Supplement to the Standard of Building Biology Testing Methods SBM-2024

BUILDING BIOLOGY EVALUATION GUIDELINES

FOR SLEEPING AREAS

The Building Biology Evaluation Guidelines are based on the precautionary principle. They are specifically designed for sleeping areas, the especially sensitive time of restoration associated with long-term risks. They are based on the current body of building biology experience and knowledge and focus on what is feasible. In addition, scientific studies and other recommendations are also consulted. With the professional approach, building biology testing methods help identify, minimize and avoid crucial indoor risk factors within an individual's framework of feasibility. The Standard's goal is to create indoor living environments that are as natural and unpolluted as practicable. By considering all Standard points and diagnostic methods in a holistic manner, it is possible to identify, locate and assess potential sources of risk in indoor living environments.

Guiding Principle:
Any risk reduction is worth it. Guideline values are meant as a guide. Nature is the ultimate standard.

No Anomaly Below this guideline value, the highest level of precaution is provided. It reflects the unpolluted natural conditions or the common and nearly inevitable background level of our modern living environment.

Slight Anomaly As a precaution, and out of consideration for those with health challenges and sensitivities, remediation measures should be implemented whenever possible.

Severe Anomaly Exposure values within this range are not acceptable from a building biology perspective. They usually require action. Remediation measures should be implemented promptly. In addition to numerous case histories, scientific studies point to biological effects and health problems.

Extreme Anomaly Above this guideline value, immediate and systematic remediation is needed. Here, international guidelines and recommendations for indoor environments and workplaces may be reached or even exceeded.

If several sources of risk with elevated exposure levels are identified for a single or for different Standard points, the overall risk should be rated as more severe.

The paragraphs in small print at the end of each Standard point are meant as a comparative guide, e.g. legally binding exposure limits or other guidelines, recommendations and research results or natural background levels.

	No Anomaly	**Slight** Anomaly	**Severe** Anomaly	**Extreme** Anomaly

A FIELDS, WAVES, RADIATION

1 AC ELECTRIC FIELDS (Low Frequency, ELF/VLF)

Field strength with ground reference in volt per meter	**V/m**	**< 1**	**1 - 5**	**5 - 50**	**> 50**
Body voltage with ground reference in millivolt	**mV**	**< 10**	**10 - 100**	**100 - 1000**	**> 1000**
Field strength w/o ground reference in volt per meter	**V/m**	**< 0.3**	**0.3 - 1.5**	**1.5 - 10**	**> 10**

Values apply up to and around 50/60 Hz, higher frequencies and predominant harmonics (aka "dirty electricity") from about 2 kHz to 1 MHz should be rated as more severe (factors of about 10-100 can be applied here; the higher the frequency, the higher the factor should be; from 100 kHz, guideline values of Standard Point A3 can also be consulted, depending on the case).

DIN/VDE 0848: occupational 20,000 V/m, public 7000 V/m; BImSchV/ICNIRP: 5000 V/m; TCO (with ground reference): 10 V/m (5-2000 Hz), 1 V/m (2-400 kHz); US EPA/NCRP Draft Report: 10 V/m; childhood leukemia studies: 10 V/m; studies on oxidative stress, free radicals, melatonin decrease: 20 V/m; VDB-Zert (best score): 2 V/m; BUND: 0.5 V/m; European Academy for Environmental Medicine EUROPAEM: daytime 10 V/m, nighttime 1 V/m, sensitive populations 0.3 V/m (to 2 kHz, higher frequencies 1/100); nature: < 0.0001 V/m

2 AC MAGNETIC FIELDS (Low Frequency, ELF/VLF)

Flux density in nanotesla	**nT**	**< 20**	**20 - 100**	**100 - 500**	**> 500**
in milligauss	**mG**	**< 0.2**	**0.2 - 1**	**1 - 5**	**> 5**

Values apply up to and around 50/60 Hz, higher frequencies and predominant harmonics (aka "dirty electricity") from about 2 kHz to 1 MHz should be rated as more severe (factors of about 10-100 can be applied here; the higher the frequency, the higher the factor should be; from 100 kHz, guideline values of Standard Point A3 can also be consulted, depending on the case).

