* HEALTH STANDARD FOR LONG TERM EXPOSURE

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

BUILDING BIOLOGY EVALUATION GUIDELINES

FOR SLEEPING AREAS

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

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

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

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

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

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

Guiding Principle:

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

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

Building Biology Evaluation Guidelines for Sleeping Areas SBM-2008, Page 1	**No** Concern	**Slight** Concern	**Severe** Concern	**Extreme** Concern

A FIELDS, WAVES, RADIATION

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

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

Values apply up to and around 50 (60) Hz, higher frequencies and predominant harmonics should be assessed more critically.

ACGIH occupational TLV: 25000 V/m; DIN/VDE: occupational 20000 V/m, general 7000 V/m; ICNIRP: 5000 V/m; TCO: 10 V/m; US-Congress/ EPA: 10 V/m; BUND: 0.5 V/m; studies on oxidative stress, free radicals, melatonin, childhood leukaemia: 10-20 V/m; nature: < 0.0001 V/m

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

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

Values apply to frequencies up to and around 50 (60) Hz, higher frequencies and predominant harmonics should be assessed more critically. Line current (50-60 Hz) and traction current (16.7 Hz) are recorded separately.

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

DIN/VDE: occupational 5000000 nT, general 400000 nT; ACGIH occupational TLV: 200000 nT; ICNIRP: 100000 nT; Switzerland 1000 nT; WHO: 300-400 nT "possibly carcinogenic"; TCO: 200 nT; US-Congress/EPA: 200 nT; BioInitiative: 100 nT; BUND: 10 nT; nature: < 0.0002 nT

3 RADIOFREQUENCY RADIATION (High Frequency, Electromagnetic Waves)

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

Values apply to single RF sources, e.g. GSM, UMTS, WiMAX, TETRA, Radio, Television, DECT cordless phone technology, WLAN..., and refer to peak measurements. They do not apply to radar signals.

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

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

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

Building Biology Evaluation Guidelines for Sleeping Areas SBM-2008, Page 2	**No** Concern	**Slight** Concern	**Severe** Concern	**Extreme** Concern

> 10 µW/m² = SEVERE HEALTH CONCERN

SMART METER SPEC'S

Itron

The following table reflects the data contained within the Certification Exhibits for FCC Rule Part: 15.247 for Itron OpenWay Smart Meters:

FCC ID	SK9AMI-xx
FCC Rule Part	15.247
Classification	Digital Transmission System Transmitter Frequency Hopping Spread Spectrum Transmitter
Device Category	Mobile
Environment	General Population / Uncontrolled Exposure
Exposure Conditions:	Greater than 20 centimeters (8 inches)
Frequency bands	RF LAN902 – 928 MHz ZigBee 2,400 – 2,483.5 MHz
Transmitter Power*	RF LAN24.83dBm (304.09 mW) at 902.25 MHz ZigBee 18.94 dBm (78.34 mW) at 2,475 MHz
Antenna Gain*	RF LAN2.2 dB (1.660 times) at 902.25 MHz ZigBee 3.8 dB (2.399 times) at 2,475 MHz

*Values have been updated to reflect the latest meter hardware release (FCC ID: SK9AMI6)

The duty cycle (or amount of time a device is active in any given time period) will have a significant impact on the long term exposure levels for a device. The Itron OpenWay smart meters are actively transmitting a very small portion of the time. The maximum duty cycle for each transmitter is listed below:

Max Duty Cycle (over period of 30 minutes)	RF LAN	5%
	ZigBee	1%

For the Itron OpenWay smart meters wireless communication equipment, the MPE limits for continuous exposure are as follows:

Frequency	**MPE level**	
	Occupational	***General population***
RFLAN (902 MHz)	3.0 mW/cm^2	0.6 mW/cm^2
Zigbee (2,400 MHz)	8.0 mW/cm^2	1.0 mW/cm^2

Calculation of RF emissions

The FCC MPE levels represent the guaranteed safety limits based on the thermal effect of continuous RF radiation.

The FCC guidelines define the following equation to calculate the power density of RF radiation under far-field conditions:

$$\text{Power\_Density } [mW/cm^2] = \frac{\text{Transmitter\_Power } [mW] \times \text{Antenna\_Gain } [times]}{(4 \times \text{pi} \times \text{Distance } [cm] \times \text{Distance } [cm])}$$

The 1992 ANSI/IEEE standard specifies that 20 cm (~ 8 inches) should be the minimum separation distance where reliable field measurements to determine adherence to MPEs can be made.

