājam, jo tādējādi projekta pieteikumā tika sasniegts lielāks siltumenerģijas ietaupījums….

Līdz ar to, ja ēkā apkures periodā tiek uzturēta augstāka iekštelpu temperatūra, faktiskais siltumenerģijas patēriņš būs lielāks. Saskaņā ar MK Nr. 39 „Ēkas energoefektivitātes aprēķina metode” [3] nosacījumiem ir jāveic pārrēķins uz normatīvo iekštelpu temperatūru. Tas savukārt nozīmē, ka, izmantojot kā normatīvo temperatūru 18^0C, pie telpu faktiskās temperatūra 20^0C palielinātais enerģijas patēriņš tiek nonivelēts un ēkas enerģijas patēriņa novērtējumā netiek ņemts vērā (skat., 1.att).

1.attēls. Enerģijas patēriņa datu korekcijas

Izmērītais patēriņš telpu apkurei (MWh)	56,00	56,00
Izmērītais patēriņš karstajam ūdenim (MWh)	0,00	0,00
Izmērītais patēriņš apgaismojumam (MWh)	0,00	0,00
Normatīvā iekštelpu temperatūra (°C)	18	20
Apkures dati:		
res dienu skaits novērtējuma periodā apkurei Dapk (-)	203	203
štelpu temperatūra novērtēšanas periodā apkurei (°C)	20,00	20,00
rgaisa temperatūra novērtēšanas periodā apkurei (°C)	0,00	0,00
Normatīvais grādu dienu skaits GDD1 (-)	3654	4060
Grādu dienu skaits novērtēšanas periodā GDD (-)	4060	4060
Koriģētais apkures enerģijas patēriņš Q (MWh)	50,40	56,00

[1] LVS EN 15251:2007 - Telpu mikroklimata (gaisa kvalitātes, temperatūras režīma, apgaismojuma un akustikas) parametri ēku projektēšanai un to energoefektivitātes novērtēšanai.

[2] Metodiskais materiāls finansējuma saņēmējiem satur papildu informāciju par telpu mikroklimatu ietekmējošajiem faktoriem.

[3] 4.3. nodaļa „Enerģijas patēriņa korekcija laika apstākļu dēļ”

Lai pēc iespējas precīzāk novērtētu ēkas faktisko siltumenerģijas patēriņu, ir ieteicams definēt „reālas" normatīvās iekštelpu temperatūras, piem., saskaņā ar 1.pielikuma datiem. Saskaņā ar MK Not., Nr.596 pirmsskolas izglītības iestādēm ir definēta minimālā nevis optimālā iekštelpu temperatūra, līdz ar to LVIF ir visas tiesības monitoringa veikšanai piemērot arī augstāku normatīvo iekštelpu temperatūru.

Taču tādas izmaiņas var nozīmēt arī „spēles noteikumu" maiņu, jo energoauditos vairumā gadījumos aprēķiniem tika izmantota zemākā iekštelpu temperatūra un paaugstināta aprēķina iekštelpu temperatūra nav izdevīga projekta pieticējam, jo apgrūtinās sasniedzamo rezultātu sasniegšanu.

Teorētiski pastāv varbūtība situācijai, kad faktiskais siltumenerģijas patēriņš atbilst projekta datiem, bet, veicot pārrēķinu uz klimatiski koriģētajiem datiem, netiek sasniegti projekta lielumi (attiecas uz gadījumiem, kad telpās tiek uzturēta temperatūra, kas ir zemāka par normatīvo temperatūru).

Jāņem vērā, ka energoneefektīvās ēkās (nesiltinātās) paaugstināta iekštelpu temperatūras uzturēšana ir uzskatāma kā attaisnota, jo ar paaugstinātu temperatūru tiek kompensēts termiskais diskomforts, ko izraisa ārējo norobežojošo konstrukciju (ārsienas, logi) pazemināta virsmas temperatūra.