Currents from power grids (50/60 Hz) and railway networks (16.7 Hz) are recorded separately.

If magnetic flux density levels fluctuate greatly and frequently, the 95th percentile of long-term measurements, especially nighttime measurements, should be used for the assessment.

DIN/VDE: occupational 5,000,000 nT, public 400,000 nT; BImSchV/ICNIRP: 100,000 nT; Switzerland 1000 nT; Netherlands: 400 nT; WHO/IARC: 300-400 nT "possibly carcinogenic"; TCO: 200 nT (5-2000 Hz), 10 nT (2-400 kHz); US EPA/NCRP Draft Report: 200 nT; DIN 0107 (EEG): 200 nT; BioInitiative: 100 nT; VDB-Zert (best score): 60 nT; BUND: 10 nT; European Academy for Environmental Medicine EUROPAEM: daytime 100 nT, nighttime 100 nT, sensitive populations 30 nT (to 2 kHz, higher frequencies 1/100); nature: < 0.0002 nT

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	No Anomaly	Slight Anomaly	Severe Anomaly	Extreme Anomaly

3 RADIO FREQUENCY RADIATION (High Frequency, Electromagnetic Waves)

Power density in microwatt per square meter	**µW/m²**	**< 0.1**	**0.1 - 10**	**10 - 1000**	**> 1000**

Values apply to single RF sources, e.g. GSM/2G, UMTS/3G, LTE/4G, 5G, TETRA, Radio, TV, WLAN, DECT, Bluetooth..., and refer to peak measurements.

Aim for lower exposure levels to RF sources with clear and periodic, pulsed signal patterns (GSM, TETRA, DECT, WLAN, digital broadcasting...) and broadband technologies (LTE/4G, 5G...) compared to RF sources with nonperiodic, nonpulsed signal patterns (FM, short, medium and long wave, analog broadcasting...) or rotating antenna radar.

Former Building Biology Guideline Values for RF radiation (SBM-2003): pulsed RF < 0.1 no, 0.1-5 weak, 5-100 strong, > 100 µW/m² extreme anomaly; nonpulsed RF < 1 no, 1-50 weak, 50-1000 strong, > 1000 µW/m² extreme anomaly

DIN/VDE 0848: occupational up to 100,000,000 µW/m², public up to 10,000,000 µW/m²; BImSch/ICNIRP: 2,000,000-10,000,000 µW/m², depending on the frequency; cell antenna sites: Switzerland up to 100,000 µW/m², Salzburg Resolution / German Medical Association: 1000 µW/m²; BioInitiative 2007: 1000 µW/m² outdoor; EU Parliament STOA: 100 µW/m²; Salzburg: 10 µW/m² outdoor, 1 µW/m² indoor; European Academy for Environmental Medicine EUROPAEM: broadcasting FM daytime 10,000 µW/m², nighttime 1000 µW/m², sensitive populations 100 µW/m² / TETRA, DVB-T daytime 1000 µW/m², nighttime 100 µW/m², sensitive populations 10 µW/m² / GRPS, DAB+, WLAN daytime 100 µW/m², nighttime 10 µW/m², sensitive populations 0.1 µW/m²; EEG / immune system effects: 1000 µW/m²; sensitivity threshold of mobile phones: < 0.001 µW/m²; nature < 0.000 001 µW/m²

4 STATIC ELECTRIC FIELDS (Electrostatics)

Surface potential in volt	**V**	**< 100**	**100 - 500**	**500 - 2000**	**> 2000**
Discharge time in seconds	**s**	**< 10**	**10 - 30**	**30 - 60**	**> 60**

Values apply to suspect materials and appliances close to the body and/or to dominating surfaces and at relative humidity levels of 40-60 %.

