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D2 National Building Code of Finland

Ministry of the Environment, Department of Built Environment

Indoor Climate and Ventilation of Buildings

Regulations and Guidelines 2012

DRAFT 28 SEPTEMBER 2010

Decree of the Ministry of the Environment on Indoor Climate and Ventilation of Buildings

Issued in Helsinki on …(day) … (month) …(year)

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 are 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 Decree will enter into force on the 1 January 2012, and it will abrogate the Decision of the 22 December 2008 issued by the Ministry of the Environment. Earlier Regulations and Guidelines can be applied to any licence applications that have been submitted prior to the date at which this Decree entered into force.

Issued in Helsinki on …(day) … (month) …(year)

Jan Vapaavuori Minister for Housing

Pekka Kalliomäki, Senior Technical Advisor

European Parliament and Council Directive 2010/31/EU (32002L0031); OJ No. L 153, 18.06.2010, p.13

D2 THE NATIONAL BUILDING CODE OF FINLAND

MINISTRY OF THE ENVIRONMENT, Department of Built Environment

Indoor climate and ventilation for buildings
REGULATIONS AND GUIDELINES 2012

Contents

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

The guidelines are printed across a narrow column using a small font size. The guidelines are not binding and it is possible to apply other solution than those given in the guidelines, providing they meet the requirements set for construction work.

Explanations *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 a new building. 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
Whenever information is given in these regulations and guidelines in the currently used SFS standards, valid standards of a corresponding level from elsewhere in the European Economic Area or Turkey may be used alongside or instead of them.

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 a temperature different to the air temperature, then the operative temperature is 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)*the annual heat recovery benefit ratio of the extracted air of the ventilation*: the proportion of the annual recovered and recycled amount of heat, recovered with heat recovery equipment, to the amount of heat required for the heating, when there is no heat recovery;

5)*ventilation*: maintaining and enhancing indoor air quality by changing indoor air;

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

7) *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, $(m^3/h)/m^3 = 1/h$;

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

9) *exhaust air*: the extract air that is conducted from the building;

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

11) *mechanical supply air and extract air system*: a system in which air is mechanically extracted from the building by fans and in exchange heated or cooled and filtered outdoor air is supplied by means of fans.

12) *mechanical exhaust air system*: a system in which air is conducted 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;

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

14)*temperature ratio*: the ratio between the change in temperature of the air supplied from the heat exchanger of the heat recovery equipment and the difference in temperatures of the extract air and the outdoor air in the heat exchanger;

15) *occupied spaces*: a room occupied for long periods of time. Hence, occupied spaces do not include, for example, hygiene spaces, cloakrooms and office corridors;

16) *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;

17) *gravity or natural ventilation system*: a system whose operation is based on the pressure differentials produced by differences in level and temperature and 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, as well as from air leakages through the structures.

18) *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;

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

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

21) *design service life*: the service life 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; and

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

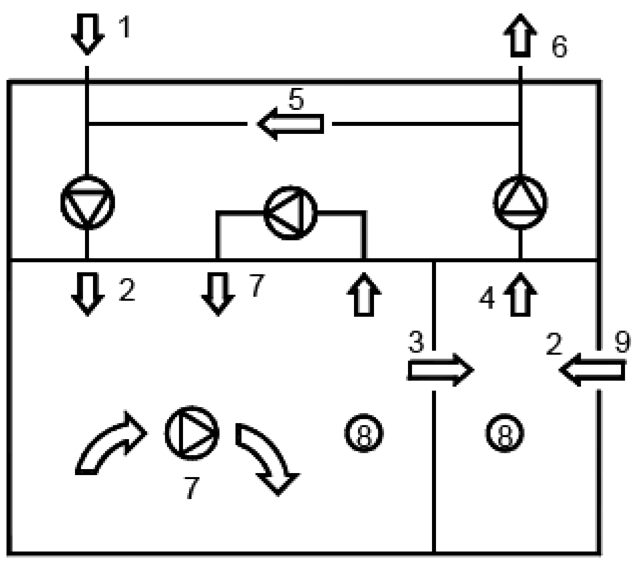

Figure 1. Designation of air flows: 1. outdoor air, 2. supply air, 3. transferred air, 4. extract air, 5. recirculation air, 6. exhaust air, 7. secondary air, 8. indoor air, 9. outdoor air (replacement air)

2

INDOOR CLIMATE OF THE BUILDING

2.1 General

2.1.1
The building shall be designed and constructed as an entity 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 person responsible for each specific plan shall ensure that the plan for its part meets the requirements for indoor climate. The principal designer shall ensure that the construction plan and specific plans form an entity that meets the requirements for indoor climate

Explanation
Part A2 of the National Building Code of Finland includes 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 good building practices in such a way that the requirements for indoor climate are met.

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

2.1.2
In order to achieve a healthy, safe and comfortable indoor climate, it is generally necessary in the design and construction of the building 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 the building and the properties of the windows;
2) when determining the air-tightness of the building envelope, base floor and shafts as well as the air-tightness of structures between the spaces;
3)when selecting building and interior furnishing materials;
4)when designing the building services systems of the building, their operational reliability and the space required;
5)when planning moisture control at the building site;
6)when planning the control of the 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
In order to achieve a healthy, safe and comfortable indoor climate, structural means, reduction of internal load factors, limitation of the effects of external and internal load factors, and technical means are used in the design of ventilation and air-conditioning systems.

2.2 Thermal conditions

2.2.1
The building 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 normally used design room temperature for the temperature in the occupied zone during the heating season that is used is 21°C.

When justified a room temperature that differs from the guideline value may be designed. Such guideline values for room temperatures for different room types during the heating season are shown in Table 1.

The 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 m, is ± 1°C.

Table 1 .Guideline values for room temperatures for different room types during the heating season for spaces where the room temperature design value is not 21 °C. When using the guideline values the level of comfort of adjoining rooms must be ensured.

Room type	Room temperature °C
Stair well	17
Bathroom, washroom	22
Drying room	24
Shop	18
- fixed work station in a shop	21
Gymnasium	18
Church hall	18
Factory hall, medium heavy work	17
Car repair shop, inspection stations	17
Lift shaft	17

2.2.1.2
During periods of occupancy, the temperature in the occupied zone should normally not be higher than 24°C if the outside temperature is below 20°C.

2.2.1.3
When designing the maintenance of the thermal conditions the outdoor temperatures shown in Table L 1.1 in Appendix 1 of Part D5 of the National Building Code of Finland are used as design outdoor temperatures for the heating season.

2.2.1.4
For example, the data on the weather provided in Part D5 of the National Building Code of Finland can be used as design weather data for the design of the maintenance of the thermal conditions in the summer period. The cooling units of the air handling units can be dimensioned for an outdoor temperature of +25°C and outdoor enthalpy in the Province of Lapland 52 kJ/kg and in other areas of Finland 57 kJ/kg.

2.2.2
Regulations concerning the prevention of adverse heating of spaces and the management of room temperatures in summer have been issued in Part D3 of the National Building Code of Finland.

2.2.3
The building 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 shown in Appendix 1.

2.2.3.2
In case structures such as large window surfaces or devices that cause intensive thermal radiation or low or high surface temperatures, are designed or constructed for the spaces, the design room temperature is checked by calculation using the operative temperature value.

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

2.3 Air quality

2.3.1
The building 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 are harmful to health, or any odours that reduce comfort.

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

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

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

Table 3. Indoor air impurity concentration values for the purpose of designing and implementing the indoor climate of a building.

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 concentration of other impurities may in normal spaces generally not exceed 1/10 of the known hazardous concentrations in the air of work places, when the effect of a single substance is completely dominant. If there are several known harmful substances present in the air and the combined effect of these is not known, the acceptable concentrations are deemed to have been exceeded if

$$\Sigma\ (C_i/HTP_i) > 0.1$$

where C_i is the measured concentration of a single substance and HTP_i is the known hazardous concentration 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

The building 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 building.

