Ministry of the Environment
Housing and Building Department

D2

Indoor Climate and Ventilation of Buildings
Regulations and Guidelines 2003

Indoor Climate and Ventilation of Buildings

Regulations and Guidelines 2003

Decree of the Ministry of the Environment
on the indoor Climate and ventilation of buildings

Issued in Helsinki on the 30th of October 2002

In accordance with the decision taken by the Ministry of the Environment it is hereby decreed, on the basis of Section 13 of the Land Use and Building Act of 5 February 1999 (132/1999), that the following Regulations and Guidelines relating to the indoor climate and ventilation of buildings be applied to building and construction activities.

These Regulations and Guidelines have been notified in accordance with Directive 98/34/EC, as amended by Directive 98/48/EC, of the European Parliament and of the Council, laying down a procedure for the provision of information in the field of technical standards and regulations and of rules on information society services.

This Regulation will enter into force on the 1st of October, 2003, and it will abrogate the Decision of the 18th of February 1987 issued by the Ministry of the Environment on the indoor climate and ventilation of buildings. Earlier Regulations and Guidelines can be applied to any licence applications that have been submitted prior to the date at which this Regulation entered into force.

Helsinki, on the 30th of October 2002

Suvi-Anne Siimes, Minister

Pekka Kalliomäki, Senior Technical Adviser

Decree of the Ministry of the Environment on the amendment of the regulation 1.2 of the degree on the Indoor Climate and Ventilation

Issued in Helsinki on the 15th of April 2003

In accordance with the decision taken by the Ministry of the Environment it is hereby amended the regulation 1.2 of the degree on the Indoor Climate and Ventilation of Buildings (D2) enacted the 30th of October 2002, as follows:

1.2 Reciprocal acknowledgement
1.2.1
Where in these regulations and guidelines information is given on applicable SFS –standards, besides and in lieu of them can be used also equivalent standards, which are valid elsewhere in the European Ecomic Space.

This decree enters into force on the 1st of October 2003.

In Helsinki on the 15th of April 2003.

Suvi-Anne Siimes, Minister

Pekka Kalliomäki, Senior Technical Adviser

D2

NATIONAL BUILDING CODE OF FINLAND
MINISTRY OF THE ENVIRONMENT,
Housing and Building Department

Indoor Climate and Ventilation of Buildings

REGULATIONS AND GUIDELINES 2003

Content

KEY TO SYMBOLS

Regulations are printed across a wide column using this large font size. Regulations are binding.

Guidelines are printed across a narrow column using a small font size. Guidelines are not binding and it is possible to apply solutions other than those given in guidelines, provided that such solutions meet the requirements set for construction work.

Explanations, *which are printed across a narrow column in italics, provide further information and contain references to other regulations.* .

1
GENERAL

1.1 Scope

1.1.1
These regulations and guidelines concern the indoor climate and ventilation of new buildings. In so far as holiday dwellings are concerned, these regulations only apply to buildings, which are designed for use all the year round or during the winter period.

1.2 Mutual recognition

1.2.1
Where these regulations and guidelines provide information on available SFS Standards, it is also possible, mutually, to use, alongside and instead of, EN or other standards of a similar level that are in force in another Member State of the European Economic Community.

1.3 Definitions

1.3.1
In these regulations and guidelines the following terms and definitions apply:

1) *particles* PM_{10}*:* particles with an aerodynamic diameter of less than 10 micrometres;

2) *room temperature:* generally, the air temperature that prevails in the occupied zone. In case of large surfaces in the room, with temperature different from the air temperature, then the operative temperature shall be used. The operative temperature describes the effect that surface temperatures, which differ from the indoor air temperature, have on the sensation of heat of the human body;

3) *energy required for heating the ventilation air:* the energy required for heating the ventilation air flow from outdoor air temperature to room temperature;

4) *ventilation*: maintaining and providing indoor air quality by changing indoor air;

5) *specific electric power of a ventilation system*: the overall electric power drawn from the power supply by the fans in the building's ventilation system, divided by the ventilation system's entire design extract air flow rate or design outdoor air flow rate (whichever is greater). The electric power drawn from the power supply mains by the ventilation system includes the electric power for the fan motors and any frequency inverters or other power control equipment that may be used;

6) *air change rate*: the outdoor air flow that flows into or from the room during one hour per the volume of air in the room, $(m^3/h)/m^3 = 1/h$;

7) *air-conditioning*: the control of the air purity, temperature, humidity and movement of indoor air by processing the supply air or the secondary air;

8) *exhaust air*: the extract air that is discharged from the building;

9) *secondary air*: air that is taken from a room or dwelling and returned to the same room or dwelling

10) *mechanical supply air and extract air system*: a system in which filtered heated or cooled air is supplied and polluted air extracted from the building by fans.

11) *mechanical exhaust air system*: a system in which air is discharged from the building by fans and this air is replaced with outdoor air by means of outdoor air devices and air leakages through the structures;

12) *period of occupancy*: the time when the buildings or premises are occupied or when the building or premises are being used in accordance with their intended use;

13) *temperature efficiency*: the ratio between the temperature change that takes place in the supply air at the heat exchanger of the heat recovery equipment and the difference between the temperatures of the extract air and the outdoor air at the heat exchanger;

14) *occupied premises*: a room occupied for long periods of time. Hence, occupied premises do not include e.g. hygiene premises, cloakrooms and office corridors;

15) *occupied zone*: that part of a room where the requirements concerning indoor climate are designed to be implemented. Usually, this means at least the part of the room that is limited from the floor level to the level of 1,8 metres above floor level, and to a distance of 0.6 metres from the walls or similar fixed structural parts on the sides.

16) *natural ventilation system*: a system whose operation is based on the pressure differentials produced by differences in level and temperature and/or caused by wind. Warm indoor air, being lighter, flows upward in the exhaust air duct and then out of the building. This is replaced by outdoor air, from outdoor air devices and air leakages through the structures.

17) *recirculation air:* air that is returned as supply air, in such a way that the air consists of the extract air from two or more rooms ;

18) *extract air*: air that is directed out of the room;

19) *transferred air*: air that is transferred from one room to another;

20) *design life span*: the life span requirement of a building, a structural component, a building services system or any part or component thereof, determined by the person initiating a building project, by the developer or the designer;

21) *supply air*: the air that is introduced into the room

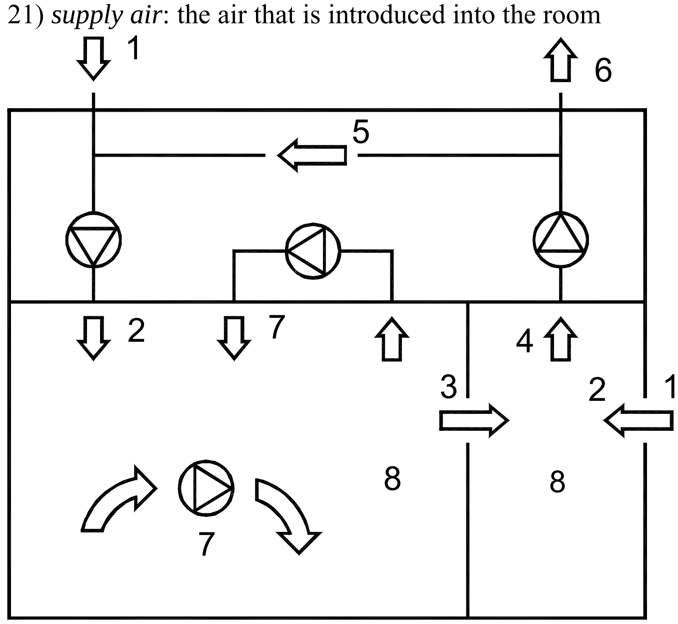

Figure 1. Designation of air flows: 1. outdoor air, 2. supply air, 3. transferred air, 4. extract air, 5. recirculation air, 6. exhaust air, 7. secondary air, 8. indoor air.

2
INDOOR CLIMATE OF BUILDINGS

2.1 General

2.1.1
As a whole, buildings shall be designed and constructed in such a way that a healthy, safe and comfortable indoor climate can be achieved in the occupied zone under all normal weather conditions and operational situations. .

2.1.1.1
The principal designer shall ensure that the building plan and all specific plans as a whole meet the requirements for indoor climate.

Explanation
Part A2 of the National Building Code of Finland contains regulations and guidelines concerning building designers and building plans.

2.1.1.2
The foreman in charge is responsible for ensuring that the building work is carried out in accordance with the building plan and specific plans and with good building practices in such a way that the requirements regarding indoor climate are met.

Explanation
Part A1 of the National Building Code of Finland contains regulations and guidelines concerning the supervision of building work.

2.1.2
In order to achieve a healthy, safe and comfortable indoor climate, it is usually necessary in the design and construction of buildings to take into account the following factors that influence the building:
1) internal load factors, such as thermal and moisture loads, human loads, processes, and emissions of building materials and interior furnishing materials;
2) external load factors, such as weather and acoustic conditions, quality of outdoor air and other environmental factors; and
3) the location of the building, and the building site.

2.1.3
The achievement of a healthy, safe and comfortable indoor climate should always be ensured:
1) when planning the thermal and moisture proofing of buildings and the properties of the windows;
2) when determining the air-tightness of a building envelope, base floor and shafts as well as the air-tightness of structures between premises;
3) when selecting building and interior furnishing materials;
4) when designing a building's building services systems, their reliability in operation and their space requirements;
5) when planning moisture control at the building site;
6) when planning the control of cleanliness of the building work and the ventilation system; and
7) when drawing up the timetables for building site, acceptance and commissioning.

2.1.3.1
A healthy, safe and comfortable indoor climate can be achieved by structural means, by reducing internal load factors, by limiting the effects of external and internal load factors, and by technical means in the design of ventilation and air-conditioning systems.

2.2 Thermal conditions

2.2.1
Buildings shall be designed and constructed in such a way that a comfortable room temperature in the occupied zone can be maintained during periods of occupancy so that unnecessary energy use is avoided.

2.2.1.1
The design temperature for the heating season that is normally used for room temperature in the occupied zone is 21°C. The design temperature for the summer season that is normally used for room temperature in the occupied zone is 23°C.

Room temperature can be designed on the basis of a value that differs from the guideline value where justified reasons for such action exist. Such guideline values for room temperatures for different room types during the heating season are given in Table 1.

The maximum acceptable deviation from the room temperature design value for the occupied zone, measured at the centre of the room at the level of 1.1 metres, is ± 1°C.

Table 1 .Guideline values for room temperatures for different room types during the heating season for premises where the room temperature design value is not 21 °C.

Room type	Room temperature °C
Stair well	17
Bathroom, washroom	22
Drying room	24
Shop	18
– fixed work point in a shop	21
Gymnastics hall	18
Church	18
Factory hall, medium-heavy work	17
Motor vehicle workshop, M.O.T. testing premises	17
Lift shaft	17

2.2.1.2
During periods of occupancy, the temperature in the occupied zone should not normally be greater than 25°C.

2.2.1.3
In case the average outdoor air temperature over a maximum period of five hours is higher than 20°C, the room air temperature may exceed this value by a maximum of 5°C.