TCO: 500 V; damage of electronic parts: from 100 V; painful shocks, sparks: from 2000-3000 V; synthetic materials, plastic coatings: up to 10000 V; synthetic flooring, laminate: up to 20000 V; nature: < 100 V

Air electricity in volt per meter	**V/m**	**< 100**	**100 - 500**	**500 - 2000**	**> 2000**

DIN/VDE 0848: occupational 40,000 V/m, public 10,000 V/m; EMFV (EMF limits for workplaces in Germany): 28,200 V/m; nature: ca. 50-200 V/m, foehn wind ca. 1000-2000 V/m, thunderstorm ca. 5000-10,000 V/m

5 STATIC MAGNETIC FIELDS (Magnetostatics)

Deviation of flux density (metal/steel) in microtesla	**µT**	**< 1**	**1 - 5**	**5 - 20**	**> 20**
Fluctuation of flux density (current) in microtesla	**µT**	**< 1**	**1 - 2**	**2 - 10**	**> 10**
Deviation of compass needle in degree	**°**	**< 2**	**2 - 10**	**10 - 100**	**> 100**

Values for the spatial deviation of the flux density in µT apply to metal/steel and for the temporal fluctuation of the flux density, to direct current.

DIN/VDE: occupational 67.9 mT, public 21.2 mT; BImSchV 500 µT; MRI: 1-7 T; nature, Earth's magnetic field: Central Europe, USA, Australia ca. 40-50 µT, equator 25 µT, north/south pole 65 µT; magnetic field: eye: 0.0001 nT, brain: 0.001 nT, heart: 0.05 nT; animal navigation: 1 nT; 1 µT = 10 mG

6 RADIOACTIVITY (Alpha, Beta and Gamma Radiation, Radon)

Count resp. **equivalent dose rate increase** in percent	**%**	**< 50**	**50 - 70**	**70 - 100**	**> 100**

Values apply in relation to the gamma radiation of the local natural background levels, at least to the average background level in Germany: 0.8 mSv/a (millisievert per year) or 100 nSv/h (nanosievert per hour); at much higher background levels, the guideline ranges for the equivalent dose rate increase need to be decreased accordingly.

Radiation Protection Ordinance, Germany: public 1 mSv/a additional exposure; EU building materials: 1 mSv/a additional indoor exposure; occupational 20 mSv/a; USA federal law: public 1 mSv/a, occupational 50 mSv/a; Northern Germany: < 0.6 mSv/a (< 70 nSv/h), Southern Germany: Erzgebirge Mountains, Thuringia, Black Forrest, Bavarian Forest... > 1.4 mSv/a (> 165 nSv/h)

Radon in becquerel per cubic meter	**Bq/m³**	**< 30**	**30 - 60**	**60 - 200**	**> 200**
in picocuries per cubic liter	**pCu/L**	**< 0.8**	**0.8 - 1.6**	**1.6 - 5.4**	**> 5.4**

For assessment purposes, the average annual background concentration level of outdoor air (e.g. as published by the German BfS Geoportal) is added to the measured indoor concentration level so that the SBM Guideline Value will be in-creased by the amount of the natural background level.

Reference level StrlSchG (occupational: common rooms): 300 Bq/m³, WHO, UBA/AIR, BfS Germany: 100 Bq/m³; Norway, Sweden, Canada, England (new construction): 200 Bq/m³; US EPA: 150 Bq/m³; BVS recommendation, Denmark (new construction): 100 Bq/m3; WHO: 100 Bq/m³; VDB-Zert (best score): 50 Bq/m³; in Germany: average indoor levels: ca. 50 Bq/m³, 1-2% > 250 Bq/m³; average outdoor levels: 5-30 Bq/m³; radon therapy / uranium mine: up to and more than 100,000 Bq/m³; lung cancer risk increase by 10-16% for each 100 Bq/m³; Bq/m³ x 0.027 = pCi/l

7 GEOLOGICAL DISTURBANCES (Earth's Magnetic Field, Terrestrial Radiation)

Disturbance of Earth's magnetic field in nanotesla	**nT**	**< 100**	**100 - 200**	**200 - 1000**	**> 1000**
Disturbance of terrestrial radiation in percent	**%**	**< 10**	**10 - 20**	**20 - 50**	**> 50**

Values apply in relation to the natural Earth's magnetic field and natural background level of gamma or neutron radiation at the location the measurement is taken.

