D 2

NATIONAL BUILDING CODE OF FINLAND

Indoor climate and ventilation in buildings

Regulations and guidelines 1987

The Ministry of the Environment

These regulations are binding. According to Section 132 of the Building Act, the Ministry of the Interior, in the case of and towns, and the County Government, in the case of rural minicipalities, have, however, the authority to grant exemption from ordinances, regulations, bans and other restrictions concerning building, on the conditions stated in said Section. A local building committee exercises the same authority with respect to a minor variation.

The guidelines present acceptable applications. Other solutions may, however, be applied in building, provided that a building authority deems them to be inconformance with the requirements of the ordinances and regulations.

Ministry of the Environment
National Building Code of Finland D 2

INDOOR CLIMATE AND VENTILATION OF BUILDINGS

Regulations and guidelines 1987

These regulations and guidelines constitute a part of the National Building Code of Finland as prescribed in resolution (867/75) by the Ministry of the Interior. These regulations and guidelines replace the regulations and guidelines on building ventilation (D2) given on the 27th day of October, 1978.

The new regulations and guidelines shall come into effect on the 1st day of January, 1988, and they shall apply to all building for which permit has been applied on or after that date. Previous regulations and guidelines may, however, be applied to building for which permit is be applied before the 1st day of July, 1988.

Helsinki, February 18th, 1987

Minister of the Environment Matti Ahde

Head of Department, Director Sirkka Hautojärvi

CONTENTS

1 General

1.1 Scope of application

Section D2 of this building code includes regulations (CAPITALIZED) and guidelines (lower case letters, indented). The regulations are binding. The guidelines present examples for applying the regulations. Other applications may be used provided that they fulfill the requirements of the regulations.

The regulations and guidelines herein concern the arrangement of satisfactory ventilation in new building construction. In building renovation and repair work, also the application clauses of Section A1 "General requirements" of the National Building Code of Finland (NBCF) must be observed.

1.2 Definitions

Ventilation

Ventilation generally means maintaining and improving indoor air quality by means of changing indoor air.

Air conditioning

Air conditioning means controlling the purity, temperature, humidity and movement of indoor air by means of treating the supply air or recirculated air.

Mechanical ventilation

In mechanical ventilation, the air movement is implemented mechanically, for example, by means of a fan.

Natural ventilation

The air movement in natural ventilation is based on the temperature difference between the indoor and outdoor air, and the effect of wind.

Venting

Venting refers to changing of indoor air through a window, door, etc., which opens directly outdoors.

Air flow terms

1. Outdoor air
2. Supply air
3. Transfer air
4. Return air
5. Recirculated air
6. Exhaust air
7. Circulated air
8. Indoor air

Air change rate

The air change rate is calculated by dividing the amount of air supplied to or removed from a confined space in an hour, by the volume of this space.

Occupied zone

The occupied zone normally refers to that part of a room space which is limited below by the floor, above by a plane at a distance of 1.8 m from the floor, and at the sides, by planes at a distance of 0.6 m from walls or similar fixed parts of the building. If the ventilation arrangement is not based on the room dimensions but on other factors, the occupied zone may be defined according to the arrangement of working areas and equipment, as in industrial spaces.

Air duct

An air duct is a building component intended for conveying ventilation air.

Shaft

A shaft is a compartment, usually vertical, for accommodating air ducts, pipes and conductors.

2 Indoor climate

2.1 Contributing factors

2.1.1 A SATISFACTORY INDOOR CLIMATE MUST BE ENSURED IN ALL OCCUPIED ZONES, UNDER ALL NORMAL WEATHER CONDITIONS AND CIRCUMSTANCES OF ACTIVITY IN EACH SPACE CONCERNED. A SATISFACTORY INDOOR CLIMATE AS REFERRED TO HEREIN MEANS THAT THE PURITY, TEMPERATURE AND HUMIDITY OF THE INDOOR AIR MUST BE UNDER CONTROL. MOREOVER, DRAFT, NOISE AND RADIANT HEAT TO A HARMFUL EXTENT MUST NOT OCCUR IN OCCUPIED ZONES.

2.1.1.1 Guide values for the main contributing factors of indoor climate are given in Appendix 1 and Figure 1. Guide values are further given in Articles 2.2.1.2, 2.3.1.1, 2.3.1.2 and 2.3.1.4.

2.1.1.2 Besides air conditioning and ventilation, other factors having an effect on the indoor climate are:

- building location
- building properties, such as insulation, air sealing and windows

- heating system of building
- internal load factors, such as heat loads, occupancy and processes, and building and interior decorating materials
- external load factors, such as weather conditions, outdoor air quality, and other environmental factors

To ensure a satisfactory indoor climate, structural means are used, internal load factors are reduced, effects of internal and external load factors are restricted and ventilation technology is employed.

2.2 Thermal conditions

2.2.1 THE TEMPERATURE IN THE OCCUPIED ZONE OF A SPACE MUST BE CONTROLLED SO AS NOT TO SIGNIFICANTLY REDUCE HUMAN COMFORT NOR WORKING PERFORMANCE, NOR TO WASTE ENERGY.

2.2.1.1 The guide values for occupied zone temperatures in the heating season are given in Appendix 1. For a justified reason, the design temperature may be selected higher than the guide value.

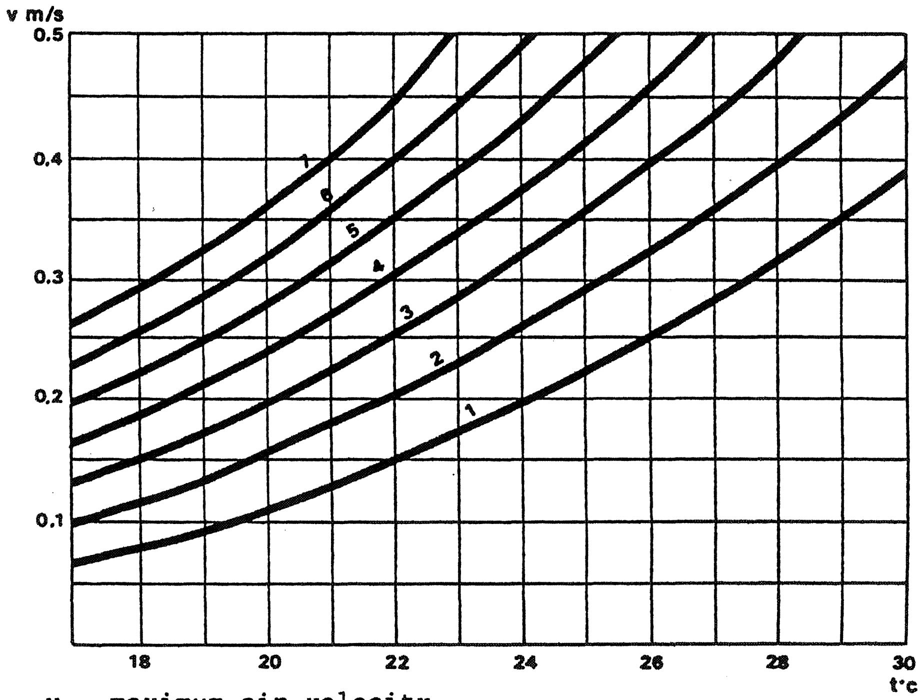
In operation it is permitted to fall short of the guide values when the temperature outdoors falls below the design temperature of that locality as given in Section D5 "Calculation of performance and energy requirement for heating of buildings" of the National Building Code of Finland. Outside operating time, the possibility of lowering the temperature shall be investigated case by case.

To avoid needless energy consumption, the given values may be exceeded during the heating season for grave reasons only, when the energy is produced with heating equipment.

2.2.1.2 When the building is in use, the temperature of the occupied zone must generally not exceed +27 oC. When the temperature outdoors rises over +22 oC, the indoor air temperature may exceed the outdoor air temperature five-hour maximum period average by 5 oC. In residential buildings, deviations from these values are permitted.

2.2.2 DISTURBING DRAFT OR OTHER THERMAL FACTORS MARKEDLY REDUCING COMFORT OR WORKING PERFORMANCE MUST NOT OCCUR IN AN OCCUPIED ZONE IN A BUILDING.

2.2.2.1 Figure 1 shows maximum permitted air velocities in occupied zones of building spaces of continuous occupancy. Selection instructions for draft characteristics for various spaces are given in Appendix 1.



v = maximum air velocity

t = air temperature at velocity measuring point

Fig. 1

Draft characteristics for determining maximum air velocities

2.2.2.2 If exceptional temperature factors, such as intensive thermal radiation or high or low surface temperatures, occur in a space, the effective temperature, for which guide values are given in Appendix 1, are checked by means of calculations or, when required, by measurements.

The effective temperature describes the effect of surface temperatures different from the indoor temperature, on the sensation of heat of the human body. It may often be determined with sufficient accuracy as an average of the indoor air temperature and the average radiation temperature.

The effective temperature is defined as the temperature of such a test room where the loss of sensible heat from the surface of a human body, by radiation and convection, equals that in the actual room studied. The interior surfaces of the test room are black and their temperature is the same as that of the test indoor air.

2.2.2.3 The effective temperature is checked, for example, in rooms with an unheated air space below, or in rooms with exceptionally large windows. If the effective temperature in any one room is not acceptable, the temperature of the entire building is not to be changed but the effective temperature of the room is influenced upon, for instance, by means of the following separate arrangements:

- details of building design, such as location of the windows, dimensioning, sunshades, etc.
- local heating and air currents

2.3 Indoor air purity

2.3.1 THE INDOOR AIR MUST NOT CONTAIN GASEOUS OR PARTICULATE IMPURITIES IN HARMFUL AMOUNTS, NOR MICRO-ORGANISMS.

2.3.1.1 The content of impurities in indoor air of non-exceptional spaces shall be maintained below the values given in the following authority resolutions or subsequent resolutions issued to replace or amend the former:

Guide values for outdoor air according to Resolution No. 537/84 by the Council of State

		annual ave.	daily ave.	hourly ave.
Sulfur dioxide	µg/m3	40	200	500
Nitrogen dioxide	µg/m3		150	300
Carbon monoxide	mg/m3		10 1)	30
Particles	µg/m3	60	150	

1) 8 hours

Circular DNo 5674/02/81 by the National Board of Health

Formaldehyde	new buildings	0.15 mg/m3
	(existing buildings	0.30 mg/m3)

Circular No. 2/1986 (DNo 5740/02/85) by the National Board of Health

Maximum radon content	the objective in new building design is to limit the radon to 200 Bq/m3; maximum content in all buildings is 800 Bq/m3

The carbon dioxide content must be less than 2500 ppm. This includes the metabolical carbon dioxide, which must not exceed 1500 ppm. If the outdoor air flows are controlled based on the carbon dioxide content of the indoor air, a maximum setpoint of 800 ppm (cm3/m3) may be used.

2.3.1.2 The content of other impurities in non-exceptional spaces shall not exceed 1/10 of the content known harmful in working area air, according to Safety bulletin No. 3 of the National Board of Labour Protection, when the effect of a single substance governs. If the air contains several substances known harmful but whose combined effect is unknown, an acceptable concentration is deemed to be exceeded when

$$\Sigma_i \frac{Ci}{HTPi} > 0.1$$

where

Ci is the content of one substance
HTPi, the content known harmful, of that substance.

2.3.1.3 If the spaces are occupied temporarily, above concentrations may be exceeded provided that it meets the approval of the occupational safety or health authorities in each individual case.

