Scanvac

CLASSIFIED INDOOR CLIMATE SYSTEMS

Guidelines and specifications

SCANVAC

The federation of the Scandinavian HVAC-Organizations

• Swedevac – VVS-Tekniska Föreningen – Riksföreningen för Energi- och miljöteknik	Sweden
• Norvac – Norsk VVS – Energi- och Miljöteknisk Förening	Norway
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• Finvac – Värme- och Sanitetstekniska Föreningen	Finland

INTRO-
DUCTION

The guidelines for classified indoor climate presented in this document have been published by the Swedish Indoor Climate Institute for voluntary application in Scandinavia. As far as possible, they comply with international standards.

The availability of these guidelines for classified indoor climates opens up new opportunities for producing purpose- designed buildings with good indoor climates and adapted to individual technical and economic requirements.

The guidelines, which have been drawn up by Scanvac, are based on specialised evaluation of experience and the results of research work, as available at the time of publication. It is the intention that they will be regularly revised and enlarged as new experience emerges.

PREFACE

This manual, 'Classified Indoor Climate - Guidelines and Specifications', published by the Swedish Indoor Climate Institute in the name of Scanvac as Document R1 in its Guideline series, specifies the requirements that should be imposed on each class of indoor climate if it is to be regarded as satisfactory from the points of view of thermal comfort, air quality and noise. These guidelines constitute a voluntary code of practice intended for use by purchasers and planners (architects; heating, ventilation and air-conditioning system designers; building planners etc.) in order to produce buildings having sustainably satisfactory indoor climates.Purchasers can use the guidelines as a foundation on which to specify quality requirements and other parameters that will form the basis for design work. For planners, the guidelines indicate the temperature levels, pollution levels, etc., to be used as a basis for design and calculation work and for the selection of ventilation and air-conditioning methods and equipment. They also serve as an aid to calculation, giving details, for example, of methods of calculating the air flow rate required to produce satisfactory ventilation when dealing with emissions etc.

If the requirements specified in the guidelines are to be fulfilled in practice, the various planning categories (architects, heating, ventilation and air-conditioning system designers, structural engineers etc.) need to work together at an early stage of the planning process. If the necessary cooperation is not sufficiently widely established, the object (i.e. the building) may comprise such an unsuitable combination of materials, ventilation systems and building services systems that it is not possible to create a satisfactory indoor climate.

The new indoor climate guidelines therefore require some changes in the planning process, together with an admittedly limited, but nevertheless real, cooperation between disciplines at an early stage, and with partly different models of purchaser's requirement specifications and planner's project documents. The purchaser, for example, will need to specify more clearly than hitherto the quality of indoor climate required. The planner must accept that more calculations will be necessary in certain cases than have previously been required, and that the choice of certain typical solutions cannot always be made in a routine manner.

These instructions are intended to provide some guidance for the purchaser's and planner's work, through such means as the use of a structure plan suitable for use both by the purchaser for his requirement specifications and by the planner for project documents.

THE SCANVAC GUIDE-LINES

These guidelines are the result of a joint Scandinavian project carried out by Scanvac, the Federation of Scandinavian HVAC Societies. The work has been carried out by a committee appointed by Scanvac, consisting of the following persons:

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ASHRAE 55-1981 R
Thermal Environmental Conditions for Human Occupancy (Draft Standard)

NKB-report no. 40 1981.
NKB Guidelines for Indoor Climate (in Swedish)

WHO-AQG
World Health Organisation, 'Air quality guidelines for Europe', 1987

WHO-IAQ
World Health Organisation, 'Indoor air quality organic pollutions' 1989

BFS 1988:18
New Building Rules (Ministry of Housing) (in Swedish)

0.4 Definitions and concepts

0.41 Air quality

Bioeffluents:
Carbon dioxide, body odour etc., produced by human metabolism.

Emission:
Emission of volatile substances.

Hygienic air flow:
The air flow rate required to provide acceptable air quality.

Air quality:
Term referring to the effect on human health and other reactions, experiences or symptoms resulting from the water vapour and pollution content of the air.

Air change:
Quotient of air flow rate to or from a room and the volume of the room. ('Room' used here to describe any essentially enclosed space.)

CFU:
Colony-forming unit: a measure of bacteria content.

0.42 Types of air (the figures refer to the diagram [figure 0.421]):

Outdoor air (1)
The air outside the building.

Supply air (2)
Air supplied to a room (may consist of outdoor air [1], transfer(red) air [3], recirculated air [5] or circulation air [7], and infiltration [10]).

Exhaust air (4)
Air removed from the room.

Recirculated air (5)
Air returned to a group of rooms from which it has been exhausted.

Discharge air (6)
Air discharged to the atmosphere outside the building.

Indoor air (8)
Air in the room.

Infiltration (10)
Leakage of air into a building as a result of gaps in the building envelope.

Exfiltration (11)
Leakage of air out of a building as a result of gaps in the building envelope.

Ventilation:
Transport and replacement of air.

Mechanical ventilation:
Ventilation powered by a fan or some

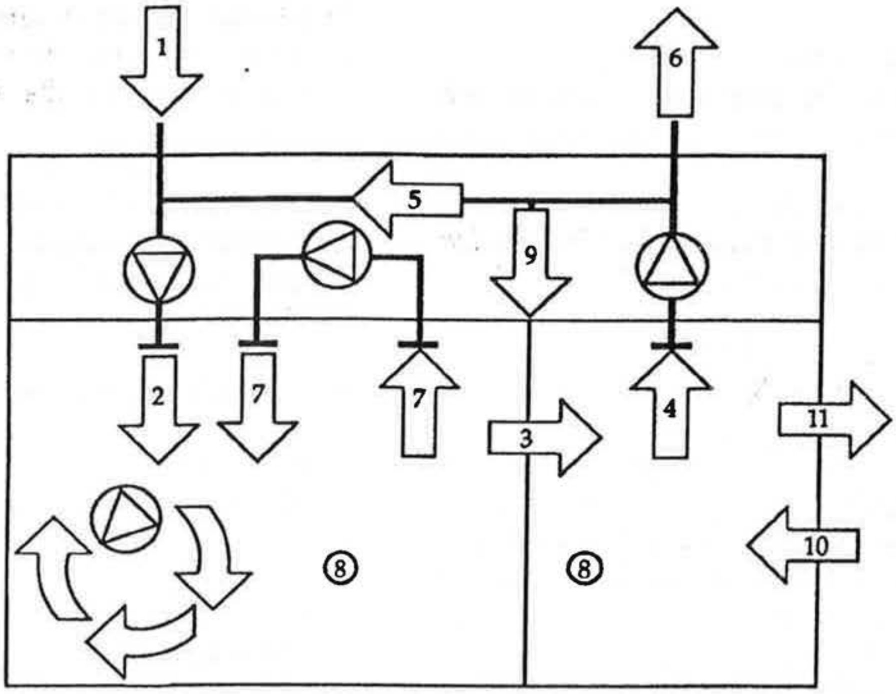


Fig 0.421 Definitions (see page 9)

other mechanical device. This is referred to as mechanical exhaust ventilation when the exhaust air flow is powered, and as balanced ventilation when both the supply and exhaust air flows are mechanically powered.

Ventilation efficiency:
A measure of the relationship between the pollutant concentration of the exhaust air and the average pollutant concentration in the indoor air.

Air exchange efficiency:
A measure of how quickly the air is replaced in a room.

Occupation zone:
Unless otherwise agreed from case to case, the occupation zone is defined as the area in the room bounded horizontally by the floor and a horizontal plane 1.8 m above the floor. Vertically, the zone is bounded by vertical planes parallel with the vertical bounding surfaces and at a distance of 0.6 m from them.

In the case of rooms or premises in which larger quantities of air pollutants can be expected, e.g. in certain industrial and laboratory premises, the size of the occupation zone is determined by the type of process and the positions of persons in the rooms or premises.

0.43 Thermal indoor climate

Metabolism:
Human energy use in the body.
Expressed in met, and varies with the level of physical activity. 1 met corresponds to a stationary, sedentary level of activity, having an energy turnover rate of 58 W per m^2 of body surface area. The average body surface area of an adult is about 1.8 m^2.

Clo:
Coefficient of thermal resistance of clothing. Expressed in clo, where 1 clo = 0.155 K m^2/W.

PMV (Predicted Mean Vote):
A climate index for assessing subjective experience of the thermal climate and activity.

PPD (Predicted Percentage Dissatisfied):
Anticipated number of persons dissatisfied.

Indoor climate systems:
The technical systems needed to establish a given indoor climate (heating and ventilation systems etc.). Air treatment and ventilation systems: Systems and devices intended to supply, distribute and process air for a room, premises, building etc., normally referred to as 'ventilation systems'.

Air distribution systems:
Fan and duct systems with air registers.

0.44 Temperature

Temperature is the factor that has the greatest effect on thermal comfort. The subjective impression of temperature depends on the actual air temperature and on radiation balance with warm and cold surfaces, air velocity etc. For this reason, a number of composite temperature concepts are employed.

- *Operative temperature (to),* which allows for the air temperature (ta) and the mean radiant temperature. The operative temperature is that weighted value of the air temperature (ta) and the mean radiant temperature (tr) which results in the same heat loss (as a result of convection and radiation) from a human body as the actual temperatures do. Where the air velocity is less than 0.2 m/s, the operative temperature can be calculated in the majority of cases as half the sum of the air temperature and the mean radiant temperature, i.e. to = 0.5(ta + tr).
- *Optimum operative temperature* is the temperature that satisfies the greatest number of persons with given clothing levels and engaged in a given activity.
- *Equivalent temperature (teq),* which allows for the air temperature and heat exchange as a result of radiation, and which is adjusted for the effects of air currents.
- *Radiant temperature asymmetry,* which allows for dissimilarities in heat exchange as a result of radiation (from cold and warm surfaces). Mean radiant temperature, the fictive temperature of surrounding temperature surfaces that results in the same heat loss through radiation from the human body as the actual temperatures do.

In order to indicate comfort limits and optimum temperatures etc. for the various different cases, these Guidelines use operative temperature (to). In practice, this can be approximated in many cases by the globe temperature (tg).

