BBEC Final Project Guidelines

Putting it all together!

The purpose of these guidelines is to help you as a BBEC carry out a Building Biology focused indoor environmental quality inspection, to help your clients create healthier living spaces, to reduce your clients' daily toxic indoor exposures, and to educate them on how to ensure ongoing indoor environmental health for themselves individually and for their household.

Building Biology Institute
The science of healthy buildings

Final Project: Putting Building Biology Principles into Practice

This final project is the home stretch for your certification as a *Building Biology Environmental Consultant*. You are expected to demonstrate understanding of and proficiency in applying the testing protocols, analysis methods, data interpretation and new home design methods as taught in IBE's 200-level seminars:

1. IBE 211, *Indoor Air & Water Quality*
2. IBE 212, *Electromagnetic Radiation*
3. IBE 213, *Natural Healthy Building & Remodeling Practices*.

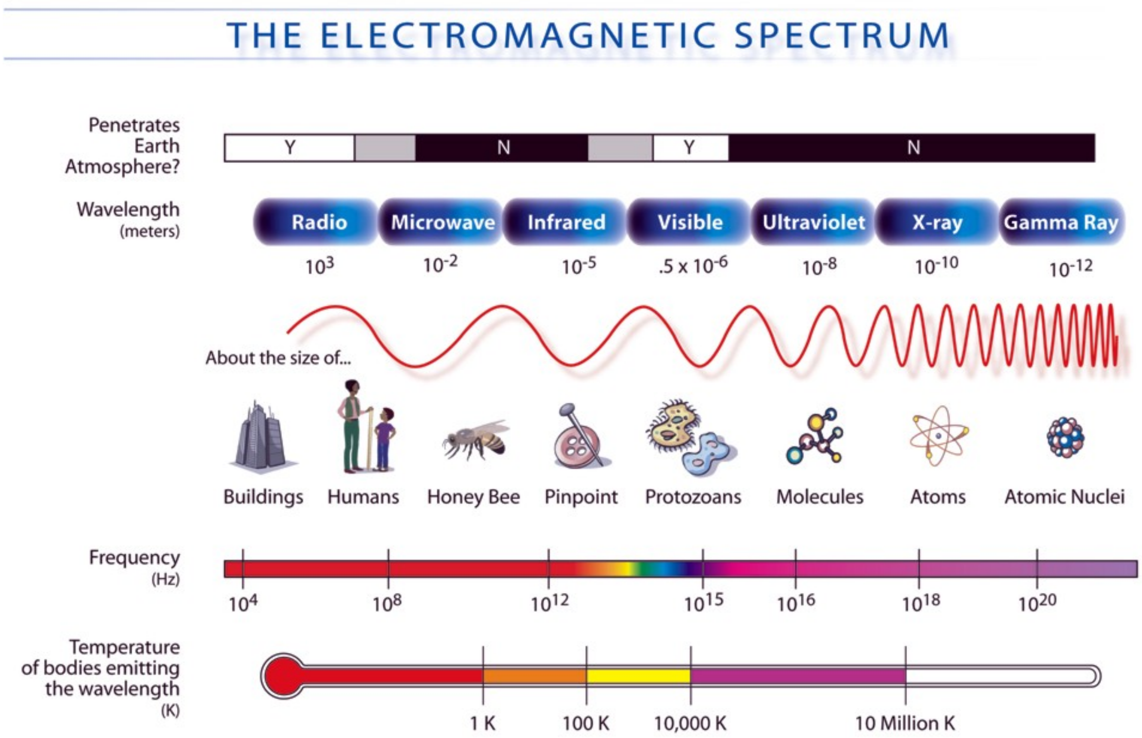
You will be working with a mentor who is an experienced BBEC. BBI will assign your mentor to you, based on the best match of a mentor's established skills and your stated goals. While BBI will make every effort to accommodate student requests for a particular mentor, BBI does not guarantee that the mentor requested will be available during the time frame you have selected, and BBI reserves the right to assign an alternate mentor to you.

Your mentor has volunteered for this responsibility, and is committed to devoting four hours aggregate of their time to your undertaking, via phone and e-mail, at no cost to you. Should your mentor agree to grant you additional time, and/or their more personalized involvement (for example, inviting you to accompany them on client house calls), with or without assessing a fee for their additional commitment, is solely at your mentor's discretion.

You must pass this final project in order to become a certified *Building Biology Environmental Consultant* (*BBEC*). Passing or failing this project rests solely on your mentor's judgment as to your ability to safely and effectively carry out the Building Biology assessment process. Please spend enough time interviewing your mentor prior to their selection to ensure that you and your mentor are suited to each other and that you can depend on full and accurate communication between the two of you.

We at the Institute look forward to welcoming you into our international community of certified Building Biology Environmental Consultants.

BBEC Final Project Guidelines
Electromagnetic Radiation



Putting it all together!

The purpose of these guidelines is to help you as a BBEC carry out a Building Biology focused indoor environmental quality inspection, to help your clients create healthier living spaces, to reduce your clients' daily toxic indoor exposures, and to educate them on how to ensure ongoing indoor environmental health for themselves individually and for their household.

Building Biology Institute
The science of healthy buildings

Final EMR Project: Putting Building Biology® Principles in Practice

This final project is the home stretch for your certification as a Building Biology Environmental Consultant. You are expected to demonstrate understanding of and proficiency in applying the testing protocols, analysis methods, data interpretation and new home design methods as taught in BBI's 200-level seminars:

1. BBI 211, *Indoor Air & Water Quality*
2. BBI 212, *Electromagnetic Radiation*
3. BBI 213, *Building Physics*

You will be working with a mentor who is an experienced BBEC. BBI will assign your mentor to you, based on the best match of a mentor's established skills and your stated goals. While BBI will make every effort to accommodate student requests for a particular mentor, BBI does not guarantee that the mentor requested will be available during the time frame you have selected, and BBI reserves the right to assign an alternate mentor to you.

Your mentor has volunteered for this responsibility and is committed to devoting three to four hours aggregate of their time to your undertaking, via phone and e-mail, at no cost to you. Should your mentor agree to grant you additional time, and/or their more personalized involvement (for example, inviting you to accompany them on client house calls), with or without assessing a fee for their additional commitment, is solely at your mentor's discretion.

In order to become a certified Building Biology Environmental Consultant (BBEC). You must pass the final project work in two areas:

- EMR Home Assessment and Report
- IAQ Home Assessment and Report

Passing or failing these project components rests solely on your mentor's judgment as to your ability to safely and effectively carry out the Building Biology assessment process.

We at the Building Biology Institute look forward to welcoming you into our international community of certified Building Biology Environmental Consultants.

Part A: Home Assessment and Report

Conduct a home assessment and write a detailed report to your client explaining your findings. There are a number of core requirements that must be part of your assessment. These are listed on page 3 of this document. Sample report formats were provided by the instructors and appear in the Student folder suppled with the BBI 212 Seminar.

The maximum time to complete Part A is three months from the date of your assignment to a mentor.

Based on the specifics of the home you are going to evaluate, it may be advisable to look at additional environmental factors. All environmental factors are listed within this package. You and your mentor will discuss the home you are going to assess and decide what additional factors need to be addressed. When you write your proposed assessment strategy for your mentor, please include an explanation of why you decided to include other attributes beyond the core elements.

Remember, the purpose of this project is to perform your first assessment—*not* to execute the recommended mitigations. Should you discover the need for mitigation, you will need to reach out to a certified BBEC; your mentor can advise you in this.

While we are focusing here on the EMR subset of the BBEC Assessment protocol elements, you are expected to develop proficiency in all elements of the assessment procedure. This will occur over time as you encounter situations that demand these elements be assessed.

What you need to do now:

1. Discuss your specific assessment home and the assessment elements with your mentor. (You may NOT use your own home. We want you to interact with a client.)
2. Write a proposed BBEC Home Assessment Plan using the subset of the documents included in this package for the home that you and your mentor have selected.
3. Submit proposal to your mentor for review, discussion, modification and approval.
4. Upon approval of assessment plan, conduct the assessment of the home.
    a. For EMF assessment use the BBI Protocol: *Measurement of Non-ionizing Radiation in Low-rise Residential Buildings* provided.
    b. Any additional elements decided on with your mentor
5. Write a report following the templates provided. Include photos, diagrams if

useful, results and mitigation recommendations.

6. Submit the report to your mentor. Your mentor will review the report and give you a *Pass* or contact you to discuss changes.

Note: You are not yet a certified BBEC; Please do not present yourself as one. You may negotiate a nominal fee with your client if you desire to do so.

EMR Core Testing Requirements

Measurement of Electromagnetic Radiation

Please click here to access sample video protocols for all of the tests listed below.

1. **Magnetic field** mapping of all rooms; interpretation of findings for the client; remediation plan.
    a. Follow protocol: the BBI Protocol: *Measurement of Non-ionizing Radiation in Low-rise Residential Buildings v8.5*, page 14, Sec 6.3 included with this package.
    b. Follow the more specific protocol: the supplemental procedure *Mag Fld Assessment & Interpretation*_v12 included with this package.
    c. Rate conditions according to *The Standard of Building Biology Testing Methods SBM-2015* included with this package.

2. **Body Voltage** assessment of electric fields in bedrooms and other areas of interest based on life-style (reading areas, play areas, project areas, office); interpretation of findings for the client; Body Voltage (BV) reduction plan.
    a. Follow protocol: *Body Voltage Assessment Protocol_v3* included with this package.
    b. Also see the video of the process at https://safelivingtechnologies.com/products/body-voltage-home-test-kit.html. Scroll down and choose video tab.
    c. Rate conditions according to *SBM_2015-v1 Complt* included with this package.

3. **Electric field Bed Mapping** of all bedrooms; interpretation of findings for the client; remediation plan.
    a. Follow protocol: *Measurement of Non-ionizing Radiation in Low-rise Residential Buildings v8.5*, page 11, Sec 5.4.1 included with this package.
    b. Rate conditions according to *SBM_2015-v1 Complt. 2015* included with this package.

4. **MicroSurge Electrical Pollution** (MEP) Evaluation with both MicroSurge meters
    a. Follow protocol: *MEP Measurement & Reduction_v2,* included with this package.
    b. In lieu of actual filter testing and placement recommend a probable MEP reduction and filtration strategy.

5. **Radio Frequency Radiation** measurement; interpretation of findings for the client; remediation plan.
    a. Follow Protocol: *Measurement of Non-ionizing Radiation in Low-rise Residential Buildings v8.5*, page 18, Sec 7.3 included with this package.
    b. Interior and exterior RF levels and ID RF sources inside and outside
    c. Develop hard-wired Ethernet remediation plan based on life-style requirements
    d. Develop an RF Shielding plan and list of materials; Including floor plan showing where shielding is to be installed

BBI EMR Rental Equipment

BBI will rent a kit with all of the test equipment and supplies needed to perform the core tests. This kit can be rented for 5 days for $150 not including return shipping (USA and Canada Only). Renting the kit requires a $1200 credit card deposit. Additional details are below.

Rental Terms

Rental cost: $150 for five days in your hands (plus 4 days shipping)
Rent beyond 13 days total time including shipping: $50/day
Deposit: $1200 via credit card hold
Shipping: USPS Priority mail 2 days to most zip codes in the USA
Shipping Weight: 20 lbs (approximate)
Total Equipment Value: Insure return shipment for $6700

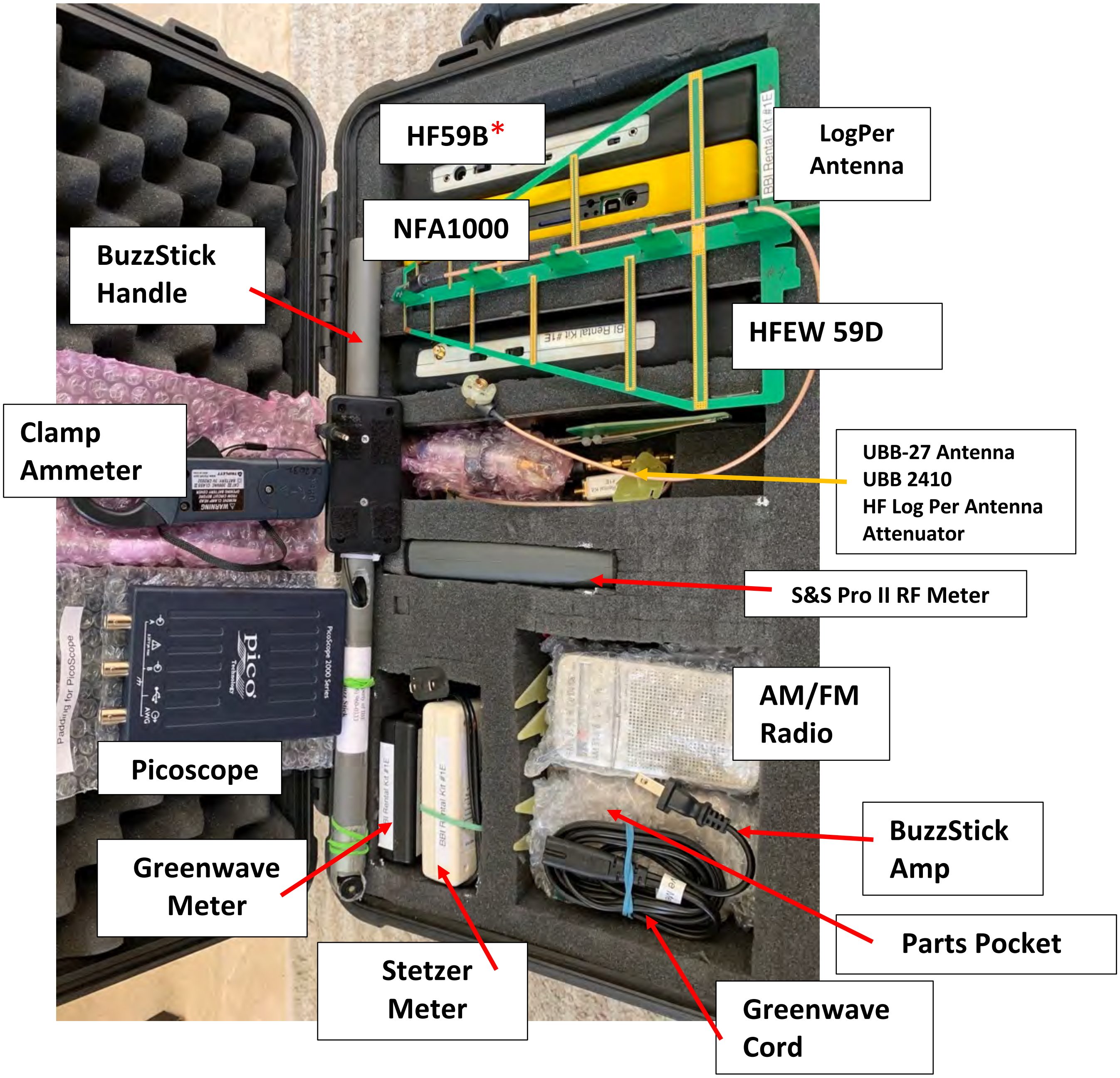
This kit contains equipment that is used by EMRS candidates:

- NFA1000
- PicoScope, Interface Box, Associated cords
- HF 59B, HFEW59D, Associated antennas & cords

Estimate of Project Costs

We require a deposit using a credit card hold for $1200 to cover the cost of damage to the equipment. Please insure your return shipment for $6700 unless you can cover the loss of the shipment out of your own pocket.

We expect you to return ship the equipment at your own expense, clean, undamaged in operating condition and packaged as delivered so as to avoid equipment damage in the return shipment. You will be billed for missing parts & equipment including time to locate and ship.


HF59B*
LogPer Antenna
NFA1000
BuzzStick Handle
HFEW 59D
Clamp Ammeter
UBB-27 Antenna
UBB 2410
HF Log Per Antenna
Attenuator
S&S Pro II RF Meter
AM/FM Radio
Picoscope
BuzzStick Amp
Greenwave Meter
Parts Pocket
Stetzer Meter
Greenwave Cord

Contents of Parts Pocket

1. 1-Picoscope to computer USB Cable (blue)
2. 2-Picoscope Interface Box BNC Patch cords
3. 1-Picoscope telescoping antenna
4. 1-NFA Stand
5. 1-NFA1000 / HF59B charger
6. 1-NFA to HF59 patch cord
7. 1-NFA grounding cord
8. 1-NFA to PC patch cord
9. Outlet Adapter
10. 1-NFA Body voltage electrode
11. 1-NFA Electrode Cord (red)
12. SD card to USD adapter for Mac
13. 1-Outlet Tester
14. Liquid filled compass
15. 1Buzz Stick Amp
16. 16. AM Radio for MEP ID
17. Earbud for AM radio or Buzz stick

Building Biology Environmental Consultant (BBEC)
EMR Assessment Procedures

Our focus is always primarily the client, followed closely by the environment. Surveys should be conducted to educate, not frighten or disillusion the client that there is too much that needs to be done. Start with the basic steps – small ones that every individual can take, and then focus on the larger items if they exist. Education is the key – so that the client can make informed choices.

Building-Biological research methods should be both deductive (reasoning from a known principle to an unknown, from a general to a specific, or from a premise to a logical conclusion) and inductive (the process of reasoning or drawing a conclusion from particular facts or individual cases), as they both supplement each other. Bau-Biologie must participate in this phase of regeneration but should be prepared to make fundamental change of thought somewhat easier. It would be easier to overcome fixed ideas and other obstacles by a holistic oriented approach that shows understanding.

Each of the 25 principles should be evaluated as it applies to the home or building. ***Also refer to separate IEQ checklist.***

Preparation and Formulation of a Hypothesis

- Based on the questionnaire completed in advance by client and reviewed the day of visit.
- Tour the property - is there a reasonable explanation for the complaints or observed issues. Remember to identify the possible pollutant source(s) and the pathway(s) to the occupants.
- If appropriate, purchase an environmental site survey from *Environmental Data Resources* to determine whether there are environmental hazards in the area.
- Conduct a remote fly-over of the area on your computer using *Google Earth* software.

EMR Sleeping Area Survey

In building biology we view the sleeping area as an area of greatest concern with regards to electromagnetic pollution. During sleep, the phase of regeneration, we are most vulnerable to electromagnetic influences. Therefore it is recommended that an EMR sleeping area survey always include the first six items of the Standard of Building Biology Testing Methods:

1. AC electric fields,
2. AC magnetic fields (power frequency fields),
3. Radio frequency radiation,
4. DC electric fields
5. DC magnetic fields, as well as
6. Radioactivity – building materials.

Power Frequency Fields (AC)

At night, anything electric should be unplugged in a bedroom, especially all those extension cords behind the headboard and the bedside lamp. An EMR survey will reveal how the wiring in the walls affects the sleeping area. A measurement of the body voltage will show how the body couples on to the ambient electric fields. Based on the test results alternating electric fields can be substantially reduced or completely eliminated from those areas where people sleep with the help of cut-off switches, shielded wiring, and electric-field shielding/absorbing materials installed in walls or on floors.