2.3.1.4 In working areas where considerable sources of air impurities exist, e.g., ones originating in working processes, the concentrations given in Articles 2.3.1.1 and 2.3.1.2 may be exceeded if the authorities approve the actions taken for the event of exposure of workers. Such concentrations must, however, be maintained below those values given in the following authority resolutions or subsequent resolutions issued to replace or amend the former:

Asbestos	According to Resolution No. 290/86 by the Council of State, the number of fibers over 5 µm in length are not to exceed 1/cm3; from the beginning of the year 1989, 0.5/cm3
Benzene	According to Resolution No. 355/82 by the Council of State, an 8-hour average benzene content in working space air must not exceed 16 mg/m3 and, a 15 minute average, 48 mg/m3

Lead	According to Resolution No. 356/82 by the Council of State, an 8-hour average lead content in working space air must not exceed 0.1 mg/m3
Radioactive substances	Values according to the resolution concerning protection from radiation, by the Ministry of Social Affairs and Health (594/68)
Other substances	Concentrations known harmful according to Safety Bulletin No. 3 by the National Board of Labour Protection

If a ventilation system is dimensioned based on the concentrations of impurities, the values given in Article 2.3.1.2 may be used for design values also for such spaces. If the amounts of impurities becoming entrained in the air, and their variations with respect to time as well as to locality are accurately known and if the ventilation system can be designed for very high performance, concentrations which are not to exceed 1/3 of the concentrations listed above may be used for design values.

2.3.1.5 If the concentrations of impurities in outdoor air are distinctly lower than the guide values given in Resolution No. 537/84 by the Council of State, the indoor air quality in non-exceptional spaces usually meets the requirements as set forth in Articles 2.3.1.1 and 2.3.1.2 if the ventilation has been arranged to conform with Articles 3.2.1.1 and 3.2.1.3 or better and particular pollution sources have been equipped with local exhaust equipment thus preventing the impurities from spreading elsewhere in the room.

2.3.1.6 The county government authorities for protection of the environment, together with environment and health authorities of rural communities, supply information on outdoor air pollution. If the concentrations of impurities in any area are notable, the supply air quality can be improved by a proper location of the outdoor air inlets and by filtering the air.

2.3.1.7 When required, the authorities shall evaluate the outdoor air quality with air analyses case by case. Unless otherwise defined, the air in areas listed below are considered not to be clean:

- a zone 50 m wide, as measured from the centerline, on both sides along a road or street with busy traffic. A road or street, at any rate, is considered having busy traffic if the average traffic density exceeds 10000 automobiles daily (24 hours).
- the vicinity of polluting installations, according to instructions by environment protection and health authorities.

2.4 Indoor air humidity

2.4.1 THE INDOOR AIR HUMIDITY MUST BE MAINTAINED AT LEVELS SUITABLE FOR THE INTENDED USE OF THE SPACE, ACCORDING TO WHICH THE BUILDING STRUCTURES AND THE VENTILATION SYSTEM ARE DESIGNED. ANY CONDENSATION ON THE BUILDING STRUCTURES OR IN THE VENTILATION PLANT MUST NOT CAUSE MOISTURE DAMAGE. IT SHALL NEITHER PROMOTE GROWTH OF MICRO-ORGANISMS NOR CAUSE ANY OTHER HEALTH HAZARD.

2.4.1.1 If the indoor air humidity is high, the air pressure in the room shall be maintained low in relation to outdoor air and surrounding spaces. The vapour barriers and insulation of the structures are to be made to conform with the indoor air design humidity. This applies particularly to such damp areas as shower rooms, swimming pools, saunas, etc. The requirements for thermal insulation are given in Section C3 "Thermal insulation" of the National Building Code of Finland, and instructions for installing the insulation and protecting structures from moisture, in Section C4, "Thermal insulation".

2.4.1.2 If the indoor air humidity, due to evaporation in the room, or the humidity of the air taken from outdoors, exceeds 7 g H_2O/kg of dry air (R.H. 45 % at a temperature of 21 °C), the air shall be humidified for strictly demanding reasons only, e.g., if so required by a process or storage. Adversities caused by low humidities are checked by avoiding temperatures higher than necessary in the heating season.

2.5 Sound level

2.5.1 THE VENTILATION PLANT MUST NOT CAUSE IN NOR TRANSMIT TO OCCUPIED AREAS NOISE WHICH, THE OVERALL SOUND LEVEL CONSIDERED, IS DISTURBING.

2.5.1.1 Guide values for the maximum acceptable sound levels originating in the ventilation system are given in Appendix 1. They correspond with sound pressure level values which may be read directly from the meter scale in an unfurnished room.

Section C1 "Soundproofing" of the National Building Code of Finland includes regulations concerning the total sound level caused by all HVAC equipment in combination. These sound level values are so-called normalized values, where attenuation due to, e.g., furniture has been accounted for.

2.5.1.2 Conforming to the guide values of Appendix 1 usually results in compliance with the regulations in Section C1 of the National Building Code of Finland. In applications according to Appendix 1, however, the combined effect of the ventilation equipment and other sources of noise and the different ways of defining sound levels are observed.

3 Ventilation and ventilation systems

3.1 Requirement for ventilation

3.1.1 ROOMS SHALL BE EQUIPPED WITH SUFFICIENT VENTILATION TO MAINTAIN THE INDOOR AIR QUALITY AT A SATISFACTORY LEVEL DURING ACTIVITY, ECONOMICALLY WITH RESPECT TO CONSUMPTION OF ENERGY.

3.1.1.1 The energy conservation aspects of a ventilation system shall be implemented to serve the purpose of the building, e.g.,

- by means of properly arranging the operating areas and operating times of the ventilation system
- by means of an appropriate control system for the ventilation
- by means of heat recovery from the return air

If the occupancy of the building or room is intermittent, its general ventilation is to be implemented to allow stopping the ventilation plant whenever the space is unoccupied. Stopping of the ventilation plant must not cause health hazards or other adversities.

3.1.1.2 The ventilation system shall be equipped with control, adjustment and monitoring equipment, which will allow controlling the factors contributing to the building climate, operation of the ventilation plant and consumption of power and fuel under varying operating and weather conditions.

3.1.1.3 Necessary control of ventilation may be implemented by means of controlling the ventilation air rates of each room individually or by combining spaces with similar use and similar times of activity for control in groups. In the case of natural ventilation, each individual room shall be equipped with air flow shutoff or control devices.

3.1.1.4 A facility for controlling the ventilation air flow rate shall be arranged in each individual office room or corresponding working space. One solution complying with the requirements is a facility allowing the building caretaker to reduce the room air rate by at least 50 % and to increase it a minimum of 20 % from the design air rate, respectively. Prescribed rates of outdoor air as defined according to the number of occupants, however, must be maintained. The facility to modulate the air flow rates shall be observed in the design of air terminal and control devices. When a good building climate is pursued, the occupant of a space is provided with a possibility of adjusting the ventilation air rate him-/herself.

3.2 Air flow rates

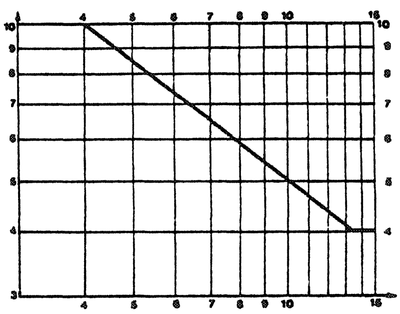
3.2.1 OUTDOOR AIR AT A RATE WHICH MAINTAINS SATISFACTORY INDOOR AIR CLEANLINESS MUST BE SUPPLIED INTO OCCUPIED SPACES.

3.2.1.1 The following minimum rates of outdoor air per occupant must be supplied into occupied spaces:

- spaces where smoking is permitted, 10 dm3/s, each occupant
- spaces where smoking is prohibited, according to Fig. 2 but no less than 4 dm3/s, each occupant

The air change rate of rooms of normal height, however, shall not be less than 0.5 times per hour.

Flow rate of outdoor air/occupant, dm3/s



Space where smoking is permitted

Space where smoking is prohibited

Volume of space, m3/occupant

Figure 2
Outdoor air flow rate per occupant

3.2.1.2 If sufficient basis for dimensioning according to the number of occupants does not exist, the guide values for supply and return air flow rates which correspond to general usage of the space, as defined in Appendix 1, shall be used.

3.2.1.3 Higher air rates than those given in Appendix 1 are often required, for example:

- to attain sufficient cooling or heating performance
- due to activity busier than normal, or intensity of odors
- to remove a larger amount of moisture or impurities
- to maintain proper air distribution
- owing to dimensioning of local exhausts

The air flow rates are then dimensioned based on calculation.

3.2.1.4 Aforesaid air flow rates may be reduced if occupancy in the space is intermittent and the amount of impurities entering the indoor air is small, e.g., in clean storage spaces.

3.2.1.5 When the outdoor air temperature is no more than 15 oC higher than the design outdoor temperature of the locality, the air flow rate guide values for individual spaces according to Appendix 1 may be temporarily reduced but no more than 50 %, to lower the heating equipment heat output below the design rate, provided that this does not result in any obvious health hazard or other adversity. The air flow rates of residential spaces may be reduced only by reducing the return air flow rates.

3.3 Supply air quality; recirculated, circulated and transfer air

3.3.1 THE DEMAND FOR SUPPLY AIR PURITY IS BASED ON THE REQUIREMENTS SET ON THE INDOOR AIR CLEANLINESS. AS DEEMED NECESSARY, THE SUPPLY AIR MUST BE CLEANED.

3.3.1.1 Since impurities are released into the indoor air from structures, furniture and activity which takes place in the room, the supply air must be cleaner than the indoor air. The air must meet the requirements stated in Articles 2.3.1.1 through 2.3.1.4 when the increase caused by the sources of impurities in the room is added to the usually low content of impurities in outdoor air.

3.3.2 ONLY AIR FROM SPACES WITH SAME OR BETTER INDOOR AIR PURITY MAY BE USED FOR RECIRCULATED AIR AND TRANSFER AIR. THIS AIR MUST NOT CONTAIN HARMFUL AMOUNTS OF SOLID PARTICLES NOR GASEOUS IMPURITIES.

3.3.2.1 The use of recirculated air must not cause the spreading of noxious impurities, especially odours. The use of recirculated air or portioning it in the supply air is restricted by the drifting of, particularly gaseous, impurities into other spaces. Instructions on application of recirculated air and transfer air are also given in Section E7 "Fire Safety of a Ventilation System" of the National Building Code of Finland.

3.3.2.2 The recirculated air and often also the circulated air is cleaned. Means of verifying the proper functioning of the air cleaning equipment in continuous operation must be arranged.

3.3.2.3 Recirculated air shall not be used for supply air to such spaces as:

- residential spaces
- commercial kitchens
- lodging quarters of lodging and restaurant establishments and boarding schools
- wards and lodging quarters of hospitals and penitentiaries
- restaurants and cafeterias
- spaces with special hygienic requirements, hospitals, etc., unless, as minimum, the recirculated air is cleaned in filters conforming with Finnish standard SFS 5150 filter class EU 7.

Return air class 3, 4 and 5 as classified in subsequent Articl 3.6.4.2 shall not be used for recirculated air.

3.3.2.4 The supply air may enter a space also as transfer air fro a hall or corridor with clean air. The velocity of the trans fer air must not exceed the values given in Appendix 1.

