CLASSIFICATION OF INDOOR ENVIRONMENT 2008
Target Values, Design Guidance, and Product Requirements

Classification of Indoor Environment 2008 is intended for use in construction and building design and in associated contracting, as well as by the building materials industry, in striving for healthier and more comfortable buildings. The classification can be used for new constructions and, when applicable, also for renovation. Classification of Indoor Environment 2008 replaces Classification of Indoor Environment 2000.

TABLE OF CONTENTS
FOREWORD
USE OF THE CLASSIFICATION
  1 THE TARGET VALUES FOR INDOOR ENVIRONMENT (S)
    1.1 Area of application
    1.2 Indoor environment categories
    1.3 Technical target values of the indoor environment during the use of the building
      1.3.1 General
      1.3.2 Thermal environment target values
      1.3.3 Target values for indoor air quality
      1.3.4 Target values for acoustic environment
      1.3.5 Lighting target values
      1.4 Verification of the requirements of the classification
      1.4.1 Using the classification in agreements
      1.4.2 Applying the classification to facility management agreements
  2 GUIDANCE FOR DESIGN AND CONSTRUCTION
    2.1 Construction clients
      2.1.1 Setting the target
      2.1.2 Design control
      2.1.3 The classification in construction documents
    2.2 Construction design and choice of construction materials
      2.2.1 Building and structural design
    2.3 Construction site design
      2.3.1 General
      2.3.2 Water and moisture control plan
      2.3.3 Classification of construction cleanliness (P)
      2.3.4 Assessing the cleanliness of a building
      2.3.5 Classification of construction work cleanliness – implementation instructions for class P1
    2.4 Designing mechanical systems for buildings
      2.4.1 Designing the heating and cooling system
      2.4.2 Designing the ventilation system
      2.4.3 Cleanliness classification of air-handling systems (P)
  3 REQUIREMENTS FOR BUILDING PRODUCTS
    3.1 Emission classification of building materials (M)
      3.1.1 General
      3.1.2 The emission classes of building materials
      3.1.3 Measurement methods
      3.2 Cleanliness classification of air-handling components
        3.2.1 General
        3.2.2 Cleanliness requirements for air-handling components
  4 REFERENCES
FOREWORD

Good indoor environment is one of the most important objectives of construction. Indoor climate quality is affected equally by heating, ventilation, and air-conditioning equipment; construction engineering; the quality of the construction work; building materials; and the use and maintenance of the building. Good indoor environment requires taking all of these elements into consideration in all stages of the design, construction, and use of the building.

The Classification of Indoor Climate, Construction and Finishing Materials was published in 1995 (FiSIAQ 1995), and its updated version was published in 2001 under the title Classification of Indoor Climate 2000. The classification system described in these works has entered wide use for determination of indoor climate targets for office and public buildings. Finland has taken a significant step toward healthier indoor climate with respect to building materials’ emissions. By December 2008, the Finnish Building Information Foundation RTS had granted the M1 label in accordance with the Emission classification of building materials for over 1,300 building materials. The Classification of construction work cleanliness has also entered more common use. Doctoral theses on the use of the indoor climate classification system (Tuomainen 2001, Järnström 2007) have indicated that the quality of indoor air can be improved by paying attention to the goals of the indoor climate classification scheme and by following its instructions. In view of this information and practical experience, this classification replaces certain difficult-to-design and difficult-to-verify measures with more detailed design and implementation instructions. Measurable targets have been set for the cleanliness of construction work. The target values for thermal environment and ventilation have been detailed further in response to recent research and international standards. Target values for acoustics and lighting have been introduced as a completely new item in the classification.

Classification of Indoor Environment 2008 has been prepared by the Finnish Society of Indoor Air Quality and Climate (FiSIAQ) under the supervision of Jorma Säteri, M.Sc. (Eng.). The manuscript team included Tarja Andersson, Master of Hospitality Management; Valterri Hongisto, Doctor of Technology; and Jarek Kumitski, Doctor of Technology. This document replaces Classification of Indoor Climate 2000 (LVI 05-10318, RT 07-10741/RT 07-10790, Ratu 424-T, KH 27-00337), prepared by Jorma Säteri and Harri Hahkala, M.Sc. (Eng.) in 2001. The work was funded by the Ministry of the Environment, the Finnish Society of Indoor Air Quality and Climate, Fläkt Woods Oy, HB Sisäilmatutkimus Oy, and Sisäilmamestarit.

The managing committee for the project was the main committee for the indoor climate classification (PT 17) of the Building Information Foundation RTS, whose members were Risto Ruotsalainen (Allergy and Asthma Federation) as chairman, Jacob Fellman (Paroc Oy Ab), Gunnar Forsman (marit Oy Ab), Jari Inkinen (Sisustusarkkitehdit Gullstén & Inkinen Oy), Ari Ilomäki (Finnish Forest Industries Federation), Vesa Juola (The Association of Finnish Architects’ Offices ATL), Kaisa Kauko (Ministry of the Environment), Esko Kukkonen (Asum), Kari Kulmala (Finnish Hardware Association), Eero Palomäki (Finnish Institute of Occupational Health), Pertti Pasanen (Kuopio University), Jorma Railio (Finnish Association of Mechanical Building Services Industries FAMBSI), Mikka Ronkainen (Kiito Oy), Hannele Rämö (Association of Residential Hygiene, AsTe ry), Kristina Saarela, Jukka Sainio (Leo Maaskola Engineering), Tiina Strand (Building Information Ltd), Leif Wirtanen (Tikkurila Oy), Riikka Vitakoski (Finnish Association of Building Owners and Construction Clients RAKLI ry), Pekka Vuorinen (Confederation of Finnish Construction Industries RT), and Laura Sariola (Building Information Foundation RTS) as secretary.

Public hearings of the Classification of Indoor Environment for comments were held in the summer of 2008. The written statements are taken into account in this completed version of the classification. It is supported by the Finnish Association of Building Owners and Construction Clients RAKLI ry, the Finnish Association of Architects SAFA, the Association of Finnish Architects’ Offices, and the Finnish Association of Consulting Firms SKOL, all of whom recommend that their members use the classification to improve construction quality.

Espoo, December 2008

Finnish Society of Indoor Air Quality and Climate
Building Information Foundation RTS
Finnish Association of Architects SAFA
Finnish Association of Building Owners and Construction Clients RAKLI ry
Finnish Association of Consulting Firms SKOL
USE OF THE CLASSIFICATION

Classification of Indoor Environment 2008 is intended for use in construction and building design and in associated contracting, as well as by the building materials industry, in striving for healthier and more comfortable buildings. The classification can be used for new constructions and, when applicable, also for renovation. The classification specifies target and design values for indoor climate and supports the work of developers, designers, equipment manufacturers, contractors, and maintenance personnel. It can be referred to in preparation of construction and mechanical specifications (appendix cards to building specification models and mechanical specification models). The classification supplements the National Building Code of Finland, Code of Building Practice RYL (Maaalauksen RYL 2001, RunkoRYL 2000, SisäRYL 2000, Talotekniikan RYL 2002), Model Specifications for Constructions (RT 15-10723), Model Specifications for HVAC Systems of Buildings (LVI 03-10360), the General Agreement between Contractors (RT 16-10699, LVI 03-10299), RT and HVAC standards sheets published by the Building Information Foundation RTS, and other documents related to construction. The classification does not overrule official building codes or interpretations of them.

The first part of the classification, ‘Target values for indoor environment’, deals with thermal climate, air pollutants, and the acoustic and lighting environment. It is limited to factors about which there is information based on research or building practice such that guideline values can be given. The factors presented in the classification can be measured by generally approved methods at a reasonable cost. In addition to the target values, the classification gives the most important indoor climate design values for heating, cooling, ventilation, and air-conditioning equipment and systems. The design values for thermal climate are based on design weather, which is also defined.

The second part of the classification, ‘Guidance for design and construction’, addresses the principles and procedures to be followed in the design of the building and the various stages of construction. Guidelines are necessary to ensure that the indoor climate objectives are taken into consideration in all stages of construction. The procedures presented are intended mainly for construction and mechanical contractors, but they also include requirements for design, equipment manufacturing, and maintenance.

The third part of the classification, ‘Requirements for construction products’, is intended to enhance the development and use of low-emission building materials and clean air-handling equipment. Building materials are characterised only from the chemical emissions standpoint. The emission classification of building materials presents limit values for emissions of building materials and their classification. The cleanliness classification of air-handling components presents the general requirements for the cleanliness of air-handling equipment and detailed requirements for ventilation ducts, fittings, air and fire dampers, and filters, as well as sound attenuators (silencers). Special requirements concerning hygiene have been presented for other components.

Setting the indoor environment targets

The targets, requirements, and instructions of the classification shall be taken into consideration at all stages of the construction project. The developer chooses the target values for the indoor environment in collaboration with the design team. The target values are chosen for each construction project from the values presented in the section ‘Target values for indoor environment, either by choosing all the values from the selected category or by setting individually considered values for various parameters. In order to reach the desired result, the developer shall control design by explicitly recording the desired indoor environment targets (for example, with the help of the classification) and making them known to all of the designers. Each member of the design team shall take care that the decisions made concerning the selected indoor environment class are presented in the following documents: drawings, work specifications, the supplement to the construction contract, and the quality control plan for the construction site. The principal designer is responsible for ensuring that the documents are free from contradictions also as regards the design details chosen for the indoor environment.

After setting the targets for the indoor environment, the design team shall describe the technical solutions with which the targets will be achieved. For advice, the design team may refer to Part 2 of this document, ‘Instructions for design and construction’. For the design and control of construction work, the construction cleanliness class and the cleanliness class of air-handling systems shall be chosen (either by choosing all of the requirements from the selected class or by setting individually considered values for various factors). For the selection of building materials, the emission class for the building materials and the cleanliness class of air-handling components shall be chosen. Meeting the targets does not require the use of certain specified technical solutions. All solutions that meet the requirements are possible. In the Finnish climate and with present heat loads indoors, indoor environment category S1 requires, in practice, mechanical cooling and room control of indoor temperature. Indoor environment category S2 may be achieved via skilled building design without mechanical cooling. In indoor environment category S3, the room temperature may be highly elevated in warm weather because of solar radiation and other heat loads. When necessary, individual target values may be selected from different classes.

The target values for indoor environment (S)

<table>
<thead>
<tr>
<th>Guidance for design and construction (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructions for developers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Requirements for building products (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building and structures</td>
</tr>
<tr>
<td>Instructions for construction and structural design</td>
</tr>
<tr>
<td>Classification of construction cleanliness (P)</td>
</tr>
<tr>
<td>Requirements for moisture control</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical systems for buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design values</td>
</tr>
<tr>
<td>Cleanliness classification of air-handling systems (P)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emission classification of building materials (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission criteria</td>
</tr>
<tr>
<td>Other requirements</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cleanliness classification of air-handling components (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General requirements</td>
</tr>
<tr>
<td>Requirements for each component group</td>
</tr>
</tbody>
</table>

Figure 1. The structure of the Classification of Indoor Environment.
1 THE TARGET VALUES FOR INDOOR ENVIRONMENT (S)

1.1 Area of application

The classification is intended for the setting of indoor air targets concerning usual work and occupied spaces (including office and public buildings, schools, day-care centres, dwellings, and similar buildings). Exceptional requirements for certain rooms or requirements for special spaces are not presented in the classification. They shall be specified individually when one is selecting suitable categories.

The purpose of the classification is to help the user, building owner, developer, and designer of the building to set the target levels for indoor environment. Based on current knowledge of health and comfort, the target levels specified in the classification describe safe indoor environment conditions, the quality of which exceeds the requirements set by authorities.

The classification is intended primarily for setting of indoor environment targets for new structures, but it may be applied to targets for renovation projects as well.

Some of the target values for indoor environment can be included in facility management agreements. In such a situation, it is recommendable to determine the factors to be used in the agreement in question (e.g., temperature or CO2 concentration) instead of using only the titles of categories (such as ‘S1’).

The classification is not an official code or an interpretation of one. The factors mentioned in the classification bind the contracting parties only to the extent in which they are specifically referred to in the contract documents for the construction project. The most important contract documents that may refer to the classification are the preliminary lease agreement / declaration of intent between the owner and user, consulting contracts, and construction contracts (supplement to the construction contract, technical specifications, and contract drawings). In addition, issues of the classification are presented in the quality control plan for the construction site. The contract documents shall refer to the classification as explicitly as possible. For example, besides mentioning the selected indoor environment category, the work specifications should also include the requirements for attaining the category in question.

Indoor environment requirements shall be taken into consideration in the construction project in the same manner as any other performance requirements. The developer chooses the most appropriate target level, and the design team specifies the details through which the selected target level can be reached. The contractor constructs the building according to plans. Reaching of the target levels is ensured by monitoring the construction work's conformance with the design values.

This classification is based on measurement methods and codes in force in Finland as of December 2008.