2.2.2
Outdoor temperatures that influence the design shall be taken into account when planning how to maintain the thermal conditions. The design outdoor temperatures for the heating season are shown in Table 2.

Table 2. Design outdoor temperatures for the heating season.

Region	Design outdoor temperature °C
Southern Finland Pr.	-26
Ahvenanmaa Pr.	-26
Western Finland Pr.	-26
Eastern Finland Pr.	-32
Oulu Province	-32
Lapland Province	-38

2.2.2.1
The design weather data for the summer season, to be used as the basis for planning the maintenance of thermal conditions, can be for instance the TEST year of the Meteorological Institute, completed with additional time periods, or the design outdoor temperature for the summer season can be taken as +25°C and the outdoor air enthalpy for the Province of Lapland as 50 kJ/kg and elsewhere in Finland as 55 kJ/kg.

2.2.3
Buildings shall be designed and constructed in such a way that air movement, thermal radiation and surface temperatures will not cause discomfort in the occupied zone during periods of use.

2.2.3.1
Guideline values for air movement in the occupied zone for different room types are given in Appendix 1.

2.2.3.2
In case any such structures or equipment are planned or constructed for any given premises that cause intensive thermal radiation or low or high surface temperatures, the design room temperature shall be checked by calculation using the operative temperature value.

2.2.3.3
Play rooms in day-care centres shall as a rule be provided with floor heating or other similar arrangement that provides similar comfort conditions.

2.3 Air quality

2.3.1
Buildings shall be designed and constructed in such a way that the indoor air does not contain any gases, particles or microbes in such quantities that will be harmful to health, or any odours that would reduce comfort.

2.3.1.1
The maximum permissible indoor air carbon dioxide content in usual weather conditions and during occupancy is usually 2,160 mg/m^3 (1,200 ppm).

2.3.1.2
In order to prevent any health hazards caused by impurities contained in indoor air, the maximum permissible concentrations of sulphur dioxide, nitrogen dioxide, particles, lead, carbon monoxide or benzene are usually as specified in the Decree (711/2001) issued by the Council of State on air quality.

2.3.1.3
The concentrations of impurities used in the design for indoor air quality are given in Table 3. The guideline values for such design apply to buildings that have been occupied for six months and where the ventilation system has been kept running constantly using the air flow rates designed for ventilation during periods of occupancy. The concentration measurements shall be carried out by using the methods described in the Guideline issued by the Ministry of Social Affairs and Health .

Table 3. Values for concentrations of impurities in indoor air for the purpose of designing and implementing indoor climate of buildings.

Impurity	Unit	Design guideline value Maximum concentration
Ammonia and amines	µg/m^3	20
Asbestos	fibres/cm^3	0
Formaldehyde	µg/m^3	50
Carbon monoxide	mg/m^3	8
Particles PM_{10}	µg/m^3	50
Radon	Bq/m^3	200 (annual average)
Styrene	µg/m^3	1

2.3.1.4
The maximum permissible concentrations of other impurities in normal premises are usually 1/10 of the occupational exposure limits (abbreviated in Finnish as "HTP") in the workplace air, where the effect of a single substance is quite dominant. If there are several known harmful substances present in the air and the combined effect of these is not known, the acceptable concentrations shall be deemed to have been exceeded if

$$\sum_i (C_i/(HTP)_i) > 0,1$$

where C_i is the measured concentration of a single substance and (HTP) is the occupational exposure limit of the substance in question.

Explanation
The Ministry of Social Affairs and Health ratifies the occupational exposure limits by a Decree and publishes the lists in the form of Safety Bulletins (HTP values).

2.3.2
Buildings shall be designed and constructed in such a way that the humidity of indoor air will remain within the values specified for the intended use of the buildings.

The humidity of indoor air shall not be harmfully high on a continual basis, nor shall humidity be allowed to concentrate on structures or on their surfaces or in the ventilation system in such a way that it will cause moisture damage, growth of microbes or micro-organisms or any other health hazards.

2.3.2.1
If the humidity of indoor air exceeds the values of 7 g H_2O/kg of dry air, the room air should be humidified for strictly demanding reasons only, e.g. where this is necessary for a production process or is required for the storage conditions. The value of 7 g H_2O/kg of dry air corresponds to a room air condition where the relative humidity is 45% at the room temperature of 21°C and at the air pressure of 101.3 kPa.

In order to minimise any harmful effects that may be caused by a low relative humidity of indoor air, unnecessarily high room temperatures shall be avoided during the heating season.

2.4 Acoustic conditions

2.4.1
Buildings shall be designed and constructed in such a way that the acoustic conditions are comfortable.

2.4.1.1
Guideline values for sound levels for different room types, concerning building services (heating, plumbing, ventilation and electrical) equipment are given in Appendix 1. The sound power levels of building services equipment and other similar equipment as well as the calculations relating to sound levels that result from such systems shall be given in the special plans and specifications. .

Explanation
Part C1 of the National Building Code of Finland contains regulations and guidelines on structural soundproofing and noise abatement measures. According to these, building services equipment and similar equipment include lifts, water supply and drainage installations, compressors, ventilation equipment, cooling equipment, heating equipment, centralised vacuum cleaning systems, carpet vacuum cleaners and laundry equipment such as washing machines, centrifuges, drying fans and laundry mangles. The Appendix to Part C1 contains guideline information on the measuring of sound levels.

2.4.1.2
The acoustic insulation of a building envelope shall be designed as an integral whole, taking into account all the structural parts that may have an influence on soundproofing, such as walls and windows as well as the outdoor air and exhaust air equipment of the ventilation system. Such integrated designs shall meet the applicable soundproofing requirements.

Explanation
Urban area development plans may impose requirements concerning the location of windows and the soundproofing of facades against traffic noise.

2.5 Lighting conditions

2.5.1
Buildings shall be designed and constructed in such a way that it is possible to maintain in the occupied zone such lighting conditions as is necessary for achieving the level of visibility required by the tasks to be performed during periods of occupancy so that energy will not be used unnecessarily.

2.5.1.1
The grouping of lighting units, the power supply for and the control of the lighting shall be implemented in such away that the lighting conditions can be varied according to the tasks to be performed and the levels of natural light available.

3
VENTILATION

3.1 Ventilation systems

3.1.1
Ventilation systems shall be designed and constructed on the basis of the planned type of use and occupancy of the buildings in such a way that they will, for their part, create the correct internal design conditions under normal weather conditions and occupancy, for a healthy, safe and comfortable indoor climate.

> *Explanation*
> *Parts A2 and D6 of the National Building Code of Finland contain regulations and guidelines on the qualifications required of persons who are in charge of the design and construction of ventilation systems.*

3.1.2
Ventilation systems shall be designed and constructed in such a way that, when used, serviced and maintained in the correct manner, they will remain fully functional for their design life span.

> *Explanation*
> *Part A4 of the National Building Code of Finland contains regulations and guidelines on the compilation of instructions for the use and maintenance of buildings and their structural parts.*

3.1.3
It shall be possible to control and monitor the operation of ventilation systems.

Measuring equipment or measuring provisions shall be designed and installed in ventilation systems for measuring key operating values and for monitoring the different functions.

3.1.3.1
The ventilation system shall be equipped with control, adjustment and monitoring equipment that enables the operation of the system to be controlled and monitored.

3.1.3.2
The air-handling unit shall usually be equipped with inspection doors and windows for the purpose of monitoring the various functions.

3.1.3.3
Mechanical ventilation systems shall be equipped with fixed air flow rate measuring sensors and devices for measuring the building's outdoor air and exhaust air flow rates. In case of air flow rates less than 0.5 m^3/s, such fixed measuring equipment may be substituted by measurement tappings compatible with portable measuring equipment.

3.1.3.4
Thermometers shall be installed on the inlet and outlet sides of the heating and cooling coils and heat recovery equipment of the air-handling units and differential pressure gauges shall be installed on air filters. In case of air flow rates less than 0.5 m^3/s, such fixed measuring equipment may be substituted by measurement tappings compatible with portable measuring equipment.

3.1.3.5
Parts of the air handling unit or ductwork downstream of a humidifier section shall be fitted with a measurement tapping for humidity measurement

3.1.3.6
The measuring equipment shall be installed in a location where it can be easily read and where it allows for unhindered access through easily accessible service routes.

3.1.4
Ventilation systems shall be designed and constructed in such a way that the installations are equipped with both guards and safety devices for servicing and maintenance purposes.

3.1.5
Ventilation systems shall be designed and constructed in such a way that, in an emergency situation, their operation can be brought to a complete standstill by means of a clearly marked stop switch. Such stop switches should be located in an easily accessible place.

3.2 Air flow rates

3.2.1
Rooms in the building shall be provided with ventilation to ensure a healthy, safe and comfortable quality of indoor air during periods of occupancy.

3.2.1.1
Design values for air flow rates for different room types are given in Appendices 1 and 2.

3.2.2
During periods of occupancy, an outdoor air flow to ensure healthy, safe and comfortable quality of indoor air shall be supplied to the occupied premises.

3.2.2.1
Design values, given in Appendix 1, are primarily used for design of outdoor air flow rates for different room types. The outdoor air flow rates are determined primarily on the basis of the number of occupants. In case there are insufficient grounds for designing air flow rates on the basis of the number of occupants, then such design shall be based on outdoor air rate per surface area.

For rooms other than those presented in Appendix 1, an outdoor air flow rate of at least 6 dm^3/s per person shall be supplied to the occupied premises, provided that there are sufficient grounds for designing the air flow rate on the basis of the number of occupants.

As a general rule, however, the outdoor air flow rate should be at least 0.35 $(dm^3/s)/m^2$, which corresponds to an air change rate of 0.5 1/h in a room with a free height of 2.5 m.

3.2.3
It shall be possible to control the air flow rates of a ventilation system according to loads and air quality, to correspond to the occupancy conditions.

3.2.3.1
The control of ventilation in residential buildings shall be designed and constructed in such a way that the boosted air flow rate during the periods of occupancy of the dwellings is at least 30% higher than the normal air flow rate during periods of occupancy. The boosting of air flow rates shall normally be implemented at least by providing a boosted air flow for cooker hoods in accordance with the guideline values given in Appendix 1.

3.2.3.2
In case the ventilation can be controlled separately for each dwelling, the ventilation system can be designed and constructed in such a way that air flow rates can also be adjusted to below the level of the air flow rates that apply during occupancy periods.

3.2.3.3
Ventilation for other than residential buildings shall be designed and constructed in such a way that outside the periods of occupancy the outdoor air flow rate in the building is at least 0.15 $(dm^3/s)/m^2$, which corresponds to an air change rate of 0.2 1/h in a room with a free height of 2.5 m.

Outside the periods of occupancy, ventilation can be implemented by keeping the ventilation system in the hygiene rooms (toilets, wash rooms and similar rooms) running continuously or by running the ventilation system intermittently.

3.3 Filtering of supply air

3.3.1
The level of filtering required for the supply air is determined on the basis of the quality requirements for indoor air and on the basis of the quality of outdoor air.

Supply air for occupied premises shall normally be filtered.

3.3.1.1
Filtering of supply air is normally designed in such a way that the efficiency of the air filters is at least 80% for 1.0 µm particles during the life span of the filters. The corresponding air filter class is F7.

