

## **ATTACHMENT 16**

### **LEGISLATION, STANDARDS AND NORMS FOR COMFORT STANDARDS IN EDUCATIONAL BUILDINGS WITH A FOCUS ON KINDERGARTEN FACILITIES**

**Legislation, standards, and norms for  
comfort standards and implementation of measures in  
educational buildings with a focus on kindergarten  
facilities of the City of Ljubljana**

**– requirements and recommendations –**

Kindergartens of the City of Ljubljana

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## **1 INTRODUCTION, DEFINITIONS**

The development of new business models in the field of sustainable construction has led to increasing recognition that it is possible to cover the investments of constructing new buildings or retrofitting existent buildings with the inclusion of external providers of finance. In this respect, two mechanisms come into play: the public-private partnership and ESCO companies.

To achieve high motivation and gain confidence of owners/users of buildings in the events of public investments and public-private partnerships, it is necessary to ensure savings as well as long-term quality and appropriate comfort standards. Thus, we can achieve a combination of sustainable construction that balances the objectives of ensuring savings and living conditions.

This is especially true for kindergarten facilities, as they accommodate children, who are much more sensitive than adults.

Comfort standards in buildings are determined by the legislation, legislative acts, statutory instruments, standards, and expert recommendations. In addition to the general requirements, the kindergarten facilities are subject to further, specific requirements which must be taken into account at the planning of the measures for energy retrofitting.

## **2 REQUIREMENTS AND RECOMMENDATIONS**

The following describes the requirements of the user, as well as guidelines shaped by the development of the profession and good practice.

Since the energy retrofitting of buildings does not always include deep energy retrofit, the planning and implementation phase demands for reasonable employment of requirements and recommendations relating to measures. In doing so, it is of course necessary to consider the interaction of the measures. For example, replacing windows does not only influence the reduction of heat conduction of the outer shell, thus providing a better thermal comfort, but also contributes to a reduction of ventilation heat loss, which, on the other hand, means less fresh air, and consequently requires special attention.

Naturally, all requirements apply in so far as the measures are implemented, and in so far as they present an impact on the comfort standards.

## **3 THE PRINCIPLES OF SUSTAINABLE CONSTRUCTION AND COMFORT STANDARDS**

In several areas, the Slovenian legislation defines requirements that have a direct impact on the comfort standards. For a better orientation, the attachments summarise the relevant section from the legislation.

In addition to the aforementioned, it is reasonable to add recommendations in the form of two comprehensible approaches or areas, which allow an insight into the wider implementation of sustainable construction and provision of comfort standards. These include the German Guideline for Sustainable Building ("Leitfaden Nachhaltiges Bauen"), BMVBS (translated by the Slovenian Chamber of Engineers, House of Architecture, Slovenian National Building and Civil Engineering Institute, and Green Building Council Slovenia in 2013), and the 25 Principles of Building Biology ("25 Grundregeln der Baubiologie") of the Institute for Building Biology, Rosenheim, Germany ([www.baubiologie.de](http://www.baubiologie.de)).

Understandably, partial measures of energy retrofitting of buildings do not provide improvement of all aspects of comfort standards, yet it is necessary to strive for deep energy retrofit.

## **4 MEASURING BASIC PARAMETERS OF COMFORT STANDARDS**

Compliance with the requirements set out in the legislation is mandatory; however, generally, measurements may be conducted in order to fulfil these requirements.

Compliance with certain basic requirements must be supported by continuous measurements and access to data history. These include monitoring the room temperature during kindergarten operation hours. At least one thermometer must be placed on each surface area of 500 m<sup>2</sup>, and temperature readings must be recorded each day between 6:00 and 7:00 in the morning, and 12:00 and 13:00 in the afternoon. The temperature readings may be recorded on a sheet of paper by hand (monthly data archiving) or in a digital form, whereby the users (childcare workers and kindergarten management) must have convenient access to the readings.

When it comes to other measurements defined in the legislation, it is necessary to follow the guidelines of the relevant legislation.

Generally, measurements are carried out by qualified and accredited institutions or experts from Slovenia. Reports must be prepared in the Slovenian language or translated by a court interpreter.

The requirements summarise the legislation of the subject area and must not contradict regulations, but may be more severe. In the event that the requirements are stricter than the law, the stricter requirements apply.

