SOC1.2

Indoor air quality

Objective

Our aim is to ensure that indoor air is of sufficient quality not to adversely affect users' health and well-being.

Benefits

Nowadays humans spend up to 90 percent of their time in closed rooms. The indoor air quality therefore plays a significant role concerning performance and health. Ensuring high air quality in rooms by using low-emission products and providing an adequate air exchange rate increases users' well-being, productivity and satisfaction.

Contribution to overriding sustainability goals

	CONTRIBUTION TO SUSTAINABLE DEVELOPMENT GOALS (SDGS) OF UNITED NATIONS (UN)		CONTRIBUTION TO THE GERMAN SUSTAINABILITY STRATEGY	
Significant	3.4	Reduction of premature death, promotion of good health/well-being	3.1.a/b	Health and food
	3.9	Effects of chemicals, air, water and soil contamination	3.2.a	Air pollution
	12.4	Environmentally friendly handling of chemicals and waste		

Outlook

The target and reference values are based on scientific findings. If these findings advise further tightening, this will likely be reflected in the future formulation of the criterion.

Share of total score

	SHARE	WEIGHTING FACTOR
Office **Assembly buildings**	**5.1%**	**5**
Residential **Logistics** **Production**	**5.4%**	**5**
Hotel	**4.9%**	**5**
Consumer market **Department stores**	**4.5%**	**4**
Shopping centre **Education**		

EVALUATION

The "indoor air quality" criterion is an exclusion criterion in the DGNB certification system (this does not apply to the new construction retail and new construction industrial schemes). A building that does not meet the minimum requirements for indoor air quality cannot be certified.

Ensuring indoor air that does not adversely affect users is evaluated via the indoor air concentration of volatile organic compounds (VOCs) (indicator 1) and via the ventilation rate (indicator 2). Improvements to the indoor air quality via innovative solutions can be acknowledged via an innovation area.

As a prerequisite for the assessment of this criterion, indicator 1 has to meet the minimum indoor air quality requirements, i.e. at least 10 points either with indoor air quality measurement ≤ 4 weeks (alternatively 5 points with indoor air quality measurement > 4 weeks) after the completion of the examined rooms, or building material declaration is required. This is linked to compliance with quality level 3 in accordance with the criteria ENV 1.2. The worst measured value is used for the evaluation of the indoor air concentration. The use of intermediate values is not possible. A total of 100 points can be achieved for this criterion or a maximum of 105 points including bonuses.

NO.	INDICATOR	POINTS
1	**Indoor air quality – Volatile organic compounds (VOCs)**	
1.1	**Measurement of volatile organic compounds**	
	Office **Education** **Hotel** **Assembly buildings**	
	■ Evaluation of the indoor air concentration of volatile organic compounds according to the ISO 16000-6, -3 standards	
	TVOC [µg/m³] / Formaldehyde [µg/m³]	**Max. 50**
	> 3000 / > 100	0
	≤ 3000 / ≤ 100	10
	≤ 1000 / ≤ 60	25
	≤ 500 / ≤ 30	50
	Alternatively:	
	■ Evaluation of incomparable VOC measurements according to the ISO 16000-6, -3 standards (measured more than four weeks after completion)	
	TVOC [µg/m³] / Formaldehyde [µg/m³]	**Max. 25**
	> 3000 / > 100	0
	≤ 3000 / ≤ 100	5
	≤ 300 / ≤ 30	25
	Alternatively:	
	■ Evaluation of the indoor air concentration of volatile organic compounds according to the EPA (Environmental Protection Agency US) Standards TO-1 / TO-15 / TO-17 and TO-11A (Formaldehyde)	**Max. 40**
	TVOC [µg/m³] / Formaldehyde [µg/m³]	
	> 3000 / > 100	0
	≤ 3000 / ≤ 100	10
	≤ 1000 / ≤ 60	20
	≤ 300 / ≤ 30	40
	Alternatively:	
	■ Evaluation of incomparable VOC measurements according to the EPA	**Max. 20**

Standards TO-1 / TO-15 / TO-17 and TO-11A (measured more than four weeks after completion)

TVOC [µg/m³]	Formaldehyde [µg/m³]	
> 3000	> 100	0
≤ 3000	≤ 100	5
≤ 300	≤ 30	20

Alternatively:

- Evaluation of the indoor air concentration of volatile organic compounds according to the ASHRAE 189.1- 2014 (TVOC reporting shall be in accordance with CDPH (California Department of Public Health) Standard Method V1.1 and shall be in conjunction with the individual VOCs listed in Annex 3). Max. 20

TVOC [µg/m³]	Formaldehyde [µg/m³]	
> 500	> 100	0
< 500	< 100	10
< 200	< 30	20

Alternatively:

- Evaluation of the indoor air concentration of volatile organic compounds according to the National (local) Regulation[1] **Variable**

Residential

- If representative measurements are not possible for ≥ 80% of the common rooms due to the implemented tenant fit out, the lower evaluation must be applied. (Evaluation of the indoor air concentration of volatile organic compounds according to the ISO 16000-6, -3 standards)

TVOC [µg/m³]	Formaldehyde [µg/m³]	< 80% / ≥ 80%	**Max. 30/50**
> 3000	> 100	0 / 0	0
≤ 3000	≤ 100	5 / 10	5/10
≤ 1000	≤ 60	10 / 25	10/25
≤ 500	≤ 30	30 / 50	30/50

Alternatively:

- Evaluation of incomparable VOC measurements according to the ISO 16000-6, -3 standards (measured more than four weeks after completion)

TVOC [µg/m³]	Formaldehyde [µg/m³]	< 80%	≥ 80%	**Max. 10/15**
> 3000	> 100	0	0	0
≤ 3000	≤ 100	5	5	5
≤ 300	≤ 30	10	15	10/15

Alternatively:

- If representative measurements are not possible for ≥ 80% of the common rooms due to the implemented tenant fit out, the lower evaluation must be applied (Evaluation of the indoor air concentration of volatile organic compounds according to the EPA Standards TO-1 / TO-15 / TO-17 and TO-11A (Formaldehyde))

TVOC [µg/m³]	Formaldehyde [µg/m³]	< 80% / ≥ 80%	**Max. 25/40**
> 3000	> 100	0 / 0	0
≤ 3000	≤ 100	5 / 10	5/10

[1] TVOC and Formaldehyde measurement methods, concentration limit values and max. points, to be agreed with DGNB

≤ 1000	≤ 60	10	20	10/20
≤ 300	≤ 30	20	40	20/40

Alternatively:

- Evaluation of incomparable VOC measurements according to the EPA Standards TO-1 / TO-15 / TO-17 and TO-11A (measured more than four weeks after completion)

TVOC [µg/m³]	Formaldehyde [µg/m³]	< 80%	≥ 80%	**Max. 7.5/10**
> 3000	> 100	0	0	0
≤ 3000	≤ 100	5	5	5
≤ 300	≤ 30	7.5	10	7.5/10

Alternatively:

- If representative measurements are not possible for ≥ 80% of the common rooms due to the implemented tenant fit out, the lower evaluation must be applied (Evaluation of the indoor air concentration of volatile organic compounds according to the ASHRAE 189.1- 2014 (TVOC reporting shall be in accordance with CDPH (California Department of Public Health) Standard Method V1.1 and shall be in conjunction with the individual VOCs listed in Annex 3)). **Max. 5**

TVOC [µg/m³]	Formaldehyde [µg/m³]	< 80% / ≥ 80%	
> 500	> 100	0	0
< 500	< 100	5	10
< 200	< 30	10	20

- Additional points for tenant obligations if representative measurements of ≥ 80% of the common rooms are not possible due to the tenant fit out:
  It is documented that the tenants/apartment owners have undertaken to implement at least 50% of the total rental spaces in accordance with quality level 3 of the criterion "ENV1.2 Local environmental impact" and that compliance with the requirements after completion of the rental space corresponds to the following results:
  Evaluation of the indoor air concentration of volatile organic compounds according to the ISO 16000-6, -3 standard

TVOC [µg/m³]	Formaldehyde [µg/m³]	**Max. 15**
≤ 3000	≤ 100	5
≤ 1000	≤ 60	10
≤ 500	≤ 30	15

Alternatively:

Evaluation of the indoor air concentration of volatile organic compounds according to the EPA Standards TO-1 / TO-15 / TO-17 and TO-11A (Formaldehyde)

TVOC [µg/m³]	Formaldehyde [µg/m³]	**Max. 10**
≤ 3000	≤ 100	5
≤ 1000	≤ 60	7.5
≤ 300	≤ 30	10

Alternatively:

Evaluation of the indoor air concentration of volatile organic compounds

according to the ASHRAE 189.1- 2014 (TVOC reporting shall be in accordance with CDPH (California Department of Public Health) Standard Method V1.1 and shall be in conjunction with the individual VOCs listed in Annex 3).

