



INDOOR ENVIRONMENTAL TECHNOLOGIES

Building Health Through Applied Science

EMF Testing Guidelines from the BBM 2008

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: 25000 V/m; DIN/VDE: occupational 20000 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 5000000 nT, general 400000 nT; ACGIH occupational TLV: 200000 nT; ICNIRP: 100000 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	$\mu\text{W}/\text{m}^2$	< 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 nA, 0.1-5 slight, 5-100 strong, > 100 $\mu\text{W}/\text{m}^2$ extreme anomaly; non-pulsed < 1 nA, 1-50 slight, 50-1000 strong, > 1000 $\mu\text{W}/\text{m}^2$ extreme anomaly

DIN/VDE: occupational up to 100000000 $\mu\text{W}/\text{m}^2$, general up to 10000000 $\mu\text{W}/\text{m}^2$; ICNIRP: up to 10000000 $\mu\text{W}/\text{m}^2$; Salzburg Resolution / Vienna Medical Association: 1000 $\mu\text{W}/\text{m}^2$; BioInitiative: 1000 $\mu\text{W}/\text{m}^2$ outdoor; EU-Parliament STOA: 100 $\mu\text{W}/\text{m}^2$; Salzburg: 10 $\mu\text{W}/\text{m}^2$ outdoor, 1 $\mu\text{W}/\text{m}^2$ indoor; EEG / immune effects: 1000 $\mu\text{W}/\text{m}^2$; sensitivity threshold of mobile phones: < 0.001 $\mu\text{W}/\text{m}^2$; nature < 0.000001 $\mu\text{W}/\text{m}^2$

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 10000 V; synthetic flooring, laminate: up to 20000 V; TV screens: up to 30000 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 67900 μT , general 21200 μT ; USA/Austria: 5000-200000 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/m^3	< 30	30-60	60-200	> 200
------------------------------------	------------------------	------	-------	--------	-------

EU: 400 Bq/m^3 (old buildings), 200 Bq/m^3 (new buildings); Radiation Protection Germany: 250 Bq/m^3 ; Sweden, Canada: 200 Bq/m^3 ; US EPA: 150 Bq/m^3 ; England: 100 Bq/m^3 (new buildings); WHO: 100 Bq/m^3 ; German Radon Protection Act (draft): 100 Bq/m^3 ; avg. indoor levels: 20-50 Bq/m^3 , avg. outdoor levels: 5-15 Bq/m^3 ; radon mine: 100000 Bq/m^3 ; lung cancer risk increase by 10% for each 100 Bq/m^3 ; $\text{Bq}/\text{m}^3 \times 0.027 = \text{pCi}/\text{l}$

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