It is important to note that the Itron's equipment operates in short bursts randomly distributed over prolonged period of silence (5% and 1% duty cycles). According to the rules, the MPE levels for interrupted transmission should be calculated by averaging the active time over interval of 30 minutes in the case of General Population exposure or six minutes in the case of occupational exposure.

A comparison of the MPE from the Itron OpenWay smart meter's transmitters to the General Population MPE limits with the duty cycles accounted for is shown in the table below:

SMART METER: 50,000 µW/m²

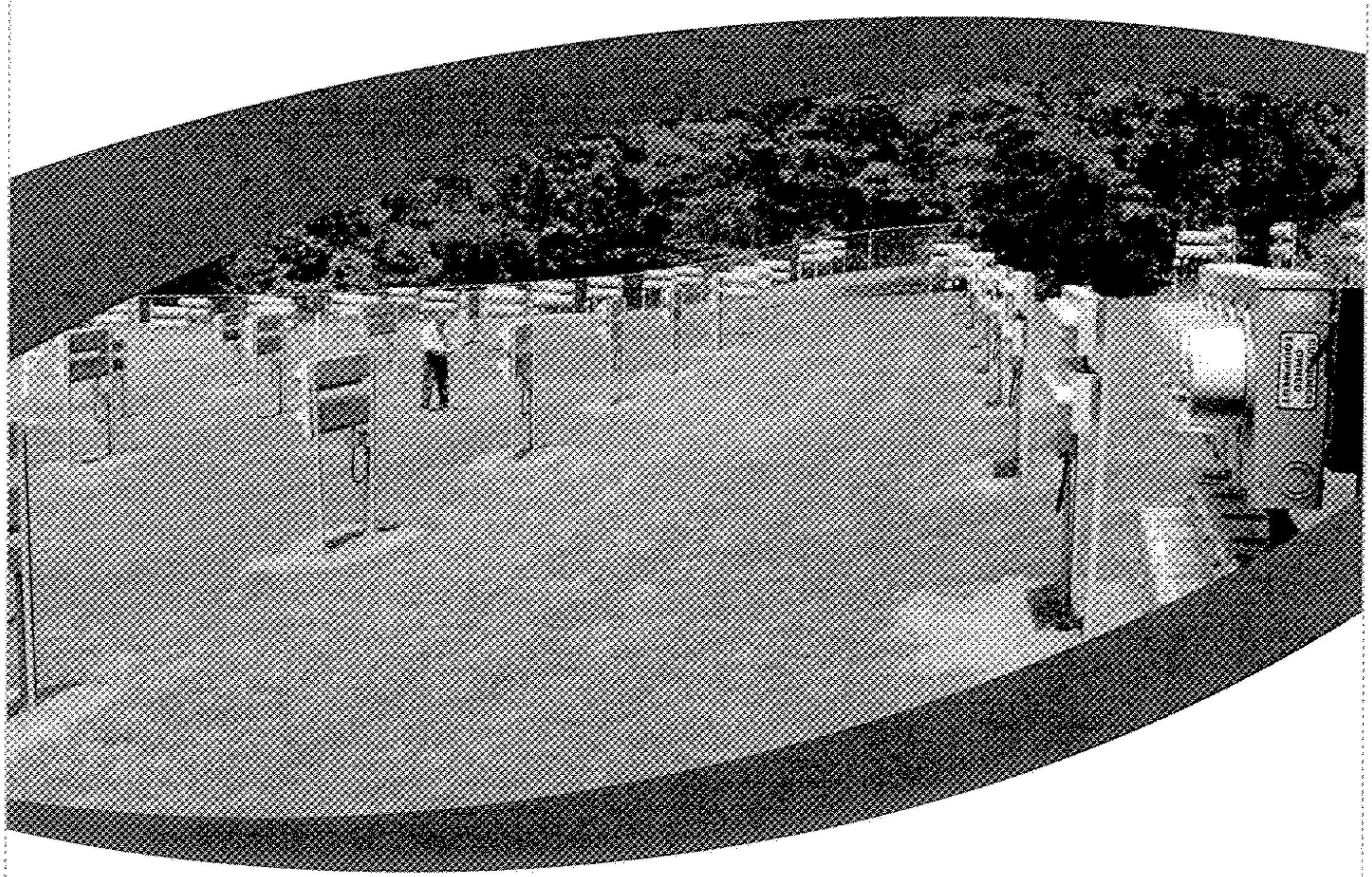
Transmitter	MPE Limit	MPE	Margin
RF LAN (902MHz)	0.6 mW/cm^2	0.0050 mW/cm^2	**0.833%** of the limit
ZigBee (2,405MHz)	1.0 mW/cm^2	0.00037 mW/cm^2	**0.037%** of the limit

The data indicates that the Itron OpenWay smart meters present an extremely low level of RF exposure when compared to the regulatory limits established for safe operation.

