IN THE SUPREME COURT OF PENNSYLVANIA
MIDDLE DISTRICT

MARIA POVACZ,	:	**No. 34 MAP 2021**
Appellee	:	
	:	
v.	:	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION,	:	
Appellant	:	
LAURA SUNSTEIN MURPHY,	:	**No. 35 MAP 2021**
Appellee	:	
	:	
v.	:	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION,	:	
Appellant	:	
CYNTHIA RANDALL AND PAUL ALBRECHT,	:	**No. 36 MAP 2021**
Appellees	:	
v.	:	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION,	:	
Appellants	:	
MARIA POVACZ	:	**No. 37 MAP 2021**
	:	
v.	:	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION	:	
	:	
APPEAL OF: PECO ENERGY COMPANY	:	

LAURA SUNSTEIN MURPHY	**:**	**No. 38 MAP 2021**
	:	
v.	**:**	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION	**:**	
	:	
	:	
APPEAL OF: PECO ENERGY COMPANY	**:**	
	:	
CYNTHIA RANDALL AND PAUL ALBRECHT	**:**	**No. 39 MAP 2021**
	:	
	:	
v.	**:**	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION	**:**	
	:	
	:	
APPEAL OF: PECO ENERGY COMPANY	**:**	
	:	
MARIA POVACZ,	**:**	**No. 40 MAP 2021**
Cross-Appellant	**:**	
	:	
v.	**:**	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION,	**:**	
	:	
Appellee	**:**	
	:	
LAURA SUNSTEIN MURPHY,	**:**	**No. 41 MAP 2021**
Cross-Appellant	**:**	
	:	
v.	**:**	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION,	**:**	
	:	
Appellee	**:**	

CYNTHIA RANDALL AND PAUL ALBRECHT,	**:**	**No. 42 MAP 2021**
Cross-Appellants	**:**	
v.	**:**	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION,	**:**	
Appellee	**:**	
MARIA POVACZ,	**:**	**No. 43 MAP 2021**
Cross-Appellant	**:**	
v.	**:**	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION, PECO ENERGY COMPANY,	**:**	
Appellee	**:**	
LAURA SUNSTEIN MURPHY,	**:**	**No. 44 MAP 2021**
Cross-Appellant	**:**	
	:	
v.	**:**	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION, PECO ENERGY COMPANY,	**:**	
Appellees	**:**	
CYNTHIA RANDALL AND PAUL ALBRECHT,	**:**	**No. 45 MAP 2021**
Cross-Appellants	**:**	
	:	
v.	**:**	
	:	
PENNSYLVANIA PUBLIC UTILITY COMMISSION, PECO ENERGY COMPANY,	**:**	
Appellees		

BRIEF OF CHILDREN'S HEALTH DEFENSE, AND BUILDING BIOLOGY INSTITUTE, *ET AL* AS *AMICI CURIAE* IN SUPPORT OF APPELLEES/CROSS-APPELLANTS "CUSTOMERS"

Brief of Amicus Curiae Supporting the Appellees/Cross-Appellant "Customers" in the Appeals from the Commonwealth Court's October 8, 2020 Order at Docket Nos. 492 C.D. 2019, 606 C.D. 2019, and 607 C.D. 2019, which affirmed in part, reversed and remanded in part, and vacated and remanded in part the Pennsylvania Public Utility Commission's Opinion and Orders entered at Docket Nos. C-2015-2475023, C-2015-2475726, and C-2016-2537666

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**Pro hac vice motion pending*

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I. IDENTIFICATION AND STATEMENT OF INTEREST OF *AMICI CURIAE*[1]

Children's Health Defense ("CHD") is a national non-profit 501(c)(3) organization. CHD has no parent corporation. No publicly-held company has a 10% or greater ownership interest.

CHD's mission is to end the epidemic of children's chronic health conditions by working aggressively to eliminate harmful exposures to environmental toxins via education, to obtain justice for those already injured and to promote protective safeguards. The emissions from pulsed radio-frequency (RF) based wireless technologies including from Wi-Fi, cell towers and smart meters are a major contributory factor in the growing epidemic of sickness among adults and children. Many CHD members and their children are sick from wireless technology and are adversely affected by smart meters. For some, the exposure aggravates other conditions. We are approached daily by adults and children who have become sick and ask for our help.

In May 2020, 6,231 people who declared that they and/or their children are sick from wireless joined a CHD submission to the FCC. 182 of them were from

[1] No person or entity other than the named *amici*, their members or counsel has (i) paid in whole or in part for the preparation of this brief; or (ii) authored in whole or in part this brief.

Pennsylvania.[2] The decision in this case will directly affect CHD and its Pennsylvania members. The court's decision will also affect nationwide policy and therefore, our members throughout the country.

We also have taken legal action to protect the injured. Most recently, on August 13, 2021, the United States Court of Appeals for the District of Columbia Circuit ruled for CHD and other petitioners in a case challenging the FCC's 2019 decision affirming the adequacy of its RF guidelines for public health purposes. *Envtl. Health Tr., et al v. FCC*, Nos. 20-1025, 20-1138, 2021 U.S. App. LEXIS 24138 (D.C. Cir. Aug. 13, 2021) (*Guidelines Remand*). The court held that the FCC decision denying non-cancer harm was arbitrary, capricious and not evidence based. This decision is highly relevant to the issues before the Court. *See* Part V.A.

Building Biology Institute

The Building Biology Institute ("BBI") is a 501(c)(3) non-profit corporation now in its twenty-eighth operating year. BBI does not have a parent corporation. No publicly-held company has a 10% or greater ownership interest.

BBI's mission is to help meet the public demand for proven methods that secure homes, schools and workplaces from toxins including RF radiation (RFR). BBI's experts work with doctors and patients to remediate exposures in patients' homes. They are on the ground, seeing widespread sickness from RFR exposure.

[2] https://www.fcc.gov/ecfs/filing/105191672708448.

They have witnessed the effects of smart meters and the tremendous health improvements after these meters are removed. BBI's experts are critical in addressing electro-sensitivity and RF related injuries.[3]

Seventy-nine (79) other health and environmental organizations promoting safe-tech, join in this *Amicus*. They are further described in the Appendix.

All *Amici* have local, national and global experience and expertise relating to the underlying and broader legal, technical, scientific, medical issues before the Court. Even more important, *Amici* see – every day – the enormous difficulty faced by individuals who, for whatever reason, simply cannot tolerate the radiation emitted from pulsed radio-frequency based wireless technologies including smart meters.

[3] https://www.womenscollegehospital.ca/assets/pdf/environmental/Preliminary%20Clinical%20Guidelines%20%20for%20EHS.pdf#page=8.

II. STATEMENT OF SCOPE AND STANDARD OF REVIEW

Amici adopt the "Customers" Statement of Scope and Standard of Review, but provide this supplement:

"While this Court has never expressly adopted the federal *Chevron* approach, we have recognized that '[t]he Chevron approach to such cases at the federal level, however, is indistinguishable from our own approach to agency interpretations of Commonwealth statutes.'" *Crown Castle NG E. LLC v. Pa. PUC*, 234 A.3d 665, 679 n.11 (Pa. 2020). *Chevron* and this Court's jurisprudence both require that the PUC's interpretation be granted little to no deference, for several reasons.

The first reason is simple: the statute is unambiguous[4] and therefore no deference is due. *Crown Castle*, 234 A.3d at 677-78 (Pa. 2020). The Commonwealth Court correctly held (p.13) that "nothing in the language of Act 129 facially requires every customer to endure involuntary exposure to RF emissions from a smart meter."

Section 807(f)(2) could not be clearer:

> (f) Smart meter technology and time of use rates.
> ….
> (2) Electric distribution companies shall furnish smart meter technology as follows:

[4] PUC Br. pp. 8, 16-19 and Energy Association *Amicus* at pp. 13-15 so contend.

(i) Upon request from a customer that agrees to pay the cost of the smart meter at the time of the request.[5]
(ii) In new building construction.
(iii) In accordance with a depreciation schedule not to exceed 15 years." [emphasis added].

Smart Meter Implementation Order Para B.4 contains the PUC's entire analysis: "The Commission believes that it was the intent of the General Assembly to require all covered EDCs to deploy smart meters system-wide when it included a requirement for smart meter deployment 'in accordance with a depreciation schedule not to exceed 15 years.'" *See also, Negley v. Metropolitan Edison Company*, Docket No. C-2010-2205305 pg. 4-5, 2010 Pa. PUC LEXIS 1919, *6 (Pa. P.U.C. December 15, 2010). The PUC therefore contends that the legislature intended to mandate ubiquitous, non-optional deployment when it required a 15-year depreciation schedule in Section 807(f)(2)(iii).

