

Dr. Christopher C. Davis

March 30, 2018

Qualifications

PECO CD-1

Educational and Training

B.A., with Honors, Natural Sciences, Trinity College, Cambridge University (England).

Diploma, with Distinction, Advanced Studies in Science (Physics), University of Manchester (England).

M.A., Natural Sciences (Physics), Trinity College, Cambridge University (England).

Ph.D. Physics, University of Manchester (England).

Post-Doctoral Fellow, Applied and Engineering Physics, Cornell University (United States).

Present Position

Minta Martin Endowed Professor of Engineering and Professor of Electrical and Computer Engineering, University of Maryland.

Research Experience

Conducted a wide variety of scientific studies in the fields of physics, biophysics, and electrical engineering, and particularly studies on electromagnetics, bioelectromagnetics, and radio frequency electromagnetics, bioelectromagnetics, and dosimetry.

Conducted a substantial amount of research on radio frequency fields of the type produced by PECO's AMI electric and gas smart meters.

Publications

Authored or co-authored two books, twelve book chapters, 252 articles published in peer-reviewed scientific journals (principally reporting on studies conducted) and 321 papers

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presented at scientific conferences. Among those publications: 2 book chapters on radio frequency fields and 24 articles published in peer-reviewed scientific journals on radio frequency fields. Presented 55 papers at scientific conferences on radio frequency fields.

Teaching Experience

Students seeking Bachelor's degrees, Master's degrees, and Doctor of Philosophy (Ph.D.) degrees, on subjects including those in the fields of Physics and Electrical Engineering, particularly Electromagnetics (which includes radio frequency).

Supervised 71 students who ultimately earned Master of Science or Ph.D. degrees in Electrical Engineering, Physics, or Biophysics.

Professional Recognition

Fellow of the Institute of Electrical and Electronics Engineers (IEEE).- Previously Chair of Subcommittee on Radio Frequency Fields of IEEE Committee on Man and Radiation (COMAR).

Fellow of the Institute of Physics.

Reviewer of papers for a number of scientific publishers, including: American Industrial Hygiene Association Journal, Australian National Health Research Council, Bioelectromagnetics, Cambridge University Press, Radiation Research, Biochimica et Biophysica Acta, Environmental Biophysics, Applied Physics Letters, The British Council, IEEE Journal of Quantum Electronics, IEEE Journal on Selected Areas in Communication, IEEE Transactions on Biomedical Engineering, International Journal of Modern Physics, Journal of Applied Physics, Journal of Manufacturing Science and Engineering, Microelectronic Engineering, Radiation and

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Environmental Biophysics, Physiological Measurement, Physics in Medicine and Biology,
Environmental Biophysics, National Institutes of Health, National Science Foundation.

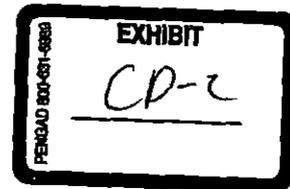
Expert Advice Experience

Provided expert advice on both power frequency and radio frequency fields, including dosimetry and proposed mechanisms for biological effects, to the United Kingdom Health Protection Agency, the U.S. National Institutes of Health, and the U.S. Food and Drug Administration's Center for Devices and Radiological Health.

Fields of Expertise Related to Testimony In This Case

Physics, Biophysics, Chemistry, Electrical Engineering, Electromagnetics, Bioelectromagnetics, and Radio Frequency Bioelectromagnetics and Dosimetry.

Recognized as an expert in those fields in several Pennsylvania Public Utility Commission proceedings in 2016, 2017, and 2018.



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**Terminology and Some Basic Concepts Relevant to My Testimony in This Case
PECO CD-2**

"EMF" is used as an abbreviation for several somewhat different terms. Sometimes it is used as an abbreviation for "electric and magnetic fields," particularly those around electrical appliances and powerlines, which can be easily separately measured; sometimes it is used as shorthand to refer to just the "magnetic fields" around electrical appliances and powerlines; and sometimes it is used as an abbreviation for "electromagnetic fields," particularly by physicists and electrical engineers. (I use it as an abbreviation for electromagnetic fields at frequencies where the electric and magnetic fields are normally measured together rather than separately.)

A "field" is an area around an object where an electric and magnetic component can be detected. An easy way to understand what a field is to think about the gravitational field we have on Earth, or the cool temperature field near an open refrigerator.

"Dosimetry" is the measurement and calculation of the level of electric and magnetic fields produced from a source. At the low frequencies used by powerlines and appliances, electric and magnetic fields are sometimes measured or calculated and referred to separately. At higher frequencies, such as radio frequency, the fields are normally measured or calculated together and referred to together as an electromagnetic field.

"Radiation" is a scientific term that describes how energy travels from a source, i.e., it "radiates" out from the source. An example of radiation is the waves that radiate out in a circle when a stone is tossed into a pond. TV and radio broadcast towers, powerlines, appliances, home wiring, and TV remote controls all produce fields that radiate out from the source. NASA has a good and simple statement about radiation on its website: "Radiation is energy that travels and

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spreads out as it goes - the visible light that comes from a lamp in your house and the radio waves that come from a radio station are two types of electromagnetic radiation." It is technically accurate to refer to radio frequency "radiation," but doing so sometimes confuses people into thinking about radio signals as though they can be harmful like sources of ionizing radiation such as medical X-rays.

There are 2 basic categories of electromagnetic radiation based on their fundamental capability and within those categories there are different types of electromagnetic fields that have different properties and thus different uses.

Physicists list sources of electromagnetic radiation on an electromagnetic spectrum in order from the longest wavelength, which has the lowest energy, to the shortest wavelength, which has the most energy. (A simplified representation of the electromagnetic spectrum is shown in exhibit CD-4.) The two fundamental categories of the electromagnetic spectrum are Non-ionizing radiation and Ionizing radiation.

The Ionizing Radiation category consists of the sources of waves that have enough energy to break chemical bonds in DNA. The Ionizing radiation category includes several types of ionizing radiation, such as Medical X-rays and Radioactive Sources, like the uranium used in bombs. The Ionizing radiation category also includes the Ultraviolet Light from the Sun (which we know can damage our skin).

The Non-ionizing category of the electromagnetic spectrum consists of waves that do not have enough energy to break any chemical bonds including the chemical bonds in DNA. That category has a number of types of radiation grouped in order starting with lower frequencies:

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from Extremely Low Frequency (produced from the electricity we use), up to Radio Frequency, and up to Infrared (e.g., used by TV remote controls), none of which has enough energy to break the chemical bonds in DNA and therefore are in the Non-ionizing Radiation category.

A radio frequency field is produced when an object sends a signal in the radio frequency range, most commonly for radio communications. The radio frequency range is generally considered to be from 3 kHz (kilo Hertz) to 300 GHz (Giga Hertz).

Microwave signals are the part of the radio frequency range between 300 MHz and 3GHz. Therefore, all microwave signals are radio frequency waves. When the term "microwaves" is used in communicating about devices that produce microwave signals but are not microwave ovens, people who are not physicists or electrical engineers can incorrectly assume that the devices have the same properties as microwave ovens.

Microwave ovens are designed to produce radio frequency waves that are intense enough to quickly heat biological matter (food and liquids) to a very high temperature and exposure to those intense waves is dangerous. All devices that use radio frequency fields in the microwave portion of the radio frequency range, however, do not produce a wave that is intense enough to heat biological matter. Smart meters are a good example of those kinds of devices. They operate in the microwave frequency range but they do not produce a wave that is intense enough to heat biological matter. In communicating with people who are not physicists or electrical engineers, unless I am talking about the properties of a microwave oven, I use the term "radio frequency" to avoid giving a false impression that a particular device produces a wave that is as intense as that of a microwave oven.

