Site Conformity Assessment

with

FCC Rules and Regulations, 47 CFR § 1.1310 *et seq*.

(Radiofrequency Emissions)

FCC Licensee: **Verizon Wireless**

Site ID: **Hilltop Market**

Site Address: **1081 Huntington Road,**
Stratford, CT 06762

Prepared for

Cellco Partnership
d/b/a Verizon Wireless
99 East River Drive
East Hartford, CT 06614

Prepared by

R C Petersen

October 3, 2015

Site Conformity Assessment
with
FCC Rules and Regulations, 47 CFR § 1.1310 *et seq*.
(Radiofrequency Emissions)

Summary

This report is an analysis of the radiofrequency (RF) environment associated with a Verizon Wireless (Verizon) personal wireless telecommunications facility (base station) proposed for installation on the roof of the Hilltop Market located at 1081 Huntington Road, Stratford, CT. The antennas will be mounted at an elevation of 21.5 ft above mean grade level (AMGL) inside an RF-transparent simulated chimney located on the roof of the building.[1] The analysis includes contributions from Verizon's antennas for the following service (which is the only service proposed for this site): Advanced Wireless Services (AWS – 2100 MHz). Engineering data and site information provided by Verizon (see Table 1) were used together with well-established analytical techniques (e.g. [1]) to calculate the maximum RF signal strength (RF power density) in areas normally accessible to the public. The results are compared with the appropriate frequency-dependent safety criteria (see Table 2 for a summary of contemporary RF exposure guidelines), and the individual comparisons are combined percentagewise to ensure that the contribution of each of the Verizon transmitting antennas, i.e., the *maximum cumulative* RF environment, is in compliance with the FCC safety guidelines [2]. Table 3 is a summary of the results for the above identified service. Worst-case assumptions were used to ensure safe-side estimates, i.e., the actual values will be significantly lower than the corresponding analytical values presented in this report (see Annex A for details). (See Annex B for typical exposures in the home from wireless consumer products and see Figure 1 for the frequency bands of familiar RF wireless systems and devices, including wireless devices used in the home and personal wireless communications services similar to that proposed for installation at the Hilltop Market.)

The results of these analyses show that the maximal levels of RF energy in publicly accessible locations in the vicinity of the Hilltop Market are below all applicable health and safety limits. Specifically, at 6 and 16 ft AMGL in the area surrounding the Market, the combined maximum level of RF energy associated with *continuous operation* of the AWS – 2100 MHz transmitting antennas will be less than 2. 5% and 19.4%, respectively, of the safety criteria adopted by the FCC and mandated by the Telecommunications Act of 1996 [2]. These values are also far below other contemporary science-based exposure criteria, e.g., those of the American National Standards Institute (ANSI) and the Institute of Electrical and Electronics Engineers (IEEE) [3], the recommendations of the National Council on Radiation Protection and Measurements (NCRP) [4], and international safety guidelines such as those of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) [5], [6]. Because of the conservative method used to perform the analysis, the actual levels of RF energy at publicly accessible locations in the vicinity of the site will be considerably lower than the corresponding values cited above. Moreover, the levels inside nearby homes, offices, and inside the Hilltop Market will be comparable to the

[1] All elevations/heights are with respect to grade level at the Hilltop Market.

levels associated with commonly used electronics equipment[2] and far lower than the values cited above for the following reasons: 1) the attenuation of commonly used building materials is such that a considerable amount of the incident energy is blocked; and 2) the narrow profile of the antenna pattern in the vertical plane (the beam divergence in the vertical plane is of the order of 10 degrees) and the height of the antennas above grade ensure that most of the energy is propagated in a narrow beam above the roofs of the Market and nearby homes and offices. This has always been found to be the case when actual measured values are compared with the corresponding calculated values for a variety of representative installations and services [7], [8]. With respect to the proposed installation, be assured that the actual RF exposure levels in the vicinity of the site will be below any science-based safety and health standards and guidelines being used anywhere in the world and literally thousands of times below any level associated with verifiable evidence of any functional change in humans or laboratory animals. This holds true even when all transmitters operate *simultaneously and continuously at their highest operating power*.