1.2 Indoor environment categories

The target values in the classification have been set such that category S3 corresponds to the requirements set by the Land Use and Building Act (LVIYM-00365, RTYM1-21357, KHYM-10488) and the Health Protection Act 309/2006 (LVI STM-00341, RT STM-21319, KH STM10460). According to present knowledge, an indoor environment manifesting this category's target values should not cause healthy people health impediments when the ventilation of the building runs as planned and no exceptional pollution sources exist.

The classification has three categories: categories S1, S2, and S3. Category S1 corresponds to the best quality, meaning higher satisfaction. Setting clear goals for indoor environment promotes solid collaboration between the various actors and therefore reduces the risk of problems compromising health or comfort.
1.3.1 General

Tables 1.3.1...1.3.5 present the technical target values for the indoor environment factors that are used to specify the target level for indoor environment during the design phase of the construction project. The target values apply to the occupied zone of a room (with respect to the speed of air, 0,1 m from the workbench at an elevation of 1,1 m), which usually extends from the floor surface up to 1,8 metres and begins at 0,6 metres from the walls (see National Building Code of Finland, Part D2). Sound pressure levels are inspected usually at a height of 1,2 or 1,5 m from the floor surface. Measurements of airborne sound reduction index, impact sound insulation and the reverberation time factor can be specified separately.

1.3.2 Thermal environment target values

Outdoor temperature tu refers to the floating 24-hour average for outdoor air at the closest weather observation site. Outdoor temperature tumax refers to the average of the outdoor temperature over a maximum period of five hours. At the request of the user of the space, the temperature may be allowed to fall below the target or rise above it in the summer. The temperature must remain within the allowable deviation range from the target value for the time required by the stability of the environment calculated from the planned time of use of the building. The floating one-hour average temperature must not fall below the minimum or exceed the maximum values with the planned use at design temperatures.

The temperature can be measured, for example, with a liquid thermometer or an electric sensor in the occupied zone at an elevation of 1,1 m (0,6 at the workbench) according to standard SFS 5511 (LVI 014-10187, SFS-käsikirja 103). Instead of the operative temperature, the room temperature can be inspected. However, if the surface temperatures clearly differ from the air temperature (e.g., in cases of a poorly insulated shell, two-pane windows, large windows, several exterior walls, unheated space below the floor, solar radiation, floor heating, ceiling heating, and a cooling ceiling), the operative temperature is determined by calculation from the air and surface temperatures or by measurement with a globe thermometer according to the standard SFS 5511 (LVI 014-10187, SFS-käsikirja 103).

1.3.3 Target values for indoor air quality

The carbon dioxide concentration target applies to carbon dioxide from humans and is measured with an infrared meter, for instance. The ambient concentration is included in the target value.

The radon concentration in the room air for new residences as specified by the Ministry of Social Affairs and Health shall not exceed 200 Bq/m³. The annual average concentration of radon is determined in the target value.

1.3.4 Target values for noise environment

The category-S1 and category-S2 targets shown in Section 1.2 are primarily met if the building implementation adheres to the procedures of Part 2 of this classification and building materials and air-handling components meeting the requirements of Part 3 are used. In addition, the air-handling system of the building shall fulfil the design values presented in Subsection 2.4.2 and shall be free from any specific pollution sources.

The target values presented below may be used for the measurement and inspection of indoor air quality.

---

<table>
<thead>
<tr>
<th>Table 1.3.1. Target values for thermal environment.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S1</strong></td>
</tr>
<tr>
<td><strong>Operative temperature</strong> t&lt;sub&gt;op&lt;/sub&gt; [°C]</td>
</tr>
<tr>
<td>t&lt;sub&gt;u&lt;/sub&gt; ≤ 10 °C</td>
</tr>
<tr>
<td>10 &lt; t&lt;sub&gt;u&lt;/sub&gt; ≤ 20 °C</td>
</tr>
<tr>
<td>t&lt;sub&gt;u&lt;/sub&gt; &gt; 20 °C</td>
</tr>
<tr>
<td><strong>Deviation allowed from set value</strong> [°C]</td>
</tr>
<tr>
<td><strong>Maximum value of operative temperature</strong> [°C]</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Minimum value of operative temperature</strong> [°C]</td>
</tr>
<tr>
<td><strong>Stability of environment [% of operating time]</strong></td>
</tr>
<tr>
<td>• office and school spaces</td>
</tr>
<tr>
<td>• residential spaces</td>
</tr>
</tbody>
</table>

<sup>1)</sup> In category S1, the operative temperature shall be adjustable in each room/apartment within t<sub>op</sub> ± 1,5 °C. If several people occupy the same room, the target level of the room temperature shall be the target value shown in the table.
### 1.3.4 Target values for acoustic environment

The acoustic environment of the building is designed according to standard SFS 5907 'Acoustic classification of spaces in buildings'. In this standard, class A refers to the highest target level and class C to the lowest, minimum level. The acoustic class of the space is determined separately for each space. In indoor environment category S2, class C is the target but targets from class B can also be selected for individual spaces. In indoor environment category S2, class B is the target but targets from classes A and C can also be selected for individual spaces. Table 1.3.4 presents examples of the target values of acoustic design corresponding to categories S1, S2, and S3.

### 1.3.5 Lighting target values

The lighting of indoor workbenches is designed according to the SFS-EN 12464-1 standard. The standard only presents the minimum requirement level, so the general lighting is designed according to the same basic criteria in categories S1 and S2. In the S1 category, the workbench lighting must be user-adjustable. Lighting intensity, evenness, glare index, and colour reproduction index values conformant to the tables in SFS-EN 12464-1's Section 5 are set for the spaces, according to their intended use.

In addition to what is specified in the standard, the following, additional requirements are set for residential spaces in this indoor environment classification. The lighting intensity of kitchens and bathrooms in residential spaces must be at least 300 lx. S1-category residential spaces must have a dimmer-controlled illuminator socket and adjustable sun protection in windows (e.g., blinds or a sun blind).

### Table 1.3.3. Target values for indoor air quality.

<table>
<thead>
<tr>
<th></th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide concentration [ppm]</td>
<td>&lt;750</td>
<td>&lt;900</td>
<td>&lt;1 200</td>
</tr>
<tr>
<td>Radon concentration [Bq/m³]</td>
<td>&lt;100</td>
<td>&lt;200</td>
<td></td>
</tr>
<tr>
<td>Stability of environment [% of operating time]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• office and school spaces</td>
<td>95 %</td>
<td>95 %</td>
<td>90 %</td>
</tr>
<tr>
<td>• residential spaces</td>
<td>90 %</td>
<td>90 %</td>
<td>80 %</td>
</tr>
</tbody>
</table>

### Table 1.3.4. Examples of lighting design target values according to SFS-EN 12464-1.

| Lighting intensity, work area [lx] | >500   |
| Lighting intensity, vicinity [lx]  | >300   |
| Glare index UGR<sub>L</sub>         | <19    |
| Colour reproduction index R<sub>a</sub> | >80    |
Table 1.3.4. Examples of target levels of acoustic measurements for most common spaces according to the SFS 5907 standard (the standard presents additional target values for different uses and special cases)

<table>
<thead>
<tr>
<th>Space and measurement</th>
<th>Label</th>
<th>Unit</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Residential room</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted sound reduction index between two apartments</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥58</td>
<td>≥55</td>
<td>≥55</td>
</tr>
<tr>
<td>Weighted normalized impact sound pressure level from surrounding spaces</td>
<td>( L'_{n,w} )</td>
<td>dB</td>
<td>≤49</td>
<td>≤53</td>
<td>≤53</td>
</tr>
<tr>
<td>HVAC equipment sound pressure level in residential rooms</td>
<td>( L_{A,eq} )</td>
<td>dB</td>
<td>≤24</td>
<td>≤28</td>
<td>≤28</td>
</tr>
<tr>
<td>HVAC equipment sound pressure level in kitchen</td>
<td>( L_{A,eq} )</td>
<td>dB</td>
<td>≤33</td>
<td>≤33</td>
<td>≤33</td>
</tr>
<tr>
<td>Sound pressure level of sources external to the building from 7am to 10pm</td>
<td>( L_{A,eq,07-22} )</td>
<td>dB</td>
<td>≤20</td>
<td>≤35</td>
<td>≤35</td>
</tr>
<tr>
<td>Sound pressure level of sources external to the building from 10pm to 7am</td>
<td>( L_{A,eq,22-07} )</td>
<td>dB</td>
<td>≤25</td>
<td>≤30</td>
<td>≤30</td>
</tr>
<tr>
<td><strong>1–2-person office room</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted sound reduction index between work rooms</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥44</td>
<td>≥40</td>
<td>≥35</td>
</tr>
<tr>
<td>Weighted sound reduction index to corridor</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥30</td>
<td>≥25</td>
<td>–</td>
</tr>
<tr>
<td>Weighted normalized impact sound pressure level from surrounding spaces</td>
<td>( L'_{n,w} )</td>
<td>dB</td>
<td>≤63</td>
<td>≤63</td>
<td>≤63</td>
</tr>
<tr>
<td>Reverberation time (^2)</td>
<td>( T )</td>
<td>s</td>
<td>≤0,5</td>
<td>≤0,6</td>
<td>≤0,7</td>
</tr>
<tr>
<td>HVAC equipment sound pressure level</td>
<td>( L_{A,eq} )</td>
<td>dB</td>
<td>≤35</td>
<td>≤35</td>
<td>≤35</td>
</tr>
<tr>
<td>Sound pressure level of sources external to the building</td>
<td>( L_{A,eq,07-22} )</td>
<td>dB</td>
<td>≤40</td>
<td>≤40</td>
<td>≤40</td>
</tr>
<tr>
<td><strong>Conference room</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted sound reduction index to next room</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥48</td>
<td>≥44</td>
<td>≥40</td>
</tr>
<tr>
<td>Weighted sound reduction index to corridor</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥35</td>
<td>≥30</td>
<td>≥30</td>
</tr>
<tr>
<td>Weighted normalized impact sound pressure level from surrounding spaces</td>
<td>( L'_{n,w} )</td>
<td>dB</td>
<td>≤58</td>
<td>≤63</td>
<td>≤63</td>
</tr>
<tr>
<td>Reverberation time (^2)</td>
<td>( T )</td>
<td>s</td>
<td>≤0,5</td>
<td>≤0,6</td>
<td>≤0,7</td>
</tr>
<tr>
<td>HVAC equipment sound pressure level</td>
<td>( L_{A,eq} )</td>
<td>dB</td>
<td>≤35</td>
<td>≤35</td>
<td>≤35</td>
</tr>
<tr>
<td>Sound pressure level of sources external to the building</td>
<td>( L_{A,eq,07-22} )</td>
<td>dB</td>
<td>≤40</td>
<td>≤40</td>
<td>≤40</td>
</tr>
<tr>
<td><strong>Open office</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted sound reduction index to office</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥30</td>
<td>≥25</td>
<td>≥25</td>
</tr>
<tr>
<td>Weighted sound reduction index to conference room</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥35</td>
<td>≥30</td>
<td>≥30</td>
</tr>
<tr>
<td>Weighted normalized impact sound pressure level from surrounding spaces</td>
<td>( L'_{n,w} )</td>
<td>dB</td>
<td>≤63</td>
<td>≤63</td>
<td>≤63</td>
</tr>
<tr>
<td>Spatial decay rate of speech (^3)</td>
<td>( D_{L} )</td>
<td>s</td>
<td>≥11</td>
<td>≥9</td>
<td>≥7</td>
</tr>
<tr>
<td>Distraction distance (^3)</td>
<td>( D_{T} )</td>
<td>m</td>
<td>≤8</td>
<td>≤11</td>
<td>≤11</td>
</tr>
<tr>
<td>HVAC equipment sound pressure level (^4)</td>
<td>( L_{A,eq} )</td>
<td>dB</td>
<td>40–42</td>
<td>40...42</td>
<td>40...42</td>
</tr>
<tr>
<td>Sound pressure level of sources external to the building</td>
<td>( L_{A,eq,07-22} )</td>
<td>dB</td>
<td>≤40</td>
<td>≤40</td>
<td>≤45</td>
</tr>
<tr>
<td><strong>School space</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted sound reduction index between classrooms and from classroom to corridor with no door in between</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥48</td>
<td>≥44</td>
<td>≥44</td>
</tr>
<tr>
<td>Weighted sound reduction index between classrooms and from classroom to corridor with a door in between</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥39</td>
<td>≥34</td>
<td>≥34</td>
</tr>
<tr>
<td>Weighted normalized impact sound pressure level from environment</td>
<td>( L'_{n,w} )</td>
<td>dB</td>
<td>≤63</td>
<td>≤63</td>
<td>≤63</td>
</tr>
<tr>
<td>Reverberation time (^2)</td>
<td>( T )</td>
<td>s</td>
<td>0,6...0,8</td>
<td>0,6...0,8</td>
<td>0,6...0,8</td>
</tr>
<tr>
<td>Speech transmission index</td>
<td>( STI )</td>
<td>–</td>
<td>≥0,8</td>
<td>≥0,7</td>
<td>≥0,7</td>
</tr>
<tr>
<td>HVAC equipment sound pressure level</td>
<td>( L_{A,eq} )</td>
<td>dB</td>
<td>≤33</td>
<td>≤33</td>
<td>≤33</td>
</tr>
<tr>
<td>Sound pressure level of sources external to the building</td>
<td>( L_{A,eq,07-22} )</td>
<td>dB</td>
<td>≤30</td>
<td>≤35</td>
<td>≤35</td>
</tr>
<tr>
<td><strong>Health care reception room, study room, or treatment room</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted sound reduction index to next room</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥52</td>
<td>≥48</td>
<td>≥48</td>
</tr>
<tr>
<td>Weighted sound reduction index to corridor</td>
<td>( R'_{w} )</td>
<td>dB</td>
<td>≥39</td>
<td>≥34</td>
<td>≥34</td>
</tr>
<tr>
<td>Weighted normalized impact sound pressure level from surrounding spaces</td>
<td>( L'_{n,w} )</td>
<td>dB</td>
<td>≤63</td>
<td>≤63</td>
<td>≤63</td>
</tr>
<tr>
<td>Reverberation time (^2)</td>
<td>( T )</td>
<td>s</td>
<td>≤0,6</td>
<td>≤0,8</td>
<td>≤0,8</td>
</tr>
<tr>
<td>HVAC equipment sound pressure level</td>
<td>( L_{A,eq} )</td>
<td>dB</td>
<td>≤33</td>
<td>≤33</td>
<td>≤33</td>
</tr>
<tr>
<td>Sound pressure level of sources external to the building</td>
<td>( L_{A,eq,07-22} )</td>
<td>dB</td>
<td>≤35</td>
<td>≤35</td>
<td>≤35</td>
</tr>
</tbody>
</table>

