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Ministry of the Environment

Housing and Building Department

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17/6/2008

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Indoor Climate and Ventilation of Buildings
Regulations and Guidelines 2010

Indoor Climate and Ventilation of Buildings

Regulations and Guidelines 2010

**Decree of the Ministry of the Environment
on the indoor climate and ventilation of buildings**

Issued in Helsinki on the xxth day of xxxxx, 2008

In accordance with the decision of the Ministry of the Environment, the following regulations and guidelines on indoor climate and ventilation in buildings are hereby laid down for use during construction under Section 13 of the Land Use and Building Act of 5 February 1999 (132/1999).

The regulations and guidelines have been published in accordance with Directive 98/34/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, as amended by Directive 98/48/EC.

This Decree shall enter into force on 1 January 2010, upon which the Ministry of the Environment Decree on indoor climate and ventilation of buildings of 30 October 2002 and the Ministry of the Environment Decree of 15 April 2003 amending regulation 1.2 of the Ministry of the Environment Decree on indoor climate and ventilation of buildings shall be repealed. The previous regulations and guidelines may be applied to applications for planning permission that the authorities receive before the entry into force of this Decree.

Done at Helsinki, th day of December 2008

Minister of Housing

Chief Engineer

Directive 2002/91/EC of the European Parliament and of the Council (32002L0091); OJ No L 1, 4.1.2003, p. 65

Indoor Climate and Ventilation in Buildings
REGULATIONS AND GUIDELINES 2010

Contents

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 solutions other than those presented may be used if they fulfil the construction requirements.

Explanations, *which are written in italics in narrow columns, provide additional information and contain references to other legislation.*

1
GENERAL

1.1 Scope

1.1.1
These regulations and guidelines relate to the indoor climate and ventilation of new buildings. With regard to holiday homes, the regulations only relate to buildings intended for all-year-round or winter use.

1.2 Mutual recognition

1.2.1
Where these regulations and guidelines provide information about the SFS (Finnish Standards Association) standards to be used, the corresponding standards in force elsewhere in the European Economic Area or in Turkey may be used as well or instead.

1.3 Definitions

1.3.1
For the purposes of these regulations and guidelines:

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

2) *room temperature* shall mean the normal temperature range of air. If the room contains large surfaces the temperature of which deviate from the temperature of the air, the operating temperature is used as the room temperature. The operating temperature describes the effect of surface temperatures that deviate from the temperature of the indoor climate on human sensations of heat;

3) *energy required for the heating of ventilation air* shall mean the amount of heat that is needed to heat the ventilation air flow from the outside temperature to room temperature;

4) *annual efficiency of heat recovery for ventilation exhaust air* shall mean the relationship of the amount of heat to be recovered and used in a year, using heat recovery equipment, to the amount of heat needed to heat the ventilation, if no heat is recovered;

5) *ventilation* shall mean maintaining and improving the quality of the air in the room by changing it;

6) *specific electrical power for the ventilation system* shall mean the electrical power taken from the electricity network by all the blowers in the building's entire ventilation system, divided by the total model waste air flow or model outside air flow for the ventilation system (whichever is the greater). In addition to the electrical power for the blower motors, the electrical power taken from the electricity network by the ventilation system includes the electrical power for any pumps and motors used for heat recovery, as well as frequency modulators and other capacity control devices;

7) *ventilation coefficient* shall mean the outside air flow that flows into or out of the room in the space of an hour, in relation to the air volume of the room, $(m^3/h)/m^3 = 1/h$;

8) *air conditioning* shall mean controlling the cleanliness, temperature, moisture and circulation of the air in the room by processing incoming or recirculated air;

9) *waste air* shall mean exhaust air that is channelled out of the building;

10) *recirculated air* shall mean air that only returns to the same room or house;

11) *mechanical incoming and exhaust air system* shall mean a system for removing air from the building and bringing in heated/cooled and filtered air from outside mechanically using blowers;

12) *mechanical exhaust air system* shall mean a system for removing air from the building mechanically using blowers and bringing in air from outside, both using outside air equipment and as air leakage from the buildings;

13) *operating time* shall mean the time during which it is present or used in the building or space in accordance with its intended use;

14) *temperature relationship* shall mean the relation of the temperature change in incoming air in the heat recovery exchanger to the difference in temperature of the exhaust and outside air in the heat exchanger;

15) *site* shall mean areas where people are present for any time longer than temporarily. For example, sites do not include hygiene areas, changing rooms and office corridors;

16) *area where people are present* shall mean a room where indoor climate requirements are to be met. It is usually at least the part of the room where the lower surface is limited to the floor, the upper surface is 1.8 m above the floor and the side surfaces are 0.6 m from the walls or similar fixed parts of the building;

17) *natural ventilation system* shall mean a system that operates on the basis of differences in pressure caused by differences in height and temperature, and by wind. The hottest indoor air flows more lightly up through the exhaust air duct and out of the building. Outside air is brought in both through outside air equipment and as air leakage from the buildings;

18) *return air* shall mean air that returns as incoming air so that it contains exhaust air from two or more different rooms;

19) *exhaust air* shall mean air that is channelled out of the room;

20) *transferred air* shall mean air that is channelled from one area into another;

21) *planned operating time* shall mean the operating time requirement laid down for the building, a part of the building, the home technology system and its parts or components, defined by the initiator of the construction project, the builder or the designer; and

22) *incoming air* shall mean air that is channelled into the room.

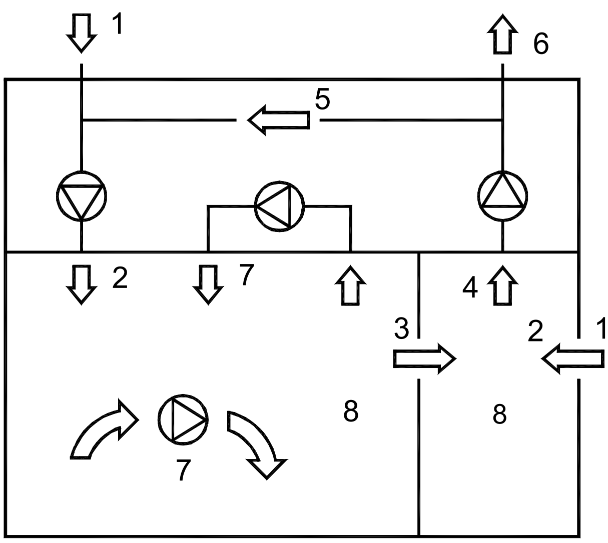


Image 1. Names of air flows: 1. outside air, 2. supply/incoming air, 3. transferred air, 4. exhaust air, 5. return air, 6. waste air, 7. recirculated air, 8. indoor air.

2
INDOOR CLIMATE OF BUILDINGS

2.1 General

2.1.1
The building must be completely designed and constructed so that a healthy, safe and comfortable indoor climate is achieved in the area where people are present in all normal weather conditions and uses.

2.1.1.1
The person responsible for each special plan shall ensure that the plan meets the indoor climate requirements. The head architect shall ensure that the building plan and special plans form a whole entity that meets the indoor climate.

Explanation
Section A2 of the National Building Code of Finland sets out the regulations and guidelines on architects and building designs.

2.1.1.2
The relevant manager shall ensure that the work is done according to the building plan, special plans and good construction practice, so that the indoor climate requirements are met.

Explanation
Section A1 of the National Building Code of Finland sets out the regulations and guidelines on monitoring construction work.

2.1.2
In order to achieve a healthy, safe and comfortable indoor climate, the following factors, which have an impact on the building, must usually be taken into account when designing and constructing a building:
1) internal stress factors such as heat and moisture stress, human stresses, processes and the discharge of building materials and fittings;
2) external stress factors such as weather and noise conditions, outside air quality and other environmental factors; and
3) the location and construction site.

2.1.3
Achieving a healthy, safe and comfortable indoor climate should be ensured when:
1) the heat and moisture insulation for the building and the characteristics of the windows are being designed;
2) the building liner, and the air impermeability of the lower floor, rawl plugs and buildings between spaces are defined;
3) the building materials and fittings are selected;
4) the home technology systems are designed, together with their reliability and space required;
5) moisture controls for the building site are designed;
6) cleanliness controls for the construction work and ventilation system are designed; and
7) the schedule for the building site, receipt and taking into use is prepared.

2.1.3.1
In order to achieve a healthy, safe and comfortable indoor climate, construction methods are used, internal stress factors are reduced, the impact of external and internal stress factors is limited and ventilation and air-conditioning methods are used.

2.2 Thermal environment

2.2.1
The building must be designed and built so that a comfortable room temperature can be maintained in the area where people are present during the operating time without using energy unnecessarily.

2.2.1.1
A temperature of 21°C is usually used as the model value for the room temperature in the area where people are present during the heating season. A temperature of 23°C is usually used as the model value for the room temperature in the area where people are present in summer.

Room temperature may be designed differently from the guideline value where there are justified reasons for this. Such guideline values for temperatures in each area during the heating season are presented in Table 1.

An acceptable deviation from the model value for room temperature in the area where people are present during the heating season, in the middle of the room and at a height of 1.1 m, is ± 1 °C.

Table 1. Guideline values for room temperature in each area during the heating season for areas where the guideline value for room temperature is not 21 °C. When using the guideline values, it must be ensured that the comfortableness of other areas is not reduced.

Area	Room temperature °C
Staircase	17
Bathroom, washroom	22
Drying room	24
Shop	18
– fixed work points in shop	21
Sports centre	18
Church hall	18
Factory, medium work	17
Car workshop, test areas	17
Lift shaft	17

2.2.1.2
While the building is in use, the temperature of the area where people are present may not normally be higher than 25°C.

2.2.1.3
If the average temperature value for outside air is higher than 20°C for a maximum period of five hours, the temperature of the air in the room may exceed this value by no more than 5 °C.

2.2.1.4
When planning the maintenance of thermal conditions, the outside air temperatures set out under L1.1 in Table 1 of Annex 1 to part D5 of the Building Code are used as the model temperatures for outside air during the heating season.