The humidity of indoor air must not continuously remain harmfully high, nor may humidity concentrate in 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 hazard.

2.3.2.1
If the indoor air humidity exceeds the value of 7 g H_2O/kg of dry air, the room air may be humidified for strictly demanding reasons only, for example, when required by a production process or storage conditions. The value of 7 g H2O/kg of dry air corresponds to a room air condition where the relative humidity is 45% at a room temperature of 21°C, and an air pressure of 101.3 kPa.

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

2.4 Acoustic conditions

2.4.1
The building 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 shown in Appendix 1. The noise levels of building service equipment and other similar equipment as well as the calculations relating to noise levels that result from such systems are shown in the special plans and specifications.

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

2.4.1.2
The acoustic insulation of the building envelope is 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
Requirements may be imposed in the town plan concerning the location of windows and the soundproofing of facades against traffic noise.

2.4.1.3
When producing artificial cover sound as required by the use of the spaces, for example in open-plan offices, adjustable equipment must be used.

2.5 Lighting conditions

2.5.1

The building shall be designed and constructed in such a way that the lighting required by the vision field in the occupied zone can be maintained during periods of occupancy so that unnecessary use of energy is avoided.

2.5.1.1
The grouping of lighting units, the power supply for and the control of the lighting is implemented in such a way 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

The ventilation system shall be designed and constructed on the basis of the planned type of use and occupancy of the building in such a way that they will, for their part, create conditions for a healthy, safe and comfortable indoor climate under normal weather and occupancy conditions.

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

Explanation
Requirements concerning the limitation of the spreading of fire and smoke in the building and from one building to another are included in Part E1 of the National Building Code of Finland. Guidelines for solutions to meet the requirements are included in Part E7 of the National Building Code of Finland.

3.1.2

The ventilation system shall be designed and constructed in such a way that, when properly used, serviced and maintained, they will be fully operational during their design service life.

Explanation
Part A4 of the National Building Code of Finland includes regulations and guidelines on the compilation of guidelines for the use and maintenance of the building and its structural parts.

3.1.3

It must be possible to control and monitor the operation of ventilation system.
Measuring equipment or measuring provisions shall be designed and installed in the ventilation system for the measurement of key operating values and for monitoring the various functions.

3.1.3.1
The ventilation system will be equipped with control, adjustment and monitoring equipment that enables the control and monitoring of the operation of the system.

3.1.3.2
The air-handling unit will generally be equipped with inspection hatches and windows for the purpose of monitoring the various functions.

3.1.3.3
Mechanical ventilation systems are equipped with fixed air flow rate measuring sensors and devices for measuring outdoor air and exhaust air flow rates of the building. If the air flow rate is lower than $0.5 m^3/s$, fixed measuring equipment is substituted by portable measurement points compatible with portable measuring devices.

3.1.3.4
Thermometers are installed on the inlet and outlet sides of the heating and cooling units of the ventilation units. Thermometers are installed on appropriate locations of the outdoor, incoming, extraction and exhaust air flow of the ventilation unit that is equipped with heat recovery equipment. Pressure gauges are installed on air filters. If the air flow rate is lower than $0.5 m^3/s$, fixed measuring equipment may be substituted by portable measurement points compatible with portable measuring devices.

3.1.3.5

Parts of the air handling unit or ductwork downstream of a humidifier section are fitted with a measurement point for humidity measurement

3.1.3.6
The measuring equipment is installed in a location where it can be easily read and where it is freely accessible using easily accessed routes.

3.1.4
The ventilation system shall be designed and constructed in such a way that the machines and devices are equipped with both protective and safety devices for servicing and maintenance purposes.

3.1.5
The 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. The stop switch shall be located in an easily accessible place.

3.2 Air flow rates

3.2.1
The 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 various room types are shown in Appendices 1 and 2.

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

3.2.2.1
The design values for different room types, shown in Appendix 1, are primarily used for the dimensioning of outdoor air flow rates. The outdoor air flow rate is primarily determined on the number of occupants. If there are insufficient grounds for dimensioning the air flow rates according to the number of occupants, the surface area is used for the dimensioning.

For rooms other than those shown in Appendix 1, an outdoor air flow of at least 6dm^3/s per person is supplied to the occupied spaces, provided that there are sufficient grounds for dimensioning according to the number of occupants.

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

3.2.3
It must be possible to control the air flows of the 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 is designed and constructed in such a way that the improved air flow during the periods of occupancy of the dwelling is at least 30% higher than the air flow during periods of occupancy. An improvement of the ventilation is normally effected with at least the improved air flow of a cooker hood in accordance with the guideline values shown in Appendix 1.

3.2.3.2
If the ventilation can be controlled separately for each dwelling, the ventilation system can be designed and constructed in such a way that the air flows can also be adjusted below the level of the air flows during occupancy periods. When the dwellings are not occupied and there is no need for occupancy ventilation, for example to manage humidity, the ventilation control can be designed so that the air flow of the dwelling can be decreased to maximum 60% of the occupancy airflow.

3.2.3.3

The ventilation for another building than a residential building shall be designed and constructed in such a way that outside the period of occupancy the outdoor air flow 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 period of occupancy, the ventilation can be effected by keeping the ventilation system in the hygiene 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 the quality of outdoor air.

Supply air for occupied spaces shall normally be filtered.

3.3.1.1
The filtering of supply air is normally designed in such a way that the efficiency of the air filters is at least 80% for 1.0µm particles during the service life of the filters. The corresponding air filter class is F7.
The leakage air flow of the filter frame and the parts with negative pressure located in the post filter frame air flow direction must not significantly impair the efficiency of the air filtering.

3.3.1.2
The filtering of supply air in buildings which are located outside built-up areas and industrial areas and far from busy traffic routes is generally designed in such a way that the air filters used are at least coarse filters. The corresponding air filter class is G4.

3.4 Location of 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 are to be located in accordance with Table 4 and Figure 2. The values shown in the Table are generally the minimum distances.

Table 4. Location of outdoor air devices.

Distance of outdoor air device	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 m above the outdoor air opening	5
From ground level and courtyard level	2

From roof surface The distance can be shorter if the formation of the snow cover hindering the ventilation is prevented with a steep pitched roof or other reliable manner.	0.9

3.4.1.2

In the case of detached houses the distances that are shorter than the minimum distances shown in Table 4 can be used, with the exception of the distance from flues of heating boilers using solid fuel and the distance of an outdoor air device from the roof surface.

3.4.1.3

In the case of spaces located at courtyard or street level, outdoor air devices used for individual rooms or suites of rooms may be located lower than 2 m from the ground level; the same applies to the outdoor air devices for spaces designed for temporary occupancy only. However, outdoor air devices are not to 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 m from the centre line of a carriageway with heavy traffic, the outdoor air devices for the building are to be located as high up as possible, generally on the side of the building not facing the traffic lane. A road or a street is considered heavily trafficked at any rate when 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

The exhaust air outlet shall be located to avoid any health or other harmful effect to the building, its users or the environment.

3.4.2.1

The exhaust air is usually conducted above the roof of the highest section of the building, and the air flow is directed upwards so as to prevent the exhaust air from entering the outdoor air devices, the windows and the occupied areas.

The exhaust air device of the gravity ventilation systems is usually located above the roof ridge of the building. The exhaust is improved, if needed, by the use of wind guides, rotors or other similar devices.

Explanation

The smoking area in restaurants and other catering establishments and its ventilation are regulated in the Act on Measures to Reduce Tobacco Smoking (693/1976), as it is in Act 700/2006, the Government Decree on Measures to Reduce Tobacco Smoking (225/1977), as it is in Decree 963/2006, and the Ministry of Social Affairs and Health Decree on Smoking Booths in Restaurants and other Catering Establishments (964/2006).

3.4.2.2

The routing of exhaust air out of the building is based on the following classification of the extract air:

Extract air class	Description and restrictions on use	Examples of spaces
1	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 spaces 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, grills, local kitchen exhausts and spaces for unwashed laundry in professional use. Garages and traffic tunnels, rooms for handling paints and solvents, rooms for foodstuff waste, chemical laboratories, smoking rooms as well as hotel and restaurant spaces where smoking is permitted.

