BS EN 15665:2009

Ventilation for buildings — Determining performance criteria for residential ventilation systems

ICS 91.140.30

British Standards

National foreword

This British Standard is the UK implementation of EN 15665:2009.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Lüftung von Gebäuden - Bestimmung von Leistungskriterien für Lüftungssysteme in Wohngebäuden

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Contents

Page

Foreword

This document (EN 15665:2009) has been prepared by Technical Committee CEN/TC 156 "Ventilation for buildings", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2009, and conflicting national standards shall be withdrawn at the latest by September 2009.

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Introduction

Nowadays most ventilation requirements either in regulations or in standards are based on required airflow rates. Also, there is relatively limited knowledge about the basis for ventilation flow rates. Airflow rates are however probably the easiest way to express ventilation requirements.

Nevertheless it is worthwhile to consider in a more detailed way the influence of the dilution due to air change on human exposure, in order to understand the ventilation requirements expressed in terms of flow rates.

Figure 1 explains the process from pollutant to health risk.

This European Standard does not deal with health effects, health risks (linked to noise, tobacco), dose and energy impact.

This European Standard is not intended to design and/or dimension a ventilation system.

This European Standard is intended to support any regulation or standard.

This European Standard is intended to give guidance to those with responsibility for producing requirements and standards for residential ventilation systems.

It is recommended that future revisions of relevant regulations and standards should consider the content of this European Standard.

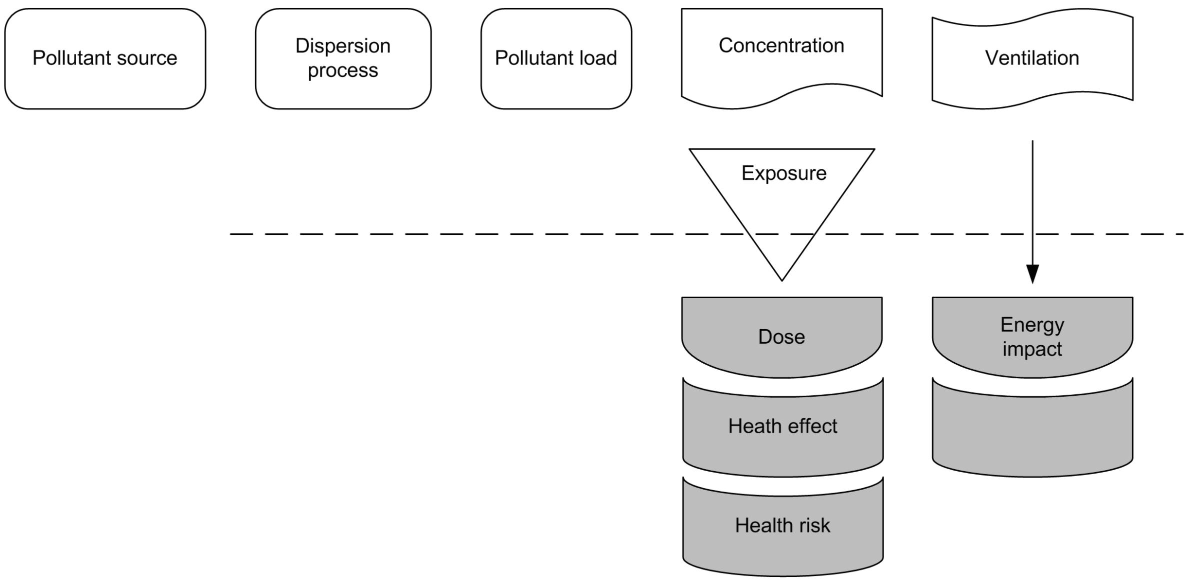


Figure 1 — Pollutant process

1 Scope

This European Standard sets out criteria to assess the performance of residential ventilation systems (for new, existing and refurbished buildings) which serve single family, multi family and apartment type dwellings throughout the year.

This European Standard specifies ways to determine performance criteria to be used for design levels in regulations and/or standards.

These criteria are meant to be applied to, in particular:

- mechanically ventilated building (mechanical exhaust, mechanical supply or balanced system);
- natural ventilation with stack effect for passive ducts;
- hybrid system switching between mechanical and natural modes;
- windows opening by manual operation for airing or summer comfort issues.

This European Standard considers aspects of hygiene and indoor air quality.

Health risk from exposure to tobacco smoke is excluded from this European Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12792:2003, *Ventilation for buildings – Symbols, terminology and graphical symbols*

EN 15242:2007, *Ventilation for buildings – Calculation methods for the determination of air flow rates in buildings including infiltration*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12792:2003 and the following apply.

3.1
background pollutants
group of indoor pollutants which are continuous and diffuse

NOTE 1 These pollutants are represented by materials, furnishings and products used in the dwelling.

NOTE 2 These pollutants also include those resulting from human occupation such as water vapour and carbon dioxide from respiration.

3.2
specific pollutants
group of indoor pollutants which are of short duration, and in specific locations in the dwelling

NOTE These pollutants are mainly represented by water vapour, carbon dioxide and odours, whose production is related to specific human activities in the dwelling (such as cooking, washing, bathing).

3.3
parameter
pollutant or marker that is used in the expression of a requirement

NOTE 1 More than one parameter may be used at the same time and combined.

NOTE 2 Relative humidity, odours, CO_2 are examples of parameters.

3.4
criteria
way (method) to express the required performance

NOTE Criteria can be, for example, numbers of hours above 70 % RH in living room calculated on a standard week basis, number of minutes to reach 25 % of the initial pollution concentration based on a standard pollutant emission in a toilet, average level of CO_2 above outside in bedroom on a 10 hours night with two standard persons.

3.5
requirement
level of required performance

NOTE Requirements can be, for example, "maximum of 100 hours above 70 % in living room", "less than 10 minutes to reach 25 % of initial ", "less than 800 10^{-6} CO_2 (generally named ppm) as an average", "minimum of 8 l/s in toilet", "35 l/s for global ventilation in standard inside/outside conditions".