3.3.1.2
Filtering of supply air in buildings that are located outside built-up areas and industrial areas is normally designed in such a way that the air filters used are at least coarse filters of filter class G4.

3.4 Locating outdoor air and exhaust air devices

3.4.1
Outdoor air devices shall be located in such a way that the outdoor air entering the building is as clean as possible.

Outdoor air shall not be introduced through any structure or structural part that could impair the air quality.

3.4.1.1
The outdoor air devices shall be located in accordance with Table 4 and Figure 2. The values shown in the Table are usually the minimum distances.

Table 4. Location of outdoor air devices.

Minimum distance of outdoor air devices	Distance m
From exhaust air devices	Figure 2
From any sources that could impair the outdoor air quality such as waste storage locations, vehicle parking and/or loading areas and ramps, openings of ventilated sewers and chimneys, central vacuum cleaner exhaust vents and cooling towers	8
From openings of ventilated sewers and chimneys where such openings are over 3 metres above the supply air opening	5
From ground level and courtyard level	2
From roof surface to lower edge of outdoor air devices This distance may be smaller provided that the formation of snow cover that hampers ventilation is prevented by means of a steep pitched roof, with snow guards or in some other reliable manner.	0.9

3.4.1.2
In the case of detached houses, distances less than the minimum distances given in Table 4 may be used, with the exception of the distance from flues of heating boilers using solid fuel and the distance of the outdoor air devices from the roof surface.

3.4.1.3
In the case of premises located at courtyard or street level, outdoor air devices used for individual rooms or suites of rooms may be located lower than 2 metres from ground level, the same applies to the outdoor air devices for premises designed for temporary occupancy only. However, outdoor air devices shall not be located in recesses that are below the courtyard or street level.

3.4.1.4
In case the building is located at a distance less than 50 metres from the centreline of a carriageway with heavy traffic, the outdoor air devices for the building shall be located as high up as possible, usually on the side of the building that is opposite to the traffic lane. A road or a street is deemed to carry heavy traffic at least in those cases where the average daily traffic volume is in excess of 10,000 vehicles per day.

3.4.1.5
The outdoor air devices shall be located outside any balcony glazing, if applicable.

3.4.2
Exhaust air shall be discharged outdoors in such a way that no health hazard or any other harmful effects are caused to the building, its users or to the environment.

3.4.2.1
Exhaust air shall usually be discharged above the roof of the highest section of the building, directing the air outlet upwards so as to prevent the exhaust air from entering the outdoor air devices, the windows and/or the occupied areas.

Exhaust air devices in natural ventilation systems shall usually be located above the building’s roof ridge level. The exhaust can be boosted as necessary by using wind deflectors, wind rotors or other similar devices.

3.4.2.2
Routing of exhaust air out of the building is based on the following extract air classification:

Extract air class	Description and restrictions on use	Examples of premises
1	Extract air that contains impurities in low concentrations. The main sources of impurities are human metabolism and emissions from structures. This air is suitable for use as recirculation and/or transferred air.	Office premises and related small storage areas, customer service areas, teaching areas, certain assembly areas and commercial areas with no odour load.
2	Extract air that contains some impurities. This air shall not be used as recirculation air for other rooms but it can be conducted as transferred air to e.g. toilets and wash rooms.	Dwelling rooms, dining rooms, café kitchens, stores, office building storage rooms, dressing rooms and restaurants where smoking is forbidden.
3	Extract air from areas where damp, processes, chemicals and odours substantially impair the quality of extract air. This air shall not be used as recirculation and/or transferred air.	Toilets and wash rooms, saunas, apartment kitchens, distribution and teaching kitchens, areas for copying drawings.
4	Extract air that contains odours or impurities detrimental to health in significantly higher concentrations than those acceptable for indoor air. This air shall not be used as recirculation and/or transferred air.	Fume cupboards in professional use, grills and local kitchen exhausts, garages and traffic tunnels, rooms for handling paints and solvents, rooms for unwashed laundry , rooms for foodstuff waste, chemical laboratories, smoking rooms as well as hotel and restaurant premises where smoking is permitted.

3.4.2.3
Exhaust air devices shall be located in accordance with Table 5 and Figure 2. The values given in the Table 5 are the minimum distances.

The distances of exhaust air devices directed upwards can be calculated either from the edge of the device or from a point above the device the distance of which, in metres, is 1/3 of the numerical value in m/s of the discharge velocity.

Table 5. Location of exhaust air devices.

Minimum distance of exhaust air devices:	Distance, m			
	Extract air class			
	1	**2**	**3**	**4**
From outdoor air devices	Figure 2	Figure 2	Figure 2	Figure 2
From openable windows below	2	2	4	6
From openable windows or occupied levels on the same level or above	3	3	6	10
From ground level or courtyard level	2	2	3	5
From roof surface s This distance may be smaller provided that the formation of snow cover that hampers ventilation is prevented by means of a steep pitched roof, with snow guards or in some other reliable manner.	0.9	0.9	0.9	0.9
From neighbouring building plot (does not apply to one-family houses)	2	2	5	8
From openings of ventilated sewers or chimneys	1	1	1	1
Distance between the exhaust air devices of natural and mechanical ventilation systems	1	1	1	1

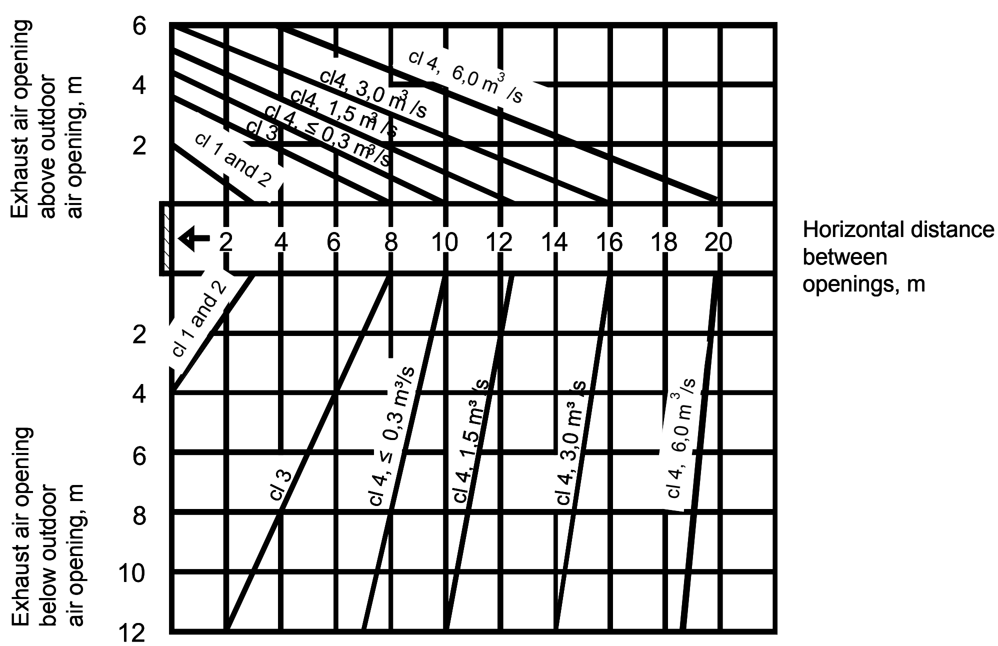

Figure 2. Distances between exhaust air and outdoor air devices. Intermediate values between the lines can be estimated.

3.4.2.4
Exhaust air from stairwells, lift shafts and technical rooms can be discharged out of the building without any restrictions. However, the exhaust air shall not be directed towards exits or any occupied spaces.

3.4.2.5
Exhaust air of Class 1 can be discharged out of the building through wall-mounted exhaust air devices on the following conditions:
1) the distance of the exhaust air device from the neighbouring plot is at least 4 metres and from the

adjacent building at least 8 metres;
2) the air flow does not exceed 1 m^3/s;
3) the distance of the exhaust air device from outdoor air device or another exhaust air device in the wall is at least 1.5 metres; and
4) the air velocity in the outlet aperture is at least 5 m/s.

3.4.2.6
Wall-mounted exhaust air devices shall usually be located in a wall that is facing a traffic lane or a parking area.

In case there are obstacles to wind, such as balcony walls or re-entrant corners that form recessed areas, exhaust air devices and outdoor air devices shall not be located in the same recessed area.

3.4.2.7
In case that an eave, a bay window or some other structural part protruding from the wall is located above the exhaust air device, the device shall be located below such protruding structure at a distance equal to the protrusion, or the device can be ducted to be located at the front edge of the protrusion.

3.5 Recirculation air, transferred air and secondary air

3.5.1
Only air that is from rooms with equal or better air cleanliness and that does not contain harmful quantities of impurities may be re-used as recirculation air or transferred air. The use of recirculation air or transferred air shall not cause harmful distribution of impurities, and odours in particular.

3.5.1.1
Air that falls under extract air class 2, 3 or 4 as described under item 3.4.2.2 shall not be used as recirculation air.

3.5.1.2
Recirculation air shall not be re-used as supply air in the following areas:
1) Residential apartments;
2) Commercial kitchens;
3) Accommodation sections of accommodation and catering businesses and boarding schools;
4) Accommodation sections of medical, day-care, and penitentiary establishments and similar;
5) Restaurants and cafés; and
6) other areas that need to be kept particularly clean, unless the recirculation air is cleaned at least to the extent that the filtering capability of the air filters is at least 80% for 1.0 µm particles throughout the useful life of such filters. The corresponding air filter class is F7.

3.5.1.3
Air of extract air class 2 can be used for air circulation inside a dwelling apartment.

3.5.1.4
Recirculation air shall usually be filtered, and often secondary air as well.

3.6 Distribution and exhaust of air

3.6.1
Supply air shall be conducted to rooms in such a way that the air flows into the entire occupied zone without causing draught and that any impurities that are generated in the room during its occupancy are effectively removed. Contaminated air shall not be allowed to return in harmful volumes to the occupied zone.

3.6.1.1
Ventilation shall be designed to be as efficient as possible so that the supply air flows into the entire occupied zone, and that impurities are conducted directly to the extract air terminal devices without spreading into the room. The supply air shall not flow directly past the occupied zone to the extract air terminal devices.

3.6.1.2
The aerodynamic and acoustic characteristics of the air distribution equipment, the outdoor air intake device and the transferred air flow routes or equipment shall be known. The devices shall be located and designed dimensionally in such a way that the air velocities and sound levels presented in Appendix 1 are not exceeded in the occupied zone.

It shall be possible to adjust the air flow of outdoor air device in mechanical extract air systems and natural ventilation systems.

3.6.1.3
As a general rule, each room is equipped with an extract air terminal device.

In dwelling apartments, at least kitchens, kitchenettes, bathrooms, toilets, utility rooms and cloakrooms shall be provided with extract air terminal devices. Extract air from other dwelling rooms can be conducted via these rooms by means of appropriate transferred air paths or equipment.

Extract air from corridors can be extracted via toilets, for example, in normal premises such as offices and accommodation areas.