Savukārt, paaugstinot konstrukciju termisko pretestību, vairāk nav nepieciešams uzturēt paaugstinātu iekštelpu temperatūru, jo ar daudz zemāku temperatūru ir iespējams nodrošināt nepieciešamo cilvēku termālo komfortu.

Par vienu grādu augstākas iekštelpu temperatūras uzturēšana aptuveni par 5% palielina ēkas kopējos siltuma zudumus un CO_2 patēriņu.

1.PIELIKUMS

Energy Performance of Buildings
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More information can be found at the CENSE project website:
www.iee-cense.eu

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Information paper on EN 15251 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

The energy consumption of buildings depends significantly on the criteria used for the indoor environment, which also affect the health, productivity and comfort of the occupants. An energy declaration should always accompany any specification of the indoor environment. The indoor environment is mentioned several times in the EPBD. Firstly, energy-saving measures should not disregard occupants' comfort and health. Secondly, in addition to the energy certificate and actual values for energy consumption, it is recommended that the design values for the indoor environment and indicators of the expected level of environmental comfort should be displayed in the building. The design, energy calculations, performance evaluation and of operating conditions should all be specified in this display.
This information paper describes how design criteria for the indoor environment are to be set when dimensioning systems and for the energy calculations mentioned in the standard (EN15251-2007). The paper highlights some of the new principles used in the standard, such as the definition of different categories of indoor environment, the difference between target values used for dimensioning and for energy calculations, the principles to be used when defining the ventilation rates, and when evaluating of the indoor environment. For dimensioning and energy calculations, different approaches are introduced for mechanically cooled buildings and for buildings without mechanical cooling.
This information paper presents only those concepts that are used in the standard when considering the thermal environment and the indoor air quality, although noise and illumination are also covered by the standard.

1 > Scope of the standard

This European Standard specifies the indoor environmental parameters

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that have an impact on the energy performance of buildings.

The standard specifies how to establish indoor environmental input parameters for building system design and energy performance calculations.

The standard specifies methods for long-term evaluation of the indoor environment by calculation or measurement.

The standard specifies criteria for measurements that can be used if compliance is to be assessed by inspection.

The standard identifies parameters to be used when monitoring and displaying the indoor environment in existing buildings.

This standard is applicable mainly in non-industrial buildings where the criteria for indoor environment concern human occupancy and where the production or process does not have a major impact on the indoor environment. The standard is thus applicable to the following building types: single family houses, apartment buildings, offices, educational buildings, hospitals, hotels and restaurants, sports facilities, wholesale and retail trade service buildings.

The standard specifies how different categories of indoor environmental quality can be used, without requiring that they be used, as this must be specified in national regulations or for individual projects.

The criteria recommended in this standard may also be used in nationally specified calculation methods, which may well differ from the methods referred to in the standard.

The standard does not prescribe design methods, but recommends what input parameters should be used when calculating design indoor temperatures, ventilation rates, illumination levels and acoustical criteria for the design of buildings, heating, cooling, ventilation and lighting systems

The standard does not include criteria for local discomfort factors like draught, radiant temperature asymmetry, vertical air temperature differences or floor surface temperatures.

Several of the criteria are given in different categories as shown in Table 1.

Table 1 Description of the applicability of the categories used

Category	Explanation
I	High level of expectation and is recommended for spaces occupied by very sensitive and fragile persons with special requirements like handicapped, sick, very young children and elderly persons
II	Normal level of expectation and should be used for new buildings and renovations
III	An acceptable, moderate level of expectation and may be used for existing buildings
IV	Values outside the criteria for the above categories. This category should only be accepted for a limited part of the year

2 > Principle of the methods

The standard provides indoor environmental criteria for the design of building and HVAC systems. The thermal criteria (design indoor temperature in winter, design indoor temperature in summer) are used as the **inputs for** heating (EN 12831) and cooling load (EN 15243) calculations and **for dimensioning** the equipment. Ventilation rates are used for dimensioning ventilation systems (Section 6), and lighting levels for the design of lighting systems including the use of daylight.