The conclusion does not follow. The statute's provision requiring a 15-year depreciation schedule says (and implies) nothing about mandatory placement. It just means that whatever capital investment is required to obtain enough meters to satisfy customer demand must be depreciated over 15 years. Utilities routinely

[5] The legislative history confirms that the legislation was not intended to require placement. House Bill 2200 as passed would have obtained that result. But the Senate deleted the relevant House language and substituted the current language. The House then concurred. The authors of the Senate changes stated that one of their specific intentions was to allow customers to *choose* whether to obtain a smart meter and make placement *not* mandatory. *See Sen. Journa*l, Oct. 8, 2008 at 2626-27 (Remarks of Senators Tomlinson and Boscola).

make capital investments for utility plant that does not directly affect every ratepayer. All such investments are recovered through depreciation expense until fully recovered. Depreciation concerns how overall rates are set and has nothing to do with the utility's customer rules. *See, e.g., Pa. Power & Light Co. v. Pa. Pub. Util. Com.*, 10 Pa. Commw. 328, 311 A.2d 151 (1973). The reliance on that part of Act 129 was misplaced.

The PUC's brief interpretive analysis in the *Smart Meter Implementation Order* did not address the far more relevant and truly unambiguous language in 807(f)(2)(i). This provision clearly contemplates an individual customer *request* and commitment to pay the cost. The PUC has admitted that "[a] plain reading of the statute may suggest that there is an 'opt-in' or 'opt out' available." *Catherine J. Frompovich v. PECO Energy Company*, Docket No. C-2015-2474602, Initial Decision p. 24 (May 11, 2017), https://www.puc.pa.gov/pcdocs/1522025.pdf, adopted, *Catherine J. Frompovich v. PECO Energy Company*, Docket No. C-2015-2474602, 2018 Pa. PUC LEXIS 160 (Pa. P.U.C. May 3, 2018), but it insists on not following the plain reading in favor of a strained interpretation of a different subsection that has nothing to do with the question.

Second, the Commission's interpretation of Act 129 has admittedly been officially held and consistent, but it did not arise from rulemaking procedures. The Commission first reached its conclusion that Act 129 contemplates mandatory

deployment with no opt-out in *Smart Meter Procurement and Installation*, Docket No. M-2009-2092655, 2009 Pa. PUC LEXIS 265, 274 P.U.R.4th 238 (Order entered June 24, 2009) (*Smart Meter Implementation Order*). That proceeding did not employ formal rulemaking processes or conclude with a legislative rule or regulation.[6] The PUC's reading is an interpretive rule. *Crown Castle*, 234 A.3d at 667-678.[7] The Commission's reading of Act 129 is at best entitled to *Skidmore*-type deference (muddled as that federal doctrine may be) and resolution requires recourse to basic statutory construction tools. *Crown Castle*, 234 A.3d at 694 (Wecht, J. Concurring), *citing Kisor v. Wilkie*, 139 S.Ct. 2400, 2415-2416 (2019).

Third, agencies do not receive *Chevron*-type deference when an agency claims its organic statute overrides other statutory provisions entirely outside the statute the Commission is charged with administering, especially when, as is the case with the ADA, FHA and PHRA, they are administered by several agencies. The court "must decide for [itself] the best reading." *Dodge v. Comptroller of the Currency*, 744 F.3d 148, 155 (D.C. Cir. 2014).

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[6] This distinguishes *Popowsky v. Pa. PUC*, 910 A.2d 38 (Pa. 2006), which involved a legislative rule.

[7] The only extant *legislative rules or regulations* on the topic of Advanced Metering Deployment clearly contemplate *voluntary* customer participation and customer-driven selection of the particular meter to be used. *See* 52 Pa. Code Chapter 57, Subchapter O. These legislative rules predate Act 129, but have not been repealed or amended.

III. STATEMENT OF QUESTIONS PRESENTED

Amici adopt the Statements of Questions Presented set forth in the "Customers'" Briefs.

IV. SUMMARY OF ARGUMENT

1. Smart meter deployment has been allowed and considered safe because the meters comply with the Federal Communications Commission ("FCC") radiofrequencies exposure guidelines. As a result of the *Guidelines Remand* ruling, the FCC guidelines can no longer be relied on for an assurance of safety as to non-cancer harm and harm to the environment. Further, the FCC has now admitted to an adverse neurological response and symptoms similar to those suffered by people with electro-sensitivity.

2. Knowledge has significantly advanced in the five years since 2016 when the administrative record below was created. It is now quite clear exposure can lead to negative health effects. Those who suffer an RF-related impairment must be afforded reasonable accommodation.

3. The PUC's interpretation is wrong. *First*, the statute cannot be read to contain a universal mandate; it clearly envisions customer consent. *Second*, regardless of the legislature's word choice the state cannot lawfully force a customer to accept a smart or digital meter when mandatory installation results in disability discrimination, exacerbates existing impairments or forces people to

abandon their home. There must be effective accommodation. *Third*, neither the Commission nor the utility can or should second-guess an attending physician's finding of impairment and the need for RFR avoidance. That too is prohibited by disability laws.

4. The impaired cannot be required to endure an interminable and expensive proceedings that requires them to meet an irrelevant and almost impossible evidentiary burden when the accommodation itself costs less than $100. Disability laws flatly prohibit imposing this burden. The rule is simple: accommodation in the form of an analog meter is required if a customer presents a professional assessment of impairment and a need for RF avoidance.

5. The Court can dispose of this case without directly wading into health effects. All that is required is a holding that Act 129 does not mandate smart meter placement absent customer consent. This outcome results from both the unambiguous terms in the legislation and proper application of statutory interpretation, including but not limited to "the consequences of a particular interpretation." 1 Pa.C.S. §1921(6).

6. If it does reach the health issues, the Court should ensure that those with electro-sensitivity receive accommodation in the form of an analog meter. Any reading that requires an impaired customer to accept a smart or digital meter will conflict with other state and federal laws. 1 Pa.C.S. §1922(3) states that

legislation should not be interpreted in a way that renders the provision unconstitutional. Thus, Act 129 cannot be interpreted to obtain a result that would conflict with the rights, remedies and venue provisions in other state or federal disability laws. These other laws require reasonable accommodation in the form of an analog meter.

V. ARGUMENT

A. *Guidelines Remand* Decision

The *Guidelines Remand* is highly relevant to this case. The PUC decisions below extensively relied on the FCC's guidelines as part the "safety" findings. *Murphy Order*, p. 68 and 84-85, R.197a and 213a-14a. The utility did so as well. PECO Br. 1, 4, 6, 26-28, 34.[8]

As the *Guidelines Remand* court noted, the FCC's emissions limits do not satisfactorily consider electro-sensitivity[9] or the effects of pulsation and modulation[10] used by wireless technologies (like smart meters).[11] The FCC

[8] The Commonwealth Court disclaimed any such reliance, *Povacz v. Pa. PUC*, 241 A.3d 481, 491 & n13 (Pa. Commw. Ct. 2020), but the PUC and utilities' briefs each rely on the FCC guidelines.

[9] 2021 U.S.App.LEXIS 24134 at *10-*14.

[10] 2021 U.S.App.LEXIS 24134 at *29-*30.

[11] https://childrenshealthdefense.org/wp-content/uploads/Corrected-Brief-and-Hyperlinks-Table-Postable-pdf-A1.pdf#page=58.

guidelines cannot be a basis for any conclusions regarding RF safety including for smart meters, yet that is a primary foundation for the PUC's conclusions below.

The case exposed that ***no*** proper review was conducted by any of the responsible federal agencies regarding non-cancer harm from exposure to radiation levels below the FCC's guidelines.[12] The petitioners in that case filed 11,000 pages of evidence of non-thermal harm including of electro-sensitivity; neurological effects; humans' biological response to pulsation and modulation; and effects of smart meters.[13] The court ruled the FCC erroneously dismissed this extensive evidence without adequate explanation[14] and remanded the decision to the FCC to conduct a review and provide reasoned explanations.[15]

B. Medical, Scientific and Engineering/Technical Information

To support their arguments, *Amici* are providing:

(1) A Statement by 57 physicians who combined have over 3,000 patients suffering from electro-sensitivity like the "customers," or other conditions aggravated by RF exposure. The physicians explain recent

[12] 2021 U.S.App.LEXIS 24134 at *14-*20.

[13] https://childrenshealthdefense.org/wp-content/uploads/Corrected-Brief-and-Hyperlinks-Table-Postable-pdf-A1.pdf.