3.3.2.5 The circulated air in residential apartments is usually take from living rooms, bedrooms, separate dining rooms or halls c similar spaces only. Air from bathrooms and lavatories may b taken as transfer air to be removed through toilets. If ther is a gas stove in the kitchen, the entire air flow for ventila ting the kitchen is removed through a hood installed over th stove. If in the case of a warm-air heating system, for example the supply air flow rate to the kitchen is higher than the desig return air rate, transfer air may be conducted from the kitche into other rooms of the apartment except bedrooms and livi rooms.

3.4 Indoor air pressure conditions

3.4.1 THE RELATIVE PRESSURES OF THE BUILDING, ITS INTERIOR ROOM SPA CES AND THE VENTILATION SYSTEM MUST BE SO DESIGNED THAT AIR FLO FROM CLEANER SPACES INTO SPACES WHERE MORE IMPURITIES ARE RELEASE THE RELATIVE PRESSURES MUST NOT CAUSE EXTENDED MOISTURE LOADS ON T BUILDING STRUCTURES.

3.4.1.1 In order to avoid damage to structures, caused by moistur and health hazards caused by micro-organisms, the general pra tice is to design the building for a slightly lower pressu than that outdoors. However, the pressure difference must n exceed 30 Pa.

Certain special spaces, however, may be designed for overpressu in relation to the outdoor air. Such spaces are clean room and spaces where, because of the use of the space or for oth reasons, the entrance doors or other openings are often ke open.

3.4.1.2 If heavy emission of impurities or moisture occurs in a room, the air pressure in such rooms shall be maintained lower in relation to other spaces. The air pressures in stairways, corridors and other passages shall be so dimensioned that they will not cause air flows from one apartment or room to another.

3.4.1.3 If the ground of the building area emits radon or other impurities, the building pressure conditions shall be arranged in such a way that they will not conduce these impurities to enter the building.

3.4.2 NO SIGNIFICANT CHANGES TO THE PRESSURE CONDITIONS OF THE BUILDING OR ROOM SPACES NOR REDUCTION OF THE VENTILATION PERFORMANCE MUST BE CAUSED BY NORMAL USE OF THE BUILDING, NOR BY CHANGES IN WEATHER CONDITIONS.

3.4.2.1 The ventilation plant shall be designed and installed so that changes in weather conditions do not change the directions of air flow in the building nor change the ventilation plant air flow rate more than 15 %.

The function of the control equipment is to be arranged so as not to change the pressure conditions in the building when adjusting the air flow rates as required.

3.4.2.2 Adverse effects of the wind shall be reduced, e.g., by means of directing the exhaust discharge upwards and by observing the local wind conditions in the arrangement of openings.

When dimensioning a natural ventilation system, the wind effect shall not be considered. The adverse effects shall be eliminated, in addition to the aforesaid, by means of extending the exhaust discharge, as a rule, above the ridge line of the building and by using wind proofing, weather heads and the like.

3.4.2.3 To eliminate the chimney effect caused by temperature differences, a multi-story building is divided vertically into separate ventilating zones. The vertical distance between the low and highest intake or return air device shall not exceed 1 when the building ventilation system includes a mechanical ret air system, or 14 m when the supply system as well as the ret system is mechanical. Alternatively, the ventilation system be equipped with control devices, e.g., constant flow dampe for controlling the pressure conditions.

3.4.2.4 In the case of natural ventilation, the air ducts are dim sioned separately for each floor and risers are run separat from each room to the roof. The minimum vertical distance betw the intake and exhaust openings in a natural ventilation sys is 4.5 m.

Since the pressure difference and air velocities are low i natural ventilation system, the ducts are usually run from e ventilated space up to the roof without using duct elbows horizontal sections, which would cause pressure losses and cumulation of particulate impurities. Horizontal sections compensated for by setting the vertical sections wholly or par at an angle which must not exeed 30 degrees from vertical.

If for any particular reason a duct elbow or a horizontal d section must be included, it shall be located immediately af the return air terminal and its lengt shall, as a rule, not exc 10 % of the vertical distance between the return air terminal the exhaust discharge opening. The cross-sectional area sh then be selected so large that the sum pressure loss of the d and the elbow will not exceed the pressure loss of a nor straight vertical duct. The shape and material selected for horizontal duct sections must be such that dust will not read accumulate in them and that they are easily cleaned. Circu metal duct should be used in the first place, and it should corporate an easily-removed return air terminal or inspect door, both dimensioned at least as large as the duct.

Service instructions according to Regulation 5.3.1 shall be p vided for horizontal ducting in single-household residen buildings. They shall include instructions on the method and frequency of the cleaning operations. The time interval must be no more than half of the cleaning interval defined in the resolution on cleaning of ventilation ducts, issued by the Ministry of the Interior on June 21st, 1984.

3.4.3 NATURAL AND MECHANICAL VENTILATION SYSTEMS MUST NOT BE COMBINED IN SUCH A WAY THAT THE RELATIVE PRESSURES IN THE SPACES NOR THE DIRECTIONS OF FLOW BETWEEN THE SPACES OR IN THE DUCTING CHANGE. THIS ALSO APPLIES FOR A CASE WHERE TWO OR MORE VENTILATION PLANTS ARE CONNECTED TO THE SAME DUCT OR PLENUM.

3.4.3.1 If several ventilation units are connected to the same duct or plenum, the fans for these units shall be selected in accordance with standard SFS 5148, to prevent the fans from disturbing proper functioning of each other. The common discharge plenum or duct for the units is to be dimensioned and the fan characteristics and locations of the operating points selected so as to restrict the change of air flow, when any unit is stopped, to 3 %. The units to be stopped are to be equipped with shut-off dampers. The maximum allowable leakage of these dampers is 2 % of the total air flow rate of the units in operation.

A common discharge plenum is not recommended if the system includes air recirculation, or if the air flow rates of the units are individually controlled.

3.4.3.2 The ventilation of an apartment or other integral space is usually based on either natural draft only or mechanical implementation only.

The performance of a natural ventilation system may be temporarily boosted by means of an exhaust fan. Sufficient inflow of supply air must be secured to avoid backdrafts through other ducts or smoke flues.

3.5 Supply air entrance, return air removal, ventilation efficiency

3.5.1 THE SUPPLY AIR MUST BE CONDUCTED INTO THE VENTILATED SPACE IN SUCH A WAY THAT THE AIR IS SPREAD OVER THE ENTIRE OCCUPIED ZONE DRAFTLESSLY AND EFFICIENTLY UNDER ALL CONDITIONS OF USE. CONTAMINATED AIR MUST NOT RETURN TO THE OCCUPIED ZONE IN HARMFUL AMOUNTS.

3.5.1.1 The ventilation system is to be designed for maximum efficiency to ensure that the supply air covers well the entire occupied zone, that contaminated air flows straight to the return openings without being spread into the space, and that the air from supply to return does not flow passing the occupied zone by.

3.5.1.2 The supply air may enter the room, moved by fan power, through the building peripheral walls, or as transfer air.

A device, opening, slit or valve, whose flow and sound characteristics are known, in the peripheral wall, may be used for outdoor air intake, whereby the air flow rate is adjustable individually for each room.

Adjustable openings for air flow, incorporated in windows or venting doors, shall be dimensioned to allow the design air flow to pass when the window or door is shut.

If the windows or other structures are subject to noise control requirements, the outdoor air intake shall be equipped with corresponding sound insulation.

In addition, non-exceptional working and residential spaces are usually provided with easily-operated means for venting.

3.5.1.3 Flow routes and flow devices for the air distribution, outdoor air intake and transfer air are to be arranged and dimensioned so as not to exceed the draft criteria specified in Article 2.2.2.1.

In systems with mechanical return air removal, the pressure loss of the outdoor air route shall be dimensioned at least twice as high as that of the transfer air route. The maximum pressure loss of the transfer air route in a mechanical ventilation system is 10 Pa. In a natural ventilation system where the vertical distance between the intake and exhaust openings is less than 10 m, the maximum pressure loss of the transfer air route is 2 Pa.

If the vertical distance between the intake and exhaust openings in a natural ventilation system is less than 10 m, the outdoor air openings shall be arranged so as to eliminate the effects of wind, or wind-protected intake devices or some other reliable arrangement is to be used.

3.5.1.4 A return air terminal is usually installed in each room. Exceptions to this may be residential apartments and single-household residences, where at least the kitchens, kitchenettes, bathrooms, toilets and wardrobes are equipped with return air terminals. The return air from other rooms is removed through these terminals. If the transfer air routes are long, installation of a return air terminal in the bedrooms is recommended.

The return air from corridors may in non-exceptional spaces, such as offices and lodging houses, be removed, for example, through the toilets.

3.5.1.5 Local exhausts shall be arranged in every such case where there is a concentrated emission of dust, gases or vapors. The efficiency of the local exhaust may be improved by means of enclosures.

If the emission of impurities involves strong thermic currents, the natural tendency of warm air to rise shall be utilized.

In rooms of considerable height, the return air openings may be concentrated as deemed purposeful.

3.6 Ventilation systems

3.6.1 A VENTILATION SYSTEM SHALL BE SELECTED ACCORDING TO THE FUN TION AND USE OF THE BUILDING SO AS TO ENSURE A SATISFACTORY INDO CLIMATE UNDER ALL NORMAL WEATHER CONDITIONS AND CONDITIONS OF USE.

3.6.1.1 A natural ventilation system is based on temperature diffe ences. Being lighter, the warm air flows upwards and eventual out through the return and exhaust ducts. This air is replac with colder outdoor air, which heats up to room temperature.

Natural ventilation may be utilized in residential spaces wi a facility for venting, mainly in single-household residence Prerequisites are that the outdoor air is clean and that no noi control requirements arise from the environment.

Natural ventilation is suitable also for spaces which are bui mainly over the ground, for temporary use, where only sma amounts of impurities, mainly from the structures, enter t indoor air.

Appendix 2 includes instructions concerning the use of natur ventilation in garages.

3.6.1.2 In a mechanical return air system, the flow of air is e fected by means of, e.g., a roof exhauster. The removed air replaced by colder outdoor air, which heats up to room tempe ature. The ventilation rate is independent of outdoor tempe atures and wind conditions.

Ventilation based on mechanical air removal may be used wh the outdoor air is clean and the requirement for ventilati is so low that the inflow of outdoor air causes no drafts the occupied zones.

The outdoor air may be conducted unheated, for instance, into the following spaces: living and storage areas and comparable working spaces where no work is done sitting, and small office spaces less than 50 m2 in floor area, club rooms, shops, etc.

3.6.1.3 In a ventilation system with mechanical air supply and removal, the air is supplied and removed mechanically by means of a fan. Make-up air is taken from outdoors also through a fan and it is heated. The ventilation air rates are independent of the outdoor temperature and wind conditions.

Mechanical ventilation may be used in all types of buildings.

Mechanical ventilation is commonly used, for example, in offices, classrooms, conference rooms, lunch rooms, day care homes, health care establishments and spaces where considerable quantities of air impurities are developed, such as kitchens, laboratories, industrial premises.

3.6.2 A VENTILATION SYSTEM MUST BE SO DESIGNED AND INSTALLED AS NOT TO CAUSE WATER, HUMIDITY, OR OTHER DAMAGE. THE USE OF WATER, OR ANY CONDENSATION OCCURRING IN THE VENTILATION SYSTEM, MUST NOT CAUSE GROWTH OF MICRO-ORGANISMS PRODUCING A HEALTH HAZARD.