In conclusion, the maximal levels of RF energy associated with the proposed personal wireless telecommunications installation will be far below any science-based safety standards and guidelines. The 60 plus year history of the study of potential biological effects associated with exposure to RF energy has led to a large scientific literature of refereed reports and studies. Continuing independent reviews of this literature by expert panels throughout the world conclude that the collective credible evidence, including the results of epidemiological studies of individuals exposed to radiowaves and laboratory studies of animals exposed both short-term and throughout their entire lifetimes, has not demonstrated that exposure to RF energy at levels that comply with contemporary science-based safety guidelines, such as those adopted by the FCC, can affect biological systems in a manner that might lead to, or augment, any health effect or interfere with the operation of medical devices such as hearing aids or implanted cardiac pacemakers. In support of this conclusion, the World Health Organization (WHO) published a position statement that specifically addresses base-stations used for personal wireless telecommunications. The WHO fact sheet concludes with the following:

> "*Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects*."[9]

[2] Annex B shows typical levels of RF energy in the home associated with commonly-used electronic devices.

Table 1
Engineering Specifications for a Proposed Wireless Telecommunications Installation
Hilltop Market, Stratford, CT

Specifications	Service AWS* (1970 - 2155 MHz)
maximum ERP per channel†	1133 watts
actual radiated power per channel	60 watts
actual *total* radiated power per sector	60 watts
number of transmitters	1 per sector
number of sectors configured	3
antenna centerline height above grade	21.5 ft ±
antenna manufacturer	Commscope
model number	HBXX-6513DS-VTM
gain	14.91 dBi
type	panel (directional)
downtilt	2º

†*Effective Radiated Power* (ERP) is a measure of how well an antenna concentrates RF energy; it is not the actual power radiated from the antenna. To illustrate the concept of "effective radiated power," compare the brightness of an ordinary 100 watt light bulb with that from a 100 watt spot-light. Even though both are 100 watts, the spot-light appears brighter because it concentrates the light in a specific direction. In this direction, the spot-light effectively appears to be emitting more than 100 watts. In other directions, there is almost no light emitted by the spot-light and it effectively appears to be much less than 100 watts.

Table 2
Summary of International, Federal, State and Consensus Safety Criteria for Exposure to RF Energy
(Frequencies Used for Personal Wireless Communication Systems: 600 MHz – 3000 MHz)

Organization/Government Agency	**Exposure Population**	**Power Density (*S*) (μW/cm²)**	
International Guidelines			
International Commission on Non-Ionizing Radiation Protection (1998), *Health Physics*, Vol. 74, No. 4, pp 494-522 [1]	Occupational	$S = f / 0.4$ ($f < 2000$ MHz)	$S = 5000$ ($f \geq 2000$ MHz)
	Public	$S = f / 2$ ($f < 2000$ MHz)	$S = 1000$ ($f \geq 2000$ MHz)
Federal Requirements			
Federal Communications Commission (47 CFR §1.1310) [2]	Occupational	$S = f / 0.3$ ($f < 1500$ MHz)	$S = 5000$ ($f \geq 1500$ MHz)
	Public	$S = f / 1.5$ ($f < 1500$ MHz)	$S = 1000$ ($f \geq 1500$ MHz)
Institute of Electrical and Electronics Engineers (IEEE Standard C95.1-2005) [3]	Occupational	$S = f / 0.3$ ($f < 3000$ MHz)	$S = 10{,}000$ ($f \geq 3000$ MHz)
	Action Level [4]	$S = f / 2$ ($f < 2000$ MHz)	$S = 1000$ ($f \geq 2000$ MHz)
National Council on Radiation Protection & Measurements (NCRP Report 86, 1986)	Occupational	$S = f / 0.3$ ($f < 1500$ MHz)	$S = 5000$ ($f \geq 1500$ MHz)
	Public	$S = f / 1.5$ ($f < 1500$ MHz)	$S = 1000$ ($f \geq 1500$ MHz)
State Codes			
New Jersey (NJAC 7:28-42)	Public	$S = f / 0.3$ ($f < 1500$ MHz)	$S = 10{,}000$ ($f \geq 1500$ MHz)
Massachusetts (Department of Health 105 CMR 122)	Public	$S = f / 1.5$ ($f < 1500$ MHz)	$S = 1000$ ($f \geq 1500$ MHz)
New York State [5]	Public	$S = f / 1.5$ ($f < 1500$ MHz)	$S = 1000$ ($f \geq 1500$ MHz)
NOTE—*f* is in MHz			