[14] 2021 U.S.App.LEXIS 24134 at *13-*14, *24-30.

[15] 2021 U.S.App.LEXIS 24134 at *43-*45.

medical developments, diagnosis guidelines and the effects of smart meters on their patients.[16]

(2) A Statement by scientists with expert knowledge of pulsed RFR effects. Combined they published hundreds of studies on RF/EMF effects and reviewed thousands. They explain recent developments and the scientific evidence as it applies to smart meters. They emphasize that smart meters generated pulsed RF is a significant harm agent.[17]

(3) An expert engineer Report addressing smart meters' operation. This report explains how smart meters generate constant RF pulses that are also conducted through electrical wiring, thereby creating a whole-home antenna.[18]

(4) A Report by the Building Biology Institute's President. BBI's experts work with the injured to mitigate their homes from RF exposure. They see the torture smart meters cause to those who are affected and the health transformations after the smart meter is removed. The Report also explains why it is impossible to sufficiently mitigate homes with smart or

[16] Addendum Physicians Statement¶¶17-42.
[17] Addendum Scientists Statement, ¶¶13-25.
[18] Addendum Engineer Report, ¶¶9-17.

digital meters and concludes that the only reasonable accommodation is a $100 analog meter.[19]

The Engineering and Science experts explain how pulsation injects RF "bursts" or turns the signal on/off.[20] The FCC emissions guidelines protect only from emissions that are so high they create a heating or "thermal effect."[21] They do not protect or recognize biological responses to non-thermal pulsed and modulated RF emissions.[22] The problem is that the factual premise – the non-existence of non-thermal biological and adverse effects – underlying the current RF guidelines is outdated and demonstrably false. This was one of the major drivers behind the *Guidelines Remand* decision. 2021 U.S.App.Lexis 24138 *10-*12, *30.

Despite the claims by the utilities and the PUC, there is no doubt the human body responds to pulsed RF radiation, even at non-thermal levels. The FCC has now agreed. Doctors routinely use pulsed RF/EMF for medical treatment because they generate biological responses.[23] With chronic exposure these biological

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[19] Addendum BBI Report at ¶¶27-34.

[20] The utility's witnesses assert the meters do not employ pulsation, but they do so by mischaracterizing what a "pulse" is. It is uncontested that the meters are not in constant communications mode, so they obviously turn on and off. That is "pulsation."

[21] FCC OET Bulletin 56, at 6-7 (August 1999), available at https://tinyurl.com/y5mbsymn.

[22] See Scientists' Statement for expiation of RF basics ¶¶1-4.

[23] Scientists Statement ¶43.

responses can lead to significant health problems.[24] The mechanisms of harm from RF exposure that transforms these biological effects into adverse effects are also known and include oxidative stress.[25, 26] These adverse effects can rise to the level of functional impairment. For some they are life-threatening.[27]

Since 2016, the scientific and medical consensus regarding non-thermal harms has become even more conclusive.[28] In January 2021 the Swiss government's expert advisory committee on EMF and non-ionizing radiation, BERENIS,[29] concluded an evaluation of the scientific literature on non-thermal RF/EMF.[30] The committee's paper concludes that exposure could cause or worsens several chronic illnesses and acknowledged oxidative stress as the underlying causal harm mechanism.

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[24] Scientists Statement ¶¶7-11.

[25] https://childrenshealthdefense.org/wp-content/uploads/rf-2018-golomb-diplomats-3.pdf.

[26] https://childrenshealthdefense.org/wp-content/uploads/rf-2015-yakymenko-oxidative-stress.pdf; https://bioinitiative.org/wp-content/uploads/2020/09/3-RFR-Free-Radical-Oxidative-Damage-Abstracts-2020.pdf.

[27] Physicians Statement ¶¶14, 26, 40.

[28] Scientists Statement ¶¶13-31; Physicians Statement ¶¶16-20, 27-32.

[29] https://www.bafu.admin.ch/bafu/en/home/topics/electrosmog/newsletter-of-the-swiss-expert-group-on-electromagnetic-fields-a/beratende-expertengruppe-nis-berenis.html.

[30]https://childrenshealthdefense.org/wp-content/uploads/rf-swiss-berenis-2021-report.pdf.

In 2020, New-Hampshire's legislative-appointed committee investigated 5G and wireless harms and published findings. It concluded that non-thermal harms are established, acknowledged electro-sensitivity and stressed the need for accommodations.[31]

Electro-sensitivity is a condition whereby the patients manifest a constellation of mainly neurological symptoms after RFR exposure. The scientific literature recites a host of symptoms, including headaches, memory and cognitive problems, sleep problems, heart palpitations and/or increased heart rate, ringing in the ears, exhaustion, skin rashes, tingling, nose bleeds, dizziness, and burning sensations.[32] RF exposure has been directly connected to these symptoms in hundreds of studies.[33] Official diagnosis guidelines have existed since 2011.[34]

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[31] New Hampshire is the only US state that has conducted an independent investigation as to the harms of these technologies.

[32] Note the overlap with the FCC's 2019 list of symptoms in *FCC RF/EMF Proposed Changes*, 34 FCC Rcd at 11744, ¶122, n.328. Part V.C.

[33] https://childrenshealthdefense.org/wp-content/uploads/rf-2018-golomb-diplomats-3.pdf; https://childrenshealthdefense.org/wp-content/uploads/rf-2018-neurological-lai-book-chapter.pdf; https://childrenshealthdefense.org/wp-content/uploads/rf-2014-electrosensitivity-dr-blythe.pdf.

[34] https://childrenshealthdefense.org/wp-content/uploads/rf-2011-austrian-medical-association-guidelines.pdf.

They were updated in 2016,[35] to include biomarkers[36] and genetic predispositions[37] found by studies on many hundreds of electro-sensitive patients. Additional biomarkers were identified in 2020.[38]

These studies establish that electro-sensitivity is not a sensitivity, nor is it "idiopathic." It involves severe physiological injuries directly associated with pulsed RF exposure, including blood-brain barrier leakage; damage to the immune system; chronic inflammation; impaired melatonin production and impaired blood flow to the brain.[39] A 2017 fMRI study shows clear evidence of impaired blood flow in 10 electro-sensitive subjects.[40]

Electro-sensitivity is a "spectrum condition." Some experience discomfort while others are entirely debilitated. Those affected become progressively

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[35] https://childrenshealthdefense.org/wp-content/uploads/rf-2016-europaem-guidelines.pdf.

[36] https://pubmed.ncbi.nlm.nih.gov/26613326/.

[37] https://pubmed.ncbi.nlm.nih.gov/24812443/.

[38] https://childrenshealthdefense.org/wp-content/uploads/rf-2020-Belpomme-guidelines.pdf.

[39] https://www.womenscollegehospital.ca/assets/pdf/environmental/Preliminary%20Clinical%20Guidelines%20%20for%20EHS.pdf; https://childrenshealthdefense.org/wp-content/uploads/rf-2018-golomb-diplomats-3.pdf; https://childrenshealthdefense.org/wp-content/uploads/rf-2020-Belpomme-guidelines.pdf.

[40] https://pubmed.ncbi.nlm.nih.gov/28678737/.

intolerant to radiation levels they could previously tolerate. Exposure avoidance is the *only* effective treatment.[41]

In December 2020, the National Academy of Sciences, Engineering and Medicine (NAS) concluded that the diplomats' "mystery illness" is likely caused by pulsed RF.[42] Prof. Beatrice Golomb MD PhD,[43] 2018 paper[44] was the first to analyze the science in detail and to show that pulsed RF is the likely cause of the symptoms suffered by some US diplomats in Cuba and China.[45] She concluded that the diplomats essentially suffer from electro-sensitivity (which she refers to as "Microwave Illness").[46] Her analysis included case studies on people sickened by smart meters.[47] She gave a detailed scientific analysis to each of the diplomats' and

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[41] Physicians Statement ¶¶7, 38; https://childrenshealthdefense.org/wp-content/uploads/rf-2016-europaem-guidelines.pdf#page=24; https://childrenshealthdefense.org/wp-content/uploads/rf-2020-Belpomme-guidelines.pdf#page=14; https://childrenshealthdefense.org/wp-content/uploads/rf-2018-golomb-diplomats-3.pdf#page=21; https://childrenshealthdefense.org/wp-content/uploads/rf-2014-electrosensitivity-dr-blythe.pdf#page=5.

[42] https://www.nap.edu/read/25889/chapter/1.

[43] Prof. Golomb signed the Scientists Statement.