3.6.2.1 If an air supply unit located inside the building is connected to a piping system conducting a liquid, the building structures shall be protected from the effects of any liquid leaks by means of, e.g., a floor drain arranged in the room, and a watertight floor.

This does not apply for air circulating units, nor for supply units arranged in the immediate vicinity of a building entrance if the flow rate of outdoor air does not exceed 0.9 m3/s. Any flow of water into the room must, however, be prevented, e.g., by means of sloping the floor.

3.6.2.2 Ventilation compartments or ducts subject to accumulat of rainwater or snow must be provided with drainage.

The ventilation machinery, equipment rooms, plenums and du shall be thermally insulated so as to prevent any damage cau to structures or ventilation system by condensation.

The air ducts and plenums are always to be insulated when s a great difference between the air stream temperature and ambient temperature exists which could result in increased c sumption of energy or an impairment of the control functions.

The air ducts shall be designed so rigid and supported so fir that they will withstand the changes of pressure in the venti tion plant and remain immobile. Plenums and compartments sh be constructed to withstand the stresses caused by the to fan pressure when the dampers are shut.

3.6.2.3 Intake and exhaust openings and their connections to ventilation system shall be arranged, protected and dimensio to prevent any entering rainwater or snow from causing dam to the building structures or the ventilation system, and f significantly impairing the ventilation system operation.

An unprotected opening in a vertical exterior wall, subject the direct effect of wind, shall be dimensioned for a maxi air velocity of 2.0 m/s over the face area unless by relia tests it can be shown that the type of grille used functi well also at higher air velocities.

3.6.2.4 Humidifiers shall be design so as not to impair the ind air quality, when properly maintained. Water which has been contact with supply air is not, as a rule, returned to the h midifier. If, however, circulating water is used for any pa ticular reason, the humidifiers shall be provided with an ove flow, and water treating devices which preclude the growth micro-organisms.

3.6.2.5 Water from an open cooling tower shall not be used directly for cooling of supply air but a closed cooling circuit shall be arranged. For the event of any leak, this closed cooling circuit shall be pressurized against the cooling tower basin with a minimum overpressure of 200 kPa, which shall be ascertained by means of reliable safety devices.

3.6.3 THE INTAKE OPENINGS FOR OUTDOOR AIR MUST BE SO ARRANGED THAT THE OUTDOOR AIR ENTERING THE SYSTEM IS AS CLEAN AS POSSIBLE.

3.6.3.1 The intake opening for outdoor air is located as far as possible and under no circumstances closer than 8 m from a garbage collection point, a parking area for three or more automobiles, driveways, loading areas, cooling towers, sewer vents, chimney heads and other objects causing outdoor air pollution.

If a chimney head or a sewer vent is more than 3 m higher than the air intake opening, a distance of 5 m between these is sufficient. In single-household residences, aforesaid minimum distances may be shorter except in the case of the smoke stack of a heating boiler using solid fuel.

3.6.3.2 The distances between air intake openings and exhaust openings are given in Figure 3. The minimum vertical distance between the bottom of the air intake opening and the grade or paving is normally 2 m. Venting openings as well as the individual outdoor air openings of rooms at grade level may be arranged lower than 2 m from the grade. This applies also for the outdoor air openings of stairways, elevator shafts, cellars, toilets, bathrooms, dressing rooms and similar spaces intended for intermittent occupation only. Outdoor air openings shall, however, not be located in pits and recesses below grade.

3.6.3.3 The height of the bottom of an air intake or exhaust opening over a roof or deck shall be dimensioned distinctly greater than the expected depth of snow on the roof. This vertical distance is, as a rule, dimensioned to exceed the average thickness of the heaviest blanket of snow, which in western Finland i cm and in other parts of the country, 90 cm. Western Fin refers herein to an area where the maximum snow load on a is 1.4 kN/m2 (see NBCF, Section B1).

This distance may be shorter if the formation of a snow bla is precluded by means of a snow shield or some other reli arrangement.

3.6.3.4 The outdoor air intake shall be so arranged or prote that the make-up air will not be excessively heated in summer.

3.6.3.5 If the outdoor air in the area is polluted (see Arti 2.3.1.5, 2.3.1.6 and 2.3.1.7), the arrangement of the open for outdoor air, and the air treatment, shall be negotiated the environment authorities. This applies also to cases w the outdoor air is taken in through the air intakes of indi ual rooms.

The outdoor air intake openings in a building located by a traffic route are located as high as possible, usually on side of the building opposite to the traffic route.

3.6.3.6 The arrangement of the outdoor air inlets must also the requirements as set forth in the regulations and guidel concerning building fire safety and sound insulation.

3.6.4 THE EXHAUST MUST BE DISCHARGED OUTDOORS IN SUCH A WAY NO HEALTH HAZARD OR HARMFUL EFFECTS ARE CAUSED TO THE BUILDING, OCCUPANTS, NOR THE ENVIRONMENT.

3.6.4.1 As a rule, the best way to prevent the exhaust from reent ing the occupied areas through the outdoor air inlets or windows is to conduct the exhaust above the roof of the high section of the building and direct the discharge upwards.

3.6.4.2 Discharging the exhaust out of the building is based on the following classification of types of return air:

Class 1. Return air comparable to outdoor air with respect to humidity, from spaces where the main sources of foreign matter are the building structures. This air is suitable to be used for recirculated and circulated air.

Class 2. Return air from occupied areas, where the main pollutants are metabolism and building structures. This air is suitable to be used for recirculated and transfer air.

Class 3. Return air from occupied areas, which contains some impurities. This air is not used for recirculated air for other areas but it may be used for transfer air to toilets, wash rooms and similar spaces.

Class 4. Return air from spaces where emitted moisture, processes, chemicals, etc. substantially lower the return air quality. This air is not used for recirculated or transfer air.

Class 5. Return air that contains odors and impurities detrimental to health in significantly larger amounts than those allowed for indoor air. This air is not used for recirculated or transfer air.

Examples of ventilated space return air classes:

Class 1. Stairways, elevator shafts, cooling air equipment rooms, exceptionally clean spaces (clean rooms, sterile rooms)

Class 2. Offices, including integrated small storage rooms, spaces for public service, class rooms, some meeting rooms, commercial spaces with no odor loads

Class 3. Residential rooms, lunch rooms, coffee kitchens, stores, storages of office etc. buildings, dressing rooms

Class 4. Toilets and washrooms, saunas, residential kitchens, catering and school kitchens, chemistry laboratories, drawing copying plants, smoking rooms

Class 5. Draft hoods in professional use, grills and local kitchen exhausts, garages and drive tunnels, rooms for handling of paints and solvents, rooms for unwashed laundry, rooms for foodstuffs waste

3.6.4.3 The exhaust air openings shall be arranged as shown in Table 1 and Figure 3. The distances shown in Table 1 are minimum distances. Longer distances are to be used whenever possible.

The distances for exhaust openings discharging upwards may be calculated either from the edge of the opening or from a point located 1/3 of the numerical value of the discharge velocity in m/s, expressed in meters, above the opening.

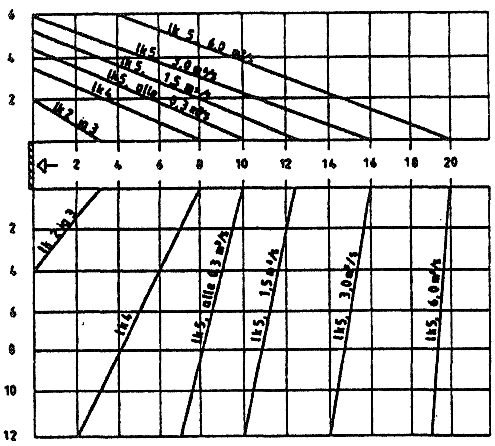
Table 1. Location of exhaust opening

Return air class	A	B m	C m	D m	E	F m
1	-	-	-	0.8	3.6.3.3	2
2 and 3	Fig. 3	2	3	2	3.6.3.3	2
4	Fig. 3	4	6	3	3.6.3.3	5
5	Fig. 3	6	10	5	3.6.3.3	8

Distance of exhaust opening from:

A Outdoor air openings
B Openable windows below
C Openable windows, or decks, at the same level or above
D Grade, paving, etc.
E Rooftop
F Adjacent building lot (does not apply to single-h'hold residences)

Exhaust discharge above outdoor air intake, m



Horizontal distance between openings, m

Exhaust discharge below outdoor air intake, m

Figure 3
Distances between exhaust discharges and outdoor air intakes

3.6.4.4 Exhaust according to Class 1 return air may be discharged out of the building without restrictions. It shall, however, not be discharged into exits or occupied areas.

Exhaust according to Class 2 return air may be discharged outdoors through an exhaust discharge opening in the building wall provided that:

- the distance of the discharge opening is at least 4 m from the adjacent building lot and at least 8 m from the adjacent building
- the distance of the discharge opening is at least 1.5 m from another discharge or intake opening in the same wall
- the air flow rate is no more than 1 m3/s
- the air velocity is at least 5 m/s

As a rule, the opening is located on the wall facing a traffic route or a parking lot. The opening may be located on the yard side of the building if at least two sides of the yard are open at the level of the discharge.

3.6.4.5 The location of an exhaust discharge opening of Class !
turn air requires consultations with the authorities befor
if the exhaust air flow rate exceeds 3 m3/s or if the exl
contains harmful amounts of gases, dust, vapors or other fo
matter. The exhaust shall be cleaned if deemed necessary.

3.6.4.6 The exhaust discharge opening shall be located a mi
distance of 1 m from a chimney top or a sewer vent. The
minimum distance shall be provided between the exhaust disch
of a mechanical ventilation system and a natural ventil
system.

If there is an eave, oriel or other protruding building de
above the opening, the opening is located the extent of the
trusion below the latter, or it is moved laterally into the
treme vertical plane of the protrusion.

3.6.4.7 The arrangement of exhaust openings must also confor
the regulations and guidelines concerning structural fire saf
and the regulations related to sound insulation.

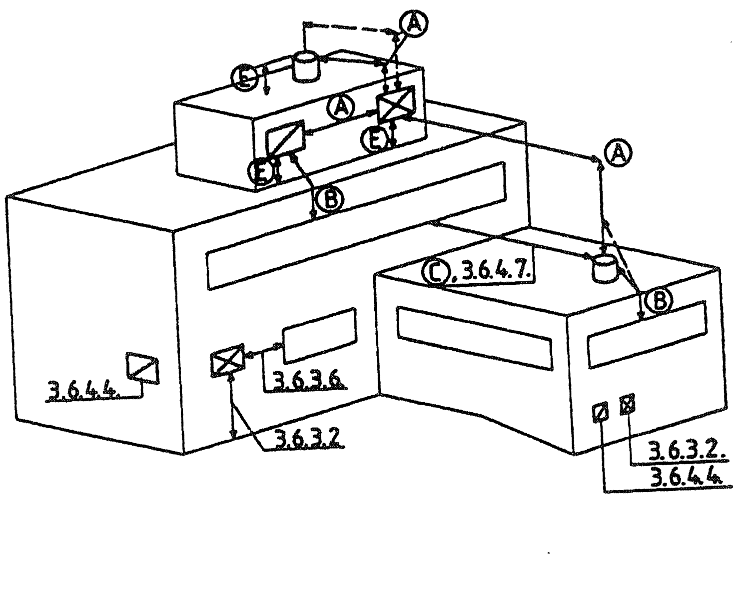


Figure 4
Examples of arrangements for exhaust openings in a building. Let
refer to Table 1, numbers, to appropriate guideline.