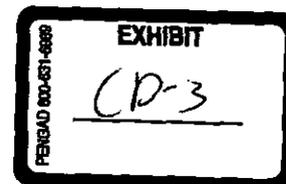
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Almost all of the electricity we use in our houses and other structures has always been produced by rotating generators at power stations. Those generators produce electricity that is transmitted to us at 60 Hz (in the United States) but it also includes harmonic waves at multiples of 60 Hz (120 Hz, 180 Hz, 240 Hz, etc.). Harmonics are not considered "dirty electricity" because they are a natural byproduct of generating electricity. AMI meters do not *generate* electricity and therefore do not produce harmonics. They simply measure the electricity flowing into a house or other structure.

Some people have expressed concern about switching-mode power supplies in electrical devices like appliances and smart meters. Switching-mode power supplies generate radio frequency fields at up to about 10 MHz at very low levels. Many modern electrical appliances use switching mode power supplies. Switching mode power supplies have filters to reduce radio frequency and other signals to avoid interference with other devices.

AMI meters do not interfere with the operation of house wiring. In that regard, they behave no differently than old mechanical meters. The very low amplitude radio frequency signals generated by the power supplies in modern electronics, including smart meters, are largely filtered out and are heavily attenuated by resistance when they try to travel along house wiring. That is why, when we want to transmit radio frequency signals for cable TV, we use coaxial cables and not ordinary house wiring. Typical household appliances can generate radio frequency fields that are much larger than those generated by AMR or AMI meters.



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**PECO's AMI Meters and
Federal Communications Commission Exposure Limits for Smart Meters
PECO CD-3**

PECO's AMI meters only send radio signals. A natural result of sending a radio signal is the creation of a radio frequency field near the source of the signal. PECO's AMI meters produce radio frequency fields only when they are sending signals, not otherwise. PECO's AMI meters do not produce ionizing radiation.

There is nothing unusual about the radio frequency fields from PECO's AMI meters, other than that their level is extremely low. The fields from PECO's AMI meters are the same types of fields that are used for radio communications by common everyday equipment and devices, including radio stations, TV stations, garage door openers, baby monitors, cell phones, Wi-Fi, and other wireless communications devices.

In communications physics and engineering, "pulsed" means using 1) amplitude modulation that is 2) done in a way that produces a signal that has abrupt changes in the amplitude of the sine wave. PECO's AMI meters produce frequency modulated, specifically "frequency shift keyed," regular non-pulsed sine waves. PECO's AMI meters do not emit "spikes" – they send out regular sine waves. The sine waves are not amplitude modulated. Therefore, PECO's AMI meters do not send out pulsed signals.

There is a scientifically reliable basis for determining whether the radio signals periodically sent by PECO's AMI meters produce safe levels of radio frequency fields. That is by determining whether the radios in PECO's AMI meters exceed or do not exceed the Federal

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Communications Commission's (FCC) Maximum Permissible Exposure Limits for non-portable devices that transmit radio frequency signals, which cover smart meters.

The FCC's Maximum Permissible Exposure limits vary depending on the frequency range used for the radio transmission. The FCC's limits for the general population are a 30-minute average power density.

The FCC's Maximum Permissible Exposure Limits for non-portable devices that transmit radio frequency signals are based on exposure guidelines issued by two expert organizations: 1) the U.S. National Council on Radiation Protection and Measurements (NCRP) and 2) the American National Standards Institute (ANSI).

In their exposure guidelines NCRP and ANSI specifically took into consideration studies of *both* thermal exposure levels (i.e., those that can produce tissue heating) and non-thermal exposure levels (i.e., those that are too low to produce tissue heating). Both found that the studies of non-thermal exposures did not show they caused any adverse biological effects. The FCC states on its website that the scientific evidence for adverse biological effects from non-thermal exposure levels remains "unproven." It explains: "A number of reports have appeared in the scientific literature describing the observation of a range of biological effects resulting from exposure to low levels of RF energy. However, in most cases, further experimental research has been unable to reproduce these effects. Furthermore, since much of the research is not done on whole bodies (in vivo), there has been no determination that such effects constitute a human health hazard." I agree with the FCC.

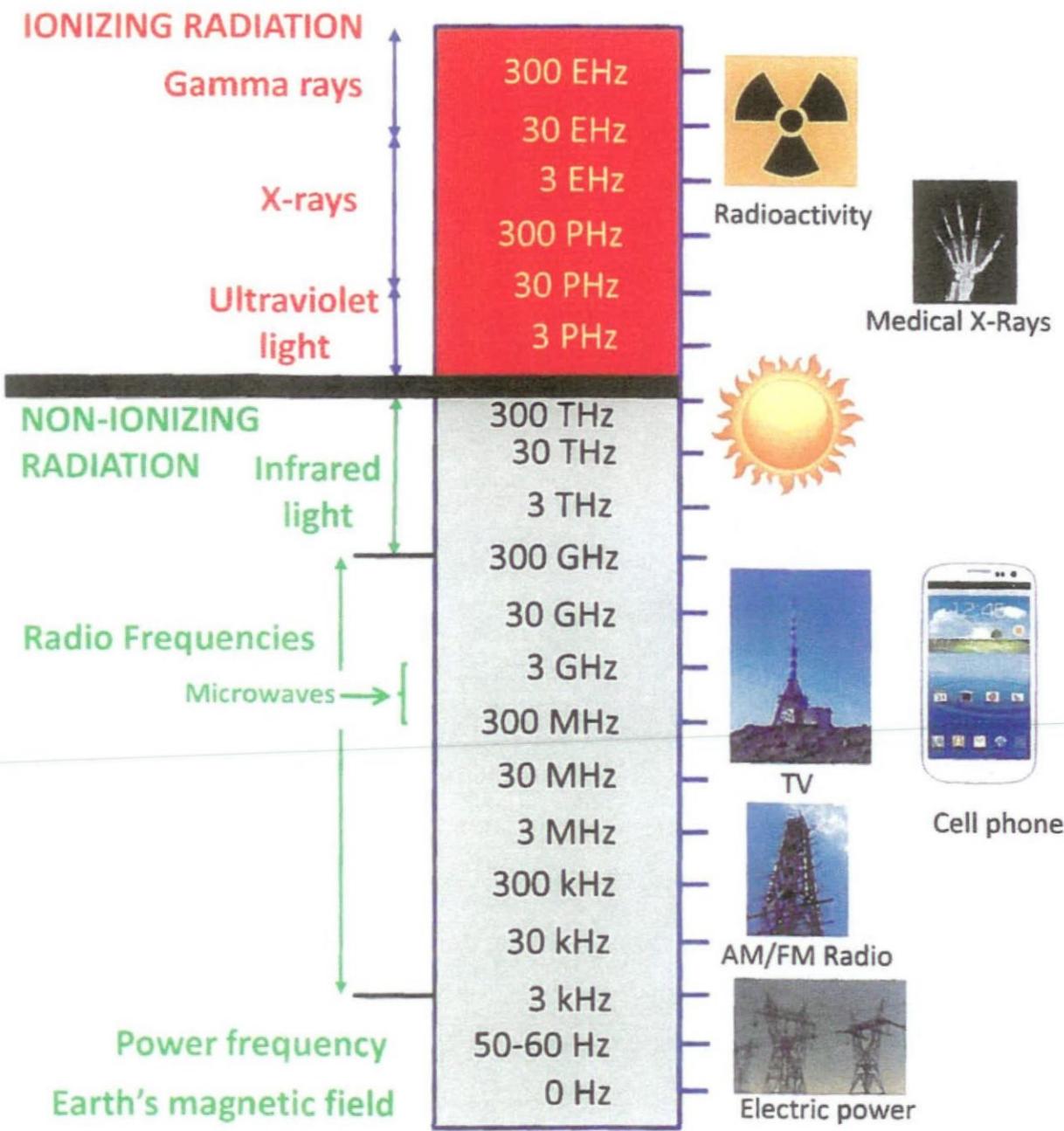
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The FCC's view about non-thermal radio frequency field exposure is shared by the consensus of independent scientists who are expert in radio frequency bioelectromagnetics. The international expert group ICNIRP has found that "[t]he studies conducted so far have not provided consistent evidence of biological effects under non-thermal RF exposure conditions." [ICNIRP 2009, 155] A recent review by the New Zealand Ministry of Health concluded "thermal effects are the only ones for which there is clear evidence." [New Zealand 2015, 32] This view is also set forth in the recent finding by the expert committee advising the European Commission on EMF/RF issues. [SCENIHR 2015, pp. 24 and 59]. In sum, the scientific consensus is that exposure to non-thermal level radio frequency fields does not produce any "non-thermal effects."