4 Symbols and units

For the purposes of this document, the symbols and units given in EN 12792:2003 apply.

5 Needs for residential ventilation: main issues

5.1 General

There shall be adequate means of ventilation provided for the building and its occupants.

5.2 General sources of pollutants

The following sources of pollutants influencing the ventilation in dwelling shall be considered:

- Outside environment, such as climate, earth (which can provide radon);
- Human respiration, odours;
- Human behaviour, such as cooking, bathing, drying machine, cleaning;
- Emissions of building materials and furniture;
- Emissions of cleaning material;
- Combustion appliance.

Each of these sources can produce pollutants.

5.3 Consequences of this pollution inside a dwelling

Depending on the pollutant sources given in 5.2, the following consequences can be observed:

a) For the building: risk of condensation, risk of dryness, mould growth, fungi's, dust mites, interstitial condensation;

b) For human health and comfort: carbon monoxide, CO_2 level and water vapour, temperature, air velocity, germs, microorganisms, formaldehydes, VOC (volatile organic compounds), "volatile organic compound, odours, noise from outside.

5.4 Expectations about ventilation

Considering the pollutant sources and their consequences, the adequate means of ventilation should be provided for one or more of the following purposes:

a) Dilution and/or removal of background pollutants such as substances emitted by furnishings and building materials and cleaning materials used in the building, odours, metabolic CO_2 and water vapour;

b) Dilution and/or removal of specific pollutants from identifiable local sources such as toilet odours, cooking odours, water vapour from cooking or bathing, combustion products;

c) Provision of outdoor air for occupants;

d) Provision of control of temperature effects (over heating and draught);

e) Provision of air for combustion appliances.

All these purposes shall be considered with regard to the health and comfort of the occupants and integrity of the building.

NOTE 1 Ventilation is primarily concerned with the first three purposes (a) to c)) but it is linked to the last two (d and e)).

NOTE 2 When providing ventilation, other aspects of performance including thermal comfort, durability, fire safety, noise and energy use should be considered.

6 General approach

6.1 Questions, assumptions and way of proceeding

Before designing a ventilation system, the people involved in regulations and/or standards shall answer lots of questions and assumptions that have to be taken into account for calculation. The result of this calculation can be expressed by a continuous explicit airflow rate (e.g. mechanical ventilation with constant airflow rate) or an equivalent airflow in terms of air quality according to conventional assumptions applicable in each country (e.g. Technical Approvals).

The following way of proceeding shall be used in order to determine airflow rates (see Figure 2):

a) Step 1: verify if there is any applicable regulation (health, fire protection, noise, gas, etc.) in the country that leads to certain limit in airflows;

b) Step 2: identify the parameters which are taken into account or which are considered as relevant;

c) Step 3: at this step of the procedure, take into account the 3 following points:

1) for each parameter, a detailed description shall be made of the nature, sources, distribution and time dependence;

2) for each parameter, the appropriate criteria shall be chosen as described in Clause 7;

3) assumptions for buildings, ventilation systems, outdoor conditions and occupancy patterns shall be described corresponding to the table at the chosen level described in 6.2;

d) Step 4: use the appropriate calculation method able to handle the chosen criteria and assumptions;

e) Step 5: make requirements on the chosen criteria and verify the performance of the calculation results with other applicable requirements (health, fire protection, noise, gas, etc.);

f) Step 6: give results which can be expressed as an equivalent airflow.

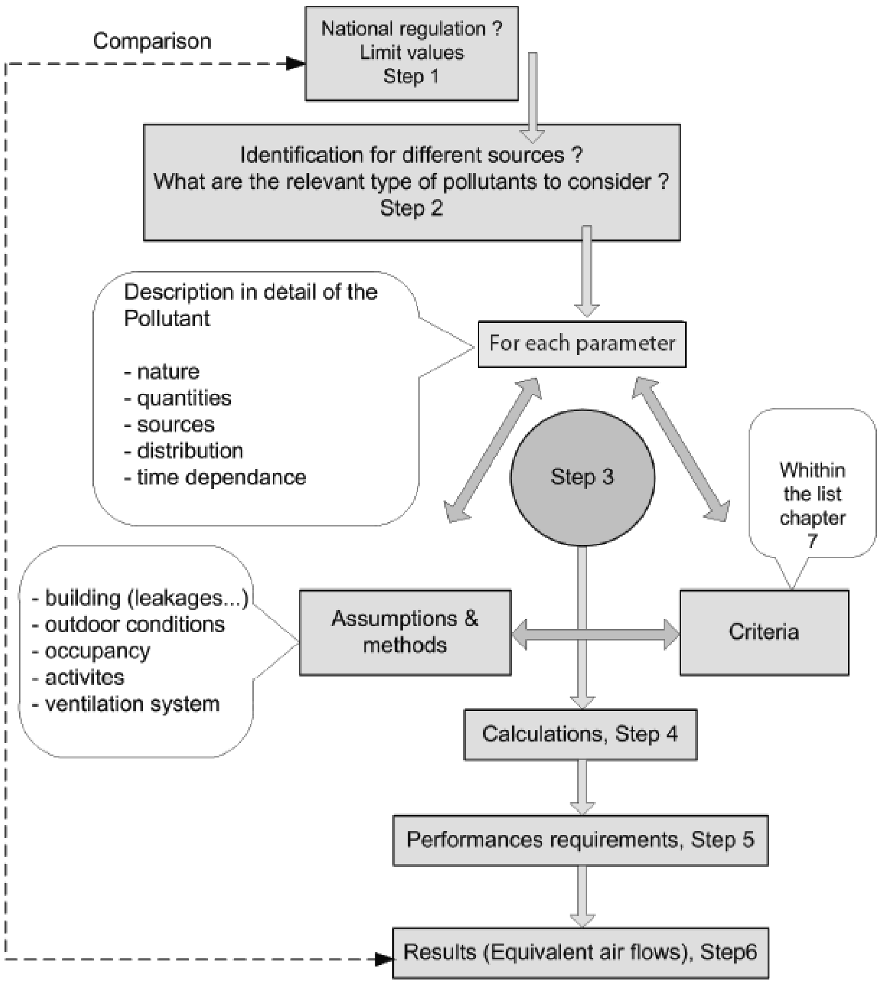


Figure 2 — Way of proceeding for the determination of airflow rates

NOTE The process remains the same but the level of the assumption can be fitted to level 1 to 3; see 6.2.