3.6.5.3 The return air from toilets, washrooms and janitoria: which open into working, dwelling and corridor areas is ı conducted outdoors through an individual return air un: return air from toilets and related spaces may, however, | ducted into a continuously-operated return air unit o: spaces, e.g., in residences and lodging establishments.

In exceptional cases, the return air from no more than two t or equivalent spaces may be connected to the vertical du(class 1, 2 and 3 return air, provided that their total air flow rate does not exceed 10 % of the total flow ı such a riser.

3.6.5.4 The return air from all rooms in a single residence conducted outdoors, or into a collection duct or chamber, t a single vertical duct, observing, however, the conditior cerning fire safety as specified in Section E7 of the NBCI applies to mechanical ventilation only.

The return air from utility rooms, and single spaces in sec use, such as small storage rooms and rooms for sporting equi may be conducted into class 4 return air risers.

3.6.5.5 The heat recovery equipment and their pressure cond shall be so designed and installed that no return air is into the supply air.

In the event that an odor may be transferred by the heat ery unit, from the return air to the supply air, the retu may contain no more than 5 % of class 4 return air and no 5 return air at all.

3.6.5.6 The return air ducts inside the building but outsi fan room are, as a rule, designed for negative pressure.

Class 1, 2 and 3 return air ducts inside the building may ever, be operated under positive pressure on the conditio the ducting is of air sealing class B according to Article 3 and that there are no make-up or supply air ducts operated at negative pressure in the same shaft.

3.6.5.7 The return air routes of a mechanical ventilation system shall be equipped with devices which close automatically when the ventilation plant stops, to prevent backdraft and uncontrolled ventilation, at least when the exhaust duct cross sectional area is larger than 0.06 m2.

3.6.6 THE COMPONENTS OF THE VENTILATION SYSTEM MUST BE SUFFICIENTLY AIRTIGHT.

3.6.6.1 No infiltration nor exfiltration in components operated at positive or negative pressures shall exceed 6 % of the total system flow rate at operating conditions. In conventional ventilation systems, sufficient air sealing is usually attained by following the guidelines given in Articles 3.6.6.2 and 3.6.6.3.

Air leakages and the requirements for air sealing may also be determined case by case based on Figure 5. Sufficient accuracy is usually obtained if the average pressure in the section operated under negative or positive pressure is used for the value of pressure. The air leakage may also be determined separately for each component, using the pressure in each component at design air flow, and then summing the component leaks.

3.6.6.2 The air ducts and the components directly connected to these, such as inspection doors, dampers and sound attenuators, shall be selected and assembled to obtain the air sealing classes conforming to Finnish standard SFS 4699 and shown in Figure 6, as follows:

Air sealing class A:
Visible ducts in a ventilated space, where the pressure difference relative to the indoor air is no more than 150 Pa.

Air sealing class B:
Ducts outside the ventilated space, or ducts separated fr(by means of covering panels; and ducts in the ventilated where the pressure difference relative to the indoor air is er than 150 Pa.

Air sealing class C:
This sealing class shall be applied as considered case b; e.g., for ducts in high pressure systems, in extensive du(tems or ducts incorporating a large number of joints, an(erally, when duct leaks may produce pronounced adverse (on the ventilation system operation, building air pressu1 ditions, indoor air quality or sound level.

3.6.6.3 The air leakage of enclosed air conditioners, and eq rooms and chambers for fans and other assemblies, shal] more than the leakage according to air sealing class I in Figure 6.

However, the air leakage shall under operating conditi(exceed 6 % of the total air flow. Therefore, a more stri sealing class is applied in cases where the area of an ag casing or an enclosure is exceptionally large in relat the total air flow, where the pressure difference betv aggregate casing or an enclosure and the surroundings is or when exceptional problems result from leakage, beca the demands on air quality, danger of condensation or an} reason. The area of an aggregate or an enclosure is calc using the outside dimensions.

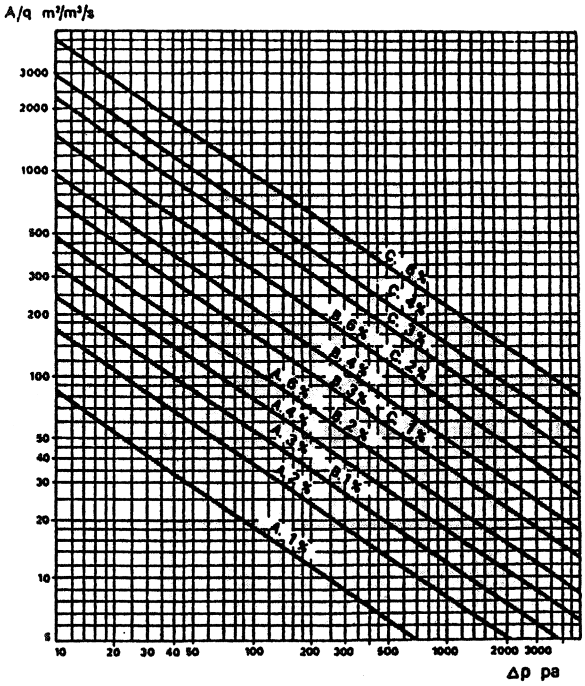
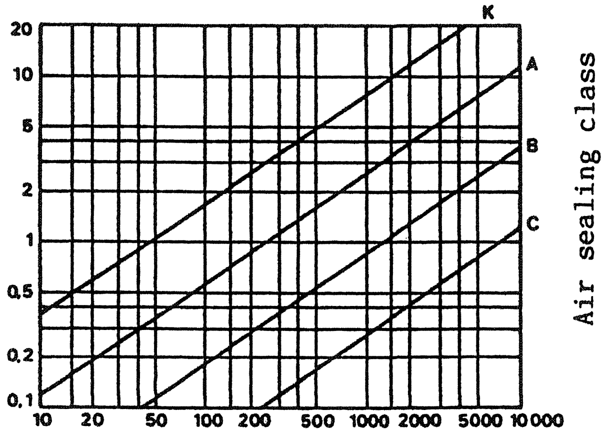


Figure 5

Selection chart for air sealing classes of ducts

Air leakage, dm3/s.m2



Test pressure, Pa

Figure 6

Air sealing classes

3.6.7 THE ENERGY CONSUMPTION OF THE VENTILATION SYSTEM MUST BE MINIMIZED. THE ENERGY CONSERVATION MUST BE EFFECTED WITHOUT SACRIFICING A SATISFACTORY INDOOR AIR QUALITY.

3.6.7.1 A mechanical ventilation system is generally equipped with heat recovery equipment, the temperature efficiency of which is no less than 50 % when the ratio of supply air to return air is 1:1.

The heat recovery equipment may be excluded if the installation of one is shown impractical, e.g., for the following reasons:

- the return air flow rate is less than 1 m3/s
- the operating hours of the system are exceptionally short, for example, less than 35 hours weekly
- the return air is exceptionally dirty or humid, or its temperature in the heating season is less than 15 oC
- the ratio of supply air to return air is larger than 1.4:1, because of, e.g., local exhausts
- a sufficient quantity of other waste energy, e.g., from refrigerating machinery, is used for heating of supply air

3.6.7.2 Fans and drives are selected and connected with the ducting so as to obtain an efficiency, as calculated from the actual power consumption of the motor at design air flow, which shall exceed the values given in Figure 7.

The efficiency is to be calculated according to equation:

$$n = \frac{q_{v1} \cdot P_{tF}}{P_E}$$

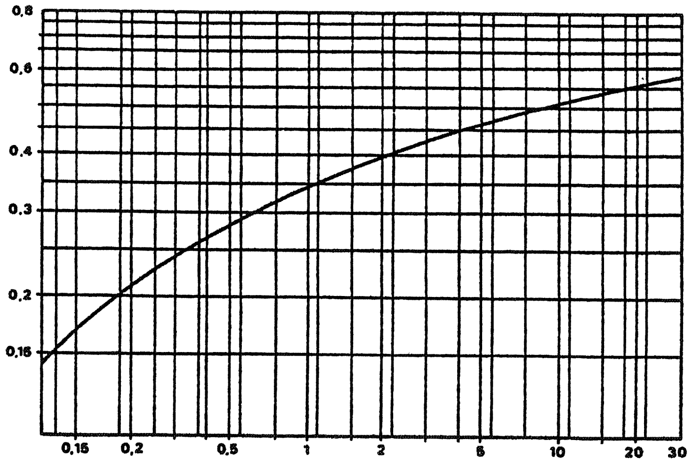
where

q_{v1} fan air flow rate, m3/s

P_{tF} total fan pressure, kPa

P_E actual power consumption, kW

Overall efficiency



Power, kW

Figure 7
Fan efficiency

3.6.7.3 Non-conformance with the efficiencies given in Figure 7 may be permitted for specific reasons. For example, because of accumulation of impurities, wear, or strict limitations on sound level, a fan type may have to be selected which does not reach the specified minimum efficiency. If the fan incorporates two motors, the efficiency requirement does not apply for the smaller motor.

4. Design, installation and commissioning of a ventilation system

4.1 Ventilation plan

4.1.1 THE REQUIREMENTS ON INDOOR AIR QUALITY, THE VENTILATION SYSTEM QUALITY LEVEL AND THE PERTINENT DATA RELATED TO SYSTEM DIMENSIONING, INSTALLATION AND OPERATION MUST BE SPECIFIED IN THE VENTILATION PLAN.

4.1.1.1 Without limitation the ventilation plan shall give the following information on the ventilation system and its components:

- flow rates of outdoor and exhaust air
- flow rates of supply and return air, which in the case of natural ventilation shall be at an outdoor air temperature of +10 oC
- design temperatures of indoor air and outdoor air in different seasons
- allowed sound pressure level in the indoor spaces, and the power level of the sound emitted by the fan into the ducting
- draft criteria of the indoor spaces
- duct and terminal sizes
- pressure losses in ducting, and maximum pressure loss permitted in ventilation system components
- filtering class of filters, maximum final pressure loss and minimum dust-arresting capacity
- heating, cooling and humidifying performances of the equipment
- temperature and/or pressures and fluid flow rates of air and heating or cooling medium
- overall fan efficiencies or maximum fan power consumption
- locations of measuring points and equipment
- air sealing requirements for ducts and equipment
- local exhaust arrangements and equipment
- an account on the harmful materials involved in the process, return air systems and desired concentration limits for pollutants

Above items shall be applied in each case so as to unambiguously define all dimensioning data

4.1.1.2 The ventilation plan shall define the requirements for the quality level of the ventilation system and its components, also for durability, fire resistance, corrosion inhibition, surface treating, vibration absorption, and materials.

4.1.2 THE VENTILATION SYSTEM DESIGN MUST INCLUDE A SYSTEM OPERATING PLAN, PROCESS AND CONTROL SYSTEM DIAGRAMS, DRAWINGS, A TECHNICAL SPECIFICATION ON THE VENTILATION WORK, A COMMISSIONING SCHEDULE AND TECHNICAL OPERATING INSTRUCTIONS FOR THE SYSTEM.