[1] Update of the 1989 International Radiation Protection Association (IRPA) guidelines. Reaffirmed in 1997 and published, with modification, in 1998.
[2] All licensees are required to comply with the limits outlined in 47 CFR §1.1307.
[3] Incorporates IEEE Standard C95.1-1991, IEEE Standard C95.1a-1998 and C95.1b-2004.
[4] The "action level" is defined as the level at which mitigative measures (e.g., an RF safety program) are implemented to protect against exposures that could exceed the upper tier (occupational limits).
[5] State of New York Department of Health follows the recommendations in NCRP Report 86.

Table 3

Summary of Calculated Maximal RF Power Density in Publicly Accessible Locations in the Vicinity of a Proposed Personal Wireless Telecommunications Facility

Hilltop Market, Stratford, CT

(Expressed in terms of RF power density and as a percentage of the 1996 FCC MPEs*)

Proposed Service: AWS – 2100 MHz

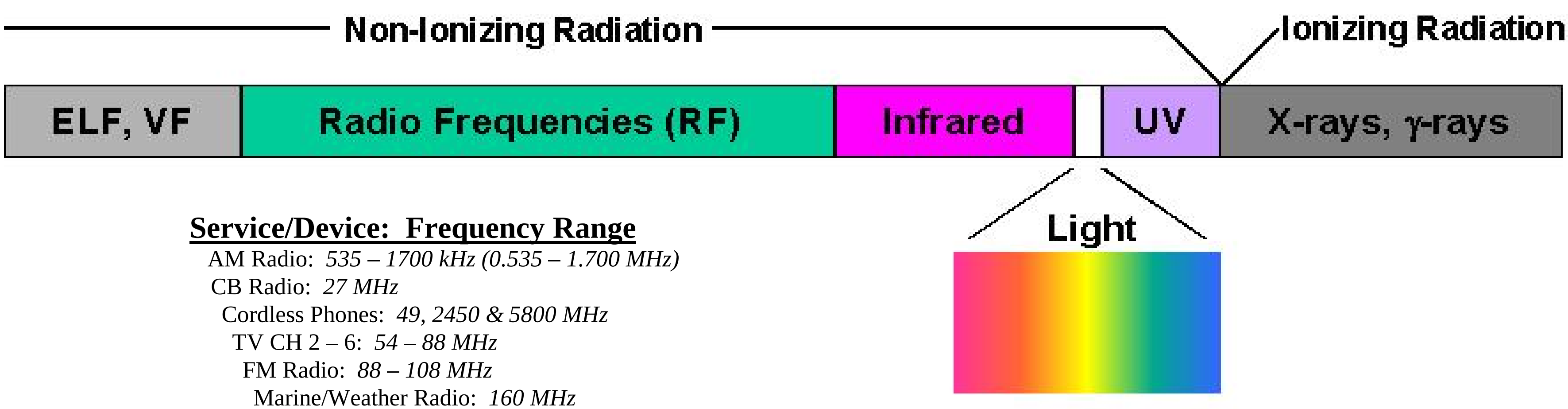
Service	Power Density (μW/cm^2)		% of MPEs*	
	6 ft AMGL†	16 ft AMGL†	6 ft AMGL†	16 ft AMGL†
AWS – 2100 MHz	< 24.5	< 194.3	2.45%	19.43%
		Total	**2.45%**	**19.43%**

* MPE: The FCC values for maximum permissible exposure, which are the same as the 1986 NCRP values at the frequencies of interest.

