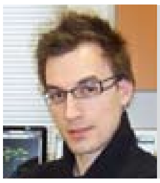
Thermal and acoustic comfort requirements in European standards and national regulations



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Summary

This paper presents some results from the Work Package 5 in the HealthVent project supported by the European Commission. One of the objectives of the project has been to review and critically evaluate the requirements on thermal and acoustic comfort requirements in national building codes and European standards. The data in national legislation and codes were collected in spring 2011 from 16 European countries with questionnaires, which were sent to project partners and trusted experts on ventilation.

The requirements on indoor temperature, air velocity, humidity, and noise levels were all found very inconsistent. Indoor air temperature in summer range from 25 to 28°C and 15 to 21°C in winter. Maximum air velocities vary from 0.15 to 0.30 m/s and in many regulations the limits do not depend on the air temperature. Limit values for air humidity are almost consistently 30% r.h.in winter and 70% r.h.in summer. Noise requirements follow the pattern of other observed requirements and vary in a wide range. Moreover, they are further complicated because they are given in three different units, which cannot be compared.

A common European regulation based on existing European Standards would help to establish uniform requirements for thermal en acoustic environment in Europe, which would also benefit industry by i.a. reducing the construction cost of HVAC systems.

Introduction

This article is the second and last from the series of articles about indoor environmental requirements in European Standards and national regulations. While the first article published in January 2012 issue of the REHVA Journal focuses on requirements for ventilation rates and indoor pollutant levels, this issue focuses on requirements for temperature, draft, humidity, and noise.

Like the previous article from the January 2012 issue of the REHVA Journal, this one also presents some of the results from the work performed in the HealthVent project [**1**], supported by the European Commission. The objective of the HealthVent project is to develop health-based ventilation guidelines for the EU. Members of the project group are experts from different disciplines from 9 European countries. One of the objectives of the project was to review and critically evaluate the existing requirements on ventilation and IAQ defined in building codes and European standards. The project's focus was set on ventilation rates, pollutants, noise, temperature and relative air movement in dwellings, offices, schools and kindergartens.

Results

Information on national regulations and practice in European countries were collected with a special questionnaire that was sent to project partners and trusted experts on ventilation in several European countries. The questionnaire comprised of 10 questions and subquestions. Respondents were asked to provide values of ventilation rates, indoor temperature and relative air velocity limits, noise levels, etc., which can be found in the national regulations. In case if no such values existed in the regulations, they were asked to provide values which are most widely used in practice (from standards, guidelines, etc.). In the responses they had to mark if the provided value is mandatory or voluntary to use. Questionnaires were returned by respondents from 16 countries (**Table 1**) in spring 2011.

In order to distinguish whether the data presented in the following diagrams is mandatory or not to use, the following applies: values in charts and tables, which are given in normal letters, are published in regulations and are therefore mandatory to be used. Values which are underlined and given in italic letters are only suggestions

[**1**] HealthVent project website: www.healthvent.eu

Table 1. Country abbreviations used in charts.

BG	Bulgaria	GR	Greece	PL	Poland
CZ	Czech Republic	HU	Hungary	PT	Portugal
		IT	Italy	RO	Romania
DE	Germany	LT	Lithuania	SI	Slovenia
FI	Finland	NL	Netherlands	UK	United Kingdom
FR	France	NO	Norway		

in regulations, or published in guidelines and standards, which are voluntary to use.

Thermal and comfort requirements

The results for indoor temperature limits and relative air velocity limits in summer and winter show that values are very inconsistent among European countries (**Figure 1**).

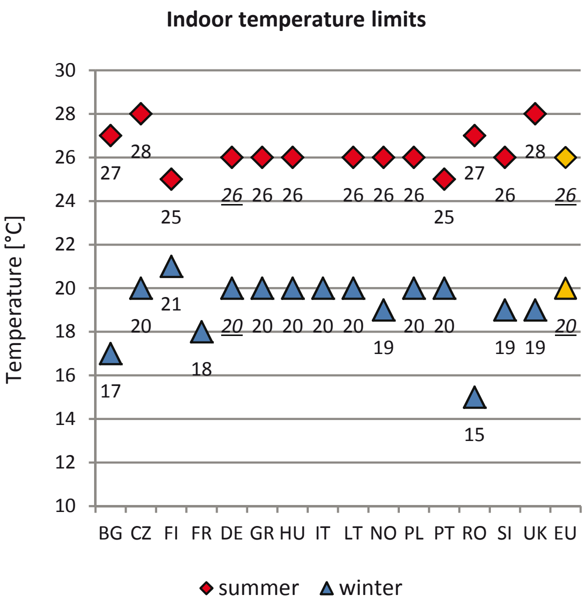
Temperature limits for summer vary from 28 to 25°C and in winter from 15 to 21°C. It is important to note that an optimum indoor air temperature is important factor for learning performance of children [1] and performance of employees in offices [2]. Summer limit of 28°C seems to be too high from that point of view since considerably reduces performance. It is interesting to see that Finland, which is a country with coldest climate among included countries, has the highest limit of the winter minimum temperature. On the other hand, Finland has also the lowest summer design temperature, thus making it the country with the set temperature limits which are the closest match of the optimum values. One can notice that the minimum air temperature limit is prescribed more countries than maximum air temperature limit. The recommended values in EN15251:2007 are 20°C and 26°C for winter and summer, respectively. A comparison with the values from the national regulations shows that seven countries have at least one temperature limit set under out of the recommended range by the EN standard. Winter minimum temperatures are more problematic since there are 6 out of 16 countries that have minimum temperature requirement below 20°C.

