Supplement to the Standard of Building Biology Testing Methods SBM-2008

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 associated with long-term risks and a most sensitive window of opportunity for regeneration. They are based on the building biology experience and knowledge and focus on achievability. In addition, scientific studies and other recommendations are also consulted. With its professional approach, building biology testing methods help identify, minimize and avoid environmental risk factors within an individual's framework of possibility. It is the Standard's goal to identify, locate and assess potential sources of risk by considering all subcategories in a holistic manner and implementing the best possible diagnostic tools available with analytic expertise in order to create indoor living environments that are as exposure-free and natural as practicable.

No Concern This category provides the highest degree of precaution. It reflects the unexposed natural conditions or the common and nearly inevitable background level of our modern living environment.

Slight Concern As a precaution and especially with regard to sensitive and ill people, remediation should be carried out whenever it is possible.

Severe Concern Values in this category are not acceptable from a building biology point of view, they call for action. Remediation should be carried out soon. In addition to numerous case histories, scientific studies indicate biological effects and health problems within this reference range.

Extreme Concern These values call for immediate and rigorous action. In this category international guidelines and recommendations for public and occupational exposures may be reached or even exceeded.

If several sources of risk are identified within a single subcategrory or for different subcategories, one should be more critical in the final assessment.

Guiding Principle:

Any risk reduction is worth achieving. Reference values are meant as a guide. Nature is the ultimate standard.

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

	No Concern	**Slight** Concern	**Severe** Concern	**Extreme** Concern

A FIELDS, WAVES, RADIATION

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

Field strength with ground potential in volt per meter	**V/m**	**< 1**	**1 - 5**	**5 - 50**	**> 50**
Body voltage with ground potential in millivolt	**mV**	**< 10**	**10 - 100**	**100 - 1000**	**> 1000**
Field strength potential-free 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 should be assessed more critically.

ACGIH occupational TLV: 25 000 V/m; DIN/VDE: occupational 20 000 V/m, general 7000 V/m; ICNIRP: 5000 V/m; TCO: 10 V/m; US-Congress/EPA: 10 V/m; BUND: 0.5 V/m; studies on oxidative stress, free radicals, melatonin, childhood leukaemia: 10-20 V/m; 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 to frequencies up to and around 50 (60) Hz, higher frequencies and predominant harmonics should be assessed more critically. Line current (50-60 Hz) and traction current (16.7 Hz) are recorded separately.

In the case of intense and frequent temporal fluctuations of the magnetic field, data logging needs to be carried out - especially during nighttime - and for the assessment, the 95th percentile is used.

DIN/VDE: occupational 5 000 000 nT, general 400 000 nT; ACGIH occupational TLV: 200 000 nT; ICNIRP: 100 000 nT; Switzerland 1000 nT; WHO: 300-400 nT "possibly carcinogenic"; TCO: 200 nT; US-Congress/EPA: 200 nT; BioInitiative: 100 nT; BUND: 10 nT; nature: < 0.0002 nT

3 RADIOFREQUENCY 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, UMTS, WiMAX, TETRA, Radio, Television, DECT cordless phone technology, WLAN..., and refer to peak measurements. They do not apply to radar signals.

More critical RF sources like pulsed or periodic signals (mobile phone technology, DECT, WLAN, digital broadcasting...) should be assessed more seriously, especially in the higher ranges, and less critical RF sources like non-pulsed and non-periodic signals (FM, short, medium, long wave, analog broadcasting...) should be assessed more generously especially in the lower ranges.