Insofar as the values set forth by the legislation are stricter than those provided by this document, the stricter requirements apply. In the event that the general rules applicable in the field of comfort standards are less strict, or in the event of inconsistencies among the provisions of the relevant Chapter 8 (comfort standards), the provisions of the more specific regulation (rules on norms for pre-school institutions) shall apply.

## **5 SUMMARY OF KEY REQUIREMENTS FOR ACHIEVING COMFORT STANDARDS**

### **5.1 Thermal comfort**

#### General recommendations

Projected or measured human thermal comfort shall be expressed in accordance with the requirements of the standard ISO 7730 (points 3.1 and 4). If clothing and activity are not defined, the values for clothing shall, in average, amount to 0.5 clo (0.078 m<sup>2</sup> K/W) during cooling season, and 1.0 clo (0.155 m<sup>2</sup> K/W) during heating season at activities of 1.2 met (seated).

Thermal environment must comply with PPD index of less than 15% and PMV index within  $-0.75 < PMV < +0.7$ .

Optimal operative temperature as a function of clothing and activity of the user of space shall be determined in accordance with CR 1752, Figure A.2, Category C.

#### **5.1.1 Air temperature, radiant temperature**

Key requirements (after special provisions of rules on norms for pre-school institutions):

5.1.1.1 Areas for children should be evenly heated as follows:

- 20 °C in areas for children,
- 23 °C in child care rooms (children to age 3),
- 18–19 °C in gymnasium.

Other requirements and recommendations:

5.1.1.2 Other rooms (administrative rooms); air temperature:

- during cooling season 22–26 °C, recommended 23–25 °C.
- during heating season 19–24 °C, recommended 20–22 °C.

- 5.1.1.3 Required air temperatures in ancillary rooms during heating season are listed in the table below.

#### TEMPERATURE IN ANCILLARY ROOMS DURING HEATING SEASON

Space	Air temperature [°C]
Changing room	21
Bathroom	24
Washroom	21
Toilet	18
Sleeping room	21
Room for employees on duty	21
First aid room	21
Nursing room	24
Warming area for employees	21
Area for drying, cleaning, and disinfection of personal protective equipment	21

- 5.1.1.4 Minimum requirements for ventilation systems (applicable in the presence of installed artificial ventilation):

Type of building/space	Metabolic rate	Space per person	Perceived temperature	
	met	person/m <sup>2</sup>	cooling °C	heating °C
Individual office	1.2	0.1	24.5 ± 2.5	22.0 ± 3.0
Shared office	1.2	0.07	24.5 ± 2.5	22.0 ± 3.0
Conference hall	1.2	0.5	24.5 ± 2.5	22.0 ± 3.0
Auditorium	1.2	1.5	24.5 ± 2.5	22.0 ± 3.0
Classroom	1.2	0.5	24.5 ± 2.5	22.0 ± 3.0
Kindergarten	1.4	0.5	23.5 ± 2.5	20.0 ± 3.5

- 5.1.1.5 Vertical air temperature difference between head and ankles for a seated person 0.1–1.1 m above floor shall be less than 3 K, for all other instances it shall be less than 4 K.

- 5.1.1.6 Floor surface temperature range shall be 17–26 °C, and up to 29 °C with underfloor heating system (exceptions consisting of rooms with non-continuous presence and spaces with a special intended function);

additionally, it must be taken into account that:

5.1.1.7 the maximum heat transfer coefficient for transparent parts of the building envelope is equal to  $k = 0.35 \text{ W/m}^2 \text{ K}$ .

5.1.1.8 Maximum radiant temperature asymmetry shall amount to:

- cold wall:  $< 13 \text{ }^{\circ}\text{C}$ ,
- warm wall:  $< 35 \text{ }^{\circ}\text{C}$ ,
- cold ceiling:  $< 18 \text{ }^{\circ}\text{C}$ ,
- warm ceiling:  $< 7 \text{ }^{\circ}\text{C}$ .

5.1.1.9 In the cooling season, the design of the building and sun shields must prevent exposure of the occupied zone to direct solar radiation.

5.1.1.10 Optimal operative temperature as a function of clothing and activity of the user of space shall be determined in accordance with CR 1752, Figure A.2, Category C.

### **5.1.2 Relative humidity**

Key requirements:

5.1.2.1 Requirement for all buildings: at air temperature of  $20\text{--}26 \text{ }^{\circ}\text{C}$  the permissible relative humidity amounts to  $30\text{--}70\%$ .