6.2 Requirements for designing a ventilation system

6.2.1 General

Depending on the parameter taken into account together with the criteria and the building, the appropriate level of calculation method shall be used:

- ventilation airflow rates values (level 1);
- calculation done for one point (level 2);
- yearly calculation done for design days (daily pattern) (level 3).

At each level, different tables shall be completed.

At each corresponding level, criteria shall be chosen between the different ways developed in Clause 7 to explain how parameters are taken into account.

For each level, the number of cases could vary from one case to many (statistical approach), depending on the size of the building, the number of habitants, etc.

NOTE The local ventilation effectiveness may affect the calculation of exposure level.

6.2.2 Assumptions and criteria chosen for ventilation airflow rates values (level 1)

The design regulation or standard shall describe the following relevant items:

a) Type of room:

   1) Type of process for extract and supply air (natural or mechanical);

   2) Floor level.

b) Regime:

   1) Continuous (min, max);

   2) Intermittent (min, max, time schedule);

   3) Closable or not (air inlets).

c) Airflow rate expressed in one of the following expression in Table 1:

   1) l/s per m^2

   2) l/s per person

   3) l/s per room

d) Global airflow rates (including infiltrations).

e) Global air infiltration.

At the level of component (externally and internally mounted air transfer devices, exhaust and supply air terminal devices, etc.) requirements can be expressed in equivalent area mm^2, in airflow at a certain pressure difference ΔP, etc.

Pressure loss due to doors between air inlets and air exhaust shall be taken into account.

Table 1 – Design airflow rates for level 1

Airflow rate in l/s

Room or space	Airflow rate (Normal value)	Airflow rate (Increased value)
Kitchen		
Bathroom		
WC		
Living room		
Bedroom 1		
Bedroom n		
All dwelling		

An example is given in Annex A.

6.2.3 Assumptions and criteria chosen for a single calculation representing point (level 2)

The requirements considered at level 2 are for a single calculation representing point, for example, for an average point in winter to roughly design a shaft natural ventilation airflow.

NOTE A shaft natural ventilation system relies on pressure differences without the aid of powered air movement components.

Assumptions for the case under consideration are given in Table 2. The size of the dwelling under consideration shall be defined as assumptions for the case under consideration.

In case of no specific assumptions, default value shall be used for the calculation, as specified in Table 2.

Table 2 — Assumptions for level 2

Assumptions	Case under consideration	Default value	Unit
Indoor temperature		19	°C
Outdoor temperature		8	°C
Wind speed		1	m/s
Wind direction[a]		60° windward	-
Shielding[a]		shielded	-
Air leakage classes		n_{50} = 1	1/h
Air leakage splitting		See Table 4.	-
Outdoor humidity (optional)			% RH

[a] According to EN 15242.

Clause 6 of EN 15242:2007 shall be used to calculate airflow rates, considering the building and ventilation system characteristics and the distribution of air leakage for each air leakage class as specified in Table 4 and Figure 3.

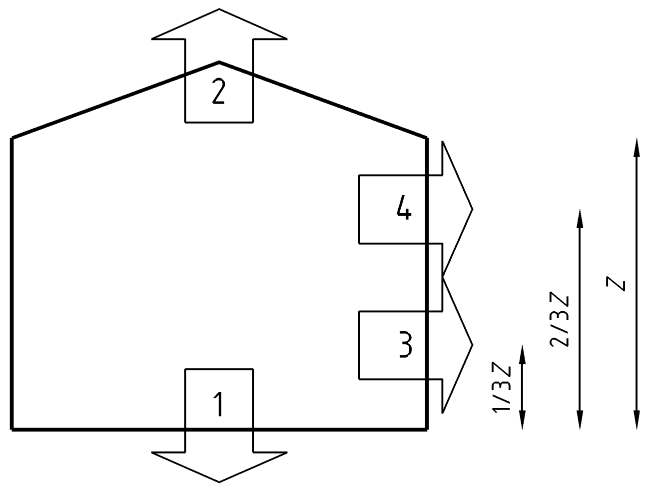
The designer shall specify criteria for the case under consideration as proposed in Table 3.

Table 3 — Criteria for level 2

Parameters[a]	Case under consideration	Default value
Airflow (l/s or m^3/h)		Minimum continuous airflow
[a] Additional parameters and corresponding assumption should be added if necessary.		

Table 4 — Distribution of air leakage (default values)

Distribution single family	Air leakage class, n_{50}			
	< 1	1 to 3	3 to 6	> 6
Floor and other leakages for instance adjacent buildings	20 %	25 %	30 %	35 %
Roof	30 %	35 %	40 %	45 %
Facade (at 1/3 height)	25 %	20 %	15 %	10 %
Facade (at 2/3 height)	25 %	20 %	15 %	10 %



Key

1 Leakage to crawlspace and other dwellings mainly penetrations for plumbing and waste water

2 Leakage through roof and joint roof/wall including penetrations for exhaust

3 Façade leakage cracks and joints between construction parts such as window-frame and walls, but also joints between movable parts concentrated on 1/3 of the height of the facade

4 Façade leakage cracks and joints between construction parts such as window-frame and walls, but also joints between movable parts concentrated on 2/3 of the height of the facade

Figure 3 — Distribution of air leakage

6.2.4 Assumptions and criteria chosen for a yearly calculation done for design days (level 3)

For level 3, assumptions shall be made for one day, at a suitable frequency for all patterns concerning occupancy, outside conditions, ventilation system use or pollutant sources.