As far as magnetic fields are concerned, you always have to keep in mind that they travel unimpeded through almost any material. Therefore such appliances as refrigerators, freezers, swimming pool pumps, breaker boxes on the other side of the bedroom wall and the like should be located far away from sleeping areas. An EMR survey will help to establish safe distances from TV-sets, electric baseboard heating elements and clock radios. It is even better to move them out of the bedroom. Net or stray currents are a reality, especially in urban areas. The resulting elevated magnetic fields need to be carefully traced and eliminated.

- Body Voltage
- Electric Field meter – potential-free (measure both the ELF and VLF ranges)
- Gauss/Tesla meter
- Ammeter

Radio-frequency Radiation (RF)

Though most sources of RF radiation are located inside of a home, external sources may also be present. In order to escape undesirable high levels of radio- and microwaves, we have the option to change the location of the bed inside the house or to shield a room from incoming radiation.

However unaware consumers may also use wireless internet, cellular or cordless phones. They should certainly not be used in the home. Cordless phones and wireless Internet equipment based on 2.4 to 6 GHz technology, which emit pulsed RF energy 24 hours a day, do not belong in a home. Choose analog 900 MHz models instead and use them most sparingly. It is also important to consider avoiding light dimmer switches as they can create RF signals that travel on the electric house installation contaminating the entire living space.

- RF Analyzer - omni-directional

Static Electricity (DC)

Synthetic wall-to-wall carpeting, synthetic stuffed animals and synthetic/cotton blend bed sheets are the major sources of static electricity in the bedroom. The cure is easy; simply use natural organic materials that cannot become so highly charged, and discharge quickly such as cotton, hemp, silk, wood, etc. If replacement is not possible, at least the offending material needs to be covered up with one of the aforementioned materials. Checking the surface potential of suspicious materials will bring clarity. The maximum surface potential achievable varies inversely with the room relative humidity.

Static Magnetism (DC)

The detection of the geomagnetic field will reveal whether we are in sync with the earth's rhythm. Often we are not because of highly magnetic metal springs in the mattress. Leave the metal out of your bed and keep a sufficient distance from any steel reinforcement including steel reinforcing bars found in a concrete slab and steel I-beams used to support the floor in house with basements or crawl spaces.

- Compass deflection

Radioactivity

Modern airtight homes run the greatest risk of accumulating radon gas which is another reason to ventilate living spaces more often.

Building materials such as concrete, glazed tiles, granite countertops, etc. may show radioactivity levels far above the ambient level. In new construction, materials with lower radiation should be selected. If possible in existing houses consider removing materials with unacceptably high radiation levels.

Prior to testing a particular sleeping area, it is important to check the outside radiation levels of the neighborhood as well as the presence of radio transmitters, mobile phone base stations, high-tension power lines, underground cables, industrial parks, natural background radiation and so forth. Relevant information can also be obtained from utility companies and geological research institutes. The better you are informed about the natural and human-made sources of electromagnetic radiation in the area, the more successful your remediation will be. Anticipated future developments in the neighborhood should also be taken into consideration.

- Geiger Counter

Remediation

1. Explain the assessment results, stressing education and options
2. Explain the extent of your remediation and/or coordination services
3. Agree to what follow-up services are expected, e.g., lab test results, remediation, coordination of remediation

Remember

Know the local building codes
Use properly licensed/certified personnel
Forge relationships with like-minded individuals
All Building Biology efforts are based on the following motto:
Any attainable reduction is worth achieving. Nature is the ultimate guide.

Sample Record Sheet

This questionnaire was designed to help you to check whether long existing health problems which could not be explained so far (e.g. insomnia, headaches, etc.) might be the result of existing hazards such as technical electromagnetic fields, geopathogenic zones, toxic substances from building materials, etc. in your dwelling/ workplace.

Please underline that which applies and add details if necessary. Use several forms in case other members of the family or a dwelling-sharing community are to be investigated.

1. Description of location with regard to:
   a. High tension power lines / power connection on rood or wall / underground power connection
   b. Transformer station
   c. Radar- / FM- / TV station
   d. Factory
   e. Road / Highway (If applicable: type, power, distance to dwelling)
   f. Neighbors / Inhabitants / density

2. Type of bed: steel springs, foam plastic mattresses, foam rubber, metal frame, plywood, etc

3. Type of heating system: Central heating, gas heating, electric heating

4. Electric installation, illumination and appliances: (radio clock, vicinity to body)

5. Other things: (geopathogenic zones?)

DC Magnetic Concern (mattress scan)

Location	Deflection	Distance	Material

Sleeping Area

		Concern			
	Units	None	Slight	Severe	Extreme
5. Static Magnetic Fields					
Deviation in compass needle		< 2	2-10	10-100	> 100

Radioactivity

Location	% change
Outdoors	Not applicable

(Indoor – avg. Outdoor) / Outdoor X 100 = percent change

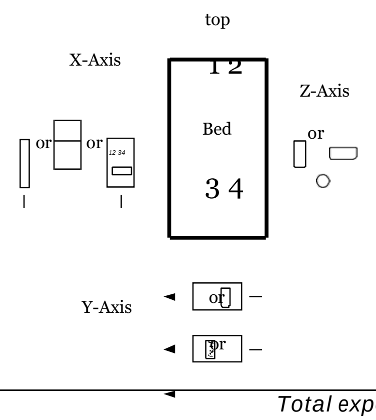
Sleeping Areas

		Concern			
	Units	None	Slight	Severe	Extreme
6. Radioactivity (Gamma Radiation and Radon)					
Increase of equivalent dose rate	Percent (%)	< 50	50-70	70-100	> 100

ELF Electric Field Measurement (50Hz – 400kHz, or similar)

Initial exposure: (measurements as potential-free)

3-Axis-Measurement of electrical fields with "ME .. " - type instruments



Position	X-axis	Y-axis	Z-axis	Total exposure
1				
2				
3				
4				

Total exposure when using a single-axis instrument: root-mean-square = sq rt ($X^2 + Y^2 + Z^2$)
Tri-axial measurements – only measure in the X-axis

Reduction in ELF electric field exposure using either the Body Voltage Test or the highest of the readings recorded in the initial exposure.

Body voltage ground source:_______________________________ Verified: Yes/No

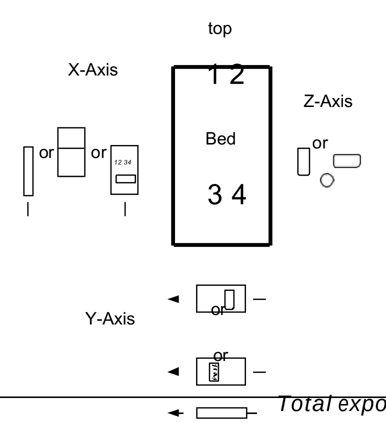
Configuration	Voltage	V/m
All Devices On		
Devices Off		
Devices Unplugged		
All Circuits Off		
Circuit # off		
Circuit # off		
Circuit # off		

Configuration	Voltage	V/m
Circuit # off		
Circuit # off		
Circuit # off		
Circuit # off		
Circuit # off		
Circuit # off		
Only impact circuits off*		

* shut off all circuits that showed a large impact to the BV or V/m measurement

Final exposure: (with only the impact circuits shut off) (measurements as potential-free)

3-Axis-Measurement of electrical fields with "ME .. " - type instruments



Position	X-axis	Y-axis	Z-axis	Total exposure
1				
2				
3				
4				

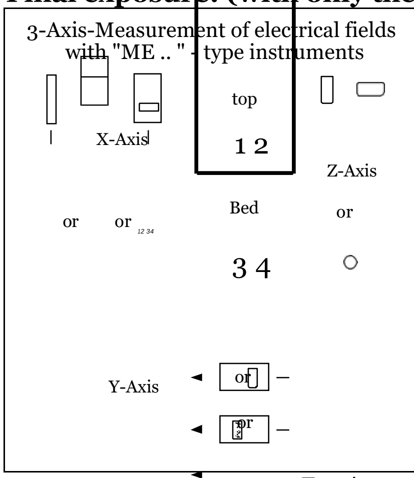
Total exposure when using a single-axis instrument: root-mean-square = sq rt ($X^2 + Y^2 + Z^2$)
Tri-axial measurements – only measure in the X-axis

VLF Electric Field Measurement (2kHz-400kHz, or similar)

Reduce in VLF electric field exposure by removing all sources. Note that IBE does not support the use of filtering devices in a sleeping area.

Notes:

Final exposure: (with only the impact circuits shut off)



Position	X-axis	Y-axis	Z-axis	Total exposure
1				
2				
3				
4				

Total exposure when using a single-axis instrument: root-mean-square = sq rt ($X^2 + Y^2 + Z^2$)
Tri-axial measurements – only measure in the X-axis

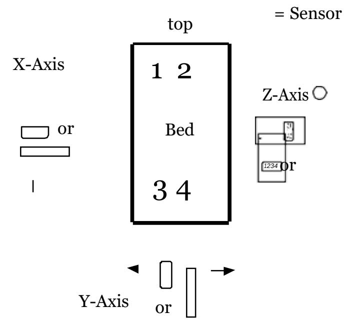
Sleeping Areas

		Concern			
	Units	**None**	**Slight**	**Severe**	**Extreme**
3. AC Electric Fields (ELF)					
Field Strength (potential-free)	V/m	< 0.3	0.3-1.5	1.5-10	> 10
Field Strength (grounded)	V/m	< 1	1-5	5-50	> 50
Body Voltage	mV	< 10	10-100	100-1000	> 1000

ELF Magnetic Field Measurement (50Hz – 400kHz, or similar)

Initial exposure:

3-Axis-Measurement of magnetic fields with "ME .. " - type instruments



Position	X-axis	Y-axis	Z-axis	Total exposure
1				
2				
3				
4				

Total exposure when using a single-axis instrument: root-mean-square = sq rt ($X^2 + Y^2 + Z^2$)
Tri-axial measurements – only measure in the Z-axis

Reduce in ELF magnetic field exposure by removing all sources.

Net Current (ammeter)

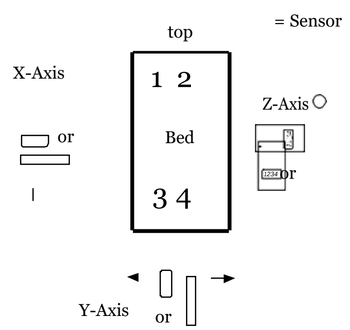
Location	Amps	Comments

Location	Amps	Comments

Notes:

Final exposure: after mitigation

3-Axis-Measurement of magnetic fields with "ME .. " - type instruments



Position	X-axis	Y-axis	Z-axis	Total exposure
1				
2				
3				
4				

Total exposure when using a single-axis instrument: root-mean-square = sq rt ($X^2 + Y^2 + Z^2$)
Tri-axial measurements – only measure in the Z-axis

Sleeping Areas		Concern			
	Units	None	Slight	Severe	Extreme
3. AC Magnetic Fields (ELF)					
Flux density	nT	< 20	20-100	100-500	> 500
Flux density	mG	< 0.2	0.2-1	1-5	> 5

RF Electromagnetic Field Measurement (27MHz – 6GHz, or similar)

For the sleeping area measurements are made with a scan in multiple antennae directions over an area of approximately 1meter (3 feet) "cloud" around the sleeping area. Measurements are done using peak-hold and must have results that are repeatable within a 2X magnitude.

Initial exposure: (measurements with an omni-directional antennae used in a survey fashion)

Location	Full	Pulsed
Outside (North)		
Outside (East)		
Outside (South)		
Outside (West)		

Comment

Check the effectiveness of building materials to attenuate the signal.

* Note if the results vary for different floors in a multi-story dwelling. Check outside windows or on balconies.

Reduce in RF electromagnetic field exposure by removing all internal sources.

Notes:

Final exposure: (measurements with an omni-directional antennae used in a survey fashion)

Location	Full	Pulsed

Comment

Sleeping Areas

		Concern			
	Units	**None**	**Slight**	**Severe**	**Extreme**
3. Electromagnetic Waves (RF) (Power density in microwatts per square meter.)					
Pulsed	W/m^2	< 0.1	0.1-10	10-1000	> 1000
Un-pulsed[3]	W/m^2	< 1	1-100	100-10,000	> 10,000

[3] Note that this is not part of the SBM-2008.

International Institute for

Building-Biology® & Ecology

IBE

TP01-2018

Protocol:
Measurement of Non-ionizing Electromagnetic Radiation in Low-Rise Residential Buildings

BRINGING TOGETHER TECHNOLOGY AND DESIGN METHODS TO PROVIDE THE INFORMATION NEEDED TO CREATE HEALTHY HOMES AND WORKPLACES

V8.6, 09.07.21

IBE Protocol

Measurement of Non- ionizing Electromagnetic Radiation (EMR)

in Low-Rise Residential Buildings©

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1st Edition: 23 Oct 2009

5th Edition 26 Sept 2014

8th Edition 21 Oct 2018

Introduction

Our electromagnetic environment has significantly changed in the last two decades. Uses of wireless communication (microwaves), entertainment (radio waves), electricity (power frequency), synthetic materials (static electricity) and magnetized metallic building materials (static magnetism) have changed our environment. Today the man-made microwave radiation is millions of times greater than the original natural emissions.

This document provides guidance for a uniform and standardized protocol to assess and document levels of electromagnetic radiation (EMR) in a low-rise residential building for medical, research, environmental, and real estate documentation.

Development Committee Roster

Committee Chair: Vicki Warren, former Executive Director, IBE
Lawrence Gust, Gust Environmental, Ventura, CA
Rob Metzinger, Safe Living Technologies, Morriston, Ontario
John Lincoln, EMR Surveys t/as Fittings Plus, Manly, NSW, Australia (advisory only)
Benoît Louppe, Etudes & vie Engineering Design, Belgium (advisory only)
Stéphane Bélainsky, 3E, Inc., Montreal, Quebec (advisory only)

Table of Contents

Protocol for the Measurement of Non-ionizing Electromagnetic Radiation (EMR) in Low-Rise Residential Buildings

1 Scope, Purpose and Application

1.1 Scope

1.1.1 This guide provides standardized methodology in measuring non-ionizing electromagnetic radiation in low-rise residential buildings. Protocol definitions and limitations of the measured values are covered.

1.1.2 Measurements selected from those that are outlined may be appropriate during new construction, remodeling, or surveys of existing construction.

1.2 Purpose

1.2.1 The purpose of this guide is to identify test methods that may be useful in the measurement of electromagnetic radiation from non-ionizing sources in low-rise residential buildings.

1.3 Application

1.3.1 Users of this standard may provide recommendations based on measured levels of non-ionizing electromagnetic radiation. There are no industry acceptance level standards, though recommendations based on research on provided in Appendix A – Data Interpretation.

1.3.2 When this standard is used as a basis for an assessment report, information to be included in the report shall be as defined in section 8 of this standard.

1.3.3 Different test methods and measuring equipment that do not meet basic requirements can be expected to yield different results, and absolute limits are not possible.

1.3.4 No attempt is made to describe here all known or conceivable systems for measuring electromagnetic radiation.

1.3.5 Many of the measurements are relative in nature, and the effects of the test conditions during measurements can be significant. Direct comparison requires that tests be conducted under similar conditions.

1.3.6 All measuring methods are limited in their scope of evaluation.

2 Referenced Publications

The documents or portions thereof listed in this section which are also referenced elsewhere in this standard shall be considered part of the requirements of this document.

1. *BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Low-Intensity Electromagnetic Radiation*, Dec 2012[1].
2. BAUBIOLOGIE MAES, (www.maes.de), Standard of Baubiologie Methods of Testing translated by the International Institute for Bau-Biology® & Ecology, Inc.[2], (#SBM-2008C),
3. Riley, Karl, *Tracing EMFs in Building Wiring and Grounding*, ELF Magnetic Surveys, 2005[3].
4. G. Oberfeld, *Environmental Medicine Evaluation of Electromagnetic Fields,* © 2007"
5. Kulczycki, Jerzy, *Basis of Electromagnetic Hygiene*, The Planetary Association for Clean Energy, 1989.
6. Roger Santini, Jean-Marie Danze, Marius Seigne, Benoît Louppe, *Guide Pratique Européen des Pollutions Electromagnétiques de l'Environnement*, éd. Marco Pietteur, 2000, ISBN 2-87211-033-x
7. Salzburg Model, Precautionary limit for indoors RF, 2002

3 Definitions

- **Alternating Current (AC) Voltage**: an electric current or voltage that reverses direction at regular intervals, having a magnitude that varies continuously in sinusoidal manner.
- **Bandwidth**: the smallest range of frequencies constituting a band, within which a particular signal can be transmitted without distortion.
- **Earthing**: Refer to grounding.
- **Electric field**: a vector quantity from which is determined the magnitude and direction of the force (electric force) on a charged particle due to the presence of other charged particles, accelerated charged particles, or time-varying currents.
- **Electromagnetic field**: the coupled electric and magnetic fields that are generated by time-varying currents and accelerated charges.
- **Electromagnetic radiation** (EMR): radiation consisting of electromagnetic waves, including radio waves, infrared, visible light, ultraviolet, x-rays, and gamma rays.
- **Electromagnetism**: the phenomena associated with electric and magnetic fields and their interactions with each other and with electric charges and currents.
- **MEP: Microsurge Electrical Pollution** in the range of >60Hz to 1 MHz, normally associated with power systems and power system components,

[1] Available through www.bioinitiative.org

[2] Available through www.buildingbiology.net

[3] Available through Amazon.com

particularly non-linear power supplies and switching mode power supplies. At these frequencies the electric and magnetic fields are distinct components.

