

GUIDELINES
FOR
ELECTRO-MAGNETIC RADIATION (EMR)
SHIELDING INSTALLATIONS

Focus of brochure:
Shielding of Electro-magnetic Radiation
(Radiowaves and Microwaves)

YSHIELD

YSHIELD EMR-Protection - Gewerbering 6 - 94060 Pocking – Germany - www.yshield.com

02-2007 / version1.2

Welcome to our new brochure “GUIDELINES FOR ELECTRO-MAGNETIC RADIATION (EMR) SHIELDING INSTALLATIONS”. In this brochure you will find information on how to install shielding materials.

At YSHIELD we give our best to develop and produce excellent shielding materials. For a number of years now we have gathered experience with the application of our shielding products. Recently we have decided to make this experience available to our customers, and now we can present you this new brochure as result of our efforts.

As shielding of radio-waves and microwaves is a rather complex technical issue, and new IT applications are continuously being developed and introduced, we will be updating this brochure regularly. If you would like some specific information to be added to this brochure, or if you think you have found a mistake, then please send us an e-mail to contact@yshield.com. We appreciate your help!

If you require any further information on our products or on the shielding process, please do not hesitate to contact us. It will be our pleasure to help!

Christian Danner
General Manager
danner@yshield.com

Bernhard J. Liebl
Diploma-Engineer
Marketing and Sales
liebl@yshield.com

Liability disclaimer: This brochure has been thoroughly checked for errors. However we do not take any responsibility for errors, and for the results of your shielding project / your shielding installation. Many different parameters are involved in proper shielding of EMR radiation, some of which are entirely beyond our control. Always make sure to follow all applicable safety regulations. The YSHIELD terms of sale and delivery as published on our website www.yshield.com apply. Please contact local EMR experts for information and advice.

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GUIDELINES FOR EMR SHIELDING INSTALLATIONS

Focus of brochure: Shielding of Radiowaves and Microwaves

Guidelines for planning and carrying out of EMR shielding installations

You are interested in shielding your living space against electromagnetic radiation (EMR)? Then this brochure is for you. If you want to shield office space or a research facility with a shielding capacity of up to 40 dB, then the examples in this brochure will offer some useful help for your projects, too.

The focus of this brochure is on the shielding of high-frequency (HF) radiation, that means shielding of radiowaves and microwaves; current applications and planned applications in this sector range from 30 Kilohertz (KHz) to approx. 11 Gigahertz (GHz). Applications using higher frequencies may be used in the future. All of our shielding paints are tested for shielding performance up to 18 GHz (18 GHz are equal to 18000 Megahertz (MHz)). This intensive testing is undertaken to ensure that shielding done with e. g. our shielding paints offers protection from all current EMR applications, and from all EMR applications currently being developed.

We mention low-frequency (LF) shielding, e. g. the shielding of AC electric fields from household electric installations, in this brochure, but only where it is important in the context of HF-shielding. Please refer to other sources for the specifics of low frequency shielding!

WARNING: High-frequency shielding installations which are not properly grounded can be the source of significant low-frequency (LF) electric fields! Please be always sure to properly ground HF shielding installations, wherever possible. Some HF shielding fabrics cannot be grounded (e. g. fabrics that are manufactured by weaving cotton or synthetics around metal threads) , but they can still be the source of significant LF electric fields, due to the missing ground connection!

Ten basic rules for successfully installing EMR shielding installations

1) Assessment of actual EMR exposure / measuring of radiation power (power flux density)

Propagation of radiowave and microwave radiation is influenced by several different parameters; distance from radiation source, objects between radiation source and point of measurement, power of radiation source, and antenna direction to name just a few. Because of this multitude of parameters, it is usually **not possible to estimate EMR exposure without measuring**. Even experienced experts will often be significantly off target with their results when trying to estimate EMR exposure without using measuring instruments.

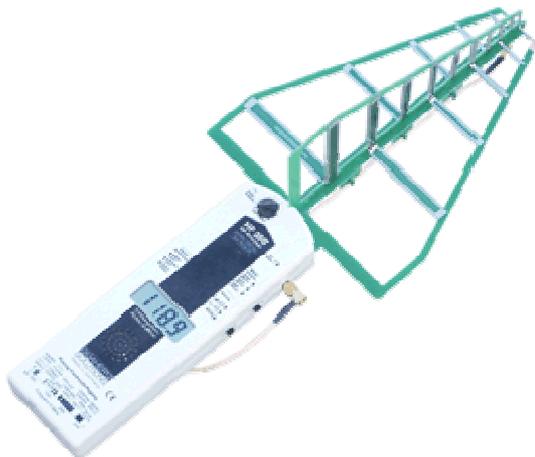
For shielding purposes, conclusive and trustworthy measuring of EMR exposure is important for several reasons:

1) If you want EMR exposure levels to drop below the recommended exposure limits suggested in the “building biology” guidelines in various EU countries (see page: guideline levels), measuring is the only way to ensure that the shielding project has been successful, and that your EMR exposure is now below these recommended guide values.