NOTE Calculations lead to relationship between airflows and pollutant concentration.

Requirements shall be used in one of the different frames defined in Clause 7.

This level 3 shall be used for daily calculations or for yearly calculations. Each day can have the same or different patterns if needed, e.g. week-end patterns are often used and are different from week patterns.

Airflow rates shall be calculated according to Clause 6 of EN 15242:2007.

Assumptions for the type of the building, the size of the room, occupancy, activity pattern, and human behaviour shall be specified as shown in Table 5. In case no such values are available, the default values given in Table 5 shall be used.

A mean (typical) schedule of human occupancy shall be provided (see example in Annex B).

Humidity, absorption and desorption shall be specified. Humidity and pollutant data shall be available before calculations.

The following assumptions are taken into account in Table 5:

— washing/drying: 1200 g/machine (100g/h for 2 h and 50 g/h for 20 h) (default set frame for drying inside and default value);

- nothing is taken into account for room cleaning;
- for meals: emission during 1 h including dish washing.
- water: 350 g/day for gas cooking for average consumption in the year of 800 kWh for one family.
- CO_2 emissions due to combustion: (g/h) shall not be mixed up with metabolic emissions for determining criteria; the two emissions shall be considered separately.

Table 5 — Assumptions for level 3

Assumptions	Case under consideration	Default value[c]	Unit
Thermal and meteorological assumptions			
Indoor temperature			°C
Outdoor temperature			°C
Wind speed		1	m/s
Wind direction[a]		60° windward	-
Shielding[a]		shielded	-
Outdoor humidity (optional)			% RH
Building assumptions			
Air leakage classes		n_{50} = 1	1/h
Air leakage splitting		See Table 4.	
Occupancy pattern			
Ventilation assumptions			
Ventilation system use pattern			
Pollutant emission[b] (Water)			
Water vapour awake		55	g/h per person
Water vapour sleeping		40	g/h per person
Breakfast		50	g/pers
Lunch		75 (150 WE)	g/pers
Dinner		300	g/pers
Natural gas cooking		350	g/day
Shower[d]		300	g/shower
Washing/drying inside		1200	g/washing
Frequency of shower/pers		1	shower/pers per day
Frequency of washing/pers		1	washing/pers per week
Pollutant emission[b] (Metabolic CO_2)			
CO_2 awake		16	l/h per person
CO_2 sleeping		10	l/h per person

a According to EN 15242.

b In case of calculations, assumptions of one pollutant (or more) is needed, in relation with the criteria chosen for requirements.

c If the parameter is used.

d Drying towels is included in the shower (default value): it is a 6 minutes shower.

7 Criteria

7.1 General

The starting point for the calculation method is to define the most important, or key, pollutant in each type of room in the dwelling. It is assumed that if the key pollutant is adequately controlled, then other pollutants in that room are also adequately controlled. For some rooms, it may not be clear which the key pollutant is, until some calculations have been made.

The following key pollutants shall be taken into account according to the schedule:

— CO_2 (metabolic) or water vapour in low pollution rooms;

— water vapour, odours and CO_2 (from combustion of fuels) in kitchens;

— water vapour in bathrooms and laundry/utility room;

— odours in WC.

Pollutant emission rates shall be calculated for each room separately based on either known emission rates or data given as assumptions in the standard frame defined in Clause 6. This may require assumptions about the number of occupants in the dwelling, the type and rating of combustion appliances, and occupant habits (clothes washing, cooking, bathing, etc).

Humidity is taken into account in separate way due to the fact that it impacts on building independently of occupancy and external value is varying in large proportion. Other particularity is that both too high level and too low level can induce discomfort or impact building.

Criteria shall be chosen among criteria specified in 7.2 to 7.7. These criteria can be associated.

7.2 Threshold or limit of the level

The chosen criteria can be a threshold of the pollutant concentration.

It shall be associated with one or more of the following:

— Time above this threshold during a reference period; a particular value of this time can be zero;

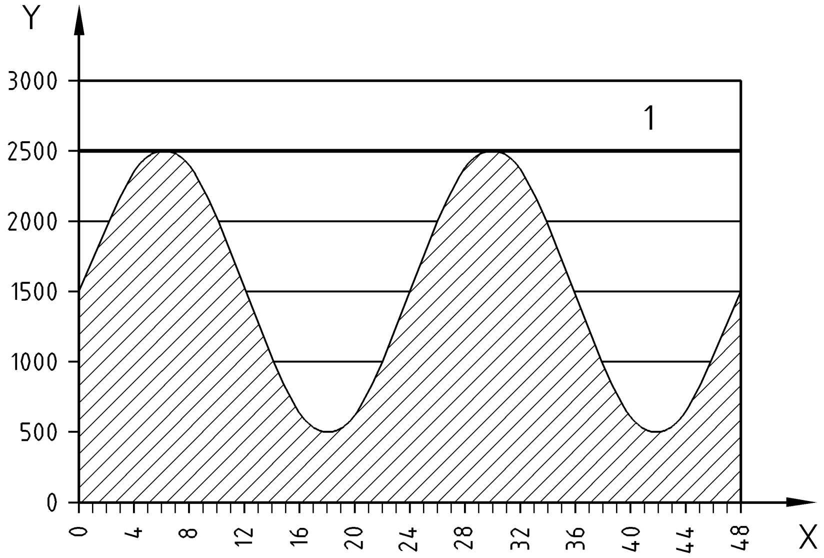
— Maximum continuous duration above this threshold during a reference period;

— Occurence of pollutant concentration has exceeded the threshold value;

— Occurence of pollutant concentration has exceeded the threshold value for a given time during the reference period.

