

Danish Society of Indoor Climate



Introduction to the Principles behind the Indoor Climate Labelling

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shows a brief up-to-date status.



This overview gives a brief introduction and an easy approach to the general principles and the concept behind the indoor climate labelling in Denmark and Norway (formerly the Danish Indoor Climate Labelling).

The paragraphs 1-3 of this summary describe the concept briefly
Paragraph 4 goes into detail with the measurement and calculation methods and achievements.

1. Introduction

Building products, furniture and other products used indoors influence the indoor air. The Danish Society of Indoor Climate Labelling, (formerly Danish Indoor Climate Labelling Association) provides a concept for documentation and labelling of this influence.

The goal of the indoor climate labelling is to improve the indoor air quality in buildings:

- By providing manufacturers with a tool to develop more indoor friendly products
- By providing users with a tool for the selection of more indoor friendly products
- By providing a tool for better understanding of the impact of products used in buildings on the indoor air

Additionally, by using low-emitting products it is not necessary to increase the ventilation.

The indoor climate labelling is established as a voluntary system for labelling the indoor properties of building products and other products to be used indoors.



The products labelled according to the indoor climate labelling are as a minimum identified by the indoor-relevant time-value, by the hawthorn logo accompanied by the text 'The Indoor Climate Label'.

Some experiences from the first years include that professional users in Denmark have emphasised the importance that the concept of the indoor climate labelling is scientifically based and the result can be given as one single indoor-relevant time-value. A time-value that can be easily understood and compared between products within the same category of use. Also the dynamic aspect of the indoor climate labelling that improvements of products are immediately shown in the time-value, is considered of major importance by users as well as a mean of competition.

Manufacturers involved in the indoor climate labelling often draw the attention to the fact that the labelling system is an operational tool that enables manufacturers and suppliers to include indoor air properties in the documentation and in the product development. Trade organisations and individual companies seem to agree that the close collaboration between manufacturers and the Danish Society of Indoor Climate and the close relation to practice is crucial for the industrial commitment.

The Danish Society of Indoor Climate is open for everybody with a profession interest in the indoor impact of products and in development of better and healthier products. For the latest news, please see our www-site <http://www.dsic.org> or contact the secretariat of the Danish Society of Indoor Climate.

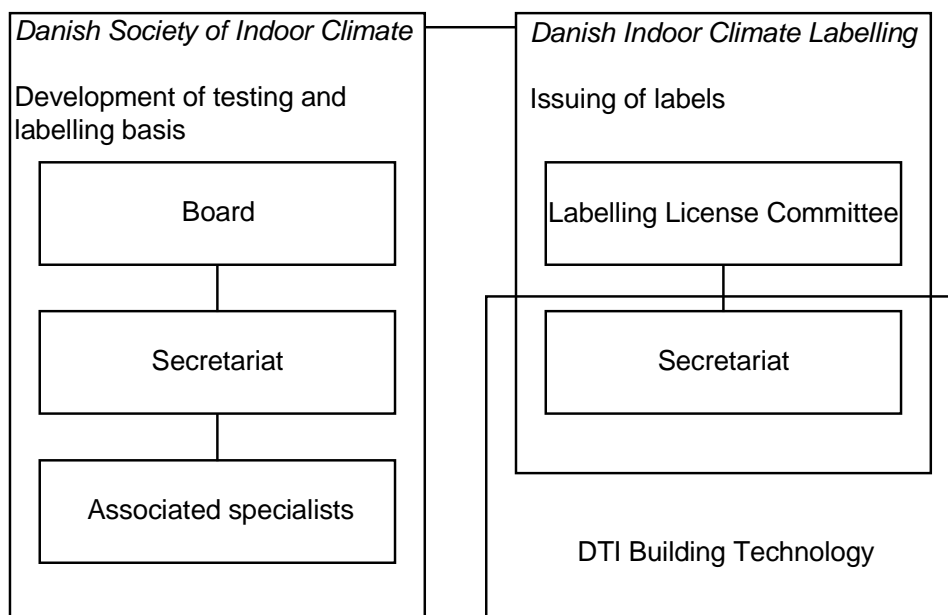
Organisation in Denmark

At first the indoor climate labelling was established as one organisation, but in order to make the organisation according to future ISO certification practice, the indoor climate labelling already in its second year was divided into two economically and legally independent organisations: A normative and a label issuing body Danish Indoor Climate Labelling respectively the Danish Society of Indoor Climate

The primary task of the Danish Indoor Climate Labelling is issuing and surveillance of labelling licenses based on the technical basis prepared in the framework of the indoor climate labelling. The labelling secretariat can at any time inform the status of the indoor climate labelled products. The labelling secretariat can be reached at phone no.: +45 72 20 23 01.