2) Even in one room, within a distance of a few feet, **radiation levels can vary dramatically**. This is at least partly due to the **quasioptical (or “light-like”) properties of the microwaves**, causing them to reflect of various surfaces, and change angle (refract) when travelling through walls. Since you want to make sure that your favourite resting area / sleeping area is not at a local maximum of EMR radiation (called a “hot spot”), it is important to measure in those places to get a clear picture of your personal EMR exposure.

3) You need to know all sources of EMR radiation in your vicinity, to be able to plan a shielding installation which will bring satisfying results. Most digital cordless phone base units continuously emit pulsed microwave radiation 24 hours a day, even when not in use; cordless phones even in a neighbouring apartment, can cause significant EMR emission levels, and are easy to miss without measuring. Wireless networks (W-LAN, WI-FI, WiMAX, etc.) and other last mile applications can also be significant sources of EMR, which should not be ignored or overlooked. A measuring instrument with a directional antenna will be a good help for locating the sources of electromagnetic radiation (EMR) in your vicinity. By pointing / aiming this antenna in different directions, you can easily find out from which direction the radiation is the strongest; this is usually where the source of the radiation will be. Directional antennas are usually mounted directly on the measuring instrument.

Picture: Measuring instrument with directional antenna



4) Frequency of radiation and waveform: It is important to know the frequency of the EMR radiation, in order to be able to accurately measure EMR levels, and to correctly plan shielding installations. The measuring instrument you use needs to have a frequency range that covers all possible sources. Try to find out the frequencies of the sources (of the cellular phone towers / mobile phone masts, TV-towers, WI-FI networks etc.) to make sure that the instrument you use actually is capable of measuring the frequencies you are exposed to! You also need to make sure that the instrument you are using is capable of not only measuring analogue signals (classic terrestrial TV and radio), but also digital “pulsed” signals as used by GSM cell phones, by 3G mobile communication standards (e. g. UMTS signals), TETRA*, etc.

5) We strongly recommend that you also measure low-frequency (LF) electric and magnetic field exposure. LF electric fields are often high in many countries nowadays, as normal mains electricity

* (TETRA; is a specialist professional mobile radio and walkie talkie standard used by police departments, fire departments, ambulance services and the military. Source: <http://en.wikipedia.org/wiki/TETRA>; uses frequencies approx. from 380 MHz to 900 MHz; local names differ: e. g. ASTRID in Belgium, VIVRE in Finland, RAKEL in Sweden, C2000 in The Netherlands).

wiring is no longer shielded (it used to be run in metal conduit pipes in some countries); and due to the building materials used (e. g. sheetrock / plasterboards). Especially in the US the LF electric and magnetic field levels can be rather high, e. g. due to the grounding system (electric field), and due to the lower supply voltages used (magnetic field). Proper grounding of HF shielding installations can solve some of those LF problems. After installing HF shielding material, we recommend to double check for LF electric fields. If you find high levels of LF electric fields after installing shielding material, maybe the grounding of the HF shielding installation has not been done properly. **NOTE: Low frequency magnetic fields will usually not be changed by installing HF shielding materials. Grounding of (conductive) shielding material will only change low frequency electric fields!**

In some countries there are **online databases** which show the **locations of radio- and TV-towers and mobile phone antennas**. Those maps can be helpful in identifying EMR-sources near your home. For the UK you can find information about mobile phone masts at www.sitfinder.radio.gov.uk. This includes TETRA masts, but does not include radio and TV transmitters or private radio systems (e.g. taxi services).

Measuring instruments: YSHIELD offers a broad selection of measuring instruments, for both high-frequency electromagnetic radiation (HF – EMR) and low-frequency alternating current (LF - AC) electric and magnetic fields. Please visit us at www.yshield.com and look at our selection of high-quality measuring instruments. We offer reliable easy-to-use instruments for the interested homeowner as well as sophisticated analyzers for professional use.

Renting of measuring instruments: In some countries it is possible to rent measuring instruments from our local distributors. Please inquire for a distributor near you.

2) Guide values for EMR exposure

YSHIELD develops and produces shielding materials for the shielding of electromagnetic radiation. We are not doctors or medical practitioners, and thus do not recommend specific exposure limits. As the guide values for EMR exposure vary significantly, please look for a set of guide values you feel comfortable with. Our documentation of shielding projects gives you an idea of levels, which customers commonly choose to provide sufficient protection for their needs (look for: **level after shielding**). When a shielding project is carried out, microwave exposure for residents / occupants typically drops below 10 microwatts per square meter (0.06 volts per meter RMS), sometimes even below 0.1 microwatts per square meter (0.006 volts per meter RMS) of power / power flux density of EMR radiation.