2.2.1.5
The TEST year of the Finnish Meteorological Institute, for example, may be used as the model weather data for summer to be used as the basis for planning the maintenance of thermal conditions, or a model outside air temperature for summer of +25°C may be used, with external air enthalpy of 50 kJ/kg in Lapland and 55 kJ/kg in the rest of Finland.

2.2.2
The building must be designed and built so that air circulation, thermal radiation and surface temperatures do not cause any lack of comfortableness in the area where people are present during the operating time.

2.2.2.1
The guideline values for air circulation in the area where people are present for each area are set out in Annex 1.

2.2.2.2
If structures such as large window surfaces or equipment that causes strong thermal radiation or high or low surface temperatures are planned or built in the areas, the room temperature is checked using the calculated operating temperature.

2.2.2.3
Games rooms in day nurseries are usually equipped with floor heating or another similar system for achieving comfortableness.

2.3 Air quality

2.3.1
The building must be designed and built so that no amounts of gases, particles or microbes that are harmful to health, or any smells that reduce comfortableness, enter the indoor air.

2.3.1.1
The carbon dioxide content of indoor air in normal weather conditions while the room is being used is normally a maximum of 2160 mg/m^3 (1200 ppm).

2.3.1.2
In order to prevent health hazards caused by impurities in the indoor air, the maximum sulphur dioxide, nitrogen dioxide, particle, lead, carbon monoxide or benzine content is normally in accordance with the Finnish Council of State Decree on Air Quality (711/2001).

2.3.1.3
The impurity content values to be used when planning the quality of internal air are set out in Table 3. The values relate to buildings that have been used for six months in which there is continuous ventilation using the air flow from ventilation during the operating time. The methods set out in the guidelines by the Ministry of Social Affairs and Health are used when measuring the content.

Table 3. Values for impurity content in indoor air for planning and implementing the indoor climate in buildings.

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

2.3.1.4
The content of other impurities in normal areas may normally be no more than 1/10 of the occupational exposure limit (OEL) when the impact of an individual substance can be completely controlled. If there are many harmful substances in the air and their joint impact is not known, the acceptable content level shall be regarded as having been exceeded if:

$$\sum_i (C_i/OEL_i) > 0.1$$

where C_i is the measured content of one substance and OEL_i is the occupational exposure limit for that substance.

Explanation
The Ministry of Social Affairs and Health confirms the occupational exposure limits by Decree and it publishes lists as a safety bulletin (OEL values).

2.3.2
The building must be designed and built so that the moisture of indoor air remains at a value consistent with the intended use of the building.

The moisture of indoor air may not continuously be dangerously high and it must not condense onto structures or their surfaces or to the ventilation system so as to cause moisture damage, growth of microbes or micro-organisms, or other health hazards.

2.3.2.1
If the moisture of indoor air exceeds a value of 7 g H_2O/kg of dry air, the air in the room is only dampened for good reasons, for example, if it is required for a process or storage. The value of 7 g H_2O/kg of dry air corresponds to the condition of the air in the room when the relative moisture is 45%, the room temperatures is 21°C and the air pressure is 101.3 kPa.

In order to reduce hazards caused by low relative moisture in indoor air, unnecessarily high room temperatures are to be avoided during the heating season.

2.4 Acoustic conditions

2.4.1
The building must be designed and built so that it has comfortable acoustic conditions.

2.4.1.1
The guideline values for acoustic levels for each area using LVIS equipment are set out in Annex 1. The acoustic efficiency levels and calculations for sound levels caused by the systems in rooms using LVIS equipment and other comparable equipment are presented in special plans or reports.

Explanation
Part C1 of the National Building Code of Finland sets out the regulations and guidelines on acoustic insulation and noise abatement in construction. According to this, LVIS equipment and comparable equipment includes, for example, lifts, water and sewage equipment, compressors, ventilation equipment, cooling equipment, heating equipment, central vacuum cleaning, carpet cleaners and utility room equipment such as washing machines, extractors, blow dryers and mangles. The Annex to part C1 sets out helpful information on measuring sound levels.

2.4.1.2
Acoustic insulation for the liner is designed as a whole entity, taking into account all the parts of the building that have an impact on sound insulation, such as, for example, walls, windows and outside air and waste air equipment for the ventilation. This entity must comply with the acoustic insulation requirement.

Explanation
The plan may give requirements for the positioning of windows and sound insulation of the facade against traffic noise.

2.5 Lighting conditions

2.5.1
The building must be designed and built so that adequate light for seeing is maintained in the area where people are present during the operating time so as not to use energy unnecessarily.

2.5.1.1
The classification, energy consumption and control of lighting are implemented so that the lighting can be varied according to the activity being carried out and the amount of natural light.

3
VENTILATION

3.1 Ventilation systems

3.1.1
The ventilation system must be designed and built based on the intended and actual use of the building so that, for its part, it creates the conditions for a healthy, safe and comfortable indoor climate in normal weather conditions and usage scenarios.

Explanation
Part A2 of the National Building Code of Finland sets out the regulations and guidelines on architects and building plans.

3.1.2
The ventilation system must be designed and built so that it remains in good working condition for its planned working life when used, serviced and maintained correctly.

Explanation
Part A4 of the National Building Code of Finland sets out the regulations and guidelines on preparing user and maintenance guides for the building and parts of the building.

3.1.3
It must be possible to control and monitor the functioning of the ventilation system.

Measuring equipment or an opportunity for measuring must be designed for and fitted to the ventilation system in order to measure the most important operating values and to monitor the functions.

3.1.3.1
The ventilation system is equipped with controls, adjusting devices and monitoring devices that are used to control and monitor the operation of the system.

3.1.3.2
In order to monitor the functions, the ventilation machine is normally equipped with inspection hatches and windows.

3.1.3.3
The mechanical ventilation system is equipped with fixed air-flow measuring transducers and equipment for measuring the flow of outside air and waste air into and out of the building. If the air flow is below 0.5 m^3/s, the fixed measuring equipment may be replaced by measuring sockets that are suitable for portable equipment.

3.1.3.4
Thermometers are fitted to the inlet and outlet sides of the heating and cooling batteries of the ventilation machines. Thermometers are also fitted to places intended for flows of outside, incoming, exhaust and waste air on the ventilation machinery, which is fitted with heat recovery equipment. The air filters are fitted with differential pressure instruments. If the air flow is below 0.5 m^3/s, the fixed measuring equipment may be replaced by measuring sockets that are suitable for portable equipment.

3.1.3.5
A measuring socket is connected to the part of the ventilation machine after the damper, in order to measure moisture.

3.1.3.6
Measuring devices are fitted to places where they can be read easily and which are easily accessible.

3.1.4
The ventilation system must be designed and built so that its machinery and equipment contains protection and safety devices for servicing and maintenance.

3.1.5
The ventilation system must be designed and built so that its functions can be shut down completely in an emergency using a clearly marked emergency switch, which should be in an easily accessible place.

3.2 Air flow rates

3.2.1
The rooms should have ventilation that guarantees the quality of a healthy, safe and comfortable indoor climate while in use.

> 3.2.1.1
> Guideline values for measuring ventilation in respect of the air flows in each area are set out in Annexes 1 and 2.

3.2.2
A flow of outside air that guarantees the quality of a healthy, safe and comfortable indoor climate must be channelled into the area where people are present while in use.

> 3.2.2.1
> The guideline values for each area that are set out in Annex 1 are those used primarily for measuring outside air flows. The outside air flow is primarily determined on the basis of the number of people. If there is not an adequate basis for measuring air flows according to the human load, measuring is done on the basis of the surface area.
>
> If there are adequate grounds for measuring according to the number of people, outside air of at least 6 dm^3/s per person is channelled into areas where people are present other than those set out in Annex 1.
>
> Nevertheless, the outside air flow should normally be at least 0.35 $(dm^3/s)/m^2$, corresponding to a ventilation rate of 0.5 1/h in a room with free height of 2.5 m.

3.2.3
It must be possible to control the air flow for the ventilation system according to the load, air quality and usage scenario.

> 3.2.3.1
> The ventilation controls for a residential building must be designed and built so that the intensified air flow while the building is in use is at least 30% greater than the normal air flow while the building is in use. The intensity of the ventilation is normally implemented at least in accordance with the guideline values in Annex 1 for the intensified air flow for a cooker hood.
>
> 3.2.3.2
> If the ventilation is to be controlled for each residence, the ventilation system may be designed and built so that the air flows can also be controlled so as to reduce the air flow during the operating time. If nobody is present in the residence and there is no need for ventilation during the operating period, for example, in order to control moisture, the ventilation controls may be designed so that the air flows in the residence can be reduced by up to 60% of the air flow for the operating time.
>
> 3.2.3.3
> Ventilation for places other than residential buildings is designed and built so that the outside air flow of the building outside the operating time is at least 0.15 $(dm^3/s)/m^2$, corresponding to a ventilation rate of 0.2 1/h in a room with free height of 2.5 m.
>
> Outside the operating time, ventilation may be implemented by keeping the ventilation in operation for hygiene areas or by using the ventilation periodically.

3.3 Filtration of supply air

3.3.1
The level of filtration for incoming air is determined on the basis of the indoor air quality requirements and the outside air.

Air coming into areas where people are present must normally be filtered.

3.3.1.1
The filtration of incoming air must normally be designed so that the degree of separation for the air filters is at least 80% of 1.0 μm particles during the operating life of the filter. The air filter class corresponding to this is F7.

3.3.1.2
The filtration of incoming air for buildings that are located far away from busy traffic routes and outside population centres and industrial areas is normally designed so that at least a coarse filter is used to filter the air. The air filter class corresponding to this is G4.

3.4 Location of outdoor air and exhaust air devices

3.4.1
Devices for outside air must be positioned so that air coming into the building is as clean as possible.

Outside air must not be brought through a structure or part of the building that reduces air quality.

3.4.1.1
Devices for outside air are positioned according to Table 4 and Image 2. The values set out in the table are normally minimum distances.

Table 4. Positioning of devices for outside air.