The Danish Society of Indoor Climate works for impartial product documentation by promoting knowledge of the impact of products on the indoor air, participates in development of standards for documentation of products impact on the indoor air and participates in diffusion of knowledge on products impact on the indoor air. As the normative body of the indoor climate labelling the Danish Society of Indoor Climate is responsible for preparation of the criteria of the indoor climate labelling.

The boards behind the Danish Society of Indoor Climate and the label issuing body include parties concerned with building and construction in Denmark (suppliers and professional users) as well as independent R&D institutes with indoor climate expertise.



Organisation in Norway

The organisation in Norway has been established on basis of the Danish lay-out with Norsk Forum for Inneklimamerking as the normative body and Norsk Inneklima Merking as the label issuing body.

International Organisation

Internationally, the indoor climate labelling is co-ordinated via an *International Committee* constituted by two representatives by the normative body of each participating country and is organised under the Danish Society of Indoor Climate, who owns the collective mark of the indoor climate labelling.

2. Testing and Labelling Criteria

The testing and labelling criteria are given in general “test methods” and in product specific “product standards”. The standard test method for determination of emission from building products (1) of the indoor climate labelling defines the frames for chamber testing. The standard test method for determination of particles (2) defines the frames for laboratory testing of particle emission.

A standard test method is common for all product areas and is used in conjunction with the specific product standards as basis of the determination of the indoor climate documentation of the products in question. The requirements of the product standards take priority over the requirements stated in the general test method.

The indoor-related properties included in the standard test methods concern newly manufactured products. To describe the potential impact on the indoor air of the total service life of a product, it is, furthermore, necessary that the indoor air documentation also comprises indoor related guidelines for the storage, transportation, installation, use, cleaning, maintenance etc. of a product. Requirements to guidelines form part of the product standards.

The basis of testing and labelling of a specific product given in the dedicated product standards, is made in collaboration with experts on the product area, e.g. independent technical resource persons, indoor scientists and suppliers of the products in question.

The product standards developed within indoor climate labelling are generally defined to be close to practice and founded in “code of practice”, on newest accessible R&D and experimental experiences.

For example, concerning flooring materials (resilient floors, wooden floors and laminated floors) the product standard allows both testing of a flooring material assembled as a surface including mechanical and chemical accessories needed, as well as testing of an entire flooring construction taking many parameters as sub-floor (kind, moisture content), membrane etc. into account.

In the product standards also the actual time from production until final installation indoors is taken into account, and the final product standard includes experience from laboratory testing of product variations covering the entire product range in the scope of the product standard.