We plan to publish a list of organisations, which will be able to advise you on this subject. In the UK you may turn to www.emfields.org for support, in Australia to www.emaustralia.com.au.

3) Quasi-optical (or “light-like”) properties of electromagnetic radiation (EMR)

Think of a room, where there are blinds or shutters at all windows, which do not allow light into the room. It will be completely dark in this room. It is sunny outside, and now you open one of those blinds: the whole room will be lit! And maybe even some other rooms, if a door is open. Microwaves and light are somewhat similar in their ways of propagation; most obvious difference: microwaves do reach places where daylight will never get to (think of the lowest storey of an underground parking lot).

When you want to shield a living area or office space, this is of utmost importance to remember: microwaves will **not** be reduced noticeably by passing through most regular construction materials. Radiation power will be reduced somewhat, more by some materials (e. g. solid brick walls) and less by others (sheetrock or glass windows). Few materials have good shielding properties, and so you need to make sure that all directions from which radiowaves or microwaves do enter the room or space you want to protect are shielded properly. Remember: if you close one window shutter, and leave the other shutters open, it will still be light in the room. And the same applies for microwaves: If you shield the windows with curtains made of shielding fabric, but leave the walls made of sheetrock without any shielding, there will likely be no significant reduction in microwave radiation levels in this room.

In case you want to prevent interception of data from wireless networks („data-stealing“) you need to make sure that all directions in which you do not want the microwave signals (which transport the information you want to protect) leaving your area / your office space are shielded properly. Some companies prefer total 6-side shielding: the floor and the ceiling as well as all walls are shielded, including all doors and windows!

4) Efficient shielding is always “large-surface” shielding (or “large-area” shielding)

Due to the quasi-optical properties of the microwave radiation, it is necessary to always shield large areas; this means one or two complete walls of a room or house (or maybe even more, depending on location of source/s of radiation); and the windows in these walls. It does normally not make much sense to shield only parts of a wall; or just one window, and leave the other windows without shielding. The radiation that comes in through the unshielded parts of the wall will still be significant, and there might be almost no effect on the microwave radiation levels measured in this room. Most common mistake: Shielding of only the windows (or only the walls) of a room or house; this may or may not lead to a reduction of microwave radiation levels for the occupants. Sometimes it is most efficient to shield the roof, or the floor, again depending on the individual situation. Worst experience we found: a person shielded only one window in a bedroom with 4 large windows; radiation levels did not drop much at all; that the levels did not drop much becomes very clear when you remember the quasi-optical properties of the microwaves.

5) Shielding on the outside is superior to shielding on the inside!

This becomes clear, when you think of the different walls, which are in a home or office building; when you put shielding material on the outside, there will be no interruptions (or “holes”) in the shielding paint coat; whereas on the inside, you will have disruptions, because there are walls, floors, ceilings, which all will transport radiation to some extent! Very often it is just not possible to shield on the outside, due to several reasons. If you do shielding work on the inside, you may consider to not only paint the wall where the radiation enters the building, but also the first few feet of the adjacent walls that separate the rooms in the house. After those few feet most of the radiation that enters the house through those walls should have died down.

6) Windows and doors, window frames (“holes” in the shielding)

Some windows, especially new windows with good thermal insulation (such as Pilkington-K double glazing units), will have good microwave shielding capacities; but most windows in private homes will not have much shielding capacity at all.

Some of the new windows even have a thin layer of metal applied for perfect thermal insulation (a “vapor deposited metal layer”), and those windows usually have excellent shielding capacities. Regular windows do have almost no shielding capacity, so shielding of the windows is a crucial point. We recommend using curtains made of shielding fabrics for the shielding of windows. Curtains will also cover the window frames, and even if the windows are opened, often you will be able to rearrange the curtains in order to get ample shielding capacity.

7) The shielding installation is just as good as the weakest link in the chain

Once again we are coming back to the quasi-optical properties of the microwaves: if you have a lot of light penetrating a room at only one place, the whole room will be lit to some degree. The same thing applies for microwave radiation: if you have microwave radiation entering the room or area in one place, you will likely have some of this radiation in most parts of the room. Attention: This “weakest link” could be the floor or the ceiling; it could be a wall that has not been adequately shielded; it could also be the windows, just the window frames or the door. A measuring instrument with a directional antenna (see picture) will help to locate the weak spots in the shielding. It will be a valuable help in identifying the places where radiation is still entering the shielded room or space.

Picture:

Measuring instrument with directional antenna (antenna not mounted)



Check shielding capacity regularly!