Earth's magnetic field: temporal natural fluctuations: 10-100 nT, magnetic storms / solar eruptions: 100-1000 nT, decrease per year: 20 nT

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No Anomaly	Slight Anomaly	Severe Anomaly	Extreme Anomaly

8 SOUND WAVES (Airborne and Structure-borne Sound)

Overarching principle: There should be no individual noises or vibrations that are perceived as disturbing.

Depending on the case and problem, the following values can serve as a guide for the assessment of airborne sound:

Sound level					
	dB(A)	**< 25**	**25 - 35**	**35 - 45**	**> 45**
	dB(C)	**< 32**	**32 - 42**	**42 - 52**	**> 52**
	dB(Z)	**< 35**	**35 - 45**	**45 - 55**	**> 55**

Values apply to equivalent continuous sound levels (L_{eq}). Both dB(A) and dB(C) sound levels should be measured; for measurements below 50 Hz, the dB(Z) sound level should be included, which is often less well represented.

Especially in the low frequency range below about 150 Hz (e.g. for not weighted third octave band, twelfth octave band or FFT analysis), there should be no predominant individual frequencies or frequency bands on a continuous basis (at least ca. 5 dB above background level).

0-10 dB(A) hearing threshold, breathing, rustling leaves / 10-20 peaceful sleep, whispering, wind / 20-30 library, 30-40 quiet living space, quiet conversation / 40-50 lively household noise, excited conversation / 50-60 office, noisy conversation, stress threshold / 60-70 daytime noise, traffic noise, shouting, loud music / 70-80 vacuum cleaner, kitchen appliance, high traffic noise / 80-90 industrial noise, noisy railway traffic, church bells / 90-100 jackhammer, power drill / 100-110 disco, aircraft noise, car racing / 110-120 low-flying aircrafts, aircraft runway / 130 pain threshold, start of jet engine at 50 m / 140 rifle shot next to ear, jet engine at 10 m / 160 risk of ruptured eardrums.

German Technical Instructions on Noise Abatement (TA Lärm): indoors daytime 35 dB(A), nighttime 25 dB(A), short-term peaks must not be more than 10 dB above threshold levels. Traffic noise regulations for new or modified roads or railways: near roads and railway lines in residential areas on average daytime 59 dB(A) and nighttime 49 dB(A), in mixed areas 64 dB(A) or 54 dB(A). VDI 2058: in exclusively residential areas daytime 50 dB(A), nighttime 35 dB(A); in general residential areas daytime 55 dB(A), nighttime 40 dB(A); in mixed areas daytime 60 dB(A), nighttime 45 dB(A). German Federal Institute for Occupational Safety and Health: offices 40–45 dB(A.

9 LIGHT (Artificial Lighting, Visible Light, UV and Infrared Radiation)

With regard to artificial lighting, sleeping areas should be as **dark** as possible (ideally **0 lx**). Especially 2-3 hours prior to sleep, the light quality should be as similar to **natural daylight** in the evening as possible. The **light spectrum** should be continuous with **smooth** transitions and without distinct spikes. Also, it should **not have a high content of blue light**, feature a **great color rendering index** (CRI > 95) and also include a **high content of near infrared radiation**. Artificial light sources should show a uniform light distribution without harmonics and the **flicker percentages should be low** (especially up to about 3000 Hz, ideally about or below **1%** or **2%**). Moreover, they should **not produce any elevated ELF/VLF electric and magnetic fields, radio frequency radiation** or **ultrasound**. In indoor environments, only as much artificial lighting should be used as is necessary for a given visual task. And during the day, it is best to expose yourself to **natural daylight** outdoors as much as possible.