1) For category S1, the figure is \( L'_{n,w} + C_{50-2500} \) instead of just \( L'_{n,w} \).
2) The reverberation time is determined in a furnished room as the average of octave ranges 250...4000 Hz.
3) Spatial decay rate of speech \( D_{L} \) and distraction distance \( D_{T} \) replace the use of reverberation time in open offices. \( D_{L} \) indicates the damping efficiency of the space and furniture in terms of the number of decimals by which speech dissipates when distance doubles. \( D_{T} \) indicates the distances after which the speech transmission index value, \( STI \), falls to below 0,50. The guideline values are presented in the guide RIL 243-3-2008 and will be transferred to the SFS 5907 standard when it is updated.
4) In an open office, the background noise level must not be rated too low, to prevent speech sound from being distinguishable over long distances. Therefore, the average noise level is rated at least 40 dB. It must not, however, exceed 42 dB. Background noise can also be generated artificially with a cover noise system.
1.4 Verification of the requirements of the classification

1.4.1 Using the classification in agreements

The specific target values for the indoor environment establish the possibility of binding construction goals with these values. This is possible where the factors presented in Table 1.4.1 are concerned, but with respect to many of the factors describing indoor air quality, a great deal of development is needed before procedures are in use that guarantee the just treatment of all parties. A major problem for the verification of indoor air quality is that it is affected by a multitude of factors, such as outdoor conditions and actions of the users, which vary greatly with place and time. Verification procedures should take all of these interrelated factors into consideration.

Table 1.4.1. Factors suitable for reference in construction and maintenance agreements.

| • Room temperature     | • Lighting intensity      |
| • Air speed            | • Radon concentration    |
| • Design air flow      | • Carbon dioxide concentration |
| • Noise level of heating and air-conditioning devices | |
| • Factors related to the sound environment (see Table 1.3.4) |

The design and warranty values, the levels of which can be verified if necessary, shall be presented explicitly in design documents. A simulation program can be used to facilitate the verification by calculating the ‘indoor climate footprint’ as shown in Appendix I to the standard EN 15251:2007. This computational ‘footprint’ can be compared in the verification to the ‘footprint’ determined in long-term measurements.

Also the verification environment must be specified, as must the measurement methods, through reference to the standard. The measurement tolerances shall be presented in accordance with, for example, Part D2 of the National Building Code of Finland.

The compliance of the target values for thermal conditions shall be checked via measurements of sufficient coverage and reliability. Measurements shall be taken when the building is in use if there is reason to doubt the attainment of the target values.

Short-term measurements can be used for checking the realisation of the target thermal environment values when the building is in use; in winter when the outdoor temperature is below 0 °C and in summer when the outdoor temperature is above 15 °C in fair weather. The compliance of the target values in other than these conditions shall be checked with calculations that take into consideration also the capacity of the heating and cooling equipment. The design and target values for indoor environment shall be measured with instruments that have a valid calibration certificate. The extent of the measurement is determined by the standard SFS 5511 (LVI 014-10187, SFS-käsikirja 103) with indoor environment category S1 equivalent to standard level C, category S2 to level B, and category S3 to level A.

1.4.2 Applying the classification to facility management agreements

This classification document has been compiled mainly for supporting new construction projects. In facility management agreements and forms of implementation wherein facility management is included in the agreement, the factors given in tables 1.3.1 to 1.3.5 can be used where applicable.

Before the target values for indoor environment are applied for facility management agreements, it shall be ensured that the building was originally designed and constructed in such a way that the target values in question can be achieved.

2 GUIDANCE FOR DESIGN AND CONSTRUCTION

2.1 Construction clients

2.1.1 Setting the target

The developer / client / construction manager shall in co-operation with the design team determine and choose the target values related to indoor environment, construction cleanliness, and the emissions of building materials at the beginning of the construction project and shall make them known to all designers involved in the construction project.

In the project design stage, the general targets are set by determining the indoor environment categories of space types central to the project programme. In the draft design, the targets are detailed as space-specific figures, applying the values in the section ‘Target values for indoor environment’.

The target values are chosen for each construction project from the values presented in the section ‘Target values for indoor environment’; either by choosing all of the values from the selected category or by setting individually calculated values for various parameters.

For the design and control of construction work, the construction cleanliness class and the cleanliness class of air-handling systems shall be chosen (either by choosing all of the requirements from the selected class or by setting individually calculated values for various factors). For the selection of the building materials, the emission class for building materials shall be chosen.

To achieve the target values for indoor environment categories S1 and S2, it is required that construction cleanliness and ventilation categories P1 be applied and that class-M1 building materials be used. The above-described principles are applicable on a general level. In each individual construction project, the design team shall describe the specific details necessary for achieving the indoor environment categories the building owner has chosen.

2.1.2 Design control

The developer shall control the design work by defining the desired indoor air targets explicitly (for example, using this classification) and making them known to all the designers. The indoor environment category selected cannot be achieved through the work of a sole designer; on the contrary, everybody participating in the design process shall be aware of the developer’s targets. The RT standards sheet RT 07-10564 contains a summary of the tasks of each designer for designing the desired indoor environment. Each member of the design team shall take care that the design solutions required by the selected indoor air category are presented in the following documents: drawings, work specifications, supplement to the construction contract, and quality control plan of the construction site. The project undertaker is responsible for ensuring that the documents are free from contradictions also as regards the design details chosen for the indoor environment.

The present instructions deal with some of the design details that are critical for achieving the desired indoor environment category. These details shall be incorporated into the design of the building, and they shall be adhered to during the construction phase. Sections 2.2, 2.3, and 2.4 deal more precisely with the issues to be presented in design documents.

If compliance with the chosen indoor environment targets is to be verified by means of measurements, the designers and
the developer shall plan the measurement procedures together. In this case, the designers shall propose the factors suitable for verification and specify their target values, as well as describe the applicable measurement procedures and conditions. Verification measurements can be considered primarily for factors presented in Table 1.4. This information shall be added to the design documents.

### 2.1.3 The classification in construction documents

The chosen targets and the technical specifications they entail shall be explicitly presented in all documents. The most crucial document from the standpoint of indoor environment is the contract limits appendix.

The contract limits appendix shall specify who is responsible for:
- schedules concerning
  - the drying out of structures before application of finishing materials
  - the testing, adjustment, and commissioning of mechanical systems
- protection of structures from the harmful effects of the weather
- proper sealing of conduits and joints in the structures to reach the target air insulation level
- on-site vibration and sound elimination for vibrating mechanisation devices and pipes supported by the structures
- removal of water during construction so that the structures remain dry
- inclusion of the moisture control plan in the quality control plan of the construction site
- provision of clean and dry storage facilities for classified building materials and air-handling equipment, or corresponding arrangements
- premises for operational testing
- quality control plan of the construction site
- training the designers and contractors in mastery of the requirements of the classification.

More detailed procedures shall be presented in work specifications, and instructions and requirements shall be presented in contract documents.

### 2.2 Construction design and choice of construction materials

#### 2.2.1 Building and structural design

Factors to be determined in construction and structural design that affect indoor environment include:
- choice of the construction site
- the suitability of the foundation and arrangements for removal of water from the foundation
- layout of spaces
- thermal insulation
- shielding of solar radiation through windows
- air-tightness
- protection from outside moisture
- construction and furnishing materials
- maintenance capacity and facilities
- cleanability

Factors that affect the indoor environment in selecting the construction and structural design include:
- the quality and possible contamination (radon) of the soil
- the groundwater level
- solar radiation and shadowing
- the prevailing wind directions as well as the pollution of outdoor air
- the noise level of the surroundings.

Spaces that are similar with respect to their functions and indoor environment targets should be located next to each other. Spaces with polluted air (restaurants, garages, toilets, waste disposal rooms, etc.) should be located apart from other spaces so that as little polluted air as possible can flow into cleaner spaces. The restrictions set by the Smoking Act 693/1976 (LVIT STIM-00339, RT STIM-21317, KH STIM-10548), shall be taken into account even during the design stage. Smoking shall be prohibited in all indoor environment classes.

**Part B3 of the National Building Code of Finland (‘Foundations’)** states that the radon risks of the construction location must be noted in the design and construction. On the basis of the instructions, the guideline design value for radon concentration, 200 Bq/m³, is generally exceeded without countermeasures in most of Finland. Radon-related technical design can be excluded only if location-specific radon research indisputably shows that the radon concentration in the apartments consistently remains below the maximum value. If radon is not considered in the design, written justifications shall be added to the design documents of the site. The effect of soil material on indoor radon concentration is eliminated primarily with the radon elimination work at the foundation stage. The radon concentration of a building can be affected significantly with the choice and implementation related to the base floor structures and foundation method. Radon elimination methods for new constructions are presented in LVI and RT standards sheets, Radonin torjunta (LVI 37-10357, RT 81-10791). Rectification of existing radon is discussed in the Asuntojen radonkorjaaminen guide (‘Radon mitigation of apartments,’ Arvela & Reisbacka 2008).

Meeting the thermal insulation requirements stated in the National Building Code of Finland generally provides a sufficiently good basis for the control of thermal conditions during the heating season in all indoor environment categories. Preventing overheating requires special measures of construction, structure, and HVAC engineering. Overheating must primarily be prevented by structural means (e.g., solar shielding) or by decreasing internal loads and utilising night-time cooling. The target values for thermal conditions in indoor environment category S1 can only be reached, in practice, with mechanical cooling (or corresponding district cooling or free cooling from, e.g. rock) and individual control of room temperature. Indoor environment category S2 may be achieved without mechanical cooling.

The air-tightness of the building envelope and the structures between the indoor spaces has a significant effect on the transfer of pollution indoors and between spaces. When aiming at good indoor quality (categories S1 and S2), the developer shall choose a target level for the airtightness of the building and present the corresponding air flow solution in the design plans.

The maximum recommended value for air-tightness is $q_{50} < 1.0...1.5 \text{ m}^3/\text{h} \cdot \text{envelope-m}^2$. The air infiltration figure $q_{50}$ is the infiltration air flow at a test pressure of 50 Pa calculated on the surface of the building envelope. The corresponding infiltration air flow calculated over the volume of the building is $n_{30}$, and the recommended $n$ values are:
- detached houses: $n_{30} < 1.0...2.0 \text{ l/h}$
- other buildings: $n_{30} < 0.5...0.7 \text{ l/h}$.

The target level for air-tightness shall be selected in collaboration with the HVAC designer. The air-handling system shall provide sufficient ventilation even if the building is very tight. The pressure difference between the outdoor and indoor air shall not be too high in buildings or apartments with mechanical exhaust ventilation.

No conduits should be used between S1-category spaces and lower-category spaces if the air flow between the spaces cannot be controlled with ventilation measures. The recommended airtightness of residential apartments is $n_{30} < 0.5...0.7 \text{ l/h}$ (including air infiltration through the building envelope and inter-apartment walls and floors).
The target value for air-tightness chosen by the building owner makes it possible to verify the final air-tightness level by means of measurements. These measurements are needed for carrying out indoor air quality assessments and in cases of conflict between the developer and the constructor. Before the measurements, supervision by a structural engineer (or another corresponding expert) can be used as a more moderate control method.