5.1.2.2 Key requirements (after special provisions of rules on norms for pre-school institutions): in premises for children the relative humidity shall amount to  $40\text{--}60\%$ .

5.1.2.3 The humidity of a room must not directly or indirectly influence health and well-being of occupants, and must not cause condensation on walls.

5.1.2.4 Relative humidity of supplied air shall not be below  $30\%$ .

5.1.2.5 Humidification chambers, filters, preheaters, and reheaters must be controlled in accordance with the state of humidity. Relative humidity of air in the system shall not exceed  $90\%$ .

### **5.1.3 Air velocity**

Key requirements (after special provisions of rules on norms for pre-school institutions):

5.1.3.1 Premises for children must have ventilation in accordance the applicable technical regulations, while the speed of movement of the air shall not exceed  $0.2 \text{ m/s}$ .



5.1.3.2 Minimum requirements for ventilation systems:

Type of building/space	Metabolic rate	Space per person	Maximum mean air velocity	
			cooling m/s	heating m/s
	met	person/m <sup>2</sup>		
Individual office	1.2	0.1	0.25	0.21
Shared office	1.2	0.07	0.25	0.21
Conference hall	1.2	0.5	0.25	0.21
Auditorium	1.2	1.5	0.25	0.21
Classroom	1.2	0.5	0.25	0.21
Kindergarten	1.4	0.5	0.24	0.19

Other requirements and recommendations:

5.1.3.3 Recommended mean air velocity:

- during heating or cooling 0.15 m/s,
- at other times 0.2 m/s.

5.1.3.4 In the presence of artificial ventilation (not required with natural ventilation):

Quantity of (outside) air intake shall be adjusted according to actual needs regarding space per person and time/duration of occupancy of premises.

Due to energy savings, the buildings or parts of buildings where artificial ventilation is present and where the ACH of the occupied zone or entire room is higher than  $n > 0.7 \text{ h}^{-1}$ , are fitted with devices for generating heat from exhaust or waste air. The devices for generating heat from exhaust or waste air must be  $\eta > 65\%$  effective (in project conditions), except:

- $\eta \geq 50\%$  with installation of plate heat and air flow exchanger  $> 15,000 \text{ m}^3/\text{h}$ ,
- $\eta \geq 45\%$  with installation of plate heat and air flow exchanger  $\leq 15,000 \text{ m}^3/\text{h}$  or a heat pipe,
- $\eta \geq 40\%$  with installation of lamel type heat exchangers or in the event of occasional operation of ventilation device (max. 150 hours per year).

5.1.3.5 When installing artificial ventilation, it is necessary to comply with the following air exchanges in ancillary rooms:

AIR CHANGE RATE IN ANCILLARY ROOMS

Space	Air changes per hour
Changing room	1
Bathroom	5
Washroom	1
Toilet	4–8
Sleeping room	1
Room for employees on duty	1
First aid room	1
Nursing room	1
Warming area for employees	2
Area for drying, cleaning, and disinfection of personal protective equipment	as calculated

## **5.2 Air quality**

### **5.2.1 Indoor air quality**

Since the energy retrofitting implements measures that influence the quality of indoor air, it is necessary to take the following requirements into account:

5.2.1.1 The parameters of the thermal environment and air quality, air flow, characteristics of electrical appliances, and other projected data must be tested with air flow which corresponds to projected and anticipated values. When testing the system, the following deviations from the measured values are acceptable:

- air quantity for individual room:  $\pm 20\%$ ;
- air quantity for individual system:  $\pm 15\%$ .

5.2.1.2 During planning, equipping, and maintenance of workplaces, it is necessary to use ventilation or air conditioning system in the event that:

- the size of room is such that natural ventilation is not possible;
- the room is more than 2 m below the surrounding terrain;
- the surrounding buildings are at a sufficient distance;
- due to the production nature, the workspace is windowless with high temperature levels and harmful emissions.

### 5.2.2 Fresh air quantity

The guaranteed air quantity in kindergartens shall equal 10.1 m<sup>3</sup>/hm<sup>2</sup>.

Type of building/space	Metabolic rate	Space per person	Air quantity
	met	person/m <sup>2</sup>	m <sup>3</sup> /hm <sup>2</sup>
Individual office	1.2	0.1	2.9
Shared office	1.2	0.07	2.5
Conference hall	1.2	0.5	8.6
Auditorium	1.2	1.5	23.0
Classroom	1.2	0.5	8.6
Kindergarten	1.4	0.5	10.1

Due to other, non-low-carbon buildings, it is important to follow 8.7 m<sup>3</sup>/hm<sup>2</sup> in kindergartens, as indicated by the table below.