The design values for dimensioning the building services are needed to fulfil the requirements in Article 4 of the EPBD referring to any possible negative effects of the indoor environment and to give advice on improving the energy efficiency of existing buildings (Article 6) and the heating (Article 8) and cooling (Article 9) of buildings.

The standard provides values for the indoor environment (temperature, ventilation, lighting) as **input for** the calculation of the **energy needs** (building energy needs), when the space is occupied, (EN ISO 13790, EN 15255, EN 15265) (Section 7). It also provides the standardised input values needed for energy calculations such as those specified in Article 3 of the

EPBD.

Output in terms of measured environmental parameters in existing buildings (EN 15203, temperature, indoor air quality, ventilation rates) will make possible an **evaluation** of overall annual energy **performance** (Section 8), which must be included in the display of climatic factors (indoor environment) in the energy performance certificate (Articles 6 and 7 of the EPBD).

Output from room temperature calculations (EN ISO 13791, EN ISO 13792) will make possible an **evaluation** of the annual energy performance of a projected building (Chapter 8), which must be included in the display of climatic factors (indoor environment) in the energy performance certificate (Article 7 of EPBD) when the evaluation is based on calculations (Article 7 of EPBD)

The standard provides methods for making **measurements** of the indoor environment and for using empirically measured data obtained during the inspection of HVAC systems (EN 15240, EN 15239, EN 15378) (Chapter 9). This information should be the basis for any advice on the heating loads and heating systems (Article 8 of the EPBD) and cooling loads and room conditioning systems (Article 9 of the EPBD) of a building.

The standard provides a method for **determining what category** of indoor environmental quality will be achieved (EN 15217) (Section 10). This approach makes it possible to condense complex indoor environmental quality information into a simple classification for inclusion in the energy certificate (Article 7 of the EPBD).

Table 3: Examples of recommended categories for the design of mechanically heated and cooled buildings.

Category	Thermal state of the body as a whole	
	PPD %	Predicted Mean Vote
I	< 6	-0.2<PMV<0.2
II	**< 10**	**-0.5<PMV<0.5**
III	< 15	-0.7<PMV<0.7
IV	> 15	PMV<-0.7; or 0,7<PMV

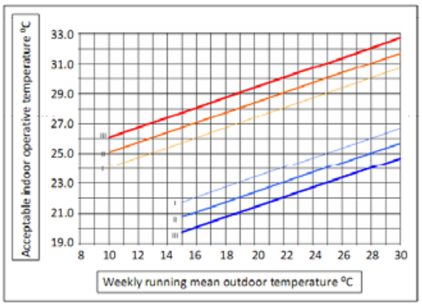

Figure 1: Design values for the indoor operative temperature for buildings without mechanical cooling systems, as a function of the exponentially-weighted running mean of the outdoor temperature . Category I ~ 90 % Category II ~ 80 % Category III ~ 65 % satisfaction

3 > Design criteria for dimensioning

For the design of buildings and the dimensioning of HVAC systems the thermal comfort criteria (minimum room temperature in winter, maximum room temperature in summer) must be used as input for heating load and cooling load calculations. This will guarantee that a minimum-maximum room temperature can be obtained under design outdoor conditions and design internal loads.

In general, nationally specified criteria for the design and dimensioning of systems should be used, but if they are not specified in national regulations, the standard gives recommended design values in informative annexes. The recommended criteria are given for three different categories. Using a higher class with stricter criteria will result in higher calculated design loads and may then result in larger systems and equipment… As an example, thermal design criteria for different types of space are given in Table 2 for buildings with mechanical cooling.

