Revised Swedish Guidelines for the Specification of Indoor Climate Requirements released by SWEDVAC

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Revised Swedish Guidelines for the Specification of Indoor Climate Requirements released by SWEDVAC

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SUMMARY

The Swedish indoor climate guidelines issued by Swedvac has been thoroughly revised. The new document is adapted to harmonize with related international, European and Swedish standards. The document comprises thermal climate, indoor air quality, sound and light.

The new R1-document is mainly intended to provide guidance for the specification of indoor climate requirements. It is recommended for use as a reference document in the very early phase of planning a new building or the reconstruction of an existing building. The document provides guidance regarding planning of measurements for verification of indoor climate quality, which is an issue to consider already when the indoor climate requirements are being specified.

INTRODUCTION

In the beginning of the nineties the first version of the Swedish indoor climate guideline document "R1" was published by Swedvac. In May 2006 a thoroughly revised version was released [1]. The new document has been updated with respect to knowledge that has evolved over the years and it is adapted to harmonize with related international, European and Swedish standards. The document comprises thermal climate, indoor air quality, sound and light; all indoor climate factors which are influenced by the installation systems in a building, and consequently should influence the design of the building services.

The starting point is that requirements and recommendations from Swedish authorities shall define the basic indoor climate requirements. As in the original R1-guideline, there is an opportunity to select a higher quality level. However, the system for classification of the indoor climate has been radically rearranged in the new version. Thermal climate and indoor air quality are divided into two quality classes each, and sound comprises three quality classes. Only one set of guideline values are specified for light.

The main objective of the new R1-document is to provide guidance for the specification of indoor climate requirements. As illustrated in Figure 1 it is intended as a reference document in the earliest phase of planning a building project. The document does neither provide guidelines for the details in the HVAC-design process, nor for the contracting or administration of buildings in operation. However, it is mandatory that the indoor climate requirements specified using the guidelines should be verified by measurements. The document provides guidance regarding the planning of such measurements, which is an issue to consider already when the indoor climate requirements are being specified.

The objective of the present paper is to provide a summary of the revised Swedish indoor climate guidelines, "R1".