Maximum air velocities were also found to be inconsistent among countries. They vary from 0.15 to 0.30 m/s. Majority of regulations only prescribe maximum air velocity but not also the temperature of air at that velocity, which has a big influence on the perceived comfort of the person that is exposed to the draft. Limits of air velocities are not prescribed as often as temperature limits since requirements exist in only 6 out of 16 countries.

Limits values of air humidity follow the pattern of temperatures and air velocities and but are slightly more consistent (**Table 2**). They are expressed as relative humidity (%) or absolute humidity (g/kg). Lower limits are constantly at 30% while higher limits are 70% in all cases except one, where it is 75%. Humidity level is given in terms of absolute humidity to limit the highest amount of water in the air and is in both cases the same, i.e. 12 g of water per one kg of air.

Noise requirements

Limit noise levels as defined in European regulations and standards are very inconsistent, which coincides with findings on temperature, air velocity and humidity limits. Inconsistency is present also in the use of units since countries use maximum level (L_{AFmax}), equivalent level (L_{eq}), and noise rating curves (NR). Due to the dif-



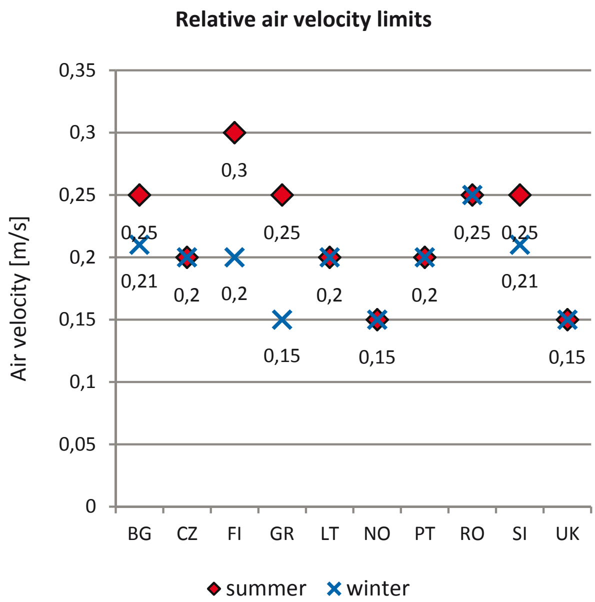


Figure 1. Comparison of requirements for indoor temperature (left) and relative air velocity (right). Markers in yellow colour designate the recommended values from EN 15251:2007 (category II).

Table 2. Limit values of air humidity.

Country	Limit value for humidity of indoor air
Czech Republic	30 -70% RH
Finland	no humidification above 45% RH
Germany	*max 12 g/kg*
Greece	winter max: 40% RH summer max: 45% RH
Hungary	30 - 70%
Italy	*45-55%*
Lithuania	max. 75% RH
Norway	only recommendations to prevent dampness and mold growth
Romania	for 20 - 27°C RH = 30 - 70% upper max 12 g/kg
Slovakia	30 - 70% RH
Slovenia	30 - 70% RH

ferent definitions used in the definitions of the three units, they are not directly comparable.

Minimum given equivalent level for bedrooms in dwellings is 28 dB(A) eq and minimum given instantaneous level is 25 dB(A). Maximum levels are 35 dB(A) eq and 40 dB(A). Lower limit values for classrooms and playrooms are in comparable range and also higher than in bedrooms. Range for equivalent levels (min – max) is 28 to 40 dB(A) eq, and for instantaneous levels 30 to 45 dB(A). Values in offices are (min – max) for equivalent levels 33 to 45 dB(A) eq and for instantaneous levels 35 to 50 dB(A). Differences min – max are big in both cases, equivalent and instantaneous. It seems that in average, equivalent levels are usually 5 dB lower than instantaneous levels.