Reference period can be for example, the occupied period, the whole year.

The evolution of concentration pollutant at threshold is illustrated in Figure 4.



Key

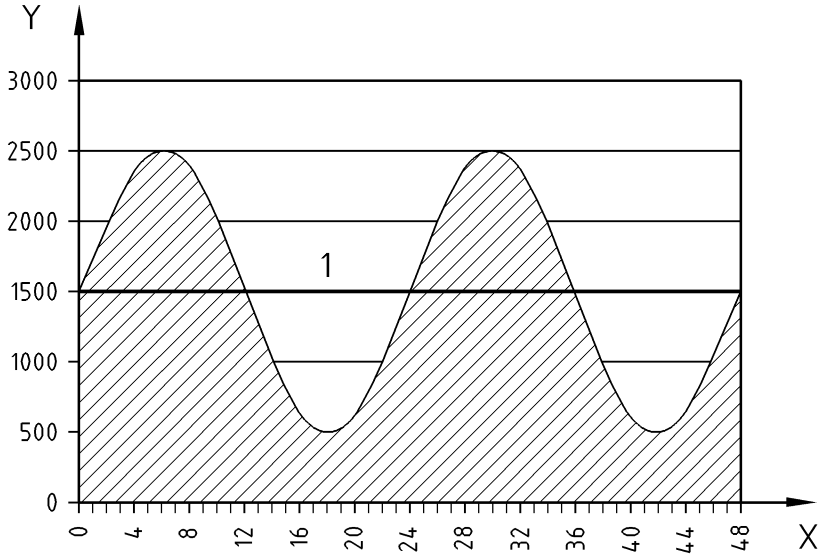
X time, in hours

Y concentrations in ppm

1 threshold

Figure 4 — Example of evolution of maximum concentration pollutant at threshold

Criteria can be the average concentration during a reference period. In this case higher values are compensated by lower values. The evolution of concentration of pollutant at average exposure is illustrated in Figure 5.



Key

X time, in hours

Y concentrations in ppm

1 average

Figure 5 — Example of evolution of concentration of pollutant at average exposure

7.3 Weighted average concentration

The different contributions are weighted (continuous function or discrete values):

In the following example in Figure 6, C is the original concentration.

A discrete weighting can be applied, for example:

C < 1000 : no change : C' = C

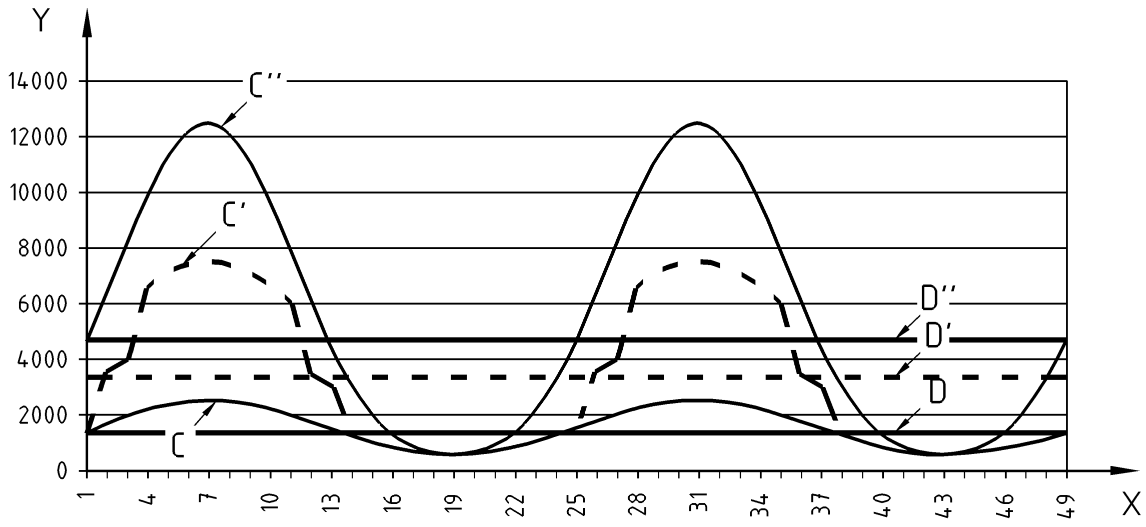
1000 < C < 1500: multiplied by 2 : C' = 2xC

1500 < C < 2000: multiplied by 3 : C' = 3xC

20000 < C : multiplied by 4 : C' = 4xC

A continuous weighting can be applied, for example:

C'' = Cx(C/500):



Key

X time, in hours

Y concentrations in ppm

C the lower curve which is the original concentration

C' the doted line which is the result of the discrete weighting process

C" the continuous line which is the result of the continuous weighting process

The straight lines are the corresponding average values.

Figure 6 — Example of evolution of weighted concentrations and average weighted concentration

NOTE The level of acceptance should be adapted from the weighting method.

The interest of this criterion is to permit a penalisation of high values; any weighting is possible, giving the possibility to choose the levels.