ELECTRIC POWER RESEARCH INSTITUTE

2010 TECHNICAL REPORT

An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter



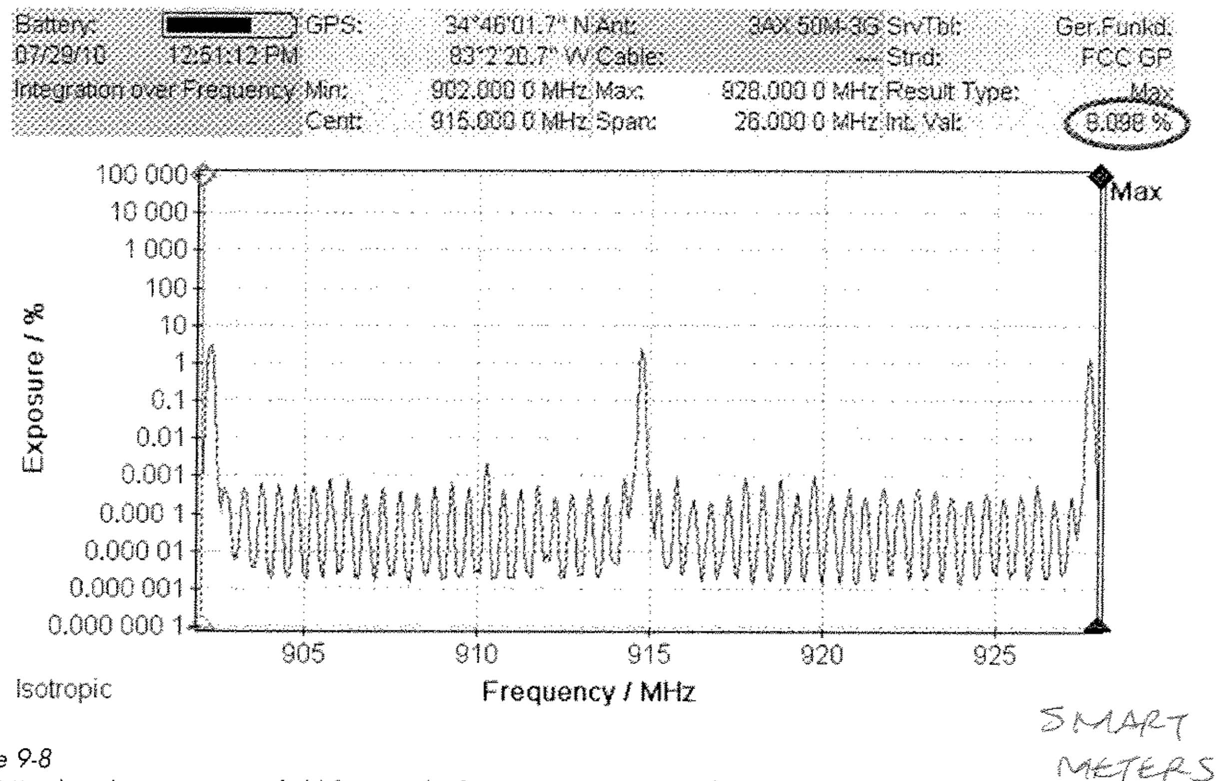


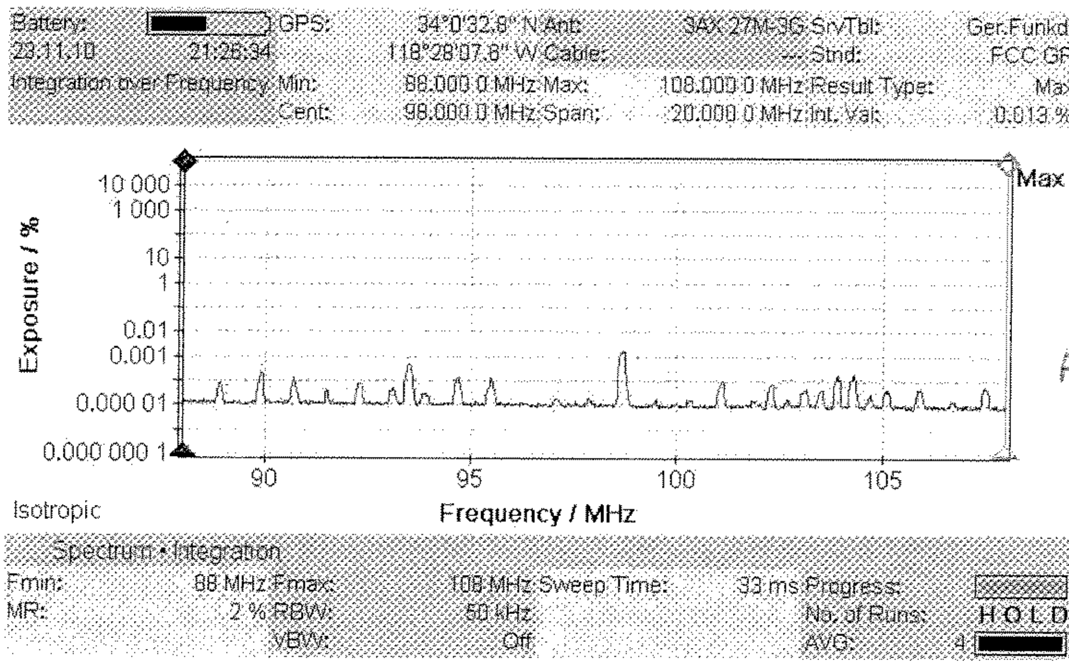
Figure 9-8
900 MHz band composite RF field from rack of 10 SmartMeters at 1 foot.

The many lower level spectral peaks were caused by the multiplicity of Smart Meters within the meter farm; in practice, it was not possible to completely remove oneself from the ambient background of RF fields present in the meter farm since moving away from one rack of meters meant that one was getting closer to another rack in some location. While the signals from the other thousands of Smart Meters were randomly occurring across the band, because of the number of meters simultaneously operating, the presence of signals on each frequency was evident. Had only one Smart Meter been operating, this would not have been the case, as discussed earlier. Using the internal integration feature of the SRM-3006, the total equivalent RF field power density was reported by the instrument as a percentage of the general public MPE in the upper right region of the spectral plot (see circled area). For the measurement at 1 foot in front of the meter rack, a total integrated RF field equivalent to 8.1% of the MPE was determined.

Using the spectrum analysis method describe above, measurements were made at successively greater distances from 1 foot to 100 feet from the Smart Meter rack. These spectrum scans obtained from the SRM-3006 are shown in Appendix B. Referring to Appendix B, it can be seen that as the distance between the rack and the measuring instrument