Relative humidity, the quotient of the vapour content in the air and the saturation vapour content is referred to as RH. The value is different at different temperatures.

Sanitary inconvenience, a disturbance that can be hazardous to human health, and which is not negligible or purely temporary.

0.45 Other definitions

Indoor climate:
General term for the physical factors that influence persons indoors.

Indoor climate quality:
General term for the overall effect of all the various indoor climate factors on persons.

Thermal quality:
Term for the overall effect on human thermal comfort resulting from the thermal indoor climate factors.

Thermal comfort:
A comfortable thermal balance with the environment.

Vertical gradient:
Vertical air temperature change.

Design outdoor temperature:
The lowest outdoor temperature (or the highest for the summer mode) at which it must be possible to maintain an acceptable indoor temperature.

0.46 Measurement

Globe thermometer:
A thermometer having a globe-shaped bulb, intended to represent the human body, and which allows for air temperature, radiant temperature and air velocity.

There is also a similar thermometer having an elliptical bulb. It is known as the elliptical thermometer, and provides a somewhat better representation of how the human body is influenced by the radiant temperature from the surroundings.

1 THE BASIS FOR CLASSIFICATION OF INDOOR CLIMATE

1.1 Prerequisites for classification

Classification of indoor climate in accordance with these Guidelines is based on subjective impressions of different indoor climate factors. The "percentage of dissatisfied", which indicates the predicted proportion of dissatisfied persons in a large group exposed to a given indoor climate quality, is used as a measure of this impression in terms of thermal comfort. For air quality, the quantifying criterion is a measure of frequency, indicating how many of a large group of persons are affected by the factor under consideration.

1.2 Percentage of dissatisfied values for the thermal quality classes

The percentage of dissatisfied values that have been used as the starting points for specification of the thermal quality classes are listed in Table 1.21.

Table 1.21 Thermal comfort (TQ) - percentage of dissatisfied for different quality classes and indoor climate factors.

Item	Indoor climate factor	Quality class				
		TQ1*	TQ2	TQ3	TQX	Notes
1	Operative temperature	<10%	10%	20%	As specified	
2	Air velocity	10%	10%	20%	"	
3	Vertical temperature difference	<10%	10%	20%	"	
4	Radiant temperature asymmetry	<10%	10%	20%	"	
5	Floor temperature	<10%	10%	20%	"	

* This class requires individual control of temperature and airflow.

Comments
An index of 10% for thermal indoor climate factors is in conformance with ISO 7730.
An index of 20% is in conformance with ASHRAE 61-1989.

In Table 2.21, the values "percentage of dissatisfied"in the table have been converted to acceptable values for different indoor climate factors. This conversion is based on well-known experimental results, and can therefore be regarded as relatively reliable.

1.3 Predicted adverse reaction frequency etc. for air quality classes

The frequency values that have been used as starting points for specification of the various air quality classes are listed in Table 1.31.

Table 1.31 Indoor air quality (AQ) - frequency values for different quality classes and indoor climate factors

Items	Indoor climate factor	Quality class			
		AQ1	AQ2	AQX	Notes
1	As determined by toxicological assessment	-	-	As specified	Note 1
2	Adverse reaction	0-1%	5%	"	Note 2
3	Mucous membrane irritation	0-1%	10%	"	Note 3
4	Dissatisfaction with subjective air quality	10%	20%	"	Note 4
5	Odour detection as first impression	10%	50%	"	Note 5

Note 1: Toxicological assessment relates to reactions that can result in health hazards. Irrespective of quality requirements, statutory requirements must be complied with, e.g. as specified by the National Board of Health and Welfare, the National Housing Board or the National Board of Occupational Safety and Health.

Note 2: Adverse reactions are reactions that can result in quantifiable responses as determined by medical/occupational hygiene adverse reaction detection methods. A frequency of 5% as shown in AQ2 is equivalent to the value specified in the WHO Air QualityGuidelines for Europe (WHO-AQG).

Note 3: Mucous membrane irritation is defined as being barely perceptible irritation, e.g. irritation of the eyes. The frequency of 10% in category AQ2 is equivalent to WHO-IAQ (Indoor Air Quality, 1989).

Note 4: 'Dissatisfaction' refers to subjective experience of indoor climate based on the human senses.

Note 5: Odour detection refers to barely detectable odour when entering the premises. A frequency of 50% is equivalent to the value given in WHO-IAQ.

Comments to table 1.31

The frequency values shown above have been converted to acceptable ranges of various air quality factors, as shown in Table 2.22. This conversion is based partly on assumptions that have still not been wholly verified, and is therefore somewhat less reliable than the values for thermal conditions given in Table 1.21.

1.4 Comments on the classification system

The classification system used in these Guidelines has been based on assessments of predicted human perception reactions in response to different qualities of indoor climate. The classes have been defined in physical terms that can be regarded as relatively unambiguous. However, the interrelationships are of a statistical nature, based on large groups of persons. The results, i.e. the number of dissatisfied persons, cannot therefore be expected always to be as exact as shown in Tables 1.21 and 1.31. The percentage of dissatisfied values and adverse reaction frequencies shown in the two tables must, therefore, not be regarded as indications of 'guaranteed outcome for each individual system'. The tables indicate the classification objectives, rather than individually quantifiable functions.

2 QUALITY REQUIREMENTS FOR INDOOR CLIMATES IN DIFFERENT CLASSES

2.1 The constituents of indoor climate

An individual's impression of, and reaction to, a given indoor climate is assumed to be dependent on the quality of a number of indoor climate factors. These factors are here assumed to be the following:

- Thermal conditions.
- Level of gaseous and particulate pollutants in the indoor air (air quality).
- Electrical factors (not considered here).
- Noise level.
- Illumination (not considered here).

Section 2.2 describes quality requirements for thermal conditions, air quality and noise for the various quality classes.

2.2 Quality requirements for indoor climate factors in different quality classes

The quality requirements that different indoor climate factors shall fulfil in order to correspond to the quality definitions given in Section 1 are shown in the following tables:

- thermal quality, Table 2.21.
- indoor air quality: Table 2.22.
- outdoor air quality: Table 2.23.
- noise level: Table 2.24.

Note the following points when using these tables:

- Table 2.21 (thermal quality) relates to the normal case, with light work in a mainly sedentary posture and light clothing (1.2 met, 1.0 or 0.5 clo). Appendix B 1 can be used to convert these values for other conditions.

- The thermal power requirement for heating can be calculated on the basis of the difference between the indoor air temperature equivalent to the 'lowest operating temperature' and the design outdoor temperature for the winter case. The indoor air temperature may not fall more than 3° C below the specified level more than once in five years. This means that the method of calculation as described in Swedish Standard SS 024310 can be employed.

- The cooling power requirement for cooling can be calculated on the basis of the difference between the air temperature equivalent to the 'highest operating temperature' and the design outdoor temperature for the summer case.

Table 2.21 Thermal quality - acceptable values of different factors in various quality classes

The table indicates values for the normal case, as described in Section 2.2. The values shown can be converted to suit other cases using the factors in Appendix B 1.

Item	Indoor climate factor	Factor value in quality class TQ1	TQ2	TQ3	TQX	Notes
1*	**Operating temperature (to)**				As specified	
1.1	Winter mode					Note 1.1
	highest value °C	23	24	26		
	optimum value °C	22	22	22		
	lowest value °C	21	20	18		
1.2	Summer mode				"	Note 1.2
	highest value °C	25,5	26	27		
	optimum value °C	24,5	24,5	24,5		
	lowest value °C	23,5	23	22		
2*	**Air velocity within the occupation zone**				"	Note 2
	winter mode m/s	0,15	0,15	0,15 (0,25)		
	summer mode m/s	0,20	0,25	0,40		
3*	**Vertical temperature difference, summer/ winter mode °C**	2,5	3,5	4,5	"	Note 3
4*	**Radiant temperature asymmetry**				"	Note 4
	to warm ceiling °K	4	5	7		
	to cold wall (window) °K	8	10	12		
5*	**Rate of change of temperature °C/h**	-	-	-	"	Note 5
6**	**Air humidity**	-	-	-	"	Note 6
7**	**Floor temperature**				"	Note 7
	maximum value °C	26	26	(32)		
	lowest value °C	22	19	16		
	optimum value °C	24	24	24		Bathroom 18°C area with children 20 °C
8*	**Temperature variation amplitude °C**	± 2	(± 1)	-	"	Note 8

Note 1.1: Note that the winter mode is equivalent to a clothingfactor of 1.0 clo. See Appendix B 1 for conversion to other values.

Note 1.2: Note that the summer mode is equivalent to a clothingfactor of 0.5 clo. See Appendix B 1 for conversion to other values.

Note 2: The air velocity is expressed as a mean value over a period of three minutes within the comfort temperature interval, and with the provision that other factors are within the comfort range and that the turbulence intensity is 30-50%. See Appendix B2 for conversion factors.

Note 3: The values shown in the table relate to that part of the occupation zone between 0.1 and 1.1 m above the floor. The value of 3.0 °C/m is, in any case, regarded as high. A value of 2.0 °C/m is often recommended for sedentary work. See Appendix B 2 for conversion factors to other Percentage of dissatisfied-values.

Note 4: The values shown apply for a plane 0.6 m above the floor. See Appendix B 2 for conversion to other percentage of dissatisfied-values.

Note 5: Temperature change in this context relates to rampchanges of operating temperature resulting from active temperature control, or temperature drift resulting from other causes. Certain international standards specify limiting values for these functions, although this has not been done in these Guidelines.

Note 6: Air humidity plays no greater part in the subjective experience of thermal comfort. For this reason, we have not specified any recommended standard values. However, from the point of view of the building structure, it is desirable that air should not contain a higher water vapour content than 7 g/kg, equivalent to a relative humidity of about 50%. Air humidity in residential buildings, in particular, should be lower than this value for at least 1-3 months per year in order to counter the growth of dust mites. See also Appendix B 1.

Note 7: See also Appendix B 2.

Note 8: Temperature control amplitude refers to the change in set value that can be applied manually on the basis of the optimum value of operating temperature. Note that control systems allowing individual adjustment of set values are assumed to be countered primarily in quality class TQ1, which means that it is normally irrelevant to express values in the other quality classes.