3.4.2.3

The exhaust air devices are located in accordance with Table 5 and Figure 2. The values shown in the Table 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 the exhaust air device

Distance of the exhaust air device:	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 court yard level	2	2	3	5
From roof surface The distance can be shorter if the formation of the snow cover hindering the ventilation is prevented with a steep pitched roof or other reliable manner.	0,9	0,9	0,9	0,9
From neighbouring plot (does not apply to single family homes)	2	2	5	8
From the opening of the ventilated sewer and the chimney	1	1	1	1
Distance between the exhaust air devices of gravity and mechanical ventilation systems	1	1	1	1

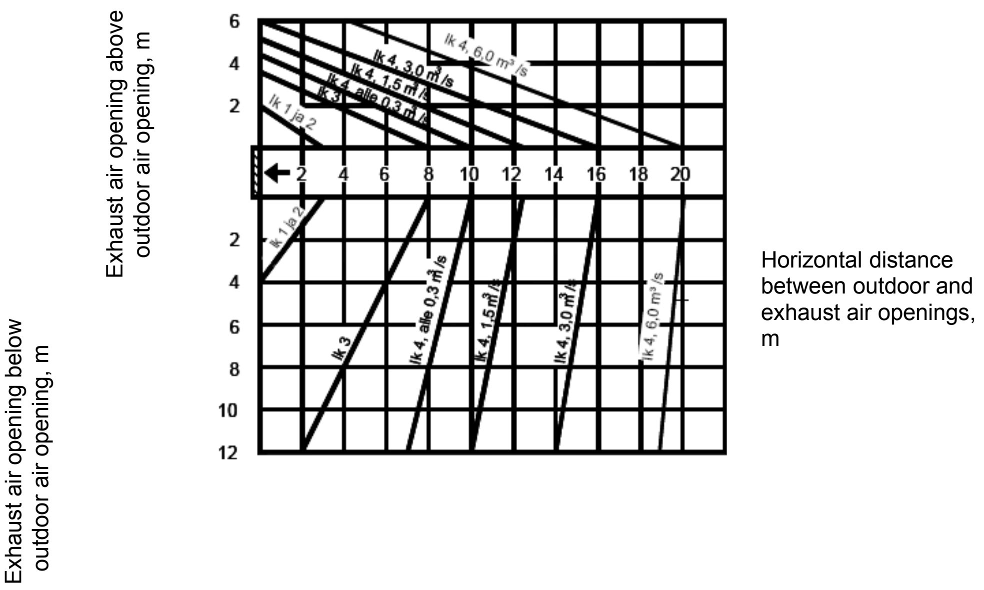

Figure 2. Distances between exhaust air and outdoor air devices. Intermediate values between the lines can be estimated.

3.4.2.4

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

3.4.2.5
Class 1 exhaust air can be conducted 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 opening is at least 5 m/s.

3.4.2.6
Wall-mounted exhaust air devices are usually located in the wall facing a traffic lane or a parking area.

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

3.4.2.7
If 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 the protruding structure at a distance equal to the protrusion, or the device can be ducted level to the front edge of the protrusion.

3.5 Recirculation air, transferred air and secondary air

3.5.1
Air from rooms with equal or higher air quality, not containing harmful quantities of impurities, may be used as recirculation air or transferred air. The use of recirculation air or transferred air must not cause harmful distribution of impurities, in particular odours.

3.5.1.1
Class 2, 3 or 4 extract air, according to item 3.4.2.2, is not used as recirculation air.

3.5.1.2
Recirculation air is not used as supply air to the following areas:
1)Residential flats;
2)Commercial kitchens;
3)Accommodation sections of accommodation and catering businesses and boarding schools;
4)Accommodation sections of medical, day-care, penitentiary, and similar establishments;
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 1.0μm particles throughout the service life of the filters. The corresponding air filter class is F7.

3.5.1.3
Class 2 extract air can be used for air circulation inside a residential flat.

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

3.6 Distribution and extraction of air

3.6.1
The supply air shall be conducted to the rooms so that the air will flow into the entire occupied zone without causing draught and so that any impurities generated in the room during its occupancy will be effectively extracted. Harmful volumes of contaminated air must not re-enter the occupied zone.

3.6.1.1
The ventilation is designed to be as efficient as possible so that the supply air will flow into the entire occupied zone, and so that the impurities are conducted directly into the extract air terminal devices without spreading into the occupied area. The supply air must not flow directly past the occupancy zone into the extract air terminals.

3.6.1.2
The air distribution devices, the outdoor air supply devices and the transferred air flow routes or devices shall be recognized devices as to their flow and audio technical properties. Their locations and dimensions are such that the air velocities and sound levels in the occupancy zone, as shown in Appendix 1, are not exceeded.

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

3.6.1.3
Generally, an extract air terminal is installed in each room.

In residential flats, at least kitchens, kitchenettes, bathrooms, toilets, utility rooms and cloak rooms are provided with extract air terminals. Extract air from other habitable rooms can be conducted via these rooms by means of appropriate transferred air routes or equipment.

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

3.6.1.4
Local extract ventilation is always used when dust, gases or fumes are generated in a centralised manner in a room. The efficacy of the extraction of impurities can be enhanced by the encapsulation of the source of impurities. For example, kitchens are equipped with cooker hoods or similar local ventilation.

3.6.2
Connecting the ventilation ducts of mechanical ventilation systems in different areas must not create a risk of the impurities or flue gases spreading or influence the operation of the ventilation system.

3.6.2.1
The guidelines in Part E7 of the National Building Code of Finland are used as the basis for connecting the ventilation ducts.

3.6.2.2
Air of different extract air classes are conducted out of the building in accordance with the following principles:
1)Class 1 and 2 extract air can usually be conducted into a common duct network;
2) Class 3 extract air is generally conducted through separate ducts or through a common duct network that serves areas with similar levels of air quality, into the ambient, into a collector duct installed above the areas it serves, or into an extract air chamber; and
3) Class 4 extract air is conducted out through separate extract air ducts.

If class 1 and 2 extract air is combined into the same duct and the class 2 air flow share exceeds 10% of the combined air flow, the combined air flow will be classified as class 2 ex tract air.

3.6.2.3
If significant quantities of substances that are harmful to health or emit strong odours are handled or stored in a space, outdoor air and extract air ducts, separate from the rest of the ventilation system, are installed in that space. Such spaces include for instance storerooms for toxic substances, waste disposal spaces and spaces for unwashed laundry.

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

Extract air from a maximum of two toilets or similar spaces can be conducted to vertical ducts for class 1 and 2 extract air, provided that the aggregate extract air flow from these spaces 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 as recirculation air.

3.6.2.5
In a mechanical ventilation system, extract air from all spaces in a single flat can be conducted through the same air duct directly out into a collector duct installed above the areas it serves, or into an extract air chamber.

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

3.7 Air-tightness and pressure of ventilation system

3.7.1

The ventilation system and its components must be sufficiently airtight and strong.

3.7.1.1
In general, the ventilation system duct network is sufficiently air-tight when it is of class B air-tightness. The maximum permissible leakage air flow of class B air-tightness is shown as a formula in Table 6 and as a graph in Figure 3.

3.7.1.2
In standard ventilation systems, class B duct network air-tightness is usually achieved when the air ducts and the duct network components are of class C air-tightness.

3.7.1.3
The ventilation unit is generally sufficiently air-tight when its casing is of at least class A and the leakage air flow between the inlet and outlet sides does not exceed 6% of the nominal air flow of the air handling unit at a 300 Pa test pressure.

3.7.1.4
The maximum permissible leakage air flows for the ventilation system and its parts in the different air-tightness classes are shown as formula in Table 6 and as a graph in Figure 3.