Type of building/space	Space per person	Minimum air quantity (for persons)	Minimum additional air quantity (for buildings)	
	person/m <sup>2</sup>	m <sup>3</sup> /hm <sup>2</sup>	Low-carbon building m <sup>3</sup> /hm <sup>2</sup>	Non-low-carbon buildings m <sup>3</sup> /hm <sup>2</sup>
Individual office	0.1	1.5	1.4	2.9
Shared office	0.07	1.1	1.4	2.9
Conference hall	0.5	7.2	1.4	2.9
Auditorium	1.5	21.6	1.4	2.9
Classroom	0.5	7.2	1.4	2.9
Kindergarten	0.5	8.7	1.4	2.9

### 5.2.3 Maximum concentrations of indoor air pollutants

#### 5.2.3.1 Maximum concentrations of indoor air pollutants

Maximum concentration of carbon dioxide (CO<sub>2</sub>), where the concentrations include CO<sub>2</sub> in outside air (700 µg/m<sup>3</sup>) and human CO<sub>2</sub> emissions, amounts to 3,000 µg/m<sup>3</sup>, i.e. approximately 1,667 ppm.

The following table lists CO<sub>2</sub> values as well as other maximum concentrations of indoor air pollutants.

		Unit	Maximum concentration
Carbon dioxide	(CO <sub>2</sub> )	mg/m <sup>3</sup>	3,000
Radon**	(Rn)	Bq/m <sup>3</sup>	400
Ammonia and amines***	(NH <sub>3</sub> )	µg/m <sup>3</sup>	50
Formaldehyde	(H <sub>2</sub> CO)	µg/m <sup>3</sup>	100
Volatile organic compounds****	(VOC)	µg/m <sup>3</sup>	600
Carbon monoxide	(CO)	µg/m <sup>3</sup>	10
Ozone	(O <sub>3</sub> )	µg/m <sup>3</sup>	100
Suspended particulate/PM <sub>10</sub> concentrations*****		µg/m <sup>3</sup>	100

5.2.3.2 Maximum levels for occupational exposure, i.e. maximum levels of hazardous chemical substances for occupational exposure are as follows:

- carbon dioxide (CO<sub>2</sub>) – maximum level: 9,000 mg/m<sup>3</sup> or 5,000 ml/m<sup>3</sup> (ppm);
- carbon monoxide (CO) – maximum level: 35 mg/m<sup>3</sup> or 30 ml/m<sup>3</sup> (ppm).

5.2.3.3 Noxious airborne levels must not exceed the values of the standard CR 1752, Annex E.

5.2.3.4 When people are present in the work and living premises of the building, it is necessary to achieve minimum air change rate (n) of n = 0.5 h<sup>-1</sup>. The applied ventilation system must prevent the flow of air from the areas with a higher pollution load (e.g. kitchen, toilet, bathroom, garage, laboratory, etc.) to other premises of the building.

5.2.3.5 The minimum external air supply is 15 m<sup>3</sup>/h per person in areas where smoking is not allowed, without taking into account other sources of indoor air pollution and at the ventilation efficiency rate of one (1).

5.2.3.6 During the absence of people from the work and living premises of the building, it is necessary to ensure and maintain the minimum air change rate of n = 0.2 h<sup>-1</sup> to effectively remove any emissions of the building and to prevent other harmful effects (e.g. condensation).

5.2.3.1 During planning, equipping, and maintenance of workplaces, it is necessary to ensure that the work area, where there are no other pollutants other than persons present, is ventilated by a ventilation system or air-conditioning, which delivers the following quantities of air:

- 20–40 m<sup>3</sup>/h per person performing work in sitting position;
- 40–60 m<sup>3</sup>/h per person performing work in standing position;
- more than 65 m<sup>3</sup>/h per person performing heavy physical work.