† AMGL: above mean grade level.

Figure 1

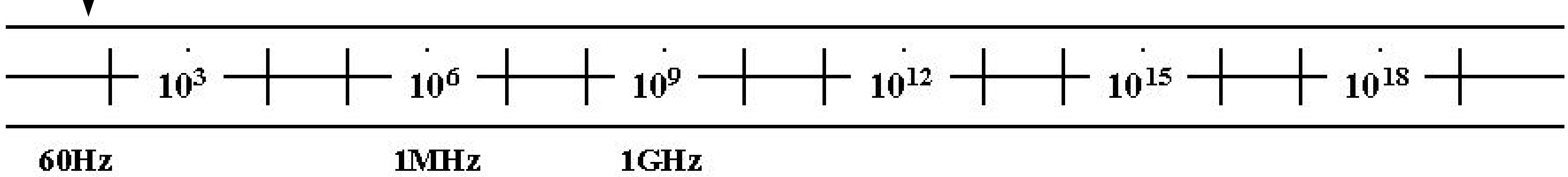
ELECTROMAGNETIC SPECTRUM



Service/Device: Frequency Range

AM Radio: *535 – 1700 kHz (0.535 – 1.700 MHz)*
CB Radio: *27 MHz*
Cordless Phones: *49, 2450 & 5800 MHz*
TV CH 2 – 6: *54 – 88 MHz*
FM Radio: *88 – 108 MHz*
Marine/Weather Radio: *160 MHz*
TV CH 7 – 13: *174 – 216 MHz*
TV UHF CH 14 – 69: *470 – 700 MHz*
Cellular Radio, ESMR, LTE 700, Paging/Data: *728 – 946 MHz*
Antitheft devices: *10 – 20 kHz and/or 915 MHz*
Wireless LAN (WiFi): *915, 2450 & 5800 MHz*
Microwave oven: *915 and 2450 MHz*
Personal Communication Services, AWS: *1800 – 2200 MHz*
Intrusion alarms/door openers: *10.5 GHz*
Microwave radio: *1 – 40 GHz*
Satellite communications: *100 MHz – 275 GHz*

Power Frequency (60 Hz)



References

[1] *OET Bulletin 65*, Edition 97-01, August 1997. Federal Communications Commission, Office of Engineering and Technology, Washington, DC

[2] Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56 (1996).

[3] IEEE Std C95.1-2005, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," Institute of Electrical and Electronics Engineers, Piscataway, NJ, 2005

[4] *Biological Effects and Exposure Criteria for Radio Frequency Electromagnetic Fields*, NCRP Report No. 86, National Council on Radiation Protection and Measurements, Bethesda, MD. (1986)

[5] ICNIRP (International Commission on Non-Ionizing Radiation Protection), "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)," *Health Physics*, vol. 74, no. 4, pp. 494-522, 1998

[6] ICNIRP (Commission on Non-Ionizing Radiation Protection), "ICNIRP Statement on the Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)," *Health Physics*, Vol. 97, No. 3, pp. 257-258, 2009.

[7] Petersen, R.C., and Testagrossa, P.A., "Radiofrequency Fields Associated with Cellular-Radio Cell-Site Antennas," *Bioelectromagnetics*, Vol. 13, No. 6. (1992)

[8] Petersen, R. C., "Levels of Electromagnetic Energy in the Immediate Vicinity of Representative Microwave Radio Relay Towers," *International Conference on Communications (ICC) Conference Record*, June 1979

[9] World Health Organization Fact sheet No. 304, "Electromagnetic fields and public health; Base stations and wireless technologies," May 2006. (Available at Internet site http://www.who.int/mediacentre/factsheets/fs304/en/)

ANNEX A

Calculation Method and Assumptions

The maximum radio frequency power density associated with a transmitting antenna can be calculated at any point in space using the Friis free-space transmission formula, i.e.