[44] https://childrenshealthdefense.org/wp-content/uploads/rf-2018-golomb-diplomats-3.pdf.

[45] https://pubmed.ncbi.nlm.nih.gov/30183509/.

[46] This Brief uses "Electro-sensitivity" but the syndrome is also called "Electromagnetic Hyper-Sensitivity" ("EHS"), "Microwave Sickness," and "Radiation Sickness." PECO calls it "Idiopathic Environmental Intolerance."

[47] Prof. Golomb signed the Scientists Statement.

[47] https://childrenshealthdefense.org/wp-content/uploads/rf-2018-golomb-diplomats-3.pdf pages: 15, 18-22, 25, 37, 38.

electro-sensitivity symptoms and showed how they can result from RF exposure. She was invited to present to the NAS committee.[48]

Smart meters can be the original cause or a subsequent aggravating cause. They are, however, undoubtedly harmful to anyone with electro-sensitivity.[49] As the guidelines for diagnosis and the physicians' statement emphasize, the ***only*** mitigation and treatment for those affected by RF is rigid, constant RF exposure avoidance, *in every aspect of their lives*. This is particularly so when it comes to peoples' last refuge: their home. For all these reasons any regime that forces people to choose between a mandatory smart meter or not having electric (or water, or gas) utility service, is especially pernicious.[50]

C. FCC Admits Adverse Effects

The FCC admitted in 2019 that at least some RFs can cause non-thermal adverse effects with RF frequencies ranging between 3 KHz and 10 MHz.[51] Pulsed

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[48] https://childrenshealthdefense.org/rf-nas-agenda-golomb/; https://childrenshealthdefense.org/wp-content/uploads/rf-nas-golumb-email.pdf.

[49] This is part of the problem with the PUC's burden of proof requirements. The issue is not what caused the impairment; it is whether the smart or digital meter interferes in any manner with a person's ability to engage in major life activities. *See* Part V.F.

[50] Some people with electro-sensitivity also have other health issues and use medical treatment devices that require electricity.

[51] *Proposed Changes in the Commission's Rule Regarding Human Exposure to Radiofrequency Electromagnetic Fields*, 34 FCC Rcd 11687, 11743-11745, ¶¶122-124 & nn. 322-335 (2019). It also noted that these harms occur instantaneously. The FCC currently averages exposure levels over 30 minutes, which completely

RF created by the AC/DC conversion performed by smart and digital meters' Switch Mode Power Supply (SMPS), generates frequencies between 2-50 KHz, which fall squarely in the range identified by the FCC as problematic.[52] The FCC noted that "[a]dverse neural stimulation effects…include acute effects such as perception of tingling, shock, pain, or altered behavior due to excitation of tissue in the body's peripheral nervous system." 34 FCC Rcd at 11743-11744, ¶122 n.328. These are the same symptoms suffered by the "customers" and by others who report adverse health effects from smart meters. 34 FCC Rcd at 11742-11744, ¶¶119-122.

D. Pulsed RF Affects at Least Some People

The FCC guidelines can no longer be said to provide any assurance regarding the public's health for non-cancer harms. The FCC has expressly acknowledged that RF emissions such as those from smart and digital meters can cause the very same symptoms reported by the Customer Petitioners and those who have developed electro-sensitivity or suffer from other conditions that are aggravated by RFR exposure. Those affected have a right to accommodation, regardless of what is "deemed safe" for the general population.

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obscures pulsation effects. It has admitted instantaneous effects for the RF frequency band involved in smart meter wire conduction.

[52] Engineer Report ¶¶14-17.

To analogize, the U.S. Agriculture Department and Food and Drug Administration each regulate peanut and peanut product quality. They ensure peanuts and peanut products are safe for most people. Additional protective steps are taken, to ensure those with nut allergies are not inadvertently (or purposefully) exposed to "deemed safe" nuts.[53] Similarly, measures must be taken to allow those adversely affected by RF to avoid exposure from even general population "deemed safe" emissions.

A state electric utility regulator certainly should not issue a mandate that someone with an impairment made worse by pulsed RFR must have a smart or digital meter as a condition of utility service unless they fund a costly lawsuit and satisfy a burden of proof that is inappropriate and almost impossible to meet given the nature of the condition. The regulator cannot base lawful findings on utility-funded "expert" doctors that never examined the customer.

E. The Federal Government Recognizes Electro-Sensitivity; Federal and State Law Requires Effective Accommodation

As noted above, the FCC has now agreed that RF can evoke a non-thermal adverse neural response to at least some RF emissions. The CDC has diagnosis and injury codes for exposure related injuries. Various federal agencies recognized the

[53] *See, e.g.,* U.S. Dept. of Justice, Civil Rights Division, Questions and Answers About the Lesley University Agreement and Potential Implications for Individuals with Food Allergies, available at https://www.ada.gov/q&a_lesley_university.htm.

condition. Three federal laws and a state law directly require accommodations. The federal government has outlined the proof required for those who seek accommodation.

1. CDC, U.S. Justice Department and Other Agencies Recognize Electro-sensitivity Can Lead to Major Life Impairments Requiring Accommodation

The federal government recognizes RF/EMF radiation exposure related sickness. The Centers for Disease Control's 2022 Classification of Diseases Codes Clinical Modification and Procedural Classification System implements the *International Classification of Diseases, 10th Revision, Clinical Modification* (ICD-10-CM) .[54] The "diagnosis code" for Radiation Sickness" is "T66." The "injury" code for "Exposure to Other Nonionizing Radiation" is "W90." These codes cover Electro-sensitivity along with other RF exposure-related injuries and maladies.

The "Access Board," the federal agency responsible for publishing Accessibility Guidelines used by the Justice Department to enforce the ADA, has held that "electromagnetic sensitivities may be considered disabilities under the ADA."[55] The Access Board contracted with the National Institute of Building

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[54] Available at https://icd10cmtool.cdc.gov/.

[55] Architectural Transportation Barriers Compliance Board, Final Rule, Americans With Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Recreation Facilities, 67 Fed. Reg. 56352, 56353 (Sept. 3, 2002) ("The Board recognizes that multiple chemical sensitivities and electromagnetic sensitivities

Sciences (NIBS) 2005 to recommend accommodations. NIBS concluded that RF could render buildings "inaccessible" to those "who are electromagnetically sensitive."[56]

The US. Department of Labor's Office of Disability Employment Policy issued guidelines for accommodations in 2015.[57] They state:

> …the nature of electromagnetic sensitivity is such that even levels that are deemed safe for the general public can cause trigger symptoms for individuals who are hypersensitive...and therefore may need accommodation.
> …
> Individuals with electromagnetic sensitivity may experience … fatigue, weakness, neurological issues, immunological issues, gastrointestinal issues, increased irritability, lack of ability to think clearly and quickly, sleep disturbance, overall malaise, and anxiety…Common workplace issues involve exposure to Wi-Fi, cell phones.
> General considerations include: ...Relocate workplace away from areas where symptoms are triggered…limiting certain types of devices in the vicinity of the employee's workstation... Provide wired telephones and network connections.

The US Department of Education ("DOE") agrees that people with other conditions may also develop intolerance to RF/EMF. In a memorandum regarding

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may be considered disabilities under the ADA if they so severely impair the neurological, respiratory or other functions of an individual that it substantially limits one or more of the individual's major life activities.").

[56] National Institute of Building Sciences (NIBS), Indoor Environmental Quality (IEQ) Final Report (July 14, 2005), © 2005, National Institute of Building Sciences. A web-based version of the NIBS IEQ Final Report is available at https://www.access-board.gov/research/building/indoor-environmental-quality/.

[57] https://childrenshealthdefense.org/wp-content/uploads/rf-accomodation-labor.pdfNetwork-EMS.pdf.

accommodation of people with Multiple Chemical Sensitivities ("MCS"), they recommend minimizing exposure to electromagnetic fields and radiation because it may trigger MCS symptoms. The memo emphasizes the importance of their home as a refuge and sanctuary free of EMF.

> …[I]ndividuals affected by MCS have created "sanctuaries" relatively free from chemical emissions and electromagnetic fields in their homes. Because of the serious impact of even an accidental unavoidable exposure, people often spend as much time at home as possible and often cannot participate fully in society. As a result, they may experience intense isolation, loss of self-esteem, and depression from not being able to have an active work, family, or social life.[58]

2. ADA, FHA, Rehabilitation Act and PHRA Require Accommodations to Disabled/Handicapped Individuals Who Would be Negatively Affected by a Smart Meter

Electricity is the "service" offered by PECO. The meter facilitates billing and demand response, but it is not the "service." If PECO's wireless smart meter cannot be tolerated due to a medical condition related to a disability or handicap, forced installation as a condition of utility service will discriminate against the customer who is "otherwise qualified" but will suffer disconnection and loss of utility service.