3.6.1.4
Local extract ventilation shall be used whenever dust, gases or fumes are generated in a centralised manner in a room. Efficacy of the capture of impurities can be enhanced by encapsulation of the source of impurities. Kitchens, for example, should be equipped with cooker hoods or with similar local exhaust ventilation.

3.6.2
Connection of the ventilation ducts of mechanical ventilation systems in different areas shall not cause a hazard of spreading impurities or flue gases or influence the operation of the ventilation system.

3.6.2.1
The guidelines laid down in Part E7 of the National Building Code of Finland shall be used as a basis for the connection of ventilation ducts.

3.6.2.2
Air belonging to different extract air classes shall be discharged out of the building in accordance with the following principles:
1) extract air of classes 1 and 2 can usually be conveyed in a common ductwork;
2) extract air of class 3 is normally conducted, through separate ducts or through common ductwork that serves areas with similar levels of air cleanliness, into the ambient, into a collector duct installed above the areas it serves, or into a extract air chamber; and
3) extract air of class 4 is conducted out through separate extract air ducts.

In case air belonging to extract air classes 1 and 2 is combined in the same duct and the share of class 2 air flow is more than 10% of the combined air flow, the combined air flow shall be classified as extract air class 2.

3.6.2.3
In case significant quantities of substances, which are harmful to health or emit strong odours are handled or stored in a room, the room in question shall be provided with outdoor air and extract air ducts that are separate from the rest of the ventilation system. Such premises include for instance storage areas for toxic substances, waste disposal areas and rooms for unwashed laundry.

3.6.2.4
Extract air from toilets, washrooms and cleaning cupboards that open up to workplaces, to areas where people spend time or to corridors, is usually conducted out to atmosphere through a separate extract air system. However, extract air from toilets and similar rooms can be ducted to continually running exhaust ventilation systems of other areas in dwelling and accommodation premises.

Extract air from a maximum of two toilets or similar rooms can be ducted to vertical ducts for class 1 and 2 extract air, provided that the aggregate extract air flow from these rooms does not exceed 10% of the total air flow in the vertical duct in question. In such cases, even class 1 extract air is not suitable for re-use as recirculation air.

3.6.2.5
In mechanical ventilation systems, extract air from all rooms of a single dwelling can be conducted through the same air duct directly into the ambient, into a collector duct installed above the areas it serves, or into an extract air chamber.

3.6.2.6
Extract air from technical rooms and from individual rooms which are in secondary use, such as small storage rooms and sports equipment rooms, can be conducted into class 3 extract air ducts.

3.7 Air-tightness of and pressures in ventilation systems

3.7.1
Ventilation systems and their components shall be sufficiently airtight and strong.

3.7.1.1
The ductwork of a ventilation system is usually sufficiently air-tight when its air-tightness corresponds to at least air-tightness class B. The maximum permissible leakage air flow rate in air-tightness class B is given in the form of an equation in Table 6 and graphically in Figure 3.

3.7.1.2
In ordinary ventilation systems, air-tightness class B for the ductwork is usually achieved when the air-tightness class of the air ducts and ductwork components is C.

3.7.1.3
The air handling unit is usually sufficiently air-tight when the air-tightness of its casing is at least in class A and the maximum leakage air flow rate between the inlet and outlet sides is 6% of the nominal air flow rate of the air handling unit at the test pressure of 300 Pa.

3.7.1.4
The maximum permissible leakage air flow rates for ventilation systems and their parts for different air-tightness classes are given in the form of an equation in Table 6 and graphically in Figure 3.

Table 6. Maximum permissible leakage air flow rates for ventilation systems and their parts per casing surface area q_{VIA} ($dm^3/s/m^2$) for different air-tightness classes. The leakage equation is in the form $q_{VIA} = k\, p_s^{0,65}$, where k is the coefficient for the air-tightness class in question ($dm^3/s/m^2/Pa^{0,65}$) and p_s is the test pressure (Pa).

Air-tightness class	Permissible leakage air flow q_{VIA} $dm^3/s/m^2$
A	$0.027 \times p_s^{0,65}$
B	$0.009 \times p_s^{0,65}$
C	$0.003 \times p_s^{0,65}$
D	$0.001 \times p_s^{0,65}$
E	$0.0003 \times p_s^{0,65}$

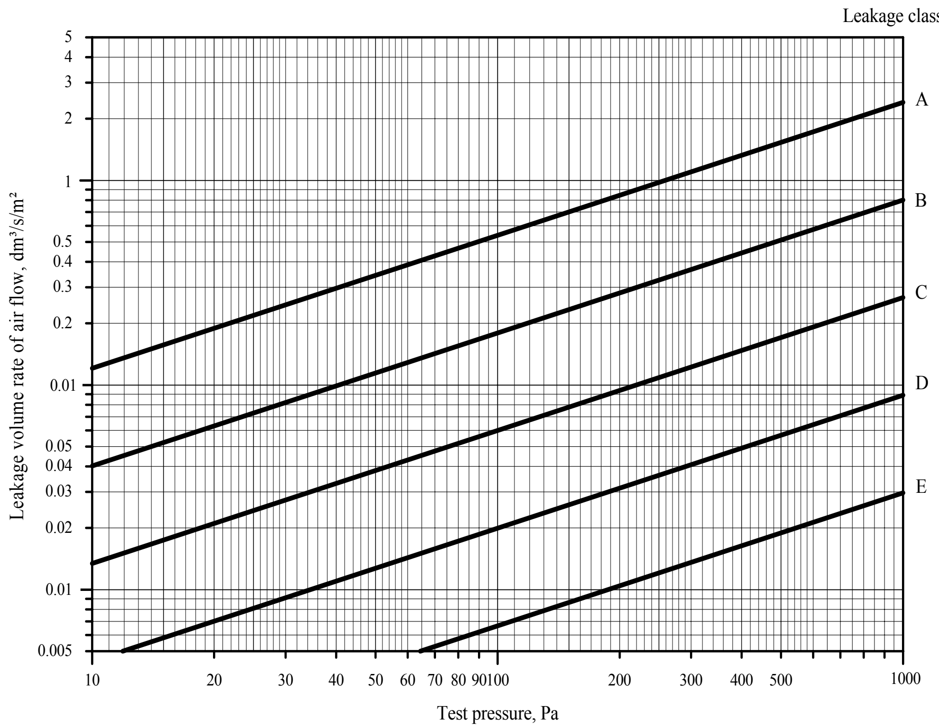

Figure 3. Maximum permissible leakage air flow rates for ventilation systems and their parts per casing surface area for different air-tightness classes.

3.7.2
Impurities shall not be allowed to spread to a harmful extent in the building through air ducts or ventilation equipment.

3.7.2.1
The construction and pressures of heat recovery equipment shall be implemented in such a way that no significant quantities of extract air will be transferred into the supply air.

3.7.2.2
When heat is recovered from class 1 extract air, there are no particular requirements that would apply to the pressure differential between the supply and extract airsides or to the direction of leakage air flow. When heat is recovered from class 2 extract air, the pressures of the heat recovery equipment shall be designed in such a way that the direction of leakage air flows is mainly from the supply air side towards the extract air side.

3.7.2.3
When heat is recovered from class 3 extract air, the pressures of the heat recovery equipment shall be designed in such a way that the direction of leakage air flows is from the supply air side towards the extract air side

Regenerative heat exchangers can only be used in cases where the extract air contains a maximum of 5% of class 3 extract air and no class 4 extract air. However, in dwellings designed for a single family it is permissible to use regenerative heat exchangers for recovering heat from class 3 extract air.

3.7.2.4
When recovering heat from class 4 extract air it shall usually be applied a heat recovery system using intermediate heat transfer medium and in which the supply air and the extract air cannot mix with each other.

3.7.2.5
In case the air-handling unit only serves a single space, it is possible to choose freely the type of the heat exchanger used for heat recovery, even though the extract air may be in class 3 or 4. In such cases it shall be ensured that the supply air is sufficiently clean in order to guarantee that it will meet the requirements set for the cleanliness of indoor air. Such spaces include e.g. industrial premises, large car parks and garages.

3.7.2.6
Extract air ducts in the building, outside the plant room, are usually built so as to be at negative pressure.

However, extract air ducts in extract air classes 1 and 2 can be pressurised inside the building provided that the ductwork corresponds to air-tightness class C. This can usually be achieved when the air ducts correspond to air-tightness class D.

3.7.2.7
Exhaust air ducts for individual dwellings can be pressurised inside the building provided that the ductwork corresponds to air-tightness class D. This can usually be achieved when the air ducts correspond to air-tightness class E

3.7.2.8
In case the cross-sectional area of the air duct is greater than 0.06 m^2 (for instance air ducts with a diameter greater than 315 mm), the outdoor air and exhaust air ducts used in mechanical ventilation systems shall be fitted with valves that close automatically when the system shuts down thus preventing any backdraught and uncontrolled ventilation. Sufficient air-tightness of the valve is achieved when the valve meets the class 3 air-tightness requirements for closed valves as specified in Standard EN 1751:1998.

3.7.3
Two or more air handling units shall not be connected to the same duct or the same chamber in such a way that the pressures indoors or the directions of air flows between rooms and in the ductwork could change from the design specifications.

3.7.3.1
A common chamber is normally not built if recirculation air is used, or if the air flows of individual air handling units can be controlled independently during operation..

Where several air handling units are connected to the same ductwork or the same chamber, their fans shall be selected in accordance with Standard SFS 5148 in such a way that they will not interfere with each other's operation. In cases where only part of the units are in operation at any time, the common chamber or ductwork shall be designed wide enough, and the operating point shall be chosen from the fans' characteristic curve in such a way that the air flow rates will change by a maximum of 3% as a result of a fan being stopped. Air handling units that are to be stopped shall be equipped with valves that meet the class 3 air-tightness requirements for closed valves as specified in Standard EN 1751:1998.

3.7.4
Natural and mechanical ventilation systems shall not be combined in such a way that the directions of air flows between rooms and in the ductwork could change from the design specifications.

3.7.4.1
Ventilation of an apartment or some other integral area is usually designed so as to be exclusively either a mechanical or a natural ventilation system.

3.7.4.2
A natural ventilation system can be designed to be boosted with an extract air fan. In such cases, an adequate supply of outdoor air is ensured by preventing air from flowing into the rooms through extract air ducts or chimney flues.

3.7.5
Air ducts shall be stiffened and supported in such a way that they will remain firmly in their position and can withstand any pressure fluctuations or other stresses that may occur in the ventilation system. Air

handling units and chambers shall be able to withstand the loads caused by the fan pressures while the valves are closed.

3.7.5.1
The supporting and stiffening structures of air ducts shall be able to withstand the stresses caused by insulation work, by the weight of insulation, and by the cleaning methods used.

3.7.5.2
Casings of air handling units and chambers as well as air ducts shall be able to withstand the loads caused by the maximum permissible pressure (maximum permissible operating pressure), but at least the test pressure of ± 1000 Pa (positive or negative pressure).

3.7.6
Pressures in a building, in its rooms and in the ventilation system shall be designed in such a way that air will flow from clean areas to more contaminated areas. These pressures shall not cause any long-term moisture loads to the structures.