Table 6. Maximum permissible leakage air flow for a ventilation system and its parts per casing surface area q_{VLA}(dm3/s/m2) in different air-tightness classes. The leakage formula is in the form $q_{VLA} = kp_s^{0,65}$ 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_{VLA} $dm^3/s/m^2$
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	$0.0003 \times p_s^{0.65}$

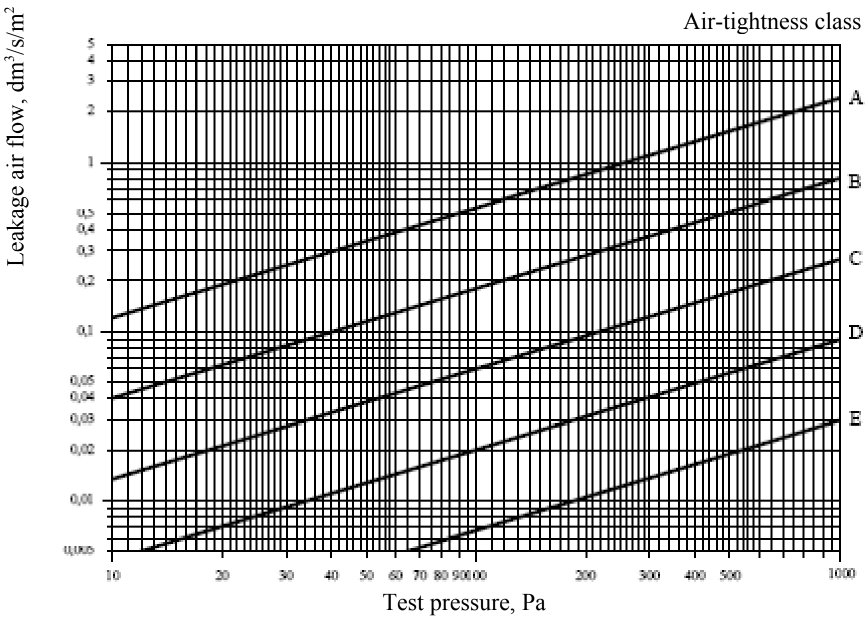

Figure 3. Maximum permissible leakage air flow for a ventilation system and its parts per casing surface area in different air-tightness classes.

3.7.2

Impurities must not be allowed to spread, to a harmful extent, in the building via air ducts or ventilation equipment.

3.7.2.1

The construction and pressures of the heat recovery equipment shall be implemented so as to prevent significant quantities of extract air from being transferred into the supply air.

3.7.2.2

When heat is recovered from class 1 extract air, no particular requirements apply to the pressure differential between the supply and extract air sides or to the direction of the leakage air flow. When heat is recovered from class 2 extract air, the pressures of the heat recovery equipment is designed so that the direction of the leakage air flow 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 is designed so that the direction of the leakage air flow is from the supply air side towards the extract air side.

Regenerative heat exchangers, where the supply and extract air alternatively flow along the same flow route (regenerative heat exchanger), can only be used if the extract air contains a maximum of 5% of class 3 extract air and no class 4 extract air. However, in single-family homes regenerative heat exchangers may be used for heat recovery from class 3 extract air.

3.7.2.4

When recovering heat from class 4 extract air a heat recovery system using intermediate heat transfer medium shall generally be applied, where the supply air and the extract air cannot mix.

3.7.2.5

If the ventilation unit only serves a single space, the type of heat exchanger for the heat recovery can be chosen freely, even if the extract air is class 3 or 4. In such cases it shall be ensured that the supply air is sufficiently clean to guarantee that it will meet the requirements set for the quality of the indoor air. Such spaces include, for example, industrial premises, large indoor car parking and garages.

3.7.2.6

Extract air ducts inside the building, outside the machine room, are usually built as spaces with negative pressure.

However, extract air ducts in extract air classes 1 and 2 can be pressurised inside the building providing the air-tightness of the duct network is class C. This is usually achieved when the air-tightness of the air ducts is class D.

3.7.2.7
Exhaust air ducts for individual flats can be pressurised inside the building providing the air-tightness of the duct network is class D. This is usually achieved when the air-tightness of the air ducts is class E

3.7.2.8
When the cross-sectional area of the air duct is greater than 0.06 m^2 (for instance an air duct with a diameter of 315 mm), the outdoor air and exhaust air ducts of the mechanical ventilation system are 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 according to Standard EN 1751:1998.

3.7.3
Two or more ventilation units must not be connected to the same duct or chamber so that the pressures in the indoor spaces or the directions of the air flow between the spaces and in the duct network can change from the design specifications.

3.7.3.1
A common chamber is generally not built if recirculation air is used in the ventilation unit, or if the air flows of individual ventilation units are independently adjusted during operation.

Where several air handling units are connected to the same duct or chamber, their fans shall be chosen in accordance with Standard SFS 5148, so that they do not interfere with each other's operation. If only a part of the units operate simultaneously the dimensions of the common chamber or duct network are spacious, and the operating point is chosen from characteristic curve of the fans, so that the air flow change will not exceed 3% due to the stoppage. The units to be stopped are equipped with valves that meet the class 3 air-tightness requirements for closed valves, according to Standard EN 1751:1998.

3.7.4
A gravity and mechanical ventilation system must not be combined so that the air flow directions between the spaces and in the duct network can change from the design specifications.

3.7.4.1
The ventilation of a flat or another common space is generally designed as exclusively either a mechanical or a gravity ventilation system.

3.7.4.2
The gravity ventilation system can be designed with an improved extract air fan. Sufficient supply of outdoor air is then guaranteed by preventing air from flowing into the spaces through exhaust air ducts or the chimney flues.

3.7.4.3
The combustion air required on a fire place is accounted for when designing the ventilation system.

3.7.5
The air ducts are stiffened and supported so that they will remain firmly in place and can withstand any pressure fluctuations or other stress that may occur in the ventilation system. Air handling units and chambers must be able to withstand the loads caused by the fan pressure when the valves are closed.

3.7.5.1
The supporting and stiffening structures of the air ducts must be able to withstand any stress caused by insulation work, the weight of the insulation, and cleaning methods.

3.7.5.2
The casing of the ventilation unit and the chambers as well as the air ducts must be able to withstand the loads caused by the permissible maximum pressure (maximum permissible operating pressure), and at least the test pressure of ± 1000 Pa (positive or negative pressure).

3.7.6

The pressures in a building, its spaces and the ventilation system shall be designed so that air will flow from clean spaces to spaces where more contamination is created. These pressures must not cause any long-term moisture load in the structures

3.7.6.1

In general, a building is designed to maintain a slightly negative pressure, relative to the outdoor pressure, in order to avoid any moisture damage to the structures and any health hazards caused by microbes. However, the negative pressure must not exceed 30 Pa.

Special spaces such as clean spaces and spaces where, owing to the type of activity, front doors or other apertures are often kept open, can, however, be designed to maintain a positive pressure, relative to the outdoor pressure.

3.7.6.2

If high quantities of impurities or moisture are generated in the space, the space is designed with a negative pressure compared to other spaces.

3.7.7

The pressures in the building and the air-tightness of the structures are designed and implemented so that they for their part reduce the spread of radon and other impurities in the building.

Explanation

The guidelines on radon, published by the Ministry of the Environment and by the Radiation and Nuclear Safety Authority describe measures for the reduction of the radon contents in indoor air.

3.7.8

The conventional use of the building or fluctuations in weather conditions must not significantly change the pressures in the building or the spaces, or impair their ventilation.

3.7.8.1

The pressures of the ventilation system is designed and implemented so that fluctuations in weather conditions will not change the directions of the air flow in the building.

3.7.8.2

The adjustment of any demand-based control of the air flows is designed so that the pressure differentials in the building and between the different spaces will not change in a harmful way.

3.7.8.3

The vertical ducts of a natural ventilation system are usually conducted separately from each room to above the roof of the building. The minimum height difference between outdoor air and exhaust air devices of a gravity ventilation system is 4.5 m.