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[58] https://www2.ed.gov/policy/speced/guid/rsa/im/2002/im-02-04.pdf. A study published in 2020 on 2,000 people with electro-sensitivity and/or chemical sensitivity showed that once a person developed one of these conditions, they are highly likely to develop the other. https://childrenshealthdefense.org/wp-content/uploads/rf-2020-Belpomme-guidelines.pdf.

The Fair Housing Act ("FHA"),[59] Americans with Disabilities Act ("ADA"),[60] and the Pennsylvania Human Relations Act (PHRA)[61] require accommodations relating to a "physical or mental impairment" that "substantially limits one or more of the major life activities." *See, e.g.*, 42 U.S.C. §12102(1)(A); 28 C.F.R. §36.105; 16 Pa.Code §44.4.

ADA Title II and the PHRA apply insofar as the PUC is establishing binding practices the utility must implement. 28 C.F.R. §35.130(a), (b)(1), (6), (7).[62] State agency prescribed practices cannot discriminate against the disabled by denying access to essential electric utility service. *Id*. The PUC's regulations must allow for "reasonable modifications in policies, practices, or procedures when the modifications are necessary to avoid discrimination on the basis of disability, unless the public entity can demonstrate that making the modifications would fundamentally alter the nature of the service, program, or activity." 28 C.F.R. §35.130(b)(7).

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[59] 42 U.S.C. §3601, *et seq.*

[60] 42 U.S.C. §12101, *et seq.* ADA Title II prohibits a state-level regulatory requirement that mandates discrimination. USDOJ Title II TAM, *supra*.

[61] 43 Pa. Stat. Ann. §951, *et seq*.

[62] *Amici* are not asserting that the utility has become a state actor and subject to Title II. *C.f. Rendell-Baker v. Kohn*, 457 U.S. 830, 842 (1982); *Jackson v. Metro. Edison Co*., 419 U.S. 345, 350 (1974); *Crissman v. Dover Downs Entm't Inc*., 289 F.3d 231, 243 (3d Cir. 2002). The PUC and the state – the ones allegedly imposing mandatory smart meters – are the state actors for purposes of ADA Title II.

A mandatory smart meter program also fails muster under the FHA. It "objectively" interferes with the "exercise or enjoyment of rights granted or protected by" 42 U.S.C. §§3604 or 3605: it makes the occupants sick or sicker, and therefore violates 42 U.S.C. §3617. *See* 24 C.F.R. §100.400(b), (c)(1), (2). 42 U.S.C. §3604(f)(1) and 16 Pa.Code §45.9 make it unlawful to "make unavailable or deny, a dwelling" and that is exactly what a smart meter effectively does to those who cannot tolerate the radiation emitted from the device. They will be constructively evicted.

The Rehabilitation Act, 29 U.S.C. §794 prohibits disability discrimination by any entity receiving federal financial assistance.[63] PECO obtained a federal SmartGrid Investment Grant. PECO Principal Br. p. 18, n.39,[64] so it is subject to the Rehabilitation Act nondiscrimination mandate.

3. The PUC is Bound by ADA Title II, the FHA and PHRA; PECO is Bound by the FHA and the Rehabilitation Act

The PUC has consistently erred by refusing to consider the impact of federal and state disability/handicap laws. It is true the PUC "lacks jurisdiction to enforce"

[63] "No otherwise qualified individual with a disability...shall, solely by reason of her or his disability, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance…." 29 U.S.C. § 794(a).

[64] Nothing in the grant requires a mandate that all customers accept smart meter installation.

the ADA, FHA, Rehabilitation Act or PHRA as a general matter. *See Edward Lucey v. Metropolitan Edison Company*, Docket No. C-2018-3003679, 2020 PA. PUC LEXIS 522, *15 (Pa. P.U.C. October 8, 2020), citing *Catherine J. Frompovich v. PECO Energy Company*, Docket No. C-2015-2474602, 2018 Pa. PUC LEXIS 160 *69 (Pa. P.U.C. May 3, 2018)(emphasis added).[65] But what everyone involved has missed is that the PUC is bound by ADA Title II and cannot impose practices or policies in derogation of ADA requirements. Act 129 should not be read to impose a regulatory mandate that would directly violate the ADA Title II prohibition on state-level policies and practices that lead to disability discrimination without reasonable and effective accommodation.

[65] These orders state the complainant should go to state or federal court to raise the disability claim. The problem is that the Pennsylvania Human Relations Commission is a mandatory prerequisite to any state court action seeking a remedy for disability discrimination. *Clay v. Advanced Comput. Applications*, 522 Pa. 86, 559 A.2d 917 (1989). On the other hand, *Phila. Elec. Co. v. Human Rels. Comm'n*, 5 Pa. Commw. 329, 290 A.2d 699 (1972) holds the PHRC could not entertain any such complaint; the petitioner would be sent back to the PUC. The Commission's interpretation therefore leads to an endless "no state jurisdiction" loop. Statutes should not be construed to lead to such absurd results. The answer to this seeming conundrum is simple, however. The Commission needs to merely acknowledge it cannot impose a practice or policy that violates the disabilities laws and ensure that the utilities offer reasonable and effective accommodations.

The U.S. Department of Justice Civil Rights Division's Americans with Disabilities Act Title II Technical Assistance Manual Covering State and Local Government Programs and Services[66] makes this eminently clear:

> …a public entity may not establish requirements for the programs or activities of licensees that would result in discrimination against qualified individuals with disabilities

If the PUC's interpretation of Act 129 is upheld on appeal and becomes final, the Commission (the state) is subject to suit under ADA Title II. Similarly, under the FHA the state might be subject to damages under 42 U.S.C. §§3613(c), 3631(a), (a)(1), since a state regulatory mandate constitutes "color of law" under which handicapped individuals may suffer grievous harm. The statute should not be construed to impose a mandate because it would result in direct conflict with federal law and expose the state to liability.

The Commission and the Court must consider the impact of the ADA, FHA, Rehabilitation Act and the PHRA on these issues as part of any interpretative analysis whether Act 129 can be reasonably interpreted as mandatory. The statute should not be read to compel a violation of other federal and state law. The PUC's willful blindness to disability laws prohibiting its attempt to mandate smart meters, constitutes legal error that must be corrected.

[66] Available at https://www.ada.gov/taman2.html#II-3.7200.

F. The PUC's "Burden of Proof" is Inconsistent with the Disability laws

The proper outcome does not depend on whether a smart meter "causes" someone to suffer "adverse health effects." The applicable law turns on entirely different considerations. The only questions are whether someone has a functional "impairment" and then what accommodation is due.

1. PUC Applied Wrong Standard

The utility and PUC each argue that the Petitioners failed to "demonstrate by a preponderance of the evidence that a 'conclusive causal connection' between the low-level RF exposure from a PECO smart meter and the alleged adverse human health effects." [67] But the PUC/utility have consistently focused on the wrong type of "causal connection" and demanded too much by way of "alleged adverse human health effects." The stated burden of proof is virtually impossible to meet for almost any Complainant because it would require resources no average person can amass, especially someone who is already sick and likely low-income or with limited means. A demand for rigorous scientific and medical support for the

[67] This standard was first established in *Letter of Notification of Philadelphia Electric Company Relative to the Reconstructing and Rebuilding of the Existing 138 kV Line to Operate as the Woodbourne-Heaton 230 kV Line in Montgomery and Bucks Counties* 1992 Pa. PUC LEXIS 160, at *7-8 (Pa. P.U.C., No. A-110550F0055, filed Mar. 26, 1993). This standard is inappropriate for those who are RF/EMF impaired since the disability laws require a different and much lower standard.

proposition the Complainant has some generally-accepted disease and then direct causation from the smart meter is unlawful for many reasons.