Former Building Biology Evaluation Guidelines for RF radiation / HF electromagnetic waves (SBM-2003): pulsed < 0.1 no, 0.1-5 slight, 5-100 strong, > 100 µW/m² extreme anomaly; non-pulsed < 1 no, 1-50 slight, 50-1000 strong, > 1000 µW/m² extreme anomaly

DIN/VDE: occupational up to 100000000 µW/m², general up to 10000000 µW/m²; ICNIRP: up to 10000000 µW/m²; Salzburg Resolution / Vienna Medical Association: 1000 µW/m²; BioInitiative: 1000 µW/m² outdoor; EU-Parliament STOA: 100 µW/m²; Salzburg: 10 µW/m² outdoor, 1 µW/m² indoor; EEG / immune effects: 1000 µW/m²; sensitivity threshold of mobile phones: < 0.001 µW/m²; nature < 0.000001 µW/m²

		No Concern	Slight Concern	Severe Concern	Extreme Concern

4 DC 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 prominent materials and appliances close to the body and/or to dominating surfaces at ca. 50 % r.h.

TCO: 500 V; damage of electronic parts: from 100 V; painful shocks and actual sparks: from 2000-3000 V; synthetic materials, plastic finishes: up to 10 000 V; synthetic flooring, laminate: up to 20 000 V; TV screens: up to 30 000 V; nature: < 100 V

5 DC MAGNETIC FIELDS (Magnetostatics)

Deviation of flux density (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 deviation of the flux density in µT apply to metal/steel and for the fluctuation of the flux density to direct current.

DIN/VDE: occupational 67 900 µT, general 21 200 µT; USA/Austria: 5000-200 000 µT; MRI: 2-4 T; earth's magnetic field: across temperate latitudes 40-50 µT, equator 25 µT, north/south pole 65 µT; eye: 0.0001 nT, brain: 0.001 nT, heart: 0.05 nT; animal navigation: 1 nT; 1 µT = 10 mG

6 RADIOACTIVITY (Gamma Radiation, Radon)

Equivalent dose rate increase in percent	**%**	**< 50**	**50 - 70**	**70 - 100**	**> 100**

Values apply in relation to local background levels: Germany on average 0.8 mSv/a (100 nSv/h). At substantial deviations from this mean background radiation, the reference ranges for the equivalent dose rate increase need to be decreased accordingly.

Radiation Protection Germany: general 1 mSv/a additional exposure, workers 20 mSv/a; BGA: general 1.67 mSv/a; USA federal law: general 5 mSv/a, workers 50 mSv/a; Germany background: < 0.6 mSv/a (< 70 nSv/h) north, > 1.4 mSv/a (> 165 nSv/h) south, Black Forest, Bavaria

Radon in becquerel per cubic meter	**Bq/m³**	**< 30**	**30 - 60**	**60 - 200**	**> 200**

EU: 400 Bq/m³ (old buildings), 200 Bq/m³ (new buildings); Radiation Protection Germany: 250 Bq/m³; Sweden, Canada: 200 Bq/m³; US EPA: 150 Bq/m³; England: 100 Bq/m³ (new buildings); WHO: 100 Bq/m³; German Radon Protection Act (draft): 100 Bq/m³; avg. indoor levels: 20-50 Bq/m³, avg. outdoor levels: 5-15 Bq/m³; radon mine: 100 000 Bq/m³; lung cancer risk increase by 10% for each 100 Bq/m³; Bq/m³ x 0.027 = pCi/l

7 GEOLOGICAL DISTURBANCES (Geomagnetic Field, Terrestrial Radiation)

Disturbance of geomagnetic 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 geomagnetic field and the earth's natural background of gamma or neutron radiation.

Natural fluctuation of the earth magnetic field: temporal 10-100 nT; magnetic storms / solar eruptions: 100-1000 nT; decrease per year: 20 nT

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**

MAK: 370 µg/m³, BGA: 120 µg/m³; WHO: 100 µg/m³; AGÖF reference value 'normal': 30 µg/m³; VDI: 25 µg/m³; irritation of mucous membranes and eyes: 50 µg/m³; odor detection threshold: 60 µg/m³; immediate danger to life: 30.000 µg/m³; nature < 2 µg/m³; 100 µg/m³ = 0.083 ppm

2 SOLVENTS and other Volatile Organic Compounds (VOC)

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

Values apply to the total sum of all volatile organic compounds in indoor air (TVOC).