Based on the scientific studies, NCRP and ANSI both identified the same threshold level (i.e., lowest level) of radio frequency exposure at which a potentially adverse biological effect could occur, which was found to be at a level where there could be tissue heating. Before setting its maximum permissible exposure limits, the FCC consulted with the U.S. Food and Drug Administration, the Environmental Protection Agency, the Occupational Safety and Health Administration, and the National Institute of Occupational Safety and Health. Each of those agencies supported the FCC setting its exposure limits based on the threshold level identified by NCRP and ANSI. The FCC then applied safety factors to that threshold level, resulting in even more strict FCC Maximum Permissible Exposure limits.

The Electromagnetic Spectrum



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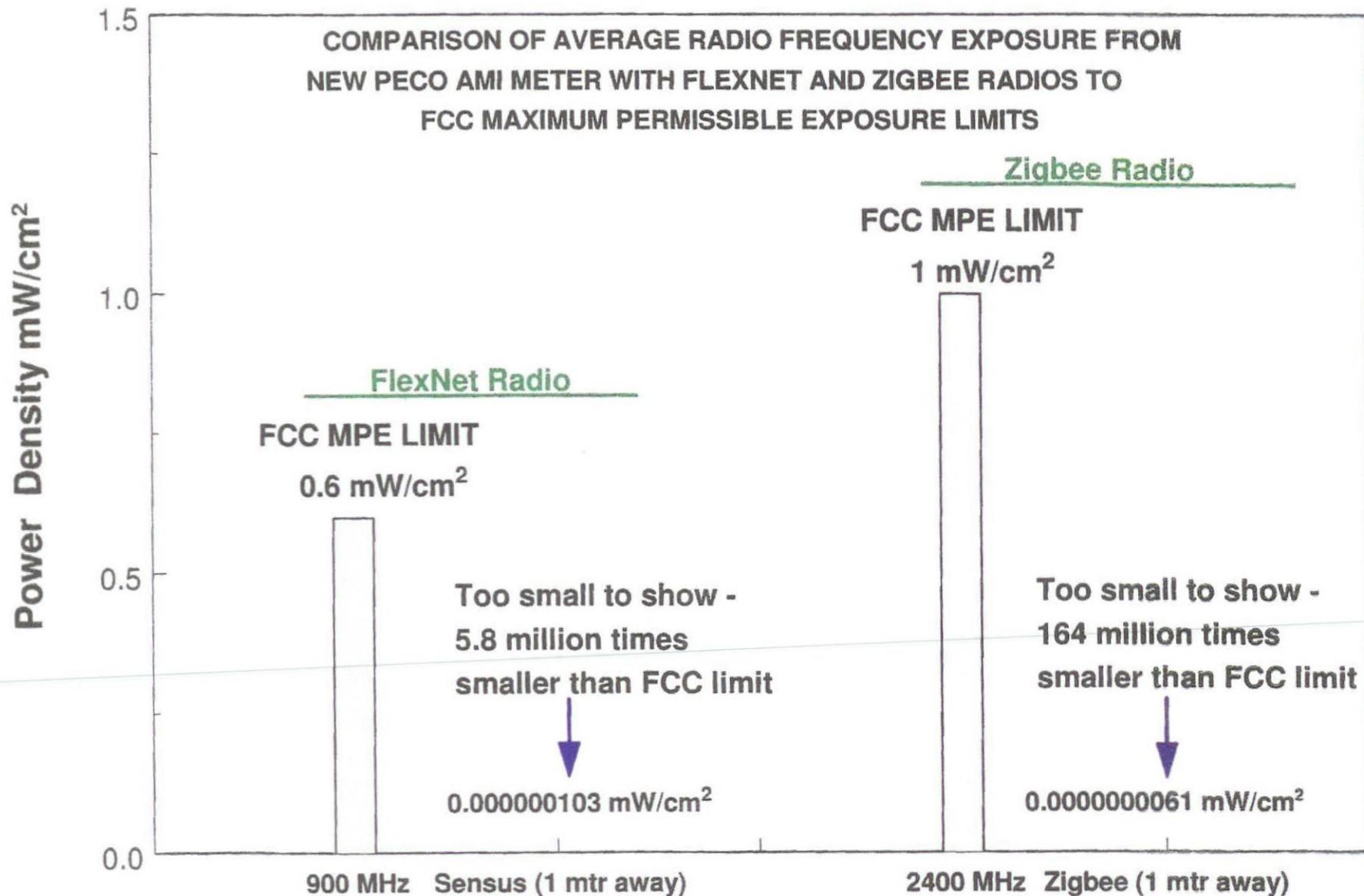
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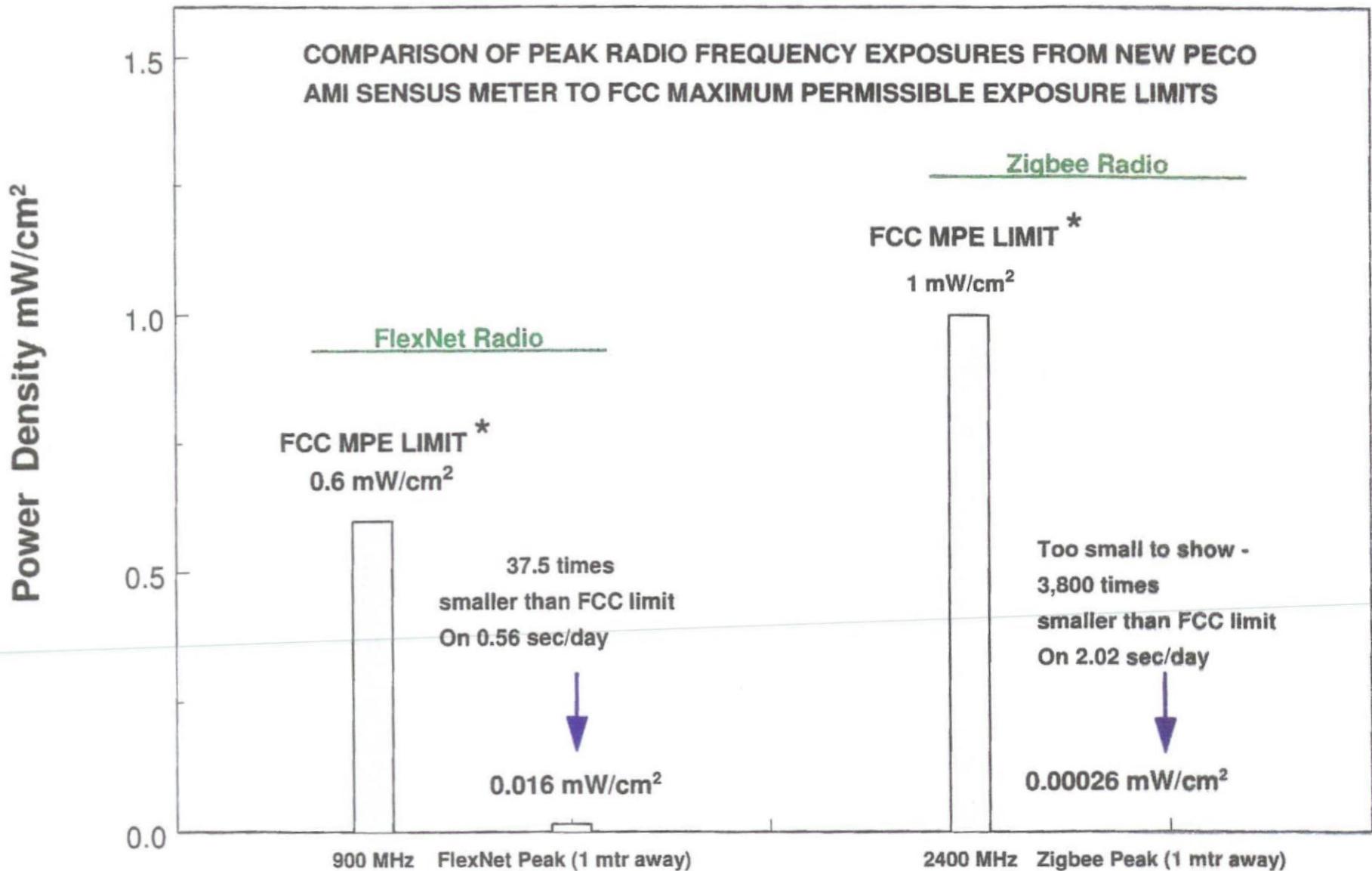
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EXHIBIT
CD-4