#### **5.2.4 Prohibited use of materials containing hazardous substances**

In construction, ordinary or major maintenance, purchase or installation of devices and products the following materials must not be used:

5.2.4.1 products containing sulphur hexafluoride (SF<sub>6</sub>),

5.2.4.2 indoor paints and varnishes containing volatile organic compounds with a maximum boiling point of 250 °C in amounts of more than:

- 30 g/l, without water, for wall paints;
- 250 g/l, without water, for other paints with a minimum spreading rate of 15 m<sup>2</sup>/l at a hiding power of 98%;
- 180 g/l, without water, for all other products, including paints, with a maximum spreading rate of 15 m<sup>2</sup>/l, varnishes, woodstains, floor coatings, and floor paints;

5.2.4.3 wood-based materials where formaldehyde emissions exceed the requirements for the emission class E1, as defined by the standards BS EN 300, BS EN 312, BS EN 622, BS EN 636, BS EN 13986;

5.2.4.4 Volatile organic compound emissions in building products must not exceed the values set out in the European standards BS EN ISO 16000-9, BS EN ISO 16000-10, BS EN ISO 16000-11, or an equivalent standard.

### **5.3 Acoustic (sound) comfort**

Acoustic comfort in buildings (especially kindergartens) is achieved by providing high quality speech perception and sound, and reducing noise to a level where it is no longer disturbing. Requirements for the provision of an appropriate quality of speech perception are obtained by an analysis of the room acoustics and by installing appropriate materials or construction products. Requirements for proper insulation against noise are achieved by implementing appropriate noise protection to eliminate noise from the environment, neighbouring premises, and systems in buildings. Since energy retrofitting includes measures that affect the acoustic comfort, it is necessary to take into account the following requirements:

### 5.3.1 Protection against outdoor noise

- 5.3.1.1 Sound insulation of exterior and internal separation elements must be suitable: the maximum equivalent continuous noise level in specific rooms (playroom, classroom, etc.) must not exceed  $L_{Aeq} = 35$  dB in specific periods of the day. Should the data on noise levels be unavailable for the area of the building, the sound insulation calculations for external separation structures of the building shall follow the maximum general environmental noise indicator limit values in Table 1.

Table 1

Noise protection zones	$L_{day}$ [dB(A)]
Zone IV	21
Zone III	60
Zone II	55
Zone I	50

- 5.3.1.2 Testing laboratory measured sound insulation capacity ( $R_w$ ) of windows and balcony doors must be 2 dB higher than the value for windows and balcony doors installed into a building ( $R'_w$ ).
- 5.3.1.3 To obtain the window sound insulation capacity of at least 30 dB, gaps must be sealed with at least one permanently elastic seal set in a single plane along the entire length of the gap. It is important to stress that, when using a single seal set in a single plane in double pane and double casement windows, the seal must be set on the outside of the gap. To obtain the window sound insulation capacity of over 35 dB, gaps must be sealed with at least two seals set in two planes along the entire length of the gap.
- 5.3.1.4 Appropriately sealing the junction between the window frame and the building structure is equally important as the sealing of window gaps. The junction between the window frame and the building structure must be made in such a way as not to influence the sound insulation capacity of the window. Types of junctions typical for different window sound insulation classes are shown, for instance, in the VDI 2719 guideline.
- 5.3.1.5 Where ventilation ducts, allowing rooms to be ventilated while windows are closed, are built into a façade wall, sound transmission through the ventilation ducts must be taken into account in determining the total sound insulation capacity of the façade. As the sound insulation capacity of ventilation ducts is low due to air openings, sound damped ventilation ducts should be used, in which sound is absorbed on its way through the openings by sound-absorbent materials (such as glass fibre fleece covered rockwool or similar materials).
- 5.3.1.6 When installing ventilation ducts, uncontrolled sound transmission through the junctions between the ventilation duct and window elements and between ventilation ducts and building structure should be prevented.

### **5.3.2 Insulation of internal separation structures against airborne noise**

In maintenance works on internal separation structures (load-bearing walls and partitions, floor constructions, etc.), it is necessary to follow the requirements set out in this chapter in order to ensure sufficient sound insulation.

- 5.3.2.1 Maximum exposure levels and peak sound pressure levels for a nominal 8-hour working day are, separately:  $L(EX, 8h) = 87 \text{ dB(A)}$  and  $p(\text{peak}) = 200 \text{ Pa}$  (140 dB(C) given the reference sound pressure of 20  $\mu\text{Pa}$ ).



5.3.2.2 Airborne sound insulation and maximum impact sound pressure levels for individual internal separation structures – depending on the intended use of the rooms these constructions separate – must meet the minimum values indicated in the table below. These values refer to a set of internal separation elements which form separating constructions. Classrooms include lecture halls, playrooms, and similar rooms for educational activities.