TVOC [µg/m³]	Formaldehyde [µg/m³]	**Max. 5**
≤ 500	≤ 100	2.5
≤ 200	≤ 30	5

Alternatively:

- Evaluation of the indoor air concentration of volatile organic compounds according to the National (local) Regulation[2] — **Variable**

Shopping centre **Department stores** — **Max. 30**

- Only low-emission construction products are used in the communal areas. The products are declared in full and are in compliance with the quality level 3 according to the ENV1.2. — +15
- It is documented that the tenants have undertaken to comply with quality level 3 as a minimum in accordance with ENV1.2 for at least 50% of the rental spaces and have confirmed compliance after completion of the rental space. — 10
- It is documented that the tenants have undertaken to comply with quality level 3 as a minimum in accordance with ENV1.2 for at least 80% of the rental spaces and have confirmed compliance after completion of the rental space. — 15

Logistics **Production** — **Max. 50**

- A declaration has been carried out and documented for all products of the floor surfaces. The products are fulfilling at least quality level 3, according to the ENV1.2. — 25
- A declaration has been carried out and documented for all products of the floor surfaces and other interior surfaces. The products are fulfilling at least quality level 3, according to the ENV1.2. — 40
- In addition, evaluation of the indoor air concentration of volatile organic compounds in compliance with the ISO 16000-6, -3 standard

TVOC [µg/m³]	Formaldehyde [µg/m³]	**+Max. 10**
> 3000	> 100	0
≤ 3000	≤ 100	5
≤ 1000	≤ 60	7.5
≤ 500	≤ 30	10

Alternatively:

evaluation of the indoor air concentration of volatile organic compounds in compliance with the EPA Standards TO-1 / TO-15 / TO-17and TO-11A

TVOC [µg/m³]	Formaldehyde [µg/m³]	**Max. 7.5**
> 3000	> 100	0
≤ 3000	≤ 100	2.5
≤ 1000	≤ 60	5
≤ 300	≤ 30	7.5

[2] TVOC and Formaldehyde measurement methods, concentration limit values and max. points, to be agreed with DGNB

Alternatively:

evaluation of the indoor air concentration of volatile organic compounds in compliance with the ASHRAE 189.1- 2014 (TVOC reporting shall be in accordance with CDPH (California Department of Public Health) Standard Method V1.1 and shall be in conjunction with the individual VOCs listed in Annex 3).

TVOC [µg/m³]	Formaldehyde [µg/m³]	**Max. 5**
> 500	> 100	0
≤ 500	≤ 100	2.5
≤ 200	≤ 30	5

Alternatively:

- Evaluation of the indoor air concentration of volatile organic compounds according to the National (local) Regulation[3] **Variable**

Consumer market **30**

Assembly buildings exception: **25**

- A declaration has been carried out and documented.

Remark: according to the “IV. Usage-specific description”, certain rooms in **Assembly buildings,** can be assessed by means of a declaration.

1.2 **AGENDA 2030 BONUS – REDUCTION IN POLLUTANT EMISSIONS IN THE INDOOR AIR, HEALTH AND WELL-BEING** **+Max. 5**

Objective of the AGENDA 2030 BONUSES is to reduce premature death and promote good health and well-being.

1.2.1 Protection of non-smokers: People are not adversely affected by other people smoking within the building or surrounding zones. In the surrounding outside areas, suitable measures are in place to ensure that cigarette smoke cannot enter the building. +2.5

1.2.2 Particulate matter in interiors: Particulate matter pollution due to copiers and laser printers is prevented by using low-emission inkjet printers or by installing copiers and laser printers in a separate printer room with sufficient ventilation. +2.5

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2 Indoor air quality – Ventilation rate

2.1 Air exchange rate

Office **Education** **Hotel** **Assembly buildings**

Mechanical ventilation systems according to EN 15251 or DIN EN 16798-1 **Max. 50**

EN 15251	Description	
IV	Values outside categories I to III; should only be used for a limited period of the year	0
III	Acceptable, moderate expectations; can be used for existing buildings.	25
I and II	Normal expectations; recommended for new and renovated buildings	50

[3] TVOC and Formaldehyde measurement methods, concentration limit values and max. points, to be agreed with DGNB

Alternatively:

Natural ventilation through opening windows **Max. 25**

Category	Description	
	no verification	0
Workplace regulation A 3.6	The requirements of workplace regulation A (continually 3.6) are met. Ventilation or boost ventilation. See Appendix A	25

Alternatively:

Zonal flow simulation **Max. 50**

EN 15251	CO_2 concentration higher than the exterior air concentration [ppm]	
IV	> 800	0
III	> 500 and ≤ 800	25
I and II	≤ 500	50

If 25 points have been achieved through both mechanical ventilation and compliance with the workplace regulation via boost ventilation, the combination of mechanical ventilation and natural ventilation is awarded 50 points.

Shopping centre **Department stores** **Consumer market**

Note regarding **Shopping centre** : Evaluation of this indicator can be carried out by means of different classification of the mall and the shops. The mall is documented separately (total max. 70 points).

Mechanical ventilation systems according to EN 15251 or DIN EN 16798-1 **Max. 70**

EN 15251	Description		
IV	Values outside categories I to III; should only be used for a limited period of the year.		0
III	Reasonable, moderate expectations; can be used for existing buildings	**Shopping centre (shops)**	
		(Mall)	25
		Department stores	10
			35
		Consumer market	30
I and II	Normal expectations; recommended for new and renovated buildings	**Shopping centre (Shops)**	
		(Mall)	50
		Department stores	20
			70
		Consumer market	70

Residential **Max. 50**

- Creation of a ventilation concept in accordance with DIN 1946 Part 6 — 15
- Ventilation measures with implementation of ventilation stages: RL — 35
- Ventilation measures with implementation of ventilation stages: RL/NL* — 50

*If the result of the calculation in accordance with DIN 1946-6 is that the air flow rate via infiltration per unit in m3/h is sufficient to cover the air flow rate for moisture protection in accordance with DIN 1946-6, this requirement is considered to have been met.

Unoccupied periods (vacancy): If no values have been defined at national level, the ventilation rate for moisture protection (FL) is recommended for unoccupied periods.

Logistics **Production**

Natural ventilation through opening windows or mechanical ventilation	**Max. 50**
■ No verification	0
■ The requirements of workplace regulation A 3.6 are met. See Appendix A	25
■ Regulation of ventilation as required	40
■ Over-fulfilment of the hygienically required minimum air exchange by at least 20%.	50

Re 2 **INNOVATION AREA**

Explanation: If the indoor air quality is verifiably improved by alternative, innovative solutions, points can be awarded accordingly.

As in 2.1.

SUSTAINABILITY REPORTING AND SYNERGIES

Sustainability reporting

Appropriate parameters (KPIs) for communication include measurement TVOCs and formaldehyde results determined in indicator 1 as well as the air exchange rate and the maximum CO_2 concentration. The findings can also be used for reporting in accordance with the "Level(s) – Common EU framework of core environmental indicators". The results of the indoor air measurement can be used for this.

NO.	KEY PERFORMANCE INDICATORS (KPIS)	UNIT
KPI 1	Measured value for TVOCs (with number/share of the rooms for which the measured values are applicable)	[µg/m³]
KPI 2	Measured value for formaldehyde (with number/share of the rooms for which the measured values are applicable), corresponds to elements of the Level(s) indicator 4.1.2	[µg/m³]
KPI 3	Total ventilation rate (with number/share of the rooms for which the ventilation rate is applicable), corresponds to elements of the Level(s) indicator 4.1.1	[l/s]
KPI 4	Maximum CO_2 concentration in 95% of the use time (with number/share of the rooms for which the maximum CO_2 concentration is applicable), corresponds to elements of the Level(s) indicator 4.1.1	[%]

Synergies with DGNB system applications

- **DGNB BUILDINGS IN USE :** Achieving a good level of indoor air quality (criterion SOC9.1 of the scheme for buildings in use) is indirectly positively evaluated for users´ satisfaction.
- **DGNB RENOVATED BUILDINGS:** High synergies with criterion SOC1.2 of the scheme for renovated buildings.
- **DGNB INTERIORS:** High synergies with criterion SOC1.2 of the scheme for interiors.