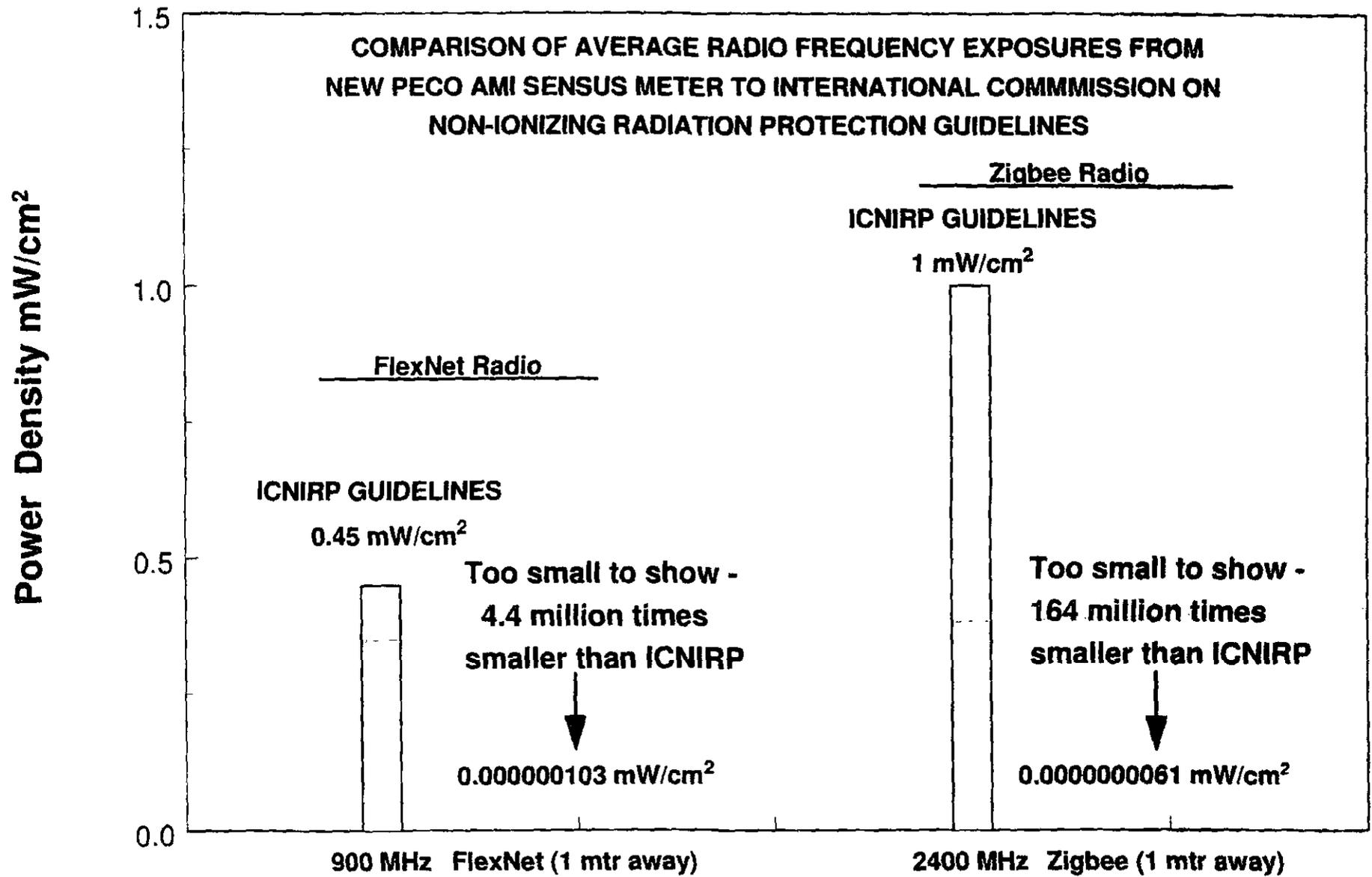
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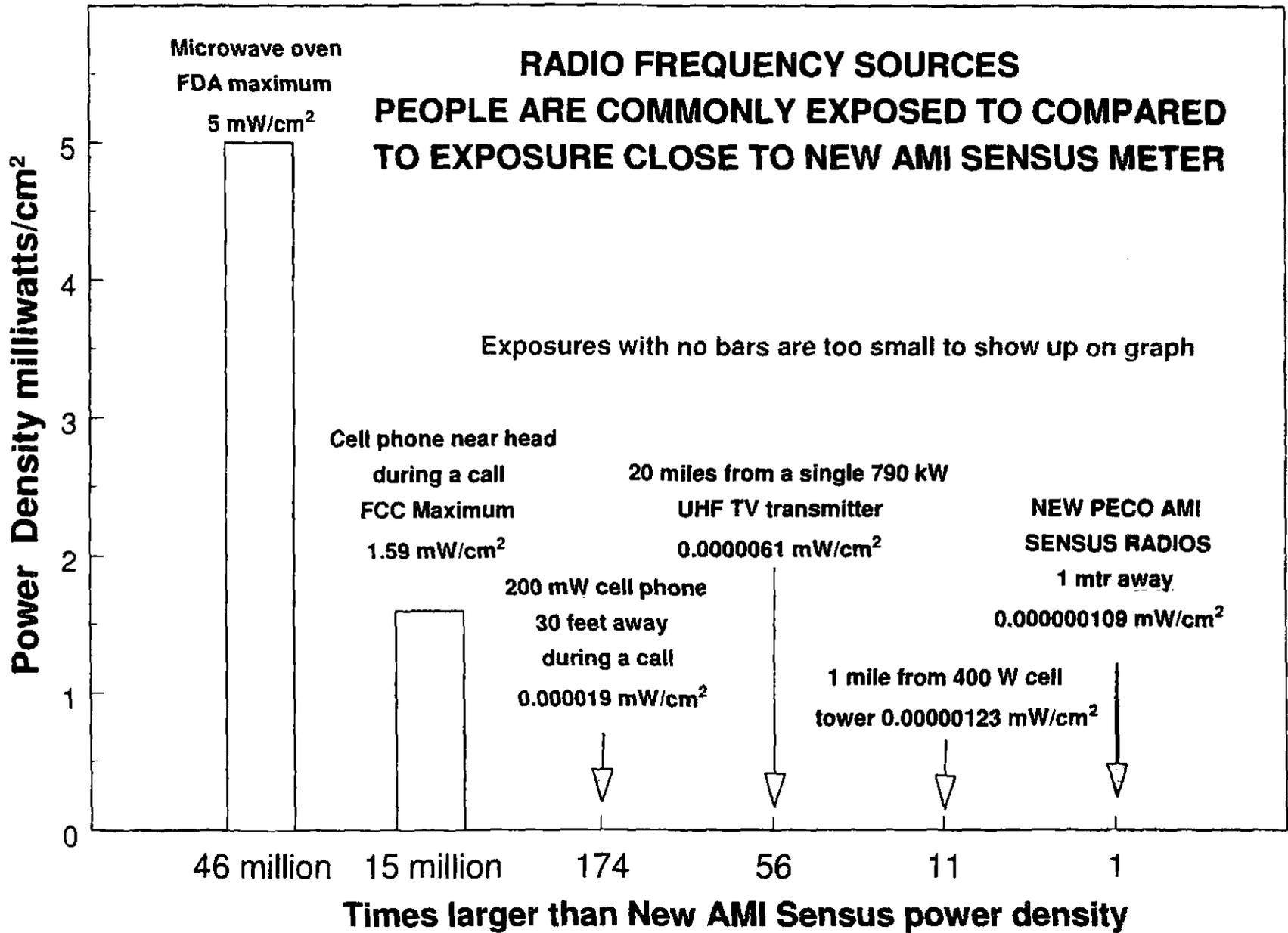
COMPARISON OF AVERAGE RADIO FREQUENCY EXPOSURE FROM
NEW PECO AMI METER WITH FLEXNET AND ZIGBEE RADIOS TO
FCC MAXIMUM PERMISSIBLE EXPOSURE LIMITS