* Items indicated by an* are design rating factors.

** Items indicated by** are not design rating factors. Design rating factors are those in respect of which requirements are made relating to fulfilment of these Guidelines.

Table 2.22 Indoor air quality - acceptable levels of pollutants in indoor air of different air quality classes

Item	Pollutant		Maximum permissible quantity mg/m³ in class			Notes
			AQ1	AQ2	AQX	
1	Carbon monoxide, total	MV 0,5 h	60	60	As specified	See note 1a
		MV 8 h	6	6		See note 1b
	- from tobacco-smoke	MV 1h	2	5	"	See note 3
2	Carbon dioxide	MV 1 h	1000	1800	"	See note 2
		(in ppm*)	600	1000		
3	Ozone	MV 1 h	0,05	0,07	"	See note 3
4	Nitrogen dioxides	MV 1 h	0,11	0,11	"	See note 1b
		MV 24 h	0,08	0,08		
5	Volatile organic compounds (VOC)					
	- total	MV 0,5 h	0,2	0,5	"	See note 4
	- formaldehyde	MV 0,5 h	0,05	0,1		See note 5
6	Particles from tobacco-smoke, inhalable	MV 1h	0,1	0,15	"	See note 3
7	Dust**		0,06	0,15	"	See note 6
8	Mildew*** cfu/m³		50	150	"	See note 7
9	Bacteria cfu/m³		4500	4500	"	

Mean values (MV) are over the time periods as shown.

* ppm can be converted to microgram/ m³ (µg/m³) by the following formula: ppm = 24.1 x content in mg per m³/mole weight in g.Typical mole weights are: carbon dioxide 44, carbon monoxide 28,sulphur dioxide 64, ozone 36, nitrogen dioxide 44, nitric oxide 30, formaldehyde 30.

** Dust in mg/m³ can be converted to the approximate number of particles in accordance with the following formula: number of particles = number of mg x 5000. (This is valid for a particle size of about 10 µm, i.e. for relatively coarse dust.)

***1 cfu=1 Colony-Forming Unit. For pathogenic spores, this value must be 0.

Note 1a: Values in accordance with WHO-AQG.

Note 1b: Values in accordance with Swedish Environmental Protection Board draft proposal 890808.

Note 2: Values for AQ1 in accordance with ASHRAE 62-1989 and forAQ2 in accordance with Morey et al (IAQ 1986).

Note 3: Values in accordance with WHO-Euro 103, 1986.

Note 4: Values partly in accordance with Molhave, partly in accordance with summary from Healthy Buildings 1988 (HB-88).

Note 5: Values in accordance with WHO-IAQ and Berglund et al,1985.

Note 6: Values in accordance with O. Seppanen, 1989.

Note 7: Values in accordance with Holmberg The Healthy House, 1987 and Canadian Ministry of Health, 1987.

Table 2.23 Outdoor air quality - acceptable levels of pollutants in outdoor air used as supply air.

Substance		Maximum concentration* in mg/m³	Notes
Carbon monoxide	8h-MV	2,0	
Sulphur dioxide	24h-MV	0,1	Note 1
Nitrogen dioxide	1h-MV 24h-MV	0,11 0,08	Note 1
Soot **	24h-MV	0,09	Note 1
Particles <10µm (Total PM 10 fraction)	24h-MV	0,11	Note 1

* Pollutants in outdoor air may not exceed a maximum of 5% of the occupational hygiene limit values for the working environment stated in AFS 1989:4. The table above is based on this, unless otherwise indicated in the Notes column.

** Soot is regarded as being respirable fractions in sizes up to 10 micrometer (µm).

Note 1. Values in accordance with the Swedish Environmental Protection Board draft proposal, 1989-08-08.

Table 2.24 Noise level - acceptable values for continuous noise levels in different quality classes.

Item	Factor	Highest level in class			Notes
		NQ1	NQ2	NQX	
1	**Sound pressure level dBA**			As specified	
1a	- dwelling room - bedroom - kitchen - bathroom - WC	- - - - -	30 30 35 40 40	"	Note 1
1b	- office premises - conference premises	- -	30 35	"	Note 2
1c	- educational premises - dining room - child day-care centre	30 30 30	35 35 35	"	Note 2
1d	- hotel room - lobby - restaurant	30 35 35	35 40 40	"	Note 2
1e	- business premises	40	45	"	Note 2
1f	- hospital room - corridor - WC etc.	25 30 40	30 35 40	"	Note 2
2	**Sound pressure level, low frequency, <500 Hz, dB(C)**	35	40	"	
3	**Sound pressure level, infranoise, dB (GL)**	60	60	"	

Key to the table:
If a dash (-) is shown in the NQ1 column, this means that only class NQ2 should be applied.

Note 1. The values given are in accordance with the Swedish Buildings Regulations.

Note 2. The values given for class NQ2 are in accordance with the Finnish Building Regulations, D2 1987, issued by the Finnish Ministry of Environment.

2.3 Deviations

2.31 Thermal comfort and noise level

Table 2.31 shows acceptable deviations from the values given in Section 2 in respect of thermal comfort, air quality and noise level. The acceptable deviations from these values shown in the table include the overall measurement error.

This means that, irrespective of the method of measurement employed, departures from the values in excess of those shown in the table cannot be accepted. The values in the table refer to measurements made at, or converted to, design rating values (optimum values) as specified in Section 2.2.
See Section 4 for details of methods of measurement.

Table 2.31 Acceptable deviations

Item	Indoor climate factor	Departure	Notes
1	**Temperature factors** Operative temperature (°C)	± 1,2	Note 1
2	**Air velocity** Air velocity as a 3-minute mean value (m/s)	± 0,05	
3	**Noise level** sound pressure level measured in the room (dBA)	± 2	

Note 1: The permissible temperature variation of 1.2 °C relates to the operating mode requiring the highest heating/cooling power.

2.32 Air quality

Many, not yet standardised, methods are used to measure air quality. The choice of method depends primarily on the particular air quality factor or pollution components to be measured. Until more accurate specifications of methods of measurement and measurement errors become available, it is recommended that a measurement error of at least 10% be allowed for when making air quality measurements.

2.33 Air flow rate

A total deviation of ± 15% of the nominal value can be approved when measuring air flow rates. It is assumed that the methods used are capable of producing results having a maximum measurement error not exceeding ± 10%. See Section 5 for methods of measurement.

3 INDOOR CLIMATE SYSTEMS - DESIGN AND IMPLEMENTATION

3.0 Overview

If an indoor climate system is to be given a quality rating in accordance with these Guidelines, it must comply not only with the quality specifications for the appropriate climate class as specified in Section 2, but also with the technical requirements in this section (Section 3).

3.1 Ventilation air treatment systems

3.11 System solutions

3.111 Technical solutions (ventilation method etc.)

No special requirements relating to the type of technical equipment or design, type of ventilation method etc. are laid down in these Guidelines.

3.112 Air flow rate

Ventilation systems shall be so designed, and have such rated capacities, that the air quality requirements in accordance with Section 2 (Table 2.22) are fulfilled. The lowest outdoor air flow rate needed for this purpose (the hygiene air flow rate) shall be calculated in accordance with one of the following alternatives.

Alternative 1.
Routine design rating of air flow

Calculate the necessary hygiene air flow rate from one of the case methods given in Appendix B 3. These methods are deemed to fulfil the air quality requirements of Table 2.22 without requiring special measurement of the indoor air quality.

The standard case methods can be applied when pollution and material emission factors are not known with any greater degree of accuracy.

Alternative 2.
Individual determination of air flow rating capacities

Calculate the necessary hygiene air flow rate as appropriate to the conditions encountered in the case concerned. Suitable methods of calculation can be found in the Swedish Indoor Climate Institute's publication 'Rules for Design and Procurement of Indoor Climate Systems'. Individual determination of rated air flow capacities can be applied when pollution and emission conditions are known. Individual determination of design capacities must also be employed in those cases in which the conditions for standard design procedures (Alternative 1) are not fulfilled.

It should be noted that premises or buildings having high surplus heat levels may require air flow rates greater than the hygiene air flow rate in order to fulfil the thermal comfort requirements as set out in Section 2.2. In such cases, calculate the necessary air flow rate using thermal balance procedures.