- **Far field**: The far-field region is the region outside the near-field region, where the angular field distribution is essentially independent of distance from the source. In the far field, the shape of the antenna pattern is independent of distance. If the source has a maximum overall dimension D (aperture width) that is large compared to the **wavelength λ**, the far-field region is commonly taken to exist at distances from the source, greater than Fresnel parameter $[S=D^2/(4\lambda)]$, S>1.
- **Full wave**: In telecommunications, a full wave, or carrier is a waveform (usually sinusoidal) that is modulated (modified) with an input signal for the purpose of conveying information. This carrier wave is usually of much higher frequency than the input signal.
- **Grounding** (Earthing): Ground or earth may be the reference point in an electrical circuit from which other voltages are measured, or a direct physical connection to the Earth.
- **Ionization**: the physical process of converting an atom or molecule into an ion by adding or removing charged particles such as electrons or other ions.
- **Ionizing radiation**: consists of highly-energetic particles or waves that can detach (ionize) at least one electron from an atom or molecule. Ionizing ability depends on the energy of individual particles or waves, and not on their number, or their frequency. Only far ultra-violet, x-rays and gamma rays have sufficient energy to exist as ionizing radiation.
- **Magnetic field**: The portions of space near a magnetized object, or a conductor carrying an electric current, in which a magnet would experience physical forces of attraction or repulsion.
- **Microwave**: The term is used to described higher frequency bands (300MHz to 300GHz), normally those associated with wireless communications – cellular phones and wireless Internet. Wavelengths in this band are between 1 meter (39 in) (300 MHZ) and 1 cm (0.39in) (300 GHz).
- **Near field**: The close-in region of an antenna where the angular field distribution is dependent upon the distance from the antenna. The near field is that part of the radiated field that is below distances shorter than the $S=D^2/(4\lambda)$ (the Fresnel parameter[4]) from the source (S) of the diffracting edge or antenna of longitude or diameter (D).
- **Non-ionizing radiation**: refers to any type of electromagnetic radiation that does not carry enough energy per quantum to ionize atoms or molecules. Note, however, that a gas can be ionized in a fluorescent lamp with ELF 50/60 Hz fields, as can be some substances within the human body.
- **Peak**: The highest value of a single event or group of events. The magnitude may be positive or negative. Peak is often used to describe the maximum point of a wave or pulse and is not necessarily the maximum value.
- **Pulse**: A signal of short duration; it may be less than half a wavelength or sometimes many wavelengths, but the duration will be a relatively short time

[4] ACOUSTIC WAVES: DEVICES, IMAGING, AND ANALOG SIGNAL PROCESSING, G.Kino, Ed. Prentice Hall (2000) Ch.3 pag.165

- **High frequency** (HF): Frequencies in the range of 300kHz to 300MHz, normally those associated with media communications – radio, and TV.
- **Signal reflection**: The retransmission of an incident signal in a different direction at the point of encountering a change in medium in which the incident signal was traveling. The angle between the direction of the incident and reflected signals will be twice the angle between the incident signal and an imaginary line drawn normal (perpendicular) to the surface of the change of medium, at the point of contact. This can be quite complicated for a broad wave front encountering an irregular surface.
- **Signal transmission**: The process of sending, propagating and receiving an analogue or digital information signal over a physical point-to-point or point-to-multipoint transmission medium, either wired or wireless. The signal travels in the same direction as the incident signal.
- **ELF: Very Low Frequency** in the range of 1Hz to 2kHz, normally associated with man-made sources from electronic devices. Our interest is the division between 60 HZ and frequencies and above 60 Hz including whole number multiples to the 3rd harmonic and random frequencies not at harmonic multiples. Some studies have shown biological sensitivity particularly to MEP frequencies. There is a lack of full agreement as to which frequencies or ranges of frequencies are more or less biologically active. But evidence exists that there is more difficulty for frequencies above the 60 Hz fundamental frequency.

4 Investigation

4.1 General

To determine the presence and quantity of non-ionizing electromagnetic radiation, users of this standard should conduct an investigation that, at a minimum, shall encompass each of the actions defined in this section.

4.2 Client Interview

4.2.1 A client interview shall be conducted if the client is available. The interview should include questions regarding the date the structure was constructed, the general use and location of electromagnetic devices, and concerns of the client, and such other questions as may be deemed necessary for the purposes of applying this standard.

4.2.2 If the client is unavailable for an interview, the consultant must document the lack of an interview in any reports issued regarding the structure.

4.3 Climatic Conditions

Users of this standard shall document climatic conditions present at the time of any investigation or sampling, including cloud-cover, precipitation, humidity and temperature. The user is required to identify if weather conditions may affect the integrity of the measurements taken.

4.4 Structure Type and Location

The investigation shall identify the type and location of the structure being assessed.

4.4.1 The investigation shall identify the location and type of structure, such as rural, urban or suburb, and metal, brick, stucco, wood, etc. In addition, proximity to transmission and distribution lines, both overhead and underground, as well as, transformers, cell/radio/TV towers and or switchyards should be identified. Any potential external sources of non-ionizing EMR shall be identified and evaluated. Document the local background electrosmog in order to better assess and mitigate if needed.

4.4.2 The investigation shall identify the location of the sleeping areas, such as front or rear of the building, first or second floor, as well as relative location to such items as appliances, garage door openers, entertainment centers, air conditioning units, WiFi hubs, Cordless Phone, etc.

4.4.3 The investigation shall identify the location of the following items and any other items relevant to assessment: utility meter, main electric panel, sub panels, power feed routing, telephone entry, cable TV entry, water line entry, gas line entry, etc.

4.5 Accessibility

In order to implement the procedures defined in this standard, the structure must be reasonably accessible for investigation and data collection.

4.5.1 Users of this standard should determine if the structure is readily accessible for visual observation and taking measurements. If the opinion of the user is that the structure is inaccessible for visual observation and/or data collection, the user is required to describe conditions rendering structure inaccessible.

4.5.2 Users of this standard should determine if it is practical to eliminate internal EMR sources from the structure in order to evaluate external sources. If the opinion of the user is that internal sources cannot be eliminated, then the user is required to describe the internal sources, conditions, and source locations.

5 AC Electric ELF Fields and Microsurge Electrical Pollution (MEP)

To perform the procedures defined by this standard, the following equipment is required.

5.1 Equipment and Supplies

Electric Field Strength (intensity) is measured in volts per meter (V/m). Alternating electric fields can be suitably measured with sensitive electric field intensity meters. The results need to be reproducible with high accuracy and a flat frequency response, which shall cover the low frequency 40Hz (16.67Hz in Europe for the railway frequency) to at least the third harmonic (150Hz/180Hz) as well as fields greater than 2k Hz up to 400k Hz or greater. The instruments shall possess sensitivity of at least 0.1V/m and be capable of measuring three-axes simultaneously and displaying individual axis and the resultant (combined reading). Note that if a single-axis instruments is used, the total value is the root mean square of the value for each of the three axes. The unit will be used in 'floating' mode without a ground for rating an area like a bed. However, the unit must have a grounded mode with grounding connection for use in source identification. The body must be grounded to shield the meter from sources to the rear.

Frequency spectrum analyzers can also be used for measuring ELF electric fields, but the sum of the power densities for the proper frequency bandwidth needs to be considered. The instruments used must also be capable of determining the power level for frequencies above 60 Hz. caused by microsurges from electronic equipment. The following procedures are also applicable to the MEP measurements as well; see Section 5.6.1.

Only equipment that meets these specifications can be used for comparative purposes regarding interpretation as described in Appendix A – Data Interpretation.

All test leads, wires and connectors shall be regularly evaluated for electrical integrity by checking circuit resistance while manipulating cords and connectors.

5.2 Technical Background

Electric field lines always "search" the shortest way from areas of higher potential (e.g. electric lights, wiring or appliances) to areas of lower potential or ground potential. The electric field may couple from a conductive item with AC voltage to a floating (no voltage) conductive item close to it without a direct connection. Any conductive object like the body of the measuring person or a grounded instrument will influence the gradient of these field lines.

5.3 Measurement Procedures for ELF Electric Fields

There are two methods to measure electric fields: Potential-free (with "floating potential") or "against ground potential" (with "earth/ground reference").

5.3.1 Grounded Potential Measurement

The TCO guideline[5] for environmental labeling of office equipment has developed a standard which uses a measurement "against ground potential" in order to measure its emission of electromagnetic pollution. The ground potential is deliberately placed in the field in order to attract the field lines from the source to the ground and be measured. (See Section 5.4.2) The advantage of this approach is that the measurement instrument can be held in the hand with the body grounded and the values will increase when getting closer to the source so that it can more easily be evaluated. This method of grounded measurement of electric fields has long been the basis of the VDB ("Standard der baubiologischen Messtechnik" or "Standard of Measurement Technique of Building Biology"), so there is a large amount of experience and data has been recorded using this procedure [2[6]].

5.3.2 Potential Free Measurement

For reasons of measurement repeatability, the potential-free measurement is a better reflection of Total Body Exposure and eliminates the potentially volatile influence of the ground reference. Potential-free measurements are approximately 1/3 of those for the grounded measurement [2[6]].

Rules for Measurement of Electric Fields:

- Potential-free measurement are for investigating the total exposure levels.
- Measurement with reference to ground potential is for identifying the sources of fields.

[5] TCO Certification is a series of product certifications for office equipment (most notably monitors). It is set by TCO Development, owned by the Swedish Confederation of Professional Employees

[6] See page 6 Reference Publications.

5.4 General Procedures for ELF Electric Field Assessment

1. Assure electrical and electronic devices, including those that run intermittently, such as refrigerators, electric heating systems, are plugged as they normally would be[7].
2. Take the potential-free measurements of the area under the normal electrical environment as described below (Section 5.4.1). If an available option, use the meter[8] to create a visual map of the surface electric fields for later reporting.
3. If using a single axis meter, calculate the root mean square for all three axes. [Electric field levels vary extensively, but potential-free levels in excess of 30V/m are not unusual.] (See Appendix A – Data Interpretation).
4. Determine and record the highest level in the area of concern– normally a bed.
5. To identify externally sourced fields, repeat the measurement with all of the circuit breakers feeding the house turned off. If high external fields are located, identify and note the sources. Note: for electric fields, source identification is best done with a grounded reference for the meter (see Sections 5.3.1 and 5.4.2).
6. Typically, internal field sources are wiring in the walls, floor and ceiling and nearby power cords that are plugged into power outlets. With all branch circuit breakers turned off, proceed to turn each breaker on in turn to determine which are the affecting branch circuits. Label and record the circuit numbers. Record the highest field level of the low level achieved by this process. Repeat for all areas (beds) of interest.
7. If #6 has not resulted in a suitably low field level proceed with source identification [Section 5.4.2] and determine mitigation plan necessary to achieve the desired electric field level following the *SBM 2008C Sleeping Room Standards*.

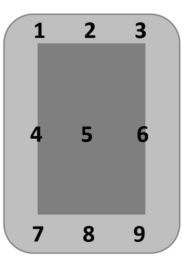
5.4.1 Assessment of Total Electric Fields in Sleeping Areas

Use an ungrounded (potential-free) instrument, (i.e. NOT connected with the grounding wire, NOT held in the hand) is placed on a non-conductive holder that secures the meter 3 to 12 inches above the bed. Read the instrument from a distance of at least 5ft away.

3-Axis Meter

1-Axis Meter

3-Axis meter:



Measure bed at 9 points (see sketch on the left). The box formed by the numbers should be approximately 10 in. from the bed edges.

For best results there should be a 1ft distance to any surrounding metal items if possible. However, the distance to the mattress from the meter shall be 3 to 12 inches above the bed. Note that with inner-spring mattresses, there can be some inevitable distortions, which can be reduced if the distance is increased slightly over 3in. A meter stand as pictured above is used for this purpose. Instruments exist that automate this 9-point mapping.

1-Axis meter

[7] Devices that have a metal enclosure if not correctly grounded can throw off large electric fields.
[8] The GigaHertz Solutions NFA1000 meter has this option.

A 1-Axis instrument will need to be rotated through all three axes and a reading taken at each location. For 1- axis instruments calculate the total or resultant 3-dimensional field by V/m = square root $(x^2 + y^2 + z^2)$". This result can be estimated by taking the largest reading and adding to it ½ of the next highest reading.

5.4.2 Source Identification

Use the grounded instrument for identifying sources of electric fields, i.e., connected to ground potential. Possible ground references for measuring electric fields could be unvarnished, metal piping for water, gas or heating, an external temporarily inserted Earth ground rod, or if the connection to ground has been verified, the grounding connection of an electric outlet. Note that for the outlet, plumbing, gas pipes, heating pipes it is quite likely that there will be a voltage with reference to Earth of approximately 50 milliVolts to several volts due to voltage on the utility neutral reflected back to the outlet. This will affect measurement accuracy but should not interfere with tracking the source of an electric field.

Checking the ground connection:

- Place the instrument in a fixed position close to an e-field source.
- Connect grounding cable to your possible grounding points one at a time.
- The highest reading will be the best grounding [explanation by common sense: if field is unchanging, the "best ground" must be the lowest reference available and thus shows the highest reading.

The "close-to-body-rule," where the instrument is to be held near the body and the body is grounded by having a finger touching a grounded point on the meter (a screw provided for that purpose or the tip of an exposed connector) to reduce external directional influences. This is often described in manuals in order to obtain readings comparable to the values as stated in the manufacturer's recommendations for grounded measurement of electric fields [2]. When using the grounded measurement for a locating source, the absolute readings are of no importance as only the relative readings are necessary to evaluate each sources contribution to the total pollution. The meter reading will increase as you approach the source.

In low frequencies (as opposed to the high frequencies) no hot spot of higher pollution from reflective action can be generated in open space, since maximum levels will always be close to the object of highest potential (e.g. cables, appliances, walls coupled to cables). The grounded instrument will always "point" to the source by displaying increased readings. For identification purposes one can approach as close to the respective source as necessary.

5.5 Limitations

Indoor measurements are difficult due to the narrowness of the space and the likelihood of the influence of the built environment. ELF field levels can differ at each point and (an in all directions in the case of a single axis meter). Even slight changes in the meter position can lead to fluctuations in the measurement values.

For evaluation of mitigation results, use the same instrument, range, procedure and location as originally used.

For electric fields, the person taking the measurements will also affect the results for a specific measurement location. At this frequency, fluctuations in the maximum values are usually an indication of an environmental change.

5.6 MEP Electric Fields

5.6.1 Field Strength Instruments

An AC electric field is not only defined by its field strength, but also the frequency composition of the voltage components. For MEP measurements, the results need to be reproducible with good accuracy with a flat frequency response over the MEP range of >60 Hz to 400kHz minimum, 1 MHz is better. The instruments shall possess sensitivity of at least 0.1V/m, or better. Only equipment[9] that meets these specifications can be used for comparative purposes regarding interpretation as described in Appendix A – Data Interpretation.

The procedures for measuring MEP electric fields is the same as that for ELF levels with the only exception that the meter be set to or read for the MEP range. See section 5.4 for test procedures.

5.6.2 Limitations for Microsurge Meters

There is no agreed standard of units or frequency range for Microsurge[10] meters. So, it is not practical or logical to simply compare results among these meters; however, like with all evaluations, the relative comparison between values from the same meter will be useful – in other words, high levels should be high on all suitable devices, and effective mitigation should lower the values accordingly.

6 AC Magnetic ELF Fields and MEP

6.1 Equipment and Supplies

3-Axis Meter

1-Axis Meter

The field strength of alternating magnetic fields is expressed as ampere per meter (A/m). However, it is common practice to evaluate the fields as magnetic flux density in tesla (T) or gauss (G). AC magnetic fields are measured with sensitive uni-axial (1-axis) or tri-axial (3-axis) magnetic field instruments, called Gaussmeters and Teslameters.

The results need to be reproducible with good accuracy. A flat frequency response over the ELF range of 40Hz to at least the 3rd harmonic (150Hz/180Hz) as well as fields greater than 2k Hz up to 400k Hz minimum, (1 MHz is better) is required. The instruments shall possess sensitivity of at least 10nT (0.1mG), or better. Only equipment that meets these specifications can be used for comparative purposes.

At this writing use of a PC based Oscilloscope and Spectrum Analyzer (using Picoscope 2204A and associated software) is under development. This development has been driven by some clients with extreme EMR sensitivity (EHS) where meter analysis is not sufficiently sensitive to both find and demonstrate the existence of offending MEP sources.

[9] GigaHertz Solutions, GMBH makes a number of suitable meters: ME3951A, NFA1000, NFA30M

[10] Meter manufacturers: Stetzer Electric Stetzerizer Microsurge Meter, Geenwave EMI Meter.

6.2 Technical Background

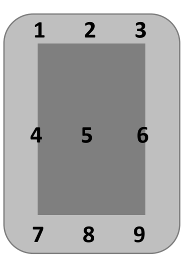
The magnetic field lines are at a 90° angle (orthogonal) to the electric field lines. For practical work this means e.g. for power lines / cables that the magnetic field lines are around the line in concentric circles, decreasing in their strength with increased distance geometrically. For point sources, such as pumps, motors, and transformers the field is normally spherical in shape. These fields will penetrate through people and most materials. Magnetic fields are produced by flowing electrical current; so, if there is no current flow there is no magnetic field.

6.3 General Procedures for Magnetic ELF Measurements

1. Turn on the 120 Volt lighting loads through out the building plus loads that run intermittently, such as the furnace blower if there is a manual/auto switch available on the thermostat.
2. Take the measurements of the area under these 'normal' electrical conditions. Record data by room and by area of interest like seating areas, play areas, beds.
3. If using a single axis meter, calculate the root mean square for all three axes. [Magnetic field levels vary extensively, but are expected to be between 0-30nT (0.3mG), while elevated levels from problems may be 10 to 100 times higher [3].] (See Appendix A – Data Interpretation).
4. Determine the highest level in the areas of concern.
5. To determine if external field sources exist, repeat the measurement with all of the circuit breakers feeding the house turned off. If high external fields are located, identify the source by following the direction of increasing readings.
6. Depending on circumstances, magnetic field measurements may need to be repeated during various times of the days and days of the week in order to identify fluctuations. Data logging over a 24 to 48-hour period may be needed, especially with externally sourced fields as from the power distribution system.
7. Proceed with internal source identification [Section 6.3.2] and mitigation as necessary.

6.3.1 <u>Measurement of Total ELF Magnetic Fields in Sleeping Area</u>

<u>3-Axis meter</u>:



Measure bed at 9 points (see sketch on the left). The box formed by the numbers should be approximately 10 in. from the bed edges.

For best results there should be a 1ft distance to any surrounding metal items if possible. However, the distance to the mattress from the meter shall be 3 to 12 inches above the bed. Note that with inner-spring mattresses, there can be some inevitable distortions, which can be reduced if the distance is increased slightly over 3in. A meter stand as pictured above is used for this purpose. Instruments exist that automate this 9 point mapping.

<u>1-Axis meter</u>

A 1-Axis instrument will need to be rotated through all three axes and a reading taken at each location. For 1- axis instruments calculate the total or resultant 3-dimensional field by V/m = square root ($x^2 + y^2 + z^2$)". This result can be estimated by taking the largest reading and adding to it ½ of the next highest reading.

6.3.2 Source Identification

Use the meter to identify field sources. The field is stringer as you draw closer to the source. It may be helpful to utilize meter information about which axis, x, y, z, the field is coming from to assist tracking the source. Source identification for magnetic fields uses these distance rules:

- For point sources, the magnetic fields attenuate with 1/cube of the distance.
- For single line sources they attenuate with 1/square of the distance.
- For unbalanced (net) current in a cable, they attenuate with the distance [3[11]].

Isolation of multiple source may require the use of a clamp on ammeter on suspected cables, wires conduits and metal pipes. The sensitivity of the clamp ammeter should allow identification of current in the milliamp range.

6.4 Limitations

Magnetic field levels are influence by source Class I, II or III and can differ from point to point and over time particularly as motor or heating loads turn on and off. Slight changes in the meter position can lead to fluctuations in the measurement values. For evaluation of mitigation techniques, use the same range, instrumentation, procedure and location.