4.1.2.1 The ventilation system shall be shown in plan and sectional drawings, in conformance with Section D4 "HVAC drafting symbols" of the National Building Code of Finland. The technical specification shall include a work description, which specifies the quality requirements for the equipment, accessories and installation, and an equipment specification, which specifies the technical data of the equipment. The technical data may also be given in the drawings.

The design may be made in an abbreviated form if the building is small, e.g., a single-household residence, or if the ventilation system is simple, e.g., serving one room or residence only.

4.1.2.2 The system operating plan shall include a detailed description on the ventilation system functions, where the function of the system and equipment under varying load conditions in different seasons, the areas of influence of different ventilation systems in the building, and the estimated energy consumption of the ventilation system, are described.

In the case of a natural ventilation system, the actions required to ensure minimum ventilation when the outdoor temperature exceeds the design temperature shall be shown.

4.1.2.3 The commissioning schedule shall include the inspections and checks required at the time of commissioning, such as

- verification that the indoor air complies with the ventilation plan
- verification of equipment performance data and quality
- checks on directions of rotation, function, flow and control

Further, the schedule shall define those operating conditions under which the design and setpoint values are checked by measurement, the measuring point locations, procedures and instruments, the scope of the measurements, and the length of the measuring period.

Moreover, the commissioning schedule shall define the number and kind of documents to be submitted to the Owner, and include a program for operator instruction and training.

4.1.2.4 The technical operating instructions for the system shall show the operating periods, control and monitoring actions, check measurements, functional and cleanliness inspections and general maintenance operations of the ventilation system.

4.2 Installation and commissioning of a ventilation system

4.2.1 THE AIR SEALING OF THE VENTILATION SYSTEM MUST BE MEASURED, AND AN ACCOUNT HEREOF SHALL BE GIVEN WHEN REQUIRED.

4.2.1.1 The air sealing of a ventilation system shall be verified by means of a pressure test according to Finnish standard SFS 3542. Some other method which serves the purpose may also be used for testing the ducting of a ventilation system installed for a single-household residence.

4.2.2 THE VENTILATION SYSTEM PERFORMANCE MUST BE MEASURED AND ADJUSTED, AND THE CONFORMANCE OF ITS FUNCTIONING WITH THE VENTILATION PLAN MUST BE VERIFIED, PRIOR TO TAKING THE BUILDING INTO USE. THE FUNCTIONING OF THE VENTILATION SYSTEM UNDER DIFFERENT WEATHER CONDITIONS MUST BE CHECKED AND ADJUSTED.

4.2.2.1 The functioning of the ventilation system electrical equipment shall be tested when connected to the final power supply, with the fuses properly in the circuits.

4.2.2.2 The functional tests shall be carried out before measuring and adjusting the air flows. Before commencing the tests, a check shall be made to ensure that the ventilation system installation and the building work are finished to the point where any unfinished details no longer have an effect on the air flows, pressure conditions nor on the direction of flow of transfer air. This means checking that, for example, the ventilation system filter media have been installed, the doors and windows are mounted, etc.

The air ducts shall be internally cleaned as required since foreign material in the ducts change the ventilation system air flow rates and pressure conditions. The air terminals, filters, etc. shall be cleaned and, if required, replaced before the performance test.

4.2.2.3 The air flow rates are adjusted for a total air volume required by the operating conditions most frequently occurring. The control devices are set under operating conditions which correspond to the average conditions for the different seasons. The conformance of the pressure conditions with the ventilation plan is verified with smoke tests or by means of measuring air flow rates or pressure differences.

4.2.2.4 The indoor climate factors and air flow rates, heating, cooling and humidifying performances, and electrical characteristics and other design data are to be measured at the ventilation plant design air flow rate. Permitted variations from design values:

Air flow rate, each individual room	±20 %
Air flow rate, each system	±10 %
Air temperatures at performance tests	
- at heating	± 2 oC
- at cooling	± 1 oC
Relative humidity	±10 % abs.
Power consumption, converted to correspond to design air flow rate	÷20 %
Heating and cooling performance	-10 %
Air velocity in occupied zone	+0.05 m/s
Sound power level, duct	+4 dB
Air temperature in occupied zone	±1 oC
Effective temperature	±1 oC
Sound pressure level in room	+2 dB(A)

If the functionability of the system requires closer tolerances, these shall be specifically defined in the ventilation plan. If specific product standards call for closer tolerances, these shall be adhered to. All temperatures and heating or cooling performances shall comply with the given tolerances simultaneously.

The tolerances include the permitted variations as well as any measuring error.

4.2.2.5 The measurements are taken and the readings obtained are converted to conform with the design data, according to valid SFS and ISO standards. Instruments with valid calibration shall be used. The accuracy of the instruments shall generally not allow deviations greater than half of the tolerances as set forth in Article 4.2.2.4. If the tolerances specified defines only an upper or lower limit, as specifically for the sound level, a greater measuring error may be tolerated.

4.2.2.6 Records shall be made of the inspections, tests, measurements, distribution system adjustments and automatic control setpoints. The records are to be attached to the transfer documents.

The records of complementary tests carried out during the warranty period shall be submitted on expiry of the warranty period.

4.2.3 ALL CHANGES MADE TO THE PLANS DURING THE CONSTRUCTION PERIOD SHALL BE NOTED ON THE DRAWINGS TO BE SUBMITTED TO THE BUILDING USER. SUFFICIENT DRAWINGS AND INSTRUCTIONS FOR OPERATING AND MAINTENANCE MUST BE PREPARED.

WHEN THE VENTILATION SYSTEM IS COMMISSIONED, THE OPERATING PERSONNEL MUST BE SUFFICIENTLY TRAINED WITH RESPECT TO SYSTEM FUNCTIONING, OPERATION AND MAINTENANCE.

4.2.3.1 When the ventilation system is commissioned, all actions concerning the ventilation system operation and maintenance shall be reviewed in the presence of the operator.

5 Operation and maintenance

5.1 Requirements of operation and maintenance, for system design

5.1.1 A VENTILATION SYSTEM MUST BE SO DESIGNED AND INSTALLED THAT, WITH PROPER OPERATION AND MAINTENANCE, IT WILL REMAIN IN OPERATING CONDITION FOR A REASONABLE PERIOD OF TIME.

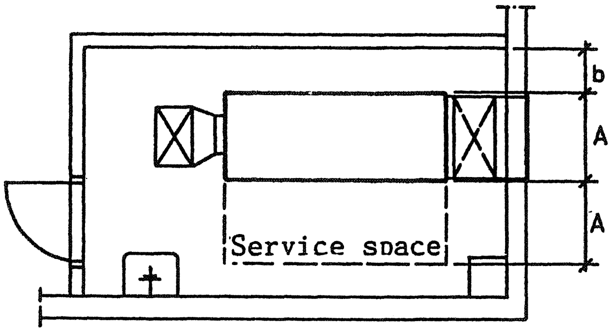
5.1.1.1 The lifetime of a ventilation system and its components is determined by the purpose and operating conditions of these. Guide values according to SFS standards are to be used for design basis, as applicable for different equipment under normal operating conditions. The major renovation cycle of the building is considered the lifetime of the ventilation system of a conventional building, e.g., an apartment house.

5.1.2 THE VENTILATION SYSTEM SHALL BE SO ARRANGED, DESIGNED AND INSTALLED AS TO FACILITATE EASY CLEANING, MAINTENANCE AND REPAIR OPERATIONS.

5.1.2.1 Sufficient space is to be arranged next to the equipment, for maintenance and cleaning operations. The minimum dimensions of this space shall be equal to the corresponding dimensions of the unit concerned. No stationary or heavy objects shall be arranged in the service space. Sufficient space shall be reserved around the equipment for dismounting of same, for maintenance and repair.

Devices and components sensitive to impurities shall not be installed unprotected inside return air ducts if the air carries a high content of foreign matter, such as grease.

When reserving space for maintenance of ventilation equipment, the principles shown in the example for an enclosed unit in Figure 8 shall be followed.



b = 0.4 x h, or 400 mm
h = height of unit

Figure 8
Example for dimensioning and arrangement of service space for an enclosed ventilation unit.

If the equipment room contains several units, space shall be reserved separately for maintenance and repairs.

5.1.2.2 The ventilation system shall be equipped with cleanout doors according to Section E7 of the NBCF.

Equipment mounted inside ducting, or related duct sections, shall be designed easily dismountable, or the duct sections shall be equipped with service doors sufficiently large.

5.1.2.3 No equipment requiring maintenance, nor service doors, shall be arranged in locations with poor access. In the case of a suspended ceiling, an access openable or removable without tools and dimensioned no less than 500 by 500 mm shall be provided at such equipment, in the ceiling.

5.1.2.4 For equipment located on the rooftop, service routes and safety measures shall be arranged according to Article 2.1.2 in Section F2 "Safety of operation and maintenance in buildings" of the NBCF.

An object of maintenance the height of which is more than 2.5 m from the floor level shall inside the building be equipped with a ladder, a stationary or easily operated mobile platform or other arrangement for maintenance work, according to Article 2.1.1.1 of Section F2 of the NBCF.

Access, service routes and service platforms, with pertinent safety arrangements, shall be provided according to standard SFS 5069, standards related to individual sectors of industry and type of equipment, and instructions by the authorities for occupational safety, for equipment requiring maintenance in ventilation equipment rooms and industrial production and storage spaces, etc.

Ladders more than 2 m high shall not be used for transport routes for filter cassettes or other bulky objects which are frequently handled. Instead, a service platform shall be installed or a mobile elevator platform used.

5.1.3 THE MACHINERY AND EQUIPMENT MUST BE FURNISHED WITH APPROPRIATE PROTECTION AND SAFETY DEVICES FOR MAINTENANCE AND REPAIR WORK, AND FOR EMERGENCY STOPPING.

5.1.3.1 Electric motors shall be equipped with safety switches, by means of which the motor power, auxiliary and control circuits may be switched off for the duration of the maintenance and repair operations. As concerns the location of the safety switches, the authority regulations in force shall be observed.

Return air compartment lighting fixture enclosures shall be so designed as to allow easy cleaning without isolating the fixtures from the electrical supply.

5.1.3.2 Open fan inlets and discharges, and any moving equipment and components shall be furnished with appropriate and reliable safety guards according to the regulations concerning occupational safety.

5.1.3.3 The ventilation system shall be equipped with a clearly-marked emergency stop switch, whereby all functions of the ventilation system may be stopped in case of emergency.

5.1.4 THE VENTILATION SYSTEM MUST BE EQUIPPED WITH MEASURING DEVICES FOR SURVEILLANCE OF ITS MAIN FUNCTIONS.

5.1.4.1 The functions of the ventilation plant are monitored by means of local, indicating and stationary instruments. If the air flow rate is less than 0.5 m3/s, stationary instruments may be substituted with connections suitable for portable instruments.

The inlets and outlets of heating and cooling coils and heat recovery units shall be provided with temperature gages, and the filters, with pressure differential gages.

A connection for measuring the humidity shall be arranged in the aggregate or duct section downstream of the humidifier.

5.1.4.2 The measuring equipment shall be installed at such locations where they are easily read and readily accessible along access routes easy to use.

5.2 Maintenance, operation and service

5.2.1 THE VENTILATION SYSTEM SHALL BE OPERATED AND MAINTAINED SO AS TO ENSURE THAT THE REQUIREMENTS CONCERNING HEALTH AND ENERGY CONSERVATION HEREIN SET FORTH REMAIN FULFILLED.

5.2.1.1 The ventilation system is to be operated and maintained in a way which ensures that the indoor climate remains beneficial to health and that the energy consumption stays reasonable.