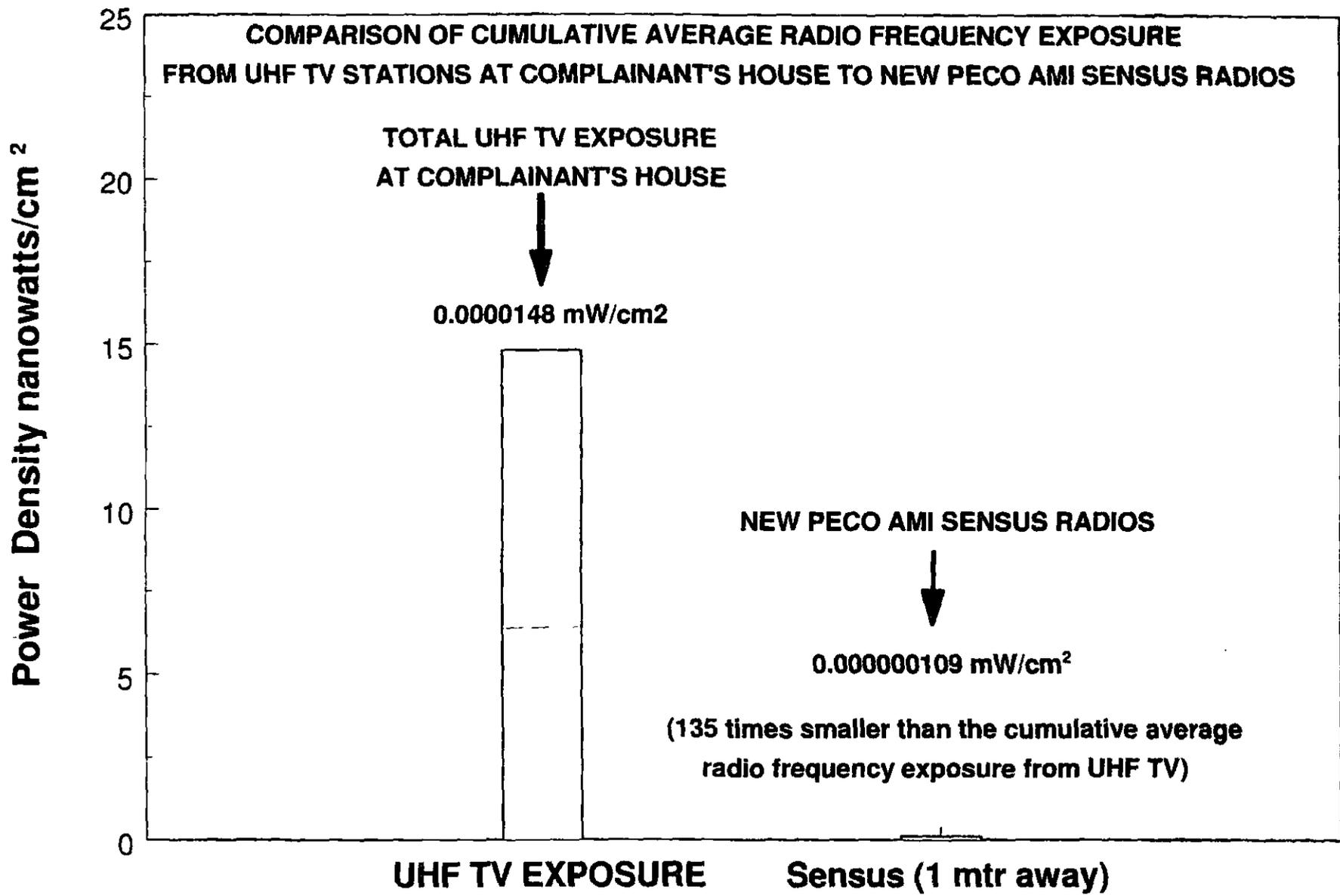




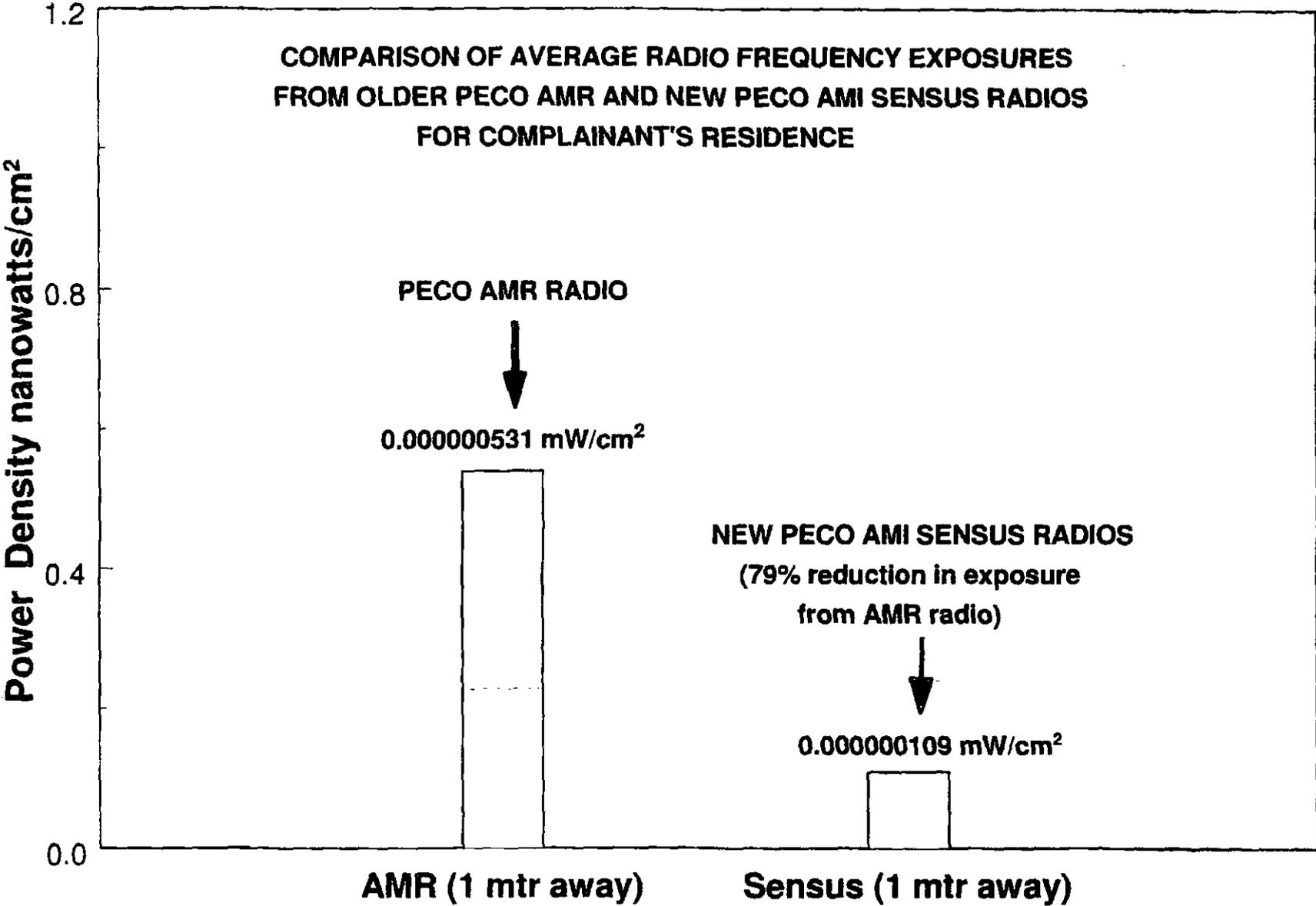
* FCC Limits are on radio's 30 minute average, not its peak

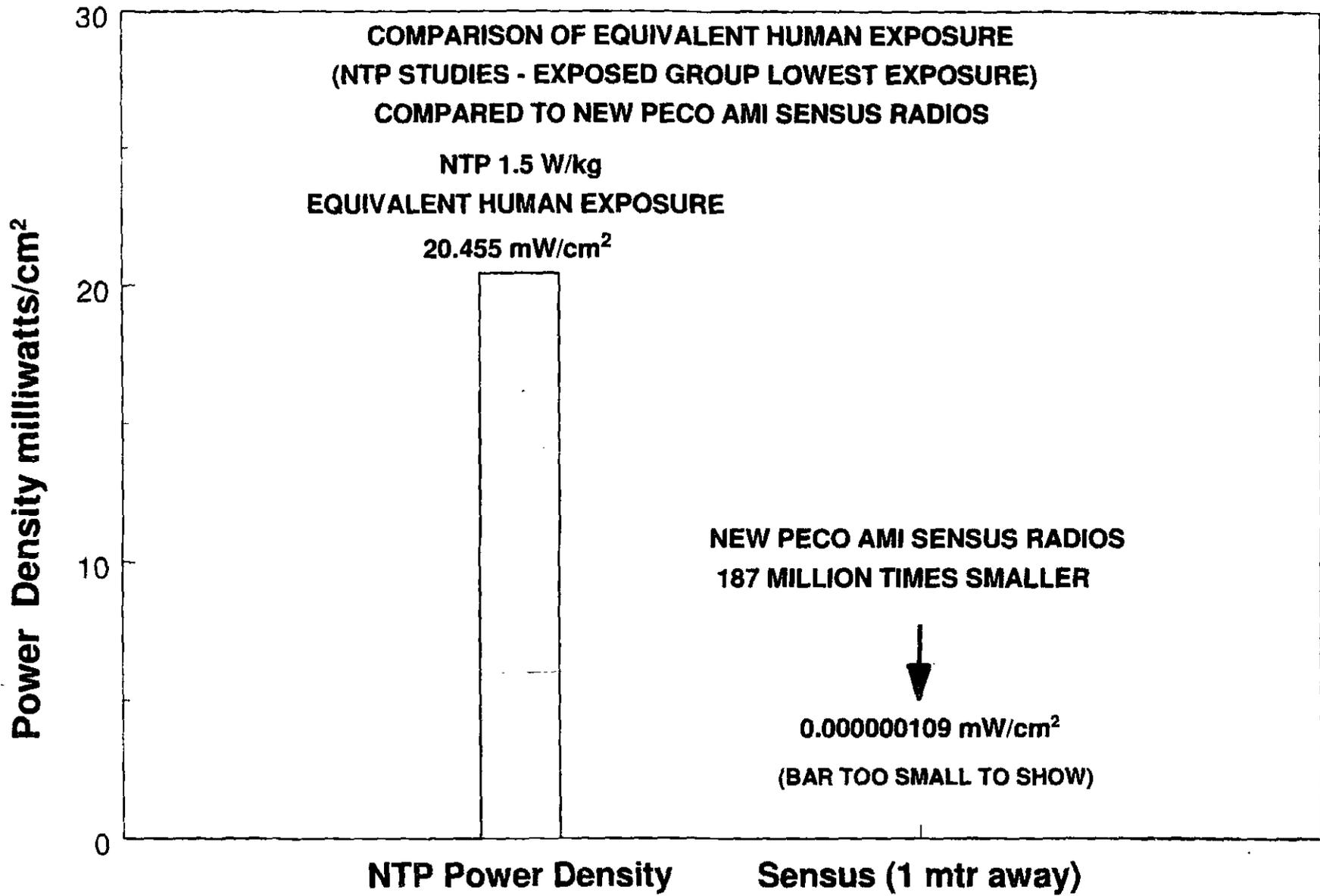






**COMPARISON OF AVERAGE RADIO FREQUENCY EXPOSURES
FROM OLDER PECO AMR AND NEW PECO AMI SENSUS RADIOS
FOR COMPLAINANT'S RESIDENCE**





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Summary of What Exhibits CD-4 – CD-11 Show

PECO Exhibit CD-12

Exhibit CD-4 shows the Electromagnetic Spectrum and the frequencies used by various sources of electromagnetic fields, including natural sources and systems, equipment, and devices.

Exhibit CD-5 shows that the radios in PECO's new AMI electricity meter comply with the FCC's Maximum Permissible Exposure Limits. Compared to the FCC's Maximum Permissible Exposure Limits, the FlexNet radio exposure is 5.8 million times smaller and the ZigBee radio is 164 million times smaller.

Exhibit CD-6 compares the *peak* exposure from the FlexNet and ZigBee radios in PECO's new AMI electricity meter to the FCC Maximum Permissible Exposure Limits, even though those limits only apply to the 30-minute average exposure and not the peak exposure. It shows that, compared to the FCC limits, the peak exposure from the FlexNet radio is 37.5 times smaller and the peak exposure from the ZigBee radio is 3,800 times smaller.

Exhibit CD-7 shows that, compared to the International Commission on Non-Ionizing Radiation Protection (ICNIRP) exposure guidelines, the radio frequency exposure from the FlexNet radio in the new PECO AMI electricity meter is 4.4 million times smaller and from the ZigBee radio is 164 million times smaller. (The FCC has not adopted the ICNIRP guidelines).