The air infiltration rate at the 50 Pa pressure difference is determined as specified in the standard SFS-EN 13829, using measurement method B (building envelope testing). The measurement can also be carried out with the building's own ventilation devices, in which case the measurement method for standard B is applied with adaptation.

In the case of non-detached houses, the air-tightness is measured from individual apartments, a staircase at a time, or a building at a time. Under-pressurising equipment is the easiest means of measurement for individual apartments. The building's own central ventilation equipment can be used for testing all apartments served by the equipment. Air infiltration between the envelope and apartments are not itemised. To assess the air-tightness of an entire block of flats, apartments must be spot-measured on the basis of individual apartment measurements – for example, one flat on the bottom and top floor and one for each floor in between.

More detailed instructions for construction and structure design can be found, for example, in the Terveen talon toteutuksen kriteerit guides (‘Criteria for implementing a healthy building’, LVI 05-10363, RT 07-10805 and LVI 05-10377, RT 07-10832).

In structural design, the target acoustic class shall be taken into account – for example, the target values for impact sound insulation and airborne sound reduction index, room acoustics, and the noise level caused by the HVAC and electrification devices and sources external to the building.

For more detailed instructions on the design of acoustic conditions, refer to the guides of the Finnish Association of Civil Engineers: RIL 243-1-2007 (Akustiikan perusteet), RIL 243-2-2007 (Oppilaatokset, auditoriot, liikuntatilat ja kirjastot), and RIL 243-3-2008 (Toimistot).

In the design of the building and its window structures, sufficient field of sight from the flat to the outside shall be taken into account while utilising daylight and preventing overheating, reflections, and glare from direct solar radiation. In S1-category spaces, it is recommended to use sunshield solutions adjustable to the user’s wishes and/or the radiation strength.

2.2.2 Surface structural design
The following elements shall be taken into consideration in structural design:
• emissions from building materials
• moisture characteristics conformant to the intended use
• noise dissipation properties
• the drying times required by the coatability of the structures (e.g., SisäRYL 2000 and Betonilattiarakenteiden kosteudenhallinta ja päälystäminen)
• ease of cleaning
• durability
• performance requirements set by sandwich structures.

The building materials should be as low-emission as possible. Especially when the building has been designed for allergic and sensitive people, even small amounts of chemical emissions from materials may cause symptoms.

The building materials of a space designed according to indoor environment categories S1 and S2 should predominantly be selected from class M1. M2-classified building materials should not cover more than 20 % of the interior surfaces of a room and never more than 1 m² per square metre of floor. Uncoated brick, stone, glass and metal surfaces, ceramic tiles, and board and log surfaces made of unprocessed wood (excluding hardwood) may be used freely.

Materials whose moisture characteristics are known and that cause as little risk as possible when used in connection with other materials should be used in the structures of the building.

The work specifications shall define how materials and equipment may be replaced with other corresponding products. The emissions of building materials shall be considered in decision on alternative materials. Work specifications may cite, for example, ‘… or an alternative material of emission class M1’ or, alternatively, ‘… or a corresponding material that fulfils the requirements of emission class M1. The compliance with requirements shall be indicated in the test report of an approved testing laboratory. The first alternative is recommended because the evaluation of whether the product meets the requirements demands expert knowledge.

The materials used shall have a goods or product specification presenting emission class data, any limitations on the use of the materials, and any requirements for environmental conditions where the material may be applied (temperature, humidity, compatibility, and other values).

Comparison values for contaminants from various construction materials (formaldehyde, VOCs, and ammonia) can be found in the doctoral thesis Reference values for building material emissions and indoor air quality in residential buildings (Järnström 2007).

In the design of the surface structures, the target acoustic class values, including, for example, the reverberation time and spatial decay rate of speech for open offices, shall be considered. For more detailed instructions on the design of acoustic conditions, refer to the following guides of the Finnish Association of Civil Engineers: RIL 243-1-2007 (Akustiikan perusteet), RIL 243-2-2007 (Oppilaatokset, auditoriot, liikuntatilat ja kirjastot), and RIL 243-3-2008 (Toimistot).

For lighting, consider the surfaces’ luminance, which depends on the lighting intensity and the surface reflection ratio. Useful reflection ratios for the most important room surfaces are: ceiling 0,6…0,9, walls 0,3…0,8, worktops 0,2…0,6, and floor 0,1…0,5 (see SFS-EN 12464-1).

For more detailed information on construction design, refer to the RT standards sheet Rakennuksen sisäilma (RT 07-10564) and the HVAC standards sheet Rakennusten sisäilmaston suunnitteluperusteet (LVI 05-10417).

2.3 Construction site design
2.3.1 General
The control of dust, moisture, and water removal during construction has a decisive effect on attaining the selected indoor environment category. Good construction site planning has a crucial effect on the control of indoor air risks. The control of water, moisture, and cleanliness should be monitored at the construction site. A moisture control plan shall be included in the quality control plan of the construction site, and a cleanliness class shall be chosen for each zone of the construction work.

2.3.2 Water and moisture control plan
As part of the work-site quality assurance plan, there must be a water and moisture control plan. The consideration of concrete floor coating in the construction process is discussed by Merikallio et al. (2007).

The water and moisture control plan shall include the following:
• A checklist concerning moisture risks. The structures, materials, and products that may give rise to moisture problems during work-site design and implementation shall be listed. The site supervision shall refer to this checklist in order to pay special attention to the details causing most risk.
• **Drying-out time estimates.** Materials coated with moisture-sensitive materials shall have drying-out time estimates for various environmental conditions. See e.g., SisäRYL and Betonillatiarakenneiden kosteudenhallinta ja pääälystääminen.

• **Heating, drying, protection, and partitioning plan.**

• **Alternate plan to keep on schedule.** If the drying-out time of the structures is estimated to be longer than the planned schedule permits, procedures to keep to schedule shall be decided on.

• **The handling of materials and supplies.** The details of transportation of materials to the construction site shall be determined in advance, and the materials’ reception, intermediate, storage, protection, and transportation step by step to their end location shall be planned.

• **Prevention of moisture damage.** The structures and cavities for thermal insulation shall be prevented from becoming wet, for example, as a result of rain or melt water. The work stages of any contractor that include risks of water damage shall be determined in advance.

• **Arrangement of drying-out conditions.** Good drying-out conditions require that the exterior structures be completed as soon as possible, the heating be turned on, and the ventilation be sufficient. The moisture control of the construction may require special procedures that shall be agreed on with the HVAC contractor.

• **Organisation of moisture control.** The organisation of the moisture control of the construction site shall be planned. As a general rule, all involved shall be aware and take care of the factors that may cause moisture problems within their own area of responsibility. The contract agreements shall state the tasks and responsibilities of all parties.

• **Moisture measurement plan.** A moisture measurement plan shall be prepared in advance at the construction site. The plan shall indicate the measurement method and equipment, the schedule and scope of the measurements, and the location of the necessary measuring points.

• **Coating criteria.** The moisture limits above which coating is not permitted shall be specified. The moisture measurement results and criteria for coating are determined for each combination of structure and coating.

• **Documentation.** The moisture control at the construction site, exceptional conditions, and water damage shall be documented to an appropriate extent.

• **Information and supervision.**

### 2.3.3 Classification of construction cleanliness (P)

The purpose of the classification of construction cleanliness is to ensure that the construction spaces are clean when delivered to the user and that no impurities from the construction stage are conveyed to the indoor air during the use of the building.

All spaces in the buildings must be clean enough at the hand-over stage that the spaces can be immediately put to use after reception.

Release of construction-time impurities to indoor air is unlikely if the ventilation system of the building has been implemented according to cleanliness class P1 of Subsection 2.4.2 of this classification and if there is no significant accumulated dust in spaces connected to the indoor air. To ensure the above, the cleanliness of the building shall be verified before operational testing of the ventilation system begins.

Construction cleanliness classification presents requirements for the cleanliness of regular work and residential facilities (including office and public buildings, schools, day-care centres, dwellings, and similar buildings). The extent and level of the requirements depend on the indoor environment category aimed at. The plans of a construction project may include requirements from different cleanliness categories, or some aspects may be left undefined. It is appropriate to select the same cleanliness class for similar spaces within any given zone of the building. The reference should be made by writing the applicable requirements of subsections 2.3.4 and 2.4.2 in the supplement to the contract document and work specifications. Subsection 2.3.4 presents instructions for construction work and certain ventilation equipment and their installation and use.

This document presents only the requirements of construction cleanliness class P1. Class P2 coincides with normal construction practices.

Requirements for special spaces are not presented. They shall be specified separately for each case in selection of the categories.

The requirements presented in the other sections of this document shall also be taken into account during the design and construction phases of the building. The developer selects the indoor environment, construction cleanliness, and building material categories in co-operation with the design team when the design of the building is commenced.

Good indoor environment requires co-operation among all parties involved in the construction project and adherence to the instructions assigned to each party. Subsections 2.3.4 and 2.4.2 present tasks essential to good indoor environment for which the responsible parties shall be specified.

**Class P1:** Work spaces and residences in which good air quality corresponding to indoor environment categories S1 and S2 is aimed at

The building must be clean before the protection of the ventilation terminals can be removed and operational testing commenced. The surfaces must not have fine, loose dirt (e.g., wood, concrete, or gypsum dust) that may become airborne when touched or with air flow. The spaces must not be used for storing construction materials or waste that prevents the cleaning of the surfaces. Plastic and cardboard protecting the surfaces have been removed. After this stage, the spaces allow for only non-dust-producing work to be carried out without special measures. This includes patch painting, installation of suspended ceilings, operational ventilation testing, adjustment and tuning, and the final cleaning.

At hand-over, the surfaces must not have visible dirt, such as rubbish, loose dirt (including dust), fixed dirt, or stains.

**Class P2:** Ordinary work spaces and residences in which air quality corresponding to indoor environment category S3 is aimed at

No special requirements are set for the cleanliness of the construction work.

### 2.3.4 Assessing the cleanliness of a building

Before operational testing, the cleanliness of all surfaces is visually inspected, including the surfaces not visible in the finished building. The assessment covers the ceiling, wall, furniture, and floor surfaces, as well as the surfaces above the ceilings.

Before the building's hand-over, all visible surfaces and interior surfaces of furniture are assessed. The assessment covers the ceiling, wall, furniture, and floor surfaces, as well as the interior surfaces of furniture. The cleanliness of the surfaces above the ceiling is not assessed when the ceiling sets are closed.

- Ceiling surfaces include, for example, top surfaces of suspended ceiling plates.
- Wall surfaces include, for example, walls, pipes on walls, windows, doors and doorframes, interior glass walls, electrical equipment, ventilation terminals, illuminators, floorboards, railings, handles, and panels.
- Furniture includes the furniture in washing and sanitary spaces, other fixed furniture, and the interior surfaces of these items, as well as machinery and equipment belonging to the building.
– Floor surfaces include floors, drain grilles and wells, thresholds, and the vertical and horizontal surfaces of steps.

The basic requirements for cleanliness are presented in Subsection 2.3.3. In the assessment of cleanliness, each space is subjected to a visual check ensuring that the cleanliness requirement of the class is met. The dust accumulation of surfaces is measured, if necessary, with the gel tape method as described in Annex D.1 to the INSTA 800 standard. It is recommended that the measurement of the dust accumulation be carried out no earlier than two hours after cleaning, so that airborne dust has time to settle before the measurement. The maximum levels for accumulated dust are presented in Table 2.3.1. In assessment of the cleanliness of the building, the procedure compliant to the surface dust accumulation procedure set forth in the INSTA 800 standard can be used by special agreement or if the parties otherwise cannot reach consensus on the assessment method and/or interpretation of results.

2.3.5 Classification of construction work cleanliness – implementation instructions for class P1

<table>
<thead>
<tr>
<th>Time of inspection</th>
<th>Surfaces assessed</th>
<th>Dust accumulation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before operational</td>
<td>Top surface of ceiling</td>
<td>5,0</td>
</tr>
<tr>
<td>ventilation test</td>
<td>Surfaces above 180 cm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surfaces below 180 cm (excl.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>floors)</td>
<td></td>
</tr>
<tr>
<td>Before building</td>
<td>Surfaces above 180 cm</td>
<td>1,0</td>
</tr>
<tr>
<td>hand-over</td>
<td>Surfaces below 180 cm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Floors</td>
<td>3,0</td>
</tr>
</tbody>
</table>

2.3.5.1 Transportation, storage, and protection of building supplies

The building supplies, for both interior spaces and structures, shall be protected from contamination and moisture throughout transportation, storage at the construction site, intermediate storage at the installation site, and installation, either by covering or by protection through some other means. The storage area shall be off the ground and protected so that rain and surface water cannot ruin the building materials. The building materials and equipment shall be covered according to the manufacturer’s instructions. Torn or broken covers shall be repaired immediately. Building materials and equipment shall be stored indoors, and their intermediate storage shall be avoided. Storage conditions and protective covers shall satisfy the requirements of the manufacturer.