APPENDIX A – DETAILED DESCRIPTION

I. Relevance

II. Additional explanation

If TVOC and formaldehyde concentrations, exceeding limit values listed in the evaluation tables above or the transgression of Guide value 2 according to Annex 2 or Regulatory and Advisory numbers according to Annex 3, endanger hygiene of rooms in dwellings, offices or teaching rooms used by the same persons for several hours, buildings with these high pollution levels are excluded from certification.
In rooms where occupants stay only for few hours and change on a continuous basis (e.g. sales rooms, film screening rooms) , appropriate methods must be applied to reduce the abovementioned danger to hygiene to the lowest possible level. Buildings presenting an identifiable risk to health must be excluded from certification.
Rooms where surrounding building components present only a limited threat and rooms which are not used on a continuous basis (e.g. large sheds or warehouses) present a limited risk to health. The objective is for building materials and methods in rooms of this type to present only limited pollution levels.

In the analyses specified above, unpleasant olfactory perception should be additionally avoided.

III. Method

Indoor air quality (IAQ) is evaluated on the basis of a checklist including various indicators, which are combined to arrive at a total score. The following indicators are assessed as part of the checklist:

Indicator 1: Indoor air quality – Volatile organic compounds (VOCs)
For this indicator, there is a purely planning-based evaluation approach in addition to the measurement-based approach. For buildings where the requirements for the subsequent indoor air situation has not or only partially been decided in the planning phase, e.g. because fitment is to be carried out by the tenant, a replacement method (low-emission products) is used.

Indicator 1.2: AGENDA 2030 BONUS – Reduction in pollutant emissions in the indoor air, health and well-being
The objective is to reduce premature death and promote good health and well-being of humans.

1.2.1 Protection of non-smokers
The harmful effects of smoking and passive smoking are firmly established. For this reason, people in the building or other surroundings should not be adversely affected by smoking. Suitable measures should be implemented, in and around the building, in order to prevent cigarette smoke entering the building from the outside.

1.2.2 Particulate matter in interiors
Ultra-fine particulate matter is particularly dangerous to humans. Copiers and laser printers in particular contribute to a significant increase in ultra-fine particulate matter in indoor air and increased concentrations of volatile organic compounds. Because every printing process expels ultra-fine particulate matter into the air, where it can cause damage to human respiratory organs, laser printers should be replaced with low-emission inkjet printers or copiers and laser printers should be installed in a separate printer room with sufficient ventilation.

Indicator 2: Indoor air quality – Air exchange rate
There are a number of different evaluation approaches for this indicator depending on the building use.

IV. Usage-specific description

Office **Education** **Residential** **Hotel** **Assembly buildings**

Indicator 1: Indoor air quality – Volatile organic compounds (VOCs)
The indoor air measurement is conducted in a random sample of rooms no more than four weeks after building completion (see table of the representative furnishing types). The building is deemed complete when all packages with a possible impact on indoor air quality, including building service installations, painting and commissioning of sanitary and ventilation systems, have been delivered. Furniture that is permanently installed in the building (e.g. built-in cupboards) are to be taken into account in the indoor air measurement, while furniture provided by the user (chairs, computer, table, etc.) is not.
In addition to the total TVOCs, the substances listed in Annex 2 or Annex 3 must be quantified individually and the concentration of formaldehyde in the indoor air must be determined.
The TVOC concentration and the formaldehyde content in the indoor air are determined on the basis of the relevant standards. The TVOC value is assessed in accordance with the specifications of:

- DIN ISO 16000-6;

Alternatively:

- US EPA (United States Environmental Protection Agency) compendium method TO-1 / TO-15 or TO-17: Determination of Volatile Organic Compounds,

Alternatively:

- TVOC value reported in accordance with the method described in the ASHRAE 189.1.

All other national or local standards and methods must be firstly agreed with DGNB in system adaptation process.

The formaldehyde concentration is assessed in accordance with the specifications of:

- DIN ISO 16000-3,

Alternatively:

- US EPA compendium method TO-11A,

Alternatively:

- Formaldehyde value reported in accordance with the methods described in the ASHRAE 189.1 standard.

All other national or local standards and methods must be firstly agreed with DGNB in system adaptation process

Ventilation of the selected rooms is carried out in accordance with the specifications of DIN EN ISO 16000-5. This process differentiates between naturally and mechanically ventilated rooms. Alternatively measurement procedure can be carried out according to the specifications described in ASHRAE 189.1-2014 standard under the chapter “post-construction, preoccupancy baseline IAQ monitoring”.

The assessment regarding the ventilation must be based on the following conditions:

- Naturally ventilated rooms are ventilated intensively for 15 minutes. Then, all doors and windows must be kept closed for at least eight hours preceding the measurement (preferably overnight). Finally, the measurement is conducted with all doors and windows closed.
- In rooms with mechanical ventilation, the plant should be operated as usual. The plant must be taken into use no less than three hours before the measurement is conducted. In rooms with a recommended ventilation pattern (e.g. schools, crèches) an entire cycle of typical use should be completed.

- The operation of the mechanical ventilation or the conditions of ventilation before the measurement must be documented in a Ventilation Protocol similar to that described in DIN EN ISO 16000-1, Annex D, sections D and E.

The ventilation must be coordinated with an accredited laboratory and the report regarding the ventilation must be presented as documentation.

Measurements taken at a later date are not comparable as a result of the building materials varying emission patterns. Levels measured at a later date can be accepted if they are lower than those required for hygiene.
In this case, the evaluation is carried out in accordance with Table 3 (Evaluation of incomparable VOC measurements).

TABLE 1 TABLE OF REPRESENTATIVE ROOMS

ROOMS IN THE BUILDING	TYPE OF ROOM	NUMBER OF ROOMS TO BE SAMPLED
≤ 100	All of the rooms within the building do have essentially the same interior (fit-out)	2
	Room interiors (fit-outs) vary throughout the building. Each room type accounting for more than 10% of NFA in the building must be tested [T&D_04]	1 per type
> 100	All of the rooms within the building do have essentially the same interior (fit-out)	3
	Room interiors (fit-outs) vary throughout the building. Each room type accounting for more than 10% of NFA in the building must be tested [T&D_04]	2 per type

Essentially similar room specifications are floor coverings, wall and ceiling surfaces and permanent installations that feature no significant differences with regard to the materials used and their emissions performance. Differences in colour, pattern, shape or manufacturer are not relevant.

This means, for example, that two textile coverings with different manufacturers and structures, both of which have been fixed in place with low-emission adhesives and certified with the *GUT* label (i.e. emissions controlled), can be considered to constitute a single, essentially identical room specification. Here it must be noted that TVOC and formaldehyde emissions from construction materials such as floor coverings can decay at different rates. Not all carpets are tested up to the TVOC end value of 300 or 100 µg/m³ guaranteed by the label (e.g. *GUT, RAL-UZ*). Formally, *AgBB* (Committee for the Health Assessment of Construction Products Emissions)-certified carpets are permitted to still display a test chamber concentration of up to ≤1.0 mg/m³ TVOC/m3 after 28 days. It is therefore recommended to take necessary decay times into account.

A building cannot be certified if it has a TVOC concentration exceeding 3000 µg/m³ (or 500 µg/m³ if measurement process refers to the ASHRAE 189.1 standard) or a formaldehyde content exceeding 100 µg/m³.

Any situation where the limits for the substances specified under guide value I (Annex 2) have been exceeded on a sustained basis is not acceptable. For this reason, a statement is required regarding instances where guide value I is exceeded, indicating the source of the substance or including a declaration regarding the decay behaviour. The same is valid also for the Annex 3 where the references “Health numbers” are provided. These values are used as a recommendation for exposure levels for chronic inhalation (i.e. > 8h per day). The ASHRAE 189.1 threshold values also serve as the orientation numbers and with a threshold violation a relevant statement (as described above) must be provided.
For evaluation of volatile organic compounds without guide values, the VOC guide values for new buildings determined as part of a research assignment of the German Federal Environment Agency must be used, see Annex 2. For substances with provisional odour reference values derived from the working group of interior guide values, odour reference value II is documented in each case. Values of this magnitude indicate that unpleasant odours can be expected.
Measured values higher than these comparison values indicate that the building studied features levels of indoor air VOC pollution that are higher than the background level to a statistically significant degree.
If significantly higher concentrations than would "normally" be expected occur for individual VOCs (this refers to the New Construction Benchmarks value in accordance with Annex 2), this does not result in the building being rejected, but does mean that an independent expert report must be presented alongside the test report, indicating the source of the substance or including a declaration regarding the decay behaviour. If this information is not provided, the measurement will not be accepted.
The recommendation of the expert (such as recommended ventilation or further measurement) in the event that levels of individual substances or of TVOCs and formaldehyde exceed the limit values must be made available to the client/building owner to enable measures to be taken at an early stage.
A template for the verification has been created to simplify the documentation process (see Annex 1).