3.7.6.1
Usually, buildings shall be designed for slightly negative pressure in relation to outdoors in order to be able to avoid any moisture damage to the structures and any health hazards that might be caused by microbes. However, such negative pressure shall generally not be greater than 30 Pa.

However, special rooms such as clean rooms and spaces where, owing to the type of activity, front doors or other apertures are often kept open, can be designed for overpressure in relation to outdoors..

3.7.6.2
In case high amounts of impurities or moisture are generated in the room in question, such a room shall be designed for a negative pressure as compared to other areas.

3.7.7.
Pressures in buildings and the air-tightness of structures shall be designed and implemented in such a way that they on their part will contribute to a reduction in the spreading of radon and other impurities in the building.

Explanation
The guidelines on radon, published by the Ministry of the Environment and by the Radiation Protection Centre describe measures that can be taken in order to reduce the radon content of indoor air.

3.7.8
Normal occupancy of buildings or fluctuations in weather conditions shall not cause any significant changes to pressures in buildings or rooms, or impair their ventilation.

3.7.8.1
The operating pressures of ventilation systems shall be designed and implemented in such a way that fluctuations in weather conditions will not change the direction of air flows in the building.

3.7.8.2
Operation of any demand-based control of air flow rates shall be designed in such a way that the pressure differentials in the building and between the different rooms will not change in a harmful way.

3.7.8.3
Vertical ducts of a natural ventilation system are usually conducted separately from each room, to above the roof of the building. The minimum permissible difference in the levels of the outdoor air and exhaust air devices of natural ventilation systems is 4.5 metres.

3.8 Cleanliness and serviceability of ventilation systems

3.8.1
Ventilation systems shall be designed and constructed in such a way that they are clean before the building is commissioned and that their cleanliness is easy to maintain.

3.8.1.1
Ventilation systems shall be built from parts free of oil, dust or other impurities on their inner surfaces. No harmful substances or odours shall be emitted into the air flow.

3.8.1.2
Ducts shall be stored at the building site suitably plugged so that they are not exposed to rain, dirt or mechanical damage . Small duct components and air terminal devices shall be kept at the building site in sealed packages.

3.8.1.3
Ventilation systems shall be protected against contamination during the installation work. The protective materials shall be finally removed only after the cleaning operation has been completed, i.e. when no more dust-generating work operations remain to be performed in the area concerned.

3.8.1.4
Ventilation systems should have such inner surfaces that it is easy to maintain system cleanliness. Stiffeners or supports of the air ducts shall not be located within the air ducts in such a way that they would significantly hamper the cleaning of the ventilation system.

3.8.1.5
Air ducts and chambers shall be fitted with an adequate number of sufficiently large access panels so as to enable cleaning operations to be carried out. The locations and types of such access panels shall be selected in such a way that all cleaning operations can be performed with ease and safety.

Access panels are normally located on chambers, at closing fire dampers and in ducts in such a way that there are not more than two bends of over 45° between any two such panels. In horizontal ducts, access panels are normally located at 10-metre intervals. The distances between access panels may be greater than 10 metres provided that the ducts in question can be cleaned over the entire distance between such panels through these panels. Access panels shall also be located at branch points if the main ducts and the ducts that branch off cannot be cleaned otherwise, for instance through the air terminal devices.

The access panels for horizontal ducts in areas that are very demanding with regard to fire safety and cleaning, shall normally be located at intervals of 3 to 5 metres.

An access panel shall be located on either side of the equipment, such as gate valves, installed in the ductwork, provided that the equipment in question cannot be removed for cleaning purposes. A section of ductwork or a duct fitting that can be removed and is sufficiently large can also act as an access panel for cleaning purposes.

3.8.1.6
Components and equipment that are sensitive to impurities shall not be placed unprotected in extract air ducts if the extract air contains large quantities of impurities, e.g. grease.

3.8.1.7
Cooling equipment installed between a suspended ceiling and an intermediate floor should be able to be cleaned throughout without the need to dismantle the suspended ceiling. In cases where air is allowed to circulate in the space above the suspended ceiling, also the suspended ceiling should have provision for easy cleaning.

3.8.2
Ventilation systems shall be designed and constructed in such a way that they will not cause water, moisture or other damage. The use of water or any resulting condensation in the system shall not result in growth of microbes or fungi that could be harmful to health.

3.8.2.1
In case a supply air unit located in a room is connected to a pipe system that carries liquid, the penetration of any leaking water into structures shall be prevented for instance by means of a floor drain located in the room, and/or with a waterproofed floor. This provision does not apply to the following air handling units with an outdoor air flow rate that is below 0.9 m^3/s: units that serve individual dwellings, units installed in the immediate vicinity of a front door, and units that serve a single room and are visible in the room it serves.

Condensation in air handling units that serve individual dwellings, or any other leakage water, shall be conveyed into a drain without disturbances.

3.8.2.2
Water shall not be taken from an open cooling tower directly for the cooling of supply air; in such cases a separate closed-loop cooling circuit shall be used.

3.8.3
Air humidification, and the water treatment in the humidifier, shall be designed and implemented in such a way that the humidification will not adversely influence the room air quality.

3.8.3.1
Any water coming into contact with supply air shall normally not be returned to the humidification section. However, if there are particular reasons why the use of water circulation is desirable, the humidifiers shall be equipped with an overflow system and with water treatment equipment that prevents any growth of microbes.

3.8.4
Outdoor air devices and their connections to the ventilation system and the building shall be located, protected and designed in such a way, or the construction of the outdoor air device shall be such that no harmful quantities of snow or rainwater will enter the ventilation system. Any snow or rainwater that enters the system shall not cause damage to the building or the ventilation system or negatively influence the operation of the ventilation system.

3.8.4.1
Unprotected outdoor air devices located on vertical outer walls and directly exposed to wind, shall normally be designed for a maximum face velocity of 2.0 m/s.

3.8.4.2
In case rainwater or snow may gain access to ventilation chambers or ducts, suitable drainage should be provided.

3.8.5
Air handling units, chambers and ducts shall be provided with thermal and vapour barriers in such a way that condensation will not cause any damage to the structures or to the ventilation system.

3.8.5.1
Air ducts shall be provided with thermal and vapour barriers in such a way that any indoor air humidity will not condensate into water . For instance outdoor air ducts located in heated areas of dwellings and extract air ducts located downstream from the heat recovery equipment shall be provided with thermal insulation and vapour barriers.

3.8.6
Ventilation systems and their servicing access routes shall be designed and constructed in such a way that the ventilation system can be serviced easily and safely.

3.8.6.1
Adequate space, at least of size equal to the equipment to be serviced in the servicing direction, shall be reserved for the servicing and cleaning of such equipment. In order to ensure good serviceability, sufficient space shall be provided around the functioning parts of the equipment and the air-handling units. All air handling units shall be equipped with servicing doors that can be opened without tools.

The principles as shown in Figure 4 for an encased air handling unit shall be followed when reserving space around ventilation equipment. If there are several units in the plant room, space shall be reserved separately for servicing and repair operations. No fixed or heavy objects shall be located in such servicing areas.

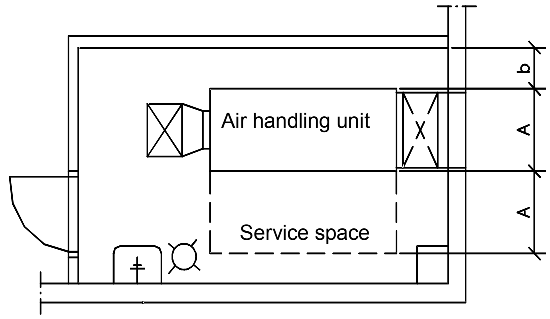

Figure 4. An example of the location and dimensions of the servicing area for an encapsulated air handling unit. A is the width of the unit and b is 0.4 times the height of the unit or a minimum of 400 mm.

3.8.6.2
Suspended ceilings shall be fitted with a clearly marked, removable or opening part of at least 500 mm x 500 mm at the ventilation equipment to be serviced and at the access panels.

Explanation
Part F2 of the National Building Code of Finland gives regulations and guidelines on the service access routes and safety arrangements in connection with ventilation systems.

4

ENERGY PERFORMANCE OF VENTILATION SYSTEMS

4.1.1
Ventilation systems for buildings shall be designed and constructed on the basis of the building's planned purpose and occupancy in such a way that this, for its part, creates the right preconditions for an efficient use of energy.

The energy performance of a ventilation system shall be ensured by using means that are appropriate in view of the building's intended use and without prejudice to a healthy, safe and comfortable indoor climate.

4.1.1.1
The preconditions for efficient energy use by the ventilation system shall be ensured by appropriate design, such as grouping of the operating ranges and operating periods of the ventilation equipment, control of the ventilation system according to the actual demand, and by operating extract air heat recovery equipment as necessary.

4.1.1.2
All ducts and chambers shall be thermally insulated in such a way that the temperature differential between the air flows and the surrounding area does not give rise to unnecessary energy consumption, heating or cooling of the air flow, or impairment of the indoor climate or of the control functions.

4.1.1.3
The ventilation system shall be designed and constructed in such a way that the electric power drawn by the system can be easily measured.

4.1.1.4.
The maximum permissible specific electric power of a mechanical supply air and extract air system is normally 2.5 kW/(m³/s). The maximum permissible specific electric power of a mechanical extract air system is normally 1.0 kW/(m³/s).

4.1.1.5
The specific electric power of a ventilation system can be higher than 2.5 kW/ (m³/s) if, for instance, the control of the building's indoor climate requires exceptional air-conditioning.

4.1.2
A quantity of heating energy that corresponds to at least 30% of heating energy required for the heating of the ventilation system shall be recovered from the extract air of the ventilation system. A similar reduction in the need for thermal energy can be implemented by improving the thermal insulation of the building envelope, which shall be verified by relevant calculations.

It is permissible not to have heat recovery from extract air for certain individual areas of the building, and also without any corresponding reduction in energy consumption, provided that such heat recovery system can be shown to be inappropriate.

4.1.2.1
A mechanical supply and extract air system is normally equipped with heat recovery from the extract air; in which the heat exchanger's supply air temperature efficiency shall be at least 50% in a test situation when the mass flow rates of the supply air and extract air are equal, and protection against freezing and removal of water condensed from the extract air is arranged in a reliable way.

The annual efficiency of the heat recovery equipment used in the calculations is the heat exchanger's supply air temperature efficiency value multiplied by 0.6, unless proved to be otherwise by calculations.

Explanation
The temperature efficiency can be determined in accordance with Standard EN 308.

4.1.2.2
Heat recovery system can be shown to be inappropriate for instance in cases where the exceptionally contaminated state of the extract air prevents the functioning of the heat recovery system or the temperature of the extract air is less than +15 ^{o}C during the heating season.

5

ENSURING GOOD OPERATING CONDITIONS AND COMMISSIONING OF VENTILATION SYSTEMS

5.1.1
The ventilation system's air-tightness shall be checked and measured as necessary. A report on the checks and measurements carried out shall be attached to the building inspection documents.

Explanation
Part A1 of the National Building Code of Finland contains regulations and guidelines concerning building work inspection documents.