The determination of whether an individual is disabled is not necessarily based on a finding that matches a generally-accepted and named disease in a Diagnosis and Treatment Manual. The question is simply whether a person has an "impairment" and then the effect of that impairment on the life of the individual. 42 U.S.C. §12112(a)(5)(A); 28 C.F.R. §35.108(vii).[68]

2. Burden of Proof Inconsistent With Disabilities Laws

Covered entities like the PUC cannot impose the level and burden of proof applied below. Congress rejected the idea that the disability determination should be "an onerous burden for those seeking accommodations or modifications" when it amended the ADA and FHA. 154 Cong. Rec. S8842 (daily ed. Sept. 16, 2008) (Statement of the Managers). The federal agencies overseeing these acts have implemented rules of construction that make this plain. 28 C.F.R. §36.101; Part 36,

[68] The analysis for a disability or handicap is the same for each of the three ADA Titles, FHA handicap purposes and Rehabilitation Act claims. That is why courts routinely address discrimination claims together. *Friedman v. Cent. Me. Power Co.*, No. 2:20-cv-00237-JDL, 2021 U.S. Dist. LEXIS 62585, at *5 n.2 (D. Me. Mar. 31, 2021), *citing Astralis Condo. Ass'n v. Sec'y, U.S. Dep't of Housing & Urban Dev.*, 620 F.3d 62, 66 (1st Cir. 2010), *Calero-Cerezo v. U.S. DOJ*, 355 F.3d 6, 19 (1st Cir. 2004) and *Theriault v. Flynn*, 162 F.3d 46, 53 n.10 (1st Cir. 1998) (Lipez, J., concurring). Pennsylvania generally uses the same tests and criteria for purposes of the PHRA. *See Lazer Spot, Inc. v. Pa. Human Rels. Comm'n*, 184 A.3d 200 (Pa. Commw. Ct. 2018).

Appendix C - Guidance to Revisions to ADA Title II and Title III Regulations Revising the Meaning and Interpretation of the Definition of "Disability" and Other Provisions in Order to Incorporate the Requirements of the ADA Amendments Act. An individualized assessment is necessary,[69] but the Guidance directly states that once there is an individualized professional assessment "there is no need for further inquiry into the nature of the disability:"

> …Reports from experts who have personal familiarity with the candidate should take precedence over those from, for example, reviewers for testing agencies, who have never personally met the candidate or conducted the requisite assessments for diagnosis and treatment.[70]

None of the utility's expert witnesses performed an in-person individualized assessment of any of the Complainants before the Court. Doctor Israel did his "evaluation" remotely and merely compared reported symptoms to "databases" and "studies." *Murphy Order*, p. 61 (R.190a). Thus, the PUC erred by giving the utility's testimony overriding weight to that from the Complainants' medical evidence. The PUC also erred in its evaluation of the Complainants' evidence. The

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[69] *See* 28 CFR Appendix A to Part 36 - Guidance on Revisions to ADA Regulation on Nondiscrimination on the Basis of Disability by Public Accommodations and Commercial Facilities: "The question of whether an individual meets the definition of disability should not demand extensive analysis… determining whether an impairment substantially limits a major life activity requires an individualized assessment."

[70] AG Order No. 3181-2010, 75 FR 56258, Sept. 15, 2010; 76 FR 13287, Mar. 11, 2011. The block-quoted sentence appears at 75 FR 56297.

Complainants clearly described an impairment that substantially limits major life activities and showed that installation of a smart meter would significantly interfere with their medically-affirmed need for avoidance. In other words, consistent with the NIBS report finding smart meters can render homes "inaccessible" to those who are electromagnetically-sensitive.

VI. Only Reasonable and Effective Accommodation is Analog Meter

Requiring a smart meter unlawfully discriminates against those who are exposure intolerant.[71] The service here is electricity, and utilities were able to provide that service for many decades without smart or digital meters. Allowing opt-out for the disabled will not impose an impossible or even overly difficult burden. The RF-impaired cannot be required to sacrifice their health, worsen their impairments. and live in an intolerable home environment in order to have essential utility service.

Once an "impairment" and its "limitations" are shown the question then turns to what "accommodations" are appropriate. Here, the PUC offers an "accommodation" in the form of moving the meter away from the home. This "accommodation" does not resolve the problem since it will not fully prevent RF exposure despite the additional distance from the wireless transmitting antenna.

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[71] *Friedman v. Cent. Me. Power Co., supra* held that the plaintiff had adequately plead discrimination when he had to pay a smart meter opt-out fee. An inability to opt-out at all is clearly worse.

A. Placement in Yard is Not Reasonable Accommodation

Moving the smart meter to a more distant location in the yard would reduce the wireless RF exposure level inside the home. There would, however, still be RF emissions in the house and on the property. Anyone with electro-sensitivity will have to stay far away from the meter. As a result, the person will not have full use and enjoyment of a significant part of their property. This is still unlawful discrimination under the FHA and Rehabilitation Act, because customers who are not electro-sensitive do have full use and enjoyment of all their property, including the part near the utility meter. *Friedman v. Cent. Me. Power Co., supra*. Thus, the proffered "accommodation" is not "reasonable" and neither the PUC nor PECO can impose that outcome. Further, installing the meter further away merely reduces but does not eliminate the emissions that will enter the house. The customers will still have to expend resources to shield the house from the radiation.[72]

B. Placement in Yard Does Not Eliminate Harmful RF "Noise" in House

The smart meter's AC/DC conversion process by the SMPS generates variable RF spikes that enter the house electric wiring, transforming the house into a whole house antenna. Installing the smart meter further away from the house

[72] BBI Report ¶¶29-31.

would not eliminate this problem. Digital meters also contain SMPS and therefore generate RF and cannot be considered a reasonable accommodation.[73]

The only reasonable and effective accommodation is an analog meter – the kind that has been used for many decades. It does not have a SMPS and will cost the utility less than $100.[74] Accommodating the "customers" in this case and all the hundreds of people who requested accommodation would have been cheaper than this case.

VII. CONCLUSION

Act 129 does not compel smart meters absent customer consent; it clearly envisions affirmative customer request (Opt-In). Regardless of the legislature's word choice the state cannot lawfully force a customer to accept a smart or digital meter when mandatory installation results in disability discrimination, exacerbates existing impairments or forces people to abandon their home. There must be effective accommodation.

The rule is simple: accommodation in the form of an analog meter is required if a customer presents a professional assessment of impairment and a need for RF/EMF avoidance.

[73] Engineer Report ¶¶18-19; BBI Report ¶¶27-34.
[74] BBI Report ¶36.

The Court can dispose of this case without directly wading into health effects or even disability by merely applying the statute according to its plain terms. If it does go farther the Court should ensure that those with electro-sensitivity can receive accommodation in the form of an analog meter. Any other outcome will be inhumane. No decent society purposefully punishes the innocent for conditions they cannot control. The Court cannot allow an outcome that will lead to even more sickness and homelessness for those who cannot tolerate a smart or digital meter.

Respectfully Submitted,

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**Pro hac vice motion pending*

APPENDIX

LIST OF ADDITIONAL AMICI CURIAE

PENNSYLVANIANS FOR SAFE TECHNOLOGY is a volunteer grassroots organization that seeks to educate and inform Pennsylvanians about ways to protect health and the environment through the safer, more secure use of technology, especially wired connections.

PENNSYLVANIA SMART METER WORK GROUP is an organization in Pennsylvania which acts as a support group for utility customers with Formal Complaints entered with the PA Public Utilities Commission objecting to the installation of smart meters on their properties. Their members, pro-se litigants, help each other get through the legal and bureaucratic tangle of utility and administrative law. Their mission has broadened to include 5G and other wireless devices and systems as the ramifications of wireless extend beyond smart meters.

NATIONAL ASSOCIATION OF ENVIRONMENTAL MEDICINE is a 501(c)(6) national medical organization based in Washington that provides clinical guidelines and specialization in environmental medicine for naturopathic physicians and allied primary care providers.

MOMS ACROSS AMERICA is a 501(c)(3) nonprofit organization with national networks based in North Carolina which reaches millions of people every month. Its mission is to educate and empower mothers and others with actions and solutions to create healthy communities.

NATIONAL ASSOCIATION FOR CHILDREN AND SAFE TECHNOLOGY is an organization whose mission statement is to advance policies regarding technology that protect children's health and well-being in order to ensure a strong future for the United States of America.

MASSACHUSETTS FOR SAFE TECHNOLOGY is a public interest advocacy group based in Massachusetts and is a project under the 501(c)(3) nonprofit Concerned Citizens for the Appropriate Placement of Telecommunications Facilities, Inc., which serves as its fiscal agent. Its mission is to educate citizens, public servants, lawmakers and health care professionals on the risks of wireless radiation exposure to children, adults and our environment and to promote the use of biologically safe and fiscally responsible technology in our homes, schools, communities, and workplaces.

VIRGINIANS FOR SAFE TECHNOLOGY LLC is based in Virginia. Its mission is to advocate for safe, accessible, affordable, and ethical technology for all and provide information, education, resources, and support to empower consumers and lawmakers to make informed decisions and act as stewards of their communities.