The criteria to be used for kindergartens and department stores are the subject of a detailed discussion. In these types of building, activity levels will not be uniform, as some people will be sedentary, children will be playing and some people will be walking. Clothing insulation values may vary between the different groups of occupants (sales personnel, customers). Other types of building such as hospitals, restaurants, sports facilities and warehouses will have similar problems due to variations in activity level and clothing insulation value between different types of occupant. The temperature ranges are based on general comfort criteria using the PMV-PPD index (Table 3)

Buildings without mechanical cooling

Criteria for the thermal environment in buildings without mechanical cooling may be specified differently from those with mechanical cooling during the warm season, because the expectations of the building occupants and their adaptation to heat stress are strongly dependent on external climatic conditions. As in this case there is no mechanical cooling system to dimension, the different categories of summer temperatures are mainly used as input to the design of the building itself, for example to prevent overheating by using solar shading, increasing the thermal capacity of the building, altering the design, orientation and opening of windows etc. Based on a running average outside air temperature, recommended criteria for the indoor temperature are given in Figure 1. This diagram has been validated only for office buildings with operable windows under occupant control

Table 2 Examples of recommended design values of the indoor temperature for the design of buildings and HVAC systems

Type of building/ space	**Category**	**Operative temperature °C**	
		Heating (winter season), ~ 1,0 clo	**Cooling (summer season), ~ 0,5 clo**
Residential buildings: living spaces (bedrooms, drawing rooms, kitchen etc) Sedentary ~ 1,2 met	I	21,0	25,5
	II	20,0	26,0
	III	18,0	27,0
Residential buildings: other spaces: boxrooms, halls, etc) Standing-walking ~ 1,6 met	I	18,0	
	II	16,0	
	III	14,0	
Single and Landscaped offices, conference rooms, Auditoriums Sedentary ~ 1,2 met	I	21,0	25,5
	II	20,0	26,0
	III	19,0	27,0
Cafeterias/Restaurants Sedentary ~ 1,2 met	I	21,0	25,5
	II	20,0	26,0
	III	19,0	27,0
Classrooms Sedentary ~ 1,2 met	I	21,0	25,0
	II	20,0	26,0
	III	19,0	27,0
Kindergarten Standing/walking ~ 1,4 met	I	*19,0*	*24,5*
	II	*17,5*	*25,5*
	III	*16,5*	*26,0*
Department store Standing-walking ~ 1,6 met	I	*17,5*	*24,0*
	II	*16,0*	*25,0*
	III	*15,0*	*26,0*

For the design of ventilation systems and the calculation of heating and cooling loads, the required ventilation rate must be specified in the design documents, either based on national requirements or using the recommended methods in this standard. In the design and during operation, the main sources of pollutants should be identified and eliminated or decreased by any feasible means. Local exhausts and ventilation must then be able to deal with the remaining pollution. Air cleaning devices can also be used to remove pollutants from the room air in order to improve the air quality. The ventilation rates for acceptable indoor air quality are independent of season.

In EN15251, different methods for calculating the recommended ventilation rate are included. As a minimum spaces must be ventilated to dilute the bioeffluents from the occupants (people component, q_p). In addition, the rate must be increased to take into account emissions from the building and systems (q_B). One method is to add these values as shown in Table 3 for the different categories. The people part depends on the occupant density and the building part depends on the type of building.

Table 3 Recommended ventilation rates for non-residential buildings with default occupant density for two categories of pollution from the building itself. If smoking is allowed the last column gives the additional required ventilation rate