Additional Indoor Related Properties

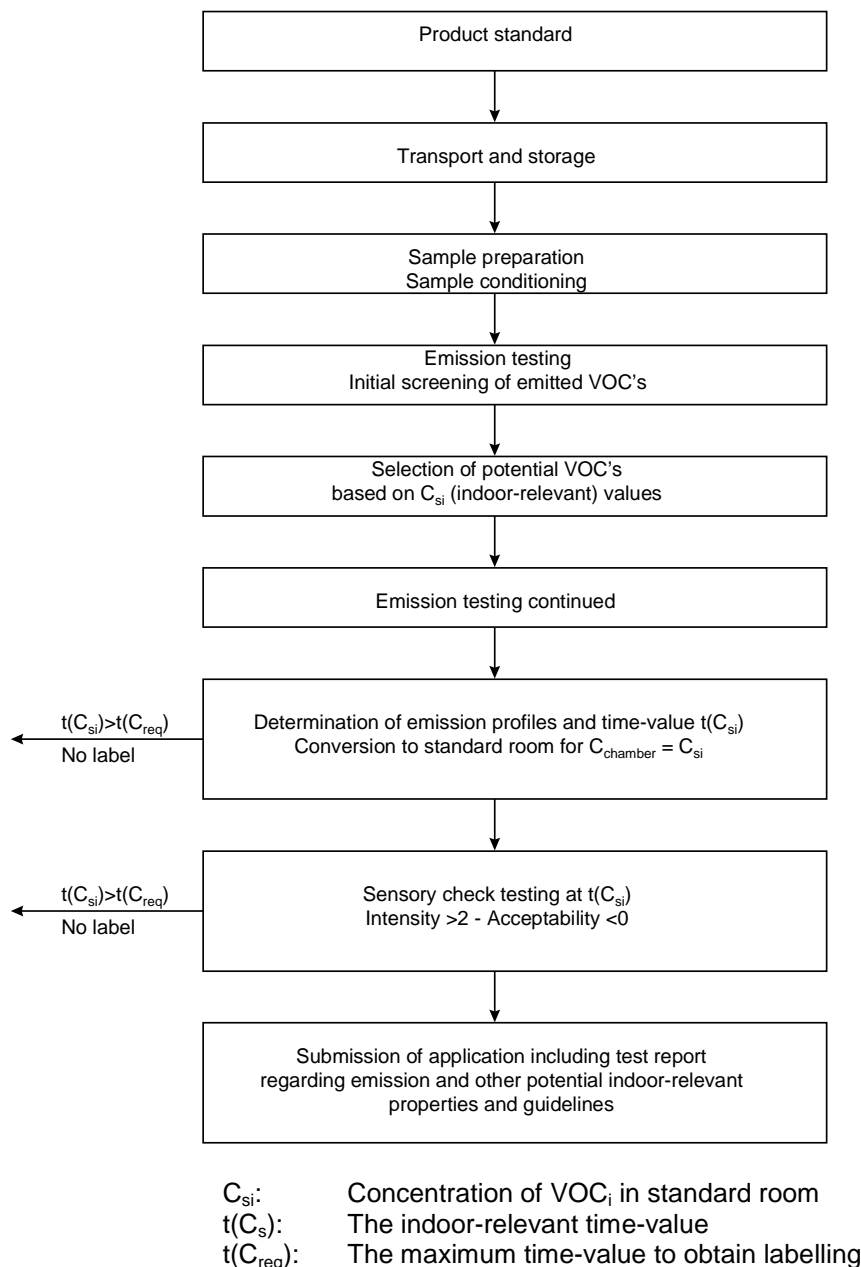
The indoor climate labelling has a defined scope to expand to cover other indoor-related properties than chemical and sensory emission, particle emission, and guidelines.

R&D projects provide continuous improvement and developments of the indoor climate labelling and are carried out mainly by the Danish Building Research Institute, the National Institute of Occupational Health and the Danish Technological Institute.

When generally accepted indoor air threshold values concerning carcinogenic and allergenic effects are defined, these health effects will be included. Additionally, it can be decided to include other indoor related properties on specific product areas, if property and test method are well defined.

3. General Principle - Indoor-relevant Time-Value and Guidelines

A summary of procedures for testing and evaluation according to the indoor climate labelling is given below:



The indoor climate labelling focuses at the moment primary on:

- The indoor-relevant time-value based on determination of emission of volatile organic compounds (VOC's) from primary sources
- Indoor-relevant guidelines

The test includes chemical measurement of individual substances and sensory measurements.

Indoor-Relevant Time-Value

The indoor-relevant time-value is defined as the time it takes to reach down on a defined acceptable concentration of the indoor climate in a standard room under standard conditions.

To phrase it popularly the indoor-relevant time-value is the time it takes from a product is installed till the emissions of all single substances are down at an acceptable concentration in the indoor air - based on odour and mucous irritation thresholds for eyes and upper respiratory passage as well as standard room considerations.

A declared time-value of, for example, 10 days means that the probability of the product to cause odour or to cause irritation in eyes, nose and upper respiratory passage is insignificant later than 10 days after installation of the product.