Exhibit CD-8 compares the radio frequency exposure close to the FlexNet and ZigBee radios in the new PECO AMI electricity meter to the radio frequency exposure from sources of radio frequency fields people are commonly exposed to, showing:

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1) people are and have been commonly exposed to radio frequency fields from a number of sources for many years that have much higher power density than the PECO AMI electricity meter;

2) compared to the exposure close to PECO's AMI electricity meter, the power density from:

(a) exposure 1 mile from a 400-Watt cell phone tower is 11 times larger,

(b) exposure 20 miles from a single 790-Kilowatt UHF TV broadcast transmitter is 56 times larger,

(c) exposure 30 feet away from a 200-milliwatt cell phone when someone else is making a call is 174 times larger,

(d) exposure allowed by the FCC from using a cell phone near the head during a call is 15 million times larger, and

(e) exposure allowed by the FCC from a microwave oven is 46 million times larger.

Exhibit CD-9 shows that at complainant's house the radio frequency exposure close to the radios in the new PECO AMI electricity meter is 135 times smaller than the cumulative average exposure there from UHF TV broadcast towers.

Exhibit CD-10 shows that installing the new PECO AMI electricity meter in place of the old AMR meter will reduce the radio frequency field exposure by 79%.

Exhibit CD-11 shows that compared to the equivalent human exposure at the lowest radio frequency field exposure of the exposed group in the National Toxicology Program (NTP)

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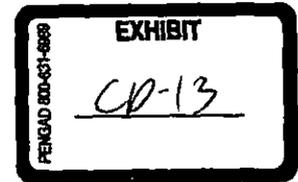
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studies (identified in draft Technical Reports issued by NTP February 2, 2018), the exposure close to the new PECO AMI electricity meter is 187 million times smaller.

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Opinions
PECO Exhibit CD-13

I hold each of the following opinions to a reasonable degree of scientific certainty:

1. The opinions in PECO CD-2 – CD-12.
2. The levels of radio frequency fields from PECO's AMI electricity meter comply with the Federal Communications Commission safety limits that apply to smart meters.
3. There is not a reliable scientific basis to conclude that radio frequency fields from PECO's AMI meters are capable of causing any adverse biological effects.

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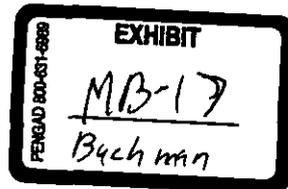
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Exhibit MB-17

SAR Test



2.5.1 Exemption Limits for Routine Evaluation — SAR Evaluation

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in [Table 1](#)

Table 1: SAR evaluation — Exemption limits for routine evaluation based on frequency and separation distance

Exemption Limits (mW)					
Frequency (MHz)	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Exemption Limits (mW)					
Frequency (MHz)	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

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Qualifications

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Medical Education: M.D., Albert Einstein College of Medicine.

Medical Training: Internship, Harvard Medical School and affiliated hospitals; Residency in Pediatrics, Harvard Medical School and affiliated hospitals.

Medical Practice Licenses: California; New Hampshire.

Medical Certifications: Diplomate, American Board of Pediatrics.

Present Positions: Professor, Dartmouth Medical School; Executive Director, Israel Cancer Research Fund

Medical Research Experience:

National Institutes of Health, Bethesda, Maryland (14 years)

Research Associate, National Institute of Allergies and Infectious Diseases

Senior Investigator, National Institute of Allergies and Infectious Diseases

Clinical Associate, Pediatric Branch, National Cancer Institute.

Senior Investigator, Pediatric Branch, National Cancer Institute

Head, Molecular Genetics Section, Pediatric Branch, National Cancer Institute.

University of California Medical School, San Francisco, California (11 years)

Department of Pediatrics

Brain Tumor Research Center

Molecular Medicine Program

Developmental Biology Program

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Preuss Laboratory for Molecular Neuro-Oncology (Director)

Dartmouth College, Hanover, New Hampshire (16 years and ongoing)

Medical School

Dartmouth-Hitchcock Cancer Center (Director, 15 years)

Medical Research Publications and Evaluations: Author of 246 medical research articles; evaluation for scientific journals of research papers submitted for publication (39 years); evaluation of power and radio frequency research on electromagnetic fields and health (32 years); editorial staff of scientific journals (24 years).

Medical Practice Experience

U.S. Public Health Service (14 years)

University of California Medical School affiliated hospitals (11 years)

Dartmouth Medical School affiliated hospitals and Dartmouth-Hitchcock Cancer Center (15 years)

Medical Teaching Experience

Professor, University of California Medical School (11 years) (Kathleen M. Plant

Distinguished Professor, 4 years)

Professor of Medicine, Pediatrics, and Molecular and Systems Biology, Dartmouth Medical School (16 years)

Students: medical school students, interns, residents, and practicing physicians.

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Subjects include: pediatrics, anatomy, endocrinology, immunology, hematology, neurology, neurosurgery, cardiology, biochemistry, cell biology, genetics, molecular genetics, medical oncology, and radiation oncology.

Supervised research of candidates for Ph.D. degrees in Genetics and in Systems and Molecular Biology.

Supervised advanced research training of over 50 post-doctoral fellows who previously earned M.D. or Ph.D. degrees.

Professional Recognition (examples)

American Association for the Advancement of Science Fellow (Elected)

American Society for Clinical Investigation (Elected)

Pediatric Consultant, National Institutes of Health

Pediatric Policy and Coordination Committee, National Institutes of Health

C. Everett Koop Courage Award

Board of Directors, Foundation for Advanced Education in the Sciences (Elected)

Association of American Physicians (Elected)

PDQ Pediatric Cancer Treatment Editorial Advisory Board

Chair, Scientific Advisory Board, Yale Cancer Center

Eurocan Platform Scientific Advisory Board, Sweden

International Board of Trustees, Israel Cancer Research Fund

Farber Award, American Association of Neurological Surgeons

Board of Directors, Association of American Cancer Institutes

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Heinz Karger Memorial Foundation Prize

National Cancer Institute Board of Scientific Counselors, National Institutes of Health

Reviewer, International Human Frontier Science Organization

Scientific Advisory Committee, The Robert Steel Foundation

Selection Committee, Pediatric Scientist Development Program

CCG Genetic Epidemiology Committee

Reviewer, John Sealy Memorial Endowment Fund Review Panel

Referee, Italian Ministry for Education University and Research

Reviewer, Medical Research Council of New Zealand

CCG Biology Research Steering Committee

Scientific Advisory Board, Damon Runyon-Walter Winchell Foundation

National Institutes of Health Clinical Investigator Award Committee

Reviewer, Cell Biology Program, National Science Foundation

Pediatric Consultant, National Institutes of Health

U. S. Public Health Service Commendation Medal (twice)

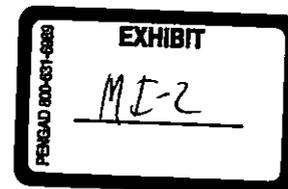
Fields of Expertise Related to Testimony In This Case

Medicine; medical research; radio frequency electromagnetic fields and health.

Recognized as an expert in those fields in prior Pennsylvania Public Utility Commission proceedings in 2016, 2017, and 2018.

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Methodology of Medical Evaluation
PECO MI-2

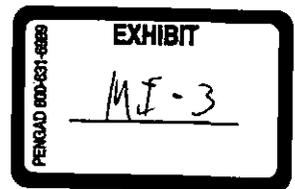
I use the same methodology that I use in usual course of my medical work when determining whether an exposure causes, contributes to, or exacerbates a reported medical condition or symptom.