3.8 Cleanliness and serviceability of ventilation

3.8.1

The ventilation system shall be designed and constructed so that it is clean before the commission of the building and will be easy to maintain clean.

3.8.1.1

The ventilation system is constructed of parts where no oil, dust or other impurities are attached to their internal surfaces No harmful substances or odours may come loose from the ventilation system.

3.8.1.2

The ducts are stored on the building site suitably plugged so that they are not exposed to rain, dirt or mechanical damage. Small duct components and terminals are stored on the building site in sealed packages.

3.8.1.3

The ventilation system is protected form dirt during the installation work. The protections are finally removed only after cleaning when no dust emitting work stages are performed in the space.

The ventilation system's internal surface must be easy to clean and maintain cleaned. The stiffening or fixations of the air ducts may not be placed inside the air duct so that they significantly hinder the cleaning of the ventilation system.

3.8.1.5
The air ducts and chambers are fitted with an adequate number of sufficiently large cleaning hatches to enable cleaning operations. The locations and types of such cleaning hatches are selected so that all cleaning operations can be easily and safely performed.

The cleaning hatches are generally located in the chamber, close to closing fire dampers and in ducts, so that a maximum of two bends of over 45° are between any two such hatches. In the horizontal ducts, the cleaning hatches are generally located at 10m intervals. The distances between the cleaning hatches can be greater than 10 m if the duct can be cleaned via the hatches over the entire distance between the hatches. Cleaning hatches are also placed at branch points of the ducts if they and the ducts that branch out cannot be cleaned otherwise, for example through the terminals.

The cleaning hatches of the horizontal duct networks that are demanding from the point of view of fire safety and cleaning are generally placed 3-5m apart.

An access panel shall be placed on both sides of a device, for example a gate valve, which is installed in the duct network, provided that the device cannot be removed for cleaning. A removable section of a duct or a duct part , which is sufficiently large, can also be used as a cleaning hatch for cleaning.

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, for example grease.

3.8.1.7
Cooling equipment installed between a suspended ceiling and an intermediate floor must be possible to be cleaned in its entirety without dismantling the suspended ceiling. If the air is circulating in the space above the suspended ceiling, the suspended ceiling must also be easy to clean.

3.8.2
The ventilation system shall be designed and constructed so that it does not cause water, moisture or other damage. The use of water or any resulting condensation in the system must not result in growth of microbes or fungi that are harmful to health.

3.8.2.1
If a supply air unit that is located in a room is connected to a liquid carrying pipe system, the penetration of any leaking water into the structures is prevented, for example, by means of a floor drain installed in the room, and/or with a waterproof 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: Ventilation units that serve individual flats, supply air units installed in the immediate vicinity of a front door, ventilation units that serve a single space and are visible in the space they serve.

Condensation in ventilation units that serve individual flats, or any other leakage water, is conducted to a drain without interference.

3.8.2.2
Water for the cooling of supply air is not taken directly from an open cooling tower, but a separate closed-loop cooling circuit is used.

3.8.3
Air humidification and the water treatment in the humidifier shall be designed and implemented so that the humidification does not adversely influence the room air quality.

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

3.8.4
The outdoor air devices and their connections to the ventilation system and the building shall be placed, 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 can enter the ventilation system. Any snow or rainwater that enters the system must not cause damage to the building or the ventilation system or negatively influence the operation of the ventilation system.

3.8.4.1
An unprotected outdoor air device located on a vertical outer wall and directly exposed to wind is generally dimensioned for a maximum face velocity of 2.0 m/s.

3.8.4.2
If rain water or snow enters the ventilation chambers or ducts a water drain will be made.

3.8.5
The ventilation units, chambers and ducts are provided with thermal and vapour barriers so that the condensation does not cause any damage to the structures or to the ventilation system.

3.8.5.1
The air ducts are provided with thermal and vapour barriers so that the indoor air humidity or the humidity of the air that flows in the air duct does not condensate into water. For example, the outdoor air duct located in the heated areas of flats and the extract air ducts located downstream from the heat recovery equipment are provided with thermal and vapour barriers.

3.8.6
The ventilation system and its servicing access routes shall be designed and constructed so that the ventilation system can be easily and safely serviced.

3.8.6.1
Adequate space, at least the size equal to the equipment to be serviced in the servicing direction, is reserved for servicing and cleaning of the equipment. In order to ensure good serviceability, sufficient space is reserved around the functioning parts of the equipment and the ventilation units. The ventilation units are equipped with service doors that can be opened without tools.

The principles shown in Figure 5 for an encased ventilation unit shall be followed when reserving space for the ventilation equipment. If there are several machines in the machine room, a separate space is reserved for service and repairs. No fixed or heavy objects are placed in the service space.

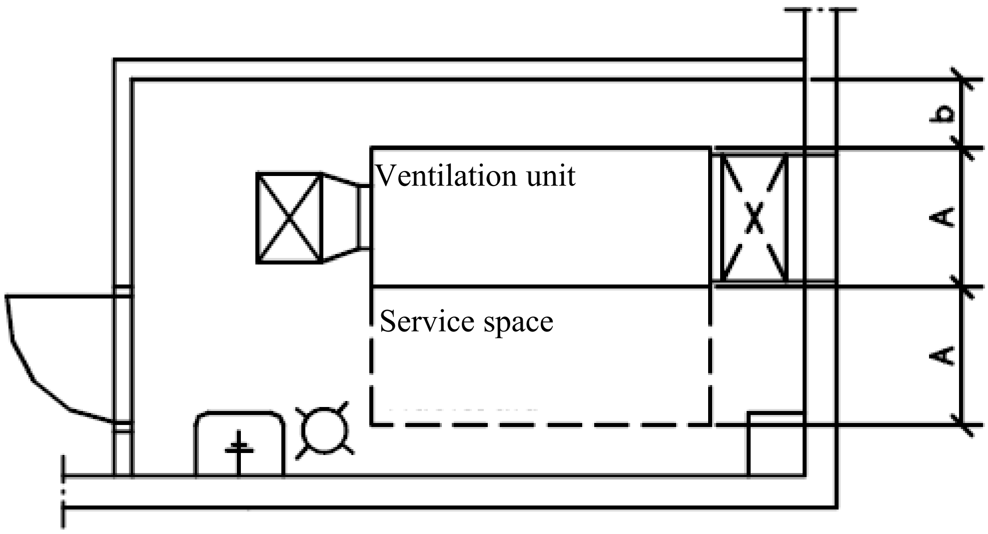

Figure 5. An example of the location and dimensions of the service space for an encapsulated ventilation unit. A is the width of the ventilation unit and b is 0.4 times the height of the ventilation unit or at least 400 mm.

3.8.6.2

Suspended ceilings shall be fitted with a clearly marked, part that can be removed or opened, measuring at least 500mm x 500mm, close to the ventilation units to be serviced and the cleaning hatches.

Explanation

Part F2 of the National Building Code of Finland provides regulations and guidelines on the service access routes and safety arrangements of the ventilation system.

4

ENSURING GOOD OPERATING CONDITION AND COMMISSIONING OF THE VENTILATION SYSTEM

4.1.1
The air-tightness of the ventilation system shall be checked and measured as necessary. A report on the inspection and measurement shall be attached to the inspection documents of the building work.

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

4.1.1.1
Generally, the air-tightness of the ventilation system is measured. The air-tightness is measured with a air-tightness test according to Standard SFS 3542.

4.1.1.2
If the duct network consists of at least class C, quality tested and inspected ducts and duct components, the air-tightness can be measured using spot checks. The extent of the spot checks is 20% of the surface area of the duct network. If the air-tightness class of the ducts and the duct components is higher than C, the extent of the spot checks is 10% of the surface area of the duct network.

If there are class C or lower air-tightness class ducts and duct components in the duct network, the extent of the spot checks is increased on the corresponding surface area. If the surface area of these ducts or ductwork components exceeds 25% of the total surface area of the duct network, the total duct network system is 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 m. For example, a T piece has three joints while duct connections have two joints.