5.1.1.1
Normally, the air-tightness of the entire ventilation system shall be measured. Air-tightness shall be measured by performing air-tightness tests in accordance with Standard SFS 3542.

5.1.1.2
Where the ductwork system consists of ducts and ductwork components that correspond to be at least of air-tightness class C and are tested and checked for quality, air-tightness can be measured by random tests. The extent of such random tests to be carried out shall be 20% of the surface area of the ductwork. In case the air-tightness class of the ducts and ductwork components is better than C, the extent of such random tests is 10% of the surface area of the ductwork.

In cases where the ductwork system incorporates ducts or ductwork components whose air-tightness class is lower than C, the extent of the random tests shall be increased by a surface area that corresponds to such parts. If the surface area of these ducts or ductwork components is more than 25% of the total surface area of the ductwork system, then the entire ductwork system shall be measured. The surface area of such parts is calculated by assuming that the surface area of a joint is the circumference of the cross-section times 2 metres. For instance a 'T' piece has three joints while duct connections have two joints.

5.1.1.3
In case the ventilation system serves a single room or a single dwelling, the air-tightness test can be replaced with an installation survey, provided the entire ductwork system consists only of ducts or ductwork components whose air-tightness class is at least C and which are of a tested and checked quality.

5.1.1.4
The air-tightness of the entire ductwork system shall be measured if the ductwork system is used for conveying air that contains toxic or corrosive gases or air that is otherwise harmful to health.

5.1.1.5
Where an air handling unit of air-tightness class A or higher and of a tested and controlled quality is supplied as a single assembly or in sections in such a way that at the installation site a maximum of two connections on the supply air side and/or two connections on the extract air side need to be made, no air-tightness checks need to be performed on site. For other air handling units of air-tightness class A or higher and of a tested and controlled quality, the air-tightness test is performed in the form of a random test. The extent of such tests is 20% of a number of units, but at least one whole unit shall be tested.

5.1.2
The cleanliness of ventilation systems shall be checked and the system shall be cleaned if found necessary, prior to the measurement of and adjustments to the air flow rates.

The air flow rates of a ventilation systems shall be measured and adjusted, their specific electric power measured, and the operation and cleanliness of the system shall be verified to be in accordance with specifications prior to the commissioning of the building. Reports on these checks shall be attached to the building work inspection document.

5.1.2.1
Operation of the electrical equipment of the ventilation system shall be tested using the final electrical connections with all the fuses in their final position.

5.1.2.2
The operational tests shall be carried out prior to the measurement of and adjustments to the air flow rates. Prior to starting these tests it is necessary to check that the building or the ventilation system is not so incomplete that this will have an effect on the air flow rates, or pressures or the directions of the transferred air flows. In this context it shall also be checked that the building is sufficiently clean, that no more dust-generating work is performed in the rooms in question, that the filters of the ventilation system have been installed, and that doors and windows are in their final position. At least a visual inspection to determine the cleanliness of the building and its ventilation system shall be done, and recorded in the building work inspection document.

5.1.2.3
The air flow rates shall be adjusted at the non-boosted air flow that corresponds to the main occupancy situation. The setting of the control equipment shall be carried out in occupancy situations that correspond to the average conditions during the various seasons. The conformity of these pressures to the design values shall be verified by means of smoke tests or by measuring the air flow rates and pressure differentials.

5.1.2.4
The performance values of ventilation systems regarding their air flow rates, sound levels, and electrical and thermal characteristics shall be measured using the non-boosted air flow rate of the system's period of occupancy and, in the case of dwellings, also at the boosted design air flow rate. The permissible tolerances from the design values are usually as follows:

1) air flow rate, per system	± 10 %;
2) air flow rate, per room	± 20 %;
3) air velocity in occupied zone	+ 0,05 m/s;
4) electric power	+ 10 %; and
5) heating effect	-10 %.

These permissible tolerances take into account both deviations in measurement results and the measurement uncertainty.

5.1.2.5
The measurements and the conversion of measurement values to correspond to the design values shall be carried out in accordance with the standards currently in force. The measurements shall be carried out using equipment with currently valid calibrations and methods in which the maximum element of uncertainty is normally one half of the permissible tolerances listed in 5.1.2.4.

APPENDIX 1

Guideline values for air flow rates, air movement and sound levels

Tables 1 to 11 present the guideline values for the design of ventilation during periods of occupancy. The number of occupants primarily determines the outdoor air flow rates. In case there is not sufficient basis for designing air flow rates according to the number of occupants, the design shall be based on the surface areas in question. In the dimensional design of air ducts, the boosted air flow rates during periods of occupancy shall be taken into account.

Outdoor air flow rates have been determined in order to maintain the quality of indoor air when the building and furnishing materials used are low-emitting. In case the increase of concentrations or rise in room temperatures, caused by internal and/or external contaminant loads or thermal loads, need to be restricted by means of ventilation, air flow rates higher than those given in the Tables shall be used.

On demand control of ventilation systems shall normally be implemented in the rooms where human occupancy or emissions of impurities vary significantly.

Part C1 of the National Building Code of Finland gives regulations and guidelines on the maximum permissible sound levels in internal areas and to the ambient, due to building services equipment and other comparable equipment. The sound levels specified in Part C1 of the National Building Code of Finland are shown in **bold** text in the Tables of this Appendix. These sound levels are the values specified in the regulations of Part C1 concerning dwelling rooms and kitchens, and the values specified in the guidelines of Part C1 concerning patient rooms, children's rest rooms, educational premises and offices.

The guideline values for sound levels are expressed as the 'A' frequency-weighted mean sound level, $L_{A,eq,T}$ (dB), and the maximum sound level, $L_{A,max}$ (dB), in a room, caused by building services equipment and other similar equipment. The combined effect of the ventilation system and other sources of noise shall be taken into account when applying these guideline values. In case the room is affected by sounds from more than one source of noise, the sound level produced by each source alone shall be so low that the combined sound level produced by all of these together does not exceed the maximum permissible sound level. The effect of several sources on the room's overall sound level shall be taken into account by adding together the sound levels of all pieces of equipment producing a noise that affects the room in question using the following formula

$$L_{Atot} = 10\ \lg(10^{LA1/10} + 10^{LA2/10} + ... + 10^{LAn/10}),$$

where L_{Atot} is the aggregate sound level produced by all the equipment and $L_{A1} \ldots L_{An}$ is the sound level produced by each piece of equipment alone.

The air velocity values given in the Tables, for the movement of air in the occupied zone, correspond to the room temperatures defined in section 2.2. Air velocities that cause discomfort at various room air temperatures can be evaluated by means of the draught curves shown in Figure 1.

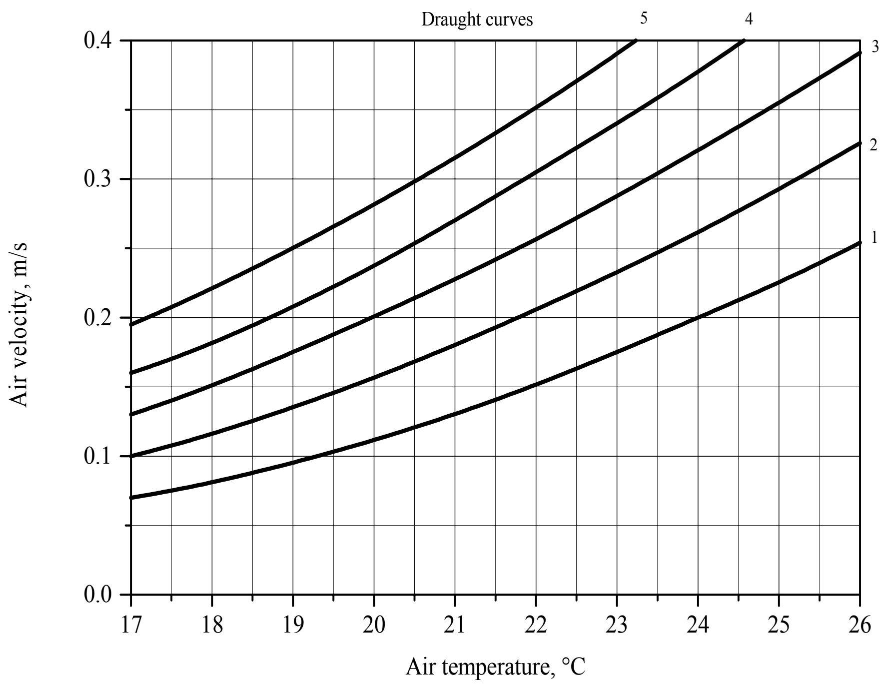

Figure 1. Draught curves describe the relationship between air temperature and air velocity that causes discomfort.

If the boosting of ventilation or air circulation equipment can be controlled by the occupant, to exceed the guideline values for periods of occupancy, then the guideline values for air velocity as shown in the Tables may be exceeded during such boosting periods by + 0.1 m/s and the guideline values for sound levels ($L_{A,eq,T}$ and $L_{A,max}$) by + 10 dB.

Table 1. Residential buildings

Ventilation in dwellings is normally designed on the basis of the Table's extract air flow rates in such a way that the air change rate of dwellings is at least 0.5 l/h, while the adequacy of outdoor air flows is ensured to at least equal the guideline values. Extract air flows in small dwellings are normally designed to be lower than the guideline values in such a way that the maximum air change rate of such dwellings during periods of occupancy is 0.7 l/h, while the boosting of the extract air flow rate can be controlled separately for each room or each dwelling as necessary. If the boosting of the extract air flow rate can only be controlled for the entire building, the extract air flows in small dwellings can be designed to be lower than the guideline values in such a way that the air change rate of such dwellings is at least 1.0 1/h. Extract air flows in large dwellings are normally designed to be higher than the guide-line values so that the outdoor air flow for each room is in accordance with the guideline value and for the air change rate of the apartment to be at least 0.5 l/h.

Space type	Outdoor air flow (dm^3/s) per person	Outdoor air flow (dm^3/s)/m^2	Extract air flow dm^3/s	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter) m/s	Note!
Dwelling areas:	6					
Dwelling rooms		0.5		**28 / 33 ***	0.20	*C1 regu.
Kitchen		#S	8 #A	**33 / 38 ***	0.20	*C1 regu.
- boost during occupancy		#S	25	33 / 38	0.20	
Cloakroom, storage room		#S	3	33 / 38		
Bathroom		#S	10 #B	38 / 43	0.20	
- boost during occupancy		#S	15	38 / 43	0.20	
WC		#S	7 #B	33 / 38		
- boost during occupancy		#S	10	33 / 38		
Utility room		#S	8	33 / 38	0.30	
- boost during occupancy		#S	15	33 / 38	0.30	
Sauna in the apartment		2 #C	2/m^2 #C	33 / 38		
Common spaces:						
Stair well		0.5 1/h	0.5 1/h	38 / 43		
Storage areas		0.35	0.35 /m^2	43 / 48		
Cold cellar (also cold stores in apartments if area is > $4m^2$)		0.2	0.2 / m^2	43 / 48		
Dressing room		2	2 / m^2	33 / 38	0.20	
Wash room		3	3 / m^2	43 / 48	0.20	
Hot room in sauna		2	2 / m^2	33 / 38		
Laundry area in the building		1	1 / m^2	43 / 48		
Drying room		2 #D	2 / m^2 #D	43 / 48		
Hobby room, club room		1 #E	1 / m^2 #E	33 / 38	0.20	

A Guideline value when the boosting of cooker hood air flow rate can be controlled separately for each room or each dwelling; otherwise the guideline value for cooker hoods is 20 dm³/s.
B Guideline value when the boosting of air flow rate can be controlled separately for each room or each dwelling; otherwise the guideline value for the air flow is the same as the boosting value during periods of occupancy.
C But not less than 6 dm^3/s. Air flows in the sauna are not taken into account in the calculation of the dwellings's air change rate if the sauna's outdoor air flow rate is equal to the extract air flow rate.
D Can be designed to be lower when using an air drier.
E Requires an openable window for airing; otherwise 1.5 (dm^3/s)/m^2.
S Outdoor air flow is normally substituted with transferred air flow conducted from the dwelling rooms.