Both incomplete and complete building elements and equipment shall be protected against moisture and damage during installation breaks and interruptions. The protective covers of the building materials to be installed indoors shall be removed just before installation according to the manufacturer’s instructions. During the installation and fitting of the building materials, the indoor air shall be clean and dry. No simultaneous dust-producing work shall be allowed in the vicinity of the installation or fitting site. It shall be ensured, both before the work is commenced and also during the work, that the environmental conditions and the relative humidity of the base material meet the requirements mentioned in the design documents and set by the manufacturers. The Ratu Construction Productivity Information File presents such working methods and installation instructions for building materials as comply with good construction practice (Ratu).

2.3.5.2 Partitioning of spaces that are ready for operational testing

Spaces ready for operational testing shall be separated after the assessment of cleanliness from other spaces into separate partitions if work producing dust or other dirt is in progress in the other spaces.

Within the partition, dust-producing work must be done with local exhaust tools and equipment. Additionally, sufficient ventilation of the space must be ensured.

Spaces ready for operational testing must not be used for regular through passage if the adjacent spaces belong to a lower cleanliness class.

Spaces ready for operational testing shall be marked clearly with a visible ‘Cleanliness class P1 space’ label.

If the space must be cleanliness-partitioned because of the progress of the work before the concrete surfaces have reached the maximum relative humidity value required for coating, the space must have sufficient ventilation and the air conducted to the space during winter must be heated.

2.3.5.3 Cleaning of spaces – cleanliness class P1

Construction cleaning is an essential means of ensuring the attainment of cleanliness targets. For more detailed instructions on the design, implementation, and quality assurance of construction cleaning, refer to the Rakennussiivuus guide (SSTL 2:10).

When spaces are cleaned during construction, a high-flow vacuum cleaner, spade, or spatula shall be used for removing coarse dirt, and a central vacuum cleaner or a vacuum cleaner with a fine dust filter shall be used for finer dirt (at least 98 % filtering for particles of 3 μm). The filter of the vacuum cleaner shall be changed according to the manufacturer’s instructions.

Spaces ready for operational testing are always cleaned after dust has been produced in the space. In dust-producing work stages performed after cleanliness-partitioning, local exhaust equipment shall be used.

In the final cleaning, including non-visible surfaces, such as electrical grilles and top surfaces of ceilings, a central vacuum cleaner or a vacuum cleaner with a fine dust filter shall be used (at least 98 % filtering for particles of 3 μm). Hard and smooth surfaces shall be cleaned with a moist cloth. The surfaces shall be cleaned according to the instructions of the building material manufacturers. Odourless and low-emission cleaning and treatment agents and waxes shall be used.

2.3.5.4 Classification communication and training

The indoor environment targets defined by the building owner, and the details decided on for reaching the targets, shall be presented in the meetings of the building owner, designers, and contractors when the construction work is commenced. The crucial points shall be documented in the quality control plans of the contractors, and their realisation shall be monitored in the construction site meetings.

A written bulletin concerning the indoor environment, cleanliness, and building material categories selected for the construction shall be distributed to every worker at the construction site.

Before the construction work is commenced, one-day training shall be arranged for the workers and most important contractors (e.g., building, painting, and HVAC/E contractors) during which the indoor environment targets and instructions and the tasks for reaching these targets are explained. The arrange-
ment of the training shall be agreed on, for example, in the supplement to the contract agreement. Contractors and workers joining the project at a later stage should also be trained.

2.4 Designing mechanical systems for buildings

2.4.1 Designing the heating and cooling system

The design values presented in the following tables shall be used specifically in the dimensioning of heating and air-handling equipment. The designers shall also specify the conditions to which the design values apply, such as:

- the internal loads and use of the space (number of occupants, lighting load, equipment load, etc.) – if the use is not known during the design stage, values in Table 2.4.1 can be used; if not otherwise specifically agreed in the plans, these values shall also be used in the verification
- the technical characteristics of the structures (thermal insulation, air-tightness, etc.)
- the external loads of the space (weather conditions).

Outdoor design temperatures used in the dimensioning of heating systems are stated in the National Building Code of Finland, Part D5. In calculation of summertime indoor temperatures and dimensioning of cooling systems for the summer, the test year conformant to the ISO 15927-4:2005 standard for energy calculation or the weather information from the test year from the Finnish Meteorological Institute shall be used (FMI 1979), or one may use any other period agreed on separately in the contract documents. The enthalpy value of 57 kJ/kg d.a. in Northern Finland shall be used for dimensioning the airconditioning for summer conditions. The design temperature of the outdoor air to the air condenser and air-cooler shall be at least 30 °C.

The mean occupancy in Table 2.4.1 can be used in the calculation of energy consumption and in simulation of thermal conditions and concentrations. The cooling power requirement is dimensioned with a 100 % occupancy (during use); the room devices are tuned according to actual use or mean occupancy.

At the design stage, it must be checked that the selected solutions fulfil conditions conformant to the targets set (Table 1.3.1) in the design weather and with the building’s designed use. The verification must be done in winter, summer, and spring/autumn conditions so that the temperature of the structures has stabilised when the calculation starts. The calculations are added to the plans and can be utilised for checking the realisation of the conditions.

The realisation of the target thermal environment values is checked when the building is in use: in winter when the outdoor temperature is below 0 °C and in summer when the outdoor temperature is above 15 °C in fair weather. If the measurement is conducted with an outdoor environment other than the above, the fulfilment of the requirements can be assessed with the temperature index in Asumisterveysohje (STM 2003, LVI STM-00288, RT STM-21232, KH STM10391). Compliance with the target values in other than these measurement conditions shall be checked with calculations, taking into consideration also the capacity of the heating and cooling equipment. The design and target values of indoor environment shall be measured with instruments that have a valid calibration certificate. The extent of the measurements is determined by the standard SFS 5511 (LVI 014-10187, SFS-käsikirja103) with indoor environment category S1 equivalent to standard level C, category S2 to level B, and category S3 to level A.

2.4.2 Designing the ventilation system

Ventilation is used for removing primarily contaminants caused by humans. The adverse effects of construction and furnishing materials must be eliminated mainly through the use of low-emission materials (e.g., class M1 in the construction mate-

### Table 2.4.1 Space usage profiles and internal heat loads.

<table>
<thead>
<tr>
<th>Building/space</th>
<th>Time</th>
<th>Operating hours</th>
<th>Occupant density</th>
<th>Mean occupancy</th>
<th>Lighting equipment</th>
<th>Mechanical equipment</th>
<th>Occupants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>hours/day</td>
<td>days/week</td>
<td>m²/person</td>
<td>W/m²</td>
<td>W/m²</td>
<td>W/m²</td>
<td></td>
</tr>
<tr>
<td>Residential spaces (1–2 persons)</td>
<td>00:00–24:00</td>
<td>24 7</td>
<td>37</td>
<td>6,6</td>
<td>8 2)</td>
<td>2,4 3)</td>
<td>2</td>
</tr>
<tr>
<td>Residential spaces (multistorey)</td>
<td>00:00–24:00</td>
<td>24 7</td>
<td>25</td>
<td>6,6</td>
<td>8 2)</td>
<td>3 3)</td>
<td>3</td>
</tr>
<tr>
<td>Offices</td>
<td>07:00–18:00</td>
<td>11 5</td>
<td>12</td>
<td>0,55</td>
<td>12</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Conference rooms</td>
<td>08:00–17:00</td>
<td>9 5</td>
<td>3</td>
<td>6,6</td>
<td>12</td>
<td>18 60</td>
<td>25</td>
</tr>
<tr>
<td>Classrooms</td>
<td>08:00–16:00</td>
<td>8 5</td>
<td>2</td>
<td>0,5</td>
<td>18</td>
<td>12</td>
<td>35</td>
</tr>
<tr>
<td>PC classrooms</td>
<td>08:00–16:00</td>
<td>8 5</td>
<td>2</td>
<td>0,4</td>
<td>18</td>
<td>12</td>
<td>35</td>
</tr>
<tr>
<td>Day-care centres</td>
<td>07:00–18:00</td>
<td>12 5</td>
<td>2</td>
<td>0,55</td>
<td>15 70</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Business spaces</td>
<td>07:00–21:00</td>
<td>14 7</td>
<td>17</td>
<td>0,55</td>
<td>14 7</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Accommodation spaces (hotel)</td>
<td>00:00–24:00</td>
<td>24 7</td>
<td>19</td>
<td>0,8</td>
<td>20</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>Restaurants</td>
<td>10:00–22:00</td>
<td>10 7</td>
<td>3</td>
<td>0,4</td>
<td>20</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Sports halls</td>
<td>07:00–23:00</td>
<td>14 7</td>
<td>21</td>
<td>0,6</td>
<td>20</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Health care spaces</td>
<td>00:00–24:00</td>
<td>24 7</td>
<td>8</td>
<td>0,8</td>
<td>14</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

1) Does not include latent heat; the total heat release can be obtained by dividing by 0.6.
2) The mean occupation in illumination in residential buildings is 0.1.
3) The electricity use of devices in residential buildings is obtained by dividing the heat release by 0.7.
4) In simulation programs, a person’s heat release is 125 W (1.2 m², body surface 1.8 m²). In schools and day-care centres, the children’s heat release is 110 W (1.0 m², body surface 1.8 m²).
Use of ‘—’ means that no requirement has been set.

I  The heating and cooling system design values are intended to be the first default values in dimensioning and component selection. The operation of the selected system must be checked computationally in different dimensioning situations, and the design solution must be changed if the temperature targets in Table 1.3.1 are not met.

II Temperature adjustability refers to ability to adjust the room temperature to other than the design value. In the design weather in the summer, adjustability is required only to account for higher-than-designed temperatures and in the winter only for lower-than-designed temperatures. In zone- or system-specific adjustment, the temperatures of rooms in a single zone may differ from each other by at most ±1 °C when the internal loads of the spaces are conformant to the designed use.

III Air velocity refers to the three-minute direction-independent average in the occupied zone. It is measured, for example, with a hot-wire anemometer or touch sensor in accordance with the standard SFS 5511 (LVI 014-10187, SFS-käsikirja 103).

IV Vertical temperature difference refers to the temperature difference between the ankles and neck, at measurement heights 0,1 m and 1,1 m (sitting work).

V The floor surface temperature must not be outside the presented range in any part of the occupied zone. In bathrooms and washing rooms, the recommended maximum floor surface temperature is 27 °C. The surface temperature is measured, for example, with an infrared thermometer or touch sensor according to the standard SFS 5511 (LVI 014-10187, SFS-käsikirja 103).

VI The relative humidity of the air may temporarily drop below the target value during frost peaks. The relative humidity of the air must be below 60 %. In humidifying the air, particular attention shall be paid to the humidifiers not increasing impurities in the air. The relative humidity of the air is measured with, for example, a psychrometer or capacitive sensor in accordance with the SFS 5511 standard (LVI 014-10187, SFS-käsikirja 103).

Table 2.4.2. Design values for heating and cooling systems in office, teaching, and other spaces.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Unit</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling system design value</td>
<td>°C</td>
<td>25</td>
<td>25</td>
<td>–</td>
<td>I</td>
</tr>
<tr>
<td>Heating system design value</td>
<td>°C</td>
<td>21,5</td>
<td>21,5</td>
<td>21,5</td>
<td>I</td>
</tr>
<tr>
<td>Space-specific adjustability of temperature, winter</td>
<td>°C</td>
<td>20...23</td>
<td>–</td>
<td>–</td>
<td>II</td>
</tr>
<tr>
<td>Space-specific adjustability of temperature, summer</td>
<td>°C</td>
<td>23...25</td>
<td>–</td>
<td>–</td>
<td>II</td>
</tr>
<tr>
<td>Air velocity, $t_{a3}$ = 21 °C</td>
<td>m/s</td>
<td>&lt;0,14</td>
<td>&lt;0,17</td>
<td>&lt;0,20</td>
<td>III</td>
</tr>
<tr>
<td>Air velocity, $t_{a3}$ = 23 °C</td>
<td>m/s</td>
<td>&lt;0,16</td>
<td>&lt;0,20</td>
<td>&lt;0,25</td>
<td>III</td>
</tr>
<tr>
<td>Air velocity, $t_{a3}$ = 25 °C</td>
<td>m/s</td>
<td>&lt;0,20</td>
<td>&lt;0,25</td>
<td>&lt;0,35</td>
<td>III</td>
</tr>
<tr>
<td>Vertical temperature difference</td>
<td>°C</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>IV</td>
</tr>
<tr>
<td>Floor surface temperature, minimum</td>
<td>°C</td>
<td>19</td>
<td>19</td>
<td>17</td>
<td>V</td>
</tr>
<tr>
<td>Floor surface temperature, maximum (floor heating)</td>
<td>°C</td>
<td>29</td>
<td>29</td>
<td>31</td>
<td>V</td>
</tr>
<tr>
<td>Relative air humidity, winter</td>
<td>%</td>
<td>&gt;25</td>
<td>–</td>
<td>–</td>
<td>VI</td>
</tr>
</tbody>
</table>

Table 2.4.4 presents the design values conformant to this design principle for air flows for various spaces. The control of room temperature or provision for flexibility may require greater air flow. The need for air flow from specific sources of contaminants must be taken into consideration on a case-by-case basis. It must be possible to adjust the air flow when the use of the space changes.