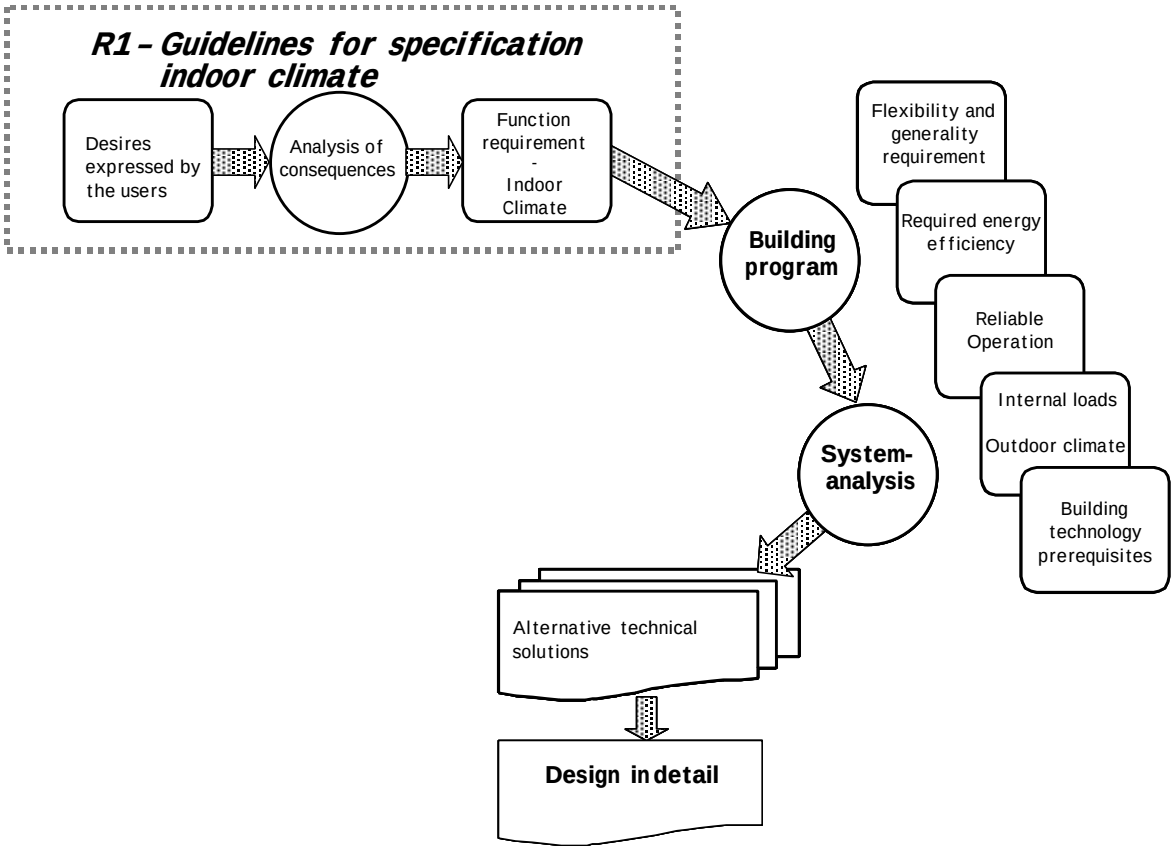

Figure 1. Illustration of the transformation of occupant's desires to an unambiguous indoor climate requirement specification, and further towards selection and design of feasible technical solutions.

BASIS FOR THE GUIDELINES

Thermal climate

The guidelines regarding thermal climate are based on the ppd/pmv approach specified by the standard SS EN ISO 7730:2006 [2]. The ppd-index, defined in this standard, is used as a parameter to find a suitable target interval for the operative temperature. The starting point is to aim at a climate that is *normally perceived as comfortable*. According to the R1-guideline this corresponds to a ppd-index not exceeding 10%. However, the climate requirement is not explicitly expressed using the value of the ppd-index, since such an approach is deemed dubious and not feasible in practice. The requirement must be specified in a manner that enables a rather straightforward method of verifying compliance by measurements. The operative temperature is judged as a feasible measure, the ppd-index is not.

Some standards and guidelines suggest classification of the thermal climate based on the ppd-index. For example, SS EN ISO 7730 suggests 6%, 10% and 15% as the maximum allowable ppd-index values in three alternative quality classes. A ppd-index of 6% leads to a very narrow temperature range close to the "optimal operative temperature". For example in an

office during summer conditions the temperature range would be about 24.5±1.0°C. The precision of the pmv/ppd approach suffers from uncertainties of the assumed input data, especially regarding the clothing and activity of people, as well as the air velocity. For example, a small change of the met-value from 1.2 to 1.3 may correspond to a change of the preferred operative temperature of more than 0.5°C. Changing the assumed clo value from 0.5 to 0.6 (e.g. by assuming a thin long-sleeved shirt instead of a t-shirt being worn) has a similar effect on the predicted temperature preference. Thus, it can be questioned whether the narrow temperature interval ±1.0°C in practice reflects a higher quality level than the interval 24.5±1.5°C, resulting from calculations using a ppd-index value of 10%. According to the R1-guideline for offices and other premises the higher quality class is obtained by individual temperature control, not by trying to keep the temperature as constant as practically possible.

The R1-guideline does not comprise a third thermal quality class, as e.g. SS EN ISO 7730 does, allowing ppd-index values up to 15%. Such high ppd-values exceeds the recommendation of ppd<10% made by the Swedish Work Environment Authority, and cannot be applied: -A basic principle of the R1-guideline is that not only mandatory requirements, but also the recommendations made by the Swedish authorities shall be met. Thus, the R1-guideline comprises two thermal quality classes, denoted TQ1 and TQ2.

In residential buildings the occupants shall have the possibility to influence the room temperature in both climate classes. The higher quality class is in this case instead obtained by reducing high temperatures during hot summer days. This shall not be interpreted as a recommendation to install mechanical cooling in residential buildings, but rather implies extensive thermal insulation and sun shading.

Values to minimize local thermal discomfort follows the SS EN ISO 7730 closely, but with a few modifications justified by recommendations from Swedish authorities regarding, e.g. floor temperatures. In quality class TQ1 the requirements for reduction of the risk of local discomfort are more sharp than they are in quality class TQ2.

Indoor air quality

According to the R1-guideline, not only the mandatory requirements, but also the recommendations given by the Swedish authorities shall be met (The National Board of Housing, Building and Planning, the National Board of Health and Welfare, the Swedish Work Environment Authority). It is a matter of prescribing minimum outdoor airflow rates, and maximum acceptable concentrations of various pollutants. The R1-guideline does not explicitly prescribe requirements regarding emissions from building products. However, it is mandatory that this issue be addressed by quality assurance in line with some established method. In this respect the R1-guideline refers to, and implies the use of either the Finnish system, administered by The Building Information Foundation [www.rts.fi], or the recommendations made by SP The Swedish Technical Research Institute, in connection to the quality system for “P-marking” of indoor environments [3].