Exception rule by **Assembly buildings :**
Assessment of **Assembly buildings** is based on above mentioned "usage-specific description" (such as **Education**).
In the case of certain “Assembly building” types, with constantly changing fitouts / exhibitions / inventory (e.g. exhibition halls), assessment can be carried out via a declaration of the surface/subsurface materials/products e.g. primers and top coatings, coverings and adhesives etc. The basis for the evaluation is the creation of a project-specific list with the division of room types:
Lounge (measurement according to "usage-specific description" such as **Education**)
Lounge area with constantly changing fitouts / exhibitions / inventory (assessment based on a declaration of surface/subsurface products/materials accordance with the "usage-specific description" such as **Consumer market**)
Rooms division is plausible and based on the use of the space. Rooms that are assessed by means of a declaration are included in the assessment with a weighted area of 25 points if the requirements of quality level 3 according to ENV 1.2 are met and verified for these rooms. The minimum requirement for indoor air quality measurement must be met.

Shopping centre **Department stores**

Due to the significant impact of the facilities installed, indoor air measurements are not included in the evaluation. The evaluation is carried out via declaration of the products used. In some circumstances, indoor air measurements can be used to monitor planning objectives.
A declaration is required for all products situated close to the surfaces in the communal areas and, if applicable, the rental spaces. These include, in particular, paints, varnishes and coatings on walls, ceilings and floors as well as adhesives and sealants. Declarations are produced on the basis of the specifications in criterion ENV1.2, Recording local impacts. The requirements of quality level 3 in accordance with ENV1.2 must be complied with and

documented.
Involving the tenants in the requirements for the construction materials is evaluated particularly positively.
Documenting that the tenants have undertaken to comply with quality level 3 as a minimum for at least 50% of the rental spaces and that compliance has been confirmed after completion of the rental space is evaluated positively.

Logistics **Production**

The indoor air quality of industrial buildings is affected quite significantly by the use of the building and the ventilation system in place. Users are subject to occupational health and safety requirements. In buildings where low-emission products are verifiably used in the interior, a comparatively low level of indoor air pollution can be expected. The evaluation is therefore not solely performed using the results of indoor air measurements. Indoor air measurements are a suitable method for monitoring planning objectives.
A declaration is required for all products situated close to the surfaces in work areas; these include, in particular, paints, lacquers and coatings on walls, ceilings and floors as well as adhesives and sealants. Declarations are produced on the basis of the specifications in criterion ENV1.2, Recording local impacts. The requirements of quality level 3 in accordance with ENV1.2 must be demonstrated and complied with. Involving the tenants in the requirements for the construction materials is evaluated particularly positively.

The measurement is conducted in a random sample of rooms no more than four weeks after building completion. In addition to the total TVOCs, the substances listed in Annex 2 must be quantified individually and the concentration of formaldehyde in the indoor air must be determined. The rooms must be selected such that the significant differences between the interior surfaces are recorded. If rooms are divided into smaller parts, at least two measurements must be carried out in different rooms. In the case of a single large hall, one or more measurements and a ventilation system structured on the basis of those measurements must be used to achieve the closest possible approximation of the actual pollution levels. The measurement must be coordinated with an accredited laboratory and the report regarding the measurement must be presented as documentation.
The TVOC concentration and the formaldehyde content in the indoor air are determined on the basis of the applicable standards (EN ISO 16000-5, ISO 16000-6, ISO 16000-3, US EPA TO-1 / TO-15, US EPA TO-17, US EPA TO-11A and methods described in the ASHRAE 189.1 standard). The TVOC value is assessed in accordance with the specifications of ISO 16000-6, Annex A, or in accordance with the Table 1 in US EPA standard method TO-1 / TO-15 / TO-17.
The comparative evaluation is carried out on the basis of measurements taken within four weeks after completion.

A building cannot be certified if it has a TVOC concentration exceeding 3000 µg/m³ or a formaldehyde content exceeding 100 µg/m³, (respective 500 µg/m³ if ASHRAE 189.1 standard list was used) or if the most recent version of guide value II or Regulatory and Advisory numbers have been exceeded.

A building will achieve the maximum evaluation points if the TVOC value is < 500 µg/m³ (respective 300 µg/m³ or 200 µg/m³ for a measurement referring to US EPA TO-1/15/17 or the ASHRAE 189.1 standard) and the formaldehyde value is < 30 µg/m³. The partial target value is achieved if the TVOC value is < 1000 µg/m³ and the formaldehyde value is < 60 µg/m³.
For evaluation of volatile organic compounds without a guide value I, the VOC guide values for new buildings determined as part of a research assignment of the German Federal Environment Agency must be used, see Annex 1. Measured values more than 50% higher than these comparison values indicate that the building studied features levels of indoor air VOC pollution that are higher than the background level to a statistically significant degree.

If significantly higher concentrations than would "normally" be expected occur for individual VOCs, this does not

result in the building being rejected, but does mean that the test report must indicate the source of the substance or include a declaration regarding the decay behaviour. If this information is not provided, the measurement will not be accepted.

Indicator 2: Indoor air quality – Air exchange rate

Office **Education** **Assembly buildings** **Hotel** all room types to be considered, e.g. for Hotels the office and guest rooms.

Multiple alternative evaluation methods are available for evaluating the ventilation rate. For mechanical ventilation using ventilation systems, the evaluation can be carried out in accordance with EN 15251 or via a zonal flow simulation or DIN EN 16798-1 (new standard). For natural ventilation through opening windows, documentation is possible via the workplace regulation or a zonal flow simulation.

The evaluation of the total ventilation rate for non-residential buildings must be carried out in accordance with the calculation specifications of EN 15251 (or DIN EN 16798-1), Annex B, Section "B.1.2 Method based on person and building component". The person component takes into account natural perspiration of users as well as CO_2 pollution due to breathing. The total ventilation rate q_{tot} (= air flow per person + air flow for the building component) defines the satisfaction rate of users in accordance with EN 15251.

$q_{tot} = n * q_P + A * q_B$ (n: Number of persons, A: Floor area)

Where:
q_{tot} is the total ventilation rate of the room, in l/s;
n is the design specification for the number of persons in the room, –;
q_P is the ventilation rate for the occupancy or use per person, l/s, per;
A is the floor area of the room, m^2;
q_B is the ventilation rate based on the building emissions, l/s, m^2.

The ventilation rates recommended in EN 15251 are based on complete mixing of the air in the room. If the air distribution does not equate to complete mixing, the required ventilation rates can be adjusted accordingly. The ventilation rates recommended in EN 15251 can be divided by the ventilation efficiency. The following flat-rate values can be applied for the ventilation efficiency:

- Ventilation efficiency for mixing ventilation = 1.0
- Ventilation efficiency for displacement ventilation = 1.3

If it is documented that the implemented ventilation outlets achieve a higher ventilation efficiency, that value can be applied instead.

For evaluation of the building component, the building is assigned to one of the following categories: Very low polluting, low polluting and not low polluting. This categorisation is carried out in accordance with Annex C of EN 15251.
The category of "very low polluting building" in accordance with EN 15251 can be applied for the DGNB documentation as an alternative to Annex C if the VOC emissions are restricted to the target value (50 points) for the VOC/formaldehyde indicator. The category of "low polluting building" can be achieved with an indoor air quality corresponding to the partial target value (25 points) for the indicator.

The category of "very low polluting building" in accordance with EN 15251 can be applied for the DGNB documentation as an alternative to Annex C if the requirements of quality level 4 in accordance with ENV1.2 are complied with and documented for all internal materials. The category of "low polluting building" can be achieved by complying with the requirements of quality level 3.

For natural ventilation, the evaluation of the ventilation rate is carried out in accordance with the specifications of workplace regulation A 3.6, Section 5. Natural ventilation can be implemented either as boost ventilation or as continuous ventilation.

The following values as a minimum must be plausibly presented for the review:

- Natural ventilation system.
- Description of the representative room, demonstrating that it can be applied to the other rooms.
- Compliance with the maximum permitted room depth with regard to clear room height in accordance with workplace regulation A 3.6 (Table 3.1.3).
- Calculation documenting the opening surfaces (see also the calculation examples in the appendix of workplace regulation A 3.6).