*Table 2. Office buildings #*1

Space type	Outdoor air flow (dm³/s) per person	Outdoor air flow (dm³/s)/m²	Extract air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter / summer) m/s	Note!
Offices and similar rooms		1.5		**33 / 38 ***	0.20 / 0.30	*C1 guidel.
Conference room	8	4		33 / 38	0.20 / 0.30	#3
Customer area		2		38 / 43	0.30 / 0.40	#2,
Corridor area		0.5		38 / 43	0.30	#2,
Canteen, break area		5		38 / 43	0.25	
Archive, storage room			0.35			
Smoking room:						
– during building occupancy		10	20	38 / 43	0.30	#4
– outside building occupancy			10			#4
Copying room		1	4			

#1 For hygiene rooms' extract air flows, see Table 11 Hygiene rooms.
#2 Guideline values for air velocity at fixed work stations are the same as for offices.
#3 If a building has three or more conference rooms, it shall be possible to control their ventilation according to the actual demand..
#4 The pressure in smoking rooms shall always be lower than in the surrounding rooms.

*Table 3. Educational establishments #*1

Space type	Outdoor air flow (dm³/s) per person	Outdoor air flow (dm³/s)/m²	Extract air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter / summer) m/s	Note!
Classroom	6	3		**33 / 38 ***	0.20 / 0.30	#4, *C1 gdln
Corridors / Lobbies		4		38 / 43		#2
Gym:						#3
– use for gym purposes		2		38 / 43	0.30	
– use as assembly hall		6		33 / 38	0.25	
Lecture room	8	6		33 / 38	0.20 / 0.30	#4
Team work area	8	4		33 / 38	0.20 / 0.30	#4
Canteen	6	5		33 / 38	0.25	
Storage rooms			0.35			#S

#1 For hygiene rooms' extract air flows, see Table 11 Hygiene rooms.
#2 Guideline values for air velocity at fixed workstations are the same as for offices.
#3 Indoor climate and ventilation shall be designed in accordance with the most demanding use, shall be able to be controlled as necessary for the purposes of different types of use.
#4 Ventilation shall be controllable according to the actual demand..
#S Transferred air can be used.

Table 4. Restaurants, workplace canteens and hotels #1

Space type	Outdoor air flow (dm³/s) per person	Outdoor air flow (dm³/s)/m²	Extract air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter / summer) m/s	Note!
Restaurants where smoking is not permitted at all	10	10		38 / 43	0.20	#2, T
Restaurants where smoking is partly permitted:						#2, 3, T
a) dining restaurants and cafés	15	15		38 / 43		
b) evening restaurants such as pubs, night clubs, meeting and dance restaurants	20	20		38 / 43		
Hotel room	10	1		28 / 33	0.20	
Corridor		0,5		33 / 38	0.25	
Lobby		2		33 / 38	0.20	#2
Meeting rooms	8	4		33 / 38	0.20	#2

#1 For hygiene rooms' extract air flows, see Table 11 Hygiene rooms.
#2 Guideline values for air velocity at fixed work stations are the same as for offices.
#3 At least 75% of the outdoor air flow shall be conducted to the non-smoking zone and, similarly, at least 75% of the extract air shall be extracted from the smoking zone. At least 75% of the supply air flow to the smoking zone shall be brought in as transferred air from the non-smoking zone.
#T Ventilation in restaurants shall be able to be controlled according to the actual demand..

Explanation:
An example of the division of air flows in a dining restaurant where smoking is partly permitted:
The surface area is 100 m², one half of it is a non-smoking zone and the other half a smoking zone. The total outdoor air flow rate is 1,5 m³/s, of which (at least) 1125 dm³/s is conducted to the non-smoking zone and the rest (not more than 375 dm³/s) is conducted to the smoking zone. Similarly, the extract air flow rate in the smoking zone shall be at least 1125 dm³/s. At least 750 dm³/s of the supply air of the smoking zone shall be transferred air from the non-smoking zone.

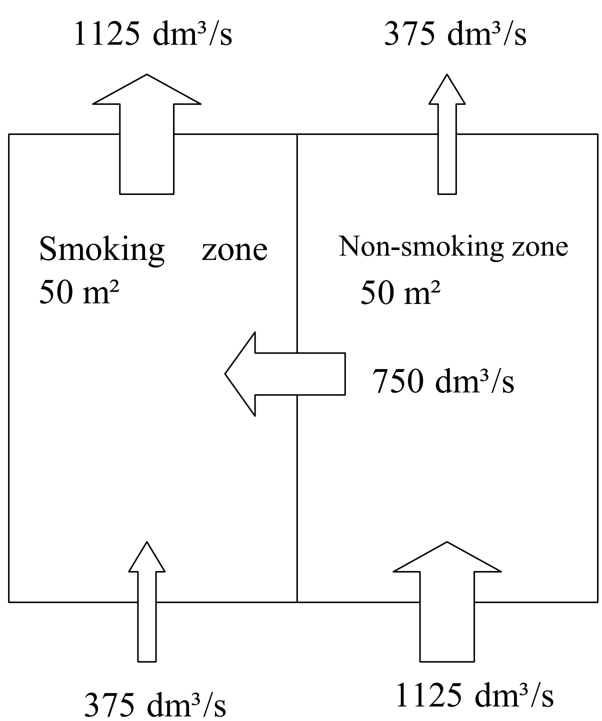

Table 5. Shops and theatres #1

Space type	Outdoor air flow (dm³/s) per person	Outdoor air flow $(dm^3/s)/m^2$	Extract air flow $(dm^3/s)/m^2$	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter / summer) m/s	Note!
Shop		2		43 / 48	0.25	#2, #T
Theatre auditorium	8			28 / 33	0.20	#T
Theatre stage		3		28 / 33	0.25	#2
Lobby, foyer		5		38 / 43	0.25	#T
Concert hall	8			25 / 30	0.20	#T
Film theatre	8			33 / 38	0.20	#T

#1 For hygiene rooms' extract air flows, see Table 11 Hygiene rooms.
#2 Guideline values for air velocity at fixed work stations are the same as for offices.
#T Ventilation shall be able to be controlled according to the actual demand.

Table 6. Sports premises, swimming pools and barracks #1

Space type	Outdoor air flow (dm³/s) per person	Outdoor air flow $(dm^3/s)/m^2$	Extract air flow $(dm^3/s)/m^2$	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter / summer) m/s	Note!
Physical exercise premises:						#T
– Fitness hall		6		38 / 43	0.25	
– Gym hall, small		4		38 / 43	0.25	
– Gym hall, large		2		38 / 43	0.25	
– Auditorium	8			33 / 38	0.25	
Corridors/lobbies, occupied		5		38 / 43	0.30	#2
Corridors for temporary occupancy only		1		38 / 43	0.30	
Swimming pool area		2		38 / 43	0.40	#K
Barracks areas:						
Dormitory	8	2		33 / 38	0.20	
Canteen	6	5		33 / 38	0.25	
Wash room			5	38 / 43	0.30	#S
Corridor		1		38 / 43	0.25	
Leisure room		3		33 / 38	0.20	
Teaching room	6	3		33 / 38	0.20	

#1 For hygiene rooms' extract air flows, see Table 11 Hygiene rooms.
#2 Guideline values for air velocity at fixed work stations are the same as for offices.
#T Ventilation shall be able to be controlled according the actual demand..
#K Moisture removal is a design factor. To be calculated separately in each case.
#S As transferred air flow

Table 7. Medical, penitentiary and day-care establishments #1

Space type	Outdoor air flow (dm³/s) per person	Outdoor air flow (dm³/s)/m²	Extract air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter / summer) m/s	Note!
Hospital patient room	10	1.5		**28 / 33 ***	0.20 / 0.30	*C1 gdln
Hospital treatment room		2		33 / 38	0.20 / 0.30	#E
Hospital rehabilitation room		2		33 / 38	0.20 / 0.30	
Hospital leisure rooms		3		33 / 38	0.20	
Child care rooms		2		33 / 38	0.20 / 0.30	
Long-term patient treatment rooms		2		33 / 38	0.20 / 0.30	#3
Corridor		0.5		33 / 38	0.20 / 0.30	#2
Waiting rooms		3		33 / 38	0.20 / 0.30	#2
Toilets for patient and waiting rooms			30 per seat	38 / 43	0.20	
Flushing room			10	38 / 43	0.20	#3
Detainee reception area		3	1	33 / 38	0.20	#4
Lockup corridor		3		38 / 43	0.20	
Lockup for drunks		8	10	33 / 38	0.20	#S
Cell corridor		2		38 / 43	0.30	
Cell	8	2.5	3	33 / 38	0.20	#S
Day-care centres:						
Rest rooms	6	2.5		**28 / 33 ***	0.20 / 0.30	*C1 gdln
Play and team rooms	6	2.5		33 / 38	0.20 / 0.30	
Water play room		2		33 / 38	0.20 / 0.30	
Entrance hall		2		33 / 38	0.20	
Porch (for removing wet clothes)			5			#3, #S

#1 For hygiene rooms' extract air flows, see Table 11 Hygiene rooms.
#2 Guideline values for air velocity at fixed work stations are the same as for offices.
#3 Extract air flow and similarly outdoor air flow shall be increased by as much as is required by local exhaust ventilation and/ or by odour control.
#4 Extract air through surrounding hygiene or other such areas.
#E Ventilation of specialised rooms such as operating theatres, treatment rooms, X-ray rooms, equipment servicing areas, rooms reserved for the washing of patients, etc. shall be planned separately in each case.
#S Transferred air flow

Table 8. Other public spaces #1

Space type	Outdoor air flow (dm³/s) per person	Outdoor air flow (dm³/s)/m²	Extract air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter / summer) m/s	Note!
Public transport stations:						
Waiting area and corridor		5		43 / 48		#2
Spaces used for exhibitions:						
- Exhibition rooms		4		33 / 38	0.20 / 0.40	#2, #T
- Museums		4		33 / 38	0.20 / 0.40	#2, #T
- Trade fair hall		4		38 / 43	0.20 / 0.40	#2, #T
Libraries:						
– Library hall	8	2		33 / 38	0.20 / 0.40	#2
– Reading room	8	2		33 / 38	0.20 / 0.30	
– Storage room			0,5			#S
Churches:						
– Church hall	6			33 / 38	0.20	#T
– Other public spaces		5		33 / 38	0.20	#T

#1 For hygiene rooms' extract air flows, see Table 11 Hygiene rooms.
#2 Guideline values for air velocity at fixed work stations are the same as for offices.
#S Transferred air flow
#T Ventilation shall be able to be controlled according to actual demand.