was increased, the signal level of the programmed meters decreased until, at approximately 50 feet from the rack, the signal levels of the meter rack being investigated blended into the background of all of the other ambient RF fields from other meters within that area of the meter farm. In other words, the emitted signals became indistinguishable from the ambient environment of RF fields and could not be identified as being contributed by a specific meter rack or collection of Smart Meters. Field measurements taken to the rear of the meter rack are provided in Appendix C. Figure 9-9 shows measurements being performed behind the rack of specially programmed Smart Meters. The presence of other racks of active meters are evident in the background. As distance from the back side of the subject rack was increased, the distance to the other meter racks located behind the subject rack decreased meaning that the ambient, but intermittent, RF fields of other meters in the farm could be detected.

A second SRM-3006 was use to measure RF fields in several other frequency bands in Santa Monica, CA (The calibration certificates are contained in Appendix A). Measurements included the:

- FM radio broadcast band of 88-108 MHz (Figure 9-32),
- spectrum of 800 to 900 MHz band (Figure 9-33),
- PCS band from 1.9 to 2.0 GHz (Figure 9-34).
- VHF spectrum of 50 MHz to 216 MHz (Figure 9-35), and
- 2.4 to 2.5 GHz band which includes Wi-Fi and microwave ovens
- (Figure 9-36)



FM RADIO

Figure 9-32
Spectrum scan of the FM radio broadcast band in Santa Monica, CA with a band integrated RF field equivalent to 0.013% of the FCC MPE for the public.