As an alternative, it is possible to document the ventilation rate via a zonal flow simulation, both for naturally ventilated and mechanically ventilated rooms. The flow simulations must be based on the same information as is required for the thermal simulations for documentation of SOC1.1, indicators 1 and 5, operative temperature. The aerodynamic surfaces of the window casements must be depicted for the natural ventilation simulation. For windows/doors that are opened manually, suitable boundary conditions for the user behaviour must be selected.

A simulation covering the entire year, demonstrating the progression of the CO_2 concentration over time, is required for documentation of the ventilation rate. The maximum permitted CO_2 concentration in excess of the exterior air concentration (see Table B.4 of EN 15251) must be complied with for ≥ 95% of the use time.

The boundary conditions of the zonal flow simulation must be clearly documented, e.g. occupancy scenarios, CO_2 emissions from users, ventilation elements and cross-sections, ventilation behaviour. In addition, the aerodynamic parameters for the ventilation openings used in the simulations must be also specified.

Residential

The indoor air in an apartment is contaminated more or less heavily by the breathing of residents, the development of water vapour in the bathroom or kitchen (moisture and CO_2), the emissions from the facilities (VOCs) and other discharges. In order to ensure hygienic air quality in the apartment, the air present in the room must be exchanged in sufficient quantities. The number of residents, possible emissions from construction materials and items of equipment and the activities in the rooms must be taken into account here. The German DIN 1946 Part 6 defines protection against excessive moisture and measures to ensure indoor air hygiene. The evaluation of the air exchange rate achieved in the building is carried out on the basis of the categorisation in DIN 1946 Part 6.

Air exchange rate
Ventilation concept in accordance with DIN 1946 Part 6: In accordance with DIN 1946 Part 6, four different minimum values are defined for the total exterior volume flows (values including building infiltration).

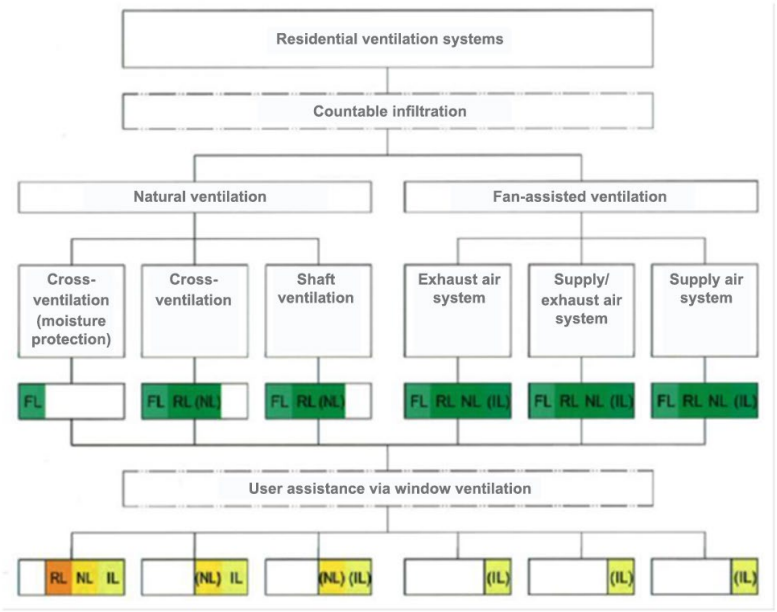
Ventilation for moisture protection:

User-independent ventilation (minimum operation) intended to prevent mould and moisture damage in the building depending on the thermal insulation level of the building (0.3 x nominal ventilation for high thermal insulation; 0.4 x Nominal ventilation for low thermal insulation) under normal use conditions (partially reduced moisture loads; room temperatures).

Reduced ventilation:
Usage-independent ventilation (0.7 x nominal ventilation) that meets the minimum requirements for indoor air quality under normal usage conditions with temporary absence (moisture and pollutant loads).

Nominal ventilation:
Ventilation required (1.0 x nominal ventilation) to ensure building protection as well as the hygiene and health requirements for planned use (normal operation). This level is the basis for the design of mechanical ventilation.

If the ventilation air volume required for moisture protection is not achieved by means of user-independent ventilation via building infiltration, one of the following ventilation measures as defined by DIN 1946-6 is required:



Design in accordance with values given in brackets is recommended.
Tables 5 and 6 in DIN 1946 Part 6 can be used as an indicator for the values of individual total exterior flow rates. The total extracted air flow rates are defined in accordance with Table 7 of DIN 1946 Part 6 or the requirements of the German DIN 18017 Part 3.

The different systems of the residential ventilation have different properties with regard to planning reliability, energy efficiency and usage comfort. The influencing factor of the user only plays a secondary role.

Shopping centre **Department stores**

In accordance with EN 15251 (or DIN EN 16798-1), the ventilation rates for non-residential buildings are designed on the basis of the building and person component.
The evaluation of the total ventilation rate for non-residential buildings must be carried out in accordance with the calculation specifications of EN 15251 (or DIN EN 16798-1), Annex B "Basis for the criteria for indoor air quality and ventilation rates". Here, the person component takes into account natural perspiration of users as well as CO2 pollution due to breathing. The total ventilation rate q_{tot} (= air flow per person + air flow for the building component) defines the satisfaction rate of users in accordance with EN 15251.

$q_{tot} = n * q_P + A * q_B$ (n: Number of persons, A: Floor area)

Where
q_{tot} is the total ventilation rate of the room, in l/s;
n is the design specification for the number of persons in the room, –;
q_P is the ventilation rate for the occupancy or use per person, l/s, per;
A is the floor area of the room, m^2;
q_B is the ventilation rate based on the building emissions, l/s, m^2.

The ventilation rates recommended in EN 15251 are based on complete mixing of the air in the room. If the air distribution does not equate to complete mixing, the required

ventilation rates can be adjusted accordingly. The ventilation rates recommended in EN 15251 can be divided by the ventilation efficiency. The following flat-rate values must be applied for the ventilation efficiency:

- Ventilation efficiency for mixing ventilation = 1.0
- Ventilation efficiency for displacement ventilation = 1.3

If it is documented that the implemented ventilation outlets achieve a higher ventilation efficiency, that value can be applied instead.
The evaluation of the ventilation rate due to persons must be carried out within Categories I to III in accordance with the table "Examples of recommended ventilation rates" (EN 15251:2012 Annex B, Table B3). The same applies to the applicable building component, i.e. contamination due to the building itself.
The total ventilation rate and thus the ventilation rate due to persons must be documented with the NSC15_SOC1.2_Tool.

General specifications for rental spaces and mall spaces:
Evaluation of the rental and mall spaces takes place separately. The following basic principles apply to both areas here:

EN 15251 contains recommendations for the occupancy rate of department stores (7 m² per person), but it is possible to deviate from these recommendations in justified cases. Studies of various building types have shown that this occupancy rate is generally not achieved in reality. For this reason, one of the following methods can be applied for determining the occupancy rate for the purposes of the DGNB certification:

- Reliable project-specific predictions are applied (the following are required: Daily number of customers, average length of stay, opening times)
- Assignment to one of the specified typical profiles (discount store, full-range supplier, DIY store); the

auditor recommends the assignment to the DGNB and plausibly justifies this assignment. The assignment must be confirmed by the DGNB.

- If no information is available: Application of the conservative value of 7 m² per person in accordance with EN 15251, Table B.2

The NSC15_SOC1.2_Tool must be used for cases 1 and 2. The daily number of customers, average length of stay and opening times are entered into this tool. In addition, a safety margin of 100% is applied to the average length of stay by the tool in order to take peak times into account. This process calculates the number of persons applicable for the evaluation, taking into account the parameters mentioned above.

In addition, in all cases (1 to 3), categorisation as a "very low polluting", "low polluting" or "polluting" building must be carried out in order to enable the building components to be taken into account on a project-specific basis; this categorisation is fundamentally carried out in accordance with EN 15251, Annex C.

For the DGNB documentation, a "very low polluting" or "low polluting" building can be categorised on the basis of criterion ENV1.2 as an alternative. Quality level 4 as defined in criterion ENV1.2 corresponds to a very low polluting building, quality level 3 corresponds to a low polluting building and quality levels 1 and 2 correspond to a non-low polluting building.

It is assumed that a reasonable selection of construction materials is taken into account as part of the project planning. In addition, it must be ensured that the indoor air quality is not adversely affected by using construction materials that are not taken into account in ENV1.2. If a rental space has no documentation proving that emissions from construction materials are restricted (cf. indicator 1), that area must be categorised as "not low polluting".