Testing conditions 2024: illumination level: daytime ca. 100-100,000 lux, evenings ca. 10-100 lux, nighttime < 1 lux; color temperature daytime ca. 4000-6000 K, evenings ca. 1500-3000 K; no ultrasound, electric fields up to 2 kHz < 10 V/m (ELF), above 2 kHz < 1 V/m (VLF); magnetic fields up to 2 kHz < 50 nT or 0.5 mG (ELF), above 2 kHz < 5 nT or 0.05 mG (VLF); no light modulation for data transmission (precautionary approach because of insufficient data); no toxins or odors; no toxic ingredients such as mercury

EU Ecodesign Guideline: flicker PstLM ≤ 1 (for frequencies 0.3-80 Hz), stroboscopic effect SVM ≤ 0.9, from 9/2024 ≤ 0.4 (for frequencies 80-2000 Hz); IEEE modulation depth (percent flicker %): for 10-100 Hz 0.025f, for 100-1000 Hz 0.08f; ASR: occupational guidelines for offices: > 500 lux, Ra > 80

B INDOOR TOXINS, POLLUTANTS, INDOOR CLIMATE

1 FORMALDEHYDE and other Toxic Gases

Formaldehyde in microgram per cubic meter	**µg/m³**	**< 20**	**20 - 50**	**50 - 100**	**> 100**
in parts per million	**ppm**	**< 0.016**	**0.016 - 0.04**	**0.04 - 0.08**	**> 0.08**

AGW: 370 µg/m³, BGA: 120 µg/m³; WHO / UBA/AIR: 100 µg/m³; DGNB certification (best score): 30 µg/m³; VDB-Zert (best score): 30 µg/m³; AGÖF guidance value: 30 µg/m³; VDI: 25 µg/m³; irritation of mucous membranes and eyes, odor detection threshold: ca. 50 µg/m³; danger of death: 30,000 µg/m³; nature < 2 µg/m³

2 SOLVENTS and other Volatile Organic Compounds (VOC)

Solvents VOC in microgram per cubic meter	**µg/m³**	**< 100**	**100 - 300**	**300 - 1000**	**> 1000**

Values apply to the sum total of all volatile organic compounds (TVOC, depending on the situation substances according to UBA, DIN, ISO 16000-6 2022-0...) in the indoor air, provided that there are mixtures of diverse single substances typical for the indoor air. If single substances or groups of substances are predominant, they should be rated as more severe, which applies especially to hazardous, odorous, allergenic, irritating or carcinogenic air pollutants, such as benzenes, naphthalene(s), styrene, phenol, cresols, acetaldehyde, benzaldehyde, furfural, dichloroethane, isothiazolinones... For the assessment of single substances, see e.g. "AGÖF Guidance Values for Volatile Organic Compounds in Indoor Air" or UBA/AIR Indoor Air Guide Values (at least take action when RWI values are exceeded); for the assessment of odorous substances, consult the AGÖF Guideline "Gerüche in Innenräumen [Odors in the Indoor Air]," UBA Odor Guide Values. Special substances such as short-chain carbonic acids or VVOCs (methanol, acetone...) should be analyzed separately as needed.

German Federal Environment Agency (precautionary guide value RWI): 300 µg/m³; Seifert BGA target value: 300 µg/m³; DGNB certification (best score): 300 µg/m³; methylisothiazolinone: 1 µg/m³; Molhave: 200 µg/m³; AGÖF normal values a) sum total: 360 µg/m³, b) single substance (examples): acetaldehyde 20 µg/m acetone 42 µg/m³, benzene 1 µg/m³, ethylbenzene 1 µg/m³, naphthalene < 1 µg/m³, phenol < 1 µg/m³, styrene 1 µg/m³, toluene 7 µg/m³, m,p-xylene 3 µg/m³, alpha-pinene 4 µg/m³; delta-3-carene 1 µg/m³, limonene 4 µg/m³; nature: < 10 µg/m³

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	No Anomaly	Slight Anomaly	Severe Anomaly	Extreme Anomaly

3 **PESTICIDES** and other Semivolatile Organic Compounds (SVOC)

Pesticides		Air	**ng/m³**	**< 5**	**5 - 25**	**25 - 100**	**> 100**
E.g. PCP, lindane, permethrin, chlorpyrifos, DDT, dichlofluanid…		Dust	**mg/kg**	**< 0.2**	**0.2 - 1**	**1 - 10**	**> 10**
		Wood, material	**mg/kg**	**< 1**	**1 - 10**	**10 - 100**	**> 100**
		Material with skin contact	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 10**	**> 10**
Fire Retardants	Chlorinated	Dust	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 10**	**> 10**
	Halogen-free	Dust	**mg/kg**	**< 5**	**5 - 50**	**50 - 200**	**> 200**
Plasticizers		Dust	**mg/kg**	**< 100**	**100 - 250**	**250 - 1000**	**> 1000**
PCB Sum total of LAGA		Dust	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 5**	**> 5**
PAH Sum total of EPA		Dust	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 20**	**> 20**