8) Good ground connection of the shielding paint coat / the shielding material is essential

In some countries conductive surfaces have to be grounded by law. As the shielding paint coat is a conductive surface (due to its carbon content) it has to be grounded in those countries. Apart from the legal situation we strongly recommend to ground the shielding paint coat, as conductive surfaces will attract and transport low-frequency (LF) AC electric fields. Those LF electric fields may cause problems with personal wellbeing. If the shielding paint coat is grounded, all the low-frequency electric fields of the respective wall will be shielded, and personal wellbeing and sleep may be much better as a result of this. The meters for the measuring of those low-frequency electric fields are easy to operate, and they are relatively inexpensive, starting from approx. 95.00 Euros apiece. All the meters we sell are combination meters, and allow to measure LF electric fields as well as LF magnetic fields (that means

they include a "Gauss meter"). In case you use curtains made with a non-conductive surface (such as our shielding fabrics Naturell, Evolution and Topas), you need to take care that those fabrics do not pick up low-frequency electric fields. Since those fabrics cannot be grounded, you need to keep some distance to all possible sources of LF electric fields; or keep some distance from the fabrics, in case you use them as curtains in front of windows or doors. It is best to ensure proper installation by measuring the LF electric fields after installing the curtains; if the installation has been properly designed and implemented, you should not find any significant LF electric fields.

The grounding procedure may seem much more complicated to you than it actually is. The grounding by itself is actually rather simple: a metal plate with a conductive backside is screwed to the wall, and from this plate a wire runs to the grounding (whatever you choose to use for grounding: can be the grounding in the fuse box; or a power outlet with ground connection; or maybe the main equipotential bonding (system); always make sure to comply with local law).

NOTE: The high-frequency shielding properties are not affected by the grounding (or not grounding) of the shielding paint coat, or of the shielding material in general.

9) Shielding of low-frequency AC electric fields and low-frequency AC magnetic fields

Low-frequency AC **magnetic fields** are hard to shield, and shielding those fields is usually very expensive. If you cannot eliminate the field source, we recommend putting some distance between you and the field source, as the field strength decreases with distance. Lots of sources of LF magnetic fields are "homemade" and can be easily removed, e. g. magnetic fields caused by power transformers in radio receivers, and other electrical appliances. If you need LF magnetic field shielding, please contact us and we will advise you individually. **NOTE:** YSHIELD shielding paints are not designed to eliminate LF magnetic fields.

Low-frequency (LF) AC **electric fields** are ubiquitous in today's households. This is why we recommend grounding of the shielding paint coat, as grounding will eliminate the LF electric fields. All YSHIELD shielding paints will very effectively eliminate LF electric fields when grounded. It is always best to check the completed installation with a meter, to make sure that ground connection is good, and the fields are eliminated. **NOTE:** Frequent sources of LF electric fields are extension cords and the like, so make sure to eliminate all possible LF electric field sources from the area which you have shielded.

10) Make it a step by step process

If you start a shielding project, bear this in mind: The first thing you have to do is to assess your exposure. Then you plan where to most effectively put which sort of shielding material. Next you carry out the installation, and then you measure again. If improvements have to be made, you go ahead and make those (identifying "leaks" is important, so your measuring instrument with directional antenna comes in handy again). After those improvements you measure again, a. s. o. I recommend to measure at least once every two months: your neighbour may have installed a new DECT cordless telephone or a WLAN system; trees might have lost their leaves in wintertime, and suddenly you are exposed to radiation from a cellphone tower which you did not even notice last summer (don't laugh now – this

actually happened to me, and now I have to use a canopy in wintertime; in summer with the leaves on the trees in front of my apartment I am doing fine); or your neighbours across the street put in new windows with fancy mirror glass, and now all the radiation reflects from their windows exactly in your apartment, etc. As you can see, there are quite a number of reasons why it does make sense to measure every few months, to make sure that you and your family are not exposed to new sources of radiation.

It does take some effort to get yourself acquainted with the measuring instruments, and to go through the whole shielding process; but we can assure you that many customers in countries from all over the world have gone through this process, and the feedback we get is quite favourable. Friendships are often formed in the process, as people who have gone through the process in any one country will often be able to provide others in their vicinity with helpful advice.

LAST BUT NOT LEAST

Ask for advice if necessary! Share your experience, and help others learn how to properly shield electromagnetic radiation (EMR). We are all learning, and our personal experience is that most people in this field of business are helpful and genuinely interested!

At YSHIELD we are always happy to receive pictures, testimonials and feedback in general! The more feedback we get, the better we can serve you in the future.

Picture:

Typical power (power flux density) of radiation before and after shielding. (In this case the outside wall of the house has been painted with shielding paint; values given in microwatts per square meter.)