Distance of device for outside air	Distance m
From waste air devices	Image 2
From sources that spoil the quality of outside air, such as waste storage sites, car parks, loading bays and driveways, openings in ventilation shafts and chimneys, exhaust blowers for central vacuum cleaning and cooling towers	8
From openings in ventilation shafts and chimneys over 3 m taller than the opening for outside air	5
From ground or yard level	2
From the roof surface The distance may be shorter if snowfall that impedes ventilation is prevented from forming using a steep ridged roof, snow shield or other reliable method.	0.9

3.4.1.2
For separate private homes, the values may be less than the minimum distances set out in Table 4, irrespective of the distance from flues of boilers and fireplaces that use solid fuel or the distance of the outside air device from the roof surface.

3.4.1.3
Outside air devices for each room or group of rooms located at yard or street level may be lower than 2 m from ground level, in the same way as outside air devices for areas intended for temporary presence. However, outside air devices are not positioned in hollows below yard or street level.

3.4.1.4
If the building is located closer than 50 m to the middle of a busy traffic route, the outside air devices for the building are positioned as high up as possible, normally on the opposite side of the building

from the road. A road or street shall be regarded as a busy traffic route when the average traffic volume is over 10 000 cars a day.

3.4.1.5
Outside air devices are positioned outside any balcony glazing.

3.4.2
Waste air must be channelled out so that no health or other hazards are caused to the building, its users or the environment.

3.4.2.1
Waste air is normally channelled to the top of the highest part of the building's roof and blowing is normally directed upwards, so that waste air is prevented from reaching outside air devices, windows and areas where people are present.

A waste air device for a natural ventilation system is normally positioned at the top of the building's roof. Where necessary, removal is made more effective by using wind controls, rotors or other similar devices.

Explanation
Measures are laid down for smoking areas in restaurants and other catering establishments and for their ventilation in the Act on Measures to Reduce Tobacco Smoking (693/1976), as it is in Act 700/2006, Finnish Council of State Decree on Measures to Reduce Tobacco Smoking (225/1977), in Decree 963/2006, and in the Ministry of Social Affairs and Health Decree on Smoking Areas in Restaurants and Other Catering Establishments (964/2006).

3.4.2.2
Waste air is channelled away from buildings based on the following exhaust air classifications:

Exhaust air class	Description and demarcation of use	Example of area
1	Exhaust air that only contains a few impurities. The impurities mainly originate from humans or structures. The air is suitable for return and transferred air.	Operating areas and related small storage areas, service areas, teaching areas, some assembly areas and business premises where there is no smell load.
2	Exhaust air that contains some impurities. The air is not used as return air for other areas, but may be channelled as transferred air, for example for toilets and washrooms.	Homes, dining areas, drink preparation areas, shops, office storage areas, changing rooms and restaurant areas where smoking is prohibited
3	Exhaust air from areas where moisture, processes, chemicals and smells significantly worsen the quality of the exhaust air. The air is not used as return or transferred air.	Toilets and washrooms, saunas, kitchens for homes, catering kitchens and training kitchens, copy areas on the plans.
4	Exhaust air that contains bad smells or unhealthy impurities significantly more than the acceptable content for indoor air. The air is not used as return or transferred air.	Professionally used: - fume cupboards, grills and localised ventilation for kitchens; - dirty laundry areas in laundries. Garages and car tunnels, paint and solvent processing rooms, food waste rooms, chemical laboratories, smoking areas and hotel areas where smoking is permitted.

3.4.2.3

Waste air devices are positioned according to Table 5 and Image 2. The values set out in the table are minimum distances.

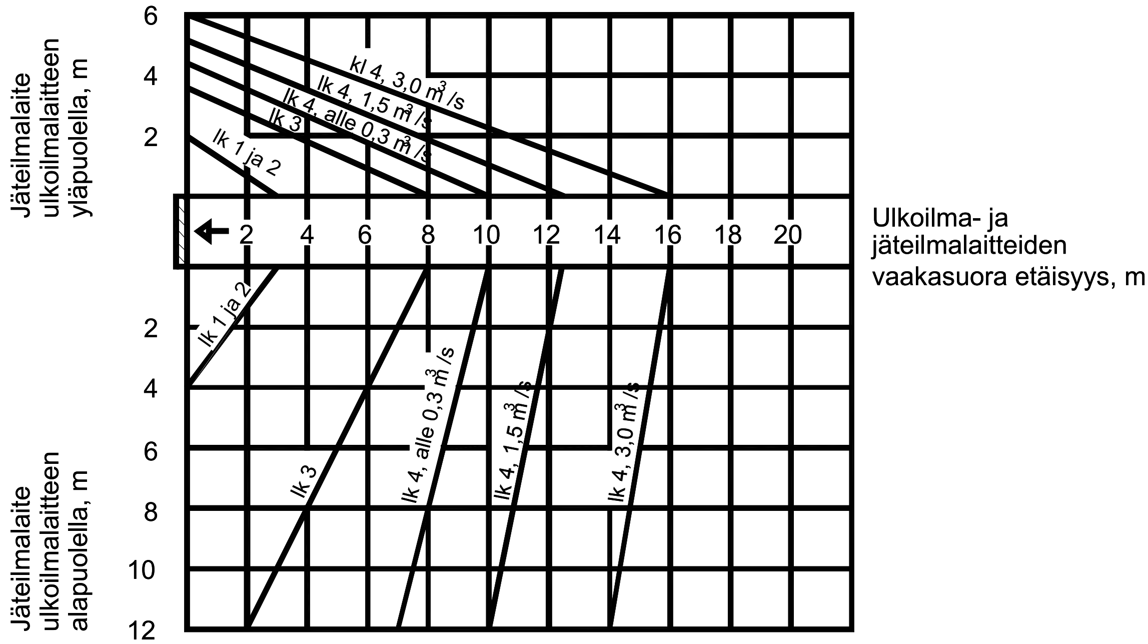
The distances for waste air devices that are directed upwards may be calculated either from the edge of the device or from the top of the device, and the distance from the device in metres is 1/3 of the numerical value for the blower speed in m/s.

Table 5. *Positioning of waste air devices.*

Distance of waste air device:	Distance, m			
	Exhaust air class			
	1	**2**	**3**	**4**
From outside air devices	Image 2	Image 2	Image 2	Image 2
From opening windows on the lower extremity	2	2	4	6
From opening windows on the same level or upper extremity or from levels where people are present	3	3	6	10
From ground or yard level	2	2	3	5
From the roof surface The distance may be shorter if snowfall that impedes ventilation is prevented from forming using a steep ridged roof, snow shield or other reliable method.	0.9	0.9	0.9	0.9
From neighbouring sites (does not affect private houses)	2	2	5	8
From openings in ventilation shafts and chimneys	1	1	1	1
Distance between waste air devices for natural and mechanical ventilation	1	1	1	1

Waste air device above outside air device, m

Outside air and waste air devices horizontal distance, m



Waste air device below outside air device, m

Image 2. Distances between waste air and outside air devices. The values between the lines may be estimated.

3.4.2.4

Waste air from staircases, lift shafts and technical areas may be channelled out of the building without any restrictions. However, it may not be channelled onto escape routes or areas where people are present.

3.4.2.5
Class 1 waste air may be channelled out through the waste air device in the wall of the building under the following conditions:
1) the distance of the waste air device is at least 4 m from a neighbouring site and at least 8 m from the building opposite;
2) the air flow is no more than 1 m^3/s;
3) the distance of the waste air device from an outside air or waste air device on the same wall is at least 1.5 m; and
4) the air speed in the blower opening is at least 5 m/s.

3.4.2.6
A waste air device fitted to a wall is normally positioned on a wall on the same side as a traffic route or parking area.

If the wall has fire barriers, for example balcony walls or internal corners that create nooks, no waste air or outside air devices are positioned in the same nook.

3.4.2.7
If there are eaves, bay windows or other parts of the building that project out from the wall above the waste air device, the device is positioned on the lower side of the projecting part or the device is channelled to the level of the front edge of the projecting part.

3.5 Return air, transferred air and recirculated air

3.5.1
Only air that is equally clean or cleaner may be used as return or transferred air, and it must not contain dangerous amounts of impurities. The use of return or recirculated air must not cause impurities, particularly smells, to spread harmfully.

3.5.1.1
Exhaust air classes 2, 3 and 4 are not used as return air, according to section 3.4.2.2.

3.5.1.2
Return air is not used as incoming air for the following areas:
1) homes;
2) professional kitchens;
3) accommodation areas in the hotel and catering sectors and internal educational establishments;
4) hospitals, care homes and prisons and similar accommodation;
5) restaurants and cafeterias; and
6) other areas that must be kept especially clean, unless return air is cleaned at least so that the degree of separation for the air filters is at least 80% for 1.0 µm particles during the operating time of the filter. The air filter class corresponding to this is F7.

3.5.1.3
Exhaust air class 2 may be used for recirculating air inside homes.

3.5.1.4
Return air and often also recirculated air must normally be filtered.

3.6 Distribution and removal of air

3.6.1
Incoming air must be channelled into homes so that the air flows draught-free into the whole area where people are present and efficiently removes any impurities that have been generated in the room during the operating time. Dirty air must not return in harmful quantities to the area where people are present.

3.6.1.1
Ventilation is designed as efficiently as possible so that incoming air flows to the whole area where people are present and any impurities are carried directly to the exhaust air terminals without spreading to the room. Incoming air must not flow directly past the area where people are present to the exhaust air terminals.

3.6.1.2
Air distribution devices, outside air intake devices and flow routes or equipment for transferred air must have known flow and acoustic technology properties. They are positioned and designed so that the air speeds and noise levels set out in Annex 1 are not exceeded in the area where people are present.

It must be possible to regulate the air flow of outside air equipment in mechanical exhaust air systems and natural ventilation systems.

3.6.1.3
An exhaust air terminal is normally fitted in every room.

In homes, at least kitchens, kitchenettes, bathrooms, toilets, utility rooms and walk-in wardrobes are fitted with exhaust air terminals. Exhaust air from other rooms may be channelled through these, using appropriate transfer routes or equipment.

Exhaust air from corridors may be channelled, for example, through toilet areas in normal conditions, such as in offices and accommodation areas.