Outside normal usage times, the building must have basic ventilation of 0,1...0,2 dm³/s·m², with which impurities originating from the building are removed. Basic ventilation may be used only when there are no humans in the space. For example, during cleaning, the ventilation must be at least at the level of normal use. After a basic ventilation period, the ventilation must be run at normal level for two hours before the users arrive at the building.

In this case, the ventilation must be designed to correspond to the actual human load in the space as closely as possible. If that level is not known during the design stage, the air-handling unit and main and branch ducts must be designed according to the greatest probable ventilation requirement, using, for example, the space efficiencies in tables 2.4.1 and/or 2.4.3 and an assumed 100 % operating level. In this case, the air terminal devices must not be selected until the actual use of the spaces is known or must be adjustable to conform with the actual requirement. The operation of the air terminal devices must also be inspected in view of the operating levels, interim periods, and partial levels specified in Table 2.4.1.

The ventilation of living rooms and bedrooms in flats is designed according to Table 2.4.4. The air-handling unit and ducts are designed such that each room suitable as a bedroom allows for inputting the air flow required by two people. The air flow of the living room can be reduced if the bedroom air flow is exhausted through the living room. The air flows of other spaces in apartments shall be designed according to Part D2 of the National Building Code of Finland. The design exhaust air flows of apartments are 10 % greater than the supply air flows. If the sum of the exhaust air flows exceeds 110 % of the sum of the supply air flows, the supply air flows of the bedrooms shall be increased. If the total supply air flow exceeds 90 % of the exhaust air flow, the exhaust air flows of wet spaces shall be increased. Furthermore, it must be checked that the flat’s total outdoor air flow is at least 0,5 dm³/s·m² for category S1, and at least 0,35 dm³/s·m² for category S2.
Table 2.4.3. The design values in the normal usage situation of outdoor air flow in spaces that meet the criteria for a building causing very little pollution (control of room temperature or provisioning for flexibility may require greater air flow).

<table>
<thead>
<tr>
<th>Space</th>
<th>Floor surface m²/person</th>
<th>Cat S1 dm³/s per person</th>
<th>Cat S3 dm³/s per m²</th>
<th>Cat S3 dm³/s per person</th>
<th>Cat S3 dm³/s per m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office space, normal space efficiency</td>
<td>12</td>
<td>16</td>
<td>1,5</td>
<td>13</td>
<td>1,5</td>
</tr>
<tr>
<td>Office space, high space-efficiency</td>
<td>8</td>
<td>14</td>
<td>2,0</td>
<td>11</td>
<td>1,5</td>
</tr>
<tr>
<td>Conference room</td>
<td>3</td>
<td>12</td>
<td>4,0</td>
<td>9</td>
<td>4,0</td>
</tr>
<tr>
<td>Break room, canteen</td>
<td>1,5</td>
<td>11</td>
<td>7,0</td>
<td>8</td>
<td>5,0</td>
</tr>
<tr>
<td>Hotel room</td>
<td>10</td>
<td>15</td>
<td>1,5</td>
<td>12</td>
<td>1,0</td>
</tr>
<tr>
<td>Corridor and staircase</td>
<td>1</td>
<td>1</td>
<td>0,5</td>
<td>1</td>
<td>0,5</td>
</tr>
<tr>
<td>Lift shaft</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Classroom</td>
<td>2</td>
<td>11</td>
<td>5,5</td>
<td>8</td>
<td>4,0</td>
</tr>
<tr>
<td>Lecture room</td>
<td>1</td>
<td>11</td>
<td>10,5</td>
<td>8</td>
<td>7,5</td>
</tr>
<tr>
<td>Corridor, school lobby</td>
<td>2</td>
<td>11</td>
<td>5,5</td>
<td>8</td>
<td>4,0</td>
</tr>
<tr>
<td>Lobby</td>
<td>6</td>
<td>13</td>
<td>2,0</td>
<td>10</td>
<td>2,0</td>
</tr>
<tr>
<td>Day-care centre</td>
<td>3</td>
<td>12</td>
<td>4,0</td>
<td>9</td>
<td>2,5</td>
</tr>
<tr>
<td>Wet entrance at day-care centre (exhaust)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Canteen and cafeteria</td>
<td>2</td>
<td>11</td>
<td>6...8</td>
<td>8</td>
<td>5...6</td>
</tr>
<tr>
<td>Heating and distribution kitchen 1)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Preparation kitchen</td>
<td>15...40</td>
<td>15...40</td>
<td>15...40</td>
<td>15...40</td>
<td></td>
</tr>
<tr>
<td>Dishwashing room 1)</td>
<td>12...20</td>
<td>12...20</td>
<td>12...20</td>
<td>12...20</td>
<td></td>
</tr>
<tr>
<td>Business space 1)</td>
<td>13</td>
<td>2,5</td>
<td>4</td>
<td>10</td>
<td>2,0</td>
</tr>
<tr>
<td>Exhibition space</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Library</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Foyer</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Gym</td>
<td>6,0</td>
<td>6,0</td>
<td>6,0</td>
<td>6,0</td>
<td></td>
</tr>
<tr>
<td>Large gym</td>
<td>5,5</td>
<td>4,0</td>
<td>4,0</td>
<td>4,0</td>
<td></td>
</tr>
<tr>
<td>Large gym and pool, athletes</td>
<td>2,5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Large gym and pool, spectators</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Clinic</td>
<td>15</td>
<td>3,4</td>
<td>3,6</td>
<td>3,6</td>
<td></td>
</tr>
<tr>
<td>Hospital (excluding special spaces) 2)</td>
<td>15...20</td>
<td>15...20</td>
<td>15...20</td>
<td>15...20</td>
<td></td>
</tr>
<tr>
<td>Patient room</td>
<td>2</td>
<td>2,0</td>
<td>1,5</td>
<td>1,5</td>
<td>1,5</td>
</tr>
<tr>
<td>Operating room 1)</td>
<td>15...20</td>
<td>15...20</td>
<td>15...20</td>
<td>15...20</td>
<td></td>
</tr>
<tr>
<td>Laboratory 1)</td>
<td>2...5</td>
<td>2...5</td>
<td>2...5</td>
<td>2...5</td>
<td></td>
</tr>
<tr>
<td>Storage room, archive (exhaust)</td>
<td>0,5</td>
<td>0,5</td>
<td>0,5</td>
<td>0,5</td>
<td></td>
</tr>
<tr>
<td>Copying and printing room (exhaust)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Office restrooms (exhaust)</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Washing room (exhaust)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Dressing room</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Sauna room</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cleaning room (exhaust)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Rubbish bin room (exhaust)</td>
<td>5...10</td>
<td>5...10</td>
<td>5...10</td>
<td>5...10</td>
<td></td>
</tr>
</tbody>
</table>

1) The ventilation required by processes or exhausting of excess heat must be designed individually.
2) For instructions on designing hospital indoor climate and air flows, refer to the report *Sairaalailmanvaihdon suunnitteluohjeita* (Ryynänen 2007).

Table 2.4.4. Design values for outdoor air flow in residential spaces (living rooms and bedrooms).

<table>
<thead>
<tr>
<th>Usage</th>
<th>Unit</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>Note(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal use</td>
<td>dm³/s-person</td>
<td>12</td>
<td>8</td>
<td>6</td>
<td>I</td>
</tr>
<tr>
<td>Boost, apartment-specific increase option</td>
<td>%</td>
<td>30</td>
<td>30</td>
<td>–</td>
<td>II</td>
</tr>
<tr>
<td>Basic ventilation outside the time of use</td>
<td>dm³/s-m²</td>
<td>0,2</td>
<td>0,2</td>
<td>0,15</td>
<td>I, III</td>
</tr>
</tbody>
</table>

I Air flows are measured, for example, with fixed device, a measurement device, a hot-wire anemometer, or the bag method according to the SFS 5512 standard (LVI 014-10187, SFS-käsikirja 103).

II It must be possible to increase the air flows temporarily to remove the contaminants produced. It is recommended that the ventilation of the flat be boosted overall, not just the air flow in the stove fan. Instead, the boost should apply to washing rooms and restrooms.

III Outside normal usage times, the building must have basic ventilation with which impurities originating from the building are removed. This basic ventilation outside usage time may only be used during long-term absence (more than one day), assuming, for example, that the wet spaces do not remain wet.
2.4.3.1 General

The objective of the cleanliness classification of air-handling systems is to ensure the quality of the supply air flowing through a new air-handling system. Supply air of good quality shall not contain contaminants detrimental to the health originating from the air-handling system (such as microbes, fibres, and particles) or odours that decrease comfort.

The cleanliness classification of air-handling systems includes the cleanliness requirements for the components of the air-handling system (see Section 3.2) and the cleanliness requirements for the design and installation of an air-handling system to be presented below.

The air-handling components shall be tested and classified just as the other characteristics of the component in question are ascertained – by means of approval procedures based on quality control agreements and laboratory measurements. Emission testing or odour assessment shall always be carried out in the laboratory. The approval labels of the components ordered shall be checked at the construction site.

The cleanliness requirements of the air-handling system are intended to ensure that the air-handling system is clean when the building is handed over. These requirements have been defined such that their fulfilment is easily assessed by means of simple procedures.

The cleanliness class of the air-handling system shall be specified in the planning documents.

2.4.3.2 Assembly of the air-handling system

There are two cleanliness categories (P1 and P2) in the cleanliness classification of a new air-handling system. The cleanliness class shall be selected during the design stage for the air-handling system.

The filters must meet the requirements of cleanliness class M1 for air-handling components.

Supply air filtering can be replaced with space-specific air purifiers whose cleaning capacity corresponds to the filtering capacity of the supply air filters of the selected quality class with the design air flows.

The filters and/or air purifiers must not release ozone to the supply air or indoor spaces.

2.4.3.3 Special requirements for design and implementation

Ducts and fittings

The thermal insulation and the vapour barrier of ductwork shall be fixed with care and skill to prevent moisture condensation and to control energy losses. The exhaust air duct shall be insulated from the heat recovery unit right up to the exhaust fan. In a warm space it shall also be moisture-insulating. The main, branch, and connection ducts shall be designed and installed in such a way that all parts can be cleaned either via terminal units or in some other way to be agreed upon separately.

The ducts and fittings that are situated outside or in cold spaces shall be thermally insulated so that no water condenses on their inner surfaces.

Control and measuring devices

The control and measurement devices shall be installed in the ducts such that the cleaning of the ducts does not become too difficult.

Water traps and drainage

The water traps of the air-handling unit shall be connected outside the unit, and the drainage water shall be led through the floor drains to the drainage system.

Table 2.4.5. Filtering of supply air and air-handling cleanliness class.

<table>
<thead>
<tr>
<th>Filtering class</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.4.6. The requirements for cleanliness class P1.

- The supply air ducts and fittings shall be manufactured using cleanliness-classified air-handling components, or the components shall be cleaned at the construction site to satisfy the same requirements.
- The sealing materials shall be selected from building materials in emission class M1 or M2, or other materials known to have low emissions.
- The average amount of dust on the inner surface of a new air-handling system shall not exceed 0.7 g/m² when measured with the filter sampling method (Pasanen et al. 1999) or inspected visually (Narvanne 2001).
- Return air shall not be used except in air-handling units serving only one dwelling.
- Fragrances shall not be used in the supply air.
- The supply air side of the air-handling machines shall have a two-stage filtering system whose degree of separation corresponds to the requirements of Table 2.4.5.

Table 2.4.7: The requirements for cleanliness class P2.

- The supply air ducts shall be manufactured using cleanliness-classified air-handling components, or the components shall be cleaned at the construction site to satisfy the same requirements.
- The average amount of dust on the inner surface of a new air-handling system shall not exceed 2.5 g/m² when measured with the filter sampling method (Pasanen et al. 1999) or inspected visually (Narvanne 2001).
- The facility may use the exhaust air of spaces of equivalent cleanliness as return air. Return air must be filtered with a cleanliness-classified filter corresponding to supply air filtering.
- Fragrances shall not be used in the supply air.
- The supply air side of the air-handling machines shall have a two-stage filtering system whose degree of separation corresponds to the requirements of Table 2.4.5.