$$S = \left(\frac{P \cdot G_o(\theta)}{4\pi r^2} \right)$$

where

S = plane-wave equivalent power density (watts per square centimeter – W/m^2)

P = total radiated power (watts – W)

r = radial distance from the antenna to the point of interest (meters –m)

$G_o(\theta)$ = directional gain of the antenna in the radial direction of interest (compared with the gain of an isotropic radiator, i.e., a hypothetical antenna that transmits equally in all directions)

For the case at hand,

$$S = 4 \cdot \left(\frac{1.64 \cdot n \cdot P_n \cdot G_d(\theta)}{4\pi r^2} \right)$$

where

n = number of radio channels (transmitters) per sector

P_n = antenna input power per radio channel (watts – W)

$G_d(\theta)$ = directional gain of the antenna compared with a resonant half-wave dipole. The directional gain is obtained from the antenna manufacturer – e.g., Amphenol, Andrew, Commscope, Decibel, Powerwave.

1.64 = correction factor to convert $G_d(\theta)$ to $G_o(\theta)$

The factor of 4 is included to account for the possibility of constructive interference of reflections

The values shown in Table 3 are the theoretical maxima that could occur and are not typical values. There are a number of reasons why this is true including the following:

- The calculations include the effect of 100% field reinforcement from in-phase reflections, which quadruples the power density. Although this is possible theoretically for a single frequency and perfect reflecting surfaces, the probability of it occurring here is negligible.
- It is assumed that each transmitter operates continuously at maximum power listed in Table 1. In practice, adaptive power control is used to dynamically vary both the output power of the mobile device and base station so that no more power than is necessary is used at any given time. Thus the actual exposures may be considerably lower than the calculated values in Table 3.
- The combined maximum power density is obtained by adding the maximum values for each of the services. This assumes that the maximum power density for each service occurs at the same horizontal distance from the antennas, which is not the case.

Experience has confirmed that the analytical technique used in this analysis is extremely conservative and overestimates the actual RF power density. The actual (measured) power density levels have always been found to be smaller than the corresponding calculated levels, even when extrapolated to maximum-use conditions (all transmitters operating simultaneously) [7], [8].

ANNEX B

Radiofrequency (RF) in the Home: A Comparison of Exposures from Consumer Products with those from a Nearby Mobile Telephone Base Station

Numerous measurements of the typical radiofrequency (RF) exposure levels in the home have been carried out by various researchers and agencies throughout the world. For example, Croft, et al., carried out detailed measurements of typical exposures associated with consumer electronics in 20 homes in Australia [B1]. Included were microwave ovens, WiFi routers, cordless telephones, wireless computer keyboards, etc. Their results are summarized in the figures below. As seen in Figure B.1, most exposures are below 10% of the safety limits, with the microwave oven being the major contributor. The predicted maximal exposure values for the Verizon installation (as proposed) are 2.45% and 19.43% of the FCC safety guidelines at 6 ft and 16 ft above grade. These values, however, would occur ***outside*** of nearby homes and buildings, including the Hilltop Market—***not inside***. Because of the attenuation of building materials and the directionality of the antenna patterns, the corresponding levels from the Verizon installation would be far lower inside.

Figure B.1 – Exposure to individual devices—average of 20 homes (from Croft, et al., [B1])