NEW YORK SAFE UTILITY METER ASSOCIATION is a nonprofit corporation whose mission is dedicated to the continued use of mechanical analog utility meters. NYSUMA educates the public about the hazards associated with electronic digital utility meters (aka: AMR, ERT, AMI, "smart," and "opt-out digital"). They are also very concerned about the unchecked privacy invasion of digital utility meters and skyrocketing utility rates. NYSUMA advocates for the rate payer's right to choose the safest meter without penalties. NYSUMA also works to raise awareness about the dangers of other wireless radiation technologies, including Wi-Fi, cell phones, 3G, 4G, 5G cell towers and their negative impact on public health and the environment.

RHODE ISLANDERS FOR SAFE TECHNOLOGY is an organization based in Rhode Island that envisions a world in which computer and telecommunications technology is safer. Its mission is to educate the public regarding wireless health risks and best practices.

ARIZONANS FOR SAFE TECHNOLOGY is a group seeking to protect Arizona neighborhoods through better, safer technologies.

UTILITY METER CHOICE FOR 4 MICHIGAN is an organization whose mission is to inform the public of the harm of wireless radiation from smart meters and pass legislation which will provide utility customers with the right to choose not to be exposed to the dangers caused by smart meters.

MARYLAND SMART METER AWARENESS is a 501(c)(3) nonprofit corporation out of Baltimore, MD, whose mission includes education of the public regarding smart meters, wireless technology and the health impacts of radio frequency microwave radiation, as well as to provide and advocate for alternatives to wireless smart meters and to engage in litigation to protect Maryland residents from the harmful effects of smart meters. They have about 1,000 members.

AUTISM AGE is a 501(c)(3) nonprofit corporation based in Connecticut that gives voice to those who believe autism is an environmentally-induced illness that is treatable, and that children can recover. They believe that autism is the defining disorder of our age, is man-made and therefore preventable. Smart meters are an environmental risk to health that is preventable.

COLORADANS FOR SAFE TECHNOLOGY is an advocacy group based in Colorado whose mission is to educate the public and public representatives of the risks and downsides of wireless technology and to promote the implementation of safe, efficient alternatives.

SAFE TECHNOLOGY MINNESOTA, a project of the 501(c)(3) nonprofit corporation Minnesota Natural Health Coalition, has as its mission to educate and support the public regarding the health and environmental hazards of electromagnetic radiation, especially from wireless technology.

CONNECTICUT RESIDENTS FOR RESPONSIBLE TECHNOLOGY is a grassroots organization based in Connecticut consisting of 1,500 members, most of whom have suffered from radiofrequency radiation. Their mission is to increase community awareness of the negative health effects of macro cell towers in close proximity to homes, schools, health centers and workplaces, and to stop the irradiation of citizens.

MICHIGAN FOR SAFE TECHNOLOGY is an organization in Michigan whose mission is to educate, inform, and advocate for the safe use of wireless technology.

IDAHOANS FOR SAFE TECHNOLOGY FOUNDATION is a 501(c)(3) nonprofit corporation whose mission is to provide educational and financial support for statewide efforts toward deployment of responsible broadband technology to our communities and throughout the State of Idaho.

MALIBU FOR SAFE TECH is an organization in California that consists of active local residents fighting to protect the community and environment from the threats of wireless telecommunication. Its mission is to raise awareness of these immediate issues and actively participate in local government to stop the spread of 5G before its effects become detrimental to residents.

MANHATTAN NEIGHBORS FOR SAFER TELECOMMUNICATIONS is an educational initiative whose mission is to bring awareness to the harmful physical and mental health effects of cell phones, Wi-Fi, wireless computer equipment, portable phones, excessive screen time, too-early technology use, wireless utility equipment and neighborhood cell towers and antennas.

ELECTROMAGNETIC SAFETY ALLIANCE, INC. is a 501(c)(3) nonprofit corporation based in Arizona whose mission is to advocate for and educate others about the health risks of electromagnetic fields. Their fiscal sponsor is Vitalyst Health Foundation.

ALLIANCE FOR MICROWAVE RADIATION ACCOUNTABILITY, INC. (AMRA) is a nonprofit corporation based in New York that seeks to improve public health and safety through the advocacy of tougher standards and safer technology. AMRA works for greater awareness of Microwave Radiation Syndrome and the health impact on its victims.

A VOICE FOR CHOICE ADVOCACY, INC. is a 501(c)(4) nonprofit corporation based in California that advocates for people's rights to be fully informed about the composition, quality, and short- and long-term health effects of all products that go into people's bodies, such as food, water, air, pharmaceuticals, cosmetics, as well devices such as smart meters.

SAFE TECH FOR SANTA ROSA is an advocacy group in California whose mission is to post relevant information about current and planned wireless transmission facilities and "small" cell sites in Santa Rosa, California and provide resources on the biological effects of microwave radiation as supported by scientific studies.

SAFE TECH SANTA BARBARA COUNTY is an unincorporated association and advocacy group whose mission is to educate the community about the adverse cumulative effects of invisible wireless Radio Frequency Radiation (RFR) and advocate for safe technology.

SAFE TECH TUCSON is comprised of residents, business owners and respected members of the various communities within Pima County and the City of Tucson who are committed to working in partnership with elected officials to enact a telecommunications ordinance that protects public safety, privacy and property values.

BEE HEROIC LLC is a nonprofit, limited liability company located in Colorado whose mission is to provide an information-to-action platform for initiating practices that will save and protect Earth's bees and other pollinators from near-term extinction. It is focused on agrochemical threats, telecommunication/5G/IoT, and other environmentally and biologically destructive industries that contribute to the mass extinction of a key indicator species.

CALIFORNIA BRAIN TUMOR ASSOCIATION is a 501(c)(3) nonprofit organization whose mission is to educate the public about environmental health threats including those from exposure to electromagnetic radiation.

CALIFORNIANS FOR RENEWABLE ENERGY (CARE) is a 501(c)(3) nonprofit corporation whose purpose is to offer legal advice and appear before administrative bodies to help enforce environmental laws through court actions.

CENTERVILLE CONCERNED CITIZENS is a grassroots advocacy group in Massachusetts focused on advancing environmental health and protecting the community of Centerville. It was founded to stop the powering of a telecommunications cell tower in the historic village of Centerville. The initial group of nine neighbors has grown to hundreds of supporters who work to keep the community free of dangerous, untested wireless technology. “We have children and grandchildren that will one day look to us and be grateful we fought so strongly for their future health and well-being.”

CLEAR WIDBY is an organization in Washington state. CLEAR (Citizen League Encouraging Awareness of Radiation) is dedicated to the safety from electronics of wildlife, flora, fauna, and insects that experience 24/7 radiation from towers, as well as from humans who carelessly install and use their electronics. They assist citizens with wireless issues: town and county ordinances, 5G developers, smart meter issues, wildlife protection from EMF excesses, helping the human population use wireless more safely, calling for increased protections for the electromagnetically sensitive, and encouraging fiber-optic hookups for broadband coverage for all.

COALITION AGAINST SMART METERS AND 5G is an organization in the state of Washington whose purpose is first to prevent installation of smart meters

in Snohomish County, Washington, and also to prevent installation of 5G small cell towers in Edmonds, Washington.

FRIENDS OF MERRYMEETING BAY is a Maine-based 501(c)(3) nonprofit engaged in research, advocacy, education, and land conservation. Because of its inordinate proliferation and its biological effects on people and the environment, FOMB considers radiofrequency radiation (RFR) the most significant environmental toxin of our time. Smart meters dramatically increase rural presence and effects of RFR. FOMB filed an Amicus Curiae Brief with the Commonwealth Court in support of petitioners Povacz, Murphy, Randall and Albrecht (NO. 606 CD 2019).

ECOLOGICAL OPTIONS NETWORK is a 501(c)(3) nonprofit organization in California. Since 1999 they have been actively organizing, informing, and producing media and to influence policy that protects people's right to health in the midst of cell towers, cell phones, smart meters, and 5G. They organized in their county and region for a smart meter opt-out. They also served as official public intervenors in the smart meter proceeding at the California Public Utilities Commission.

DAMS (Dental Amalgam Mercury Solutions), INC. is a 501(c)(3) nonprofit corporation based in Minnesota whose mission is to educate the public about

biological dentistry and the dental-health connection. It is also concerned about the proliferation of wireless radiation causing biological harm. DAMS has about 2,000 members, and approximately half are health care professionals.

EMF WELLNESS LLC is a 501(c)(3) nonprofit corporation in Arizona comprised of residents, business owners and members of the various communities within Pima County and the City of Tucson who are committed to working in partnership with elected officials to enact a telecommunications ordinance that protects public safety, privacy, and property values.