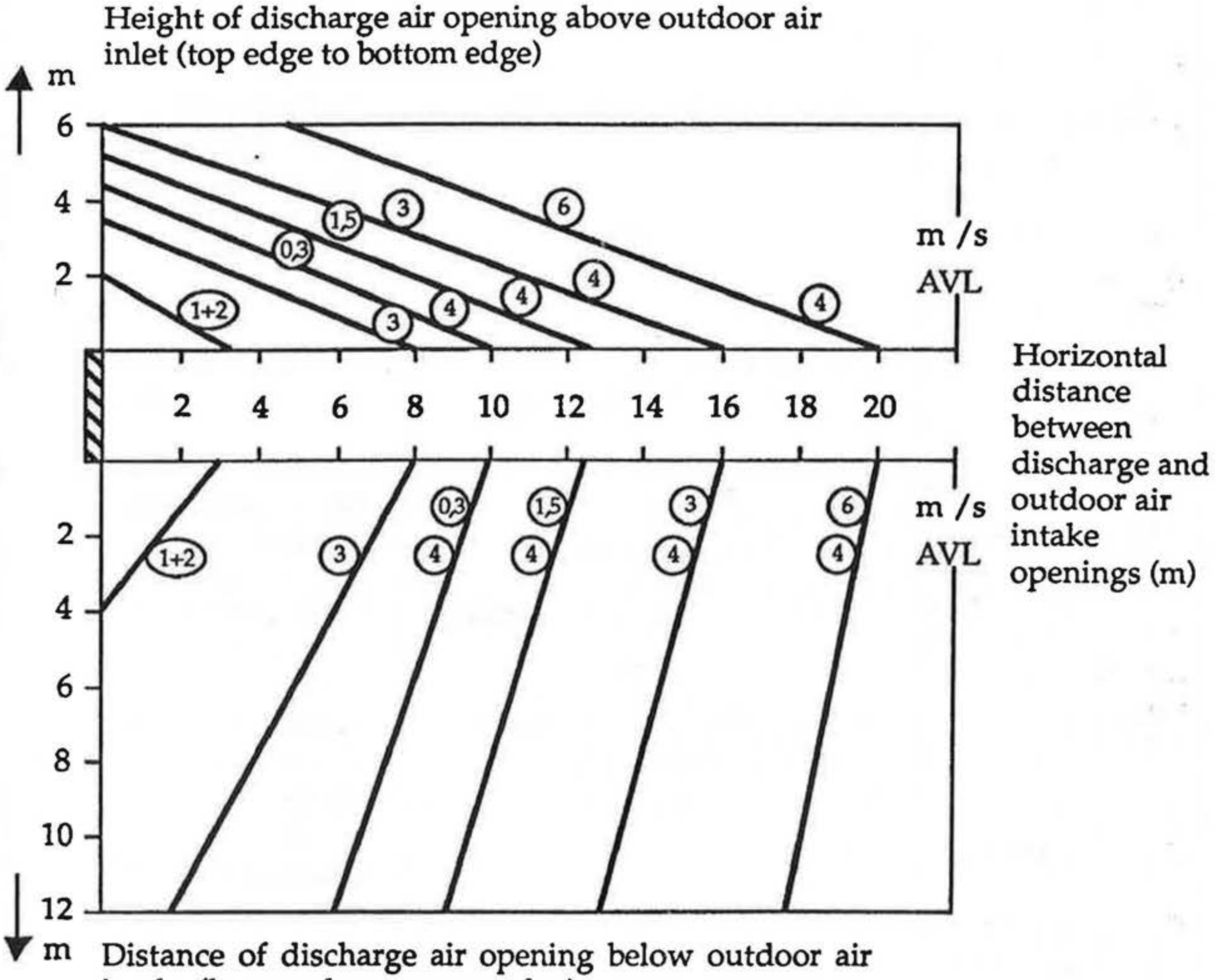
3.113 Air distribution

As far as air distribution, use of transferred air and so on no special requirements are laid down in these Guidelines. (See Section 3.4 concerning the use of recirculated air.)

3.12 Air distribution systems

The following points apply for the design of air distribution systems.

- Install outdoor air intakes in such positions that the air can be expected not to be polluted by discharge air, traffic fumes and so on, or to be affected by solar radiation. Figure 3.121 illustrates acceptable positions.
- Install discharge air openings in such positions that there is no inconvenience to the surroundings, and that supply air is not polluted. Figure 3.121 illustrates acceptable positions.
- Comply with the requirements of national standards etc.
- The Swedish Indoor Climate Institute has published special Guidelines, 'Classified air distribution systems - guidelines and specifications', in order to indicate suitable designs of air distribution systems.



AVL = Discharge Air Class

Figure 3.121 Suitable minimum separations between outdoor air intakes and discharge air points.

Table 3.122 Classification of discharge air (exhaust air)

Class	Definition	Example of premises with discharge air categories in the class
AVL 1	Exhaust air from premises etc. with no pollutants other than bio-effluent and building material emissions from:	
AVL 1a	- low-emission surface coatings	
AVL 1b	- medium-emission surface coatings	
AVL 1c	- high-emission surface coatings	Office rooms Dwelling rooms Service premises without odour loading etc.
AVL 2	Exhaust air from premises having low odour loading	Service premises Changing-rooms etc.
AVL 3	Exhaust air from areas in which dust, moisture, process emissions, odour etc. significantly degrade air quality	WC/washrooms Kitchens Laboratories Copy rooms etc.
AVL 4	Exhaust air containing health-hazardous or strongly odourous substances	Fume cupboards Canteen/restaurant kitchens Grills Process premises

Table 3.181 Contents of the system description

The following table shows examples of information that should be included in a system description for an indoor climate and ventilation system etc.

Item	Heading	Notes
1.	**Conditions, quality specifications**	
1.1	**The building** Give details of the type of building, its purpose etc.	
1.3	**Ambient conditions, surroundings** Give details of: - outdoor air quality - infiltration to the building	
1.4	**Emission conditions** Give details of: - material emission class for various premises etc. - specific indoor air pollution sources - occupier loading in different premises	 See B 5.1 See B 4.
1.5	**Quality classes** Give details of: - quality classes for indoor climate system (and for different premises) - air distribution system class	 See 2.2 See B 4
1.6	**Energy form etc.** Give details of: - method and form of energy supply - energy balance of the building - maximum power requirements for heating, fan operation, cooling etc. - operating times for ventilation and heating systems	
3	**Technical systems**	See 3.0-3.5
3.1	**Ventilation and air conditioning systems**	
3.11	**System solutions**	
3.111	**Technical solutions, type of ventilation** Give details of design principles employed, e.g.: - type of ventilation- variable flow or constant -flow system	See 3.1

(cont.)

Table 3.181 (cont.)

Item	Heading	Notes
3.112	**Air flow rate** Give details of air flow rates in different areas	
3.113	**Air distribution**	
3.12	**Distribution system** Give details of main design features of duct systems etc.	See 3.2
3.13	**Air conditioning** Describe the main principles of providing the following: - heating - cooling - filtration	See 3.3
3.14	**Heat recovery** Give details of: - type of heat recovery and amount of heat recovered - any use of recirculated air	See 3.4
3.15	**Control system** Indicate the main design features of the control and monitoring system	See 3.5
3.16	**Other systems**	

Key to the table:

1) The references in the Notes column refer to the respective items in the Indoor Climate Guidelines and appendices

2) The item numbers in the Item column refer to the corresponding numbers in the checklist in the Institute's'Directions for Design and Procurement of Indoor Climate Systems'. For this reason, there are a number of jumps in the numbering in the table above

Appendix B 1 Conversion of thermal indoor climate factors for different application cases

B 1.0 General

The values of thermal indoor climate factors used in Section 2 for specification of quality classes TQ1, TQ2 and TQ3 apply for the reference condition. This is equivalent to an activity factor of 1.2 met, a clothing factor of 1.0 or 0.5 clo and a relative humidity of 50% RH during the winter and 60% RH during the summer. Figure B 1.11 and Tables B 1.12 - B 1.13 can be used to calculate the values of the indoor climate factors under different conditions in terms of activity factor and clothing factor.

B 1.1 Relationship between optimum operative temperature and met/clo values

Figure B 1.11 shows how the optimum operative temperature varies with activity factor, expressed as met value, and clothing factor, expressed in clo. Met values for different activities are listed in Table B 1.12. Note that Table B 1.12 is a brief summary in accordance with ISO 7730. Table B 1.13 gives clo values for typical types of clothing.

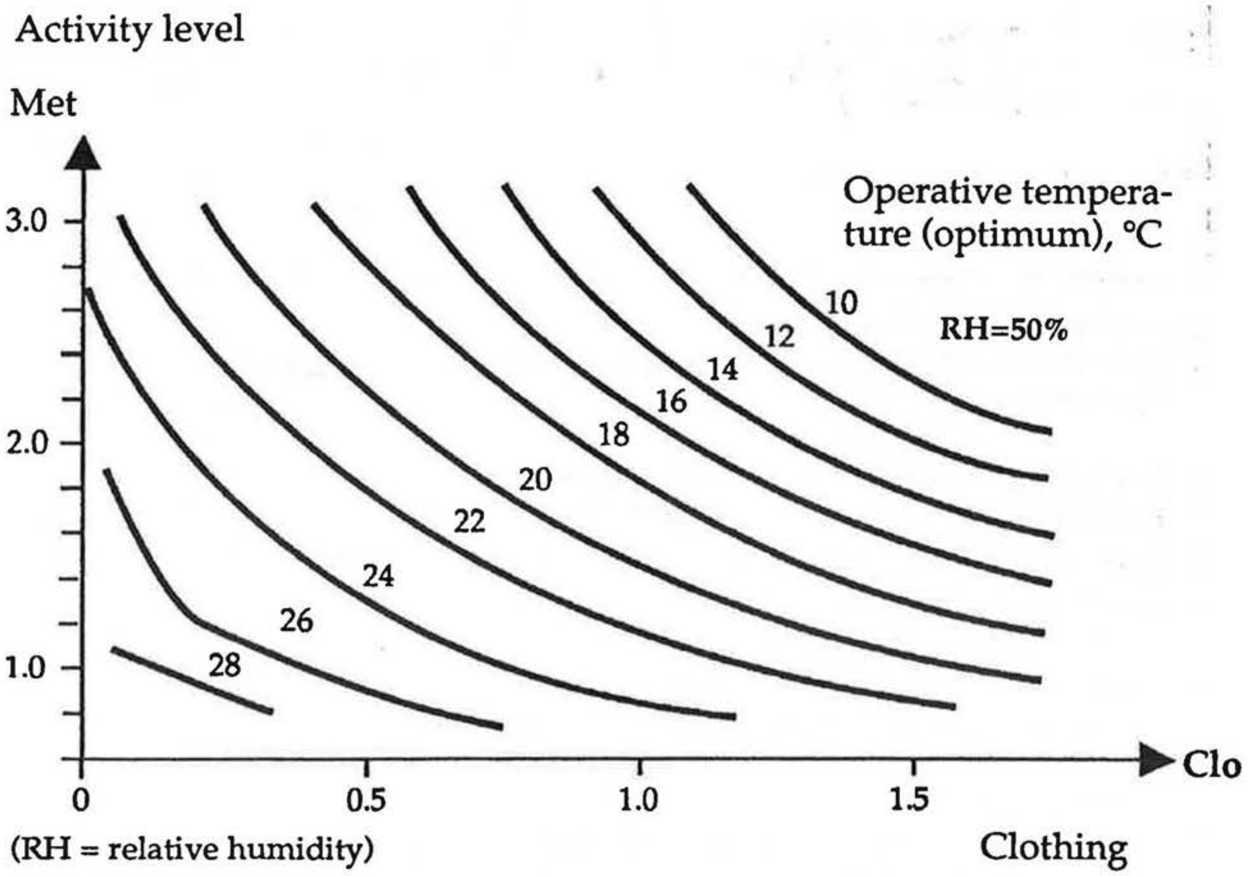


Figure B 1.11 Relationship between optimum operative temperature and met and clo values

Table B 1.12 Metabolic rates

Activity	Metabolic rate	
	W/m²	Met
Reclining	46	0,8
Seated, relaxed	58	1,0
Standing, relaxed	70	1,2
Sedentary activity (office, dwelling, school, laboratory)	70	1,2
Standing acticity (shopping, laboratory, light industry)	93	1,6
Standing activity (shop assistant, domestic work, machine work)	116	2,0
Medium activity (heavy machine work, garage work)	165	2,8

Table B 1.13 Clo values of clothing ensembles

Clothing ensemble	Clo	
	m² °C/W	(Clo)
Nude	0	0
Shorts	0,015	0,1
Typical tropical clothing ensemble: briefs, shorts, open-neck shirt with short sleeves, light socks and sandals	0,045	0,3
Light summer clothing: briefs, long light-weight-trousers, open-neck shirt with short sleeves, light socks and shoes	0,08	0,5
Light working ensemble: light underwear, cotton work shirt with long sleeves, work trousers, woollen socks and shoes	0,11	0,7
Typical indoor winter clothing ensemble: underwear, shirt with long sleeves, trousers, jacket or sweater with long sleeves, heavy socks and shoes	0,16	1,0
Heavy traditional European business suit: cotton underwear with long legs and sleeves, shirt, suit including trousers, jacket and waistcoat, woollen socks and heavy shoes	0,23	1,5

B 1.2 Relationship between operative temperature and relative humidity etc.