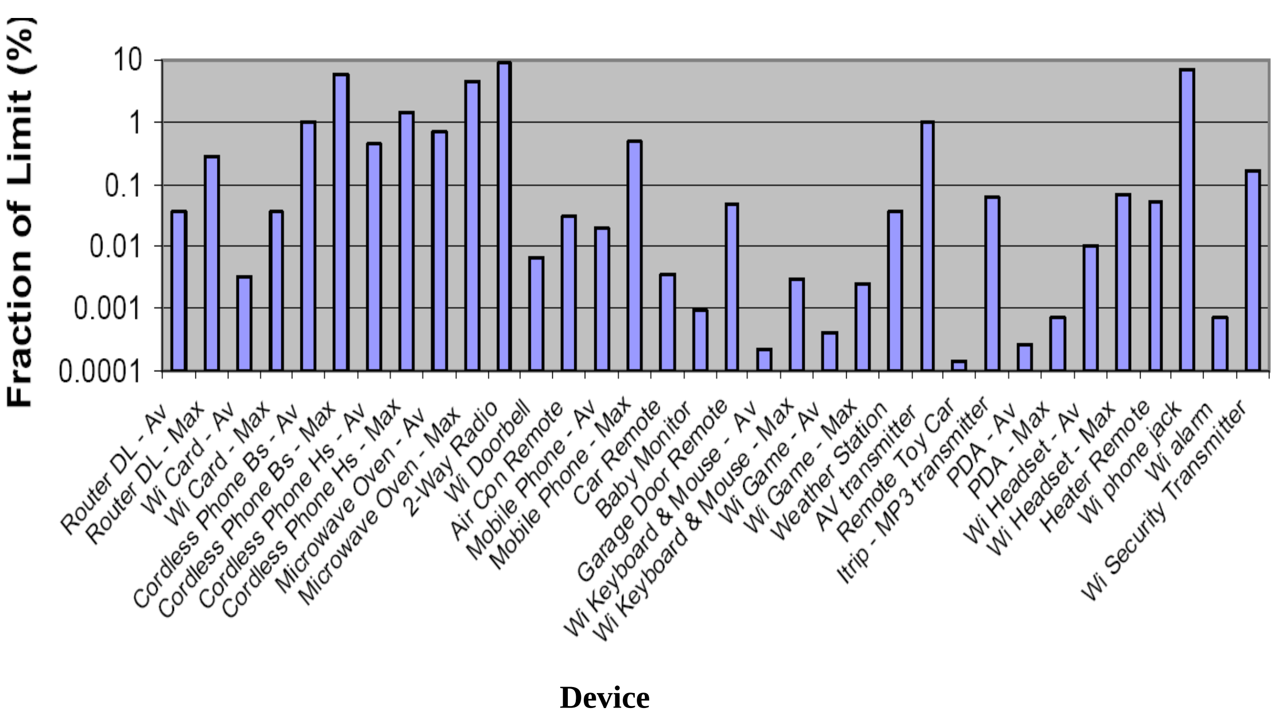
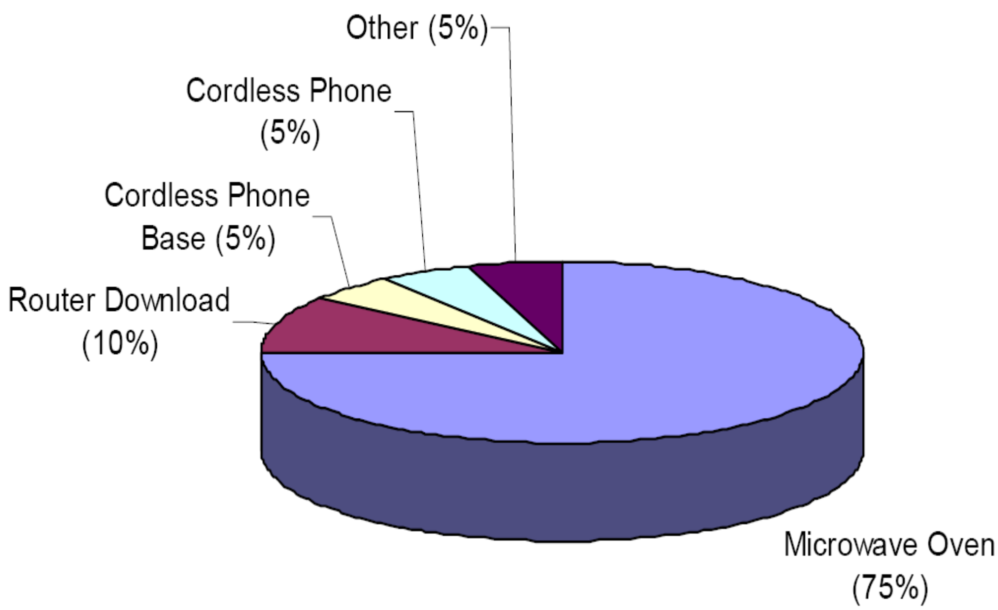


Figure B.2 – Maximum exposure in homes by device (from Croft, et al., [B1])



Reference

[B1] Croft, R., McKenzie, R., and Leung, S.,“EME In Homes Survey: Final Report,” *Australian Centre for Radio-frequency Bioeffects Research*, July 2009.