The drainage pipes of the supply and exhaust systems shall not be connected.

Outdoor air grille

The outdoor air grille shall be classified in accordance with the SFS-EN 13030:en standard. Without special arrangements, this means that the air velocity (the air flow divided by the flow area of the grille) shall generally not exceed 1.5 m/s.

The grille shall be fixed to the wall so that no water can enter the structures or the air-handling unit. The drainage of the water, snow, and ice in the grille shall be arranged in such a manner that the water does not damage the structures or the air-handling unit.

The mesh size of the grille shall not be under 10 mm in a mechanical air-handling system.

The outdoor air ducts shall be thermally insulated when the duct is situated in a warm space.
Outdoor air plenum
The outdoor air plenum shall be fitted with a dry floor drain, which shall be connected to a floor drain with a water trap. The height of the water trap of the floor drain shall correspond to at least twice the pressure loss caused by the outdoor air grille at the highest air flow rate. The air velocity in the outdoor air plenum shall generally not exceed 1 m/s.

Air-handling units connected to the same outdoor air plenum shall in no circumstances draw air through other air-handling units.

Outdoor air damper
The melting water condensing on the damper shall be drained through the water trap. The damper shall have thermal insulation against outdoor air.

Heat recovery
The pressures of the supply and exhaust air in the heat recovery unit shall be designed such that the exhaust air cannot flow through any leakage in the heat recovery unit to the supply air. The exhaust air shall be filtered with a filter meeting the supply air filtering system before a regenerative heat recovery unit. Regenerative heat recovery units shall be used only when the exhaust air does not contain tobacco smoke or other harmful contaminants or when the device serves only one space (e.g., a garage).

To defrost the heat recovery unit and to prevent breakdowns, a safe method of protection against freezing should be used.

The temperature of the supply air after the heat recovery unit shall be adjustable in order that the supply air can cool rooms in summertime. The velocity of the exhaust air shall not exceed 2.3 m/s if condensation of water on the coil is possible. Melting frozen dew and ice, as well as water condensing on the heat recovery unit, shall be drained away so that water cannot damage the air-handling unit or other structures.

The height of the water trap shall correspond to twice the negative pressure existing in in-use conditions. The water trap shall be easily cleaned and shall be designed such that the water in the trap is effortlessly visible, and such that water can be added to it directly and not via the basin in the air-handling unit.

Cooling coil
The cooling coil shall be equipped with a droplet eliminator and two drip pans, one on the outside and the other on the inside, both of which shall be connected to a floor drain with a water trap or to some other device if water condenses on the coil.

The height of the water trap shall correspond to twice the negative pressure existing in in-use conditions. The water trap shall be easily cleaned and shall be designed such that the water in the trap is effortlessly visible, and such that water can be added to it directly and not via the basin in the air-handling unit.

Sound attenuator and a duct insulated on the inside
The sound-attenuating and insulation materials shall not become wet.

Humidifying equipment
Humidifiers shall not release water droplets into the duct air. The dew-point temperature of the air after the humidifier shall be significantly lower (at least 2 °C) than the temperature on the inner surfaces of the ducts.

2.4.3.4 Storage and installation technologies
The air-handling components shall be protected against interior dirt and moisture at the construction site. The protective covers (e.g., caps of the duct ends) shall not be removed or broken during storage, and broken covers shall be repaired immediately.

The following items shall be taken into consideration in installation of the air-handling system:
- the protective covers of the components shall be removed only just before installation
- dirt shall not accumulate in the air-handling system during installation
- burrs, screws, or other items that may accumulate dirt or make cleaning of the ducts difficult shall not remain in the ducts or fittings
- the use of excessive sealant for sealing of the air-handling system shall be avoided
- all open ends of the ductwork shall be capped throughout any breaks and interruptions of the installation work, to prevent dust from accumulating in the ductwork until the deployment, or the ductwork shall be airtight (cleanliness class P1: tightness class C, SFS 4699 (LVI 30-10213); or cleanliness class P2: tightness class B, SFS 4699 (LVI 30-10213))
- the proper functioning of the service and access doors (in terms of accessibility, possibility of opening the doors and working via the doors, and cleaning distance) shall be checked

2.4.3.5 The use of the air-handling system during construction
If the air-handling system is used during construction, the filters shall be in place in the air-handling unit. The air-handling unit shall be cleaned to fulfil the requirements of the selected cleanliness class, and the filters shall be changed before the air-handling system is handed over.

2.4.3.6 Instructions for the operation and maintenance of the air-handling system
Operation and maintenance instructions shall be prepared for the air-handling system and be given to the user when the air-handling system is handed over.

The operation and maintenance instructions shall address the following:

The planned running time of the air-handling system
The air-handling unit shall run continuously for one year after the building has entered use. Even after this, the air-handling units shall be switched on for at least a minimum of two hours before the occupants of the building arrive.

The replacement of filters
Fibre filters shall be replaced when the final pressure drop has reached the value determined by the designer or, at the latest, when more than half of their back surface has changed colour because of accumulated dust or the filters have been wet for a long time (microbes may begin to grow on a filter from a few days to a week after it becomes wet). Fibre filters for one-stage filtering shall be replaced at least every six months. The coarse filters of two-stage filtering shall be replaced at least this often, and the fine filters shall be replaced at least once a year.

Cleaning of ducts
The supply and exhaust air ductwork shall be inspected at least every five years. The dirtiness of the ducts can be determined by quantifying the dust accumulation on the inner surface of the duct by means of, for example, the filter sampling method. Dust samples shall be taken from at least five measuring points. When the amount of dust exceeds 2 g/m² (for P1-classified ducts) or 5 g/m² (non-P1-classified ducts), the ductwork shall be cleaned. For more information, refer to Ilmanvaihtojärjestelmän puhtauden tarkastus. Ilmanvaihdon parannus- ja korjausratkaisut (LVI 39-10409).
3 REQUIREMENTS FOR BUILDING PRODUCTS

3.1 Emission classification of building materials (M)

3.1.1 General

Various chemicals are emitted from building and interior decoration materials into room air. They may originate, for example, from the raw materials used, defects in the manufacturing process, or the ageing of the materials. Improper use of materials may also be a reason for emissions. The concentration of chemicals in the room air depends on the total emission of the materials and on ventilation. The concentration of chemicals in the room air can be diminished by decreasing the total emission or by increasing the ventilation and improving ventilation effectiveness. In aiming for a low concentration of chemicals, the total emission quantity should primarily be controlled through the use of low-emission materials and only secondarily should the ventilation be increased.

The classification system for building materials presents the requirements for materials used in ordinary workspaces and residences with respect to good indoor air quality. The goal is to enhance the use of low-emission products so that material emissions do not increase the need for ventilation. However, the use of low-emission building materials does not entirely guarantee good indoor air quality. Ventilation shall be adequate, and materials shall be used according to the manufacturers’ specifications. Very few materials can withstand excessive moisture or attachment to a moist substructure. The materials shall also be easy to clean.

The emission classification of building materials is primarily designed for classification of materials present in ordinary residential and work rooms. The classification of building materials has three emission classes, where emission class M1 corresponds to the highest quality and emission class M3 includes materials with the highest emission rates. Because the total amount of emissions is also influenced by the quantities of materials used, the design instructions in Subsection 2.2.2 present normative values for the amounts of building materials in each emission class. When one aims for the best indoor environment category, S1, the use of materials with higher emissions (emission classes M2 and M3) shall be restricted.

The requirements presented in the other sections of this document shall also be taken into account during the design and construction phases of the building. The developer selects the indoor environment, construction cleanliness, and building material categories collaboratively with the design team when the design of the building is commenced.

The operation of the emission classification system maintained by the Building Information Foundation RTS is described in more detail in the document Emission Classification of Buildings Materials. General Instructions.

3.1.2 The emission classes of building materials

Emission class M1 is designated for emission-tested materials whose emissions fulfill the requirements of Table 3.1.1. Emission class M2 is designated for emission-tested materials whose emissions fulfill the requirements of Table 3.1.2. Emission class M3 includes materials whose emissions exceed the values specified for materials in class M2. Materials that have not been tested shall not be granted a classification label.

The material that has the highest amount of emissions determines the emission class of a combination of materials. For example, an M2-classified material coated with an M1-classified coating material remains M2-classified until emission tests carried out on the coated material prove otherwise. Correspondingly, an M1-classified material coated with an M2-classified coating material is M2-classified until emission tests carried out on the coating material prove otherwise.

Table 3.1.1. Requirements for class M1.

- Total volatile organic compound (TVOC) emissions shall be below 0.2 mg/m²h. A minimum of 70 % of the compounds shall be identified.
- The emission of formaldehyde (H₂CO) shall be below 0.05 mg/m²h.
- The emission of ammonia (NH₃) shall be below 0.03 mg/m²h.
- The emission of carcinogenic compounds belonging to category 1 of the IARC classification (WHO 1987) shall be below 0.005 mg/m²h (does not apply to formaldehyde, the criteria for which are presented above).
- The material is not odorous: an untrained panel’s satisfaction with odour shall be >0.1.
- Plasters, levelling agents, and putty shall not contain casein.

Table 3.1.2. Requirements for class M2.

- Total volatile organic compound (TVOC) emissions shall be below 0.4 mg/m²h. A minimum of 70 % of the compounds shall be identified.
- The emission of formaldehyde (H₂CO) shall be below 0.125 mg/m²h.
- The emission of ammonia (NH₃) shall be below 0.06 mg/m²h.
- The emission of carcinogenic compounds belonging to category 1 of the IARC classification (WHO 1987) shall be below 0.005 mg/m²h (does not apply to formaldehyde, the criteria for which are presented above).
- The material is not odorous: an untrained panel’s satisfaction with odour shall be >0.1.
- Plasters, levelling agents, and putty shall not contain casein.

The manufacturer of the materials shall have an approved quality control system. The emission testing of the material shall be repeated if the raw materials or the production process for the building material changes.

3.1.3 Measurement methods


3.2 Cleanliness classification of air-handling components

3.2.1 General

The cleanliness classification of air-handling systems includes the cleanliness requirements of air-handling components presented in this section and the cleanliness requirements set for the design and installation of the air-handling system (see Subsection 2.4.2).

The objective of the cleanliness classification of air-handling systems is to ensure the good quality of the supply air flowing through a new air-handling system. Supply air of good quality shall not contain contaminants detrimental to the health that originate from the air-handling system (such as microbes, fibres, and particles) or odours that reduce comfort. Because many factors affect the quality of supply air, the following cleanliness requirements for the components and the entire air-handling system have been derived from the more general principles.

The cleanliness class of the air-handling system and the cleanliness requirements of air-handling components shall be specified in technical documents.
3.2.2 Cleanliness requirements for air-handling components

3.2.2.1 General requirements

Air-handling components have one cleanliness class. A component either is classified or is not. The general requirements for a classified component are presented below.

- A classified component shall not increase the concentration of contaminants that are detrimental to health or comfort in the air-handling system or supply air.
- A classified component shall not produce odours, or gaseous or particulate contaminants that decrease the quality of supply air.
- A classified component shall be easy to clean.

The above-mentioned requirements are fulfilled if, after manufacture, the component satisfies the component-group-specific requirements. Thus far, these component-group-specific requirements have been determined for ducts, fittings, air and fire dampers, filters, and sound attenuators. The general requirements presented in this classification and the special requirements presented in item 3.2.2.4 should be applied to other components.

Solutions other than those dealt with in this document may also meet the requirements of the cleanliness classification, but they shall be addressed case by case.

3.2.2.2 Ducts and fittings, and air and fire dampers

The requirements for ducts, fittings, and air and fire dampers pertain to sheet-metal spiralseamed ducts and fittings manufactured using traditional techniques (oil-based lubricants).

The general requirements of item 3.2.2.1 and Table 3.2.1 shall be applied to products manufactured using other methods or materials.

The inner surfaces of classified ducts and fittings shall satisfy the requirements of Table 3.2.1.

The odour criterion may be used as an alternative to the above-mentioned criteria on the surface density of oil. Odour assessment may become a reasonable choice when the component has been manufactured from some other material than sheet metal, or some other lubricant than mineral oil has been used in the manufacturing process. Odour assessment and detailed criteria are presented in the Protocol for the Cleanliness Testing of Air-handling Components.

Emission tests need not be performed on metal ducts; instead, their cleanliness can be measured by determining the oil residue levels. The materials of the inner surfaces of ducts manufactured from some other material shall satisfy the ammonia, formaldehyde, and TVOC requirements of emission-class-M1 building materials when measured with an air speed in the duct that corresponds to normal usage.

The ducts, fittings, and adjustment and fire dampers must be cleanable according to the SFS-EN 12097:en standard or the construction code or type approval instructions valid in Finland. This applies also to access doors.

Fixing of stick-on labels to the inner surfaces of the components is not allowed.