Figure B 1.21 indicates the relationship between optimum operative temperature and relative humidity. The optimum operative temperature varies relatively little with relative humidity. It should be noted that relative humidity is not an indoor climate factor that determines design ratings or capacities, which means that it is not normally necessary to convert temperature values as obtained in Section 2 with respect to relative humidity.

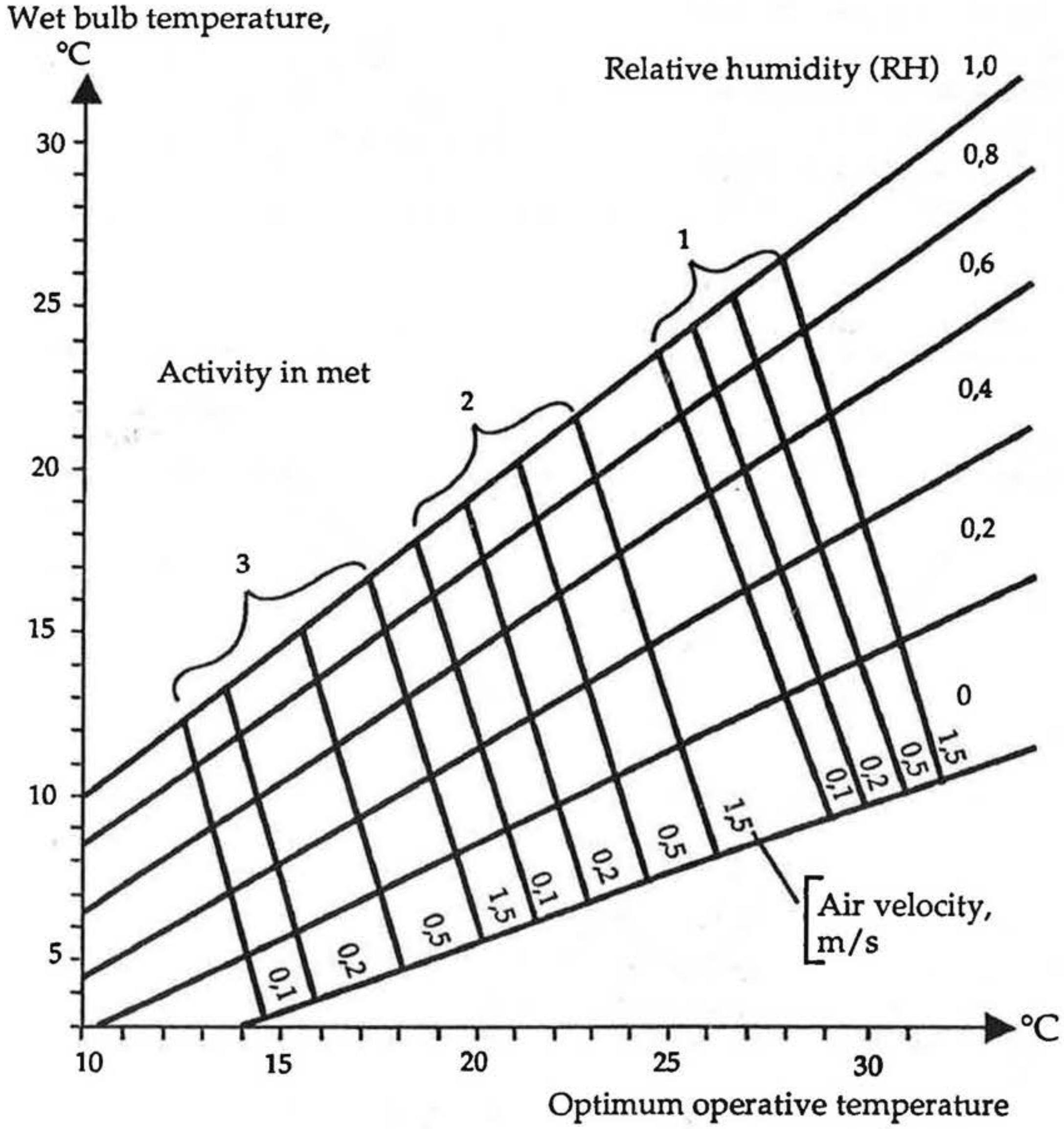


Figure B 1.21 Relationship between optimum operative temperature and relative humidity etc.

Appendix B 2 Human sensitivity to different indoor climate factors

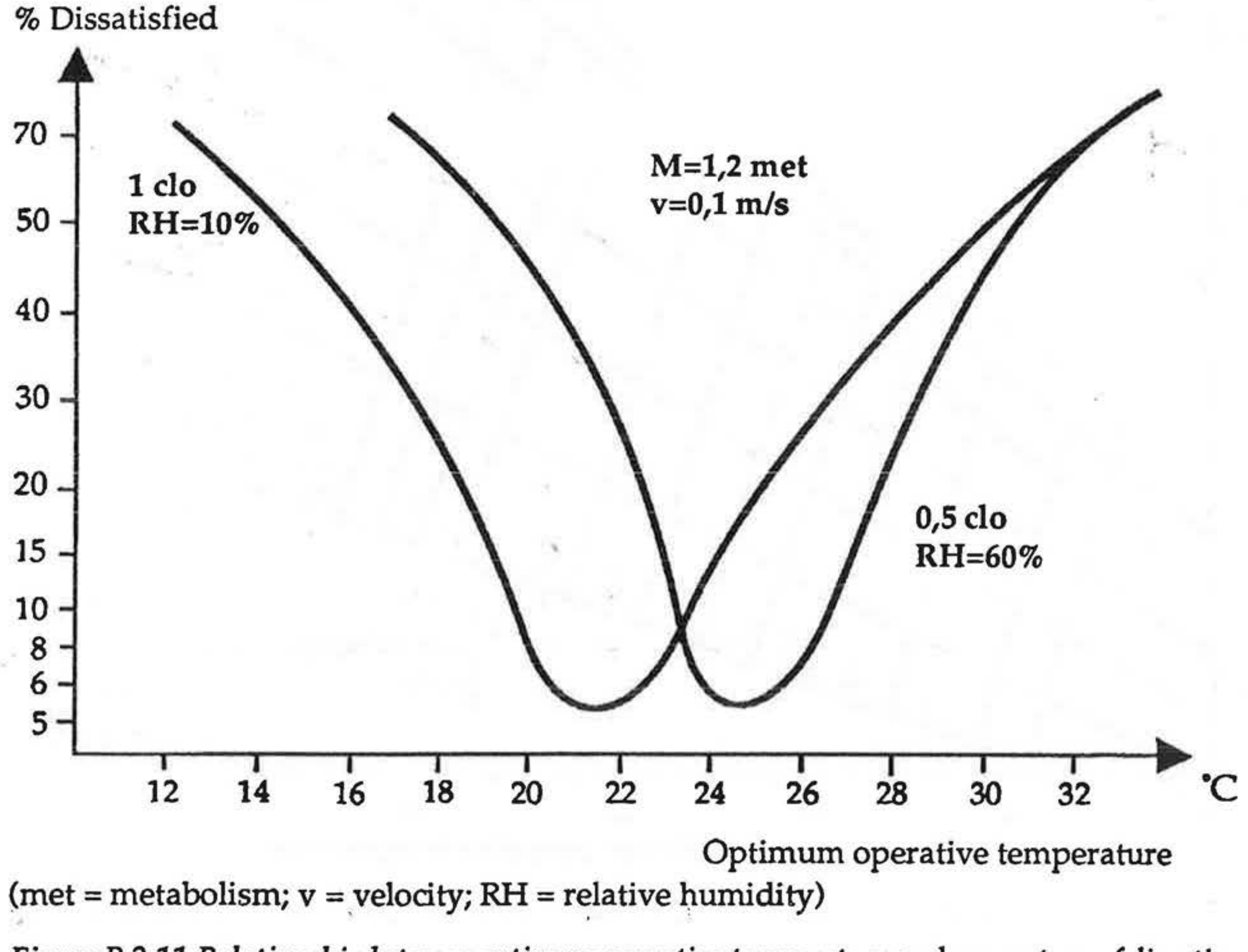
B 2.0 General

Human sensitivity to variations in different indoor climate factors can be evaluated using the percentage of dissatisfied-value. The more rapidly the percentage of dissatisfied-value changes in response to a given change of an indoor climate factor, the more sensitive persons are to the factor.
Details of the relationship between the percentage of dissatisfied-value and different indoor climatic factors are shown in the diagrams in Sections B2.1 - B 2.5.

These diagrams can be used for such purposes as calculating the values of indoor climate factors between or outside the class groups listed in Sections 2.1 - 2.2.

B 2.1 Operative temperature and percentage of dissatisfied

The relationship between optimum operative temperature and the percentage of dissatisfied for different application cases (level of activity, clothing, air velocity, relative humidity) is shown in Figure B2.11.