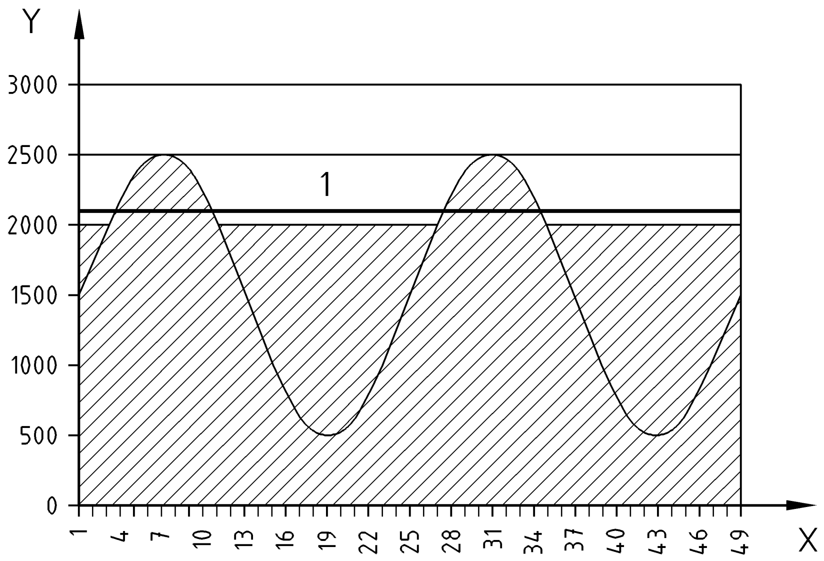
The drawback is to be far from any physical reality and to give arbitrary coefficients that could be discussed.

7.4 Average concentration above a threshold with limited compensation

To calculate the compensated average above a given threshold, one takes equal to the value threshold all the values lower than the threshold. On this basis, the average concentration is calculated.

The interest is to limit the compensation of higher level with lower level.

The evolution of concentration of pollutant at average exposure above a threshold is illustrated in Figure 7.



Key

X time, in hours

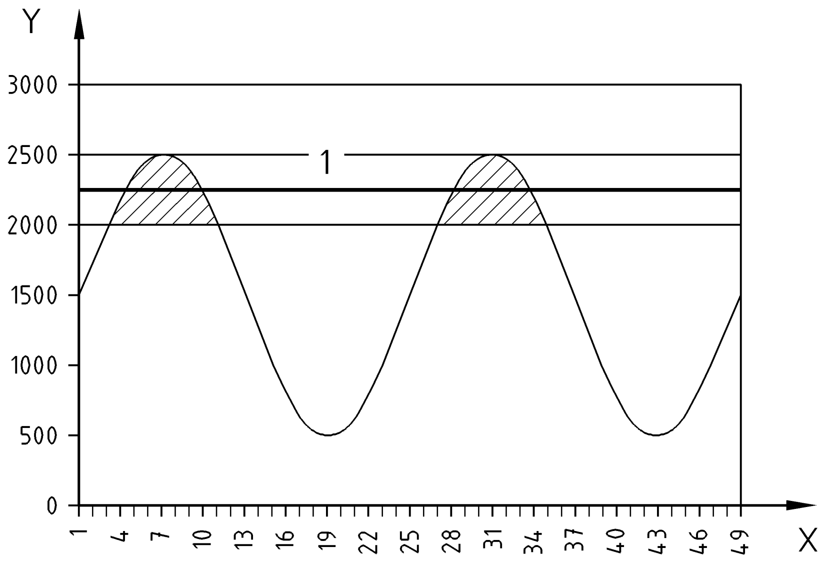
Y concentrations in ppm

1 average above a limit

Figure 7 — Example of evolution of concentration of pollutant at average exposure above a limit

7.5 Average concentration above a limit

The chosen criteria can be the average concentration above a limit value, calculated with the time during which this value is exceeded, as illustrated in Figure 8.



Key

X time, in hours

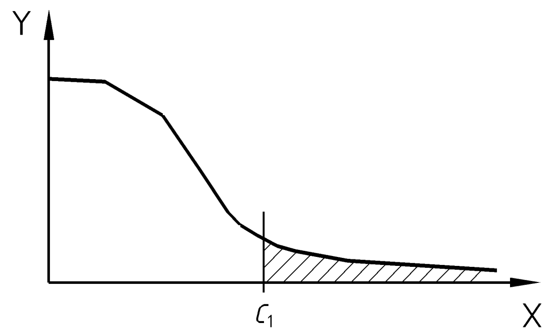
Y concentrations in ppm

1 average above a limit

Figure 8 — Example of evolution of concentration of pollutant and average of concentration above a limit

7.6 Dose above a given value

The chosen criteria can be the integration of time exposure in function of level of concentration, above a given concentration value, as illustrated in Figure 9.



Key

X concentrations in ppm

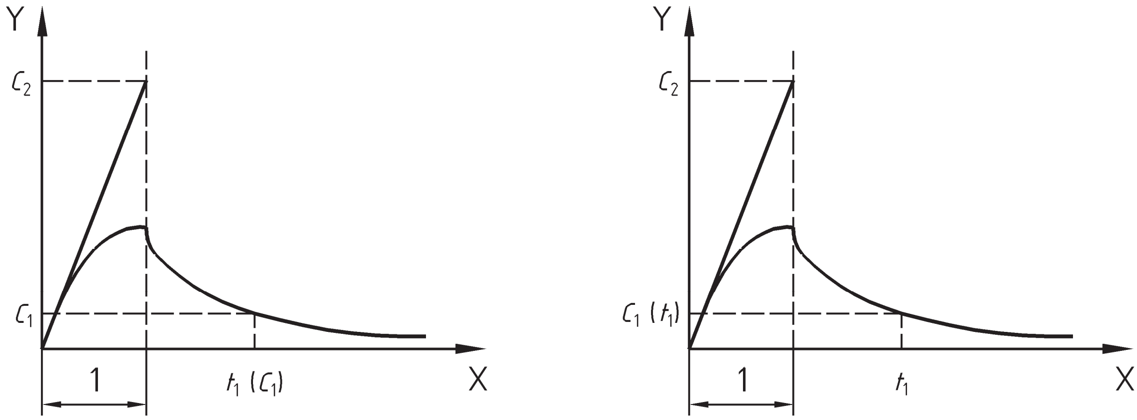
Y number of hour

C_1 given concentration

Figure 9 — Integration of time exposure in function of level of concentration, above a given concentration value

7.7 Decay criteria

Compared to the concentration obtained with non ventilation at the end of emission time, the chosen criteria can be the necessary time to obtain a given percentage of this value (see Figure 10 a) or the level of concentration obtained after a given time (see Figure 10 b)).