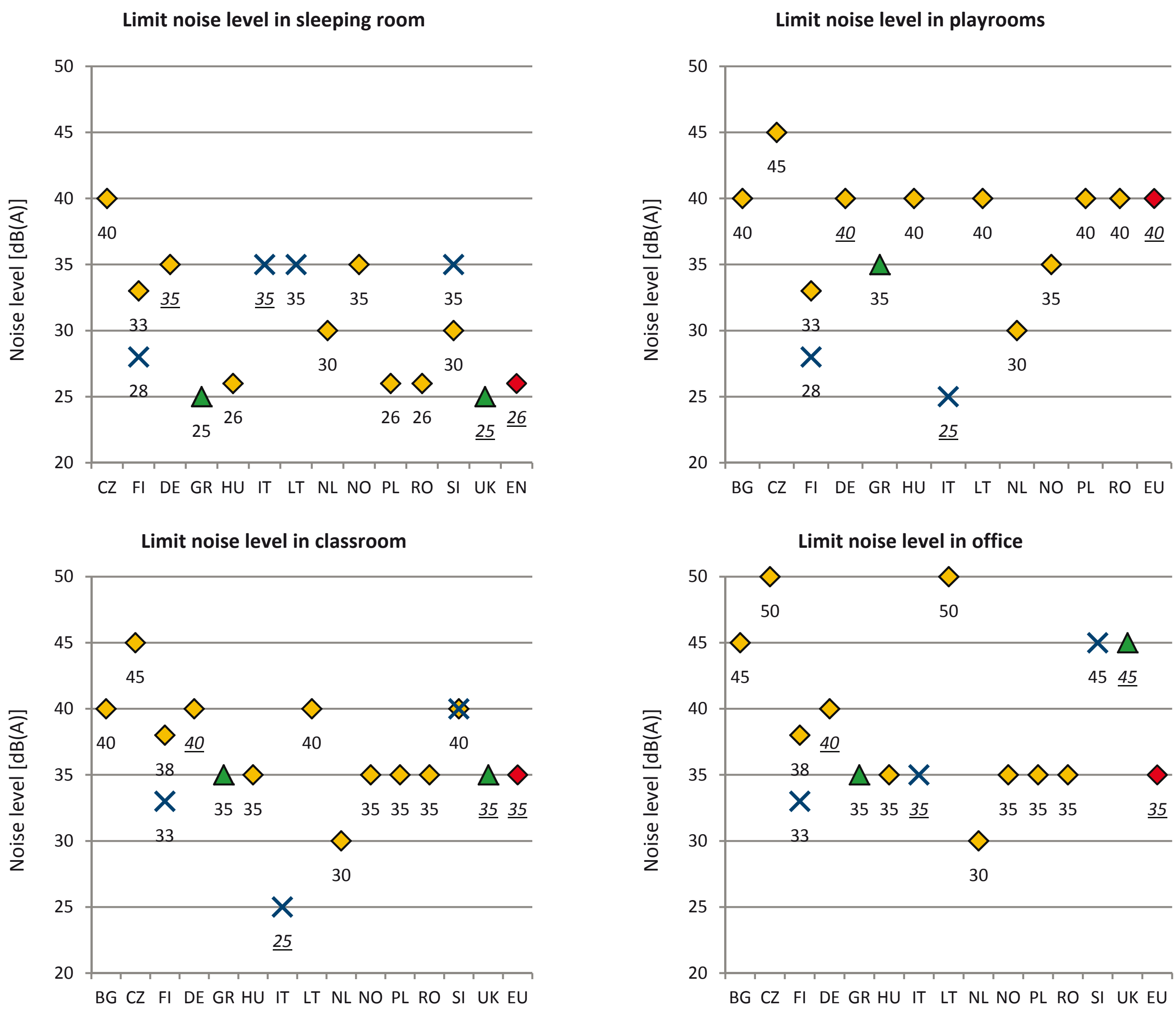


Figure 2. Comparison of requirements for limit noise levels. Markers in red colour designate the recommended values from EN 15251:2007. ◆ LAFmax ✕ Leq ▲ NR

In comparison to the values, which are recommended by the EN 15251, many of directly comparable limit values (given as instantaneous sound power levels) are too high. In the sleeping room, where EN value is 26 dB(A) the highest limit is 40 dB(A). Recommended level in classroom of 35 dB(A) is exceeded only by one country, while the recommended limit in classrooms in exceeded six time and for maximum 10 dB(A). The recommended limit for offices of 35 dB(A) is exceeded five times. The comparison of values in regulations and European Standard clearly shows that in general the noise limits are set to high. In the case of too high ventilation noise building occupants, especially in family houses or apartments, tend to reduce the fan speed or even turn off the ventilation, which results in poor indoor air quality.

Conclusion

The data was collected from 16 countries from all parts of Europe, thus giving a good coverage of regions with different building practice and climate. Questionnaires were returned by respondents in spring 2011, i.e. about two years ago. Since regulations are periodically a subject of modifications some of the presented data may now already be obsolete. Although the respondents are experts on ventilation, a certain measure of uncertainty exists regarding the accuracy of the collected data. Due to limited resources, all data could not be verified. Due to these limitations the nature of data presented in this article is informative and should not be used in practice.

Despite some limitations in the reliability of collected data it is clear that the values found in regulations are inconsistent and missing in regulations of some countries. We can conclude that common European regulatory values are needed for thermal and acoustic environment. European Standards, if properly applied, should already ensure no problems with thermal and acoustic environment (good practice). They already cover a significant part of the elements which should be respected during design of ventilation systems. National regulations, on the other hand, do not regulate all the elements of thermal and acoustic environment. Moreover, the values are inconsistent and vary in a wide range. A common European regulation based on existing European Standards would help to establish uniform requirements for thermal en acoustic environment in Europe, which would also benefit industry by i.a. reducing the construction cost of HVAC systems.

Acknowledgements

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