If the ventilation system is shut down when the premises are not in use, the shutdown must cause no health hazard nor other adversity. Restarting shall be done well in advance of reoccupation of the premises, usually so that one air change has taken place before occupation is resumed.

In summer it is most often recommendable to operate the ventilation system continuously, to remove excess heat and to cool building structures.

During the first year of operation, a ventilation system is usually operated continuously because of abnormally high emission of moisture and foreign matter from structures and furniture. Later on, local exhausts from toilets, etc., may be operated continuously, thereby warding off potential problems caused by moisture resulting from prolonged periods of overpressure.

5.2.1.2 When servicing and cleaning a ventilation system, the instructions given for fire safety, occupational safety, and cleaning of air ducts shall be followed.

5.2.1.3 The service intervals of humidifiers are defined in the ventilation plan, based on the type of humidifier, method of operation, water quality and treating, purity of the air humidified, etc. The humidifying equipment shall be cleaned every time they are put into or out of operation. They shall be inspected for cleanliness and cleaned as required at least at every service operation and inspection of the ventilation system, more often if deemed necessary.

5.3 Operating and maintenance instructions

5.3.1 DETAILED AND EXPLICIT OPERATING AND MAINTENANCE INSTRUCTIONS MUST BE PREPARED FOR ALL VENTILATION SYSTEMS.

5.3.1.1 The operating and service instructions for the ventilation system, and the final ventilation system plans where any changes have been noted, shall be submitted to the Owner. The instructions shall have been written in the Finnish or Swedish language as specified by the Owner.

Instructions, drawings and work descriptions concerning building maintenance, and process and control diagrams shall be preserved at an appropriate location, for the use of the building caretaker.

In the service instructions, a specific account shall be given on the necessity of sufficient maintenance of equipment significant with respect to healtful indoor climate and economic utilization of energy.

5.3.1.2 Operating and maintenance instructions intended for the residents of the building shall be permanently affixed, e.g., in kitchen furnishings. The instructions shall show the capabilities and proper use of the ventilation equipment, necessary and permitted cleaning operations, and instructions on suitable cleaning intervals. Furthermore, a description of the dangers to health and structures, caused by shutting the ventilation off, shall be included in these instructions.

The caretaker of a residential building shall be provided with operating and service instructions covering the ventilation and its components, of the entire building. Among other things, these instructions shall include the ventilation plant operating schedule, the location and arrangement drawings for the equipment, and the equipment control setpoint values.

5.3.1.3 Operating and maintenance instructions to be submitted to operating personnel of buildings other than residential shall include descriptions of the operating principles of the ventilation system and its components, operating schedules, wiring and control diagrams, location and arrangement drawings, control setpoint values, and operating and maintenance instructions for the equipment.

The instructions intended for the operating personnel shall be preserved in an appropriate location available to the operators.

5.3.1.4 The ventilation system service instructions shall include an account on the service operations required, an estimated service schedule, and listings of spare parts and accessories.

Appendix 1

Guide values for indoor climate and ventilation, related to various indoor spaces

Complying with the guide values given in Appendix 1 generally results in satisfactory indoor climate in non-exceptional indoor spaces. When striving for a good indoor climate, the design data are defined separately for each individual case, based on the ventilation load conditions in the spaces concerned.

The guide values for air temperature and effective temperature apply to the heating season. The air temperature is generally the basis for dimensioning heating equipment. In spaces where the air temperature is not sufficient to describe the thermal conditions, the effective temperature is used for basis. Such spaces are, for example, rooms with large window areas or radiant space heating.

The maximum air velocity permitted in an occupied zone may be determined from the draft characteristics in Figure 1.

The guide values given for air flow rates are the minimum outdoor air flow rates in winter. In cold peak periods, the outdoor air flow rates for individual spaces may be reduced according to Article 3.2.1.5. The air flow rate is determined primarily according to the number of occupants. If the number of occupants in a space is unknown, the floor area may be used for design parameter. In spaces where the occupancy varies, adjustment of ventilation according to needs is recommended. The total air flow rate must often be specified larger than the guide values given prescribe, in order to maintain control over the temperatures.

The guide values for sound levels are maximum permitted sound pressure level values caused in an unfurnished room, by the ventilation system. Section C1 of the NBCF specifies the permitted sound level caused by all HVAC equipment combined. When applying the tabulated guide values, the combined effect of the ventilation and other sources of noise must be accounted for.

If the ventilation or air circulation can be increased by an individual, to exceed the guide values, the guide values may under these circumstances be exceeded as follows:

- air velocity, the maximum velocity according to the draft characteristic + 0.1 m/s;
- sound level, guide value + 10 dB.

Appendix 1. Guide values for indoor climate and ventilation, related lated to various indoor spaces.

1. Residential buildings A)

Space/Use	Air temp.	Eff. temp.	Draft char.	Outdoor air rate (transfer air = s)		Return air rate	Sound level
	oC	oC		dm3/s,pers	dm3/s,m2	dm3/s,unit	dB(A)
Living spaces							
1.1 Living room	21	20	2		0.5		30
1.2 Bedrooms	21	20	2	4	0.7		30
1.3 Hallway	19	17	5		(s)		35
1.4 Kitchen	21	20	2		(s)	20 B)	35
1.5 Separate dining area	21	20	2		0.5		30
1.6 Clothes room	19	17			(s)	3	35
1.7 Bathroom, shower	22	22	2		(s)	15	40
1.8 Toilet	21	19			(s)	10	35
1.9 Utility room	21	19	3		(s)	15	35
1.10 Private sauna					2 C)	2/m2 C)	35
1.11 Hobby room	21	19	3		0.7	0.7/m2	35

Common spaces						
1.12 Stairway	17			0.5 1/h	0.5 1/h	40
1.13 Store rooms (also those integral with dwelling)	17			0.35 D)	0.35/m2	45
1.14 Cold cellar (also cold cabinet integral with dwelling if area > 4 m2)	5			0.20	0.20/m2	45
1.15 Dressing room	21	20	2	2	2/m2	35
1.16 Washroom	22	22	2	3	3/m2	40
1.17 Sauna steam room				2	2/m2	35
1.18 Laundry room	21			1	1/m2	45
1.19 Drying room	21			2 E)	2 /m2 E)	45
1.20 Hobby room, club rm	20	18	3	1 F)	1/m2 F)	35

A) The ventilation of living quarters is usually dimensioned based on the tabulated return air flow rates. The return air rates of small dwellings may be dimensioned lower than the guide values but maintaining a minimum air change factor of 1.0. The return air rates in large dwellings must often be dimensioned larger than the guide values, in order to maintain the outdoor air rate specified for living quarters.

The ventilation air rate of a dwelling may be reduced when the design air rates are not necessary in the kitchen or in the rooms for hygiene. It must be ascertained that under these circumstances the outdoor air rate in the living quarters remains in conformity with the guide values and that the air change factor is 0.4 for the entire residence.

B) Guide value when the kitchen is equipped with a stove hood or equivalent local exhaust device. If this is not the case, the return air flow rate shall be a minimum of 50 dm3/s.

C) No less than 6 dm3/s, at any rate.

D) Transfer air may be taken from a dwelling room or a hallway, to a storage room integral with the dwelling.

E) May be dimensioned lower when an air dryer is used.

F) Provides that a venting facility exists; else 1.5 dm3/s, m2.

2. Office buildings A)

Space/Use	Air temp.	Eff. temp.	Draft char.	Outdoor air rate (transfer air = s)		Return air rate	Sound level
	oC	oC		dm3/s,pers	dm3/s,m2	dm3/s,unit	dB(A)
2.1 Office room	21	20	2	10	1		35
2.2 Open office	21	20	2	10	1.5		35
2.3 Conference room	21	20	3	10	4		35
2.4 Drafting room	21	20	2	10	1.5		35
2.5 Spaces for public service	21 B)	19 B)	4 B)	6	2		40
2.6 Exhibition space	20 B)	18 B)	4 B)	5	1.5		40
2.7 Data processing rooms							
- processor room	21	19	5	4	0.4		55
- printer room	21	19	4	4	0.4		55
2.8 Archive, storage	20	18	(no work	area)	(s)	0.35/m2	45
2.9 Cafeteria, rest rm.	20	19	3	10	5		40
2.10 Copying room	20	18			1	4/m2 C)	45
2.11 Office corridor, lobby	20 B)	18 B)	5 B)		D)		40
2.12 Smoking room	20	19	3	10	5	10/m2	40
2.13 Classroom	21	20	3	10	4		35

A) Return air flow rates of polluted spaces, see "Hygiene spaces".

B) Stationary working areas: draft characteristic 2, temperature/effective temperature 21 oC/20 oC.

C) If the copying process produces heavy odors, the return air flow rate is dimensioned higher according to Articles 2.3.1.2 or 2.3.1.4, or local exhaust shall be used.

D) The outdoor air required by the office rooms and the like may be introduced wholly or partly as transfer air through a corridor.

3. School rooms

Space/Use	Air temp.	Eff. temp.	Draft char.	Outdoor air rate (transfer air = s)		Return air rate	Sound level
	oC	oC		dm3/s,pers	dm3/s,m2	dm3/s,unit	dB(A)
3.1 Classroom	21	20	2	6	3		35
3.2 School laboratory	21	19	3	6	3 A)	140/acc. to draft char'tic	35
3.3 Housekeeping class room	21	19	3	6	3 A)	A)	35
3.4 Classroom for technical subjects	21	19	4	6	3 A)	A)	40
3.5 Gym hall, auditorium							
- gym hall use	21	20	5	12	2 D)		35
- auditorium use	21	20	3	8	6		35
3.6 Lecture room	21	20	2	8	6		35
3.7 Lunch room	21	18	4	6	5		35
3.8 Lobby/hallway/exhibition area	E)	E)	5 E)	4	1 F)		40
3.9 Instruction material storage room						0.35/m2	40

A) Required return air flow rates generally determine the dimensioning. As a rule, local exhausts dimensioned separately for each individual case shall be arranged.

B) A lower air flow rate may be permitted based on a survey report or the like, on the return air arrangement performance.

C) The indoor atmosphere and the ventilation are dimensioned according to the conditions of use most demanding. A facility for adjusting to suit different conditions of use must be provided.

D) Activities increase the need for ventilation.

E) Stationary work areas: draft characteristic 2, temperature/effective temperature 21 oC/20 oC.

F) In recess use, the air flow design value is 4 dm3/s, m2.

4. Restaurants and hotels A)

Space/Use	Air temp.	Eff. temp.	Draft char.	Outdoor air rate (transfer air = s)		Return air rate	Sound level
	oC	oC		dm3/s,pers	dm3/s,m2	dm3/s,unit	dB(A)
4.1 Dining room	21	20	3 B)	10	10		40
4.2 Cafeteria	21	20	4 B)	10	10		40
4.3 Bar	21	20	4 B)	10	10		40
4.4 Individual cabinet, meeting room, area < 25 m2	21	20	3	10	4		35
4.5 Hotel room	21	20	2	10	1		30
4.6 Corridors	20	18 B)	5 B)	10	0.5		40
4.7 Lobbies	20	18 B)	3 B)	10	2		40
4.8 Restaurant toilets	21	20			(s)	30/unit	40

A) Return air flow rates of polluted spaces, see "Hygiene spaces".

B) Stationary working areas: draft characteristic 2, temperature/effective temperature 21 oC/20 oC.