Table 9. Workspaces etc. #1, #2 and #3

Space type	Outdoor air flow (dm³/s) per person	Outdoor air flow (dm³/s)/m²	Extract air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter / summer) m/s	Note!
Factory work:						
– Light	10	1.5, #4			0.20 / 0.30	
– Medium	10	1.5, #4			0.25 / 0.50	
Laboratories (chemical)	8	1		38 / 43	0.20 / 0.40	#E, T
Motor garages, M.O.T. premises		7	3, #5	43 / 48	0.25	

#1 For hygiene rooms' extract air flows, see Table 11 Hygiene rooms.
#2 Guidelines for office buildings also apply to office areas situated in other types of buildings.
#3 Extract air flow and similarly outdoor air flow shall be increased by as much as is required by local exhaust ventilation and/ or by the management of impurities.
#4 Ventilation plants shall be designed for at least the air flow rate in question. Such plants can be operated with lower air flow rates on the basis of emissions of impurities and thermal loads, to be specified in reports on working methods etc. The air flow rates are examples. Temperature level and air velocity shall be planned separately in each case according to the type of work.
#5 Requires local extraction of exhaust gases to the extent of at least 100 dm^3/s for passenger cars and 300 dm^3/s for trucks. In cases where an exhaust gas rail is used to which vehicles are connected all the time, the air flow rate requirement can be reduced to 2 dm^3/s. The extract air flow rate shall be designed in such a way, taking the extraction of exhaust gases into account, that the room in question is not at negative pressure; see also Standard SFS 3352.
#E Shall be planned separately in each case.
#T Ventilation shall be able to be controlled according to actual demand.

Table 10. *Food preparation spaces*

Space type	Outdoor air flow (dm^3/s) per person	Outdoor air flow $(dm^3/s)/m^2$	Extract air flow $(dm^3/s)/m^2$	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter / summer) m/s	Note!
Kitchens:						
– Food preparation kitchen		15	15	38 / 43	0.25 / 0.50	#E
– Heating up kitchen		10	10	38 / 43	0.25 / 0.50	#E
– Distribution kitchen		5	5	38 / 43	0.25 / 0.50	#E
– Kitchenette		3	30 l/s/kitchen	33 / 38	0.20 / 0.40	
Storage room:						
– Dry storage			0.5			#S
– Cold storages >4 m^2			0.2			#S
– Waste room			5			#1
– Cooled waste room			2			#1

#1 Continuous negative pressure required.
#E Minimum air flow rates. Air flow rates shall be designed separately in each case on the basis of thermal loads in question.
#S Transferred air flow

Table 11. *Hygiene rooms and other spaces in non-residential buildings*

Space type	Outdoor air flow (dm^3/s) per person	Outdoor air flow $(dm^3/s)/m^2$	Extract air flow $(dm^3/s)/m^2$	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity (winter / summer) m/s	Note!
WCs						
– in connection with work place areas or similar			20 per seat	38 / 43		#S
– in connection with public areas			30 per seat	38 / 43		#S
Wash room		3	5,	38 / 43	0.20	#S
Dressing room		5	4/cupboard	38 / 43	0.20	#S
Sauna steam room		1	2	38 / 43		#S
Cleaning rooms			4			#S
Stair well		0.5 1/h	0.5 1/h	38 / 43		#1
Lift shaft			8			
Lift engine room	4		17			#2

#1 Air change rate
#2 To be adjusted according to thermal loads. The maximum permissible temperature in the lift engine room is 35°C.
#S Transferred air flow

APPENDIX 2

Guidelines for the ventilation of parking garages

These guidelines apply mainly to garages for parking purposes. These guidelines cannot be applied directly to cases where there are maintenance and repair premises, loading terminals and coach terminals or other premises where work is carried out continuously.

The ventilation of garages shall be arranged in such a way that air impurities will not cause any harmful effects on the health of the users of the garage. If there is a possibility that queues of vehicles may form due to e.g. payment of parking fees or traffic arrangements, the ventilation in such areas shall be boosted by installing extra extraction fans at such congested points. The boosted extraction can then be controlled according to the contaminant concentration (for instance CO content). If there are workplaces in or in conjunction with such garages, then the ventilation arrangements shall be made according to the requirements of such workplaces.

In cases where such parking garages are connected to another building, its ventilation shall be arranged in such a way that the garage is in negative pressure as compared to the other areas.

The supply air brought into parking garages may consist of transferred air.

The supply air and extract air openings shall be located in such a way that adequate ventilation is assured for the various parts of the garage. These openings shall be located in such a way that air will not be allowed to spread unnecessarily from areas where there is a high concentration of impurities. Also, there shall not be any points left in such garages where the concentration of impurities in the air could locally exceed the permitted values. For instance local extraction or air transfer fans can be used to prevent this from happening.

The extract air flow rates in mechanical ventilation systems shall be as follows:
- in premises where there is in average one movement per vehicle space during the busiest 8-hour period of the day, at least 0.9 $(dm^3/s)/m^2$. Such premises include e.g. the parking lots belonging to residential blocks of flats;
- in premises where there are, respectively, 2 to 4 such movements, at least 2.7 $(dm^3/s)/m^2$. Such premises include e.g. parking lots reserved for the personnel of offices and government departments; and
- in premises where there are, respectively, more such movements, the extract air flow rate shall be at least n x 0.9 $(dm^3/s)/m^2$. In this formula n stands for the number of vehicle movements and its numerical value shall be at least 4. Such premises include e.g. actual multi-storey car parks as well as customer parking areas serving office buildings, government departments and commercial buildings.

In parking garages where vehicles are parked in rows, with a maximum area of 60 m^2 it is permissible to use a natural ventilation system. A garage with parking in rows is a type of motor vehicle garage where there is no driving inside and which has a maximum depth of 7 metres, or 14 metres in cases where the garage is designed for buses/coaches or other long vehicles. Such garages should be in their entirety above ground or located in a corresponding manner as far as ventilation is concerned, on a slope for example. The supply air and extract air openings shall be located in such a way that adequate ventilation and circulation of air is achieved. Supply air openings may be located in the lower part of an outer wall or a door. Extract air openings are normally located in the upper part of the wall or on the ceiling/in the roof on the opposite side from the supply air opening. The free cross-sectional area of both the supply air and extract air openings shall be at least 0.1% of the floor area but not less than 150 cm^2.

In case at least 30% of the outer wall of an unheated parking garage, e.g. a multi-storey car park, is open to atmosphere and the area of the openings is at least 10% of the floor area of each level, then no separate ventilation system is required in such garage. However, in such areas there shall not be obstacles, such as partition walls or beams that would considerably impede the flow of air.

The mechanical ventilation of a parking garage may be reduced outside normal operating hours if the ventilation system is controlled by demand according to the concentration of impurities in the air, and when the garage is equipped with a separate alarm system. The ventilation shall reach full power whenever the concentration of impurities at any one sensor exceeds the set limit (for instance CO concentration of 50 ppm). An alarm is given when the concentration of impurities exceeds the set limit (for instance CO concentration of 70 ppm). At least three control and alarm sensors shall be installed in such garages on each level, normally in the vicinity of ramps and driving lanes. The operation of such sensors shall be checked on a regular basis and they shall be calibrated at least once a year. The calibration certificate shall be attached to the guidelines for the use and maintenance of the building.

Guiding information

NATIONAL BUILDING CODE OF FINLAND
Contents on 6 June 2002 (up-to-date list of contents www.ymparisto.fi)

A	GENERAL SECTION		
A1	Supervision of construction work	Regulations and guidelines	2000
A2	Building designers and construction plans	Regulations and guidelines	2002
A3	Construction products	Regulations	1995
A4	Maintenance manual for the care and use of buildings	Regulations and guidelines	2000
A5	Plan notations	Regulations	2000
B	STRENGTH OF STRUCTURES		
B1	Structural safety and loads	Regulations	1998
B2	Load-bearing structures	Regulations	1990
B3	Foundations	Regulations	1976
B4	Concrete structures	Guidelines	2001
B5	Lightweight concrete block structures	Guidelines	1987
B6	Light gauge steel structures	Guidelines	1989
B7	Steel structures	Guidelines	1996
B8	Brick structures	Guidelines	1989
B9	Concrete block structures	Guidelines	1993
B10	Timber structures	Guidelines	2001
*	National Application Documents (NAD) for Eurocode Prestandards		
C	INSULATIONS		
C1	Sound insulation and noise abatement in buildings	Regulations and guidelines	1998
C2	Moisture	Regulations and guidelines	1998
C3	Thermal insulation	Regulations	1985
C4	Thermal insulation	Guidelines	1978
D	HEATING, PLUMBING, AIR-CONDITIONING AND ENERGY ECONOMY		
D1	Water and sewage installations in buildings	Regulations and guidelines	1987
D2	Indoor climate and ventilation of buildings	Regulations and guidelines	1987
D3	Energy management for buildings	Regulations and guidelines	1978
D4	HEPAC drawings	Guidelines	1978
D5	Calculation of power & energy requirements for heating of buildings	Guidelines	1985
D6	Foreman for water supply and drainage	Regulations	1990
D7	Efficiency requirements for boilers	Regulations	1997
E	STRUCTURAL FIRE SAFETY		
E1	Structural fire safety in buildings	Regulations and guidelines	2002
E2	Fire safety of production and storage buildings	Guidelines	1997
E3	Small chimneys	Guidelines	1988
E4	Fire safety of motor vehicle shelters	Guidelines	1997
E7	Fire safety of ventilation installations	Guidelines	1980
E8	Masonry fire places	Guidelines	1985
E9	Fire safety of boiler rooms and fuel depots	Guidelines	1997
F	GENERAL PLANNING OF HOUSING		
F1	Barrier-free building	Regulations and guidelines	1997
F2	User safety of buildings	Regulations and guidelines	2001
G	HOUSING CONSTRUCTION		
G1	Housing design	Regulations	1994
G2	Subsidised housing	Regulations and guidelines	1998

MEASUREMENT METHODS

Thermal conditions

SFS 5511 Air-conditioning. Indoor climate of buildings. Field measurements of thermal conditions. 1989

Air quality

SFS-EN 12341:1998 Air quality. Determination of the PM 10 fraction of suspended particulate matter. Reference method and field-test procedure to demonstrate reference equivalence of measurement methods.
HTP* values 2000, Ministry of Social Affairs and Health, Labour Protection Provisions 3, Tampere, 2000.
* occupational exposure limits

Air flow rates

SFS 5512 Air-conditioning. Measurement of air flow rates and pressure ratios in ventilation plants. 1989

Air-tightness

SFS 3542 Air-conditioning ducts. Strength and leakage testing. 1987
EN 1751:1998 Ventilation for buildings - Air terminal devices - Aerodynamic testing of dampers and valves.