(met = metabolism; v = velocity; RH = relative humidity)

Figure B 2.11 Relationship between optimum operative temperature and percentage of dissatisfied-value

B 2.2 Air velocity and percentage of dissatisfied

The relationship between air velocity and the percentage of dissatisfied-value at different air temperatures is shown in Figure B 2.21. It is valid for 30-50% turbulence intensity.

It can be noted that human sensitivity to air velocity is relatively high, and is also dependent on turbulence, i.e. on the variations in air velocity around the mean value.
There are considerable variations in what is regarded as a suitable air velocity as given by different sources.

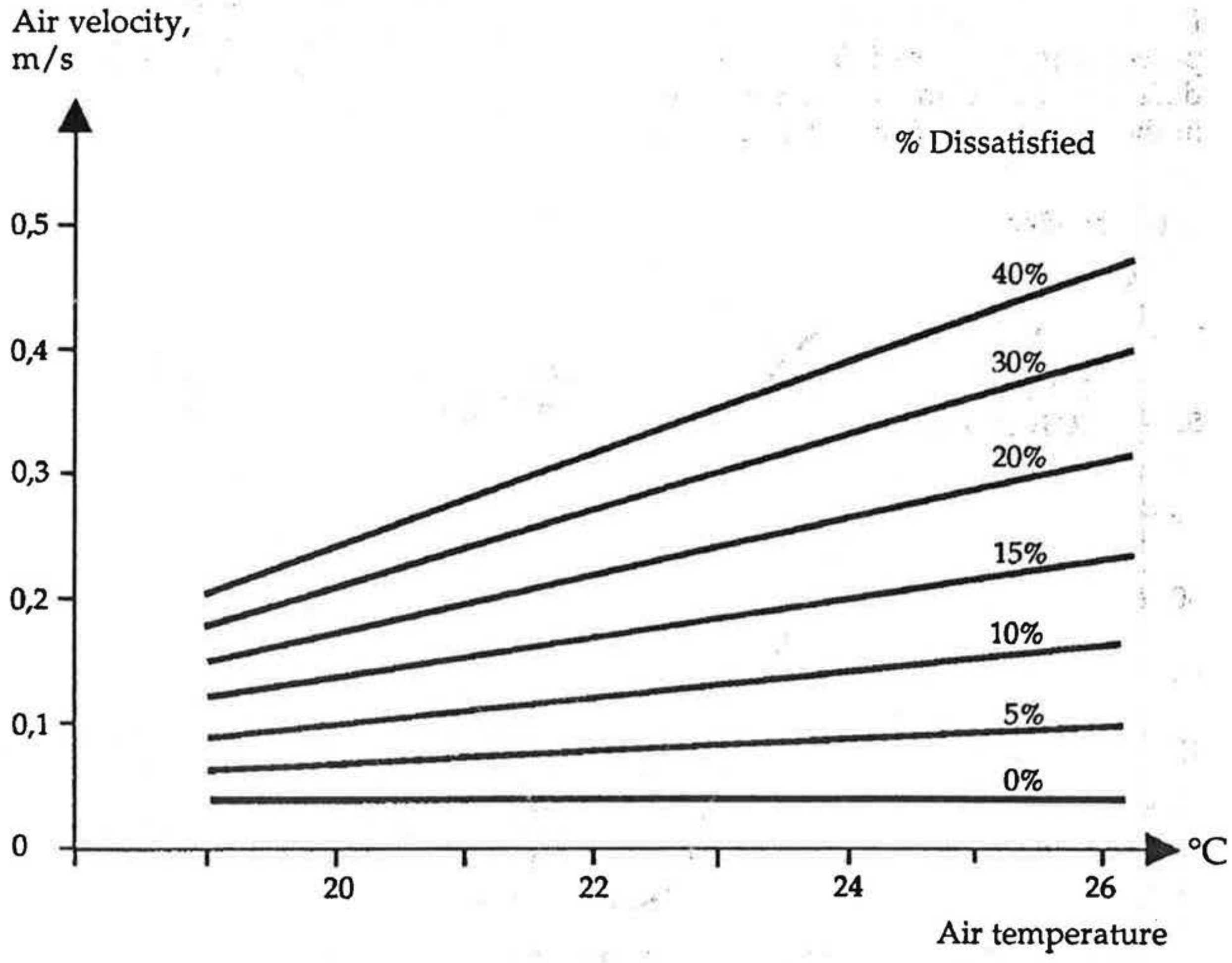


Figure B 2.21 Relationship between air velocity and percentage of dissatisfied-value

B 2.3 Vertical air temperature difference and percentage of dissatisfied

Figure B 2.31 shows the relationship between vertical air temperature difference and percentage of dissatisfied.

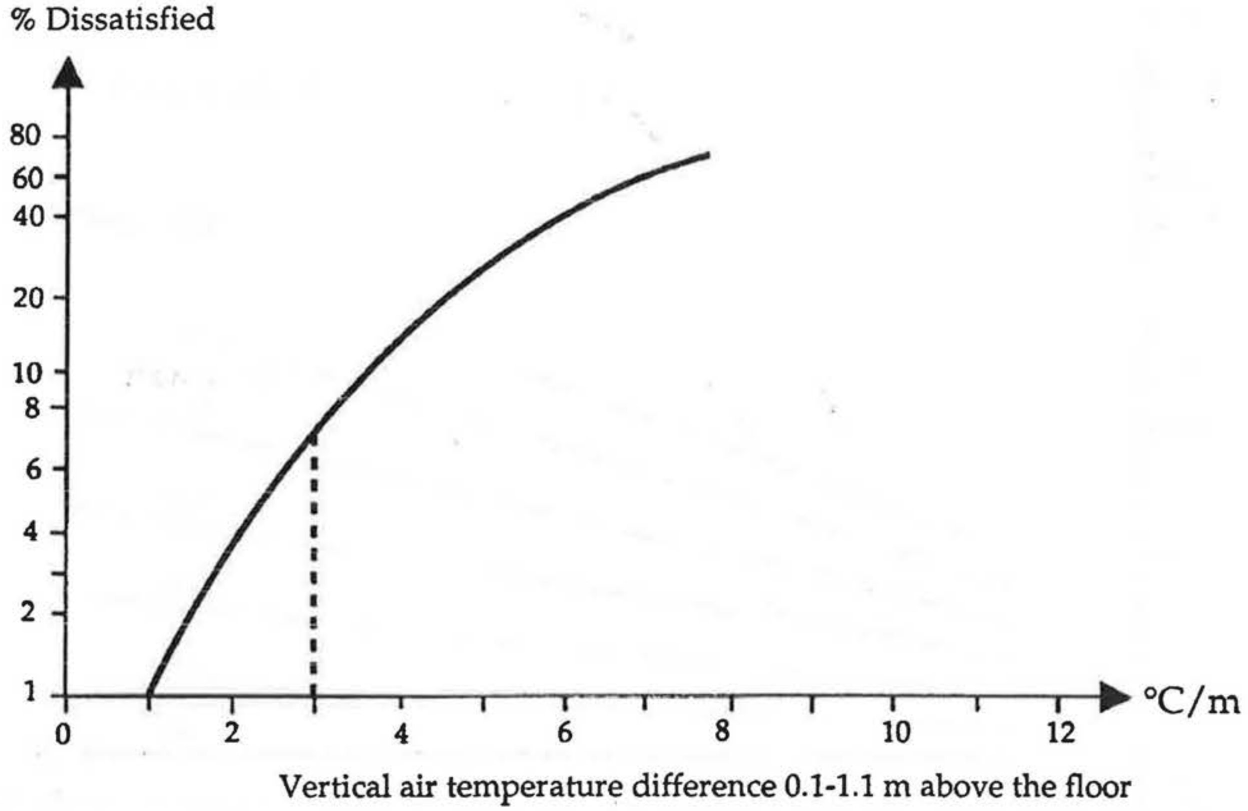


Figure B 2.31 Relationship between vertical air temperature difference and percentage of dissatisfied

B 2.4 Radiant temperature asymmetry and percentage of dissatisfied

The relationship between radiant temperature asymmetry and percentage of dissatisfied for different cases is shown in Figure B 2.41.
These temperature values are higher than those shown in Table 2.21, Item 4.