The basis of the indoor climate labelling is an indoor-relevant time-value based on chemical measurements of primary source emission of VOC's and on sensory evaluation. The labelling concerns the indoor air properties, which a new product is expected to have, when it is installed in the building.

The general principle applied when determining the emission of individual chemical substances is to place a well-defined test specimen in a test chamber at well-defined conditions. Gases and vapours emitted from the test specimen are mixed with the air in the chamber. Air samples are taken at defined times and analysed by chemical analysis techniques that include determination of at least: VOC's including aldehydes, amines, isocyanates, acids and compounds containing sulphur.

The result is given as a single indoor-relevant time-value, which is determined by converting chamber concentrations measured by chemical analyses to concentrations in a standard room and compared with odour thresholds and mucous membrane irritation thresholds (5).

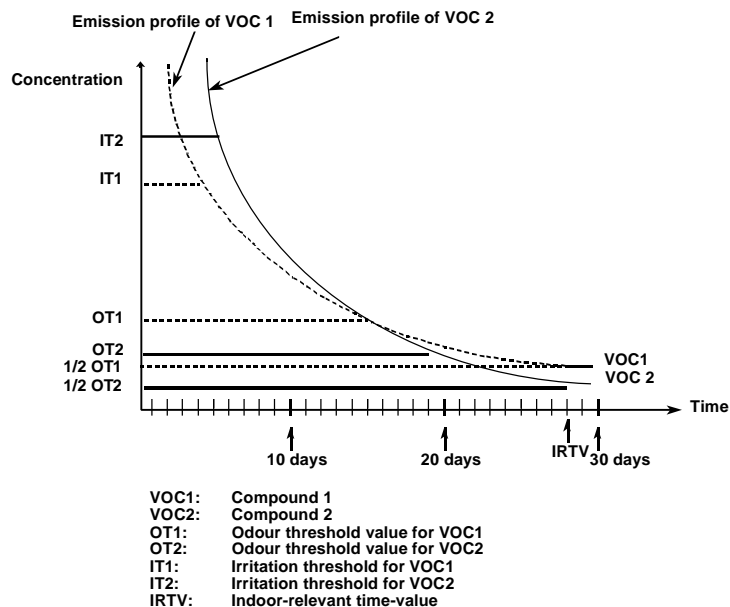
The time-value is evaluated via sensory determination of the perceived air quality. Calculations in more details are given below and in "Standard Test Method for Determination of Emission from Building Products" (1). Additional information on the technical background, assumptions, limitations and indoor comfort evaluation is given in (3), (4) and (5).

Principle in Determination of the Indoor-Relevant Time-Value

The determination of the indoor-relevant time-value of a product is based on the time, it takes the slowest emitting individual chemical substance with the lowest indoor-relevant odour or irritation threshold to reach half of this value in a fictive standard room (6) and (7).

The standard room used for general calculations of indoor air concentrations has a relatively large surface area compared to the room volume, see last part of "conversion of concentrations from test chamber to air in standard room".

In the example shown below, VOC2 showed to be the slowest emitting single substance, and to have an odour threshold value, which is lower than the irritation threshold value. The time-value corresponding to 50% of the threshold value based on VOC2 was found to be 28 days from the crossing of emission profile curve of VOC2 converted to standard room concentration and half of the odour threshold value line. The product was given a declared time-value of 30 days.



Air quality comfort thresholds for more than 800 chemical substances as well as other physio-chemical parameters are given in the databank "VOCBASE" (5), which is the reference databank of the laboratories.

The odour often becomes the determining factor, as the odour thresholds generally are magnitudes lower than mucous membrane irritation thresholds and thresholds of more severe effects.

Particle Emission

For ceiling systems an examination of the particle emission is carried out in excess of emission testing (indoor-relevant time-value).

Emission of particles from ceiling systems are determined by sedimentary dust consisting of particles including fibres, which could cause irritation on skin or in eyes, nose or upper respiratory passage in the first time after installation.

According to the test method new, undamaged ceiling plates are mounted into a mounting system according to the guidelines of the supplier.