The R1-guideline provides a set of recommendations for target values regarding maximum acceptable pollutant concentrations. The set of target values is a synthesis of previously established guidelines [4, 5, 6], and the implementation in Sweden of the European directive for outdoor air quality (published by the Swedish Environmental Protection Agency) [7]. The recommended target values are the same for both indoor air quality classes, AQ1 and AQ2. The distinction between the quality classes is based on the risk for annoyance due to odors, primarily originating from bio-effluents. In the basic quality class, AQ2, odors must be

accepted, at least shortly after entering the building. In the higher of the two classes, AQ1, this risk shall be substantially reduced. The concentration of carbon dioxide (above that outdoors) is used as the quality measure.

Sound and noise
The requirements regarding acoustic quality are based on two Swedish national standards [8, 9]. One of these standards addresses sound in residential buildings and the other addresses premises like offices, schools etc. According to the R1-guideline it is mandatory to consider noise from installations, e.g. the ventilation system. Target values are given both for A-weighted and C-weighted noise levels. However, it is recommended to consider all acoustic quailties comprised in the two standards, e.g. outdoor noise, reverberation, sound insulation etc. The R1-guideline comprises the three sound quality classes NQ1, NQ2 and NQ3.

Light
The R1-guideline prescribes that the lighting system shall be planned and verified according to the standard SS EN 12464-1 [10]. This standard does not comprise a distinction between various light quality classes, and neither does the R1-guideline. Target values are presented for the average illumination, the evenness of the illumination, the unified glare rating index (UGR-index) and the average color rendering index (Ra-index). Furthermore, recommendations regarding the reflectance of various surfaces and the daylight factor are made.

Other factors
In addition to thermal climate, air quality, sound and light, a requirement specification prepared according to the R1-guideline also addresses the risk for legionella growth in water systems, radon in tap water and electromagnetic fields.

TARGET VALUES

This section provides a summary of target values presented in the R1-guideline.

Table 1 concerns thermal climate requirements in offices and similar premises. The guideline prescribes that the ppd/pmv concept shall be used in order to determine a suitable target interval for the operative temperature, considering the clo and met values estimated for the activity the building is planned to house. As can be seen in the table the guideline also comprise recommendations on how to consider deviations from this interval, e.g. during the hottest summer days. According to the R1-guideline the designing engineer shall clarify to the commissioner the consequences of suggested technical solutions, e.g. by an estimation of the percentage of the occupied hours the indoor temperature will rise above the maximum value of the target interval.

Table 2 indicates the corresponding information for residential buildings. Table 3 summarizes target values to minimize the risk of local thermal discomfort. The criterion for reducing the risk of draught is in each quality class given at two alternative temperatures.

Table 1. Example of target values regarding the operative temperature in an office room. The same values are applicable in both quality classes, TQ1 and TQ2. In TQ1 (but not in TQ2) there is an additional requirement of individual temperature control in single rooms and/or smaller zones of large rooms.

Parameter	Target values	Deviations	Note
Operative temperature			
Winter	20.0-24.0ºC	It shall be possible to maintain the indoor temperature below 23ºC	1.0 clo / 1.2 met
Summer	23.0-26.0ºC	At outdoor conditions above 27ºC the indoor temperature should be about 3ºC below the outdoor temperature	0.5 clo / 1.2 met

Table 2. Target values for operative temperature in residential buildings. Note that the difference between quality class TQ1 and TQ2 concerns the prevalence of high temperatures during hot summer days.

Parameter	Target values	Deviations	Note
Operative temperature			
Winter	20.0-24.0ºC	It shall be possible to maintain the indoor temperature below 23ºC	1.0 clo / 1.2 met
Summer	23.0-26.0ºC	TQ1: Indoor temperatures above 26ºC accepted during short periods (hot summer days) TQ2: Indoor temperatures above 28ºC accepted during short periods (hot summer days)	0.5 clo / 1.2 met

Table 3. Target values for minimizing local thermal discomfort.

Parameter	TQ1	TQ2
Floor temperature	22-26ºC	20-26ºC 16-27ºC in rooms not intended for children
Vertical temperature difference	<2ºC	<3ºC
Radiant temperature asymmetry	Warm ceiling <5ºC Cold wall <10ºC	Warm ceiling <5ºC Cold wall <10ºC
Air velocity (draught risk)	<0.10m/s at 20ºC <0.15m/s at 26ºC (Draught rating < 10%)	<0.15m/s at 20ºC <0.25m/s at 26ºC (Draught rating < 20%)

As mentioned above the distinction between the two air quality classes AQ1 and AQ2 is based on the risk of annoyance due to odors caused by bio-effluents. Thus, in quality class AQ1 the concentration of carbon dioxide may not rise above 800 ppm (about 400 ppm above the outdoor concentration) more than temporarily, while in quality class AQ2 the limit is set to 1000 ppm (about 600 ppm above the outdoor concentration). In this respect class AQ2 corresponds to advice given by Swedish authorities.