3.6.1.4
Localised exhaust is always used when concentrated dust, gases or steam is generated in the room. The efficiency of impurity removal may be increased by sealing off the source of the impurities. For example, kitchens are fitted with cooker hoods or similar localised ventilation.

3.6.2
Connection of mechanical ventilation ducts for different areas must not cause any hazard of spreading impurities or flue gases or influence the operation of the ventilation system.

3.6.2.1
The guidelines set out in part E7 of the National Building Code of Finland are used as a basis for the connection of ventilation ducts.

3.6.2.2
Air from the different exhaust air classes is channelled out of the building according to the following principles:
1) class 1 and 2 air may normally be conveyed in a common ductwork;
2) class 3 exhaust air is normally conducted using separate ducts or common ductwork serving areas with similar levels of air cleanliness, into a collecting channel or exhaust air chamber above the areas it serves; and
3) class 4 exhaust air is conveyed out using separate exhaust air ducts.

If air from exhaust air classes 1 and 2 is combined in the same duct and the proportion of class 2 air flow is more than 10% of the combined air flow, the combined air flow is classified in exhaust air class 2.

3.6.2.3
Separate outside and exhaust air ducts are led from other ventilation systems to the room if significant quantities of dangerous substances or substances that cause strong smells are processed or stored in the area. Such areas include, for example, warehouses for poisonous substances, waste rooms and dirty laundry areas in laundries.

3.6.2.4
Exhaust air is generally channelled from toilets, washrooms and cleaning areas that open into work areas, areas where people are present and corridors via a separate exhaust air system. Exhaust air from toilets and similar areas may, however, be channelled into the exhaust air ventilation system in continuous operation for other areas in residential and accommodation areas.

Exhaust air from no more than two toilets or similar areas may be channelled into vertical exhaust air ducts for classes 1 and 2, if the total flow of exhaust air in these areas is no more than 10% of the total air flow in the vertical duct. In that case, class 1 exhaust air is not suitable for being return air either.

3.6.2.5
In a mechanical ventilation system, the exhaust air from all the areas of a residence may be conveyed directly out via the same air duct, into a collecting duct or exhaust air chamber above the areas it serves.

3.6.2.6
Exhaust air from technical areas and individual areas in secondary use, such as small storage areas and sports equipment rooms, may be conveyed into the exhaust air ducts for class 3.

3.7 Air-tightness and pressure of ventilation systems

3.7.1
The ventilation system and its parts should be sufficiently tight and firm.

3.7.1.1
The ductwork for the ventilation system is normally sufficiently tight when it is of air-tightness class B. The largest permitted leakage air flow for air-tightness class B is set out as an equation in Table 6 and as a graph in Image 3.

3.7.1.2
Normal ventilation systems generally achieve ductwork air-tightness class B when the air-tightness class for the air ducts and ductwork components used is C.

3.7.1.3
The ventilation machine is normally sufficiently tight when the air-tightness of its liner is of at least air-tightness class A and the leakage air flow between incoming air and exhaust is no more than 6% of the nominal air flow for the ventilation machine at a test pressure of 300 Pa.

3.7.1.4
The largest permitted leakage air flows for the ventilation system and its parts in different air-tightness classes are set out as an equation in Table 6 and as a graph in Image 3.

Table 6. Largest permitted leakage air flows for ventilation systems and their parts in relation to the surface area of the liner q_{VIA} ($dm^3/s/m^2$) in different air-tightness classes. The leakage equation is $q_{VIA} = k\, p_s^{0.65}$, where k is the air-tightness class factor ($dm^3/s/m^2/Pa^{0.65}$) and p_s is the test pressure (Pa).

Air-tightness class	Permitted leakage air 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	$0.0003 \times p_s^{0.65}$

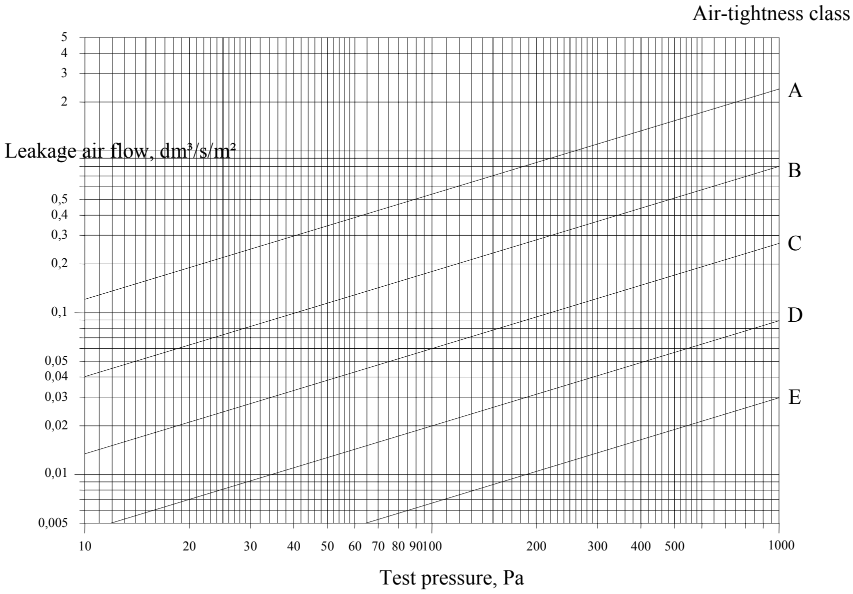


Image 3. Largest permitted leakage air flows for ventilation systems and their parts in relation to the surface area of the liner in different air-tightness classes.

3.7.2
Impurities must not spread through the building in dangerous quantities via air ducts or ventilation devices.

3.7.2.1
The structure and forces for the heat recovery equipment is implemented so that exhaust air is not significantly transferred to incoming air.

3.7.2.2
When recovering heat from class 1 exhaust air, no requirements are laid down for the differential pressure between incoming and exhaust air. When recovering heat from class 2 exhaust air, the pressure for the heat recovery device is designed so that the leakage air mainly flows from the incoming air to the exhaust air.

3.7.2.3
When recovering heat from class 3 exhaust air, the pressure for the heat recovery device is designed so that the leakage air mainly flows from the incoming air to the exhaust air.

Heat recovery devices in which the incoming and exhaust air flow alternately on the same flow route (regenerative heat transfer) may only be used if the exhaust air contains a maximum of 5% of class 3 exhaust air, and no class 4 exhaust air at all. However, such devices may be used for heat recovery from class 3 air in one-family homes.

3.7.2.4
When recovering heat from class 4 exhaust air, heat recovery in which incoming and exhaust air are not mixed must normally be used with flow-medium transmission.

3.7.2.5
If the ventilation machine only serves one room, the type of heat transfer for heat recovery may be selected freely, although the exhaust air should be of class 3 or 4. It should therefore be ensured that incoming air is sufficiently clean to ensure that the indoor air cleanliness requirements are met. Such areas include, for example, industrial areas and garages.

3.7.2.6
Exhaust air ducts located inside the building but outside the machinery room are normally made into a vacuum.

Exhaust air ducts for class 1 and 2 exhaust air classes may, however, be vacuums inside the building, assuming that the ductwork is of air-tightness class C. This is normally achieved when the air ducts are of air-tightness class D.

3.7.2.7
Waste air ducts for homes may be vacuums inside the building, assuming that the ducts are of air-tightness class D. This is normally achieved when the air ducts are of air-tightness class E.

3.7.2.8
The outside air and waste air ducts for a mechanical ventilation system are fitted with air locks that close automatically when the system stops and prevent backflow and uncontrollable ventilation when the transverse surface of the air duct is larger than 0.06 m^2 (for example, an air duct the diameter of which is 315 mm). Sufficient air-tightness for the air lock is achieved when it meets the requirements for an air lock of air-tightness class 3 under standard EN 1751:1998.

3.7.3
Two or more ventilation machines must not connected to the same duct or chamber so that room pressure or the direction of air flow between rooms and in the ducts could change from the design.

3.7.3.1
A joint chamber is not normally built if the ventilation system uses return air or the air flows from the machines are regulated independently of each other during use.

If many ventilation machines are joined to the same duct or chamber, the blowers for them are selected in accordance with standard SFS 5148 so that they do not disrupt each other's functions. If only some of the machines are in use at the same time, a joint chamber or duct is designed to be large and the operating point is selected using the blower properties graph, so that the air flows do not change by more than 3% owing to stoppage. Machines that have to be stopped are fitted with air locks that meet the requirements for an air lock of air-tightness class 3 under standard EN 1751:1998.

3.7.4
Natural and mechanical ventilation must not be joined so that the direction of air flow between rooms and the ductwork could change from the design specifications.

3.7.4.1
Ventilation in homes or other integrated areas is normally designed exclusively either as a mechanical or a natural ventilation system.

3.7.4.2
A natural ventilation system may be designed to be made more efficient using an exhaust air blower. Obtaining sufficient outside air is thus ensured so that air does not flow into the rooms through the waste air ducts or chimney flues.

3.7.4.3
The flow of air from the fire that is required by a fireplace is taken into account when designing a ventilation system.

3.7.5
The air ducts are reinforced and supported so that they remain firmly in place and can withstand any changes in pressure and other stresses that occur in the ventilation system. The ventilation machines and chambers must withstand stress caused by blower pressure when the air locks are closed.

3.7.5.1
The support and reinforcement of the air ducts must withstand insulation work, insulation weight and stress caused by cleaning processes.

3.7.5.2
The casings and air ducts of the air-conditioning machine and chambers must withstand the maximum permitted pressure (the greatest permitted usage pressure), and at least the stress caused by a test pressure of ±1000 Pa (vacuum or superpressure).

3.7.6

The building, its rooms and the pressures for its ventilation system must be designed so that air flows from the cleanest areas to the areas where the most impurities are generated. The pressures must not cause any long-term moisture stress to the structures.

3.7.6.1
A building is normally designed to create a slight vacuum for outside air which could avoid moisture damage in the structures and health hazards caused by microbes. However, the vacuum must not normally be greater than 30 Pa.

With regard to outside air, special areas may, however, be designed as vacuums, such as clean rooms and areas in which external doors or other openings are often kept open owing to the function of those areas.