Magnetic fields fluctuate with system load, which changes during a single day, weekday versus weekend, and of course with the variability of electrical devices used during the month. As such, readings can only be used to evaluate the situation at the time of the measurement. For critical situations, long-term data logging is necessary, or at the least repetitive measurement different times and on different days.

7 Radio Frequency / Microwave / High Frequency Fields (RF, MW, HF)

7.1 Equipment and Supplies

The total power density of RF radiation (HF radiation) or electromagnetic waves are detected with sensitive electronics using frequency tuned antennas or with frequency spectrum analyzers. Spectrum analyzers have the advantage of further identifying the sources based on their frequency.

Depending on the testing situation and testing equipment various units of measure are in use; however, it is usually only necessary to report in one system of units.

- Watt per Square meter (W/m2) for the power density (also called radiation density)
- Volt per Meter (V/m) - for the electric field strength

[11] See page 6 Reference Publications.

- Ampere per Meter (A/m) - for the magnetic field strength or Volt (V) for the antenna voltage
- E (V/m) = √3.77N where N is power density in µW/ cm2) [conversion of power density to electric field strength for far field]

In this standard we use µW/m² because the advisable level of radiation is so low that µW/cm² units become cumbersome to use. And they appear to understate the risk for the general public as the numbers seem to be so tiny.

Any instrument used must be capable of detecting both the full power and the pulsed (modulated) signals. Equipment must have a peak hold option. The frequency range of the device shall cover 30MHz to as high as possible, preferably at least 3GHz.

Antenna selection will include both be directional and omni-directional antennas for evaluation purposes. Antenna design is extraordinarily important to provide for full signal power transfer to the meter so that readings give a realistic evaluation of the true power density.

The predominant frequencies of radio and microwaves in our everyday life range from 55 kHz (AM radio) to 10 GHz. As of 2014 there is increasing activity above 3 GHz. Our area of interest has been from about 27 MHz to 3 GHz, but it is moving quickly toward 6 to 10 GHz. Meters that cover the spectrum from 3 GHZ to 6 or 10 GHz are now available with an omni-directional antenna making it possible to assess Total Body Exposure from multiple sources coming from different directions[12]. Only equipment that meets these specifications can be used for comparative purposes. On the basis of affordability and accuracy our preferred Total Power density meters are *GigaHertz Solutions HFE59B and the HFW59D* to cover 27 MHz to 10 GHz.

7.2 Technical Background

At these frequencies the signals behave more like a beam than a wave, which means that the signals will be reflected and distorted by building materials and furnishings. In addition, the signals have polarity and phase positions that lead to complicated patterns when attempting to identify magnitudes and sources.

Slight changes within the environment can cause major changes in the power density of a specific area inside a building. The person performing the HF testing, for example, affects the exact point of the maximum value. It is quite possible to have two different readings within 24 hours at exactly the same spot or to have big differences within only inches of the first measurement. <u>The total maximum value across a locally defined space usually changes only if the HF sources change, which is why the maximum reading is used for the assessment of total HF level.</u>

Significant changes are happening in our so-called cell phone system. The cell phone system was developed for transmitting voice only communications. Voice only is information sparse. The advent of Smart Phones has turned the predominate use of the cell system to data transmission. Data transmission is information dense. Carrying all this info density has requires new modulation, transmission and demodulation standards with increased band width.

<u>Power Density Measurement of New Wide Bandwidth Transmission Technologies</u>

[12] Currently, separate instruments are required to cover the range 3 GHz to 10Ghz, e.g. GigaHertz Solutions *HFE59B* and *HFW59D*.

The older systems like **UMTS, GMS, PCT/DECT, 3G and the Wireless LAN beacon signal** have a narrower band width and their power densities can be measured and read directly with the current generation of Total RF signal evaluation meters such as the GigaHertz Solutions HFE59B.

The new generation of data rich cell services such as **LTE/4G, WiMax, DVB & wireless LAN during data transmission** all have wider bandwidths.

ALL total power density meters no matter the manufacturer cannot look at the power density across the entire wider bandwidth. This results in significant under estimation of the power density for signals that are predominantly from these new services. The bandwidth cannot be widened because this is an inherent technical limit that does not seem likely to be overcome. When an attempt is made to widen the band width measurement capability noise overpowers the ability of the electronics to provide a accurate power density reading.

This is because the modulation of these high-speed services includes high, needle-like peaks compared to the average power transmitted. Such signals are referred to as "high crest factor" signals.

Procedure for High Crest Factor Signals

When using the GigaHertz Solutions HFE59B or HFW59D measure these signals for 1 or 2 minutes (with peak hold) by slightly panning the meter pointing to the direction of the main source. For the assessment of the peak values of such signals (including the crest factors) keep the standard setting "Peak hold" and "VBW standard"[13]

For the compensation of the crest factor multiply the displayed reading by a correction factor. A flat factor of 10 offers a good approximation[14]

Often you will find different telecommunication services being present at the same time. With the help of the audio analysis[15], you will be able to estimate how much of the total value shown is caused by such high crest factor signals.

Depending on the proportion of high crest factor signals to the total signal, please apply the following "rules of thumb":

- Slightly audible portion of "high crest factor signals": multiply display reading by 2.
- Approximately Fifty-fifty ratio: multiply display reading by 5.
- Dominating "high crest factor signals": multiply display reading by 10.

This adjusted measurement value can now be recorded and compared directly to the

[13] Ideally one would keep the setting "RMS", as the utilized circuitry by its nature ensures the correct dis- play of RMS values independently of the signal's crest factor. For practical reasons one can nonetheless use the convenient "Peak hold" setting, as with "VBW standard" the readings for RMS and Peak won't differ significantly for the signals in question.

[14] Even if the standards of these radio services in specify far higher crest factors, the industry strives for crest limitation for economic reasons, so that the resulting correction doesn't exceed a factor of 10.

[15] http://slt.co/Education/EMFSounds.aspx

building biology recommendations. Taking into account the multiple external factors of measurement uncertainty, this approach is perfectly adequate for an assessment of the total pollution.

The use of a frequency filter and service specific correction factors will allow an increased accuracy.[16] Such a filter is under development at this writing.

Note on the background noise level: In the combination of settings "VBW Maximum", "Range: min" *and* "Peak hold" noise threshold can sum up to a display value of 1.00 or more. In order to reach lower levels, use the preamplifier HV10 which increases sensitivity to 0.001 to 1.999 µW/m². The noise threshold is reduced to about 0.1 µW/m². For obvious reasons the use of a correction factor only makes sense for readings above the noise level.

Radar Signals Measurement Procedure

For air and sea navigation a radar antenna slowly rotates around its own axis, thereby emitting a tightly bundled "radar ray". Even with sufficient signal strength, this ray can only be detected every couple of seconds, for a few milliseconds. This requires special measurement technology.

Setting for the HFE59B or HFW59D:

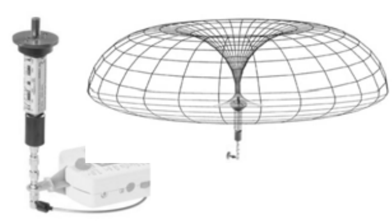
Select setting "VBW Maximum". Set signal switch to "Peak hold" and direct the LogPer antenna towards the signal emitting source. Wait for several circles of the radar ray, move the instrument left and right in order to locate the direction of the strongest signal. Note the quantitative measurement value.

If the location of the radar station is unknown it is particularly convenient to use the isotropic UBB27 antenna. However, the trade-off is no information of the direction. The long delays between pulses may consume a great deal of time trying to detect signal direction with a LogPer aerial.

Please note that there are radar systems that are operated at even higher frequencies than can be measured with these instruments.

7.3 General Procedures for Measurement of High Frequency readings

Measurement of *Power Density* level for determining Total Body Exposure is made with an omni-directional antenna with a doughnut shaped reception pattern so as to include HF energy impinging from all directions. Due



to the small physical size of the antenna's resonator (sensor tip), this type of antenna has the additional advantage to be able to identify small areas or stronger energy, which are considered to be the most relevant.

[16] For the time being with LTE a factor of 20 may still occur. For TETRA a factor of 2, for WLAN ("standby- rattling") a factor 4 is enough.

Never touch conductive materials with the antenna or get closer than one foot to conductive materials. Be aware of the limitations of indoor measurements (see Section 7.4). Use the peak hold feature of the meter to hold the peak reading for recording after the scan is completed.

<u>The maximum reading from the volume assessed represents the Total Body Exposure from the volume assessed, no matter where in the volume it is found and from which direction it comes</u>. When conducting these measurements several times, it is normal for the readings to vary significantly. The practical procedure is as follows:

- Always conduct at least three measurements, 5 are preferred – Dependent on frequency of bursts or spikes.
- If one reading is within 0.75 to 1.5 times the other, than this is a considered representative. Use the average of the two measurements to rate the area.
- If they vary more than indicated above, conduct one or more measurements to obtain a better estimate of the situation. It may happen that one erratic measurement occurred due to some intermittent event [such as a radar beam or cell phone intermittent supervisory signaling]. Ignore this, this is not unusual and is due to spikes in the system.
- Because of signal volatility, the "peak hold" signal may read off-scale, in which case, an attenuator should be used to increase the range of the meter.
- Conversely, signal amplifiers are available for some meters to extend the meter sensitivity for weaker signals.

General procedures for testing using a HF Power density Analyzer[17]:

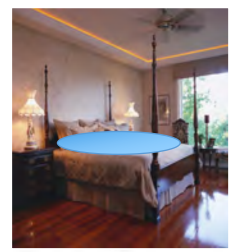
1. In order to measure HF, a certain distance must be maintained from the source. At the higher frequencies of wireless communications radiations, this is just a 3 to 4 feet.
2. For total magnitude, use a wide frequency band omni-directional antenna. The current recommended range is 30 MHz to 3 GHz. However, 30MHz to at least 6GHz[18] capability is slowly becoming necessary.
   a. Sources will vary in relation to space and time, as call loads fluctuate over a day as cell antennas are turned on and off to conserve electricity. Because of this variability, the HF readings shall be based on the "peak hold" and multiple scans of the area of interest. For best accuracy evaluations data logging should be set up to look at a 24 hour or longer period. However, measurement made during the day will likely represent full operation of the cell system as use of these phones has become so ubiquitous.
   b. Take measurements outside in all directions and orientations – measure in non-pulsed (full wave) mode and the pulsed mode. Note that in multi-story buildings, ground level readings may not be indicative of levels observed on elevated floors. External measurements in such situations can be taken from a balcony or outside of a window. Record your readings.

[17] Such as the GigaHertz Solutions HFE59B.

[18] Currently, separate instruments are required to cover the range 27MHz to 10Ghz. These instruments do not GigaHertz Solutions HFE59B and HFW59D.

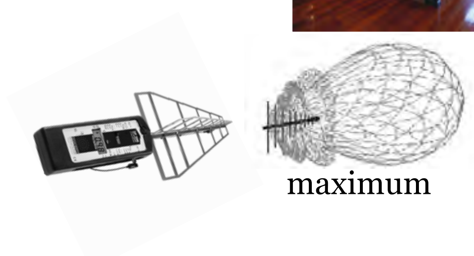
c. Determine the highest level in the area of concern for the full signal and the pulsed (modulated) signal. Use a slow scan, with the instrument set to peak hold. Walk through the entire area; measure areas of specific interest in room like the bedroom and family room.
d. The meter is to be held at arms-length and rotated through a figure 8 pattern sweeping pattern while twisting your wrist to move the antenna from horizontal through vertical and back to horizontal.
e. For best accuracy, select the most sensitive meter range without overloading the display.
f. Take minimum of three scans at each point of interest until at least two readings are in the same range. Record this.
g. Proceed with source direction identification [Section 7.3.2] and mitigation planning as necessary.

7.3.1 Measurement of Total High Frequency Fields in Sleeping Area



For assessment of HF levels in a sleeping place or bed the volume of space above the sleeping surface should be scanned. This will be an elliptical volume described by the rotation of the antenna though a figure eight pattern. The location and size of the 'volume' does not need to be exact as this only a rule of thumb.

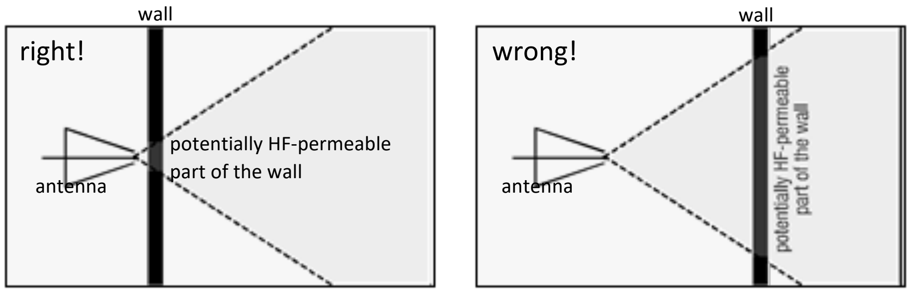
7.3.2 Source Identification & Materials Permeability



a. To identify the direction of the source, use a directional antenna in the area of local peak.
b. Hold the instrument with a slightly outstretched arm and your hand at the bottom.
c. Scan in all directions holding the antenna in a horizontal direction – be sure to turn around as well.
d. Rotate the antenna around its longitudinal axis to consider the polarization plane. Note that slight movement in a directional antenna can greatly alter the instrument readings.
e. Change the measurement spot to a different area.
f. With audio capable instruments, further help for the identification of predominant sources can be gained from the sound, as different sources produce a characteristic "sound".
g. Measure the maximum Full values using a slow scan and the instrument set to "hold."
    - Determining the dominant frequencies of full signals if you are using a Spectrum analyzer.

Be aware that sources may appear to be coming from one direction when in fact they are merely reflections of radiation entering from a different direction.

Materials Permeability: To check the permeable of structural materials position the antenna[19] close to the wall . This is done because the antenna measurement cone widens with increasing distance from the source. Reflections and cancellations inside rooms may make it difficult and often impossible to locate the “leaks” accurately. It is some



time helpful to use your own

The uncertainty of localization with HF-antenna

known source such as a router. This will make the evaluation of materials effectiveness easier and more accurate. For example, to determine if there is a RF reflecting low-e coating on the window glass and its approximate effectiveness.

7.4 Limitations

High frequency fields fluctuate with system demand, which changes over the day. The addition of new equipment at neighboring houses and to build out the 4th generation cell phone system as well as the addition of smart meters that use the cell phone system for data transmission are causing constant increases in radiation density. As such, readings can only be used to evaluate the situation at the time of the measurement. This should be stated in your report.

For critical situations, long-term data logging may be necessary, or at the least repetitive measurement different times and on different days. “Peak hold” values shall be the primary number used for evaluation, as the situation can change rapidly with time, direction of the radiation polarization and points of measurement.

Absolutely reproducible readings are usually only possible in “free field” conditions outdoors in an open field. Indoor measurements are often difficult due to the narrowness of the space and the likelihood of the influence of the built environment. Thus, it is often necessary to repeat the measurements multiple times to fully understand the patterns. All Building materials and indoor furnishings (mirrors, metal appliance cabinets) reflect, absorb and with most materials pass through a portion of the HF signal. For example, measurements near or within 1ft of a massive earthen wall may not accurately reflect the interior indoor levels away from the walls due to RF entry through windows and doors.

For evaluation of mitigation results, use the same range, instrument, location and procedure. Slight changes in the antenna position can lead to rather substantial fluctuations in the measurement values. The person taking the measurements by absorbing and reflecting RF radiation. However, for a specific spot substantial changes in the peak-hold maximum values is usually an indication of an environmental change

[19] Please note: In this position the readings on the meter only indicate relative highs and lows that cannot be interpreted in absolute terms.

such as periodic radar pulses, near-by cell phone usage, varying beacon signal strength from near-by WiFi sources.

8 Reporting

The individual performing the investigation as defined in this Protocol should provide a written report to the client. The report shall include, but is not limited to, the following information:

- Scope and purpose of assignment.
- Reference to this standard, documentation of any deviation from this standard and the reason for the deviation.
- Identification of structure(s)/area involved in a manner adequate to describe the structure(s)/area observed such that a layperson may readily identify the structure(s)/area.
- A description of all areas considered inaccessible for inspection and/or data collection and an explanation as to why they are considered inaccessible, such as the inability to remove internal sources.
- The neighborhood of structure investigated (e.g., rural, urban, suburban).
- The nature of the structure investigated (e.g., metal, brick, stucco, adobe, wood, conventional frame).
- The nature of the windows and doors (e.g., low E glass; metallic, PVC, wood frame)
- Description of any client materials or devices for lowering the EMR levels at any frequency.
- The location of the sleeping area relative to external and internal sources, and within the building.
- Location and description of potential external and internal sources that might influence the results and if evaluated, their influence.
- Specifications of instrumentation used, test configuration and duration, test methods, including suitable document photos and diagrams to enable another individual to duplicate the procedures entirely.
- Data collected (external and internal). The report shall include all relevant measurements used to rate the environment according to the *IBE Sleeping Room Standard SBM-2008C*. (See Appendix A – Data Interpretation).
- Recommendations regarding the need for remediation, if remediation is deemed necessary.
- Qualifications of investigator and other professionals who provided significant consultation on the report.

Appendix A – Data Interpretation

The levels measured should be compared against the appropriate standard to ascertain whether or not mitigation is required. As of yet, there are no acceptable industry or government acceptance standards for exposure in low-rise residential buildings. These numbers and references from different sources are provided for information only and not considered part of the standard. See Section 2 for referenced document specifics.

A.1 Extremely Low Frequency Thresholds

Frequency range: 20-180Hz

Magnetic Field

Source	Maximum mG for Residence
Switzerland	10
WHO[20] (possibly carcinogenic)	3 – 4
TACO[21]	2
EPA[22] (unpublished Report, 1990)	2
BioInitiative Report[23]	1
Building Biology for Sleeping Areas[24]	0.2
Nature	< 0.000002

Electric Field

Source	Maximum V/m for Residence
TCO	10
EPA (unpublished Report, 1990)	10
Studies: Oxidative stress, free radicals	10 - 20
Building Biology for Sleeping Areas[19]	<0.3 (floating)
Nature	< 0.0001

[20] World Health Organization
[21] Swedish Confederation of Professional Employees
[22] *Evaluation of the Potential Carcinogenicity of Electromagnetic Fields*, 1990, EPA/600/6-90/005A, (suppressed)
[23] BioInitiative.com
[24] Institute for Building Biology, Standard #SBM2008C

A.2 Microsurge Electrical pollution (MEP) Thresholds

Frequency range: >60Hz to 400kHz [some research suggests 2kHz is the lower limit, but field experience suggests that frequencies above (>) 60Hz to 2k are important too.]