Overflow from rental spaces:
If the building concept provides for air overflowing from the shop or rental spaces into the mall and contributing to ensuring hygienic air exchange there, this may also be applied for the evaluation. In order to do so, the relevant data (air flow rate, customers, etc.) for all shops is entered into the tool. Taking into account the intended ventilation quality (Category I to IV) in the shops, the tool automatically calculates how much "fresh" air is still available and makes this amount available to the mall (see "Fresh air share", "Mall overflow“). This overflow must be plausibly documented, and (partial) extraction of the used air in the rental spaces must be taken into account accordingly (e.g.: If 100,000 m³/h of supply air is introduced into the rental spaces and 70,000 m³/h of this is extracted into the mall and the rest is extracted into the shops, a value of "70%" must be entered into the tool).

Logistics **Production**

The evaluation of the ventilation is carried out in accordance with workplace regulation A 3.6.

For mechanical ventilation, the exterior air flow must be designed to ensure that loads (substances, moisture loads, thermal loads) are reliably removed and that the CO_2 concentration does not exceed 1000 ppm.

For natural ventilation, it must be documented that the requirements of workplace regulation A 3.6 have been met (e.g. compliance with the maximum room depths in accordance with Table 3 of the workplace regulation). The opening surfaces must be dimensioned such that they meet the requirements for either continuous ventilation or boost ventilation.

Alternatively, in the case of natural ventilation, it is also permitted to prove via a zonal building simulation that the

loads are removed and the CO_2 concentration does not exceed 1000 ppm.

For both natural and mechanical ventilation, it must be ensured that the exterior air is not contaminated to an impermissible degree and is not noticeably adversely affected, e.g. by outgoing air from extraction or indoor air ventilation systems, by heavy traffic or by poorly ventilated locations.

If the indoor air quality in work areas is adversely affected by additional loads (e.g. substances, moisture loads or thermal loads), it must be documented that suitable measures are in place to ensure sufficient air quality is achieved as per workplace regulation A 3.6.

If tasks are carried out at the workstation involving hazardous substances or biological agents that could thereby endanger employees, the provisions in accordance with the German Ordinance on Hazardous Substances or the German Biological Agents Ordinance, including the corresponding technical rules, apply with regard to the dangers resulting from substances at these workstations.

The appropriate level of ventilation can be achieved via the following measures, for example:

- A concept for natural ventilation is created. At minimum, the ventilation surfaces required for continuous ventilation in accordance with workplace regulation A 3.6 are motorised and operated automatically via sensors (e.g. CO_2 sensors).
- The fresh air flow rate of the mechanical ventilation can be adjusted to suit current requirements either by the user (e.g. step switch) or automatically via sensors (e.g. CO_2 sensors).

Over-fulfilment of the hygienically required minimum air exchange by at least 20% must be documented in the following way: First, the substance loads resulting from emissions due to persons, the building and industrial processes must be determined. These must be used as a basis for determining the required air quantities or natural ventilation cross-sections. For documentation of the target value, these values must be increased by 20% across at least 95% of workstations.

Natural ventilation through opening windows

The requirements of workplace regulation A

System	Maximum permissible room depth in relation to the clear room height (h) [m]	Opening surface to ensure minimum air exchange	
		for continuous ventilation [m^2/present person]	for shock ventilation [m^2/10 m^2 floor area]
I one-sided ventilation*	Room depth = 2.5 x h (at h > 4 m: max. depth of space = 10 m) (assumed air speed in cross-section = 0.08 m/s)	0,35	1,05
II Cross ventilation*	Room depth = 5.0 x h (at h > 4 m: max. depth of space = 20 m) (assumed air speed in cross-section = 0.14 m/s)	0,20	0,60

System I: Single sided ventilation through external wall. System II: Transverse ventilation from external wall to wall or from external wall to roof.

APPENDIX B – DOCUMENTATION

I. Required documentation

Examples of possible evidence include the following items. The allocation of points for individual indicators must be backed up by comprehensive and plausible evidence.

Indicator 1: Indoor air quality – Volatile organic compounds (VOCs)

- Determination of levels of volatile to semi-volatile organic compounds and formaldehyde
- Confirmation of rooms selected for measurement and time of measurement (template for the confirmation can be found in Annex 1)
- Share of total number of rooms for individual furnishing types
- Accreditation of the institute conducting measurement (analytical laboratory/measuring institute), including details of name, business address, legal entity and a copy of the accreditation certificate

Indicator 1.2: AGENDA 2030 BONUS – Reduction in pollutant emissions in the indoor air, health and well-being

- Floor plans/site plans
- Photos
- Explanation of the implemented measures

Indicator 2: Indoor air quality – Air exchange rate

- Assessment of the air exchange rate due to persons in accordance with EN 15251 / DIN EN 16798-1
- Documentation in accordance with the workplace regulation
- Completion of a zonal flow simulation

ANNEX 1

Template for verification

Confirmation of rooms selected for measurement and time of measurement (VOC):

Confirmation by the auditor or commissioned expert that the indoor air VOC measurements have been carried out in accordance with the requirements listed in the criterion.

We, _____, hereby confirm
for the project:
_____
in the scheme: _____
that the interior furnishings of the rooms selected for the indoor air measurement correspond to the main furnishing types found in the building, and that the rooms are therefore a representative sample for determining possible pollution of the indoor air by the installed construction materials and construction products.
The measured rooms have been selected on the basis of Table 1 in the criterion. Measurements have been carried out on all furnishing types with a share of more than 10% of all rooms in the building.

We confirm that the sample collection was carried out within four weeks following completion of the rooms to be sampled in each case.

_____

Date Signature of the auditor or appointed expert Stamp

Guidelines for commissioning and implementation of the indoor air measurements, required documentation:

1 The relevant interior surfaces for specifying the furnishing types in the rooms

- Floor covering type with details of system structure (above top edge of unfinished floor)
- Wall coverings, where relevant panelling, partition wall systems, etc.
- Ceiling surfaces, e.g. acoustic ceiling, with type of coatings
- Ceiling sails
- Door types (timber, plastic, metal, lacquer surfaces, etc.)
- indoor surfaces of windows (lacquer, metal, plastic, etc.)

2 Measuring conditions/measuring apparatus:

- Room conditioning before and during sampling in accordance with EN ISO 16000-5 or ASHRAE 189.1
- Submission of ventilation reports, e.g. in accordance with the template in EN ISO 16000-1 Annex D Guidelines for information to be recorded during indoor air measurement
- Sampling for formaldehyde with DNPH cartridge, ISO 16000-3, or US EPA TO-11A
- Sampling for TVOCs with Tenax TA tubes, ISO 16000-6, US EPA TO-1, or Sampling onto Sorbent Tubes US EPA TO-17, or Canister samplers US EPA TO-15.
- Please note: Sampling is carried out in coordination with the laboratory, and there are no special requirements for the sampler – except for the declarations mentioned above.

3 Institute conducting measurement (analytical laboratory/measuring institute):

- Accreditation documentation of the institute conducting measurement, including details of name, business address, legal entity and a copy of the accreditation certificate for the relevant standards and methods.

4 Laboratory report/measurement report:

- Determination of VOCs in accordance with:
  ISO 16000-3 / US EPA TO-11A / ASTM Standard Method D 5197 = Requirements for formaldehyde analysis
  ISO 16000-6 / US EPA TO-1 / 15 / 17= Requirements for TVOC analysis
- Individual VOC values (quantification of all substances in the New Construction Benchmarks list in Annex 2 or Annex 3)
- Comparison of individual values with Guidelines 2, Regulatory and Advisory numbers and New Construction Benchmarks in a suitable table format
- Specification of TVOCs and formaldehyde

5 Evaluation of the measurement results:

- Summary report/expert report
- Statement regarding source or decay behaviour if New Construction Benchmarks, Heals numbers and Guidelines 1 are exceeded
- Evaluation of the measurement results in accordance with criterion (the worst value is used for the evaluation. The use of intermediate values is not possible).