3.7.6.2
If many impurities or a lot of moisture is generated in the area, it is designed as a vacuum with regard to other areas.

3.7.7.
The pressures for the building and the air-tightness of the structures are designed and implemented so that, for their part, they reduce the transfer of radon and other impurities in the building.

Explanation
Measures to reduce the radon content of indoor air are set out in the radon guides published by the Ministry of the Environment and the Radiation Protection Centre.

3.7.8
The normal use of the building and changes in the weather must not cause significant changes to the pressures in the building or its rooms, or reduce ventilation.

3.7.8.1
The pressures for the ventilation system are designed and implemented so that changes in the weather do not change the direction of flow in the building.

3.7.8.2
Controls for air flow according to need are designed so that they do not cause harmful changes to the differential pressures of the building and its different rooms.

3.7.8.3
Vertical ducts for natural ventilation systems are normally conveyed separately for each room to the top of the roof. The minimum height difference for outside air and waste air devices in a natural ventilation system is 4.5 m.

3.8 Cleanliness and maintainability of ventilation systems

3.8.1
Ventilation systems must be designed and built so that they are clean before the building is commissioned and they can be kept clean easily.

3.8.1.1
A ventilation system is built from parts that do not have oil, dust or other impurities in their lining. No harmful substances or smells may be released into the air flow from the ventilation system's parts.

3.8.1.2
The ducts are kept plugged in temporary stores on the building site so that they do not become susceptible to rain, dirt or flaws. Small duct components and air terminal devices are kept in sealed packaging on the building site.

3.8.1.3

The ventilation system is protected from contamination during the fitting work. The protection is finally removed only after cleaning, when there are no more phases of work to be done that generate dust.

3.8.1.4
The ventilation system should be lined so that it is easy to maintain system cleanliness. The reinforcements or supports for the air ducts must not be positioned inside the air duct so that they significantly impede cleaning of the ventilation system.

3.8.1.5
Air ducts and chambers are equipped with a large enough number of access panels necessary so that cleaning work is possible. The location and type of access panels is selected so that cleaning work can be done easily and safely.

Access panels are normally located in the chamber, by the closing fire barrier, and in the ducts, so that there are no more than two curves of more than 45° between two panels. For horizontal ducts, the access panels are normally located at 10-m intervals. The distance between access panels may be more than 10 m if the duct can be cleaned over the entire distance between the locks. Access panels are also located where the ducts branch out, if they and the ducts branching out from them cannot otherwise be cleaned, for example through the terminals.

With regard to fire safety and cleanliness, the access panels for the vertical ducts at the required points are normally located at intervals of 3-5 m.

An access panel is located on both sides of a device in the ducts, for example, a control panel, if the device cannot be removed for cleaning. A section of ductwork or duct fitting that can be removed and which is sufficiently large can also function as an access panel.

3.8.1.6
Parts and devices that are sensitive to impurities are not positioned in exhaust air ducts without protection if the exhaust air contains a lot of impurities, for example grease.

3.8.1.7
Cooling devices fitted in the area between a suspended ceiling and the intermediate floor should be completely cleaned without dismantling the suspended ceiling. If the air circulates in the area above the suspended ceiling, the structure of the suspended ceiling should also be easy to clean.

3.8.2
A ventilation system must be designed and built so that it does not cause any water, moisture or other damage. The use of water or its connection to the system must not cause the growth of any microbes that are harmful to health.

3.8.2.1
If an incoming air machine located in a room is connected to pipes that convey liquids, any penetration of water leakage into the structure is prevented, for example using a floor drain positioned in the room and a water-blocked floor. This does not apply to the following ventilation machines, which have an outside air flow of less than 0.9 m^3/s: ventilation machines for homes, incoming air machines fitted in the immediate vicinity of an external door, and ventilation machines that serve one area and are visible in that area.

Moisture that condenses into water or other possible leakage water in ventilation machines in homes is channelled into sewers so as not to cause disruption.

3.8.2.2
No water is taken directly from open cooling towers for cooling incoming air, but a separate closed-loop cooling circuit is used.

3.8.3
Air humidification and the water treatment in the humidifier must be designed and implemented so that the humidification does not worsen the quality of the air in the room.

3.8.3.1

Any water coming into contact with the incoming air is not normally returned to the humidification section. If, however, recirculated water is used for any particular reason, the humidifiers are equipped with an overflow system and water-processing devices that prevent the growth of microbes.

3.8.4
Outside air devices and their connections to the ventilation system and the building are positioned, protected or designed so that, or the structure of the outside air devices must be such that snow or rainwater do not get into the ventilation system in dangerous quantities. Any snow or rainwater that gets in must not cause any damage to the building or to the ventilation system, and must not affect the functioning of the ventilation system.

3.8.4.1
An unprotected outside air device positioned on a vertical external wall and which could be entered directly by wind is normally designed with a maximum end face speed of 2.0 m/s.

3.8.4.2
Suitable drainage is made for ventilation chambers or ducts should rainwater or snow get into them.

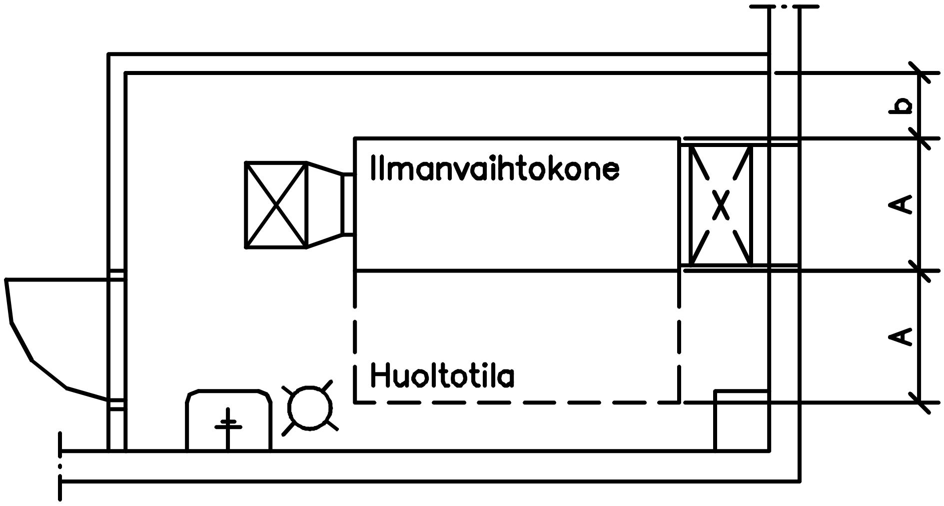
3.8.5
Ventilation machines, chambers and ducts are insulated from heat and moisture so that the condensation of moisture does not cause any damage to the structures or to the ventilation system.

3.8.5.1
Air ducts are insulated from heat and moisture so that the moisture of the indoor air or of the air flowing through the air ducts does not condense into water. For example, the outside air ducts in the warmest areas of homes and the waste air ducts after heat recovery in the direction of the air flow are insulated from heat and moisture.

3.8.6
A ventilation system and its servicing access routes must be designed and built so that the ventilation system is easy and safe to service and repair.

3.8.6.1
Sufficient space is reserved for servicing and cleaning the devices, and at least a large enough space in the direction from which the devices are to be serviced. In order to ensure serviceability, sufficient space must be reserved around the working parts of the devices and ventilation machines. The ventilation machines are equipped with service hatches that can be opened without using tools.

When reserving space for ventilation devices, the principles set out in Image 5 for enclosed ventilation machines are followed. If there are many machines in a machinery room, space is reserved separately for servicing and repairs. No fixed or heavy objects are positioned in the service areas.



Ventilation machine

Service area

Image 5. Sample positioning and design of a service area for an enclosed ventilation machine. A is the width of the ventilation machine and b is 0.4 times the height of the ventilation machine or at least 400 mm.

3.8.6.2
A clearly marked, removable or opening part measuring at least 500 mm x 500 mm should be fitted in suspended ceilings for the ventilation devices and access panels to be serviced.

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

4
ENERGY EFFICIENCY OF VENTILATION SYSTEMS

4.1.1
The ventilation system for a building must be designed and built based on the intended and actual use planned for the building, so that for its part it creates the conditions for efficient use of energy.

The energy efficiency of the ventilation is ensured using methods that are appropriate for the building's use without compromising a healthy, safe and comfortable indoor climate.

4.1.1.1
The conditions for efficient use of energy for ventilation are ensured using appropriate design and implementation solutions such as the classification of operating areas and times for the ventilation devices, any necessary ventilation controls and any necessary heat recovery functions for exhaust air.

4.1.1.2
All ducts and chambers are insulated from heat so that the temperature difference between the air flow and the environment does not cause any unnecessary consumption of energy, heating or cooling of the air flow or worsening of the indoor climate or control functions.

4.1.1.3
A ventilation system must be designed and built so that the electricity used by the system can be measured easily.

4.1.1.4.
The specific electrical power for a mechanical system for incoming and exhaust air must normally be no more than 2.5 kW/(m^3/s). The specific electrical power for a mechanical exhaust air system must normally be no more than 1.0 kW/(m^3/s).

4.1.1.5
The specific electrical power for a ventilation system may be greater than 2.5 kW/(m^3/s) if, for example, managing the indoor climate of the building requires different air conditioning than normal.

4.1.2
An amount of heat must be recovered from the exhaust air from the building's ventilation, corresponding to at least 50% of the amount of heat required to heat the ventilation. The need for heat energy may be reduced accordingly by:
1) improving the heat insulation of the building liner;
2) improving the air impermea bility of the building liner; or
3) reducing the amount of heat required to heat the ventilation in another way than by recovering heat from exhaust air.

Reducing the need for heat energy accordingly is indicated using a balancing calculation for the building's heat loss, in accordance with part D3 of the National Building Code of Finland.

4.1.2.1
The annual efficiency of heat recovery from exhaust air from the building's ventilation may be determined on the basis of the verified annual efficiency reported by the manufacturer of the heat recovery device.