Key

X time in hours

Y concentrations in ppm

1 Emission time

C_1 given x% C_2

C_2 $C_{no\ ventilation}$

a) Given % of concentration C_2

Key

X time in hours

Y concentrations in ppm

1 Emission time

t_1 given *t*

C_2 $C_{no\ ventilation}$

b) Given time

Figure 10 — Time to obtain a given percentage of concentration of pollutant (see Figure 10 a)) and level of concentration of pollutant obtained after a given time (see Figure 10 b))

7.8 Use of criteria depending on pollutant

7.8.1 General

Three families of criteria are considered:

— criteria for humidity,

— criteria for specific activities such as cooking, odours in toilets, hobbies, humidity due to shower or cooking, and

— criteria for background pollutant emission other than water vapour due to respiration such as CO2 from metabolism, VOC from furniture and building materials.

Humidity is dealt with separately because it is the source of main problems in the residential and contrary to other parameters, the humidity level presents a safe and comfortable zone rather than a single limit.

7.8.2 Criteria for humidity

— Number of hours under a certain limit;

- Maximum duration under a certain limit;
- Number of times the level has been above or under a certain limit for more than a certain duration;
- Number of hours above a certain limit;
- Maximum duration above a certain limit;
- Number of times the level has exceeded a certain limit for more than a certain duration.

NOTE These limits may be dynamic values and not single value (for example: condensation on a single glazing, a double glazing, or any value that may be considered as a cold bridge, in a yearly calculation).

7.8.3 Criteria for specific activities

- Time to obtain a given percentage of the maximum value;
- Value (percentage of maximum) after a certain time;
- Dose above a certain value;
- Average;
- Average above a threshold.

The reference time has to be chosen in relation to the emission time; an average on one week for toilets is meaningless.

7.8.4 Criteria for background pollutant

- Maximum (peak) limit;
- Average;
- Weighted average;
- Average above a certain limit;
- Dose above a certain value.

NOTE 1 The limits can be taken as an absolute value if there is a direct impact on IAQ or as a level above the outside value if the pollutant is tracked as a metabolic (or activity) tracer.

NOTE 2 The reference time should be chosen in relation to the impact of the pollutant on occupants.

Annex A
(informative)

Example of general requirements (from Switzerland)

A.1 General requirements for all ventilation systems

A reduced stage of operation is planned if the dwelling is not occupied. Min. air change 0.2 h^{-1}.

Increased airflow: increasing airflow rate in each living room, bedroom and kitchen has to be a possibility e.g. by opening windows.

The dimensioning of the ventilation system is based on the usual occupation (normal value).

A.2 Exhaust ventilation systems

A.2.1 General

Externally mounted air transfer devices are required for each room (living room and bedrooms).

The "All Dwelling value" of the exhaust airflow is approximately 1/3 higher than the sum of the supply airflows through the externally mounted air transfer devices. The difference (equal to above 1/3 of the airflow through the externally mounted air transfer devices) is caused by infiltration. The exact values can be calculated, if the air permeability of the building is known.

A.2.2 Requirements for devices (only for exhaust ventilation systems)

Pressure loss of externally mounted air transfer devices:

— dwellings with one floor: 4 – 5 Pa;

— dwellings with two floors: lower floor 6 Pa, upper floor 3 Pa.

These values include the pressure loss of filters.

NOTE It is not defined if the filter is new or used.

Pressure loss of internal air transfer devices: max. 1 Pa.

Min. supply airflow (trough externally mounted air transfer devices) in each living room and bedroom: 8.3 l/s.

Openings are usually not closable.

A.2.3 Mechanical Ventilation (with supply and exhaust fans)

The airflows are determined in four steps. By normal occupation it is assumed that the ventilation runs all day long (24 hours) one the same stage (normal stage).

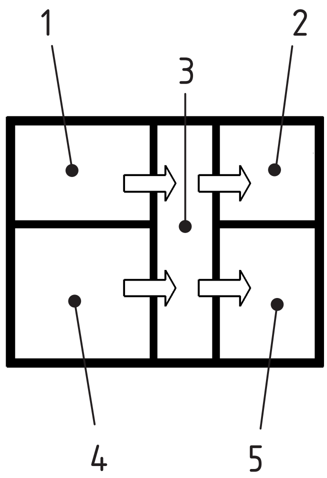
a) Step 1: Minimum all dwelling supply airflow

The value depends on the dwelling pattern. There are two tables for the determination of the minimum "All Dwelling value". Table A.1 shows the values for dwellings without a room in the air transfer area (Figure A.1). Table A.2 shows the values for dwellings with a room in the air transfer area (Figure A.2).

Table A.1 — Minimum supply airflow for all the dwellings without a room in the transfer area (see Figure A.1)

Number of rooms[a]	Occupation (persons)[b]	All dwelling supply airflow l/s
1	1	10
2	1	16,7
	2	19,4
3	2	25
	3	27,8
4	3	33,3
	4	37,5
5	4	41,7
	5	47,2

[a] The number of rooms includes living rooms and bedrooms.
[b] "Occupation (persons)" means the assumed occupation.



Key

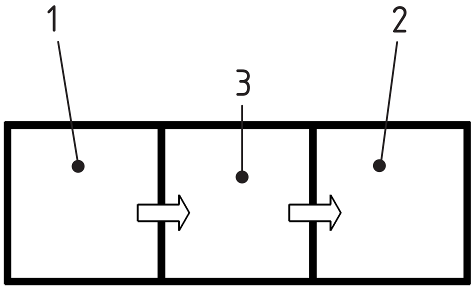
1 Bedroom
2 Bathroom/WC
3 Corridor
4 Living room
5 Kitchen

Figure A.1 — Example of dwellings without a room in the transfer area

Table A.2 — Minimum supply airflow for all the dwellings with a room in the transfer area (see Figure A.2)

Number of rooms[a]	Occupation (persons)[b]	All dwelling supply airflow l/s
2	1	11,1
	2	16,7
3	2	19,4
	3	25
4	3	27,8
	4	31,9
5	4	36,1
	5	38,9

[a] The number of rooms includes living rooms and bedrooms.
[b] "Occupation (persons)" means the assumed occupation.