The general principle when determining emission of particles is to mount well-defined test specimens in a test set-up under well-defined conditions and vibrate the test specimens by means of a loudspeaker. The test set-up is shaped as a chamber and the test specimens constituting the cover. Two clean glass plates are placed at the bottom of the chamber. Particles emitted from the test specimens fall on to the glass plates.

After some time the dust is collected from the glass plates by means of a transparent adhesive (gel-tape) and the area percentage dust is measured directly with a dust detector. The dust detector measures the difference between light transmission of the gel-tape before and after print. Determination of area percentage dust makes it possible to set the test result in relation to cleaning quality.

The weight of emitted particles per unit of area is determined gravimetrically by vacuuming the entire bottom of the chamber through a glass fibre filter, which holds back particles larger than $0.7 \mu\text{m}$. When weighing the filters before and after exposure, the emission of particles is found stated in mg dust per m^2 .

The indoor climate labelling of ceiling systems is solely based on the result of the gravimetric test.

Emission of particles including fibres is divided into 3 classes:

Low	Emission of particles less than or equal to 0.75 mg/m ²
Medium	Emission of particles larger than 0.75 mg/m ² and less than or equal to 2 mg/m ²
High	Emission of particles larger than 2 mg/m ²

For ceiling systems an emission of particles corresponding to low or medium gives the right to label according to the indoor climate labelling.

Whether an accept criterion based on area percentage dust later would form the basis of the indoor climate labelling depends on experiences from directory measurements hereunder a.o. whether connections between emission of particles determined by area percentage dust respectively mg dust per m² can be established.

Descriptions in detail appear from "Standard Test Method for Emission of Particles from Building Products" (2) and "Product Standard for Ceiling and Wall Systems" 2nd edition, 1997.

Indoor-Relevant Guidelines

To give a description of the indoor climate impact of a product through its entire service life the indoor climate labelling contains not only testing of emission from a newly manufactured product, but also requirements to indoor-related guidelines concerning storage, transport, installation, use, cleaning and maintenance etc.

Indoor related requirements to guidelines in different product areas appear from the product standard of the area in question.

4. Determination of the Indoor-Relevant Time-Value

The determination of the indoor-relevant time-value includes the following steps:

- Result of chemical analysis of air from test chamber
- Conversion of concentrations from test chamber to air in standard room
- Calculation of indoor-relevant time-value based on chemical analyses
- Evaluation of sensory determination

Result of Chemical Analysis of Air from Test Chamber

The calculation based on results from chemical analysis of air samples collected from the test chamber is carried out according to the following procedure.

The concentration changes all the time in the test chamber, also while the sampling takes place. The concentration, $C_{ki, \text{measured}}$, which is measured, is, therefore, an average value of the equilibrium concentration over the sampling time. The equilibrium concentration will in most cases change so little in time that it can be considered constant during usual sampling times, usually less than a couple of hours.

By repeated measurements the measured concentration should be given as function of the measuring time. The graduation of the axes should be adjusted to the size of the concentrations and to the size of the measuring times, the axes should start with zero.

The curve, which the points indicate, is the emission profile of the measured substance. The same test specimen may have different emission profiles for the different substances.

The concentration in the test chamber can not be compared directly with the acceptable concentration of the indoor air quality, therefore, the emission rate in the test chamber is defined in the formula below

$$R_{ki} = \frac{C_{ki} \cdot n_k \cdot V_k}{A_k}$$

where

R_{ki} is the emission rate in the test chamber for the compound "i", $\mu\text{g}/(\text{m}^2 \text{ h})$ or $\text{mg}/(\text{m}^2 \text{ h})$

C_{ki} is the concentration in the test chamber of the compound "i", $\mu\text{g}/\text{m}^3$ or mg/m^3

n_k is the air exchange rate in the test chamber, h^{-1}

V_k is the volume of the test chamber, m^3

A_k is the exposed area of the specimen in the test chamber, m^2

The area divided by the volume is called the material loading.

Conversion of Concentrations from Test Chamber to Air in Standard Room

The concentration measured in the test chamber should be converted to a concentration in a fictive standard room representing the indoor air quality. It is assumed that the emission rate is the same in the test chamber as in the standard room, which implies that the test chambers used give completely uniform concentration conditions.