In both air quality classes AQ1 and AQ2 the aim shall be to maintain the pollutant concentrations below the values given in Table 4.

Table 4. Target values regarding maximum acceptable pollutant concentrations. All values are applicable to both air quality classes, AQ1 and AQ2.

Substance	Designation	Maximum concentration	Reference
Radon	Rn	100 Bq/m^3	FiSIAQ [4]
Carbon monoxide	CO	2 mg/m^3	SP, FiSIAQ [3, 4]
Nitrogen dioxide	NO_2	40 µg/m^3	WHO, ISIAQ-CIB, Swedish EPA [5, 6, 7]
Ozone	O_3	50 µg/m^3	FiSIAQ [4]
Formaldehyde	HCHO	50 µg/m^3	SP, FiSIAQ [3, 4]
Particulate matter <10µm	PM10	40 µg/m^3	FiSIAQ, Swedish EPA [4, 7]
Particulate matter <2.5µm	PM2.5	15 µg/m^3	FiSIAQ, ISIAQ-CIB, Swedish EPA [4, 6, 7]

Furthermore, the R1-guideline prescribes that the outdoor airflow rate shall be selected according to recommendations given by Swedish authorities. In office buildings and other similar work premises this means at least 7 l/s per person plus 0.35 l/s per m^2 floor area. In residential buildings the corresponding values are 0.35 l/s per m^2 floor area or 0.5 air changes per hour, but at least 4 l/s per person. However, the requirement to limit the carbon dioxide concentration is valid also for residential buildings, which typically leads to a higher airflow rate than 4 l/s per person.

The entire occupied zone shall be efficiently ventilated without occurrence of stagnant zones. This shall be verified, e.g. by measurement of the local ventilation index (>90%) or the air change efficiency (>40%). A recommendation is to carry out this verification according to applicable Nordtest medhods [11, 12]

If air filters are needed these should preferably at least be of class F7, and they should be quality assured, e.g by the Swedish “P-mark” system for air filters [13], administered by SP Technical Research Institute of Sweden.

Table 5 gives examples of target values for thee selected indoor environment types regarding noise from installations. As mentioned above the R1-guideline specifies target values regarding noise from installations, but recommends that also other acoustic qualities be considered, with reference to two Swedish standards [8, 9].

Table 5. Examples of recommended target values regarding noise from installations.

	Office room			Classroom			Residential room*		
Class	NQ1	NQ2	NQ3	NQ1	NQ2	NQ3	NQ1	NQ2	NQ3
LpA, dB(A)	35	35	35	26	30	30	22	26	30
LpC, dB(C)	55	-	-	45	45	50	42	46	50**
LpAFmax, dB(A)	-	-	-	-	-	-	27	31	35
Note.	-	-	-	-	-	-	No tones	No tones	No tones

* Less stringent values specified for kitchens

** Applies to bedrooms

In addition to the illumination parameters presented in Table 6 the R1-guideline specifies that the illumination in no single point may be lower than 70% of the average illumination over a workplace-surface. The corresponding value for surrounding surfaces and corridors etc is 50%. The daylight factor is recommended to be at least 1%. Furthermore, light sources shall be located with respect to the location of the occupants in order to avoid glare. It is recommended to shade sources of strong luminance, e.g. windows. Guidance regarding the reflectance of various surfaces are given: ceiling: 0,6-0,9; walls 0,3-0,8; floors 0,1-0,5; writing table 0,2-0,6.

Table 6. Examples of recommended target values regarding light.

	Office room	Classroom	Waiting room
Average illumination, lux	500	300*	200
UGR-index	<19	<19	<22
Ra-index	>80	>80	>80

* Classroom for adults, 500 lux

DISCUSSION

The Swedish R1-guideline for specification of indoor climate requirement has been revised. The guideline is adapted to Swedish conditions and regulations, although it has been of priority also to harmonize the document with respect to European standards and guidelines.

The main purpose of the guideline is that it shall be used as a reference document in the earliest planning phase of the building process. The guideline provides a basis for the communication between primarily the commissioner and the HVAC-engineer, but it can also serve as a common basis for the united efforts by all participants in the building process, e.g. also the architect, the tenant and the contractor.

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