Key

1 Bedroom
2 Kitchen, bathroom/WC
3 Living room

Figure A.2 — Example of dwellings with a room in the transfer area

b) Step 2: Minimum All Dwelling exhaust airflow

This is the sum of the minimum exhaust airflows of all wet rooms (kitchen, bathroom, WC).

Values are given in Table A.4.

c) Step 3: Relevant all dwelling airflow

The higher of the values from step 1 and step 2 is relevant.

The lower value has to be increased at the level of the higher value.

d) Step 4: Determination of the airflows of the rooms

The "All Dwelling values" of exhaust and supply airflow have to be distributed to the individual rooms.

Supply airflow:

1) Minimum value for living rooms and bedrooms: 8,3 l/s;

2) Maximum value for bedrooms with two persons: 11,1 l/s;

3) Exhaust airflows: minimum values in accordance to Table A.4.

— ***Stages***

Beside the normal stage a stage for reduced airflow has to be taken into account (e.g. for low outside temperature and risk for too low humidity). The reduced stage has to provide each bedroom with a minimum supply airflow of 5 l/s.

— ***Internal air transfer devices***

Maximum pressure loss: 3 Pa.

A.3 Assumptions and criteria chosen for ventilation airflow rates values (level 1)

A.3.1 Exhaust ventilation systems

Tables A.3 and A.4 give, respectively, the description of exhaust ventilation systems and an example of airflows values from Swiss regulation in accordance with 6.2.2, for level 1.

Table A.3 — Description of exhaust ventilation systems

Exhaust	Supply	Regime	Minimum global airflow rate	Infiltration	Air transfer
Mech.	. (negative pressure, due to exhaust fan)	Continuous	No	Yes	Yes

Table A.4 — Design airflow rates for level 1 for exhaust ventilation systems

Airflow rate in l/s

Room or space	Airflow rate (Normal value)	Airflow rate (Increased value)
Kitchen	11,1	16,7
Bathroom	11,1	16,7
WC	5,6	8,3
Living room	8,3	12,5
Bedroom	8,3	12,5
All dwelling	-	-

A.3.2 Mechanical ventilation (with supply and exhaust fans)

Tables A.5 and A.6 give, respectively, the description of mechanical ventilation (with supply and exhaust fans) and an example of airflows values from Swiss regulation in accordance with 6.2.2, for level 1.

Table A.5 — Description of mechanical ventilation (with supply and exhaust fans)

Exhaust	Supply	Regime	Minimum global airflow rate	Infiltration	Air transfer
Mech.	Mech.	Continuous	Yes	Yes	Yes

Table A.6 — Design airflow rates for level 1 for Mechanical Ventilation (with supply and exhaust fans)

Airflow rate in l/s

Room or space	Airflow rate (Normal value)	Airflow rate (Increased value)
Kitchen	11.1	16.7
Bathroom	11.1	16.7
WC	5.6	8.3
Living room	8.3	12.5
Bedroom	8.3	12.5
Bedroom especially for 2 persons	8.3 – 11.1	12.5 – 16.7
All dwelling	See Table A.1 and Table A.2	1.5-times normal value

Annex B
(informative)

Example of occupancy scenario

		week																							
		person 1								person 2								person n							
hour		liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc
0	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
1	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
2	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0

week

		person 1								person 2								person n							
hour		liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
3	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
4	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
5	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0

week

		person 1								person 2								person n							
hour		liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc
	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	0	S	0	0	0	0	0
6	0	0	0	0	0	0	A	0	0	0	0	0	0	0	0	A	0	0	0	S	0	0	0	0	0
	0	0	0	0	0	0	A	0	0	0	0	0	0	0	0	A	0	0	0	S	0	0	0	0	0
	0	0	0	0	0	0	0	A	0	0	0	0	0	0	A	0	0	0	0	S	0	0	0	0	0
	0	0	0	0	0	0	0	A	0	0	0	0	0	0	A	0	0	0	0	S	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

week

		person 1								person 2								person n							
hour		liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0
	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0

week

		person 1								person 2								person n							
hour		liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

week

		person 1								person 2								person n							
hour		liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A	0	0	0	0	0
18	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	0	0	A	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	0	0	A	0	0	0	0	0
19	0	0	0	0	0	0	A	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
	0	0	0	0	0	0	A	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
	0	0	0	0	0	0	A	0	0	A	0	0	0	0	0	0	0	0	0	A	0	0	0	0	0

week

		person 1								person 2								person n							
hour		liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc
	0	0	0	0	0	0	A	0	0	A	0	0	0	0	0	0	0	0	0	A	0	0	0	0	0
20	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
21	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	0	0	A	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	0	0	A	0	0	0	0	0
22	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	0	0	S	0	0	0	0	0
	0	A	0	0	0	0	0	0	0	A	0	0	0	0	0	0	0	0	0	S	0	0	0	0	0
23	0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	S	S	0	0	0	0	0

	week																							
	person 1								person 2								person n							
hour	liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc	liv	bedA	bedS	bed3	bed4	kit	bath	wc
0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	S	S	0	0	0	0	0
0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	S	S	0	0	0	0	0
0	0	S	0	0	0	0	0	0	0	S	0	0	0	0	0	0	0	S	S	0	0	0	0	0

Key

S Sleeping

A Awake

Figure B.1 — Example of occupancy scenario

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