4.1.1.3
In a ventilation system serving a single space or a single flat the air-tightness test can be replaced with an installation survey, if the duct network has been constructed entirely of air-tightness class C, quality tested and inspected ducts or duct components.

4.1.1.4
The air-tightness of the entire duct network must be measured if the duct network carries air that contains toxic or corrosive gases or air that is otherwise harmful to health.

4.1.1.5
If a class A or higher air-tightness class, quality tested and inspected ventilation unit is supplied as a single assembly or in sections, so that at the installation site a maximum of two connections on the supply air side and/or two connections on the extract air side are necessary to be made, no air-tightness tests need to be performed on site. For other class A or higher air-tightness class, quality tested and inspected ventilation units, the air-tightness test is performed as a spot check. The extent of the checks is 20% of the units, but at least one unit shall be checked

4.1.2
The cleanliness of the ventilation system shall be inspected and, if necessary, the system shall be cleaned prior to the measurement and adjustment of the air flows.

The air flows of the ventilation system shall be measured and adjusted, the specific electric power measured, and the design specific operation and cleanliness of the system shall be verified prior to the commissioning of the building. Reports on these inspections shall be attached to the inspection documents of the building work.

4.1.2.1
The operation of the electrical equipment of the ventilation system is tested using the final electrical connections with all the fuses fixed.

4.1.2.2

The operational tests are performed before the measurement and adjustment of the air flows. Prior to starting the 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 flows, pressures or transferred air flow directions. The check shall also verify that the building is sufficiently clean, that no more dust-generating work is performed in the spaces in question, that the filters of the ventilation units have been installed, and that the doors and windows are in place. At least a visual inspection to determine the cleanliness of the building and its ventilation system shall be done, and recorded in the inspection documents of the building work.

4.1.2.3

The basic adjustment of the air flow rates is done according to the non-boosted air flow that corresponds to the main occupancy situation. The setting of the control devices is determined by the occupancy situations corresponding to the average conditions of the various seasons. The conformity of the pressures to the design values is verified by means of smoke tests or by measuring the air flow and pressure differentials.

4.1.2.4

The performance values of the flow, sound, electric and thermal technical performance values of the ventilation system are measured, using the system's non-boosted design air flow of the occupancy period and in the flats also the boosted design air flow. The acceptable tolerances from the design values are generally the following:

1) Air flow per system ± 10 %;
2) Air flow per space ± 20 %;
3) Air velocity in the occupancy zone + 0.05 m/s;
4) Electric power + 10 %; and
5) Heating capacity - 10 %.

Acceptable tolerances include both the measurement result deviations and the measurement uncertainty.

4.1.2.5

The measurement and the conversion of measurement values to correspond to the design values are performed in accordance with the standards currently in force. The measurements are performed using equipment with valid calibrations and methods in which the maximum element of uncertainty is generally one half of the acceptable tolerances listed in 4.1.2.4.

APPENDIX 1

Guideline values for air flow, air movement and sound levels

Tables 1 to 11 show the guideline values for the design of ventilation during periods of occupancy. The number of occupants primarily determines the outdoor air. If there are insufficient grounds for the dimensioning of the air flow according to the number of occupants, the surface area is used for the dimensioning. When dimensioning the air ducts the improved air flows during the periods of occupancy have to be taken into account.

The outdoor air flow has been determined in order to maintain the quality of indoor air when the building and furnishing materials used are low-emitting. Restricting the increase of the concentration or the rise in room temperatures caused by internal and/or external contaminant loads or thermal loads by ventilation requires air flows that are higher than those shown in the table, which must be taken into account when dimensioning the air ducts.

The control of the ventilation based on need shall generally be implemented at least in spaces where there is a significant variation of the load due to persons or impurities.

Part C1 of the National Building Code of Finland provides regulations and guidelines on the maximum permissible sound levels in internal spaces and outdoors, resulting from building service equipment and other comparable equipment. The sound levels specified in Part C1 of the National Building Code of Finland are shown in bold font in the Tables of this Appendix. These sound levels are the values specified in the regulations of Part C1 for flats and kitchens, and the values specified in the guidelines of Part C1 concerning patient rooms, children's rest rooms, teaching spaces 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 space, resulting from building service 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. If sounds from more than one source of noise enter the space, the separate sound level produced by each source must be so low that their combined sound level does not exceed the maximum permissible sound level. The effect of several sources on the overall sound level of the space is taken into account by adding together the sound levels of all devices producing a noise that affects the space 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 devices, and L_{A1} L_{An} is the sound level produced by each individual device.

The air velocity values shown in Tables 1 to11 for the movement of air in the occupied zone correspond to the room temperatures defined in Item 2.2. An air velocity that causes discomfort at various room air temperatures can be evaluated by means of the draught curves shown in Figure 1. The higher the room temperature, the higher the air velocity can be without reducing the comfort. Intermediate values between the curves can be estimated.

Draught curves

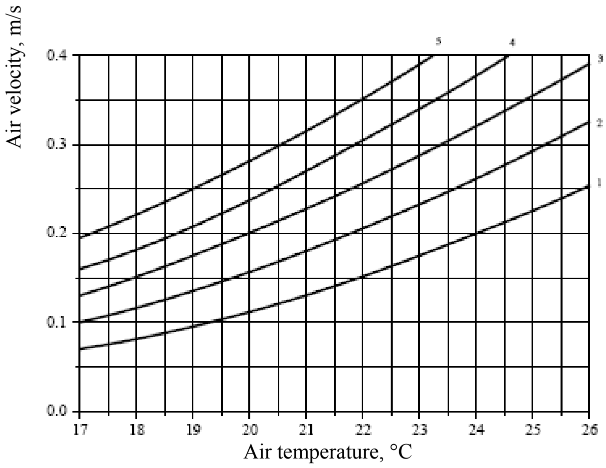

Figure 1. Draught curves describing the relationship between the air temperature and the air velocity that causes discomfort.

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

Table 1. Residential buildings

The ventilation in dwellings is generally designed on the basis of the extract air flow of the Table in such a way that the air change coefficient in the dwellings is at least 0.5 l/h, while the adequacy of outdoor air flows is guaranteed to be at least equal to the guideline values. The extract air flows in small dwellings are generally designed to be lower than the guideline values, so that the maximum air change coefficient in the dwellings during periods of occupancy is 0.7 l/h, while the improvement of the extract air flow can be controlled separately for each room or each dwelling, as needed. If the improvement of the extract air flow only can be controlled for the entire building, the extract air flows in small dwellings can be designed to be lower than the guideline values so that the air change coefficient of the dwellings is at least 1.0 1/h. Extract air flows in large dwellings are generally designed to be higher than the guideline values so that the outdoor air flow for each space is in accordance with the guideline value and the air change coefficient of the space is at least 0.5 l/h. .

Space/use	Outdoor air flow (dm³/s)/person	Outdoor air flow (dm³/s)/m²	Extract air flow dm³/s	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air velocity winter m/s	NB
Dwelling spaces	6					
Dwelling rooms		0.5		**28 / 33 ***	0.20	*C1 regulation
Kitchen		#S	8 #A	**33 / 38 ***	0.20	*C1 regulation
- improvement of occupancy period		#S	25	33 / 38	0.20	
Cloak room, storeroom		#S	3	33 / 38		
Bathroom		#S	10 #B	38 / 43	0.20	
- improvement of occupancy period		#S	15	38 / 43	0.20	
Toilet		#S	7 #B	33 / 38		
- improvement of occupancy period		#S	10	33 / 38		
Utility room		#S	8	33 / 38	0.30	
- improvement of occupancy period		#S	15	33 / 38	0.30	
Sauna in the flat		2 #C	2/m² #C	33 / 38		
Common spaces:						

Stairwell		0.5 1/h	0.5 1/h	38 / 43		
Storerooms		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 room 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 20dm3/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 dm3/s. Air flows in the sauna are not taken into account in the calculation of the dwelling's air change rate, if the sauna's outdoor air flow is equal to the extract air flow.