The emission rate in the standard room is defined below

$$R_{si} = \frac{C_{si} \cdot n_s \cdot V_s}{A_s}$$

where:

R_{si} is the emission rate in the standard room for the compound "i", $\mu\text{g}/(\text{m}^2 \text{ h})$ or $\text{mg}/(\text{m}^2 \text{ h})$

C_{si} is the concentration in the standard room of the compound "i", $\mu\text{g}/\text{m}^3$ or mg/m^3

n_s is the air exchange rate in the standard room, h^{-1}

V_s is the volume of the standard room, m^3

A_s is the exposed area of the building material in the standard room, m^2

Furthermore, the definition is valid:

$R_{si} \cong R_{ki}$ This approximation will to a great extent be valid for most resilient materials

Accordingly, the concentration of the indoor air quality can be calculated according to the formula below:

$$R_{si} = R_{ki}$$

$$\frac{C_{si} \cdot n_s \cdot V_s}{A_s} = \frac{C_{ki} \cdot n_k \cdot V_k}{A_k}$$

$$C_{si} = C_{ki} \cdot \frac{n_k}{n_s} \cdot \frac{L_s}{L_k}$$

In cases where the influence of the air temperature, the relative humidity or other factors on the emission (and thereby the concentration) are known, this influence can be included in the technical assessment.

Conversion of the results from the test chamber to indoor air quality is based on the following standard room and standard conditions (6):

Volume of the standard room:	17.4 m ³
Exposed areas in the standard room, m ²	
Flooring material	7
Ceiling material	7
Wall coating	24
Door surface	2
Window frame	0.2
Sealants	0.2
Fixtures	4
Total	<u>44.4 m²</u>

When the conditions in the test chamber do not vary significantly from the requirements to the climate parameters of the standard room, the results can be used without correction.

Air exchange rate	0.5 h ⁻¹
Air temperature	23°C
Relative humidity	50% RH
Air velocity	0.15 m/s

All materials can have the same emission per m².

Calculation of the Indoor-Relevant Time-Value Based on Chemical Analyses

The databank "VOCBASE", includes odour thresholds, OT, and irritation thresholds, IT, (5).

The acceptable concentration in the indoor air quality of one individual compound is 50% of the smallest of the values OT and IT. The acceptable concentration is calculated from the formula below:

$$C_{Li} = 0.5 \cdot \min \{OT, IT\}_i$$

where

C_{Li}	is the acceptable concentration of the indoor air quality of the compound "i", $\mu\text{g}/\text{m}^3$ or mg/m^3
OT	is the odour threshold, $\mu\text{g}/\text{m}^3$ or mg/m^3
IT	is the irritation threshold, $\mu\text{g}/\text{m}^3$ or mg/m^3

It is assumed that the irritative impact from more compounds at the same time is bigger than the irritative impact from an individual compound. When there are more compounds, which is often the case, the requirement to the concentration is made on the level of a sum of compounds and not on the level of one single compound, see the formula below. The sum formula does not apply in the case of odour.

$$\sum_{i=1}^x \frac{C_{si}}{C_{Li}} < 1$$

The measured indoor-relevant time-value is given in whole days.

Evaluation of Sensory Determination

When the indoor-relevant time-value is determined from the chemical analyses a sensory evaluation of the acceptability and intensity of the air is carried out at the time corresponding to the time-value based on chemical testing. The sensory determination is used as a total and supplementary determination of the air quality.

The panellists indicate their evaluations on two continuous scales regarding intensity (scale from no odour to overwhelming odour) and acceptability (scale from clearly acceptable to clearly unacceptable) of the air compared to reference air.

An acceptability of "0" (just acceptable) and an odour intensity of "2" (moderate odour) can, for example, be used as the limits for acceptable air quality.

Achievements

The achievements of DICL covering determination of chemical emission and indoor related guidelines comprise:

- A larger probability of reducing the exposure from primary source emission and partly also secondary source emission of newly produced products
- A larger probability of reducing symptoms of indoor related diseases caused by emission from newly produced products

References

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