Ref. no.	Function of separation structure	Insulation (dB)	
		$R'_w$	
9.1	Wall between classrooms, wall between a classroom and a study, wall between a classroom and a room with other intended use	$R'_w$	52
9.2	Wall between studies, wall between laboratories	$R'_w$	48
9.3	Wall between a classroom and a room with other intended use or different users' rooms	$R'_w$	57
9.4	Wall between a classroom or study and a noisy classroom, a room with other intended use or different users' rooms	$R'_w$	60
9.5	Door between a classroom or study and a hallway	$R'_w$	27
9.6	Door between a classroom or study and a hallway in higher education and university buildings	$R'_w$	37
9.7	Wall between a classroom or study and a hallway – wall with an installed door (wall only)	$R'_w$	47
9.8	Wall between a classroom or study and a hallway in higher education and university buildings – wall with an installed door (wall only)	$R'_w$	52
9.9	Wall with no door between a classroom or study and a hallway or staircase	$R'_w$	52
9.10	Wall adjoining a quieter engine room	$R'_w$	57
9.11	Wall adjoining a noisy engine room	$R'_w$	Article 6
9.12	All floors except for those listed under sequence numbers 8.12, 8.13, 8.14 and 8.15	$R'_w$	52
		$L'_{n,w}$	58
9.13	Floor between a classroom or study and a noisy classroom below them	$R'_w$	60
		$L'_{n,w}$	58
9.14	Floor between a classroom or study and a noisy classroom above them	$R'_w$	60
		$L'_{n,w}$	43
9.15	Floor above a quieter engine room located below it	$R'_w$	57
		$L'_{n,w}$	58
9.16	Floor below a quieter engine room located above it	$R'_w$	57
		$L'_{n,w}$	43
9.17	Floor below or above a noisy engine room	$R'_w$	Article
		$L'_{n,w}$	6

- 5.3.2.3 Ventilation ducts should be as small as possible and acoustically treated (in the case of a  $p=1/1000$  opening ratio the maximum possible insulation capacity is 30 dB, at 1/10 it is up to 10 dB).
- 5.3.2.4 Testing laboratory measured sound insulation capacity ( $R_w$ ) of doors used as internal separation elements must be 5 dB higher than the value for doors installed into a building ( $R'_w$ ).
- 5.3.2.5 Soft floor covering, ceiling and wall linings must be sound-absorbent.

### **5.3.3 Maximum equivalent noise levels (sources of noise: ventilation, air conditioning, installations, etc.)**

- 5.3.3.1 Maximum equivalent noise levels for educational workplace (intellectual work) are 40 dB(A) and apply to workplace noises generated by non-industrial sources (ventilation, air conditioning, establishments in the vicinity, traffic noise, etc.).
- 5.3.3.2 The equivalent noise levels for educational workplace are 45 dB(A) and apply to general workplace noise generated by other industrial sources in the vicinity.
- 5.3.3.3 Noise level limits values  $L_{AFmax1}$  caused by service equipment in specific rooms or noise from rooms for other intended purposes must not exceed 40 dB in playrooms, classrooms, etc.
- 5.3.3.4 Aerodynamic and hydrodynamic noise is often reduced by using silencers, which should be installed as close as possible to the noise source.
- 5.3.3.5 The installations must be planned and implemented in such a way as to prevent the transfer of noise into rooms for children.

### **5.3.4 Reverberation time**

Reverberation reduction measures are particularly important in high reverberation areas, such as offices, gymnasiums, and multifunctional rooms.

- 5.3.4.1 The optimum reverberation time value  $T_{opt.}$  in filled to capacity classrooms and lecture rooms, depending on their volume  $V$ , is calculated by using the following formula:

$$T_{opt.} = 0,32 \cdot \log V - 0,17$$

5.3.4.2 The optimum value of reverberation time in school multipurpose areas and lecture theatres depends on the principal use of the room and is shown in Table 12. The reverberation time value for other rooms, not included in the table below, is established by interpolation to a tenth of a second.