Values in nanogram per cubic meter of air or in milligram per kilogram of material, wood, dust. Values apply to single substances, except for PCBs for which the total sum of congeners 28, 52, 101, 138, 153, und 180 is multiplied by a factor of 5 according to LAGA and for PAHs the 16 priority pollutants according to the US EPA are used. As a rule, values for dust apply to samples of 7- to 10-day-old dust and secondary contamination, not primary contamination (not to directly vacuumed, treated sources, surface areas and materials). As an additional assessment tool, see "AGÖF Guidance Values for Semivolatile Compounds in House Dust" or, regarding surface contamination, the Guidelines for Fire Loss Restoration (VdS 2357).

German PCP Prohibition Ordinance: 5 mg/kg (material); PCP Guideline: 1000 ng/m³ (air), target value:100 ng/m³; ARGE-Bau: 100 ng/m³ (air), 1 mg/kg (dust); PCB Guideline: 300 ng/m³ (target value); PCB target value for remediation in NRW (Germany): 10 ng/m³; acute health hazard: 3000 ng/m³; toxic waste disposal: 50 mg/ kg; VDB-Zert (best score): sum total of biocides and insecticides 50 ng/m³, sum total of organic flame retardants 100 ng/m³, sum total of phthalate plasticizers 500 ng/m³; AGÖF normal values for dust (examples): PCP 0.3 mg/kg, lindane 0.1 mg/kg, permethrin 0.5 mg/kg, chlorpyrifos 0.1 mg/kg, DDT / DDD / DDE > 0.1 mg/kg, dichlofluanid 0.1 mg/kg, tolylfluanid < 0.1 mg/kg, TCEP 0.5 mg/kg; PAH benzo(a)pyren < 0.2 mg/kg, DEHP 400 mg/kg

4 **HEAVY METALS** and other Similar Toxins

Building Biology Guideline Values for heavy metals are not yet available. For an assessment tool, see "AGÖF Guidance Values for Semivolatile Compounds in House Dust."

AGÖF normal values for dust (examples): arsenic mg/kg, lead 20 mg/kg, cadmium 1.5 mg/kg, chromium 75 mg/kg, copper 80 mg/kg, mercury 0.5 mg/kg, zinc 500 mg/kg; mercury UBA/AIR: air 35 ng/m3 (RWI); German Drinking Water Ordinance: lead 0.01 mg/L (until 2028), 0.005 mg/L (from 2028); German Federal Soil Protection Ordinance, soil in residential areas: lead 400 mg/kg, mercury 20 mg/kg

5 **PARTICLES** and **FIBERS** (Fine Particulate Matter, Nanoparticles, Asbestos, Mineral Fibers...)

Indoor concentration levels of particulate matter, fibers or dust should be below the common, uncontaminated outdoor concentration levels. In indoor air, on surfaces or in house dust, asbestos and mineral fibers should not be detectable or only at extremely low levels.

Former Building Biology Guideline Values for asbestos fibers, SBM-2000: < 100 no, 100-200 weak, 200-500 strong, > 500/m³ extreme anomaly

Asbestos fibers in air – TRGS 519: 500/m³ (remediation target level); occupational acceptable concentration level: 10,000/m3; outdoor air: 50–150/m³; clean air region: 20/m³
Particulate matter in air – BImSchV: 40 µg/m³ (PM10 annual avg.), 50 µg/m³ (PM10 daily avg.), 25 µg/m³ (PM2.5 annual avg.); EU: 50 µg/m³ (PM10), 25 µg/m³ (PM2.5); EPA: 12 µg/m³ (PM2.5); WHO: 15 µg/m3 (PM10); Alps at 3000 m: 5-10 µg/m³; rural: 20-30 µg/m³; urban: 30-100 µg/m³; indoor air with tobacco smoke: > 1000 µg/m³ (PM10)

6 **INDOOR CLIMATE** (Temperature, Humidity, Carbon Dioxide, Air Ions, Air Changes, Odors...)