Type of building or space	Ca-te-go-ry	Floor area m^2/pe r-son	q_p	q_B	q_{tot}	q_B	q_{tot}	q_B	q_{tot}
			l/s, m^2 people	l/s,m^2 very low-polluted building		l/s,m^2 low-polluted building		l/s,m^2 non-low polluted building	
Single office	I	10	1,0	0,5	1,5	1,0	2,0	2,0	3,0
	II	**10**	**0,7**	**0,3**	**1,0**	**0,7**	**1,4**	**1,4**	**2,1**
	III	10	0,4	0,2	0,6	0,4	0,8	0,8	1,2
Land-scaped office	I	15	0,7	0,5	1,2	1,0	1,7	2,0	2,7
	II	**15**	**0,5**	**0,3**	**0,8**	**0,7**	**1,2**	**1,4**	**1,9**
	III	15	0,3	0,2	0,5	0,4	0,7	0,8	1,1
Confe-rence room	I	2	5,0	0,5	5,5	1,0	6,0	2,0	7,0
	II	**2**	**3,5**	**0,3**	**3,8**	**0,7**	**4,2**	**1,4**	**4,9**
	III	2	2,0	0,2	2,2	0,4	2,4	0,8	2,8
Audito-rium	I	0,75	15	0,5	15,5	1,0	16	2,0	17
	II	**0,75**	**10,5**	**0,3**	**10,8**	**0,7**	**11,2**	**1,4**	**11,9**
	III	0,75	6,0	0,2	0,8	0,4	6,4	0,8	6,8
Restau-rant	I	1,5	7,0	0,5	7,5	1,0	8,0	2,0	9,0
	II	**1,5**	**4,9**	**0,3**	**5,2**	**0,7**	**5,6**	**1,4**	**6,3**
	III	1,5	2,8	0,2	3,0	0,4	3,2	0,8	3,6
Class room	I	2,0	5,0	0,5	5,5	1,0	6,0	2,0	7,0
	II	**2,0**	**3,5**	**0,3**	**3,8**	**0,7**	**4,2**	**1,4**	**4,9**
	III	2,0	2,0	0,2	2,2	0,4	2,4	0,8	2,8

4 > Indoor environmental parameters for energy calculations

As the energy calculations may be performed on a seasonal, monthly or hourly basis (dynamic simulation), the indoor environment must be specified accordingly.

For seasonal and monthly calculations, the same values of indoor temperature as for design (dimensioning) of the heating and cooling systems should be used (Table 2) for each category of indoor environment.

In dynamic simulations, the energy consumption is calculated on an hourly basis. Recommended values for the acceptable range of indoor temperature for heating and cooling are based on an acceptable range for the PMV-index. An example is shown in Table 4. The midpoint of the temperature range should be used as a target value but the indoor temperature may fluctuate within the range due to the energy- saving features or the control algorithm.

If the cooling power is limited (mixed mode buildings) the excess indoor temperatures must be estimated using one of the methods in the standard.

Table 4 Temperature ranges for hourly calculation of cooling and heating energy in three categories of indoor environment

Type of building or space	Category	Temperature range for heating, °C Clothing ~ 1,0 clo	Temperature range for cooling, °C Clothing ~ 0,5 clo
Offices and spaces with similar activity (single offices, open-plan offices, conference rooms, auditoriums, cafeterias, restaurants, classrooms (activity ~1,2 met)	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

Thermal environment in buildings without mechanical cooling

For heating, the same lower temperature limits apply as for mechanically cooled buildings. As in this case there is no mechanical cooling, no energy will be used for cooling and the upper limit in Figure 1 has no impact. It may, however, be recommended to calculate how often and by how much the recommended temperature range is likely to be exceeded.

Indoor air quality and ventilation

For energy calculations, the ventilation rates during the hours of operation of the ventilation system are usually the same as those specified for design load calculations and for dimensioning the ventilation system.

5 > Evaluation of the indoor environment

As the loads of a building vary both spatially and temporally, the designed system may not be able to fulfil the design intent in all rooms at all times. The long-term performance of a building in terms of the indoor environment must be assessed. The standard specifies indicators for such an evaluation and describes their use. The indoor environment of a building is evaluated in terms of the indoor environment of typical rooms representing different zones in the building. Such an evaluation can be based on design, on empirical measurements or on calculations. As the criteria are based on instantaneous values, variations outside the recommended range may be acceptable for short periods during any given day. It is recommended that for 3 to 5% of working hours the calculated or measured values can be permitted to be outside the range. The figure of 3 to 5% may be applied to daily (15-25 minutes during a working day), weekly (24-120 working minutes) and yearly (50-100 working hours) periods.

Finally, the standard discusses methods to be used for an overall evaluation of the indoor environment, which may eventually be included in an indoor environmental certificate.

6 > References

1. EN 15251, Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics, May 2007

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