Ducts and fittings shall withstand at least 10 cleaning sessions (in special cases, such as professional kitchens, even more) without detrimental changes in their structure, using cleaning methods specified for them. No more than 0, 1 pcs/m² of fibres from ducts and fittings shall pollute the supply air during or after cleaning (see the Protocol for the Cleanliness Testing of Air-handling Components, Appendix 7).

Air and fire dampers shall not prevent the cleaning of the ductwork. It shall be possible to reset the air dampers to their original position after cleaning. It shall also be possible to check the position of the dampers without opening the ducts.

The inner surface of the components shall be smooth, so that it does not advance the accumulation of dust. The roughness of the duct material may not exceed 1 mm. The seams of the connection joints of ducts and ducts whose diameters are 200 mm or under may not exceed a height of 2 mm on the inner side of the duct. The seams of the connection joints of ducts and ducts with diameters of 315 mm and above may not exceed a height of 3 mm on the inner side of the duct. The components shall be free from burrs that can make cleaning difficult or break cleaning equipment.

The air-tightness of the components shall satisfy the requirements of class C in the SFS 4699 standard (LVI 30-10213).

Sealing materials shall not emit compounds into the supply air that are harmful to the health or that decrease the quality of the air. Excessive use of putty shall be avoided. Sealing materials in emission class M1 or M2, or other sealing materials known to have low emissions, should be used in the manufacturing of classified air-handling components.

3.2.2.3 Air filters

These requirements apply to filters intended for use primarily in business, office, service, and residential buildings as supply air filters.

The initial pressure loss, dust-binding capacity, degree of separation, filter class, and effects of any electrical charge on the filter material shall be specified according to standard SFS-EN 779:en. The test measuring the effect of electrical charges can be replaced with a six-month field test, which can be executed according to SP method 1937. In this case, the minimum separation degree must conform to Table 3.2.2.

The manufacturers shall also specify the ozone production of electric filters – i.e., the highest ozone concentration in the supply air under normal use.

The filter classification has two categories. All classified filters belong to class M1, but they are additionally categorised into various classes on the basis of their degree of particle separation.
Table 3.2.2. Air filter classes.

<table>
<thead>
<tr>
<th>Filter class</th>
<th>Pressure drop Pa</th>
<th>Total leakage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollen filters</td>
<td>F5 + M1 / F6 + M1</td>
<td>Fine filter that separates out at least 20% of particles of over 1,0 μm.</td>
</tr>
<tr>
<td>Urban dust filters</td>
<td>F7 + M1</td>
<td>Fine filter that separates out at least 80% of particles of over 1,0 μm and at least 50% of particles of over 0,4 μm</td>
</tr>
<tr>
<td>Fine particle filters</td>
<td>F8 + M1 / F9 + M1</td>
<td>Fine filter that separates out at least 90% of particles of over 1,0 μm and at least 70% of particles of over 0,4 μm</td>
</tr>
</tbody>
</table>

Table 3.2.3. Total leakage for each filter class presented at a certain pressure difference.

<table>
<thead>
<tr>
<th>Filter class</th>
<th>Pressure difference Pa</th>
<th>Total leakage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worse than F5</td>
<td>200</td>
<td>6</td>
</tr>
<tr>
<td>F5</td>
<td>400</td>
<td>6</td>
</tr>
<tr>
<td>F6</td>
<td>400</td>
<td>4</td>
</tr>
<tr>
<td>F7</td>
<td>400</td>
<td>2</td>
</tr>
<tr>
<td>F8</td>
<td>400</td>
<td>1</td>
</tr>
<tr>
<td>F9</td>
<td>400</td>
<td>0,5</td>
</tr>
</tbody>
</table>

The intensity of the odour of the air flowing through an unused filter shall be below 4 for a trained odour panel. With a non-trained odour panel, the acceptability value of air passed through the product or product combination shall be > 0.1. The odour production shall be determined according to the sensory tests in annexes 1 and 6 to the Protocol for the Cleanliness Testing of Air-handling Components, or on the basis of the emission classification of building materials.

The filter shall not release mineral fibres into the supply air during the use of the building. The total quantity of fibres released from a new filter should be less than 0,1 pcs/m3 (Protocol for the Cleanliness Testing of Air-handling Components, Appendix 7). Oils or biocides detrimental to the health are not allowed in a filter in Finland.

The bypass leakage of the filter (leaks through the gaps in the casing of the unit and the filter cartridge) and the sections of the air-handling unit subject to negative pressure shall not exceed the figures in Table 3.2.3 at the pressure differences presented in the table.

The filter cartridge and the frames shall withstand a pressure difference of three times the design pressure differential value.

The filter shall be easily replaced.

The filter shall not touch the floor of the filter plenum or any other potentially moist part, even when the air-handling unit is not running.

The manufacturer shall specify the filter replacement need and how used fibre filters are to be disposed of in an environmentally friendly way.

In the case of electric filters, the manufacturer shall specify the filter-cleaning interval or how the functionality of an automatic cleaning system can be monitored.

3.2.2.4 Sound attenuators

The sound attenuation requirements presented here apply to sound attenuators intended for use primarily in business, office, service, and residential buildings as sound attenuators. The sound attenuators to be classified shall meet the requirements of the National Building Code of Finland (for noise attenuation and cases of fire), and their attenuation characteristics shall be known.

<table>
<thead>
<tr>
<th>Table 3.2.2. Air filter classes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollen filters</td>
</tr>
<tr>
<td>Urban dust filters</td>
</tr>
<tr>
<td>Fine particle filters</td>
</tr>
</tbody>
</table>

The sound attenuators shall not release particles, fibres, or other harmful impurities to the air. The total concentration of fibres (with a size of over 20 μm) released from the attenuators shall be less than 10 pcs/m3 in a vibration test (Protocol for the Cleanliness Testing of Air-handling Components, Appendix 7).

Sound attenuators shall be cleanable and endure at least 10 cleaning cycles using a method intended for them without visually detectable or otherwise harmful changes to their structure. Even after their cleaning (brush test 24 h after cleaning), sound attenuators shall not release more fibres than 0,1 pcs/m3 (see Protocol for the Cleanliness Testing of Air-handling Components, Appendix 7). These requirements may be amended if the sound attenuator can be detached for cleaning or easily replaced.

The quality of air passed through the sound attenuator shall be acceptable. The odour production shall be determined, when necessary, according to sensory tests as specified in the Protocol for the Cleanliness Testing of Air-handling Components (appendices 1 and 6) or the emission classification of building materials.

The acoustic characteristics, operation and cleaning instructions, rated air flow, and restrictions on use shall be available with the product and also separately.

The perforated metal sheet or other material used in the sound attenuator shall meet the requirements for oil-requiring processes specified in the classification, 0,3 g/m2 (300 mg). The certificate shall be attached to the application.

The manufacturer shall specify the attenuator cleaning need and how used attenuators are to be disposed of in an environmentally friendly way.

3.2.2.5 Other components of an air-handling unit

When suitable, the same requirements as for ducts, fittings, and filters concerning chemical and particulate pollutants and the acceptability or intensity of odour shall be applied also to other components of an air-handling unit.

Outdoor air grille

The mesh size of the outdoor air grille shall be at least 10–15 mm, and the grille shall be cleanable.

The grille shall be fixed to the wall such that no water can enter the structures or the airhandling unit through the fixing frame or supplies.

Outdoor air plenum

The structure of the outdoor air plenum is, for example, a sandwich structure wherein thermal insulation corresponding to 100 mm of mineral wool is fixed between two steel panels. The inner and outer surfaces of the plenum shall be easy to clean and vapour-tight.

The surfaces of the outdoor air plenum shall be cleanable. The outdoor air plenum shall be fitted with a dry floor drain, which shall be connected to a floor drain with a water trap. The height of the water trap of the floor drain shall correspond to at least twice the pressure loss caused by the outdoor air grille at the highest air flow rate. The plenum shall be designed to allow the water to flow easily into the floor drain. The plenum shall also withstand the negative pressure in the air-handling unit without deformation, because otherwise the water might be hindered from flowing out of the plenum.

Outdoor air damper

The structure and air-tightness of the outdoor air damper shall fulfill the requirements of the Finnish standard SFS 5330. It shall have thermal insulation such that the coefficient of thermal transmission is lower than 3 W/m²K. Freezing shall not impede the movement of the outdoor air damper. The casing of the outdoor air damper shall also be insulated, if necessary.
Heat recovery
Leakage between the exhaust and supply side of the heat recovery unit shall not cause harmful transfer of pollutants that allows the quality of supply air to worsen. The maximum leakage air flow shall not exceed 6% of the designed supply air flow when the pressure difference between the supply and exhaust sides, before the heat recovery unit, is 250 Pa. A product with approval in accordance with the type approval instructions in force in Finland is considered to fulfill the above requirements. Condensation water produced in the heat recovery unit shall be drained. It shall be possible to wash the heat recovery unit without the washing water causing damage to the unit.

Heating coil
It shall be possible to wash the heat transfer surfaces of the heating coil without washing water permeating the structures of the air-handling unit casing. It should be possible to remove the coil and wash it separately.

Cooling coil
It shall be possible to wash the heat transfer surfaces of the cooling coil without washing water getting inside the structures of the air-handling unit casing. It should be possible to remove the coil and wash it separately. The cooling coil shall be equipped with two drip pans, one of which is on the outside and the other of which is on the inside. The one on the inside shall be connected to a floor drain with a water trap, or to some other device, if water condenses on the coil. The water trap shall be situated after the drip pan from a water flow perspective. The drip pan shall be designed such that the water flows easily into the floor drain. The drip pan shall also withstand the negative pressure in the air-handling unit without deformation, as otherwise water might be impeded from flowing out of the pan.

Fan
The power transmission of the fan shall not emit harmful particles into the air or any other contaminants that cause deterioration in the air quality. The engine shall be selected and placed such that it does not pollute the air. The fan and its blades shall be cleanable.

Humidifying equipment
It shall be possible to clean the humidifier. The humidifier shall be equipped with a droplet eliminator and a drip pan, which shall be connected to a floor drain with a water trap or to some other device. The drip pan shall be designed such that the water flows easily into the floor drain. The drip pan shall also withstand the negative pressure in the air-handling unit without deforming, because otherwise the flow of water from the pan might be inhibited. The duct where the steam humidifier is installed shall be watertight. Humidifiers shall be equipped with an automatic system that drains the humidifier when it has not been in operation for one day.

The body of the air-handling unit
Sealing materials shall not emit compounds into the supply air that are harmful to the health or that decrease the quality of the air. Excessive use of putty shall be avoided. Materials in emission class M1 or M2, or other sealing materials known to have low emissions, should be used in the manufacture of classified air-handling components. It shall be possible to wash the casing of the air-handling unit, and its surfaces shall be as smooth as possible.

Terminal units
It shall be possible to open or remove the terminal units for cleaning. It shall be possible to adjust them to their original positions after cleaning. The structure and performance of each terminal unit shall be such that the air currents in it do not release any accumulated dust and dirt onto surfaces; for example, cooling beams should not release settled dust from the ceiling. The accumulation of dust and dirt shall not affect the performance of control devices.

3.2.2.6 Labelling and protection of components
Classified components shall be labelled in such a manner that they are easily distinguished from unclassified components. The labelling shall withstand normal transport, storage, and handling at the construction site.

The components shall be protected against contamination during storage at the factory and in transportation by fixing caps to duct ends or packing fittings into boxes and covering or otherwise protecting the load during transportation. The means of protection (e.g., caps) and the storage boxes shall withstand transportation and varying conditions at the construction site as well as several openings and closings.

If ducts are placed within each other for transportation, their outer surface shall be as clean as their inner surface is.

Storage, installation, and management instructions shall be provided for each component, and these shall cover the essential aspects of cleanliness.
4 REFERENCES

Official orders and instructions

HAW, RT, and KH sheets and publications of the Building Information Foundation RTS


M1 testing instructions
Annex 1: Sensory assessment with trained odour panel
Annex 6: Sensory assessment with non-trained odour panel
Annex 7: Determining the quantity of mineral fibres released in air flow
Annex 8: Air filter classification

International standards
EN 15251:2007 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.
ISO 16000-3: Indoor air – Part 3: Determination of formaldehyde and other carbonyl compounds – Active sampling method.
ISO 16000-6: Indoor air – Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS/FID.

HVAC, RT, and KH sheets and publications of the Building Information Foundation RTS
SFS standards


SFS-käsikirja 103/EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset, SFS-EN 12599 Ilmastoointiteknikka, osa 2. (Includes the standards SFS 5511 Rakennusten sisäilma. Lämpöolojen kenttämittaukset, SFS 5512 Ilmavirtojen ja painesuhteiden mittaustavoitteet, SFS 5517 Ilmastoointilaitosten vastaanottomittaukset,


In the event of any differences in interpretation of this LVI (HVAC) sheet the Finnish version LVI 05-10440 shall take precedence over this translation.