Explanation
Guidelines for determining the annual efficiency are set out in Ministry of the Environment template 122. Any reduction in the temperature ratio owing to the cooling protection for the heat recovery device may be taken into account in the manner presented therein. Annex 1 to part D5 of the National Building Code of Finland sets out the outside tem-

perature distribution to be used when calculating annual efficiency (data from the duration curve) for the whole year and for each month.

Unless the verified annual efficiency for the heat recovery device is used, the temperature ratio of the heat exchanger for incoming air, multiplied by 0.6, may be used in the calculations.

A mechanical system for incoming and exhaust air is normally equipped with a heat recovery device for exhaust air, and the temperature ratio of its heat exchanger for incoming air must be at least 55% in test scenarios when the mass flows of incoming air and exhaust air are equally large, and its cooling protection and removal of condensation from exhaust air is implemented in a reliable way.

Explanation
Parts C3 and D3 of the National Building Code of Finland contain stipulations on the balancing calculations for the building's heat loss.

Explanation
The temperature ratio may be determined in accordance with standard SFS-EN 308.

Explanation
The amount of heat needed to heat the building's ventilation may be reduced in another way than through heat recovery from exhaust air, for example by using a pre-heating solution for outside air, which reduces the building's energy consumption. For example, this may be a pre-heating battery with liquid circulation for floor heating, which can be used to prevent cooling of the heat recovery device.

4.1.3
Heat recovery from exhaust air may be abandoned for an individual area of the building without a corresponding reduction in energy consumption if the construction of heat recovery is reported to be inappropriate.

4.1.3.1
For example, the construction of heat recovery may be reported to be inappropriate when the exceptional dirtiness of the exhaust air prevents heat recovery from working.

5

ENSURING WORKING ORDER AND THE INTRODUCTION OF VENTILATION SYSTEMS

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

Explanation
Part A1 of the National Building Code of Finland sets out regulations and guidelines on the inspection documents for construction work.

5.1.1.1
Normally, the air-tightness of the whole ventilation system is measured. The air-tightness is measured using the air-tightness test in accordance with standard SFS 3542.

5.1.1.2
If the ductwork system comprises of ducts and ductwork components that are tested and inspected as at least air-tightness class C, the air-tightness may be measured using random tests. The scope of the random tests shall be 20% of the surface area of the ducts. If the air-tightness class of the ductwork and ductwork components is better than class C, the scope of the random tests shall be 10% of the surface area of the ductwork.

If the ductwork system comprises of ducts and ductwork components that have an air-tightness lower than class C, the random tests shall be increased by their surface area. If the surface area of these ducts or ductwork components is more than 25% of the total surface area of the ductwork, all the ducts shall be measured. The surface area of these parts is calculated so that the surface area of the joints is the circumference of the cross section multiplied by 2 metres. For example, a ‘T’ piece has three joints while duct connections have two.

5.1.1.3
In ventilation systems that serve one area or one home, the air-tightness test may be corrected during the fitting inspection if the entire ductwork system comprises ducts and ductwork components that are tested and inspected as at least air-tightness class C.

5.1.1.4
The air-tightness of all ductwork must be measured if air containing poisonous or corrosive gases or any air that is otherwise harmful to health is conveyed through the ductwork.

5.1.1.5
If a ventilation machine that is tested and monitored as air-tightness class A or better is delivered as a whole entity or as pieces so that no more than two connections are made on the incoming air side and/or two joints on the exhaust air side during the project, the project need not include an air-tightness test. An air-tightness test is performed as a random test for other ventilation machines that are tested and monitored as air-tightness class A or better. The scope of the tests shall be 20% of the ventilation machines, but at least one ventilation machine.

5.1.2
The cleanliness of the ventilation system must be inspected and, where necessary, the system must be cleaned before air flows are measured and regulated.

The air-flow rates of the ventilation system must be measured and regulated, the specific electrical power must be measured and the functioning and cleanliness of the system must be verified according to the specifications prior to the commissioning of the building. The reports on these must be attached to the building work inspection documents.

5.1.2.1
Operation of the electrical equipment of the ventilation system is tested using final electrical con-

nections with all the fuses attached.

5.1.2.2
The operational tests are carried out before the air flows are measured and regulated. Before the tests start, it is checked that the building and ventilation system are not so incomplete that it would affect the air flows, pressure or direction of flow for transferred air. It is therefore checked that the building is sufficiently clean, that no more dust-generating construction work is being done in the areas, that the filters of the ventilation system have been installed and that the doors and windows are in place. At least a visual inspection of whether the building and its ventilation system are sufficiently clean is confirmed in the building work inspection documents.

5.1.2.3
The basic regulation of the air flows is done using an air flow that does not intensify the usage time, according to the most common usage scenario. The control devices are fitted in usage scenarios corresponding to the average conditions for the different seasons. Smoke tests or measurements of the air flow and differential pressure are used to state whether the pressures are consistent with the design.

5.1.2.4
The performance of the ventilation system's flow, acoustic, electrical and heating technology is measured using at least a model air flow that does not intensify the system usage time and also using an enhanced model air flow in homes. The acceptable deviations from the model values are normally as follows:

1) air-flow rate per system	± 10%;
2) air-flow rate per room	± 20%;
3) air speed in the area where people are present	+ 0.05 m/s;
4) electrical efficiency	+ 10%; and
5) heating efficiency	-10%.

These permissible tolerances take into account both deviations from the results of the measurements and of measurement uncertainty.

5.1.2.5
The measurements and measurement values are converted so as to correspond to the model values, according to the standards in force. Devices with valid calibration, and methods of which the uncertainty of measurement is normally no more than half of the acceptable deviations listed in section 5.1.2.4, are used when taking the measurements.

ANNEX 1

Guideline values for air-flow rates, air circulation and sound levels

Tables 1-11 set out guideline values for designing the ventilation usage time. The outside air flow is primarily defined on the basis of the number of people. If there are insufficient grounds for designing the air flows according to the human load, the designing is done on the basis of the surface area. When designing the air ducts, any air flows that intensify the usage time must be taken into account.

Outside air flows are defined in order to maintain the quality of indoor air when low-carbon materials are used as building materials and fittings. Restricting the fall in content or room temperature caused by internal and external impurities or heat using ventilation requires air flows that are greater than those set out in the table.

Appropriate ventilation controls must normally be implemented at least in the areas for which the human or impurity loads vary significantly.

Part C1 of the National Building Code of Finland provides regulations and guidelines on the greatest permitted sound levels inside and outside buildings that are caused by LVIS devices and other comparable equipment. The sound levels in part C1 of the National Building Code of Finland are set out in the tables in this Annex in bold type. These sound levels are values that are consistent with the regulations in part C1 with regard to homes and kitchens and consistent with the guidelines in part C1 with regard to hospital wards, children's nurseries, teaching areas and offices.

The guideline values for sound levels in a room are a frequency-weighted average sound level of $L_{A,eq,T}$ (dB) and a maximum sound level of $L_{A,max}$ (dB), caused by LVIS devices and other comparable equipment in a building. When applying the guideline values, the joint effect of ventilation and other sources of sound must be taken into account. If there is sound in the area from more than one source, the level of sound created separately by each source should be so low that the sound level that they cause together does not exceed the permitted sound level. The effect of many sources of sound on the total sound level in the room is taken into account by adding up the total sound level caused in the room by devices, using the following equation:

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

where L_{Atot} is the total sound level caused by devices and $L_{A1}…L_{An}$ is the sound level caused separately by each device.

The values for air speed in Tables 1-11 that describe the air circulation in the area where people are present correspond to the room temperatures defined in section 2.2. Air speed that causes discomfort in the air temperatures of different rooms may also be assessed using the draught curves in Image 1. The higher the room temperature, the higher the air speed may be without reducing comfortableness. The average values of the curves can be estimated.

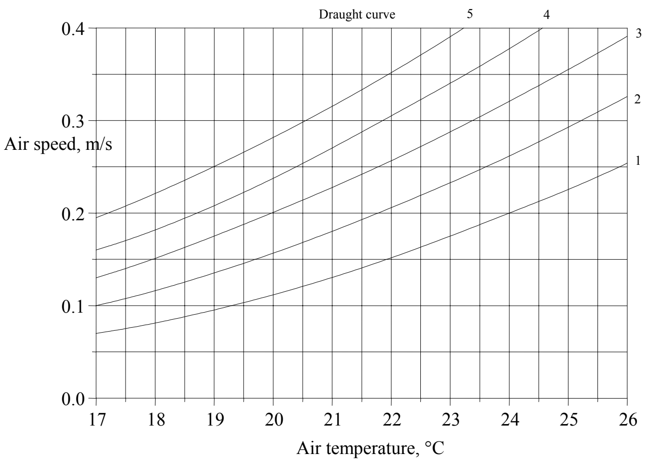


Image 1. The draught curves show the dependency of air circulation on air temperature that causes discomfort.

If the intensity of the ventilation or recirculated air devices can be controlled at a level that is greater than the guideline values per person during the operating time, the guideline values for air speed in the tables during the period of intensity may exceed + 0.1 m/s and the guideline values for the sound level may exceed ($L_{A,eq,T}$ and $L_{A,max}$) + 10 dB.

Table 1. Residential buildings

Ventilation in homes is normally designed on the basis of the exhaust air flows in the table so that the ventilation factor for homes is at least 0.5 1/h and the adequacy of outside air flows is guaranteed to be at least at the guideline values. Exhaust air flows for small homes are normally designed to be smaller than the guideline values so that the ventilation factor while the home is used is no more than 0.7 1/h and the intensity of the exhaust air flow can be controlled for each area or home where needed. If the intensity of the exhaust air flow can only be controlled for each building, the exhaust air flows for small homes may be designed to be smaller than the guideline values so that the ventilation factor for the home is at least 1.0. The exhaust air flows for large homes are normally designed to be bigger than the guideline values so that the outside air flow for each area would be consistent with the guideline value and the ventilation factor for the home would be at least 0.5 1/h.