Allergenic, irritating or odor-intensive individual substances or compound classes need to be assessed more critically, especially harmful or carcinogenic air pollutants.

Federal Environment Agency Germany: 200-300 µg/m³; Seifert BGA: precautionary threshold 200-300 µg/m³; Molhave: 200 µg/m³; AGÖF target value: 100 µg/m³; nature: < 10 µg/m³; AGÖF 'normal' values: toluene 12 µg/m³, xylene 5 µg/m³, benzene 1.7 µg/m³, ethylbenzene 2 µg/m³

3 PESTICIDES and other Semi-Volatile Organic Compounds (SVOV)

Pesticides		air	**ng/m³**	**< 5**	**5 - 25**	**25 - 100**	**> 100**
e.g. PCP, lindane, permethrin, chlorpyrifos, DDT, dichlofluanid...		wood, material	**mg/kg**	**< 1**	**1 - 10**	**10 - 100**	**> 100**
		dust	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 10**	**> 10**
		material with skin contact	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 10**	**> 10**
PCB		dust	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 5**	**> 5**
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**
PAH		dust	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 20**	**> 20**
Plasticizers		dust	**mg/kg**	**< 100**	**100 - 250**	**250 - 1000**	**> 1000**

Sum total values in nanogram per cubic meter (air) and in milligram per kilogram (material, wood, dust), respectively.

Values for dust apply to typical mixtures of substances. Values for adsorbed plasticizers in dust (sum total: x 2); PCB according to LAGA. PAH according to EPA.

Decree of prohibition of PCP (Germany): 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; AGÖF reference value 'normal' for dust: PCP 0.3 mg/kg, permethrin 0.5 mg/kg, TCEP 0.5 mg/kg; PAH benzo(a)pyren < 0.2 mg/kg, DEHP 400 mg/kg

	No Concern	Slight Concern	Severe Concern	Extreme Concern

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

Indoor concentrations of particulate matter, fibers or dust should be below the common, uncontaminated outdoor concentrations. Asbestos should not at all be detectable in indoor air, house dust and on indoor surfaces.

Former building biology reference values for asbestos fibers, SBM-2000: < 100 no, 100-200 slight, 200-500 strong, > 500/m³ extreme anomaly

Asbestos fibers in air - BGA: 500-1000/m³; TRGS target: 500/m³; EU: 400/m³; WHO: 200/m³; outdoor air: 50-150/m³; clean air region: 20/m³; Particulate matter in air (annual avg.) - BImSchV: 40 µg/m³; EU: 50 µg/m³ (< 10 µm); EPA: 25 µg/m³ (< 2.5 µm); VDI: 75 µg/m³; TA: 150 µg/m³; Alps 3000 m: 5-10 µg/m³; rural: 20-30 µg/m³; urban: 30-100 µg/m³; indoor with tobacco smoke: 10 000 µg/m³; smog warning: 800 µg/m³

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

Relative humidity in percent	**% r.h.**	**40 - 60**	**< 40 / > 60**	**< 30 / > 70**	**< 20 / > 80**
Carbon dioxide in parts per million	**ppm**	**< 600**	**600 - 1000**	**1000 - 1500**	**> 1500**

MAK: 5000 ppm; DIN: 1500 ppm; VDI: 1000 ppm; USA (occupational/classrooms): 1000 ppm; unventilated bedroom after one night or classroom after a one-hour lesson: 2000-4000 ppm; nature in 2008: 380 ppm, in 1985: 330 ppm; annual increase: 1-2 ppm

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

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

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

DIN/VDE: occupational 40 000 V/m, general 10 000 V/m; nature: ca. 50-200 V/m, foehn: ca. 1000-2000 V/m, thunderstorm: 5000-10 000 V/m