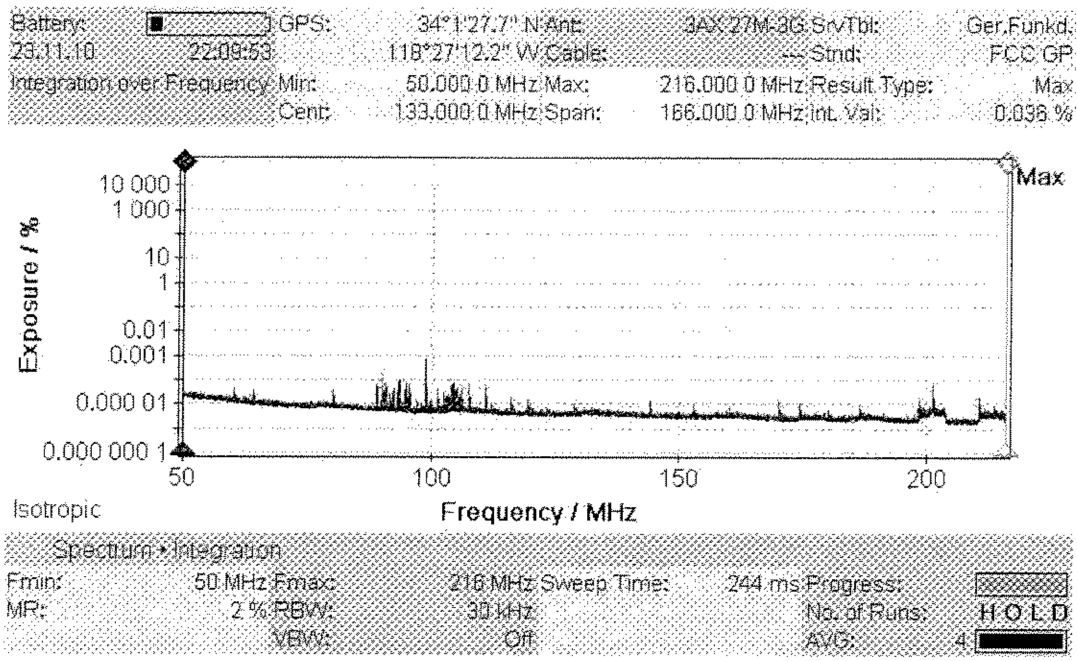


Figure 9-35
Spectrum scan of the 50 MHz to 216 MHz band in Santa Monica, CA, with a band integrated RF field equivalent to 0.036% of the FCC MPE for the public.

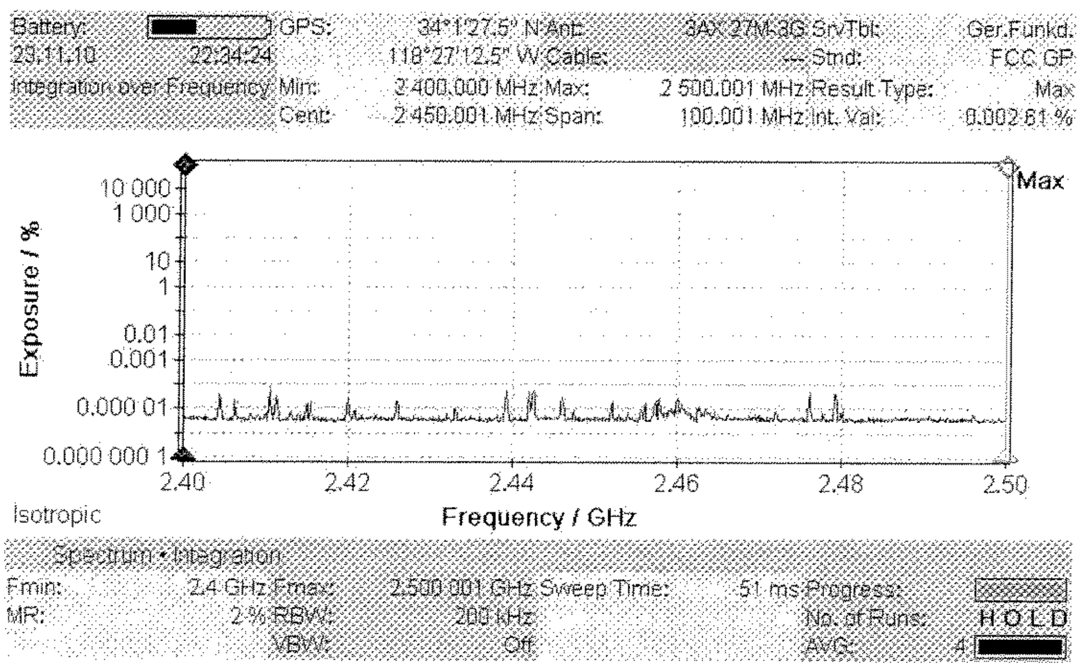


Figure 9-36
Spectrum scan of the 2.4 GHz to 2.5 GHz band in Santa Monica, CA, with a band integrated RF field equivalent to 0.0026% of the FCC MPE for the public.