Area / intended use	Outside air flow (dm^3/s)/person	Outside air flow $(dm^3/s)/m^2$	Exhaust air flow dm^3/s	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter m/s	N.B.
Homes:	6					
Rooms in homes		0.5		**28 / 33 ***	0.20	*C1 regula-tion
Kitchen		#S	8 #A	**33 / 38 ***	0.20	*C1 regula-tion
- efficiency of operating time		#S	25	33 / 38	0.20	
Walk-in wardrobe, storage area		#S	3	33 / 38		
Bathroom		#S	10 #B	38 / 43	0.20	
- efficiency of operating time		#S	15	38 / 43	0.20	
Toilet		#S	7 #B	33 / 38		
- efficiency of operating time		#S	10	33 / 38		
Utility room		#S	8	33 / 38	0.30	
- efficiency of operating time		#S	15	33 / 38	0.30	
Home sauna		2 #C	$2/m^2$ #C	33 / 38		
General areas:						
Staircase		0.5 1/h	0.5 1/h	38 / 43		
Storage areas		0.35	$0.35 /m^2$	43 / 48		
Cold cellar (also home cold store, if surface area > 4 m^2)		0.2	$0.2 / m^2$	43 / 48		
Dressing room		2	$2 / m^2$	33 / 38	0.20	
Laundry room		3	$3 / m^2$	43 / 48	0.20	
Steam room for sauna		2	$2 / m^2$	33 / 38		
Home laundry		1	$1 / m^2$	43 / 48		
Airing 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 air flow efficiency of the cooker hood can be controlled for each room or home, but in other cases the guideline value for the cooker hood is 20 dm^3/s.
B Guideline value when the air flow efficiency can be controlled for each room or home, but in other cases the guideline value for the air flow is in accordance with the efficiency of the operating time.
C However, at least 6 dm^3/s. The air flow to the sauna is not taken into account when calculating the ventilation factor for the home, if the sauna's outside air flow is as great as the exhaust air flow.
D May be designed to be smaller when an air dryer is used.
E Requires an opportunity for ventilation; otherwise 1.5 $(dm^3/s)/m^2$.
S Outside air flow is normally compensated for by channelling transferred air flow from rooms in the home.

Table 2. Office buildings #1

Area / intended use	Outside air flow (dm^3/s)/person	Outside air flow (dm^3/s)/m^2	Exhaust air flow (dm^3/s)/m^2	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter / summer m/s	N.B.
Offices and similar areas		1.5		**33 / 38 ***	0.20 / 0.30	*C1 guide-line
Meeting room	8	4		33 / 38	0.20 / 0.30	#3
Customer area		2		38 / 43	0.30 / 0.40	#2,
Corridor areas		0.5		38 / 43	0.30	#2,
Cafeteria, break area		5	0.35	38 / 43	0.25	
Archive, store room						
Smoking area:			20			
– while the building is in use				38 / 43	0.30	#4
– while the building is not in use			10			#4
			4			
Copying room		1				

#1 For exhaust air flows in hygiene areas, please see Table 11 Hygiene Areas.
#2 The guideline values for air speed at fixed work points are the same as for offices.
#3 If the building has three or more meeting rooms, it must be possible to control their ventilation where needed.
#4 The smoking area must always be a vacuum in relation to surrounding areas.

Table 3. Educational establishments #1

Area / intended use	Outside air flow (dm^3/s)/person	Outside air flow (dm^3/s)/m^2	Exhaust air flow (dm^3/s)/m^2	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter / summer m/s	N.B.
Teaching areas	6	3		**33 / 38 ***	0.20 / 0.30	#4, *C1 guideline
Corridors / Halls		4		38 / 43		#2
Gym:					0.30	#3
– gym use		2		38 / 43	0.25	
– function room use	8	6		33 / 38	0.20 / 0.30	
Library	8	6		33 / 38	0.20 / 0.30	#4
Group work area	6	4		33 / 38	0.25	#4
Cafeteria		5	0.35	33 / 38		
Storage areas						#S

#1 For exhaust air flows in hygiene areas, please see Table 11 Hygiene Areas.
#2 The guideline values for air speed at fixed work points are the same as for offices.
#3 The indoor climate and ventilation are designed according to the most demanding use, and it must be possible to control them where needed for different usage scenarios.
#4 It must be possible to control the ventilation for the area where needed.
#S Transferred air may be used.

Table 4. Restaurants, workplace cafeterias and hotels #1

Area / intended use	Outside air flow (dm³/s)/person	Outside air flow (dm³/s)/m²	Exhaust air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter / summer m/s	N.B.
Restaurants	10	10		38 / 43	0.20	#2, #T
Workplace cafeterias and dining areas	6	6		38 / 43	0.20	#2
Hotel rooms	10	1		28 / 33	0.20	#2
Corridors		0.5		33 / 38	0.25	#2
Halls		2		33 / 38	0.20	
Meeting areas	8	4		33 / 38	0.20	#3
Restaurant smoking area						#4
- while restaurant is in use			30			
- while restaurant is not in use			10			

#1 For exhaust air flows in hygiene areas, please see Table 11 Hygiene Areas.
#2 The guideline values for air speed at fixed work points are the same as for offices.
#3 Smoking areas in restaurants and other catering establishments and ventilation for these are regulated by the Act on Measures to Reduce Tobacco Smoking (693/1976), as it is in Act 700/2006, the Finnish Council of State 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 Areas in Restaurants and Other Catering Establishments (964/2006).
#4 However, at least 180 dm³/s per square metre of door opening.
#T It must be possible to control restaurant ventilation where needed.

Table 5. Shops and theatres #1

Area / intended use	Outside air flow (dm³/s)/person	Outside air flow (dm³/s)/m²	Exhaust air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter / summer m/s	N.B.
Shop		2		43 / 48	0.25	#2, #T
Theatre auditorium	8			28 / 33	0.20	#T
Theatre stage		3		28 / 33	0.25	#2
Hall, foyer		5		38 / 43	0.25	#T
Concert hall	8			25 / 30	0.20	#T
Cinema	8			33 / 38	0.20	#T

#1 For exhaust air flows in hygiene areas, please see Table 11 Hygiene Areas.
#2 The guideline values for air speed at fixed work points are the same as for offices.
#T It must be possible to control the ventilation where needed.

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

Area / intended use	Outside air flow (dm³/s)/person	Outside air flow (dm³/s)/m²	Exhaust air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter / summer m/s	N.B.
Sports centres:						#T
– Fitness centre		6		38 / 43	0.25	
– Gym		4		38 / 43	0.25	
– Sports hall		2		38 / 43	0.25	
– Spectators' gallery	8			33 / 38	0.25	
Corridors/halls where people are present		5		38 / 43	0.30	#2
Corridors where people are not present		1		38 / 43	0.30	
Swimming pool area		2		38 / 43	0.40	#K
Barrack areas:	8					
Personnel areas	6	2		33 / 38	0.20	
Mess room		5	5	33 / 38	0.25	
Laundry room				38 / 43	0.30	#S
Corridors		1		38 / 43	0.25	
Areas where people are present	6	3		33 / 38	0.20	
Training areas		3		33 / 38	0.20	

#1 For exhaust air flows in hygiene areas, please see Table 11 Hygiene Areas.
#2 The guideline values for air speed at fixed work points are the same as for offices.
#T It must be possible to control the ventilation where needed.
#K The removal of moisture is a design factor. It is calculated on a case-by-case basis.
#S As transferred air flow.

Table 7. Care institutions #1

Area / intended use	Outside air flow (dm³/s)/person	Outside air flow (dm³/s)/m²	Exhaust air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter / summer m/s	N.B.
Hospital ward	10	1.5		**28 / 33 ***	0.20 / 0.30	*C1 guideline
Hospital treatment room		2		33 / 38	0.20 / 0.30	#E
Hospital rehabilitation room		2		33 / 38	0.20 / 0.30	
Hospital leisure area		3		33 / 38	0.20	
Children's nursery areas		2		33 / 38	0.20 / 0.30	
Care areas for long-term patients		2		33 / 38	0.20 / 0.30	#3
Corridors		0.5		33 / 38	0.20 / 0.30	#2
Waiting areas		3		33 / 38	0.20 / 0.30	#2
Toilets for patients and waiting areas			30 / place	38 / 43	0.20	
Sluicing room			10	38 / 43	0.20	#3
Custody reception area		3	1	33 / 38	0.20	#4
Prison corridors		3		38 / 43	0.20	
Alcoholic cell		8	10	33 / 38	0.20	#S
Cell corridors		2		38 / 43	0.30	
Cell	8	2.5	3	33 / 38	0.20	#S
Day homes:						
Nurseries	6	2.5		**28 / 33 ***	0.20 / 0.30	*C1 guideline
Games and group rooms	6	2.5		33 / 38	0.20 / 0.30	
Room for water games		2		33 / 38	0.20 / 0.30	
Vestibule		2		33 / 38	0.20	
Wet room			5			#3, #S

#1 For exhaust air flows in hygiene areas, please see Table 11 Hygiene Areas.
#2 The guideline values for air speed at fixed work points are the same as for offices.
#3 Exhaust air flow and similarly outside air flow are increased by the amount required for controlling localised ventilation and/or smells.
#4 Exhaust air through surrounding hygiene and other areas.
#E Ventilation for special areas, such as operating theatres, treatment rooms, X-ray areas, equipment servicing areas, areas used for washing patients, etc. are designed on a case-by-case basis.
#S Transferred air flow

Table 8. Other public areas #1

Area / intended use	Outside air flow (dm³/s)/person	Outside air flow (dm³/s)/m²	Exhaust air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter / summer m/s	N.B.
Transport hubs:						
Waiting areas and corridors		5		43 / 48		#2
Areas used for exhibitions:						
- Exhibition areas		4		33 / 38	0.20/0.40	#2, #T
- Museums		4		33 / 38	0.20 / 0.40	#2, #T
- Places of worship		4		38 / 43	0.20 / 0.40	#2, #T
Libraries:						
– Library room	8	2		33 / 38	0.20 / 0.40	#2
– Reading room	8	2		33 / 38	0.20 / 0.30	
– Store room			0.5			#S
Churches:						
– Church hall	6			33 / 38	0.20	#T
– Other public areas		5		33 / 38	0.20	#T

#1 For exhaust air flows in hygiene areas, please see Table 11 Hygiene Areas.
#2 The guideline values for air speed at fixed work points are the same as for offices.
#S Transferred air flow.
#T It must be possible to use the ventilation appropriately.