5. and 6. Sales rooms, theaters, etc.

Space/Use		Air temp.	Eff. temp.	Draft char.	Outdoor air rate (transfer air = s)		Return air rate	Sound level
		oC	oC		dm3/s,pers	dm3/s,m2	dm3/s,unit	dB(A)
5.1	Foodstuffs store	18 A)	15 A)	4 A)	4	2		45
5.2	Other store	18 A)	15 A)	4 A)	4	2		45
5.3	Store with heavy odor load	18 A)	15 A)	4 A)		4 B)		45
6.1	Auditorium	21	20	2	8			30
6.2	Lobby, foyer	21	18 C)	2	10	5		40
6.3	Stage	21	20	3	8	3		30
6.4	Movie theatre	21	20	2	8			35
6.5	Concert hall	21	20	2	8			27
6.6	Toilet	21	20			(s)	30/unit	40

A) Stationary work areas: draft characteristic 2, temperature/effective temperature 21 oC/20 oC.

B) Based on odor intensity.

C) Ticket stands: effective temperature 20 oC.

7. and 8. Sports halls, swimming halls, garrisons

Space/Use	Air temp.	Eff. temp.	Draft char.	Outdoor air rate (transfer air = s)		Return air rate	Sound level
	oC	oC		dm3/s,pers	dm3/s,m2	dm3/s,unit	dB(A)
7.1 Motion rooms	21	17	4	12	3 A)		40
7.2 Spectator stands	21	19	3	8			40
7.3 Occupied corridors/lobbies	19 B)	17 B)	5 B)	10	7		40
7.4 Unoccupied corridors/lobbies				10	1		50
7.5 Swimming pool hall	27	24	3	14		2 C)	40
8.1 Troop quarters	20	18	3	5	1		35
8.2 Dining room	20	18	4	6	5		45
8.3 Wash rooms	22	22	3		(s)	5/unit	40
8.4 Corridors	18	16	5	4	0.8		40
8.5 Occupied area	21	20	4	10	5, s D)		35

A) Activity requires an increase in the ventilation rate.

B) Working areas, e.g., ticket sales: draft characteristic 2, temperature/effective temperature 21 oC/20 oC.

C) Determined based on the requirement for removing moisture. To be calculated case by case.

D) Transfer air from a corridor may be used.

9. Medical, penitentiary and day care establisments A)

Space/Use	Air temp.	Eff. temp.	Draft char.	Outdoor air rate (trans- fer air = s)		Return air rate	Sound level
	oC	oC		dm3 / s,pers	dm3 / s,m2	dm3 / s,unit	dB(A)
9.1 Hospital ward	22	21	2	8 B)	1.2		30
9.2 Hosp. therapy room	21	20	2		A)	8	30
9.3 Hospital rehabilitation spaces							
	21	20	2			8	35
9.4 Patient dw'lg area	21	20	3	10	3 C)		30
9.5 Child treatm't room	22	21	2	4	2		30
9.6 Treatment room for chronical patients							
	22	21	2	8	2 B)		30
9.7 Corridor	21	20	3	10	C)		35
9.8 Waiting rooms	21	20	3	10	3		35
9.9 Toilets of patient and waiting rooms, flushing room							
	21	19			(s)	30	40
9.10 Detention room	21	19	3	10	2 B)		35
9.11 Prisoner cells	21	19	3	5	1		35
9.12 Interrogation room	21	19	3	5	1		35
Day care homes:							
9.13 Play, rest and group activity rooms							
	21	20	2	5	2		30
9.14 Water game room, kitchen							
	21	20	2	5	2	2/m2	35
9.15 Entrance hall	21	20	3	5	2	2/m2	35
9.16 Wet entrance	21	20	5		(s)	D)	35

A) Ventilation of special spaces, such as therapy rooms, X-ray rooms, equipment maintenance rooms, patient bathing rooms etc., to be designed case by case.

B) A heavier than normal odor intensity probable.

C) The supply air of occupied areas may be also introduced as transfer air through a corridor or the like.

D) A drying cabinet determines the requirement of return air. General return air rate: 2 dm3/s m2.

10. Other public spaces

Space/Use		Air temp.	Eff. temp.	Draft char.	Outdoor air rate (transfer air = s)		Return air rate	Sound level
		oC	oC		dm3/s,pers	dm3/s,m2	dm3/s,unit	dB(A)
	Stations:							
10.1	Waiting rooms	18		3	10	5 A)	5/m2	45
10.2	Corridor				10	3	3/m2	50
10.3	Toilet	21				(s)	30/unit	40
	Exhibition spaces:							
10.4	Commercial exhibition spaces	20 B)	18 B)	3 B)	6	3 C)	3	40
10.5	Museums, art galleries	20 B)	18 B)	3 B)		C)	3	35
	Libraries:							
10.6	Public reading rooms, service areas	21	20	2	4	2		35
10.7	Study rooms	21	20	2	4	1		35
10.8	Lobby	19	17	4	4	1		40
10.9	Store room	19	17			(s)	0.35/m2	45
	Churches:							
10.10	Church hall	19	17	3	6	6		35
10.11	Other public spaces	20	18	3	6	6		35

A) May partly be compensated for by transfer air from integrated sales stands. For dimensioning of ventilation for sales stands in waiting rooms, dimensioning criteria for office or sales rooms shall be applied as deemed appropriate.

B) Stationary working areas: draft characteristic 2, temperature/effective temperature 21 oC/20 oC.

C) Shall be dimensioned case by case according to the highest number of occupants permitted. Facilities to adjust the air flow rates according to varying needs shall be provided.

11. Working spaces, etc.

Space/Use	Air temp.	Eff. temp.	Draft char.	Outdoor air rate (transfer air = s)		Return air rate	Sound level
	oC	oC		dm3/s,pers	dm3/s,m2	dm3/s,unit	dB(A)
Industrial work:							
11.1 Light	20 B)	18 B)	2 B)	10	1.5 B)		
11.2 Medium	17 B)	16 B)	6 B)	10	1.5 B)		
11.3 Laboratories (chemical)	20 B)	19 B)	3 B)	5	1 B)	140/acc. to draft char'tic	40
11.4 Automobile repair shops and inspection houses	17	16	6	4	7 D)	3	
11.6 Vehicle garages E)							

A) For office spaces incorporated in the building, the instructions for office buildings shall be applied.

B) The ventilation system shall be dimensioned for the given air flow rate as minimum. The system may be operated at a lower rating, based on a description of the work performed, which shall be submitted. The process often requires significantly higher air flow rates and local exhaust arrangements, whereby the dimensioning is based on estimated emission rates or heat loads, separately for each individual case. The draft characteristics and the temperatures serve as examples. The nature of work determines the temperature level and the draft characteristic case by case.

C) A lower air flow rate may be permitted based on a survey report submitted on the implementation of the return air system.

13. and 14. Hygiene and other spaces of office, commercial and public buildings

Space/Use	Air temp.	Eff. temp.	Draft char.	Outdoor air rate (transfer air = s)		Return air rate	Sound level
	oC	oC		dm3/s,pers	dm3/s,m2	dm3/s,unit	dB(A)
13.1 Toilet	20				(s)	20/unit	40
13.2 Wash room	22	22	2		(s)	16/unit	40
13.3 Dressing room	21	20	2		(s)	4/locker	40
13.4 Sauna steam room				4		4/pers.	
13.5 Janitorial spaces	18				(s)	4/m2	40
14.1 Garbage room					5	5/m2	
14.2 Elevators A)							
- elevator shaft				4	8 B)		50
- elevator machinery room						16 C)	60

A) Ventilation of elevators shall be arranged in conformance with separate instructions by the Electrical Inspectorate.

B) If transfer air is admitted to the machinery room from the elevator shaft, the air flow rate shall increase correspondingly.

C) To be checked according to the heat load. The temperature in the machinery room shall not exceed 35 oC.

Appendix 2

Instructions for ventilation arrangements in motor vehicle shelters

These instructions apply mainly for car parks. If there are automotive repair or service shops, loading or bus terminals, or other spaces of continuous working activity integrated with the car parks, these instructions cannot be applied directly as such.

The ventilation of motor vehicle shelters shall be arranged so as to eliminate any effects harmful to the health of those using the facilities, as may be caused by air impurities. If automobile queuing may take place because of, e.g., collection of parking fees, or traffic arrangements, the ventilation rate in such congested areas shall be increased with local equipment for auxiliary exhaust. The auxiliary equipment may then be controlled, for example, according to the concentration of CO in the air. If there are working areas in the shelters or in connection thereof, the ventilation shall be arranged according to the requirements for the working areas.

If the motor vehicle shelter is connected to another building, its ventilation shall be arranged to maintain the shelter air pressure lower than that in the adjoining spaces.

Transfer air may be used for motor vehicle shelter supply air.

The supply and return openings shall be arranged so as to ensure sufficient ventilation in all parts of the shelter. The openings shall be located so that air from areas where the air is more heavily contaminated is not unnecessarily spread over other areas. All such areas in the shelter where the air contamination may locally exceed the allowable limits must be eliminated. This may be implemented by means of local exhausts or transfer air fans.

In a mechanical ventilation system, the return air minimum flow rate is

- 0.9 dm3/s m2 in spaces where the ratio of entering vehicles to the number of stalls is at least 1:1 during the busiest 8 hours of a day. Spaces like these are, e.g., car parks of apartment blocks
- 2.7 dm3/s m2 in spaces where the corresponding ratio ranges from 2:1 to 4:1. Such spaces are, e.g., car parks for the personnel of offices and bureaus
- n x 0.9 dm3/s m2 in spaces where the rate of vehicle change is higher. In this equation, n denotes the first term of the ratio described above. Examples of this type of spaces are car park buildings and customer parking facilities of commercial establishments, offices and bureaus

Motor vehicle shelters less than 60 m2 in floor area, and single-row garages

Natural ventilation may be used in single-row garages and motor vehicle shelters with a floor area less than 60 m2.

A single-row garage refers to a motor vehicle shelter inside which motor vehicles are not driven and the depth of which is not to exceed 7 m, except when intended for buses or other long vehicles, 14 m.

The shelter shall be built wholly over the ground level, or equally from ventilation point of view, e.g., on a slope.

The air supply and return openings shall be arranged in a way to ensure sufficient ventilation and air circulation. The supply opening may be located in the lower part of an outside wall or a door. The return air opening is generally located in the upper part of the wall or in the ceiling, opposite the supply air opening.

The free cross sectional area of both supply opening and return opening shall be 0.1 % of the shelter floor area, as a minimum, however, never less than 150 cm2.

If at least 30 % of the wall area of an unheated motor vehicle shelter, say, a car park building, is open and the area of the openings is 10 % or more of the corresponding floor area, no ventilation arrangements need to be made for such a shelter. However, the shelter must, then, not incorporate partitions, beams, etc. which would significantly obstruct the air flow.

The ventilation rate of a motor vehicle shelter may be reduced between the normal load hours, provided that the ventilation is controlled according to the CO content of the air and the shelter is equipped with a separate alarm system. The ventilation system shall switch to operate at full capacity when any one of the sensors detects a CO concentration exceeding 50 ppm. Alarm is obtained when the CO concentration exceeds 70 ppm. A minimum of three sensors shall be in- stalled at each parking level of the shelter, usually in the vicinity of ramps and driveways. The functioning of the sensors shall be inspected regularly, and they shall be recalibrated once every year.