Section 13: Ancillary Measurements

Microwave Oven

During the residential surveys, when a microwave oven was encountered in the kitchen, measurements were made with a cup of water placed inside the oven. Leakage fields, as documented in Table 9-8, were detected at two feet from the oven as great as 22% of the public MPE. Subsequently, additional measurements were performed at the author's home using the SRM-3006. These data for a measurement at 1 foot from the oven are shown in Figure 13-1. The spectral distribution of the detected signal in Figure 13-1 is characteristic of microwave ovens; the frequency of the microwave oven drifts across a part of the spectrum and is essentially continuous in nature. Loading on the microwave oven due to temperature increases in the material being heated will cause the frequency to vary. Measurements taken at additional distances from the oven demonstrate a rapid decrease in signal with increasing distance as shown in Figure 13-2.

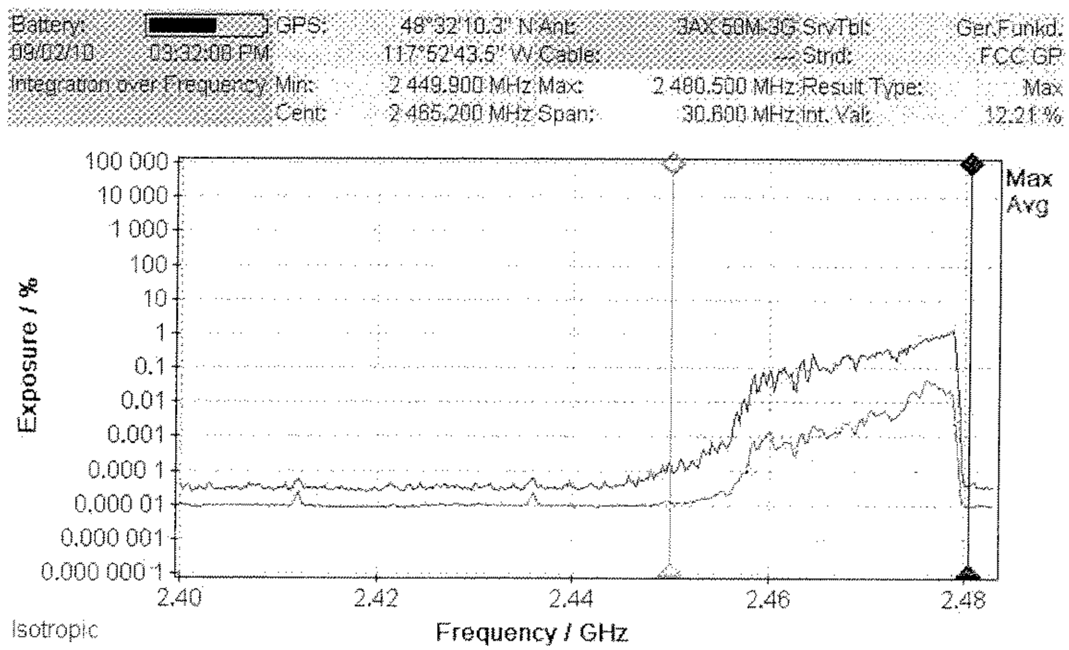


Figure 13-1
Measurement of microwave oven leakage at 1 foot from oven door seal.