	Electric Fields
Ideal threshold	**1V/m [2[25]]**
Recommended threshold	**5V/m [2] 25V/m [5]**

Information from the field through certified practicing Building Biologists suggests that people are sensitive to frequencies below 2 kHz as well. The affect apparently increases with frequency. Therefore, to be conservative, we have adopted the new term MEP which includes EMF with frequencies above 60 Hz to the limit of the meter capability. At this time that limit is 1 million Hz.

Although not formally evaluated or agreed to, certain Building Biologist have adopted a potential addition to the Building Biology Precautionary Guidelines for MEP of 1/10th the level established for ELF.

Sleeping/Critical Areas		Concern			
	Units	None	Slight	Severe	Extreme
ELF 60 Hz Field Component					
Electric	V/m	<0.3	0.3-1.5	1.5-10	> 10
Magnetic	mG	< 0.2	0.2-1	1-5	> 5

Sleeping/Critical Areas		Concern			
	Units	None	Slight	Severe	Extreme
MEP >60 Hz Field Components to 1 million Hz					
Electric	V/m	< 0.03	0.03-0.15	0.15-1	> 1
Magnetic	mG	< 0.02	0.02-0.1	0.1-0.5	>0.5

A.3 Radio or High Frequency Thresholds Limits

Frequency range: 30MHz-10GHz full spectrum power density

Source (Year)	**microWatts/m²**
US Gov't, FCC (1997), 1.5 GHz – 100GHz	10,000,000
Health Canada Safety Code 6, 1.5 GHz – 100 GHz	10,000,000
World Health Org (1998)	9,000,000
Australia (1988)	2,000,000
Russia (1988), Italy (1999), Toronto (2000)	10,000
Saltzburg, Austria (1998)	1,000
Dr. N. Cherry (NZ) (2000)	200
BioInitiative Report (2012)	100
Building Biology, *Slight Concern* (2008)	0.1 to <10
Dr. D. Klinghardt: Linked to Autism (2010)	>5
Sensitivity Threshold EHS Persons (Alasdair Philips	7

[25] See page 6 Reference Publications

A.4 Building Biology RF Precautionary Guideline

Sleeping/Critical Areas		Concern			
	Units	**None**	**Slight**	**Severe**	**Extreme**
3. Radio Frequency (RF) (Power density in microwatts per square meter.)					
Pulsed or Full	µW/m²	< 0.1	0.1-10	10-1000	> 1000

Appendix B – Mitigation

This appendix provides additional information regarding remediation or the evaluation of remediation work as determined by application of this standard to a sleeping area. This appendix is informative only and is not considered a part of the standard. Any of the procedures recommended here shall only be done by a qualified person.

B.1 Electric Field

Residential wiring systems installed since mid-1950 seldom show extreme levels of electric fields. The fields are high enough in most sleeping areas to be of concern and to require some type of intervention to reduce the effect on the individual. Electric field lines have a beginning and an end. For this reason, they can be easily shielded by means of grounded conductive materials.

Interventions: Turn off electric circuits that contribute to high electric field strength especially in a sleeping area. A Cut Off Switch and Demand Switch is commercially available for installation near the circuit breaker panel by a qualified electrician. The demand switch senses electricity demand and shut off the voltage when there is no demand. A Cut Off Switch is manually activated by a hand-held remote control in the bedroom.

Plastic jacketed cable can be replaced by use of electrical metallic tubing, Metal Clad Cable or flexible metal conduit. Unshielded device power cords can be replaced by shielded power cords.

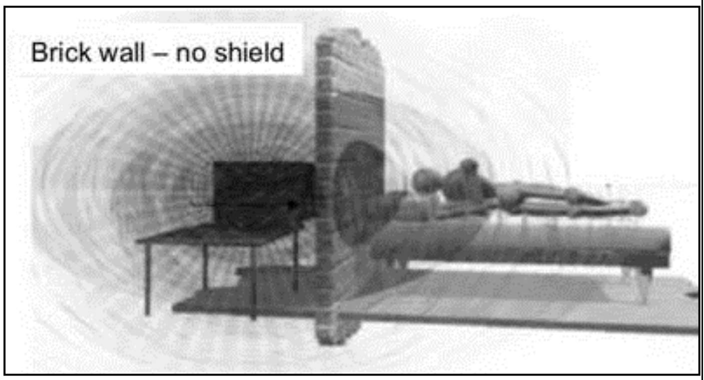
For remediation it makes sense to remove / switch off the identified sources step by step in order to find out useful combinations of removals for minimizing the exposure after remediation. During the mitigation process or at least at the end of the process of remediation, it is necessary to re-evaluate the condition at the points of interest because conditions can change in an unfavorable way.

Note that it is possible that electric or magnetic field strengths to increase even on an absolute basis when e.g. switching off circuit breakers due to field cancellation of the different branch circuits connected to the A or B leg of the typical 120/240-volt household electrical service. The goal is to create the environment with the least field exposure.

B.2 Magnetic Fields

No spot of higher pollution can be generated “somewhere in the middle of open space” due to wiring errors. Any maximum will always be close to e.g. cables with net current, pipe with unopposed current flow when current is flowing. Additionally, electronics including appliances with electronics have power supplies that likely remain on even when the device is turned off. These are point sources of intense magnetic fields.

It is most convenient to trace the source of alternating magnetic fields with a three-axis instrument. But even with a single-axis instrument, in most cases it is not necessary to measure the three axes separately as the direction of the highest reading can be located easily by holding the instrument in the same position and moving in the direction of increasing readings to locate the source of emission.



Magnetic fields permeate most materials unhindered, which is why they are so difficult to shield. Mitigation: Unplug the source device. Keep a distance of at least 2m (6ft) from internal sources. For external distribution transformers, stay at least 10m (30ft), and from transmission lines 400-800m (0.25 to 0.5 miles). Fix building wiring errors or at least de-energize the problem circuits while sleeping.

Shielding of magnetic fields is a complex task and often cost-prohibitive, though using an alloy with high magnetic permeability, shielding to induce counter-currents, and active shielding may be possible [3].

Note: If the gradients of the magnetic field in a room or house are relatively small, yet there is a relatively high basic reading and the field direction is nearly vertical, the source of the field is usually outside the house (e.g. power line etc.).

If there is a relatively-high base reading when the main power is off, parallel neutral current from outside may be the reason for the high base readings (Nearby power lines could also be a source.) These require professional assistance by an electrician to be resolved as these unbalanced currents can indicate serious mistakes in the circuitry, which may under certain circumstances be a fire hazard.

B.3 MEP Mitigation

Mitigation of MEP in the electricity delivered to the build can be done with filters located at the service entrance. None of the following comments apply to filters in that location.

Removal of all internal MEP sources is desirable. However, if not feasible, then mitigation at the source is a potential approach. There are commercially available capacitor-based filters are to decrease the magnitude the electric field MEP on the hot wire. Electrically sensitive people do benefit from interior C-filters.

But be aware that a C- filter converts electric field spikes to magnetic field spikes that appear around the neutral return wire going back to the electric panel. Some may be sensitive to one or the other, or both, or neither. Although the voltage-based microsurge meters show MEP levels have been lowered, the MEP magnetic field pulses radiating from the neutral wire during transit must be considered, especially if the path includes sleeping areas.

C- filters used in a circuit with an unresolved parallel neutral path create much increased ELF magnetic fields along with MEP that will pollute the living space affected by the wiring error magnetic field. High magnetic fields produce health effects in the general population as shown by research as far back as the 1970's when the field was principally ELF. This condition may affect more sensitives.

The electric field frequencies that are attenuated are based on what the manufacturer thinks necessary and now are limited to about 2k to 400 kHz depending on manufacturer. Frequencies above this have been observed to affect people.

There are parallel and serial filter solutions on the market using energy dissipation methods rather than the voltage to current conversion sited above. These may address the above issue.

B.4 High Frequency or Radio Frequency Mitigation

Removing potential sources is always the starting point. For example: cordless phones and wireless routers, Game consoles like X-Box 360, and Wii. Be wary of wireless features on all satellite cable equipment starting in 2013 and avoid any entertainment system remote control capable based on RF, meaning capable of controlling components inside closed cabinets and from remote locations.

Avoid 2.4 and 5.8 GHz digital baby monitors. Hard-wired monitors run through the local area network over Ethernet cables are available. Use corded external keyboard and mouse with desktop computer and laptops, Move the bed to an undisturbed zone is a possibility. Shielding specific rooms is a good solution. A variety of materials are available.

Window glass is transparent to RF. RF reflecting window film is available. Double (and triple) pane **Low-e** windows with metal coating reflect RF. These are required by energy codes since the 90's in most areas. There is a demand for low-e glass (2010) that does not block RF. Be sure to test existing glass for efficacy.

B.5 Post Remediation Testing

Following remediation, measurements should be taken using the same procedures and configurations as the initial testing. Note that both magnetic fields and high frequency fields will vary significantly based on system load, so prudence should be used when comparing before and after results.

END

Magnetic Field Assessment & Interpretation

V12

Building Biology Institute

Magnetic Field Assessment & Data Interpretation_v12.1

I. Collect Data: Electrical Features & AC Magnetic Fields

A. Survey Property

1. Measure/record representative outdoor ambient ac magnetic field. Be aware of outside sources (power lines, buried sources, etc.) (Four corners of house. Note things of interest.)
2. Note on lot plan locations of external electrical features:
   a) Distribution, transmission lines, step-down transformer
   b) Electrical equipment on or near the wall of the house (hot tubs, pools, fountains, transformers, irrigation timer motors, air conditioner units, etc.)
   c) Utility entrances:
      (1) Electric service entrance- meter (smart?); main panel
      (2) Coaxial cable/fiber optic cable
      (3) Legacy phone line & Interface box
      (4) Water & gas service entrances & meters (smart?)

B. **Loads On** (Overhead lights and table lamps, furnace blower, fridge, others)

Note: It is difficult/time consuming to load test all receptacle circuits, so wiring errors may be missed unless an *Electrical Audit with a Qualified Electrician* from the electrical panel(s) is done: See #D below.

1. Survey house by room and floor; meter about waist level; follow *Protocol*[1] *v8.5*, Sec 6.3
2. Survey house again walking front to back ; then side to side. Note any general trends (ie. field increases front to back).
   a) Note direction of the field; vertical => outside power lines
   b) Rapid fluctuations => means local distribution line, not transmission line
   c) Slow fluctuations => transmission line
   d) Correlate with outside observations
3. Check effect of any multi-location (3-way) switches on field levels; if elevated when on, note location/tag switch.
4. Record all data by room & areas of interest (beds, play area, heavy use locations).
5. If areas are elevated over ambient, measure high as you can reach & at floor and record.
6. Measure current flow or net current on
   a) Electric Service Drop, if accessible. *{Also, verify that current flows on neutral, if accessible}*.
   b) Metallic water supply pipe at service entry.
      (1) Before bonding clamp where water pipe comes into home
      (2) Wire from bonding clamp back to panel

   c) Gas supply pipe at exit from gas meter.
   d) Coax cable where it enters grounding block
      (1) Before cable grounding block
      (2) After grounding block
      (3) Wire from block to electrical ground

[1] EMR Measurement in Low Rise Blgs_v8.5

e) Legacy phone cable at entry to interface box (Only if service is buried)Other possibilities: well pump casings (rural locations), system grounded conductor to grounded electrode (rod) or water pipe or Ufer ground, ground via pool concrete & rebar when pool has 120-V pool light. Often rebar in entire pool apron is bonded to electrical ground.

7. Bed Magnetic Field Measurement
    a) Measure bed sleeping surface at 9 points per BBI Protocol[1], Section 6.3.1
    b) Excessive fields will be addressed by parallel neutral &/or internal wiring error mitigation unless:
        (1) Excessive fields from outdoor overhead or underground power lines (no fix).
        (2) Excessive fields are from point sources under mattress/near bed. Check for:
            (a) Electric or electronic bed controls.
            (b) Point sources: under bed; under floor; behind wall.

C. **Loads off** by turning off main breaker

1. Client to power down all computers first. Switch off or unplug all power strips/surge protectors for office equipment and TVs/entertainment centers.
2. Re-survey house; meter waist level; follow BBI Protocol[1] v8.5, Sec 6.3
3. Re-survey the home, if possible, moving front to back and side to side; Note any general trends (ie. field increases front to back) & compare to B2.
4. Record all data by room & areas of interest measuring at same locations as in B.
5. If areas are elevated over ambient, measure high & floor and record
6. Measure current flow/net current on
    a) Electric Service Drop, if accessible
    b) Metallic water supply pipe at entry to house
        (1) Before bonding clamp where water pipe comes into home
        (2) Wire from clamp back to panel
    c) Gas supply pipe at exit from gas meter.
    d) Coax cable where it enters grounding block
        (1) Before cable grounding block
        (2) After grounding block
        (3) Wire from block to electrical ground

    e) Legacy phone cable at entry to interface box (Only if service is buried).
    f) Other possibilities: well pump casings (rural locations), system grounded conductor to grounded electrode (rod) or water pipe or Ufer ground, ground via pool concrete & rebar when pool has 120-V pool light. Often rebar in entire pool apron is bonded to electrical ground.

Note: Sometimes significant variation in utility neutral current flow from moment to moment can frustrate ability to see if the current is influenced by internal wiring errors. Block parallel neutral current on water supply pipe or coax cable before internal wiring errors are located and fixed. **For safety** follow the specific procedure[2].

7. Bed Magnetic Field Measurement with mitigated condition(s) in place
   a) Re-measure bed sleeping surface at 9 points per BBI Protocol[3] Section 6.3.1
   b) This is what to expect when excessive fields are addressed by mitigation and/or point source removal.
      (1) Elevated fields from utility parallel neutral paths cannot be remediated on-the-spot.

[2] Student Folder > Gust's Templates & Docs > **Dielectric Section Installation** or **Dielectric Union 2 Installation**

[3] EMR Measurement in Low Rise Blgs_v8.5

D. Electrical Audit with Electrician (by *EMF Aware*)

EMF AWARE

MEP = Main Electrical Panel or Service Disconnect
Gnd = Ground
N = Neutral
N-N = Neutral to Neutral wire error between branch circuits
N-G = Neutral to Ground wire error in branch circuits
H-H = Hot to Hot wire erros between branch circuits

Electrical Panel Audit With Electrician V6

Removing the cover of an electrical panel exposes live electrical components which can cause fatal shocks and electrocution. All electrical work MUST be perform by a licenced electrician with the proper safety precautions. ***This document is provided as information only so use at your own risk.***

Step 1. Turn Off Main Breaker + All Circuit Breakers, Visually Inspect

Creates N-G Wiring Errors	MEP	Sub A	Sub B	Sub C	Sub D
Bonding Screw / Bonding Strap					
Non Insulated N Bus					
Equip. Gnd Conductors on N Bus					
N Conductors on Gnd Bus					

Good | Ok - Not Best Practice | Fix N-G Error

Step 2. Isolate Sub Panels

a. Make sure all breakers are off at all panels.
b. At MEP, disconnect feeder neutral and ground conductors to sub panels (and main disconnect if one exists).

Fix N-G Errors in step 1 before continuing.

Step 3. Determine Type of Panel Under Test

MEP c/w N and Gnd Bus + N-G bonding screw/strap removed + N Bus is insulated Sub Panel	MEP c/w shared N & Gnd Bus or non insulated N Bus or Bonding screw/strap can not be removed.

Step 4. Test A1 — Id Branch Circuits With Wiring Errors

Step 4. Test A2 — Id Branch Circuits With Wiring Errors

Take each neutral conductor one at a time off the neutral bus, test continuity to N Bus and Gnd Bus, and screw lifted neutral back to bus before going to the next neutral.

Test A1

Branch Neutral Continuity Test: Lifted N To Ground Bus Continuity	Lifted N To Neutral Bus Continuity	Continuity Test Interpretation: N-G Wire Error	N-N Wire Error	Tag and Label N Conductor
No	No	No	No	
Yes	No	Yes	No	N-G
No	Yes	No	Yes	N-N
Yes	Yes	Maybe	Yes	N-N + Maybe N-G

This step ids all branch circuits with N-N or N-G errors.
"N-N + Maybe N-G" label = One or more branches in the N-N group has a N-G error as well.

Test A2

Branch Neutral Continuity Test: Lifted N To Ground Bus Continuity	Lifted N To Neutral Bus Continuity	Continuity Test Interpretation: N-G Wire Error	N-N Wire Error	Tag and Label N Conductor
No	No	No	No	
Yes	No	[illegible]		
No	Yes			
Yes	Yes	Maybe	Maybe	Error

This step ids all branch circuit with a N-N or N-G error.
Error = N-N and/or N-G types exist on branch circuit.

Step 5. Test B1 - Find N-N Groups

Test continuity of each labelled "N-N" or "N-N + Maybe N-G" with each other and tape N-N groups together.

Example 1: Branch 2 neutral has continuity with Branch 4 neutral. Tape Branch 2 and 4 neutrals together and label N-N.

Step 5. Test B2: Find N-N Groups

Test continuity of each labelled "Error" conductors with each other. Tape N-N groups together.

Any Error conductors not in a N-N group will have N-G errors only. Label these conductors as "N-G".

Example 2: Branch 8 neutral has continuity with Branch 10. Tape Branch 8, 10 together and label N-N.

Step 6. Fix All N-N Groups Errors and Repeat Test A and Test B on all tagged N Conductors.

Once all N-N errors have been fixed all that will remain are N-G errors.

Step 7. Fix N-G Errors

Fix N-G Errors and repeat step Test A on all tagged N conductors to verify all errors have been fixed.

Step 8. Check and Fix H-H Errors

With all breakers off check continuity between hots at breaker terminals. No need unscrew and lift hot wires.

Step 9. Check Sub Panel Feeder Cable For N-N and N-G Errors

Check continuity from Feeder cable neutral to MEP N Bus. If continuity fix N-N Error.
Check continuity from Feeder Cable Ground to MEP N Bus. If continuity fix N-G error.

Step 10. Reconnect sub panels neural and ground feeder conductors at MEP and an ensure bonding strap / screws are in place according to code. Energize circuits.

hello@emfaware.ca emfaware.ca 403-264-2970

Magnetic Field Assessment & Data Interpretation_v12.1

II. **Characteristics of M Fields** from various Sources

A. Point Sources like an Appliance (Locate and Fix)

1. Greatly reduced M-Field when a device close to highest reading is unplugged (could be directly in the room or beside/above/below the highest reading point)
2. M-field does not change as loads are turned on in the home.
3. Greatly reduced M-field when mains are off.