D Can be designed to be lower when using an air drier.

E Requires an openable window for airing; otherwise 1.5 (dm3/s)/m2.

S Outdoor air flow is normally substituted with transferred air flow conducted from the dwelling rooms.

Table 2. Office buildings #1

Space/use	Outdoor air flow (dm³/s)/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	NB
Office space and similar spaces		1.5		**33 / 38 ***	0.20 / 0.30	*C1 guideline
Conference room	8	4		33 / 38	0.20 / 0.30	#3
Customer room		2		38 / 43	0.30 / 0.40	#2,
Corridor space		0.5		38 / 43	0.30	#2,
Canteen, break space		5		38 / 43	0.25	
Archive, storeroom			0.35			
Smoking room						
- during building occupancy			20	38 / 43	0.30	#4
- outside building occupancy			10			#4
Copy room		1	4			

#1 For extract air flows in hygiene spaces, see Table 11 Hygiene spaces.
#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 the smoking room shall always be lower than in the surrounding rooms.

Table 3. Educational establishments #1

Space / use	Outdoor air flow (dm³/s)/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	NB
Teaching spaces	6	3		**33 / 38 ***	0.20 / 0.30	#4, *C1 guideline
Corridors/ Lobbies		4		38 / 43		#2
Gym:						#3
- gym use		2		38 / 43	0.30	
- assembly hall use		6		33 / 38	0.25	
Lecture room	8	6		33 / 38	0.20 / 0.30	#4
Team work room	8	4		33 / 38	0.20 / 0.30	#4
Canteen	6	5		33 / 38	0.25	
Storerooms			0.35			#S

#1 For extract air flows in hygiene spaces, see Table 11 Hygiene spaces.
#2 Guideline values for air velocity at fixed work stations 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 con-trolled as necessary for the purposes of different types of use.
#4 Ventilation must be controllable according to the actual demand.
#S Transferred air can be used

Table 4. Restaurants, workplace canteens and hotels #1

Space / use	Outdoor air flow (dm³/s)/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	NB
Restaurants	10	10		38 / 43	0.20	#2, #T
Personnel and lunch restaurants	6	6		38 / 43	0.20	#2
Hotel room	10	1		28 / 33	0.20	
Corridor		0,5		33 / 38	0.25	#2
Lobby		2		33 / 38	0,20	#2
Conference room	8	4		33 / 38	0.20	
Smoking area, restaurant						#3
- during restaurant use period			30			#4
- outside restaurant use period			10			

#1 For extract air flows in hygiene spaces, see Table 11. Hygiene spaces.
#2 Guideline values for air velocity at fixed work stations are the same as for offices.
#3 The smoking area in restaurants and other catering establishments and its ventilation are regulated in the Act on Measures to Reduce Tobacco Smoking (693/1976), as it is in Act 700/2006, the Government Decree on Measures to Reduce Tobacco Smoking (225/1977), as it is in Decree 963/2006, and the Ministry of Social Affairs and Health Decree on Smoking Booths in Restaurants and other Catering Establishments (964/2006).
#4 However, at least 180dm³/s per square metre of the door opening.
#T The ventilation of the restaurant must be controllable according to the actual demand.

Table 5. Shops and theatres # 1

	Outdoor air flow (dm³/s)/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	
Shop		2		43 / 48	0.25	#2, #T
Theatre auditorium	8			28 / 33	0.20	#T
Theatre scene		3		28 / 33	0.25	#2
Lobby, foyer		5		38 / 43	0.25	#T
Concert hall	8			25 / 30	0.20	#T
Cinemas	8			33 / 38	0.20	#T

#1 For extract air flows in hygiene spaces, see Table 11. Hygiene spaces.
#2 Guideline values for air velocity at fixed work stations are the same as for offices.
#T The ventilation must be controllable according to the actual demand.

Table 6 Sports halls, swimming pools and barracks # 1

Space / use	Outdoor air flow (dm³/s)/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 m/s velocity winter/summer m/s	NB
Physical exercise spaces:						#T
- Fitness hall		6		38 / 43	0.25	
- Gym, small		4		38 / 43	0.25	
- Gym, large		2		38 / 43	0.25	
- Auditorium	8			33 / 38	0.25	
Corridors / lobbies, for occupancy		5		38 / 43	0.30	#2
Corridors, not for occupancy		1		38 / 43	0.30	
Swimming pool space		2		38 / 43	0.40	
Barrack spaces:						
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 extract air flows in hygiene spaces, see Table 11. Hygiene spaces.
#2 Guideline values for air velocity at fixed work stations are the same as for offices.
#T The ventilation must be controllable according to the actual demand.
#K Humidity extraction is a design factor Calculated case by case.
#S Transferred air flow

Table 7. Health care institutions #1

Space / use	Outdoor air flow (dm³/s)/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	NB
Hospital patient room	10	1.5		**28 / 33 ***	0.20 / 0.30	*C1 guide-line
Hospital treatment room		2		33 / 38	0.20 / 0.30	#E
Hospital rehabilitation room		2		33 / 38	0.20 / 0.30	
Hospital leisure room		3		33 / 38	0.20	
Child care room		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 room		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 guide-line
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 extract air flows in hygiene spaces, see Table 11 Hygiene spaces.
#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 and other similar areas.
#E The 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 / use	Outdoor air flow (dm³/s)/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	NB
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
- Fair grounds/halls		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	
- Storeroom			0,5			#S
Churches						
- Church hall	6			33 / 38	0,20	#T
- Other public spaces		5		33 / 38	0,20	#T

#1 For extract air flows in hygiene spaces, see Table 11 Hygiene spaces.
#2 Guideline values for air velocity at fixed work stations are the same as for offices.
#S Transferred air flow
#T The use of ventilation, as needed, to be possible.

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

Space / use	Outdoor air flow (dm³/s)/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	NB
Factory work:						
- Light	10	1.5, #4			0.20 / 0.30	
- Moderate	10	1.5, #4			0.25 / 0.50	
Laboratory (chemical)	8	1		38 / 43	0.20 / 0.40	#E, T
Car repair shop, inspection stations		7, #5	3	43 / 48	0.25	

#1 For extract air flows in hygiene spaces, see Table 11 Hygiene spaces.
#2 The guidelines for office buildings also apply to office spaces located in other types of buildings.
#3 The extract air flow and similarly the outdoor air flow shall be increased by as much as is required by local exhaust ventilation and/ or by impurities control.
#4 The ventilation plants shall be designed for at least the air flow in question. The plant can be operated with lower airflow on the basis of emissions of impurities and thermal loads, to be specified in reports on working methods etc. The air velocities are an example. The nature of the work decides the temperature level and air velocity on a case by case basis.
#5 Requires local extraction of exhaust gases to the extent of at least 100 dm³/s for passenger cars and 300 dm³/s for trucks. In cases where an exhaust gas rail is used to which the vehicles are connected all the time, the air flow rate requirement can be reduced to 2 (dm³/s)/m². The extract air flow rate shall be designed so that when the extraction of exhaust gases is taken into account, the pressure in the space is not negative; see also Standard SFS 3352.
#E Design on a case by case basis.
#T The use of ventilation, as needed, to be possible.