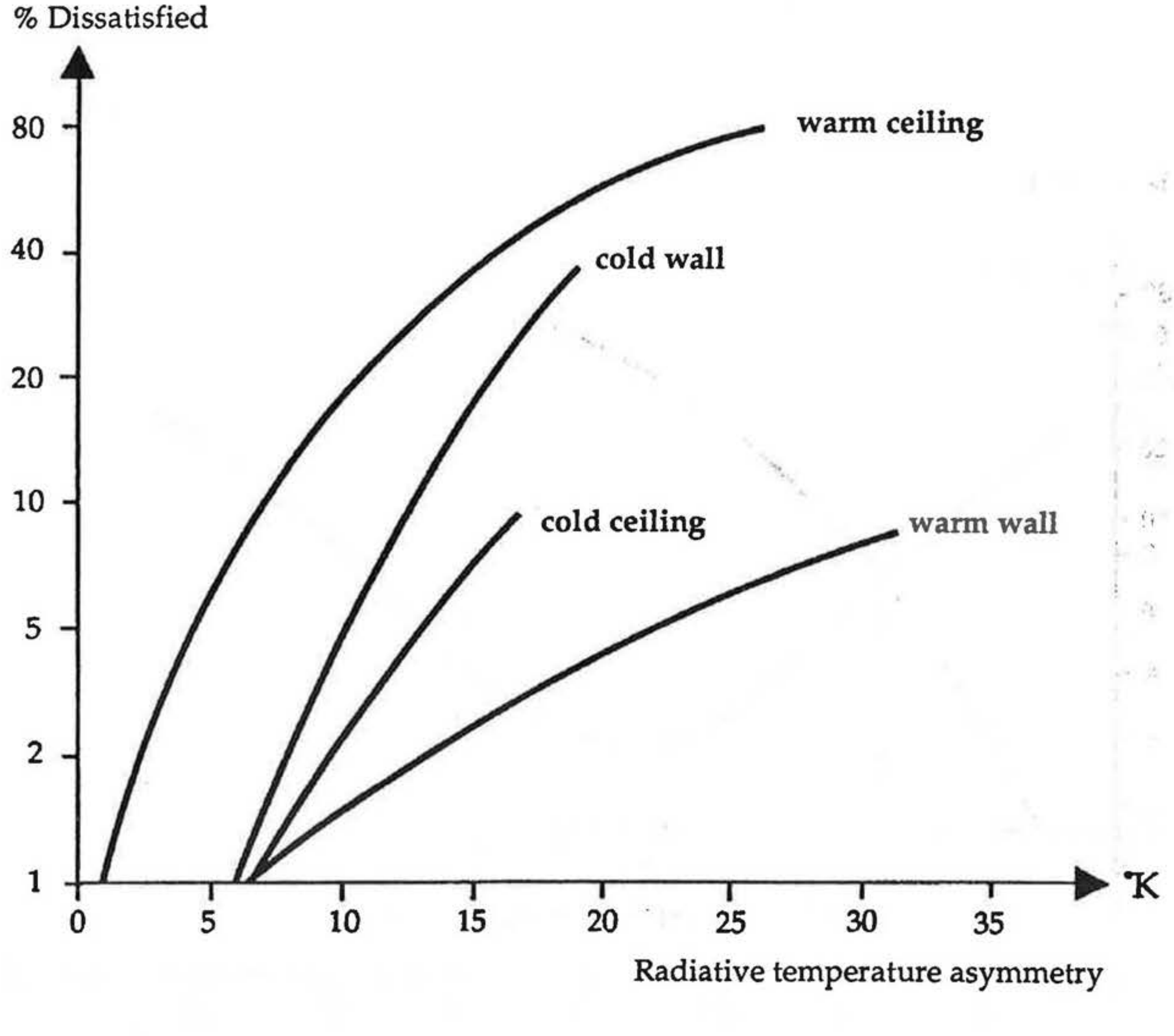


Figure B 2.41 Relationship between radiant temperature asymmetry and percentage of dissatisfied

B 2.5 Floor temperature and percentage of dissatisfied

The relationship between floor temperature and the percentage of dissatisfied is shown in Figure B 2.51.

In areas occupied by persons with bare feet, e.g bathrooms, swimming pools etc., the floor covering material also plays its part in comfort. The comfort interval for floors in such areas are as follows:

Stone, marble, concrete:	27-30 °C
Linoleum, PVC:	25-29 °C
Wood:	23-28 °C
Textile coverings (mats):	21-28 °C

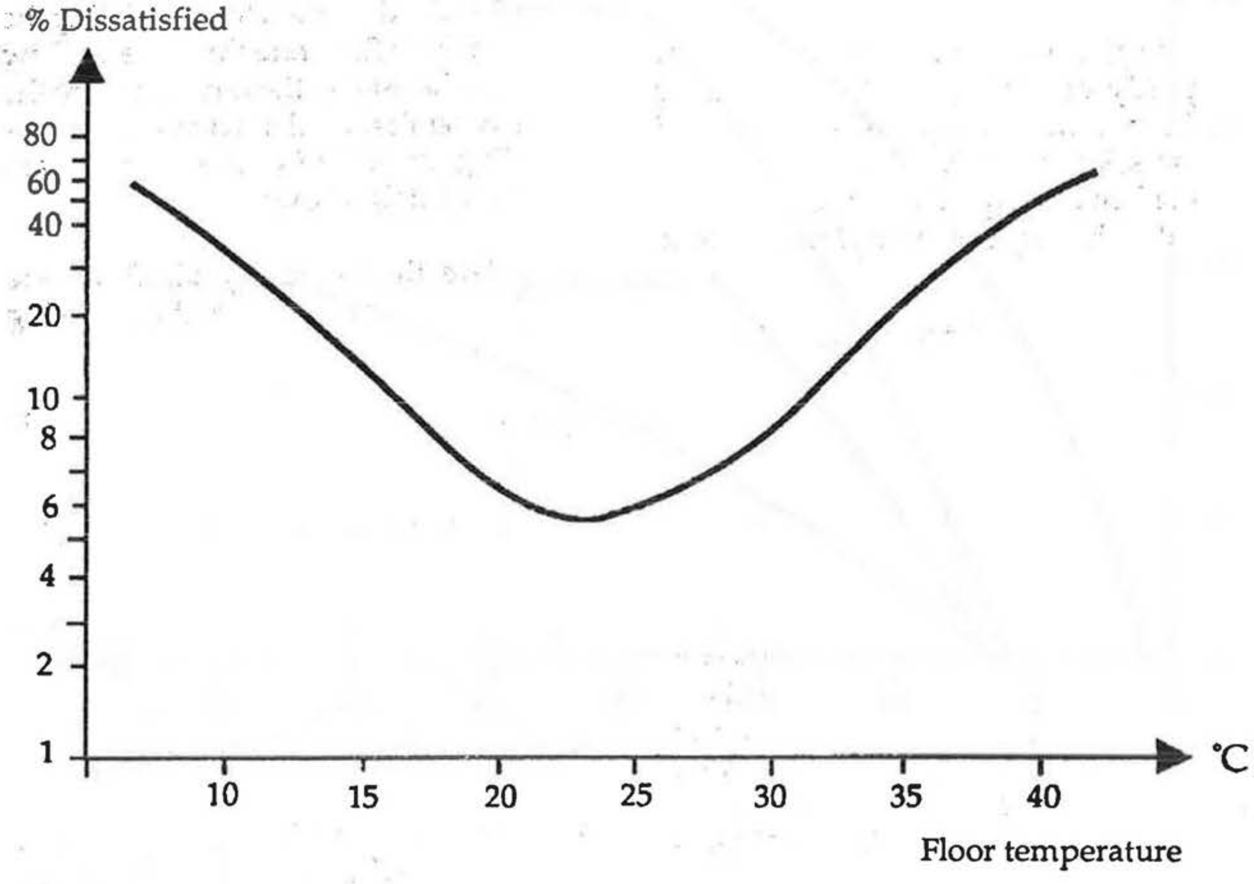


Figure B 2.51 Relationship between floor temperature and percentage of dissatisfied

Appendix B 3 Standard Methods for air flow calculations

B 3.0 General

B 3.01 Given conditions

These Standard Methods can be used to calculate the minimum air flow required (hygiene air flow) so as to provide acceptable air quality as defined in Section 2.2. The Standard Methods do not allow for heat loadings or other factors not connected with air quality.
The Standard Methods can be applied if the following general conditions are fulfilled.

a) The pollutants in indoor air consist partly of carbon dioxide and odour from human occupants, and partly of emissions from building materials and surface coatings. The outdoor air shall fulfil the requirements given in Table 2.23.

b) Local sources of pollution, such as various types of office equipment, are present in only negligible quantities, or are separately ventilated.

c) The duct system can be cleaned, and is free of pollutants.

The Standard Methods are simplified methods for approximate calculation of the requisite air flows under the above specified conditions. Details of more accurate calculations can be found in the methods specified in 'Directions for Design and Procurement of Indoor Climate Systems'.

B 3.02 Material classification

The Standard Methods are based on the division of materials and surface coatings into three different material emission classes (MEC). Low-emission materials are classified as MEC-A, medium-emission materials as MEC-B and high-emission materials as MEC-C. See also Appendix B 4.

An area load factor (s) is used to indicate the area in m^2 of a given material or surface coating in relation to the volume of the premises in m^3.

B 3.1 Standard Method I

This Standard Method for calculating the necessary air flow rate (hygiene air flow rate) can be used in those cases where the type or emission characteristics of the building materials/surface coatings are not adequately known.

Calculate the necessary air flow rate (hygiene air flow rate) from the following formula (1):

$$q/A = K1\,(np + m) \qquad (1)$$

where:

q/A is the air flow rate in $l/s \cdot m^2$ (floor area)

K1 – is a constant having the following values:

- Air quality class AQ1: K1 = 16
- Air quality class AQ2: K1 = 7

n Occupant load factor, expressed as number of persons per m^2 of floor area: see Table B 3.21.

p Smoking factor, having the following values:

- If no one smokes: p = 1

- If 20% are smokers: p = 2
- If 40% are smokers: p = 3
- If 100% are smokers: p = 6

(the above factors assume a consumption of 1.2 cigarettes/h per person.)

m A material factor, having the following values:

– Premises having mainly low-emission materials (MEC-A): m =0.05

– Premises having mainly medium-emission materials (MEC-B): m =0.3

– Premises having mainly high-emission materials or with more than insignificant amounts of mastic etc. (MEC-C): m = 0.6

For offices and similar premises, the occupant load factor can be given a value of n = 0.1 persons per m^2. The air flow rate for this reference case, assuming no smokers, is shown in Figure B3.11.

See also Note 2 on Page 40 concerning air change efficiency.

B 3.2 Standard Method II

This Standard Method for calculating the necessary ventilation air flow rate (hygiene air flow rate) can be used in those cases where the area load factor for the materials and surface coatings used can be determined. It provides an estimate of how the hygiene air flow rate changes if the source concentration of a given surface emission source is altered, i.e. the quantity of emitting material expressed as a area load factor.

Two standard emission cases in respect of the emission conditions in a given room etc. are defined for use in connection with calculating the necessary air flow rate (hygiene air flow rate)

Case LM (low/medium) indicates that the premises' materials and surface coatings are largely of low-emission type (MEC-A), and that medium-emission materials are used to the extent equivalent to the area load factor (sb). High-emission materials are assumed not to be present, or in only very small amounts.

The MH case (medium/high) is used when many of the premises' materials and surface coatings are of medium-emission type (MEC-B). High-emission materials occur to the extent indicated by the load factor (sc).

Calculate the necessary air flow for two air quality classes AQ1 and AQ2 (see Section 2.2), in combination with the two standard emission cases defined above, from the following formulae.