B. Transmission Line and Distribution Lines (No Fix)

1. Still present with Mains off and M-Field in Vertical orientation
2. Field increases side to side or back to front of house and property;
3. Field fluctuations independent of home electrical loads, and fluctuation is:
   a) <u>Slow</u> for Transmission Lines
   b) <u>Rapid</u> for Distribution Lines
      (1) Only hope of fix is if utility can locate and repair broken utility service neutral—see item D.
4. Field may peak at peak power in homes throughout neighborhood (~6 pm)

C. Utility Parallel Neutral Current or Broken Service Neutral Path M- Field

1. Identified with Mains off
   a) Suspect open service neutral if significant parallel neutral current is present on parallel paths (metal water service pipe and/or coax cable) with loads on. There will also be no parallel neutral current with mains off.
2. Current on parallel neutral paths and M-Field will change (increase or decrease) with load changes in the home AND with external load changes at transformer (neighbors) (parallel paths are only path for return current to flow to neighborhood transformer in house with broken service neutral)
3. Field may peak at peak power (~6 pm)
4. There is always current on parallel paths. Amount of current is dependent on quality of service drop neutral connection *(corroded or broken neutrals).

D. Wiring Errors Internal to The Home (Locate and Fix)

1. M-Field not Present with Mains off
2. Changes as load change on those circuit(s) with wiring errors.
3. Does not change when electrical load changes in the home on correctly wired circuits.
4. Does not change when electrical load changes in neighborhood.

III. **Data Interpretation** of AC Magnetic Field Assessment Data

A. Point Source / Appliance Test
1. Unplug device(s) near the highest reading (could be directly in the room or beside/above/below the highest reading)

B. External Sources Test
1. Mains off and indoor Field increases side to side or back to front; Vertical orientation
   a) Rapid fluctuation => local distribution system **No Fix** **or**
   b) Mostly uniform => power transmission line **No Fix**
2. Mains off and indoor Fields above ambient.
   a) Check for external point sources **Can't fix**
   b) Check for parallel path for utility neutral
3. Mains off and indoor Field at outdoor Ambient **Proceed to #C**

C. Magnetic field testing with loads on versus mains off

1. No Change in field levels & field at ambient **No Issues Detected. Only way to be sure that NO internal wiring errors exist is a Panel Electrical Audit– with Electrician.**

2. Increase with loads on; Ambient level with loads off, means
   a) Internal wiring errors; N-N; N-G; multi-location switch **Locate & fix** **or**
   b) (rare) Suspect open or poor service neutral if significant parallel neutral path current is present with loads on and no parallel neutral current with mains off. **Call Utility to fix. Recheck parallel neutral current after fix**

3. Increase with loads on; changes with mains off, but is not at ambient, means
   a) Internal wiring error: N-N; N-G; multi-location switch **Locate & fix** **AND/OR**
   b) Utility parallel neutral current paths.

4. Increase with loads on; Ambient level with loads off, But parallel neutral current exists, means
   a) Parallel neutral current not affecting areas measured **Reassess consequences**
   b) If of no consequences **no action**

5. Mains on; Parallel neutral currents summed up are several amps, means
   a) Poor utility neutral connection **Call Utility 1st to fix**
   b) Broken utility neutral connection **Call Utility1st to fix**
   c) Diagnosis and actions for a) & b) are supported by measuring several net amps on service drop, which increases when you turn on test load, such as hair dryer.

V1.0

Body Voltage Measurement Protocol

Building Biology Institute

Body Voltage Measurement Protocol

One procedure known as the *Body Voltage* (BV) measurement was developed and used by Building Biologists who are trying to determine sources of Electric Fields and what can be done to mitigate them. The Body Voltage measurement procedure is only an indication of Electric Field exposure; it is not a direct measurement of the Electric Fields. However, it is good demonstration tool about how the body is affected when exposed to high electric fields. This method is not recognized outside of the Building Biology community.

This procedure consists of taking the voltage reading between a person and a dedicated earth - rod driven into the earth or other earthed source. The practice is to concentrate on the sleeping and possibly office areas and to eliminate the electric field sources. The recommended voltmeter has a 10 megaohm (MΩ) input resistance and less than 100 picofarad (pF) input impedances. For measurements taken with the voltmeter compared to an electric field measurement, the following rule of thumb applies for an "average" adult:

- 1 V body voltage corresponds approximately to an electric field of 10 – 15 V/m at 120-Volts and 20 – 30 V/m at 240-Volts.

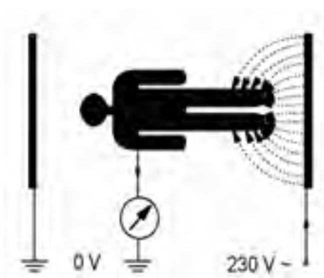


Figure 1 Body Voltage Measurement

Use an AC voltmeter to measure the voltage between a person (or surrogate) located within the electric field and a rod pushed into *moist* soil that serves as the reference point. The electrical system ground found at then 3rd hole of a north American electrical outlet is another convenient reference point. However, bear in mind that the meter reading will be missing the voltage typically found between electrical ground and the Earth. This is typically 100 to 500 mV.

Figure 1: Electric field lines from an electric field source going to the body - from the body via the hand probe to the meter from the meter to the Earth.

Body Voltage Explanation for Clients

By Lawrence Gust

1. At this point there is over 30 years of research and scientific observation by Building Biologists and doctors in Germany and the US. This work has shown that pollution in the home can have significant implications for people who are ill and not responding to treatment and by extension to the health of every individual.
2. When inspections were made of homes at the request of doctors, the Building Biologists found that 90% of the time the trail led to the sleeping area and that 90% of the time the major pollutant in the sleeping area was the excessive man-made AC electric fields.
3. When these fields were reduced or eliminated, most patients responded to treatment and recovered. For patients with well spouses, the spouses often reported that they also saw beneficial changes in soundness of sleep and how they felt during the day. Our work associates high fields with sleep disturbance, increased allergy response, muscle pain, daytime tiredness, daytime irritability and childhood bedwetting.
4. This should not be surprising. AC fields are wholly unnatural and did not exist in the human environment until the late 1800s. Recently, research has focused on electric fields and cancer. Before this, the focus was exclusively on AC magnetic fields. AC electric fields were found to be strongly associated with increased cancer risk – much more strongly than magnetic fields.[1]
5. Electricity powering our homes produces both alternating magnetic and electric fields. These together are termed AC electromagnetic fields or EMF. **Magnetic** fields are present when currents to power appliances and lights. More often than not, magnetic fields are not a sleeping place problem since most everything is shut off at night. However, **Electric** fields are present at all times and are produced by the wiring in the walls, floors and ceilings, wiring to appliances, etc. Most people cannot directly sense such fields so measurements must be made.
6. We can identify electric field exposure by using an indirect measurement. This is the AC voltage produced on a person's body by the electric field. This is called Body Voltage. Together – and I will need your full time help with this – we will be going through your sleeping areas measuring body voltage. You will be the surrogate whose body voltage will be measured while you are in the sleeping position. We will rate your situation as to biological risk using the standards developed from our 30 years of experience (show standards). Then I will determine how to reduce your body voltage to the lowest possible level.
7. In most cases we find that certain non-essential circuits must be turned off ONLY at night when you are sleeping. Normally, these circuits are not the ones powering refrigerators, freezers, or heating and air-conditioning.
8. If you become convinced that this is important, do you think it would be possible for you to sleep with the power to these non-essential circuit turned off? (It may be best to defer handling objections until after the actual demonstration in the sleeping area.)

Testing in the Home Environment

There are biological differences between sleeping area situations and daytime activities, such as the office situation. The body is more vulnerable at night to Electromagnetic Exposure due to the pineal/gland Melatonin circadian rhythm mechanism, and the fact that the body is seeking to recuperate from all stress during sleep. This means that the design goal for field exposure mitigation is stricter for the sleeping area. This is particularly true for people in weakened health condition, such as impaired immune system or **Multiple Chemical Sensitivity** (MCS).
When a house is properly wired **Figure 2**, it can be relatively straightforward to reduce body voltage in a bedroom.

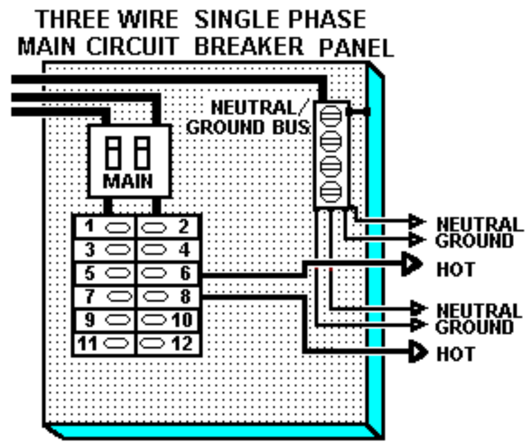


Figure 2 - Main Breaker Panel

Procedure

1. Explain and demonstrate to the client.
   a. What Body Voltage is (to identify the sources of Electric Fields)
   b. What the typical sources are (lamps and appliances, building wiring, power lines)
   c. Electrical fields and the biological impact
   d. What the measurement techniques are (voltage between a person and a driven earth rod)
   e. What the reduction techniques are (shut off, distance, shielded cords)
2. If the circuit breakers are not identified, number the breakers. Odd number on the left column of breakers and even numbers on the right column.
3. Insert the earth rod and test the earthing circuit.
   a. Using a Current clamp meter:
      i. Connect the earth rod to the outlet ground.
      ii. Measure the current with the clamp-on ammeter.
      iii. You will likely need to wrap the wire around the clamp-on ammeter 10 times in the wire in order to measure the small current.
      iv. For confirmation, disconnect from the plug and observe the current reduction.
   b. Using a BuzzStick
      i. Connect the earth rod to the outlet ground.

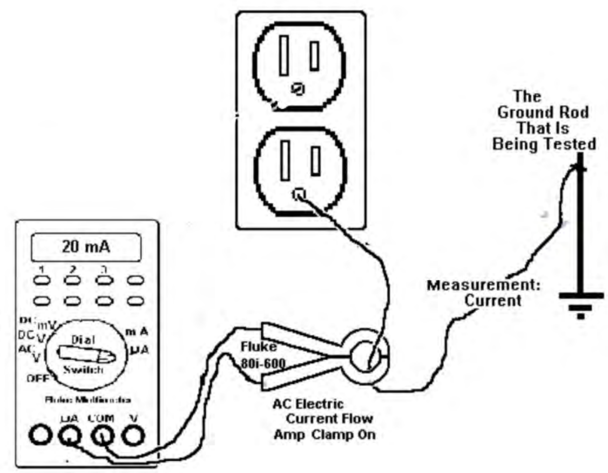


Figure 3 - Checking Good Earth Connection

ii. You will need ten turns of wire to increase the sensitivity of the Buzz Stick. Place the coil of wire around the tip of the Stick.
iii. A buzz indicates current and your setup is good.
iv. Unplug the connection to the outlet. There must be an audible reduction in the buzzing.

4. Generally, it is the power cords to electrical devices that emit the field. Turning the devices on will not likely increase the field levels or body voltage. The exception to this is the switches that power wires to ceiling, wall light or outlets.
5. **Set up** the test equipment (earthing rod, person, voltmeter). The test subject should lie on the bed where they sleep and hold the handgrip (**Figure 4**).

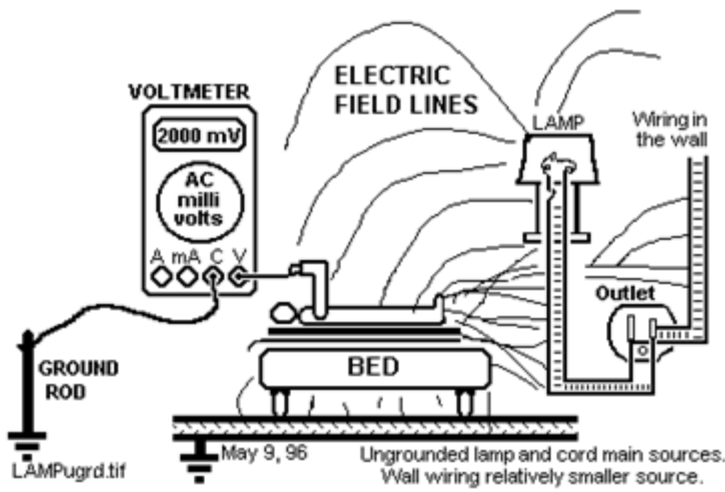


Figure 4 - Body Voltage Testing

6. Use a voltmeter to measure the AC voltage between the subject holding the hand electrode connected to the AC Voltage input of the meter and the designated test earth rod (COM input). Record this as the starting level.
7. Repeat after **Unplugging** lamps, appliances. If there is still BV above the ideal level, then the dominant source is wiring in the wall.
8. Demonstrate any changes to the homeowner. Is the BV less than 10mV?
9. **Shut off all of the circuit breakers** [A walkie talkie may facilitate this procedure.]
10. Measure the Body Voltage. Record this is as the baseline.
11. Is it below 10mV? If not, then there is a small electric field being produced by the small voltage found on the neutral and ground wiring due to utility issues. (**IBE 312**).
12. **Turn on one circuit ONLY.** Measure the Body Voltage. Record the circuit and the voltage. Does this circuit have a large impact?
13. **Turn off the first circuit breaker**, and turn on another circuit. Measure the Body Voltage and record the circuit and voltage. Evaluate the impact of this circuit.
14. **Repeat** Steps 12 and 13 for all of the circuits.
15. The final reading should be made when **ONLY** the circuits that have an important impact are off.
    a. Try turning on and off circuits that only have a small impact to determine the least numbers of circuits than need to be de-energized. You may need to be more stringent depending on the client's EMF sensistivity.

An unexpected thing can happen during BV tests - the voltage goes up when a circuit is turned off. This occurs due to field cancellation from circuits that are powered from opposite legs of the power supply.

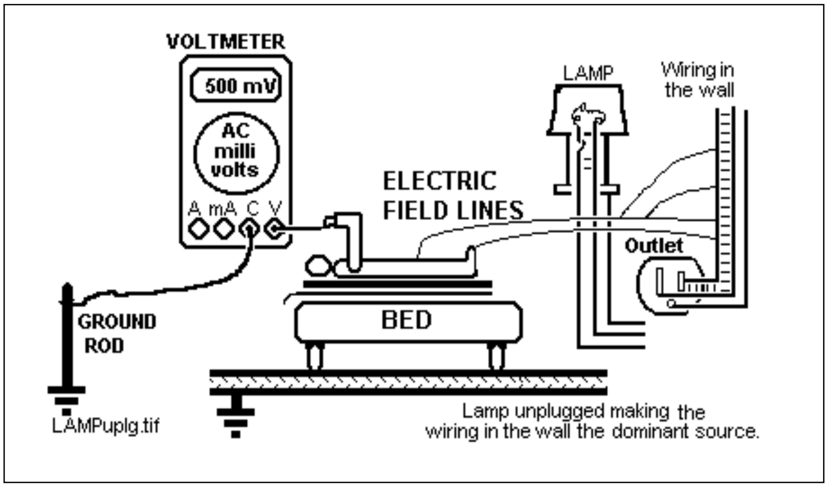


Figure 5 - Unexpected Rise in Body

Apartments, Condos, Dorms

In apartment buildings the earth will not be available from the upper stories. Therefore, the only choice is to connect the ground wire to the electrical system ground via the wall outlet. This reference point will not account for the small voltage on the grounding system and the meter will read lower than if connected directly to the earth. If it is not possible to turn-off circuits, mitigation is usually done by moving bed away from sources and by unplugging extension cords and power cords around the bed.

Body Voltage Typical Levels and Sources

These are typical numbers for the case when:

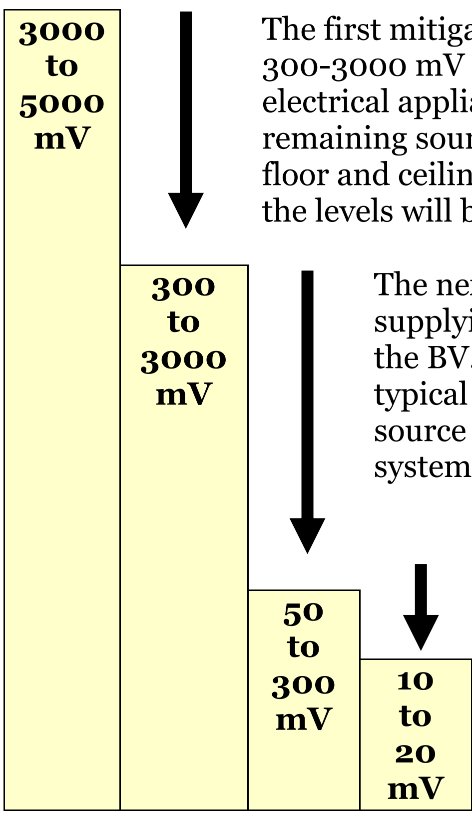
1. External power lines are not a contributing source, and
   - It is a single-family residence (so the whole building can be shut off), and
   - The wiring in the walls is plastic jacketed. Metal conduit or metal-clad (MC) cable would contain the electric field within the metal walls because the metal is connected to electrical ground.

The initial Body Voltage is typically in the 3000 to 5000 millivolts range. The usual main sources are two wire cord (ungrounded) appliances in the room, such as lamps and clocks. Installing a three-wire cord with a ground wire to the appliance will eliminate the frame's contribution, but it is necessary to use a shielded three-wire cord to eliminate the cord itself as a source. A much higher level would be seen if there is an electric blanket or waterbed heater with reverse polarity. In that case, 20-60 Volts (20,000-60,000 mV) have been measured.

The first mitigation is to unplug all appliances in the room. A 300-3000 mV level of Body Voltage is typical after all of the electrical appliances in the room are unplugged. The common remaining source is the Hot conductor of the wiring in the wall, floor and ceiling. If the wiring is old style knob and tube, then the levels will be higher.

The next mitigation is to shut off the circuit breakers supplying cables in the walls, floor and ceiling that affect the BV. A remaining 50-300mV level of Body Voltage is typical after these circuit breakers are off. The normal source of these remaining fields is from the grounding system.

The next mitigation is installing a field shield, which would only be done for people with extreme sensitivity and by **an EMRS**, a person who has successfully completing **BBI 312**.



V2.0

MEP Measurement & Reduction Procedure

Building Biology Institute

Advanced Techniques for Reducing and Minimizing MEP – Dirty Electricity

8.19.20, William Cadwallader, EMRS

Background: Why has MEP Increased Exponentially in the Last 5 Years?

- LED Lights – Normally large sources of MEP – Dirty Electricity and Blue Light
    - Mandated by California 2020
    - California now bans almost all incandescent and screw-in incandescent halogen bulbs

- Electronics with WiFi, Wireless, Bluetooth
    - A telecommunications executive bragged that he had over 60 Smart/Wireless devices in his home at the largest cell phone conference in the U.S. These devices cause MEP – Dirty Electricity when they are plugged in.

- Smart Devices in homes
    - Estimate to be over 40 Billion Smart devices by 2026.