Table 12

Use of space	Optimal reverberation time $T_{opt.}$ with volume of space			
	200 m <sup>3</sup>	400 m <sup>3</sup>	800 m <sup>3</sup>	1,600 m <sup>3</sup>
Teaching	0.5 s	0.6 s	0.8 s	0.9 s
Speech events	0.7 s	0.8 s	0.9 s	1.0 s
Music events	1.1 s	1.3 s	1.4 s	1.5 s

5.3.4.3 Gymnasiums and sports centres are classified into two categories according to their use. The first group consists of rooms intended for individual use (teaching of a single class, a single sport group). The second group includes rooms shared by several classes or sport groups for teaching purposes. Optimum reverberation time values  $T_{opt.}$  in rooms belonging to categories 1 and 2 (empty, with no audience), depending on their volume  $V$ , are determined by using the following formulas:

- category 1 rooms (room 1):  $T_{opt.} = 1,27 \cdot \log V - 2,49$ ;
- category 2 rooms (room 2):  $T_{opt.} = 0,95 \cdot \log V - 1,74$ .

## **5.4 Lighting (visual) comfort**

Lighting quality must not be reduced by energy retrofit of building. Similarly, the level of natural lighting should not be impaired in such a way as to fail to meet the requirement levels below:

### **5.4.1 Natural lighting**

- 5.4.1.1 The size of surfaces providing an individual workplace with natural lighting should amount to no less than 1/8 of the floor surface area.

### **5.4.2 Proportion of illuminated surfaces**

- 5.4.2.1 All rooms intended for educational activities and rooms in which the kindergarten employees carry out their work must be illuminated by direct natural lighting.
- 5.4.2.2 The requirements for direct natural lighting are met when the total surface of finished construction openings (only the part of the opening that is higher than 50 cm above the finished floor is taken into account) intended for lighting achieve at least 30% of the net floor area of the room.
- 5.4.2.3 Room depth should not be greater than 2.5 times the height from the floor to the upper edge of the window, or the area is to be illuminated from two sides.

### **5.4.3 Artificial lighting**

- 5.4.3.1 To meet the requirements of artificial lighting, it is necessary to follow the provisions of Slovenian standards for lighting of workplaces.

### **5.4.4 Illuminance (lux)**

- 5.4.4.1 Artificial lighting of playrooms should be uniform and dispersed. Individual rooms should meet the following illuminance requirements:
- playroom – 300 Lx,
  - child care room – 500 Lx,
  - working area – 350 Lx,
  - requirements for other rooms are listed in BS EN 12464-1:2011.

Surfaces that cause glare should be avoided.

The lamp shades must be such as to ensure that the direct lighting source is outside the children's field of vision and that in the event of light bulb explosion pieces of glass cannot hurt the children. The lower edge of the lamps must be at least 2.5 m from the floor. Lighting elements in gymnasiums must be protected against ball hits.

#### **5.4.5 Unified glare rating (UGR)**

- 5.4.5.1 Unified glare rating (UGR) in playrooms and child care rooms should not exceed 22.

#### **5.4.6 Colour rendering index**

- 5.4.6.1 Colour rendering index (Ra) must not exceed 80.

#### **5.4.7 Doors and windows**

- 5.4.7.1 The construction of windows should include installed devices for safe cleaning while preventing threats to other workers in or near the building. A safe way of opening and closing of wall and roof windows must be ensured. Open windows should not endanger health and safety.
- 5.4.7.2 Window sashes must be designed so that in they do not hinder movements in the workplace and traffic routes when opened.
- 5.4.7.3 Exterior doors for work area must open outwards.

## **6 REQUIREMENTS AND RECOMMENDATIONS FOR IMPLEMENTATION AND ACHIEVEMENT OF MEASURES**

### **6.1 Business continuity standards**

Implementation of any works on the building must be communicated to the representative of the user/manager in advance, whereby the date of implementation shall be mutually agreed upon. In doing so, it is necessary to ensure that the execution of works has minimum impact on the implementation of activities of the user/manager.

Works, relating to the implementation of measures, which cause excessive noise, excessive pollution, and generally prevent the normal conduct of business, must be implemented at a time when the teaching process is not conducted in the building. Works resulting in excessive emissions, which would interfere with the ordinary course of implementation of the activities, can be implemented after 16:00 in the afternoon or during weekends, when the building is empty, i.e. when educational and associated activities are not being conducted.

When activities are being carried out in the building, the implementation of works must ensure compliance with the standards laid down in Chapter 8 of this document. If this cannot be achieved with the existing systems or capacities, the concessionaire is required to provide replacement or temporary systems or capacities for the duration of the implementation of works.