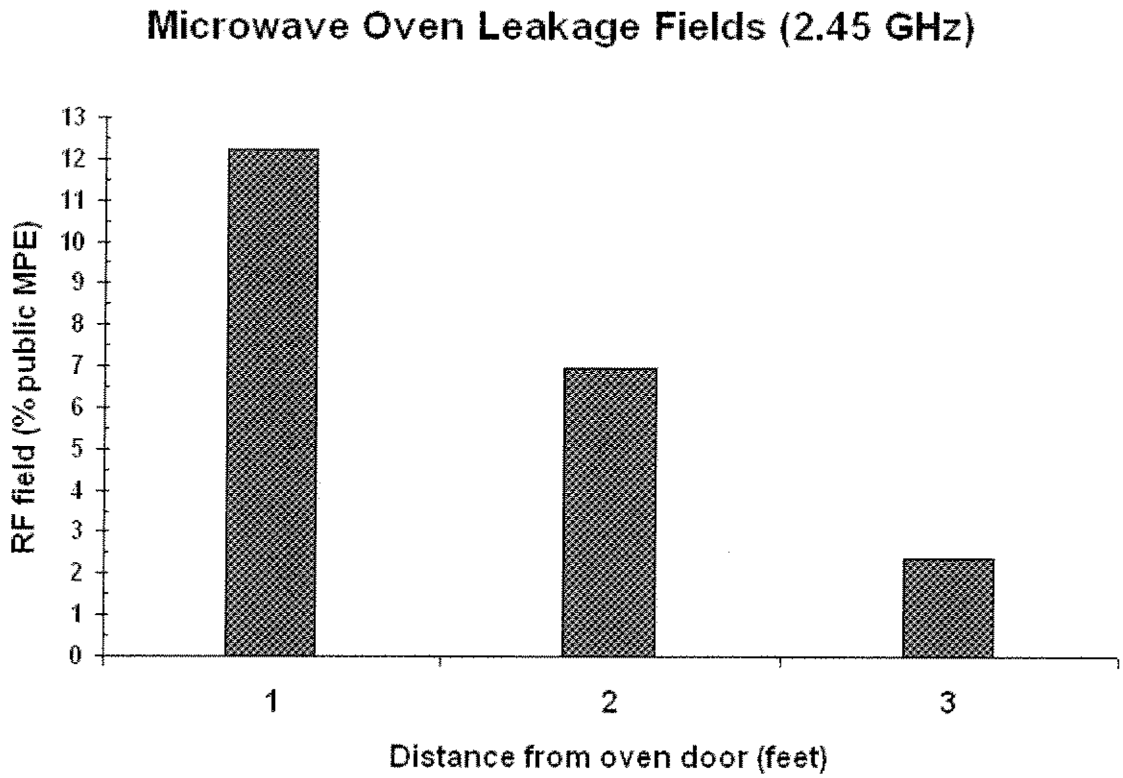


Figure 13-2
Microwave oven leakage vs. distance.

Microwave ovens must comply with regulations promulgated by the Food and Drug Administration (FDA) on leakage levels.[21] These regulations specify that the maximum leakage from a new oven, at the time of manufacture, shall not exceed a power density of 1 mW/cm^2. Once put into operation, the limit is set at a maximum leakage value of 5 mW/cm^2 at 5 cm from the oven surface. This is a product performance standard, not an exposure standard.[22] In practice, modern microwave ovens typically comply easily with the regulations by a wide margin. Since the FCC MPE for whole body exposure at the microwave oven frequency, 2.45 GHz, is 1 mW/cm^2, a measurement value of 12% of the MPE corresponds to only 1/5 of 12%, or about 2.4% of the 5 mW/cm^2 product performance standard.

[21] Performance Standards for Microwave and Radio Frequency Emitting Products, 21CFR1030.10. Food and Drug Administration, Department of Health and Human Services.

Cordless telephone

Cordless telephones operate in a number of different frequency bands including 49 MHz, 900 MHz, 2.4 GHz and 5.8 GHz. Figure 13-3 shows a spectrum obtained from a 900 MHz band cordless phone with the base unit emitting signals near the upper end of the spectrum and the portable receiver unit emitting near the bottom of the spectrum. This figure is applicable to a measurement at one foot from the base unit and receiver.

[22] It should be noted that the local RF field leakage limit of 5 mW/cm^2 is five-fold greater than the MPE for whole body exposure applied by the FCC.