ANNEX C

Biography

Ron Petersen served four years as an aviation communications/radar technician in the US Marine Corps. He received the BSEE (1968) and MSEP (Electrophysics - 1970) degrees from the Polytechnic Institute of Brooklyn, NY. He joined the Bell Laboratories Solid-State Device Development Laboratory in 1960 and the Bell Laboratories Environmental Health and Safety Center in 1970. Up until his retirement in July 2001 he managed the Wireless and Optical Technologies Safety Department (WOTS), which served as the AT&T and then the Lucent Technologies Inc. resource on all non-ionizing radiation safety issues. He is now the president of an independent consulting firm, R C Petersen Associates LLC that specializes in RF safety issues.

Mr. Petersen served as Chairman of the Institute of Electrical and Electronics Engineers (IEEE)[3] International Committee on Electromagnetic Safety (ICES), Chairman of IEEE Standards Coordinating Committee 28 (SCC-28—Safety standards with respect to human exposure to electric, magnetic, and electromagnetic fields), Chairman of IEEE SCC-34 (Product performance standards relative to the safe use of electromagnetic energy), Chairman of the International Electrotechnical Commission (IEC)[4] Technical Committee 106 (Assessment of exposure of humans to electric, magnetic and electromagnetic fields), Chairman of ANSI/Accredited Standards Committee Z136 (Laser safety) and Chairman of ANSI/ASC Z136 Subcommittee 2 (Safety of optical fiber and free space optical communications systems). Mr. Petersen also served as Chairman of the National Council on Radiation Protection and Measurements (NCRP) Scientific Committee 89 (Non-Ionizing Radiation) and as Scientific Vice-President of the Non-Ionizing Radiation Program Area.[5] He is a former member of the NJ Non-Ionizing Radiation Advisory Committee to the NJ Commission on Radiation Protection. He served several terms as a member of the IEEE Standards Association Standards Board (SASB), chaired the SASB New Standards Committee and the SASB Audit Committee. He is an IEEE Life Fellow and a Fellow of the Laser Institute of America. He has published a number of papers and book chapters on the safety aspects of wireless technologies.

---

[3] IEEE is a non-profit technical professional society with more than 425,000 members in 160 countries. Within IEEE are 38 societies and 7 technical Councils, including the Consumer Electronics Society, Education Society, Electromagnetic Compatibility Society, Engineering in Medicine and Biology Society, Information Theory Society, Neural Networks Society, Society on Social Implications of Technology. While many IEEE societies sponsor standards committees, when the scope of a proposed standard overlaps the scope of several societies, "Standards Coordinating Committees" (SCC) are established to develop such standards—ICES is one such committee. IEEE membership is not a requirement for participation on an IEEE SCC or on any of its subcommittees.

[4] The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes international standards for all electrical, electronic and related technologies. These serve as a basis for national standardization and as references when drafting international tenders and contracts. The IEC charter embraces all electrotechnologies including electronics, magnetics and electromagnetics, electroacoustics, multimedia, telecommunication, and energy production and distribution, as well as associated general disciplines including, safety and the environment.

[5] NCRP is a non-profit corporation chartered by the U.S. Congress. The Charter of the NCRP includes as one of its objectives "To collect, analyze, develop and disseminate in the public interest information and recommendations about (a) protection against radiation (referred to herein as radiation protection) and (b) radiation measurements, quantities and units, particularly those concerned with radiation protection." Although more focused on "ionizing radiation," e.g., X-rays, gamma-rays, nuclear radiation, NCRP has developed several reports that address radiofrequency issues.