6 Persons responsible for reporting:
The areas of responsibility can vary from project to project; one possible distribution is:

- Explanation of the criterion: Auditor

- Confirmation and specification of the furnishing types in the rooms: Auditor/expert
- Points 2 and 5: Expert
- Points 3 and 4: Analytical laboratory

ANNEX 2*

New Construction Benchmarks for evaluation of individual substances as part of VOC measurements

CAS NO.	SUBSTANCE NAME	NEW CONSTRUCTION BENCHMARKS [µg/m³]	GUIDELINES 1 [µg/m³]	GUIDELINES 2 [µg/m³]
57-55-6	propane-1,2-diol	95		
107-98-2	1,2-Propylene glycol monomethyl ether, 1-methoxy-2-propanol		1000	10,000
1569-02-4	2-Propylene glycol-1-ethyl ether		300	3000
57018-52-7	2-Propylene glycol-1-tert-butyl ether		300	3000
	Default value: Glycol ether with insufficient data available		0.005 ml/m³ (v) (=0.05 ppm)	0.05 ml/m³ (v) (=0.005 ppm)
71-36-3	1-Butanol		700	2000
872-50-4	1-Methyl-2-pyrrolidone		100	1000
96-29-7	Butanone oxime		20	60
104-76-7	2-Ethylhexanol		100	1000
112-25-4	2-Hexoxyethanol		100	1000
57018-52-7	2-Propylene glycol-1-tert-butyl ether (2PG1tBE)		300	3000
75-07-0	Acetaldehyde		100	1000
Group	Aldehydes, C4 to C11 (saturated, acyclic, aliphatic)		100	1000
Group	Alkylbenzenes, C9–C15		100	1000

CAS NO.	SUBSTANCE NAME	NEW CONSTRUCTION BENCHMARKS [µg/m³]	GUIDELINES 1 [µg/m³]	GUIDELINES 2 [µg/m³]
80-56-8	alpha-Pinene (bicylic terpene)	200		
100-52-7	Benzaldehyde		20	200
100-51-6	Benzyl alcohol		400	4000
123-72-8	Butanal	70		
Group	C9–C14-Alkanes/isoalkanes (low aromatics content)		200	2000
75-09-2	Dichloromethane		200	2000
111-96-6	Diethylene glycol dimethyl ether		30	300
111-77-3	Diethylene glycol methyl ether		2000	6000
112-34-5	Diethylene glycol monobutyl ether		400	1000
111-90-0	Diethylene glycol monoethyl ether, ethyldiglycol		700	2000
84-66-2	Diethyl phthalate	5		
34590-94-8	Dipropylene glycol monomethyl ether		2000	7000
105-60-2	Epsilon-Caprolactam	5		
64-19-7	Acetic acid	116		
141-78-6	Ethyl acetate		600	6000
100-41-4	Ethyl benzene		200	2000
111-76-2	Ethylene glycol monobutyl ether		100	1000

CAS-NO.	SUBSTANCE NAME	NEW CONSTRUCTION BENCHMARKS [µg/m³]	GUIDELINES 1 [µg/m³]	GUIDELINES 2 [µg/m³]
112-25-4	Ethylene glycol hexyl ether		100	1000
112-07-2	Ethylene glycol monobutyl ether acetate		200	2000
110-80-5	Ethylene glycol monoethyl ether, 2-Ethoxyethanol		100	1000
111-15-9	Ethylene glycol monoethyl ether acetate		200	2000
109-86-4	Ethylene glycol monomethyl ether, 2-Methoxyethanol		20	200
122-99-6	Ethylene glycol monophenyl ether (EGMP, 2-Phenoxyethanol)		30	300
98-01-1	Furfural		10	100
Group	Cresols		5	50
138-86-3	Limonene	1000		
78-93-3	Methyl ethyl ketone, ethyl methyl ketone	290		
108-10-1	Methyl isobutyl ketone		100	1000
Group	Monocyclic monoterpenes (lead substance d-Limonene)		1000	10,000
Group	Naphthalene and compounds similar to naphthalene		10	30
123-86-4	n-Butyl acetate	60		
124-19-6	Nonanal	10		

CA- NO.	SUBSTANCE NAME	NEW CONSTRUC-TION BENCHMARKS [µg/m³]	GUIDELINES 1 [µg/m³]	GUIDELINES 2 [µg/m³]
124-07-2	Octanoic acid	20		
108-95-2	Phenol		20	200
1569-02-4	Propylene glycol monoethyl ether		300	3000
100-42-5	Styrene		30	300
Group	Terpenes, bicyclic (lead substance ?-Pinene)		200	2000
127-18-4	Tetrachloroethene	5		
108-88-3	Toluene		300	3000
Group	Cyclic dimethylsiloxane D3-D6 (total guide value)		400	4000
94-47-6; 108-38-3; 106-42-3; 1330-20-7	Total xylenes		100	800
75-29-6	2-Chloropropane		800	8000

Information regarding documentation of New Construction Benchmarks (Annex 2) incl. Guidelines 1: All listed compounds and groups are detectable with a sufficient level of certainty using the assigned analysis method using Tenax TA tubes in accordance with ISO 16000-6. There are other documentation processes available for a portion of the compounds that enable a higher level of detection certainty, but the limits of determination that can be achieved with Tenax are below the applicable New Construction Benchmarks/Guideline 1 with a sufficiently safe margin.

* Annex 2 is regularly updated in accordance with newly derived guidelines published by the German Committee on Indoor Guide Values.

ANNEX 3**

Reference concentrations (RfC) and regulatory numbers for evaluation of individual substances as part of VOC measurements:

CAS NO.	SUBSTANCE NAME	ASHRAE 189.1 BENCHMARKS [µg/m³]	HEALTH NUMBERS[4] (NON-CANCER) [µg/m³]	REGULATORY AND ADVISORY NUMBERS[5] [µg/m³]
79-34-5	1,1,2,2-Tetrachloroethane; C2H2C14		3000	3.500
79-00-5	1,1,2-Trichloroethane; C2H3C13		400	4.500
57-14-7	1,1-Dimethylhydrazine; C2H8N2		1	15
120-82-1	1,2,4-Trichlorobenzene; C6H3C13		200	4.000
96-12-8	1,2-Dibromo-3-chloropropane; C3H5Br2C1		1	10
106-88-7	1,2-Epoxybutane (1,2-butylene oxide); C4H8O		20	590
75-55-8	1,2-Propyleneimine (2-methylazindine); C3H7N		46	460
542-75-6	1,3-Dichloropropene; C3H4C12 (cis)		20	1.000
106-46-7	1,4-Dichlorobenzene (p-); C6H4Cl2	800	800	6.000
123-91-1	1,4-Dioxane (1,4 Diethylene oxide); C4H8O2	3000	30	3.600
540-84-1	2,2,4-Trimethyl pentane; C8H18		350	35.000
79-46-9	2-Nitropropane; C3H7NO2		20	9.000

[4] Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA (Environmental Protection Agency US).

[5] Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are non-regulatory values provided by the Government or other groups as advice.

75-05-8	Acetonitrile (cyanomethane); C2H3N		60	7.000
98-86-2	Acetophenone; C8H8O		490	3.200
107-02-8	Acrolein (2-propenal); C3H4O		1	25
79-06-1	Acrylamide; C3H5NO		1	30
79-10-7	Acrylic acid; C3H4O2		1	300
107-13-1	Acrylonitrile (2-propenenitrile); C3H3N	5	5	430
62-53-3	Aniline (aminobenzene); C6H7N		1	1.900
71-43-2	Benzene; C6H6	60	30	320
100-44-7	Benzyl chloride (a-chlorotoluene); C7H7C1		22	220
57-57-8	Beta-Propiolactone; C3H4O2		15	150
542-88-1	Bis(chloromethyl) ether; C2H4C12O		0.5	3
75-25-2	Bromoform (tribromomethane); CHBr3		50	500
56-23-5	Carbon tetrachloride; CC14	40	40	1.200
120-80-9	Catechol (o-hydroxyphenol); C6H6O2		200	2.000
79-11-8	Chloroacetic acid; C2H3C1O2		42	190
108-90-7	Chlorobenzene; C6H5C1	1000	1000	8.000
67-66-3	Chloroform; CHC13	300	150	300
126-99-8	Chloroprene (2-chloro-1,3-butadiene); C4H5C1		20	400

CAS NO.	SUBSTANCE NAME	ASHRAE 189.1 BENCHMARKS [µg/m³]	HEALTH NUMBERS[6] (NON-CANCER) [µg/m³]	REGULATORY AND ADVISORY NUMBERS[7] [µg/m³]
1319-77-3 , 95-48-7, 108-39-4, 106-44-5	Cresylic acid (cresol isomer mixture); C7H8O		4	50
98-82-8	Cumene (isopropylbenzene); C9H12		400	4.000
111-44-4	Dichloroethyl ether (BIS(2-Chloroethyl)Ether); C4H8C12O		100	300
77-78-1	Dimethyl sulfate; C2H6O4S		5	50
79-44-7	Dimethylcarbamyl chloride; C3H6C1NO		2	7
106-89-8	Epichlorohydrin (l-chloro-2,3-epoxy propane); C3H5C1O	3	3	1.000
140-88-5	Ethyl acrylate; C5H8O2		5	2.000
100-41-4	Ethylbenzene; C8H10	2000	2000	10.000
106-93-4	Ethylene dibromide (1,2-dibromoethane); C2H4Br2		1	30
107-06-2	Ethylene dichloride (1,2-dichloroethane); C2H4C12		400	2.000
107-21-1	Ethylene glycol C2H6O2	400	400	10.000
75-34-3	Ethylidene dichloride (1,1-dichloroethane); C2H4C12		500	5.000
50-00-0	Formaldehyde; CH2O	33[8]	9	100
87-68-3	Hexachlorobutadiene; C4C16		90	240

[6] Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA (Environmental Protection Agency US).