Table 10. Food preparation and storage spaces

Space / use	Outdoor air flow (dm³/s)/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	NB
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
- Coffee kitchen		3	30 1/s/kitchen	33 / 38	0.20 / 0.40	
Storage spaces:						
- Dry storage			0.5			#S
- Cold stores >4 m²			0.2			#S
- Waste room			5			#1
- Refrigerated waste room			2			#1

#1 The pressure in the space shall always be lower than in the surrounding rooms.
#E Minimum air flows. The air flows are designed on a case by case basis according to the thermal loads.
#S Transferred air flow

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

Space / use	Outdoor air flow (dm³/s)/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 m/s velocity winter/summer m/s	NB
Toilets:						
- In connection with work place spaces or similar spaces			20 per seat	38 / 43		#S
- In connection with public spaces			30 per seat	38 / 43		#S
Wash room		3	5,	38 / 43	0,20	#S
Dressing room		5	4 per locker	38 / 43	0,20	#S
Hot room in sauna		1	2	38 / 43		#S
Cleaning room			4			#S
Stairwell		0.5 1/h	0.5 1/h	38 / 43		#1
Lift shaft	4		8			
Lift machine room			17			#2

#1 Air change coefficient
#2 To be adjusted according to the thermal load. The maximum temperature is 35°C.
#S Transferred air flow

APPENDIX 2

Guidelines for the ventilation of parking garages for motor vehicles

These guidelines apply mainly to parking garages for motor vehicles. If there are maintenance and repair spaces, loading terminals and bus terminals, or other spaces where work is continuously carried out in connection with the garages, the guidelines are not directly applicable. .

The ventilation of motor vehicle garages is arranged so that the air impurities have no harmful effect on the health of the users of the garage. If there is a possibility that queues of vehicles may form due to, for example, payment of parking fees or traffic arrangements, the ventilation in such areas is improved by the installation of extra extraction fans at such congested points. The improved extraction can then be controlled according to the contaminant concentration (for instance CO content). If there are workplaces in, or in connection with, the car garages, the ventilation is arranged according to the requirements of such workplaces.

In cases where the parking garage is in connection with another building, ventilation of it is arranged so that the pressure in the garage is negative as compared to the other spaces.

The supply of air to the motor vehicle garage can be transferred air.

The supply air and extract air openings shall be placed so that adequate ventilation is assured for the various parts of the garage. These openings shall be placed so that air cannot unnecessarily spread from areas where there is a high concentration of impurities. There must also be no points in the garage where the concentration of impurities in the air can locally exceed the permitted values. For example, local extraction or air transfer fans can be used to prevent this.

The extract air flow rates in mechanical ventilation systems are: - in spaces, where on average there is one movement per vehicle space during the busiest 8-hour period of the day, at least 0.9 $(dm^3/s)/m^2$. Such spaces include, for example, the parking lots belonging to residential blocks of flats; - in spaces where there are, respectively, 2 to 4 such movements, at least 2.7 $(dm^3/s)/m^2$. Such spaces include, for example, parking lots reserved for the personnel of offices and government departments; and - in spaces where there are, respectively, more such movements, the extract air flow 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, for example, proper parking houses as well as parking spaces for customers in office buildings, government departments and commercial buildings. In parking garages where vehicles are parked in rows, with a maximum area of 60 m^2 gravity ventilation system may be used. 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. The garage should be entirely above ground or correspondingly located from the point of view of ventilation, for example, in a slope. The supply air and extract air openings are located so that adequate ventilation and air circulation can be achieved. Supply air openings can be located in the lower part of an outer wall or a door. Extract air openings are generally 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. .

If at least 30% of the outer wall of an unheated parking garage, for example a parking house, is open and the area of the openings is at least 10% of the floor area of each level, no separate ventilation arrangement is required in the garage. However, there shall be no obstacles in the space, such as partition walls or beams that may considerably impede the air flow.

The mechanical ventilation of a motor vehicle garage may be reduced outside normal operating hours if the ventilation system is controlled according to the concentration of impurities in the air, and the garage is equipped with a separate alarm system. The ventilation shall reach full power when the concentration of impurities at any one sensor exceeds the set limit (for instance CO concentration of 50ppm). An alarm is given when the concentration of impurities exceeds the set limit (for instance CO concentration of 70ppm). At least three control and alarm sensors are installed in the garage on each level, generally in the vicinity of ramps and driving lanes. The function of the sensors must be checked on a regular basis and they must be calibrated at least once a year. The calibration certificate is attached to the users and service manual of the building

Information for guidance

NATIONAL BUILDING CODE OF FINLAND
Situation at xx.xx.20xx according to the information on xx.xx.20xx, the date of issue of this Decree (up to date list of contents at www.ymparisto.fi)

A	GENERAL PART		
A1	Building supervision and technical inspection	Regulations and guidelines	2006
A2	Building designers and designs	Regulations and guidelines	2002
A4	Guideline for use and maintenance of a building	Regulations and guidelines	2000
A5	Diagram markings	Regulations	2000
B	STRENGTH OF STRUCTURES		
B1	Reliability and loadings of structures	Regulations	1998
B2	Load bearing structures	Regulations	1990
B3	Foundation structures	Regulations and guidelines	2004
B4	Concrete structures	Guidelines	2005
B5	Light concrete block structures	Guidelines	2007
B6	Thin steel sheet structures	Guidelines	1989
B7	Steel structures	Guidelines	1996
B8	Brick structures	Guidelines	2007
B9	Concrete block structures	Guidelines	1993
B10	Wood structures	Guidelines	2001
C	INSULATION		
C1	Sound insulation and noise abatement in a building	Regulations and guidelines	1998
C2	Humidity	Regulations and guidelines	1998
C4	Thermal insulation	Guidelines	2012
D	PLUMBING, HEATING, VENTILATION AND ENERGY EFFICIENCY		
D1	Water supply and drainage equipment for properties	Regulations and guidelines	2007
D2	Indoor climate and ventilation for buildings	Regulations and guidelines	2012
D3	Energy efficiency of buildings	Regulations and guidelines	2012
D4	Plumbing, heating and ventilation drawing signs	Guidelines	1978
D5	Calculation of energy consumption and heating energy needs for buildings	Guidelines	2007
D5	Calculation of energy consumption and heating energy needs for buildings	Guidelines	2012
D7	Efficiency requirements for boilers	Regulations	1997
E	STRUCTURAL FIRE SAFETY		
E1	Fire safety of buildings	Regulations and guidelines	2002
E2	Fire safety in production and storage buildings	Guidelines	2005
E3	Small chimneys	Guidelines	2007
E4	Carport fire safety	Guidelines	2005
E7	Ventilation plant fire safety	Guidelines	2004
E8	Walled fireplaces	Guidelines	1985
E9	Fire safety in boiler rooms and fuel stores	Guidelines	2005
F	GENERAL BUILDING DESIGN		
F1	Obstacle free building	Regulations and	2005

		guidelines	
F2	Safe use of a building	Regulations and guidelines	2001
G	RESIDENTIAL CONSTRUCTION		
G1	Residential design	Regulations and guidelines	2005

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. (SFS-EN 12341:1998 Ilmanlaatu. Hiukkasten PM10-osuuden määrittäminen. Referenssimenetelmä ja kenttätesti mittausmenetelmien vastaavuuden osoittamiseksi.)

Known Hazardous Concentrations (HTP-arvot) 2007, Ministry of social Affairs and Health Publication 2007:4, Helsinki 2007. (HTP-arvot 2007, sosiaali- ja terveysministeriön julkaisuja 2007:4, Helsinki 2007).

Housing Health Guidelines, a Ministry of Social Affairs and Health Guide 2003:1, Ministry of social Affairs and Health, Helsinki 2003.
(Asumisterveysohje, sosiaali- ja terveysministeriön oppaita 2003:1, sosiaali- ja terveysministeriö, Helsinki 2003.)

Housing Health Guide, Application Guide to the Housing Health Guidelines, published by the Ministry of Social Affairs and Health (a Ministry of Social Affairs and Health Guide 2003:1), Vammala 2005.
(Asumusterveysopas, sosiaali- ja terveysministeriön asumisterveysohjeen (STM:n oppaita 2003:1) soveltamisopas, Vammala 2005.)

Arvela H., Asuntojen radonkorjauksen menetelmät (STUK-A-127), Helsinki 1995.
(Methods to correct radon in dwellings)

Fighting radon in small and row houses. Design of ground-facing structures. Guide 2., 1993, Ministry of the Environment, Helsinki 1994.
(Opas 2, 1993, ympäristöministeriö, Helsinki 1994.)

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.