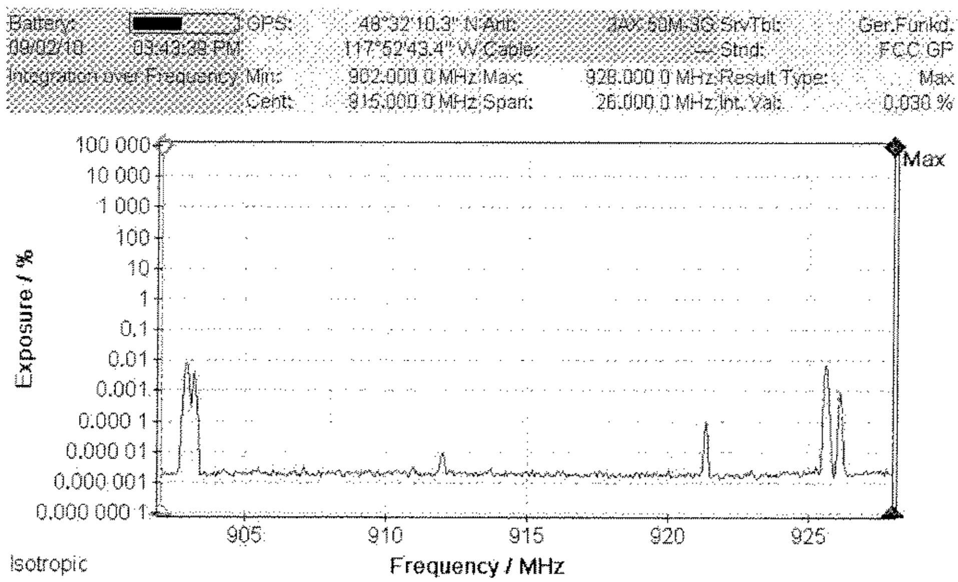


Figure 13-3
900 MHz cordless telephone RF fields from the base unit near the upper end of the spectrum and from the portable receiver unit near the lower end of the spectrum, measured at 1 foot from the base and receiver.

Wireless router

An observation also made during the residential measurements was the presence of a wireless router in a home office operating in the 2.4 GHz band. Figure 13-4 illustrates a measurement of the RF field produced by a wireless router in the author's office at approximately one foot from the router. A maximum field of 0.24% of the MPE was measured.

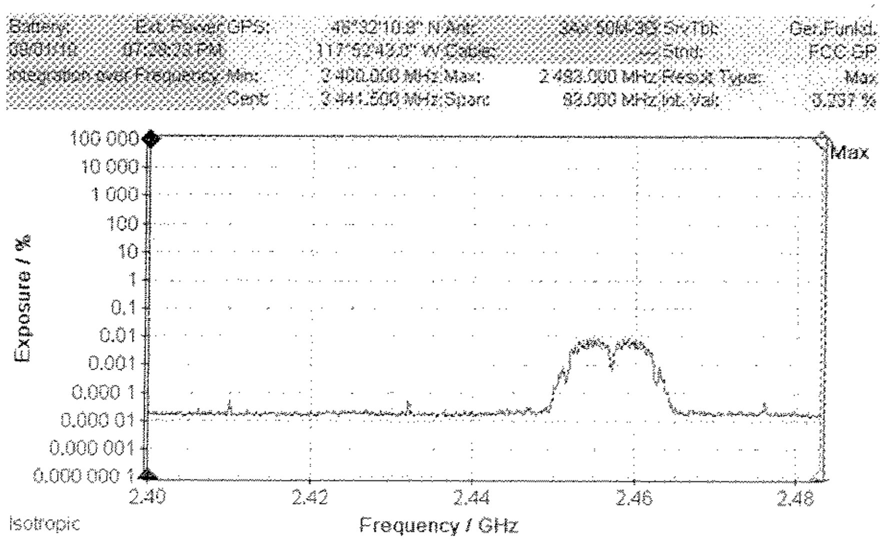


Figure 13-4
Measured RF emission spectrum of a wireless router at one foot from the router. The router was set to operate on Wi-Fi channel 10.

Measurement comparison (Model B8742D probe and SRM-3006)

Using the two specially programmed Smart Meters previously employed in the simulated stucco wall attenuation measurements, a comparison was made between the response of the broadband probe and the SRM meter. RF fields were measured by placing either of the two probes with their centers at 20 cm from the face of either Smart Meter and recording the readings. Each broadband probe reading was multiplied by the factory determined correction factor for the appropriate frequency (0.67 at 915 MHz and 0.97 at 2450 MHz). The results are presented below.

Table 13-1

Comparison of RF field probe readings at 902.25 MHz and 2405 MHz (%MPE)

	Frequency (MHz)	
Probe	902.25	2405
B8742D	2.01	1.21
SRM-3006	2.29	1.37
Percentage difference (%)	13.0	12.3
Difference (±dB)	+0.53, -0.57	+0.54, -0.54

These data indicate that the two instruments yielded readings of the RF fields that were within the manufacturer's specified uncertainties of calibration.