- Increase Solar Energy use in homes and by Utilities
    - Since 2008, there are 35 times more solar installations in the U.S. than in 2008.
    - California now mandates any new home construction must have rooftop solar which started in 2020

- Variable Speed Motors - Air Conditioning and Heating Systems
    - Builders are now installing and replacing motors with variable speed motors and compressors

- Variable Speed Motors Pool Pumps
    - The California Pool Pump Law of 2018 now requires all new and replacement pool pumps to have a variable speed motor.

- MEP – Dirty Electricity is now inescapable and increases every single year. Neighbors and Electrical Utilities are now pumping MEP – Dirty Electricity from the outside into the home to the already high levels created internally in a home.

- Remember, most of the time, when devices save energy, they are increasing the radiation for you and your family in your home

General Solutions to MEP

- Unplug electronics whenever possible.
- Turn Dimmers OFF or remove dimmers
- No CFL, fluorescent, halogen (without a screw-in base) or LED light bulbs.
- Increase Distance from sources of MEP 6 to 8 feet.
- Plug-in filters can lower MEP radiation from electric cables. Better for tighter budget.
- Use both a Greenwave meter and a Stetzer meter to measure.
- MEP is the only type of EMF that can be remediated by the use of filters.
- The filters actually deal with the High Frequency Voltage Transients and Harmonics or MEP (Microsurge Electrical Pollution).
- The filters plug into your electrical outlets.
- There are several different types of filters that are used.
- Greenwave filters and Stetzer filters are both effective in lowering MEP – Dirty Electricity.
- They are portable, so they can be taken when you travel to a hotel or move to a new home.
- And they last more than 20 years.

Steps to Select the Best Plug-in MEP Filter

- Test the MEP as the last step in an EMF Audit and Remediation after remediating Electric Fields, Magnetic Fields, and WiFi / Wireless / Bluetooth – RF.
- MEP is the only type of EMR that can be remediated by plug-in filters or whole-house filters.
- Keeping in mind the client's needs in the home, you want to first remediate or eliminate anything possible in the home that produces MEP.
- Clients will tell you what they can live with and what they can live without.
- Try to present Good, Better or Best solutions to the client for remediation.
- So when a client wants to keep a MEP – Dirty Electricity device, offer a way of cutting the power to that device when the device is not being used.

Equipment Needed

- It is important to have both Greenwave and Stetzer meters because they measure MEP – Dirty Electricity differently and measure a different set of frequencies. By using both meters, you will be measuring all the types of MEP – Dirty Electricity in your client's environment

1 - Greenwave EMI (Dirty Electricity) Meter – $115 or Free if you have registered IBE 212 or IBE 312. Contact

Greenwave customer support to have a free Greenwave Meter shipped to you.

2 - Stetzerizer Microsurge Meter – $99

3 - NFA1000 or Gauss meter like the ME3030B

4- Grounded Extension Cord with 3 grounded outlets at the end – $14.

5- Basic Receptacle or Circuit Tester - $10

6- 3-Outlet Adapter or 3-Prong Power Splitter – $4 – Plug both meters into the left and right end and the receptacle or circuit tester into the middle and then the 3-outlet adapter into the end of the extension cord above. This way when you plug in the extension cord, you can view the readings on both meters and the receptacle or circuit tester at the same time.

7- Plug-in MEP – Dirty Electricity Filters – Complete list below. The more filters you use for this 5-minute test, the best chance you have in selecting the right filter for your client.

- Stetzer filter

- Greenwave 2500i
- Greenwave 1500G
- Greenwave 2500I (3P)
- Greenwave 2500i (2P)

8- Use power strips only – no surge suppressor power strips – Utilitech 6-Outlet White Power Strip – $4 – is a good power strip and have a quantity of at least 5 or more for remediation.

Used in the section on **Steps to reduce Stubborn MEP**

9- 3-Prong Outlet Wall Tap Adapter, Grounded – Various Types – to add more than one MEP – Dirty Electricity Filters into a single outlet. Some samples are below have a quantity of at least 5 or more for remediation. Sometimes a power strip reduces the MEP – Dirty

Electricity best and sometimes a 3-Prong Outlet Wall Adapter works the best at reducing the most MEP – Dirty Electricity.

Since filters are different sizes, carry the adaptors that can work with all the sizes of filters.

These are used in the section on **Steps to reduce Stubborn MEP.**

Steps for the Kitchen Test

- If there are already MEP – Dirty Electricity filters in the home, please unplug all of the filters before proceeding.
- If they have whole-house filter(s), please turn off the breaker that they are wired in to or unplug the whole-house filters.
- We want an electrical system with no installed MEP – Dirty Electricity filters before you do this 5-minute test.
- Before you plug in any filter, go to the kitchen.
- Determine which outlet that is above the kitchen counter that has the most MEP – Dirty Electricity in the kitchen.
- It is very important to use these outlets in the kitchen because they are physically located higher than most of the outlets in the home
- Kitchen outlets are normally at the height of one’s torso, and consequently the client has a better response to this MEP – Dirty Electricity filter test.
- Plug in both the Greenwave and Stetzer MEP – Dirty Electricity meters and the receptacle or circuit tester in the 3-outlet grounding adaptor which is plugged into one outlet at the end of an extension cord.
- Use the other 2 outlets on the extension cord to plug in MEP – Dirty Electricity filters during remediation.
- Make sure the outlet is free of basic wiring errors by viewing the lights on the receptacle or circuit tester plugged into the extension cord.
- If there are wiring errors, do not use that outlet or any other outlet with wiring errors to plug in MEP – Dirty Electricity filters for this test or for the remediation of the entire home.
- Verify the MEP – Dirty Electricity levels on both the Greenwave and Stetzer meters and make a note of both levels.
- Take the NFA1000 or another gauss meter and measure the current magnetic radiation at least two feet from the filters in the room where someone would normally sit, stand or sleep. Please note what this magnetic radiation number is also.
- Unplug both the Greenwave meter and the Stetzer meters, and receptacle or circuit tester from that outlet.
- We want to use exactly the same outlet that the meters and receptacle or circuit tester were plugged into for the filter test.

- Tell the client you want to find the best filter for them personally.
- If one client is more electromagnetic sensitive, use that client for the test.
- You can use more than one client for the test since it only takes about 5 minutes.
- Have your client's back toward the kitchen counter outlet and see how they feel with their eyes shut without any MEP – Dirty Electricity filters in the home.
- Have your client's back toward the counter and have them close their eyes again and plug in a filter, in the same outlet that the meters and receptacle or circuit tester were plugged into and see how they feel.
- Wait about 5 to 15 seconds which enables the client to feel the full effect of the filter plugged in.
- Do this exercise with each of the MEP – Dirty Electricity filters you have – until you have found the best filter for the client.
- Below is a list of the 5 basic plug-in MEP – Dirty Electricity filters you can use. Use all 5 of the filters to see which one is best for the client – if you have them available.
    - Stetzer filter,
    - Greenwave 2500i
    - Greenwave 1500G
    - Greenwave 2500I (3P)
    - Greenwave 2500i (2P)
- From about half of the clients you should get a positive or a negative response after a filter is plugged in. These tend to be clients who are more electromagnetic sensitive.
- From the other half of the clients you will not get a positive or negative response – just a neutral response (no response at all).
- Use the filter which the client feels the best within the kitchen.
- If no positive or negative response happens, you can use the Greenwave or the Stetzer filters.
- Note: The following filters:
    - Greenwave 2500I (3P)
    - Greenwave 2500i (2P) and
    - Stetzer filter

  These do not shunt a small amount of MEP to the ground wire at the filter.
- If you do have that concern of shunting a very small amount of MEP to ground wire use only the Greenwave 2500I (3P), Greenwave 2500i (2P), and the Stetzer filter.
- Check with Greenwave customer support to order those particular filters. They are the same price as the other Greenwave filters – $29 and also use the Stetzer filter as part of the three filters for the kitchen test.
- Always concentrate on the client and use the best MEP – Dirty Electricity filter for them – you never know what is the best MEP filter until you try all of the filters you have available.

- Verify with the NFA1000 on magnetic or another gauss meter that the magnetic radiation did not go up significantly after a filter was plugged in – this might indicate a wiring error that the receptacle or circuit tester does not show.
- You are now ready to install the plug-in MEP – Dirty Electricity filters – but first turn back on the breaker for the whole-house filter(s) or re-plug in the whole-house filter(s) – if they have one(s) installed.
- Once the whole-house filter(s) or plug in whole-house filter(s) are back on, then you can spot filter through the home with the best plug-in filters for your client to reach the minimum levels of MEP in sleeping and non-sleeping areas.
- If you don't have whole-house filter(s) or plug in whole-house filter(s), just use the plug-in filters that the client feels the best with.
- If client resists (budgetary or convenience factor) turning off effecting circuit breakers for the bedroom you will be able to reach minimal levels of MEP in sleeping and non-sleeping areas without purchasing more expensive whole-house MEP filters.
- If you are not reaching the optimal levels of MEP in sleeping and non-sleeping areas, please see the section on **Steps to reduce Stubborn MEP – Dirty Electricity.**
- Normally in a bedroom, do not plug in filters right behind the head of the bed but normally on the sides of the bed or at the foot of the bed
- Levels that Greenwave and Stetzer use for MEP – Dirty Electricity are:
    - Less than 25 – Desirable
    - 25 to 50 – Average
    - Above 50 – Undesirable
    - For sleeping areas always try to get below 30 and non-sleeping areas always try to get below 50.
- If someone is EHS – Electromagnetic Hypersensitive, is ADHD, or is extremely compromised in their health, try to always get below 30 in all areas where you are plugging in filters.

Steps to reduce Stubborn MEP – Dirty Electricity

Sometimes MEP – Dirty Electricity is harder to reduce—especially with

- Solar panels,
- LED lights,
- Electronic devices with wireless (ie. RF, WiFi, Bluetooth, etc.)
- Swimming pool pumps with variable speed motors,
- Air conditioning and heating systems with variable speed motors – just to name a few of the MEP producing devices.

Super Stubborn MEP

After selecting the best MEP filter for your client and you are not reaching the optimal levels of MEP in sleeping and non-sleeping areas

Please use the following procedures – If you find yourself in this situation you can:

- Check to see which outlet has the highest MEP in the entire home.
- Start with that outlet in that specific room.
- If the MEP does not reduce to a reasonable level by just plugging filters into the wall outlets directly, then try a $4 power strip listed in the equipment list and plug the filters into the power strip.
  - You can get 3 or more filters in a dual outlet if you use a power strip or an electrical outlet multiplier as shown in the Equipment List.
- Sometimes at an outlet, the power strip reduces MEP the most and sometimes the electrical outlet multiplier reduces MEP the most – try each one if you have not reduced the MEP to optimal levels for sleeping and non-sleeping areas to see which technique works the best.

- Concerning the type of power strip to use, you do not need to use power strips that are surge protectors – which could interrupt the functioning of MEP.
- Some power strips reduce MEP better than others. You can use the one in your equipment list above which seems to work better than some other power strips that have been tested.
- Re-measure the outlets in that room and reduce the next highest outlet in the room with the same techniques until you reach optimal levels of MEP in sleeping and non-sleeping areas.
- After plugging into the highest MEP outlet with filters, and you have not reached optimal MEP levels, then plug in filters at the next highest outlet until the optimal levels have been reached in a room.
- Sometimes you have to try multiple outlets with different combinations of MEP filters in a room to get the optimal reduction,
- Do these techniques throughout the home and go to the next room with the next highest MEP.
- With MEP filters we do find that at certain point, when one additional MEP filter is plugged into an outlet, the MEP can go back up.
- If this happens, unplug the last filter and go to another outlet.
- Verify with the NFA1000 on magnetic or another gauss meter that the magnetic radiation did not go up significantly after a filter was plugged in – this might indicate a wiring error that the receptacle or circuit tester does not show.
- Once you install filters in a room, leave those filters plugged in as you go through the home.
- MEP filters can have a synergistic effect on reducing MEP on other breakers throughout the home.

- Levels that the manufactures use for MEP are the following:
  - Less than 25 – Desirable
  - 25 to 50 – Average
  - Above 50 – Undesirable

  Manufactures use these same levels for both the Greenwave meter and the Stetzer meter

  For sleeping areas try to get below 30 and non-sleeping areas always try to get below 50.

- Since whole-house filters are more expensive than plug-in filters and if a client is on a tighter budget, try to use the plug-in filters first to see if they will reduce the MEP levels for sleeping and non-sleeping areas to the optimum level.
- If you can't reduce the MEP with these procedures, you may need to install two plug-in filters on each electrical leg or phase at dedicated outlets wired directly to the main breaker panel.
- If this does not bring the MEP levels for sleeping and non-sleeping areas to the optimal level, then install one or two whole-house filter(s) at or close to the main breaker panel.

Can MEP filters raise magnetic fields in a home?

- MEP filters can effectively lower MEP.
- But on occasion they can raise magnetic fields over extended areas.
- This happens because of wiring errors.
- If this happens, try moving to another outlet in that room that does not raise the magnetic fields significantly.
- You can also use a Certified Electromagnetic Radiation Specialist for remediation of these wiring errors.

What happens if someone is EHS and uses MEP – Dirty Electricity filters?

- There are some EHS (electromagnetic hypersensitive) people who respond better with one filter than another.
- If your client is EHS, it becomes even more important to follow the Kitchen Test with one or more of the 5 filters to determine which filter works best for them.
- Test each filter out.
- If they have a negative response, pull that filter out and try another type of filter.
- In rare occurrences, if none of the above plug-in filters are right for them, there are whole-house filter options for some EHS people, but they are more expensive.
- If you want to test any whole-house filter, test in the kitchen with the plug-in version of that whole-house filter first to make sure the client is not going to react negatively house filter as noted in the section **Steps to select the best plug-in MEP filter.**
- Consult a Certified Electromagnetic Radiation Specialist for these other solutions.

What happens if someone actually feels worst after they plug in MEP filters?

If someone feels worst after pugging in filters, it becomes even more important to use the testing of each filter in a kitchen that has already been discussed in the section **Steps to select the best plug-in MEP.**

- Since you might have MEP filters that you won't be using, most of the time, you can return both Greenwave and Stetzer filters if you don't need them.
- Check with the sources you are buying filters from to see what their return policy is.

Examples of Reduction of MEP by Different Filters installed at the Breaker Panel:

Physical Parameters

- A home in Southern California that had…
- minimum electronics
- no WIFI,
- no Bluetooth,
- no wireless,
- no pool,
- no solar power.

Multiple neighbors had:

- solar power,
- variable speed pool pumps,
- LEDs,
- WiFi,
- Wireless devices
- Bluetooth devices, and
- smart devices in their single family detached homes.

Filters were wired directly into main breaker panel on a dedicated breaker or plugged into dedicated outlets with their own breakers installed by an electrician next to the breaker panel.

	Stetzer Meter	**Greenwave Meter**
Before filter installation	949	1480
After filter installation		
1 – One Filter A	536	1450
2 – One Filter B	515	1370
3 – One Filter C	435	1125
4 – One Filter D	390	400
5 – Two Filter E	370	320
6 – Two Filter F	365	310

Filter performance is affected by building's electrical system, so the same results are not likely to be gotten on different buildings.

Building Biology Institute, Inc

BBI SBM-2015

V1

Standard of Building Biology Testing Methods

BRINGING TOGETHER TECHNOLOGY AND DESIGN METHODS TO PROVIDE THE INFORMATION NEEDED TO CREATE HEALTHY HOMES AND WORKPLACES

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Standard of Building Biology Testing Methods, SBM-2008C
(Combines and updates SBM 2003 and SBM 2008)

Between 1987 and 1992, *BAUBIOLOGIE MAES* developed the *Standard of Building Biology Testing Methods*, the accompanying *Building Biology Evaluation Guidelines for Sleeping Areas* and additional testing details on behalf and with the support of the *Institut für Baubiologie und Ökologie Neubeuern IBN*. Scientists, medical doctors and colleagues also offered their support. The *Standard* was issued for the first time in May 1992. The most current *Standard* SBM-2008 is the seventh edition and was published at the beginning of 2008. Since 1999 a 10-member expert commission assists in maintaining and updating the *Standard,* including the *Guidelines* and specific testing protocols. The current members of the commission are as follows: Dr. Dipl. Chem. Thomas Haumann, Dipl.Ing. Norbert Honisch, Wolfgang Maes, Dipl.Ing. Helmut Merkel, Dr. Dipl. Biol. Manfred Mierau, Uwe Münzenberg, Rupert Schneider, Peter Sierck, Dipl. Chem. Jörg Thumulla, Dr. Ing. Martin H. Virnich.

The Standard gives an overview of the physical, chemical and biological risks encountered in sleeping areas, living spaces, workplaces and properties. It offers guidelines on how to perform specific measurements and assess possible health risks. All testing results, testing instruments and procedures are documented in a final written report. In case potential problems are identified, an effective remediation strategy is developed.

The individual subcategories of the Standard describe critical indoor environmental influences. With its professional approach, it helps identify, minimize and avoid such factors within an individual's framework of achievability. It is the Standard's goal to create indoor living environments that are as exposure-free and natural as practicable, this holistic approach is accomplished by taking all subcategories into account and implementing all available diagnostic possibilities. Testing, assessment and remediation strategies focus mainly on the building biology experience, precaution and achievability. Any risk reduction is worth striving for.

A Fields, Waves, Radiation

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

Sources: AC voltage in electrical installations, cables, appliances, outlets, walls, floors, beds, high-tension and other power lines...
Measurement of low frequency electric **field strength** (V/m) and human **body voltage** (mV) as well as identification of dominant **frequency** (Hz) and prominent **harmonics**

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

Sources: AC current in electrical installations, cables, appliances, transformers, motors, overhead and ground cables, power lines, railways...
Measurement and data logging of low frequency magnetic **flux density (nT)** from power grid or railway system as well as identification of dominant **frequency (Hz)** and prominent **harmonics**

3 RADIOFREQUENCY RADIATION (High Frequency, Electromagnetic Waves)

Sources: cell phone technology, RF transmitters, broadcast, trunked radio systems, line-of- sight systems, radar, military, cordless phones...
Measurement of high frequency electromagnetic **power density (µW/m²)** as well as identification of dominant **RF sources** and low frequency **signals** (pulse, periodicity, modulation...)

4 DC ELECTRIC FIELDS (Electrostatics)

Sources: synthetic carpeting, drapes and textiles, vinyl wallpaper, varnishes, laminates, stuffed toy animals, TV or computer screens...
Measurement of electrostatic **surface potential** (V) as well as **discharge time** (s)

5 DC MAGNETIC FIELDS (Magnetostatics)

Sources: steel components in beds, mattresses, furniture, appliances, building materials; DC current in street cars, photovoltaic systems...
Measurement of **geomagnetic field distortion** as **spatial deviation** of magnetic flux density (µT, metal/ steel) or **temporal fluctuation** of magnetic flux density (µT, current) as well as **compass deviation** (°)

6 RADIOACTIVITY (Gamma Radiation, Radon)

Sources: building materials, stones, tiles, slags, waste products, devices, antiques, ventilation, terrestrial radiation, location, environment...
Measurement of **equivalent dose rate** (nSv/h, %) as well as **radon concentration** (Bq/mP3P)

7 GEOLOGICAL DISTURBANCES (Geomagnetic Field, Terrestrial Radiation)

Sources: currents and radioactivity in the earth; local disturbances caused by faults, fractures, underground water courses...