LM (low/medium) standard emission case

$$q/A = 0.4\ K2\ (20n + 2 + 1.5sb) \qquad (2a)$$

MH (medium/high) standard emission case

$$q/A = 0.9\ K2\ (8n + 2 + 3.5sc) \qquad (2b)$$

where:

q/A Air flow rate in l/s, m^2 (floor area)

K2 A constant having the following values:
- Air quality class AQ1: K2 = 1
- Air quality class AQ2: K2 = 0.45

n Occupant load factor, expressed as number of persons per m^2 of floor area: see Table B 3.21.

s Area load factor for the material or surface coating, in m^2/m^3 of premi-

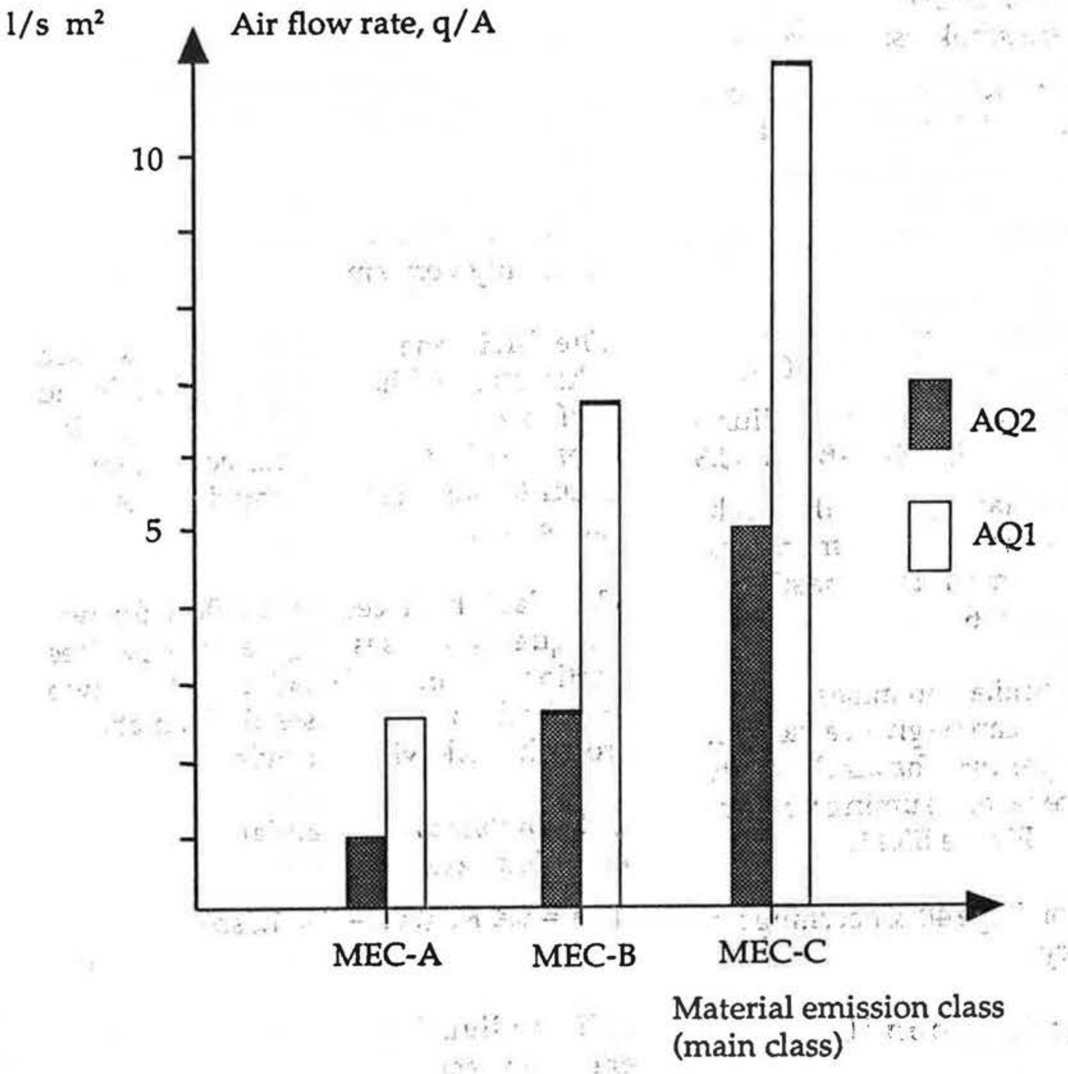


Figure B 3.11 Hygiene air flow rate for n = 0.1 pers/m² in accordance with Standard Method I, 0% smokers

Air flow rates are given in litres per second and sqm floor area. To convert to cfm per sqft multiply by 0,2 (approximately).

Table B 3.21 Occupant loading factors for different types of premises

Type of premises	Persons/m² of floor area
Shop premises:	
Sales departments, basement and ground floor levels	0.30
Upper floors	0.20
Restaurant premises:	
Dining room	0.70
Cafeteria	1.00
Bar (for persons standing)	1.00
Conference room	0.50
Theatres etc.:	
Lobby	1.50
Auditorium	1.50
Stage	0.70
Meeting room	1.50
Dance hall	1.00
Conference room	0.50
Sports centres:	
Gymnasia	0.30
Spectator positions	1.50
Ice rink	0.30
Transport:	
Waiting room	1.50
Offices:	
Conference room	0.50
Waiting room	0.60
Office room	0.10 (reference case)
Schools and educational establishments:	
Classroom	0.50
Laboratory	0.30
Assembly hall	1.50
Library	0.20
Child day-care centre	0.40

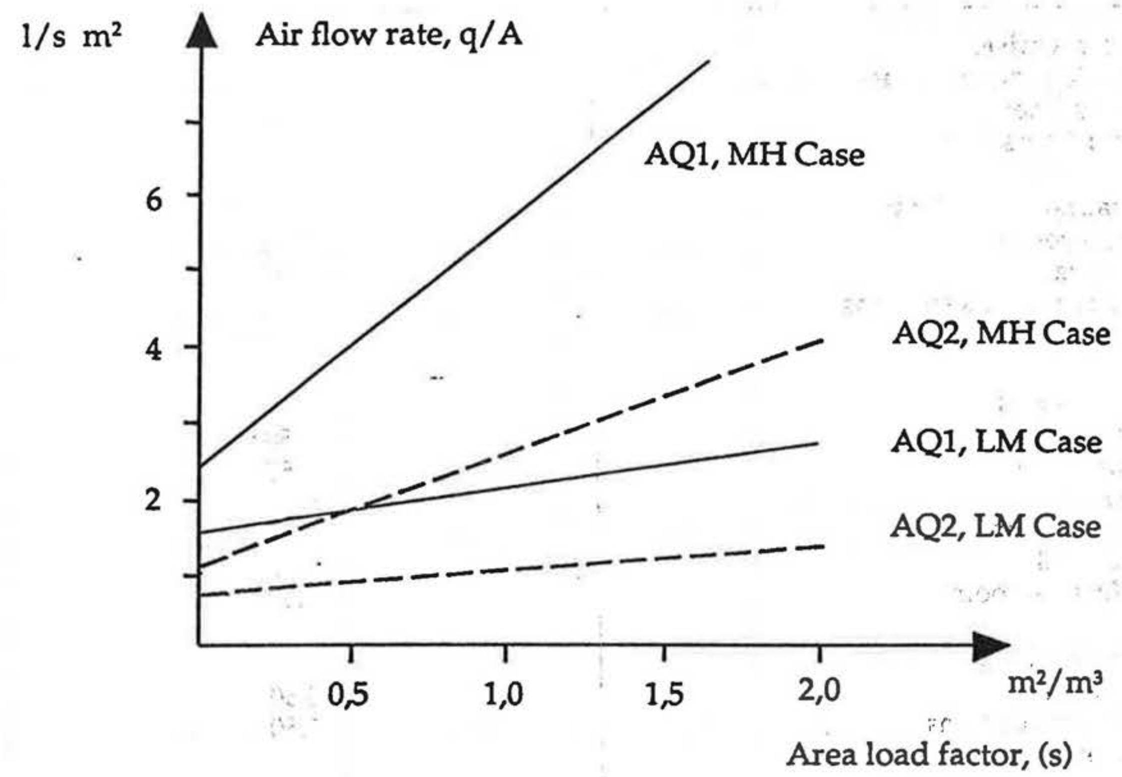


Figure B 3.23 Hygiene air flow rate for n = 0.1 pers/m² and low/medium (LM) and medium/high (MH) emission categories in accordance with Standard Method II, 0% smokers

Air flow rates are given in litres per second and sqm floor area. To convert to cfm per sqft multiply by 0,2 (approximately).

Table 3.31 Minimum air flow rates for 'special premises'

Item	Surface coating	Air flow rate in class l/s · m²		Notes
		AQ1	AQ2	
1	**Special working premises**			
1a	Dry-cleaning	3,0	2,5	Note 1
1b	Vehicle workshop	10	7,5	Note 2
2	**Garages**			
2a	Enclosed garages without natural ventilation	7,5	7,5	Note 3
3	**Transport routes**			
3a	Corridor	0,4	0,25	Note 4
3b	Elevator	5	5	Note 5
4	**General hygiene areas etc.**			
4a	Rooms with WC/urinals in l/p.	30	25	

Note 1. Assumes that dry-cleaning machines etc. are separately ventilated.

Note 2. Assumes that special local extraction points are provided for running engines or that demand controlled ventilation is provided.

Note 3. Assumes that vehicle traffic is uniformly distributed over the floor area.

Note 4. Often ventilated using transfer air.

Note 5. Ventilated by movement of the elevator.

B 4.2 The effect of emissions on ventilation requirements

Emissions from building materials and surface coatings have a considerable effect on ventilation requirements. Appendix B 4 describes Standard Methods for the calculation of ventilation requirements (hygiene air flow rates) in respect of emissions.

Table B 4.11 Material emission classes for different types of building materials and surface coatings

Item	Surface coating/ material	Class MEC- A	Class MEC- B	Class MEC- C	Notes
1.	NATURAL MATERIALS				
	• Glazed tiles	X			
	• Unglazed tiles	X			
	• Brick	X			
	• Stone/marble	X			
	• Wood panels				See Note 1
	- Untreated	X	(X)		
	- Treated with alkyd paint	X			
	- Treated with water-based paint, mat	X			
	• Concrete	X	(X)		See Note 2
	- Untreated	X			
	- Treated with lime or silicate paint	X			
	- Acrylic paint, mat	X			
	- PVA paint, mat	X			
2.	WALLPAPERS				
	Wallpaper with low-emission paste	X			
	Fabric wallpaper with low-emission paste	X			See Note 6

(cont.)