Relative humidity in percent	**% RH**	**40 - 60**	**30 - 40 / 60 - 70**	**20 - 30 / 70 - 80**	**< 20 / > 80**
Carbon dioxide in parts per million	**ppm**	**< 700**	**700 - 1000**	**1000 - 1500**	**> 1500**

MAK: 5000 ppm; DIN: 1500 ppm; VDI: 1000 ppm; UBA: 1000 ppm; USA (occupational/classrooms): 1000 ppm; unventilated bedroom after one night or classroom after a one-hour lesson: 2000-4000 ppm; nature in 2023: 420 ppm, in 1985: 330 ppm; annual increase: 1-2 ppm

Small air ions per cubic centimeter air	**/cm³**	**> 500**	**200 - 500**	**100 - 200**	**< 100**

Note: In the indoor air, high levels of air ions may indicate radon.

Nature by the sea: > 2000/cm³; clean outdoor air: 1000/cm³; rural: < 800/cm³; urban: < 700/cm³; industrial areas/traffic: < 500 /cm³; indoor with static electricity: < 300/cm³; indoor with tobacco smoke: < 200/cm³; smog < 50/cm³; continuous decrease of air ions over past years/decades

Overarching principle: There should be **no individual odors that are perceived as disturbing**.

Depending on the case and problem, the following subjective perceptions may serve as a guide for odor assessments:

Odors	**None**	**Slight**	**Distinct**	**Severe**
		Not unpleasant	**Unpleasant**	**Very unpleasant**
		Still acceptable	**Hardly acceptable**	**Unacceptable**

These perceptions can be verified by several persons (e.g. trained odor inspectors) as needed. The assessment of odors is best carried out in connection with direct-reading instruments or laboratory analyses of toxicologically suspect substances and substances of safety concern.

Additional assessment tools: AGÖF odor guideline, UBA/AIR odor guide values

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No Anomaly	Slight Anomaly	Severe Anomaly	Extreme Anomaly

C FUNGI, BACTERIA, ALLERGENS

1 MOLDS and their Spores and Metabolites

In indoor environments mold growth should **not be visible** to the naked eye or with instruments (microscope, building forensic lamps...). Contamination with mold **spores** or mold metabolites should not exist either:

Area (extent) of mold growth In square centimeter	cm²	**0**	**0 - 20**	**20 - 5000**	**> 5000**
Mold hyphae, sporulating fruiting bodies, spores as seen under a microscope Per square centimeter	/cm²	**None**	**Sparse**	**Many**	**Excessive**

Particularly serious types of mold like Aspergillus, Stachybotrys... and/or mold growth in deeper layers of materials should be rated as more severe.

The mold count in the indoor air, on surfaces, in house dust, cavities and materials... should be **lower** compared to ambient outdoor air or uncontaminated reference rooms. Mold **types** in indoor environments should be **very similar** to those outside or in uncontaminated reference rooms. **Particularly serious** types of molds, such as toxigenic or allergenic molds or those thriving at 37 °C body temperature, should be **undetectable** or only minimally detectable. There must be no contamination with **metabolites** of molds (mycotoxins, MVOCs, glucans...).

To counteract mold growth, constantly high levels of material moisture or air humidity and cool surface temperatures and severe thermal bridges should be avoided; the **water activity** of materials should not stay above **0.65** for longer periods of time.

Any additional **sign, suspicion**, or indication of a potential microbial problem should be investigated or included in the assessment: e.g. discoloration and mold stains, odors typical of microorganisms, moisture-indicating mold species, construction, moisture damage and fecal contamination, problematic construction details, hygiene aspects, increased exposure from outside, previous damage, building history, on-site inspection, health issues of occupants, occupants' medical lab test results...

Additional building biology-based assessment tools and analytical information regarding air, surfaces, dust, MVOCs, moisture... can be found in the supplementary Building Biology Testing Conditions, Instructions and Additions.