1. Conduct new searches of medical and scientific databases to identify all studies, both those that report an effect and those that report no effect, of radio frequency fields and the reported medical conditions and symptoms.
2. Analyze individually all studies identified in step 1 that I have not previously analyzed. (If study previously analyzed but all important elements do not immediately come to mind, I analyze study again.)
3. Evaluate all studies identified, both those that report an effect and those that report no effect, taking into account what each type of study can and cannot show, quality of study design and protocol, performance of study in accordance with the protocol, size of study population, completeness of data reporting, use of standard statistical methods for data analysis, and any other factors that may affect the reliability of the study data.
4. Make initial determinations of what the studies as a whole show for each particular reported medical condition and symptom.
5. Consider other reliable sources of information published by public health authorities and their expert panels for their evaluations of the studies, insights, and conclusions.
6. Make final medical evaluation.

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Medical Evaluation

PECO MI-3

Complainant claims she has “electromagnetic hypersensitivity” (because of permanent physical damage from chronic Lyme disease). (Complaint PDF page 9)

Complainant claims that as a result of that condition she has symptoms that include acute tachycardia, chest pain, palpitations, feelings of paralytic heaviness, muscle spasms, shaking, severe brain fog that interferes with daily mental functions, and anxiety.” *Id.*

Complainant forwarded to PECO a letter dated March 29, 2017, from Dr. Peter Prociuk that recounts those symptoms and states that complainant “discovered that Electromagnetic Hypersensitivity Syndrome accounted for all of her symptoms.”

In attrition, that letter says she reported various of her symptoms increased in public places from LED lighting, LED television screens, scanners at store check-out counters, electric lighting, sound systems, personal electronic devices of others, and proximity to smart meters in other’s homes. (PECO exhibit BU-7)

That letter also reported that complainant (1) had an episode of tachycardia and a feeling of paralytic heaviness on August 5, 2012 but an emergency room evaluation “revealed no obvious abnormality” and she was “given a diagnosis of acute panic disorder” and (2) in June 2016 complainant had an emergency room evaluation for tachycardia, chest pain, and foggy head and “[a]gain the findings were unremarkable.” *Id.*

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This medical evaluation was arrived at using the Methodology of Medical Evaluation in PECO MI-2.

Studies of people who claim to have electromagnetic hypersensitivity (EHS) have examined whether there is a relationship between the various self-reported symptoms, including those reported by complainant, and exposure to actual radio frequency fields.

As explained in a systematic review of the studies by Rubin:

"The aetiology [cause] of 'electromagnetic hypersensitivity' is controversial. While most patients and some scientists believe that the condition is caused by an as yet unrecognised 'bioelectromagnetic' mechanism, most mainstream medical bodies maintain that there is not sufficient evidence to support this theory and that the symptoms experienced by sufferers are unrelated to the presence of electromagnetic fields. Indeed, a working group of the World Health Organisation has recommended that the use of terms like 'electromagnetic hypersensitivity' should be discontinued in favour of the more aetiologically [causologically] neutral phrase 'idiopathic environmental intolerance attributed to electromagnetic fields...'" [Rubin 2010] (emphasis added)

(Even though the World Health Organization (WHO) prefers the term Idiopathic Environmental Intolerance attributed to Electromagnetic Fields, it also continues to refer to electromagnetic hypersensitivity on its website, which is the term often used by people who claim they have such a condition.)

For purposes of a medical evaluation, I believe "Idiopathic Environmental Intolerance attributed to Electromagnetic Fields" (IEI-EMF) is a medically more neutral term and that is why I use it.

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There are reliable controlled laboratory studies of IEI-EMF dating back to at least 2002, and also reviews of studies and reviews by public health authorities. The reviews found IEI-EMF and the variety of symptoms and conditions attributed to it are not caused by radio frequency fields. Studies evaluated in such reviews are designed to determine whether reported conditions and symptoms are related to actual exposure to electromagnetic fields rather than sham (no actual) exposure and are called “provocation studies.”

An early and careful study [Hietanen 2002] of people who claimed they were hypersensitive to electromagnetic fields is revealing. That study used a double-blind design, which means neither the subjects being studied nor the researchers knew when there was or was not radio frequency field exposure. *The study used radio frequency fields of 900 and 1800 MHz from cellphones and a sham exposure. (Dr. Davis informs me that the maximum allowable radio frequency field levels from cellphones are almost 15 million times higher than the radio frequency fields 1 meter from a PECO AMI ACLARA meter.)* The study found that the number of reported symptoms was higher during sham exposure than during actual exposure and none of the test subjects could distinguish actual radio frequency field exposure from sham exposure. The study concluded that adverse subjective symptoms and sensations perceived by the test subjects were not produced by radio frequency fields.

Another study designed to determine if radiofrequency fields affected the well-being of individuals who claimed to have electromagnetic hypersensitivity, compared to those who did not, found that those who made that claim reported lower levels of well-being when they knew they

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were exposed to a radiofrequency field, but when they did not know whether they were exposed their symptoms were not associated with exposure to radio frequency fields (Eltiti 2015).

The systematic review of the studies of Idiopathic Environmental Intolerance to Electromagnetic Fields by Rubin, referred to above, was careful and thorough and reported:

“Including studies reported in our earlier review, 46 blind or double-blind provocation studies in all, involving 1175 IEI-EMF [Idiopathic Environmental Intolerance to Electromagnetic fields] volunteers, have tested whether exposure to electromagnetic fields is responsible for triggering symptoms in IEI-EMF. No robust evidence could be found to support this theory. However, the studies included in the review did support the role of the nocebo effect with symptoms in triggering acute symptoms in IEI-EMF sufferers. Despite the conviction of IEI-EMF sufferers that their symptoms are triggered by exposure to electromagnetic fields, repeated experiments have been unable to replicate this phenomenon under controlled conditions. A narrow focus by clinicians or policy makers on bioelectromagnetic mechanisms is therefore, unlikely to help IEI-EMF patients in the long-term.” [Rubin 2010]

A number of public health authorities have evaluated the studies of Idiopathic Environmental Intolerance to Electromagnetic Fields:

The United Kingdom Health Protection Agency 2012 report found:

“A large body of experimental evidence now exists concerning the impact of RF fields on self-reported symptoms. ... [W]hen taken together the experimental evidence suggests that short-term exposure to RF fields below guideline levels ... does not cause acute symptoms, either in the general public or in people who report being sensitive to electromagnetic fields.”

The Royal Society of Canada Expert Panel 2013 report found:

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“Taken together, research in the past ten years does not provide firm evidence for the hypotheses that people with IEI-EMF can perceive RF energy at levels below the limits in SC6 or that there is a causal link between exposure to RF energy and their symptoms.”

The New Zealand Ministry of Health 2015 report found:

“Recent reviews of these studies continue to conclude that people who consider themselves unusually sensitive to EMFs are, in fact, unable to detect EMFs, and the occurrence of symptoms appears unrelated to exposures... .”

The Scientific Committee on Emerging and Newly Identified Health Risks of the European Commission 2015 report found:

“The symptoms that are attributed by people to RF EMF exposure can sometimes cause serious impairments to a person’s wellbeing. However, research conducted since the previous Opinion adds weight to the conclusion that RF EMF exposure is not the cause of these symptoms. This applies to the general public, children and adolescents, and to people with idiopathic environmental intolerance attributed to electromagnetic fields. Recent meta-analyses of observational and provocation data support this conclusion.”

In sum, the studies of IEI-EMF and the reviews of them by public health authorities do not show that radio frequency fields cause, contribute to, or exacerbate IEI-EMF or the various self-reported symptoms attributed to it.

Expert Opinion

I hold the expert opinions set forth in this report to a reasonable degree of medical certainty.

**Bachman v. PECO
Pa. PUC Docket # C-2017-2623504**

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Based on my medical evaluation, it is my expert opinion there is no reliable medical basis to conclude that radio frequency fields from PECO's AMI meters cause, contribute to, or exacerbate IEI-EMF or any of the symptoms or conditions attributed to it by the complainant.