Table 9. Work areas, inc. #1, #2 *and* #3

Area / intended use	Outside air flow (dm³/s)/person	Outside air flow (dm³/s)/m²	Exhaust air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter / summer m/s	N.B.
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
Car workshops, inspection areas		7, #5	3	43 / 48	0.25	

#1 For exhaust air flows in hygiene areas, please see Table 11 Hygiene Areas.
#2 The guidelines for offices apply to office areas belonging to the building.
#3 Exhaust air flow and similarly outside air flow are increased by the amount required for controlling localised ventilation and/or impurities.
#4 The ventilation plant is designed for at least the relevant air flow. The plant may be used with a smaller air flow than is normal for work, including on the basis of any reports made of impurities being emitted and heat stress. The air speeds are examples. The nature of the work will dictate the temperature level and the air speed on a case-by-case basis.
#5 Requires the removal of local exhaust gas, the size of which is at least 100 dm^3/s for private cars and 300 dm^3/s for vans. If a bar is used to remove exhaust gas, to which vehicles are attached all the time, the air flow may be 2 $(dm^3/s)/m^2$. The exhaust air flow is designed taking into account the removal of exhaust gas, so that the area is not a vacuum; see also standard SFS 3352.
#E Designed on a case-by-case basis.
#T It must be possible to use the ventilation appropriately.

Table 10. Food preparation and storage areas

Area / intended use	Outside air flow (dm³/s)/person	Outside air flow (dm³/s)/m²	Exhaust air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter / summer m/s	N.B.
Kitchen areas:						
– Preparation kitchen		15	15	38 / 43	0.25 / 0.50	#E
– Hot kitchen		10	10	38 / 43	0.25 / 0.50	#E
– Catering kitchen		5	5	38 / 43	0.25 / 0.50	#E
– Drink preparation area		3	30 1/s/kitchen	33 / 38	0.20 / 0.40	
Storage areas:						
– Dry storage			0.5			#S
– Cold stores >4 m²			0.2			#S
– Waste room			5			#1
– Cooled waste room			2			#1

#1 The area must always be a vacuum in relation to other areas.
#E Minimum air flows. The air flows are designed on a case-by-case basis and on the basis of heat stresses.
#S Transferred air flow.

Table 11. Hygiene areas other than in homes, and other areas

Area / intended use	Outside air flow (dm³/s)/person	Outside air flow (dm³/s)/m²	Exhaust air flow (dm³/s)/m²	Sound level $L_{A,eq,T}$ / $L_{A,max}$ dB	Air speed winter / summer m/s	N.B.
Toilets						
– for workplaces or similar			20 / place	38 / 43		#S
– for places visited by the public						
			30 / place	38 / 43		#S
Laundry room						
Dressing room						
Steam room for sauna		3	5,	38 / 43	0.20	#S
		5	4/wardrobe	38 / 43	0.20	#S
		1	2	38 / 43		#S
Cleaning areas						
Staircase			4			#S
Lift shaft		0.5 1/h	0,5 1/h	38 / 43		#1
Lift machinery room						
	4		8			
			17			#2

#1 Ventilation factor.
#2 To be inspected on the basis of the heat stress. The maximum temperature for the machinery room is 35°C.
#S Transferred air flow.

ANNEX 2

Guidelines for the ventilation of garages

These guidelines mainly apply to garages intended for parking motor vehicles. If the garages have servicing and repair areas, loading bays, coach terminals or other areas where work is done continuously, these guidelines need not be applied directly.

Ventilation in garages for motor vehicles is arranged so that impurities in the air do not cause any harm to the health of those who visit the garage. If there is a possibility that a line of cars will form, e.g. owing to parking fees or traffic systems, the ventilation for these areas is made more efficient by positioning additional extractors at the points where traffic jams occur. Reinforced extraction can therefore be controlled according to the impurity content (for example CO content). If there are workplaces in or at the garages, ventilation is arranged according to the requirements of the workplace.

If the garage for motor vehicles is together with another building, its ventilation is arranged so that the garage is a vacuum in relation to the other areas.

Incoming air for garages for motor vehicles may be transferred air.

Openings for incoming and exhaust air are positioned so that adequate ventilation is ensured for the different parts of the garage. The openings are positioned so that no air is spread unnecessarily from areas where there is high impurity content. Also, no points should remain in the garage where the concentration of impurities in the air could locally exceed the permitted values. In order to prevent this, local extraction or air-transfer fans, for example, may be used.

The exhaust air-flow rates for mechanical ventilation are as follows:
- for areas where there is an average of one car during the peak time in an 8-hour period, at least 0.9 $(dm^3/s)/m^2$. These include, for example, parking areas for homes;
- for areas where the same number is 2-4, at least 2.7 $(dm^3/s)/m^2$. These include, for example, parking areas for office staff; and
- for areas where the same number is greater, the exhaust air flow must be at least n x 0.9 $(dm^3/s)/m^2$. In the equation, n is the number of vehicles, which must be at least 4. These include, for example, real car parks and customer parking areas for offices and commercial buildings.

Natural ventilation may be used for row garages and garages for motor vehicles that are no more than 60 m^2. A row garage is a garage for a motor vehicle that cannot be driven in and the depth of which is no more than 7 m, or 14 m when the garage is intended for coaches or other long vehicles. The garage should be completely at ground level or similarly for ventilation, for example, on a slope. Openings for incoming and exhaust air are positioned so that adequate ventilation and air circulation are achieved. An opening for incoming air may be positioned on the lower part of the external wall or the door. The opening for exhaust air is normally positioned on the upper part of the wall or on the side of the roof opposite the opening for incoming air. The free transverse surface of the openings for both incoming air and exhaust air is at least 0.1% of the floor surface area, but at least 150 cm^2.

If at least 30% of the external wall of an unheated garage for motor vehicles, e.g. a car park, is open and the surface area of the openings is at least 10% of the floor surface area for each level, the garage will not require separate ventilation. However, the area must not contain any barriers that significantly impede the passage of air, such as dividing walls or beams.

Ventilation for garages for motor vehicles may be reduced outside the normal operating time, when the ventilation is controlled according to the impurity content and a separate alarm system is fitted to the garage. The ventilation starts up at full power when the impurity content at one sensor exceeds the limit value laid down (for example, CO content of 50 ppm). The alarm goes off when the impurity content exceeds the limit value laid down (for example, CO content of 70 ppm). At least 3 control and alarm sensors are fitted to each level of the garage, normally close to the driving ramps and routes. The functioning of the sensors must be checked regularly and they must be calibrated at least twice a year. The calibration certificate is attached to the guidelines for the use and maintenance of the building.

Helpful information

NATIONAL BUILDING CODE OF FINLAND
With information for the situation at 1/1/2010 as it stands on the date of issue of this Decree, x/x/2008
(up-to-date list of contents at www.ymparisto.fi)

A	GENERAL SECTION		
A1	Supervision of construction work	Regulations and guidelines	2006
A2	Building designers and plans	Regulations and guidelines	2002
A4	Maintenance manual for the care and use of buildings	Regulations and guidelines	2000
A5	Plan notations	Regulations	2000
B	THE STRENGTH OF STRUCTURES		
B1	Structural safety and loads	Regulations	1998
B2	Loadbearing structures	Regulations	1990
B3	Foundations	Regulations and guidelines	2004
B4	Concrete structures	Guidelines	2005
B5	Structures of lightweight concrete blocks	Guidelines	2007
B6	Light gauge steel structures	Guidelines	1989
B7	Steel structures	Guidelines	1996
B8	Brick structures	Guidelines	2007
B9	Structures of concrete blocks	Guidelines	1993
B10	Timber structures	Guidelines	2001
*	National Application Documents (NAD) to the Eurocode Prestandards		
C	INSULATION		
C1	Sound insulation and noise abatement in building	Regulations and guidelines	1998
C2	Moisture	Regulations and guidelines	1998
C3	Thermal insulation in a building	Regulations	2010
C4	Thermal insulation	Guidelines	2003
D	HEPAC AND ENERGY MANAGEMENT		
D1	Water supply and drainage installations for buildings	Regulations and guidelines	2007
D2	Indoor climate and ventilation of buildings	Regulations and guidelines	2010
D3	Energy management in buildings	Regulations and guidelines	2010
D4	HEPAC drawings	Guidelines	1978
D5	Calculation of power and energy needs for heating of buildings	Guidelines	2007
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 warehouse buildings	Guidelines	2005
E3	Small chimneys	Regulations and guidelines	2007
E4	Fire safety of garages	Guidelines	2005
E7	Fire safety of ventilation installations	Guidelines	2004
E8	Masonry fireplaces	Guidelines	1985
E9	Fire safety of boiler rooms and fuel stores	Guidelines	2005
F	GENERAL BUILDING PLANNING		
F1	Barrier-free building	Regulations and guidelines	2005
F2	Safety in use buildings	Regulations and guidelines	2001
G	HOUSING PLANNING AND BUILDING		
G1	Housing design	Regulations and guidelines	2005
G2	Subsidized housing	Regulations and guidelines	1998

MEASURING METHODS

Thermal conditions

SFS 5511 Air conditioning. Indoor climate in buildings. Field measurements of thermal parameters. 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.

OEL values 2000, Ministry of Social Affairs and Health, Labour Protection Provisions 3, Tampere 2000.

Residential Health Guide, Ministry of Social Affairs and Health guides 2003:1, Ministry of Social Affairs and Health, Helsinki 2003

Ministry of Social Affairs and Health Residential Health Guide (MSAH guides 2003:1) application guide, Vammala 2005

Arvela H., Methods for compensating for radon in homes (STUK-A-127), Helsinki 1995

Radon prevention in homes and flats. Planning ground-based structures. Guide 2, 1993, Ministry of the Environment, Helsinki 1994

Air flows

SFS 5512 Air conditioning. Measurements of air flows and pressure conditions in air conditioning systems. 1989

Air-tightness

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