More detailed assessment tools and information: "Guideline on the Prevention, Detection and Remediation of Mould in Buildings" by German Environment Agency (UBA), WTA-Merkblatt 4-12 0.52021/D, VDB-Zert, LGA guideline...

2 YEASTS and their Metabolites

Yeasts should be **undetectable** or only minimally detectable in the indoor air, on surfaces and materials or in laundry, beds, bathrooms, kitchens and hygiene and food storage areas. This applies especially to **critical** yeasts like Candida or Cryptococcus.

3 BACTERIA and their Metabolites

Bacteria counts in the indoor air should be similar or **below** outdoor air or uncontaminated reference rooms. Particularly **serious** types of bacteria, such as certain Pseudomona, Legionella, Actinomycete/Actinobacteria species... should be undetectable or only minimally detectable in the indoor air or on material surfaces, in drinking water or in areas of hygiene, bathrooms or kitchens. There must be no contamination with metabolites of bacteria (endotoxins, MVOC...).

Any additional **sign**, suspicion, or indication of a potential bacteria problem should be investigated or included in the assessment: e.g. high material moisture, water damage, mold growth or assessment, hygiene and fecal problems, foul odors typical of bacteria, increased exposure from outside, building history, on-site inspection, health issues of occupants, occupants' medical lab test results...

More detailed assessment tools and information: "Guideline on the Prevention, Detection and Remediation of Mould in Buildings" by German Environment Agency (UBA), VDB-Fäkal-Leitfaden [VDB Guideline of Fecal Contamination]...

4 DUST MITES and other Allergens

Building Biology Guideline Values for dust mites and allergens are not yet available.

For the assessment of dust mites and allergens, consult reference ranges issued by analytical laboratories or allergists.

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Final Considerations

When Building Biology Guideline Values are applied, it is important to consider and document the sensitivity threshold and accuracy of the testing equipment used. In many cases, exploratory testing methods can be used. However, when dealing with complex exposure levels or issues, it is advisable to choose more precise (and more sophisticated) testing equipment and methods.

The Standard of Building Biology Testing Methods and these Guideline Values for Sleeping Areas are supplemented by the Building Biology Testing Conditions, Instructions and Additions that describe the technical and analytical testing procedures in more detail and point to additional precautionary guideline values and the Guiding Principles that describe the fundamental values and principles guiding building biology testing practices.

Since the Building Biology Guideline Values are first and foremost based on experience and scientific studies, not all Standard points offer a value (yet). The Guideline Values are revised and updated regularly as new knowledge becomes available. Like so many other guideline values, the Building Biology Guideline Values are also recommendations and not legally binding exposure limits.

In occupational settings and especially in sensitive areas where people spend extended periods of time regularly, exposure levels should be kept as low as possible. In occupational settings and other high-use areas, the building biology guiding principle also applies: Any risk reduction is worth it. Feasibility is the first priority. For the assessment of occupational exposure levels, other regulations, recommendations and findings may apply, such as TCO Certified, EUROPAEM, US EPA/NCRP (ELF electric/magnetic fields, static electricity), BioInitiative Working Group, EU Parliament STOA or BUND (RF radiation), EU, WHO or German Federal Office for Radiation Protection (radioactivity, radon), AGÖF (pollutants, odors), UBA/AIR (mold, pollutants, carbon dioxide...), VDI, German Hazardous Substances Ordinance, TRGS (pollutants), ARGE-Bau (pesticides, PAHs), LGA Baden-Württemberg (mold)...

The Building Biology Standard was developed by BAUBIOLOGIE MAES at the request and with the support of the Institute of Building Biology + Sustainability IBN between 1987 and 1992. Colleagues and medical doctors contributed to this work. The Standard was first published in May 1992 and since then has formed the basis of building biology testing practices and precautionary assessments, in Germany and worldwide. The 2002-established Building Biology Association (Verband Baubiologie / VB) makes the Standard the foundation of its activities.

Since 1999 the Standard, Guideline Values, Testing Conditions and Guiding Principles have been further developed by the SBM Standard Committee of experienced building biology professionals with the support of independent scientists from physics, chemistry, biology and architecture including experts from analytical laboratories, environmental medicine specialists and others.

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