Measurement of earth's **magnetism** (nT) and earth's **radiation** (ips) and its prominent
disturbances (%)

8 **SOUND** and **VIBRATION** (Airborne and Solid Sound)
Sources: traffic noise, air traffic, train traffic, industry, buildings, devices, machines, motors, transformers, sound bridges...
Measurement of **noise level**, **sound**, **infrasound**, **ultrasound**, **oscillations** and **vibrations** (dB, m/s²)

B Toxins and Indoor Climate

1 **Formaldehyde** and Other Toxic Gases
Measuring formaldehyde, ozone and chlorine; industrial pollutants, natural gas, carbon monoxide, nitrogen dioxide and other combustion gases (ppm, ng/m3)
Sources: varnishes, glues, particle board, wood products, furnishings, devices, type of heating, gas leaks, exhaust fumes

2 **Solvents** and Other Volatile Organic Compounds **(VOC's)**
Measuring **volatile organic compounds (ppm, ng/cm3)** such as aldehydes, aliphates, cycloalkanes, alcohols, amines, aromatic compounds, chlorine hydrocarbons, esters, ethers, glycols, isocyanates, ketones, terpenes
Sources: paints, varnishes, adhesives, synthetics, particle board, building parts, furniture, cleaners, furnishings

3 **Biocides** and Other Semi-volatile Organic Compounds **(SVOC's)**
Measured are **semi-volatile organic compounds (mg/kg, ng/cm3)** such as pesticides, insecticides, fungicides, wood preservatives, fire retardants, plasticizer, pyrethroids, PCBs, PAHs, dioxins
Sources: wood, leather and carpet protections, adhesives, plastics, sealers, moth-proofing agents, pest-control agents

4 **Heavy Metals** and Other Inorganic Toxins
Measuring **inorganic substances** (mg/kg) such as heavy metals, metal compounds, salts
Sources: wood preservatives, building materials, building moisture, PVC, paints, glazes, plumbing pipes, industry, environment

5 **Particles and Fibers** (Dust, Suspended Particles, Asbestos, other Mineral Fibers...) Measuring **dust, number and size of particles**, **asbestos**, and other **fibers** (/cm3, /l)

Sources: aerosols, smoke, soot, dust, building and insulating materials, heating and air-conditioning and heating systems, insulation, appliances, ventilation, environment

6 **Indoor Climate** (Temperature, Humidity, CO_2, Air Ions, Smells)

Measuring air **temperature** (C), air **humidity** (% r.h., a_w), **oxygen** (vol. **%), carbon dioxide** (ppm), **air pressure** (mbar), **air movement** (m/s) as well as **small ions** (/cm3) and **air electricity** (V/m), identification of **odors** and **air exchange rate**
Source: building moisture, ventilation, heating, furnishings, breathing activity, static electricity, electromagnetic radiation, dust, environment.

C Fungi, Bacteria, Allergens

1 Molds (Spores and Metabolites)
Measuring and identifying of **fungi** that can or cannot be cultivated, their spores (/m3, /dm3, /g) and their metabolites (volatile organic compounds such as MVOC and mycotoxins)
Sources: moisture damage, heat bridges, building material, ventilation, air-conditioning, furnishings, environment......

2 Yeast and their Metabolites
Measuring and identifying **yeast-like fungi** (/m3, /dm3, /g) and their metabolites
Sources: moist areas, hygiene problems, food storage, garbage, appliances, furnishings, environment

3 Bacteria and their Metabolites
Measuring and identifying **bacteria (/m3, /dm3, /g) and their metabolites**
Sources: moisture damage, waste water damage, hygiene problems, food storage, garbage, environment

4 Dust Mites and other Allergens
Measuring **number** and **feces of dust mites, pollen, grasses, animal hair** (/m3, /g, %)
Sources: dust mites and their metabolites, hygiene problems, house dust, humidity, ventilation, environment

Additional measurements that can also be part of a *Building Biology Survey* include: light quality, lighting intensity and UV exposure, potable water quality, testing of building materials, furniture and other furnishings, as well as for home and wood pests.

We now direct your attention to the Building Biology Evaluation Guidelines for Sleeping Areas, which were developed for assessing the level of concern for a long term health risk during our sleeping period a delicate time of body regeneration. The Guidelines are on the next page.

Building Biology Testing Method SBM-2008C

BUILDING BIOLOGY EVALUATION GUIDELINES FOR SLEEPING AREAS

The Building Biology Evaluation Guidelines are based on the precautionary principle, with specific regard for the potential long-term exposure and risks associated with sleeping areas, and the fragile window of opportunity that sleep presents for biological and metabolic regeneration. These guidelines are based on fifty years of accumulated building biology experience and knowledge, as well as on outside scientific research and studies, and they focus on solutions that are practicable and achievable. Approaching the built environment in an holistic manner, considering all possible sources of risk to health and wellness, these guidelines set forth the best possible diagnostic and analytic methodology for creating indoor living environments that are as exposure-free, risk-free, and natural as is reasonably possible.

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 subcategory or for different subcategories, one should be more critical in the final assessment.

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.

Building Biology Evaluation Guidelines for Sleeping Areas	**No** Concern	**Slight** Concern	**Severe** Concern	**Extreme** Concern

A FIELDS, WAVES, RADIATION, SBM-2008

	No Concern	Slight Concern	Severe Concern	Extreme Concern

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

Field strength with ground potential in volt per meter **V/m Body voltage** with ground potential in millivolt **mV Field strength** potential-free in volt per meter **V/m**

No Concern	Slight Concern	Severe Concern	Extreme Concern
< 1	1-5	5 - 50	> 50
< 10	10 - 100	100 - 1000	> 1000
< 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/mBuilding Biology Evaluation Guidelines for Sleeping Areas

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

		No Concern	Slight Concern	Severe Concern	Extreme Concern
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 **μW/m²**

No Concern	Slight Concern	Severe Concern	Extreme Concern
< 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 / Vi-enna 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

4 DC ELECTRIC FIELDS (Electrostatics)
Surface potential in volt

< 100	100 - 500	500 - 2000	> 2000
< 10	10 - 30	30 - 60	> 60

s

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

< 1	1-6	6-20	> 20
< 1	1-2	2-10	> 10
< 2	2-10	10-100	> 100

Values refer to the flux density deviation through metal/steel or flux density fluctuation through direct current.

Germany: DIN/VDE 0848 occupational 67,000 µT and general public 21,200 µT; USA/Austria 5,000-200,000 µT; MRI ca. 2T; earth's magnetic field across temperate latitudes 40-50 µT   1 µT; magnetic field of eye 0.0001 nT; brain 0.001 nT; heart 0.05 nT

6 RADIOACTIVITY (Gamma Radiation and Radon)
Increase of equivalent dose rate in p

< 50	50-70	70-100	> 100

Values refer to the local radiation in the surroundings when the levels in the vicinity are average. In the case of a distinct higher radiation in the vicinity, a percentage wise smaller equivalent-dose rate is applied.

USA federal law: general population <5mSv and workers < 50mSv/a; USA average background 1.3mS/a;

depending on the local surroundings. Germany: average 0.85 mSv/a (100 nSv/h); BGA: general population 1.67 mSv/a; SSK (Radiation Protection Branch in Germany) general population 1.5mSv/a additional impact and workers 15mSv/a; if unusual deviation from average background radiation is substantial the frame of equivalent dose rate increase must be reduced.

	No Concern	**Slight** Concern	**Severe** Concern	**Extreme** Concern
Radon in Becquerel per cubic meter **Bq/m^3**	< 30	30-60	60-200	> 200
Radon in curies per liter **pCi/L**	< 0.75	0.75-1.5	1.5-5	> 5

EPA recommendation 160 Bq/m^3 or 4 pCi/L; Swedish recommendation 200 Bq/m^3 or 5 pCi/L; Radiation Protection Branch Germany (SSK) 250 Bq/m^3 or 6.25 pCi/L

7 TERRESTRIAL RADIATION (Geomagnetic Field, Earth Radiation)

Disturbance of geomagnetic field				
In nanotesla	< 100	100-200	200-1000	> 1000
In milliGauss	< 1	1-2	2-10	> 10
Disturbance of terrestrial radiation in percent %	< 10	100-20	20-50	> 50

Values refer to the natural geomagnetic field and to the natural radioactive gamma radiation or neutron radiation of the earth.

Natural fluctuations of the earth's magnetic field temporal 10-100nT; local (magnetic storms caused by solar eruptions) 100-1,000nT

B Environmental Toxins & Indoor Climate, SBM-2003

1 Formaldehyde and Other Toxic Gases

formaldehyde in parts per million **ppm**	< 0.02	0.02 – 0.05	0.05 – 0.1	> 0.1

MAK–threshold value: 0.5 ppm;
WHO 0.05 ppm; ACGHI ceiling limit 0.3 ppm; BGA Recommendations: 0.1ppm; Katalyse Institute 0.04 ppm; VDI 1992: 0.02 ppm; natural background 0.002 ppm; irritation of mucuous membranes and eyes 0.05 ppm; smell threshold 0.05 ppm; life threat from 30 ppm

2 Solvents and Other Volatile Organic Compounds **(VOC)**

values of VOC's in microgram/m^3 ug/m^3	< 100	100 – 300	300 – 1,000	> 1,000

Molhave (1986) 200 g/m3; Seifert (BGA 1990) 300 g/m3; Association of Enviornmental Chemistry GfU (1998) 200 g/m3

3 Biocides and other Semi-volatile Compounds **(SVOC's)**

Values for air in nanogram per cubic meter and in milligram per kilogram for material

pesticides	air ng/m³	< 5	5 - 50	50 – 100	> 100
PCP, Lindane, Permethrin	**wood** mg/kg	<0.2	0.2-5	5-100	> 100
Dichlofluanid, Chlorpyriphos	**dust** mg/kg	<0.2	0.2-1	1-5	>5
PCB, fire retardants	**dust** mg/kg	<0.1	0.1-1	1-10	>10
PAH (PAK)	**dust** mg/kg	< 0.5	0.5-5	5-50	>50

h

Plasticizer dust	mg/kg	**< 100**	**100-250**	**250-500**	**>500**

Values only for chlorinated fire retardants; values only for plasticizers absorbed by dust (total content x 3); PCB according to LAGA; PAH (PAK) according to EPA; PCP ban in Germany: 5 mg/kg (wood); BGA 1000 ng/m3; ARGE-Bau 100 ng/m3, 1 mg/kg (dust

5 Particles and Fibers (Dust, Suspended Particles, Asbestos, other Mineral Fibers...) Under evaluation

WHO 200 /m3; European Community 400 /m3; Germany BGA 500 – 1,000/m3

5 **Indoor Climate** (Temperature, Humidity, CO_2, Air Ions, Odors)

relative humidity in percent	**40 – 60**	**< 40 / >**	**< 30 / >**	**< 20 / >**
carbon dioxide in parts per million ppm	**< 500**	**500 –**	**700 –**	**> 1.000**

USA occupational exposure 1,000 ppm; Germany MAK limits 5,000 ppm; nature: rural areas < 360 ppm and urban areas 400 – 500 ppm

small air ions per cubic centimeter air/cm³	**> 500**	**200 – 500**	**100 – 200**	**< 100**

nature: oceanside > 3,000/cm3; clean outdoor air 2,000/cm3; urban areas < 1,000/cm3; indoor living space with synthetics < 100/cm3; smog < 50/cm3

air electricity in volt per meter, V/m	< 100	100 – 500	500 – 2,000	> 2,000

DIN/VDE 0848: workplace 40,000V/m; general public 10,000 V/m; nature ca. 50 – 200 V/m; foehn/thunderstorm ca. 1,000 – 10,000 V/m

B Fungi, Bacteria, Allergens, SBM-2003

1 Molds (their Spores and Metabolites)
The **mold count** of air in living spaces should be substantially less compared to the one in the surrounding outdoor environment or in not contaminated rooms. **Mold type**s of indoor air should be very similar to those outside. Particularly **toxic species** of mold-like fungi such as aspergillus or stachybotrys and yeast-like fungi such as candida, cryptococcus and coliform bacteria should **not be found at all** in living spaces or in very low quantities. In the event of a suspected microbial infestation indicated by building damages, history of the building, moisture, smells, symptoms of illness, presence of fungi and bacteria an inspection is recommended.

< 200	**200 – 500**	**500 – 1000**	**> 1000**

Given exposure limits refer to colony forming units (CFU) on building biology agar (YM anilin blue) and culture temperature at 20 – 24 C as well as to relative low concentrations in the outside air. Climatic, geographic and the hygiene of rooms needs to be taken in consideration as well.
Spores CFU per cubic meter air /m^3
WHO: pathogenic and toxigenic biologicals should not at all be tolerated in indoor air; if more than 50/m3 of a single fungal species is found, the source should be identified; a mixture of fungi typical for a given location can be tolerated up to 500/m3.

Any attainable reduction in readings is worthwhile to achieve.
Nature is *the* ultimate guide.

Please See our Glossary of Terms on the Following Pages

Glossary Term	German	Definition
µg	µg	micro gram
ACGIH	ACGIH	American Conference of Industrial Hygienists
agar	Agar	A gel culture medium based on a seaweed extract, widely used for growing microorganisms in laboratories
ARGE-BAU Conference of minister of building	ARGE BAU Bauministerkonferenz	The conference of minister of building is a working group for town construction, building and housings responsible Minister and senators of the 16 countries of the Federal Republic of Germany.
a_w	a_w	
Becquerel	**Becquerel**	(symbol Bq) the SI unit of the activity of a radioactive substance. The unit is named after Henry Becquerel, a French physicist, who discovered natural radioactivity in 1896 and together with Pierre and Marie Curie was awarded the Nobel Prize of physics in 1903.
BGA		
BlmSchV		
Bq/m^3	**Bq/m^3**	SI unit of the activity of a radioactive substance per cubic meter of air – see also *pCi/L*
Building Biology™	Baubiologie™	a branch of science concerned with the holistic interrelationship of humans and their living environment that is rooted in ancient wisdom and based on current scientific knowledge covering all aspects of home, health & habitat; originating in Germany where it is called *Baubiologie* and first introduced to North America by the International Institute of Bau-biology & Ecology as *Bau-biology*
DIN	**DIN** (Deutsche Industrienorm)	a non-governmental association in Germany concerned with industry standards regarding quality assurance, standardization and environmental protection; founded in 1917
EEG	**EEG** (Electrocardiogram)	recording of the changing electrical potentials of brain waves

EPA	EPA	Environmental Protection Agency
EU	EU European Union	European Union
EU-Parliament STOA		
Gauss	**Gauss**	(symbol G) the former unit of magnetic flux density, which is still in common usage in North America
Glossary Term	**German**	**Definition**
GfU	GfU Gesellschaft für Umweltchemie	Society for Environmental Chemistry
ICNIRP	ICNIRP (Internation ale Kommission für den Schutz von nicht-ionisieendr Strahlung)	(International Commission on Non-ionizing Radiation Protection) an international organization concerned with radiation protection of the non-ionizing portion of the electromagnetic spectrum; founded in 1992
ips	ips Impressions per second	Measuring the number of impression per second. When measuring radioactivity a Geiger counter is used.
IRPA	**IRPA** (Internationale Gesellschaft für Strahlenschutz)	(International Radiation Protection Association) an international health physics society setting international exposure limits for electromagnetic radiation; founded in 1964
ISM	ISM	an abbreviation for Industrial, Services, Medical; covering various frequency ranges for multiple uses allocated internationally by standards bodies
Katalyse Institute Köln, Germany	Katalyse Institut	Catalysis Institute for Applied Research
LAGA	LAGA Länderarbeitzgemeinschaft Abfall	The State (Land) Working Group Waste in Germany
large ions	**Grossionen**	are found in high concentrations in polluted air with a diameter up to 0.1 micron (or at least ten times the size of small ions) having a low mobility and disintegrating rather slowly – also referred to as *aerosol ions*

mbar millibar	mbar Millibar	A unit of atmospheric pressure equal to 1/1000 of a bar
mG		milliGauss, a a unit of magnetic field flux density (US System)
micotoxin		
MPR	**MPR**	an abbreviation for Swedish Board for Technical Accreditation, which set the first low-emission exposure limits for computers
MRI	Kernspin	magnetic resonance imaging
mSv	**mSv** (Millisievert)	(**m**illi**s**ie**v**ert) a millionth of Sievert, the SI unit of equivalent dose rate
mSv/a	**mSv/a** (Millisievert pro Jahr)	(**m**illi**s**ie**v**ert per **a**nnum) a millionth of Sievert per year, the equivalent dose rate per year
µT	µT microTesla	Millionth of a Tesla, a unit of magnetic field flux density
MVOC		Microbial Volatile Organic Compound
ng	ng Nanogramm	nano gram
nT	nT NanoTesla	Billionth of a Tesla, a unit of magnetic field flux density
Glossary Term	**German**	**Definition**
PAH	PAK	Polycyclic Aromatic Hydrocarbons
PPM/ PPB	ppm parts per million/ billion	Parts per million/ billion
pulsed	**gepulste (Strahlung)**	to produce or modulate electromagnetic waves as pulses- rapid increase and decrease
RH	r.F relative Feuchte	Relative humidity
radio frequency radiation (RF)	**hochfrequente Strahlung**	(RF radiation) electromagnetic radiation that ranges approximately from 30 thousand Hz (kHz) to 300 billion Hz (GHz) including radio and microwaves
rem	**rem**	(**r**oentgen **e**quivalent **m**an) a former unit of dose equivalent of absorbed ionizing radiation
RF also HF	**HF** (Hochfrequenz)	an abbreviation for radio frequency or high frequency - see also *radio frequency radiation*
SI units	**SI-Einheiten**	(Système International d'Unités) the internationally agreed system of units

		now in use for all scientific purposes
Sievert	**Sievert**	(symbol Sv) the SI unit of dose equivalent of absorbed ionizing radiation. The unit is named after the Swedish physicist Rolf Sievert.
small ions	**Kleinionen**	are found in high concentrations in fresh air with a diameter between 0.001 – 0.003 micron, which consist of only a few molecules and therefore are highly mobile and instable - also referred to as *cluster ions*
SSK	SSK Strahlenschutzkommission	a German commission for radiation protection
TCO	TCO (Schwedische Zentralorganisation der Angestellten und Beamten)	an abbreviation of the Swedish Association of Professional Employees, which sets a standard for low-radiation computer systems including ergonomic, ecological and indoor air considerations
TLV		Threshold Limit Value
VDE	VDE Verein Deutscher Ingenieure	Association of German Engineers
WHO	WHO	World Health Organization