[7] Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are non-regulatory values provided by the Government or other groups as advice.

[8] If the US EPA TO-11A method will be used for a measurement, then the threshold for Formaldehyde can be set at 100 µg/m³

CAS NO.	SUBSTANCE NAME	ASHRAE 189.1 BENCHMARKS [µg/m³]	HEALTH NUMBERS[9] (NON-CANCER) [µg/m³]	REGULATORY AND ADVISORY NUMBERS[10] [µg/m³]
67-72-1	Hexachloroethane; C2C16		80	1.000
110-54-3	Hexane; C6H14	7000	200	18.000
78-59-1	Isophorone; C9H14O	2000	12	11.000
67-63-0	Isopropanol C3H8O	7000	320	2.450
67-56-1	Methanol; CH4O		4000	10.000
71-55-6	Methyl chloroform (1,1,1 trichloroethane); C2H3C13	1000	1000	6.800
78-93-3	Methyl ethyl ketone (2-butanone); C4H8O		1000	5.900
108-10-1	Methyl isobutyl ketone (hexone); C6H12O		80	2.000
80-62-6	Methyl methacrylate; C5H8O2		320	2.040
1634-04-4	Methyl tert-butyl ether; C5H12O	8000	3000	14.500
60-34-4	Methylhydrazine; CH6N2		2	20
108-38-3	m-Xylene; C8H10		240	2.600
91-20-3	Naphthalene	9	9	5.000
121-69-7	N,N-Dimethylaniline; C8H11N		25	2.500
68-12-2	N,N-Dimethylformamide; C3H7NO	80	30	3.000

[9] Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA (Environmental Protection Agency US).

[10] Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are non-regulatory values provided by the Government or other groups as advice.

98-95-3	Nitrobenzene; C6H5NO2		2	500
95-48-7	o-Cresol(2-Methylphenol); C7H8O		100	2.200
95-47-6	o-Xylene; C8H10		80	900
108-95-2	Phenol; C6H6O	200	6	1.900
78-87-5	Propylene dichloride (1,2-dichloropropane); C3H6C12		4	3.500
107-98-2	Propylene glycol monomethyl ether	7000	2000	20.000
106-42-3	p-Xylene; C8H10		80	900
96-09-3	Styrene oxide; C8H8O		6	1.900
100-42-5	Styrene; C8H8	900	1000	8.500
127-18-4	Tetrachloroethylene (Perchloroethylene); C2C14	35	40	1.700
108-88-3	Toluene; C7H8	300	5000	7.500
79-01-6	Trichloethylene; C2HC13	600	500	6.000
121-44-8	Triethylamine; C6H15N		7	1.900
108-05-4	Vinyl acetate; C4H6O2	200	200	1.500
1330-20-7,95-47-6, 108-38-3, 106-42-3	Xylenes (isomer & mixtures); C8H10	700	400	4.350

** This list of 72 compounds for TO-1/15/17 measurement standards, more closely matches with the EPA 8260 target list, but this list can be extended to 100 compounds. In some cases (for some regions or countries) where availability of the relevant laboratory equipment is restricted, measured compounds list can be shortened. In this case, information about the measurement procedures and technical aspects must be communicated and agreed with DGNB in the system adaptation phase.

Description “Health numbers”:
Vast majority of Health numbers are referring to the US EPA Reference Concentrations (RfC) and California Environmental Protection Agency (CalEPA) reference exposure levels.
The reference concentration or RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Generally used in EPA's noncancer health assessments.
The California Environmental Protection Agency (CalEPA) has established a chronic reference exposure level. The CalEPA reference exposure level is a concentration at or below which adverse health effects are not likely to occur.

Description “Regulatory and advisory numbers”:
Regulatory numbers are referring to OSHA PEL (Occupational Safety and Health Administration's permissible exposure limit) expressed as a time weighted average - the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.
Majority of advisory numbers are referring to ACGIH TLV (American Conference of Governmental and Industrial Hygienists' threshold limit value) expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects and to NIOSH REL (National Institute of Occupational Safety and Health's recommended exposure limit) exposure limit for an 8- or 10-h time-weighted-average exposure.
(All “Regulatory and advisory numbers” have been corrected in compliance with to odour thresholds, chronic exposure levels and NOAEL- non observed adverse effect levels).

Appendix C – Literature

I. Version

Change log based on version 2018

PAGE	EXPLANATION	DATE
all	General, Evaluation and Usage-specific description: scheme “Assembly buildings” has been added	16.09.2021
all	Evaluation, method and documentation: alternative norm/standard has been introduced DIN EN 16798-1	16.09.2021
358	Usage-specific description: measurement unit change, instead of 10% of rooms now 10% NFA to be measured, amendment in the Table 1	16.09.2021

II. Literature

- EN 15242. Ventilation for buildings – Calculation methods for the determination of air flow rates in buildings including infiltration. Berlin: Beuth publisher. September 2007
- EN 15251: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics. Berlin: Beuth publisher. August 2007
- DIN EN 12599. Ventilation for buildings – Test procedures and measurement methods
- to hand over air conditioning and ventilation systems. Berlin: Beuth publisher. January 2011
- ISO 16000-1. Indoor air – Part 1: General aspects of sampling strategy. Berlin: Beuth publisher. June 2006

- ISO 16000-3: Indoor air – Part 3: Determination of formaldehyde and other carbonyl compounds; active sampling method. Berlin: Beuth publisher. March 2003
- EN ISO 16000-5: Indoor air – Part 5: Sampling strategy for volatile organic compounds (VOCs). Berlin: Beuth publisher. May 2007
- 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 or MS-FID. Berlin: Beuth publisher. December 2004
- EN ISO 16000-9: Indoor air – Part 9: Determination of the emission of volatile organic compounds from building products and furnishing – Emission test chamber method. Berlin: Beuth publisher. April 2008
- EN ISO 16000-11: Indoor air – Part 11: Determination of the emission of volatile organic compounds from building products and furnishing – Sampling, storage of samples and preparation of test specimens. Berlin: Beuth publisher. June 2006
- Sustainable Development Goals icons, United Nations/globalgoals.org
- Level(s) – Common EU framework of core environmental indicators - http://publications.jrc.ec.europa.eu/repository/bitstream/JRC109285/jrc109285_171205_levels_eu_framework_of_building_indicators_parts_1_and_2_pubsy_version_b1.0.pdf
- ANSI/ASHRAE/USGBC/IES Standard 189.1-2014 - Standard for the Design of High-Performance Green Buildings, ASHRAE and U.S. Green Building Council, 2014.
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- EPA/625/R-96/010b - Compendium Method TO-17, Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes, Centre for Environmental Research Information, U.S. Environmental Protection Agency, 1999
- Volatile Organic Compounds (VOC) Criteria for New Construction - White Paper, approved by AIHA (American Industrial Hygiene Association) Construction and Toxicology Committees, 2017
- Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profiles for VOCs (Update). Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1998
- California Environmental Protection Agency (CalEPA). Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels. Draft for Public Comment. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1997.
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- National Institute for Occupational Safety and Health (NIOSH). Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. Cincinnati, OH. 1997.
- U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS). National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999The WHO European Centre for Environment and Health, Bonn Office, WHO guidelines for indoor air

quality selected pollutants, 2010.

- Standard Method for the Testing & Evaluation of VOC Emissions, Division of Environmental and Occupational Disease Control, California Department of Public Health 2010.
- OEHHA (the Office of Environmental Health Hazard Assessment) Acute, 8-hour and Chronic Reference Exposure Levels (chRELs), 2016.
- DIN EN 16798 – 1 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, May - 2021.