C FUNGI, BACTERIA, ALLERGENS

1 MOLDS and their Spores and Metabolites

The combination of different diagnostic methods that take the specifics of each situation into account and the pooling of diverse results and observations maximizes especially in the case of mold problems the analytical certainty and makes it possible to identify sources and reach meaningful assessments, e.g. investigations of air, surfaces, dust, materials and cavities by culturing on agar, using microscope identification for non-culturable species and mold fragments, toxicological analyses, measurements of indoor air climate and humidity/moisture levels…

The mold **count** in indoor air should be less compared to the ambient outdoor environment or to uncontaminated comparison rooms. Mold **types** in indoor spaces should be **very similar** to those outside or uncontaminated comparison rooms. Particularly, **critical** or toxigenic molds should **not** be detectable or only minimally. Any **sign**, **suspicion** or indication of a potential mold problem should be investigated: visible mold growth - the larger, the more critical, moisture-indicating molds, mycotoxins and other metabolites, cold surfaces - thermal bridges, constantly high air humidity and material moisture, construction and moisture damage, problematic construction details, odors, building history, ill-health symptoms, results of environmental medicine investigations...

Former building biology reference values for molds, SBM-1998 through SBM-2003 (using YM Baubiologie Agar at a culture temperature of 20-24 °C, colony forming units CFU): in the air < 200 no, 200-500 slight, 500-1000 strong, > 1000/m³ extreme anomaly (values refer for indoor air when outdoor reference levels are relatively low, below 500/m³); on surfaces: < 20 no, 20-50 slight, 50-100 strong, > 100/dm² extreme anomaly (values refer to surfaces that are subject to common and regular cleaning practices)

WHO: pathogenic and toxigenic fungi are not acceptable in indoor air; from 50/m³ of a single fungal species, the source(s) needs to be identified; a mixture of common fungi typical for a given location (e.g. cladosporium) can be tolerated up to 500/m³. Senkpiel/Ohgke: Indoor concentrations that are over 100/m³ above the outdoor air indicate a problem. EU statistics for apartments: < 50/m³ very low, < 200/m³ low, < 1000/m³ medium, < 10 000/m³ high, > 10 000/m³ very high. See 'Schimmelpilz-Leitfaden' by Environment Agency (Germany) for assessment details.

2 YEASTS and their Metabolites

Yeasts should **not** be detectable or only minimally in indoor air, on surfaces and materials or in areas of hygiene, bathrooms, kitchens and food storage. This applies especially to pathogenic yeasts.

3 BACTERIA and their Metabolites

The level of bacteria in indoor air should be within the same range or **below** outdoor air or uncontaminated comparison rooms. Especially **critical** bacteria should not be detectable or only minimally, neither in indoor air or on material surfaces, neither in drinking water or in areas of hygiene, bathrooms or kitchens. Any **sign** of a potential bacterial contamination should be investigated: high material moisture, water damage, hygiene and fecal problems, foul odors. During a mold investigation, bacteria should also be considered and vice versa, they often occur together.

Since the Building Biology Evaluation Guidelines are first of all based on experience, not all subcategories have a reference range (yet). They are regularly revised and updated as new knowledge becomes available.

In addition to the Standard of Building Biology Testing Methods and the Building Biology Evaluation Guidelines, there are Building Biology Testing Conditions and Explanations that describe the technical and analytical procedures in more detail.

The Standard of Building Biology Testing Methods, the accompanying Building Biology Evaluation Guidelines for Sleeping Areas and additional testing details were developed by *BAUBIOLOGIE MAES* on behalf and with the support of the Institut für Baubiologie+Ökologie Neubeuern IBN between 1987 and 1992 and first published in May 1992. Scientists, medical doctors and colleagues also offered their support. The most current version SBM-2008 is the 7th. edition. Since 1999 a 10-member expert commission assists in maintaining and updating the Standard and its Guidelines.

The Building Biology Evaluation Guidelines SBM-2008 were translated from German into English by Katharina Gustavs in June 2008.