When implementing services, it is important to ensure that, in the event of interventions, any technical defects are eliminated immediately, i.e. no later than in 2 hours, in accordance with the regulations and standards in the field of education.

### **6.2 Quality control standards**

In the context of the contractual relationship with the selected concessionaire, it is required to provide mechanisms that establish:

- the right to receive payment for implemented service only if the agreed-upon actual energy savings, i.e. reduced energy consumption costs, from the contract are achieved;
- the concessionaire's responsibility for correct execution of contractual tasks and for all the damage regardless of the cause or reason that might be caused to the users/managers and third persons related to the implementation of the concession;
- user's/manager's right to form their own proposals and initiatives for better and more efficient concession implementation so that the user/manager can communicate such proposals directly to the concessionaire (and immediately inform the City of Ljubljana in writing via regular mail or email); the concessionaire is obligated to reply in writing to all such initiatives within 15 days of the receipt;
- user's/manager's right to forward complaints to the concessionaire and the City of Ljubljana if they consider the service rendered in conflict with the Decree or the concession contract, or if they think that the services fail to meet the standards of permanent, regular, uninterrupted, and quality provision (in the event that the user/manager forwards the complaint directly to the concessionaire, the concessionaire is obligated to immediately notify the City of Ljubljana in writing via regular mail or

email), whereby the concessionaire is obligated to reply to all complaints within 15 days of the receipt;

- user's/manager's right to access any and all relevant information and documents at the concessionaire's disposal regarding the implementation of measures or services.

### **6.3 Safety standards and other standards**

In carrying out the works related to the implementation of measures, and subsequent implementation of services, the following documents are to be strictly observed:

- Occupational Health and Safety Act (Official Gazette of the RS, No. 43/11),
- Construction Act (Official Gazette of the RS, Nos. 102/04 – official consolidated text, 4/05 – corr., 92/05 – ZJC-B, 93/05 – ZVMS, 111/05 – Constitutional Court Decision, 126/07, 108/09, 61/10 – ZRud-1, 20/11 – Constitutional Court Decision, 57/12, 101/13 – ZDavNepr, 110/13 and 19/15),
- Fire Protection Act (Official Gazette of the RS, Nos. 2/76, 21/78 – ZSlar-A, 15/84, Official Gazette of the RS, Nos. 71/93 – ZGas, 71/93 – ZVPoz and 83/12 – ZVPoz-D),
- Decree on the implementation of safety and health requirements at temporary and mobile construction sites (Official Gazette of the Republic of Slovenia, Nos. 83/05 and 43/11 – ZVZD-1),
- Rules on construction sites (Official Gazette of the Republic of Slovenia, Nos. 55/08 in 54/09 – corr.),
- Decree on management of waste arising from construction work (Official Gazette of the Republic of Slovenia, No. 34/08),
- Machinery Safety Rules (Official Gazette of the Republic of Slovenia, Nos. 75/08, 66/10, 17/11 – ZTZPUS-1 and 74/11),
- Rules on safety signs at work Official Gazette of the Republic of Slovenia, Nos. 89/99, 39/05, 34/10, 43/11 – ZVZD-1 and 38/15),
- Rules on reports in the field of health and safety at work (Official Gazette of the Republic of Slovenia, No. 54/13),
- Rules on design documentation (Official Gazette of the Republic of Slovenia, No. 55/08),

as well as any and all legislation and technical guidelines relating to the safety and health at work.

Prior to the commencement of works on the building, the concessionaire is obliged to present the user/manager with the copies of the following documents:

- notification to the Labour Inspectorate about the commencement of work (registration of construction site);
- security plan,
- document on appointed coordinator(s) for safety and health at work,

and the documentation on safe building maintenance upon the completion of works (maintenance plan).

Before commencing individual works on the building, the concessionaire must provide the user/manager with a list of all authorised persons who will participate in the execution of works (both in the implementation phase and the phase of providing services). Unauthorised persons are not allowed access to the building, whereby the user/manager may deny them access or arrange for their removal from the building.

At the construction site, the concessionaire must maintain appropriate housekeeping, removing all generated waste (at least on a daily level) to a temporary waste disposal site and, in accordance with the regulations, from there to a waste landfill.

The concessionaire must ensure that workers carrying out any work on the buildings do not to smoke, drink alcohol, or use any other psychoactive substances, and that all biological needs are undertaken only in dedicated sanitary cabins.