DR. OLINDO FLORO PA is a clinical practice out of Minnesota that provides natural health care and education to their patients so that they can be happy, healthy and pain free. They educate and treat patients that have symptoms of wireless radiation exposure.

EARTH PROTECTOR LICENSING CORPORATION is a 501(c)(3) nonprofit environmental and health organization based in Minnesota whose mission is to improve life and to be an earth protector. It is concerned about the proliferation of wireless technology, including smart meters, and the harmful effects of this radiation.

ENVIRONMENTAL HEALTH COMMITTEE is a nonprofit organization in New York with a mission to educate the residents of the Butternut Valley on the dangers of, and ways to mitigate, environmental pollution from all sources, currently focusing on the dangers of wireless microwave radiation-emitting devices.

5G FREE CALIFORNIA is a 501(c)(3) nonprofit corporation based in California whose mission is to engage in education, outreach and advocacy on the health effects of wireless radiation and on support for safer technology; to enhance the vision that people have the right to be protected from harm and that those already injured are acknowledged, respected and supported; and that people have the right to make informed choices about exposure to radiation and health sovereignty.

5G FREE MARIN is a nonprofit coalition in California composed of local Marin-based groups fighting to stop unnecessary, unsafe and excessive wireless technologies from being imposed on local communities by the telecommunications industry.

5G FREE OREGON is a nonprofit volunteer organization based in Portland, Oregon, dedicated to raising awareness of the critical issue of radio and microwave radiation technologies and their adverse effects on health.

5G FREE RHODE ISLAND is a group of private individuals with a common interest in protecting humans and the environment from the harms of wireless radiation. Its mission is to continue to actively educate communities and public officials at the city, state, and federal levels. It takes action in furtherance of the foregoing by holding their cities and towns accountable for protecting all residents and stopping the 5G rollout.

FOUNDATION FOR ADVANCEMENT IN CANCER THERAPY is an educational 501(c)(3) nonprofit corporation. Their goal is to educate physicians and patients about a different concept of treatment and prevention of cancer and chronic degenerative conditions. They are concerned about the health impacts of electromagnetic radiation-producing devices such as smart meters.

HANDS ACROSS THE RIVER COALITION is incorporated in the state of Massachusetts with about 600 members. Their primary focus is the health-conscious cleanup of the New Bedford Harbor Superfund site contaminated primarily with PCBs which can affect public health. Their fiscal sponsor is People Acting in Community Endeavors, PACE, in New Bedford, MA. They are concerned about smart meters and other emitters of harmful electromagnetic radiation.

KEEP BALDY WILD is an organization based in California that is committed to projects and education that support the unique ecosystem of the San Antonio Canyon watershed for current and future generations. Their group distributed the summary of the BioInitiative Report of 2012 to community members and did educational outreach regarding smart meters, cell phones and cell towers.

KEEP CELL ANTENNAS AWAY is an informal group of residents in California, united by a common goal of keeping cell antennas away from homes. Their mission is to influence 5G roll-out in their cities by building a large and active movement of residents.

KEEP YOUR POWER is an advocacy group in Hawaii that consists of a coalition of educated, concerned citizens whose mission is to stop harmful wireless technologies from being deployed in the Hawaiian islands and to advocate for safe technology.

KUNZE PRODUCTIONS, LLC is a for-profit company based in California which presents an investigative documentary called “Mobilize” that explores the potential long-term health effects from cell phone radiation, including cancer and infertility.

LAST TREE LAWS is an informal group for advocacy based in Massachusetts and is also organized as a Massachusetts state ballot question committee, focusing on lobbying and ballot question work. Its mission is to lobby for environmental and social justice, as well as reducing wireless exposures.

NATIONAL HEALTH FEDERATION (NHF) is a 501(c)(3) nonprofit organization whose mission is to educate consumers, producers, healthcare professionals, government and other leaders regarding freedom of choice and informed consent in healthcare, and to protect the health rights and freedom of individuals and healthcare practitioners regarding freedom of choice and true informed consent in all matters concerning healthcare.

NATIONAL TOXIC ENCEPHALOPATHY FOUNDATION is a 501(c)(3) nonprofit organization whose mission is to provide education and services to the growing segment of the population who are adversely affected by everyday chemicals and toxins in our environment, and to provide education on cell phone safety that is showing a correlation with the increase of brain tumors and cancer.

NEVADA CITY TELECOMMUNICATIONS ORDINANCE PUBLIC WORKING GROUP is a group of individuals in Nevada, California, whose mission is to amend the city's telecommunication ordinance and strengthen the City’s legal authority to protect residents and the quiet enjoyment of their streets.

NEW YORKERS 4 WIRED TECH is a group of grassroots advocates in New York whose mission is to alert the public to the serious biological harm caused by wireless communications infrastructure's pulsed-modulated microwave radiation, and support municipally-owned and controlled wireline solutions (fiber optic broadband direct to homes and businesses as a basic public infrastructure, a public necessity and a public good) in the public rights-of-way. It advocates for the preservation and maintenance of existing legacy copper, switched telephone landlines.

NORTH CENTRAL WEST VIRGINIA FOR SAFE TECHNOLOGY is a nonprofit organization in West Virginia whose mission is to reflect the feelings and actions of like-minded people in West Virginia and around the world, to make our area on the planet one of the healthiest (low radiation) places to live in the USA.

ONCE A FOREST is a community organization based in Santa Fe, NM, supporting living forests and community-inclusive decision-making about forest health with a mission to inform the public about forest service cut and burn plans. They are concerned about the impact of harmful electromagnetic radiation on the health of the forests.

ORGANIC CONSUMERS ASSOCIATION is based in Minnesota and is an online and grassroots 501(c)(3) nonprofit public interest organization, and the only organization in the U.S. focused exclusively on promoting the views and interests of the nation's estimated 50 million consumers of organically and socially responsibly produced food and other products. Their mission statement is to protect and advocate for consumers' right to safe, healthful food and other consumer products, a just food and farming system and an environment rich in biodiversity and free of pollutants.

PATRONS OF THE PLANET is an environmental group in Connecticut working to bring awareness and information to residents about the importance of protecting the lands, water, insects and air from the harmful effects of “small cells,” cell towers and smart meters. They advocated against a bill that would extend the rollout of “small cells.”

PLUMAS WIRED! is an advocacy group of Plumas County residents in California, with hundreds of members, whose mission is to support safer, affordable, wired telecommunications for the public.

SAINT CROIX APPRAISALS is an organization that offers appraisal services for residential homes and educates people about the destructive effects of Wi-Fi and electromagnetic energies in their homes.

SANTA BARBARA PERMACULTURE NETWORK is a 501(c)(3) nonprofit organization in California that helps Santa Barbara design systems to reconcile human communities with the ecological imperatives of a living planet.

SECOND LOOK is a nonprofit organization whose main goal is to facilitate full public and scientific examinations of public policy issues that have become obscured by media treatment (or lack thereof), or by political rhetoric, or because of the inaccessibility of accurate information to relevant constituencies. Their primary environmental health concerns are fluoride toxicity, fluoride poisoning in individuals, and electromagnetic field toxicity science.

SOCIAL JUSTICE COMMITTEE is a faith-based committee of the Berkeley Fellowship of Universalist Unitarians, a 501(c)(3) nonprofit organization based in California, whose mission is to support inclusion and diversity, environmental stewardship, fair labor practices, and general peace, democracy, and human rights in the U.S. and abroad.

SOUTH CAROLINA COALITION FOR WIRELESS SAFETY STANDARDS is a 501(c)(3) nonprofit corporation whose mission is to educate and advocate on the dangers that wireless technology poses to human health and the environment. The SCCWSS represents thousands of people across South Carolina. The Coalition embraces and supports getting safe, connected technology to every

citizen in South Carolina while reducing the man-made electromagnetic pollutant of radio frequency, microwave and millimeter wave radiation.

STOP 5G CARLSBAD is a grassroots movement of residents in Carlsbad, California who are deeply concerned about the pending construction of 5G "small cell" towers every 300-500 feet throughout their neighborhoods. They are also concerned with such harmful devices as smart meters.

STOP 5G ENCINITAS is a California organization that envisions and seeks to ensure a world where 4G, 5G, 6G or any other "G" is implemented by safe technology standards that has undergone scrutiny to ensure the health and well-being of all life on the planet before being unleashed. They also envision and seek to ensure a world where the health and well-being of all life takes precedence over corporate self-gain.

STOP 5G INTERNATIONAL is a voluntary association of individuals from around the world with about 5,000 members from multiple countries whose mission is to support the global effort to stop 5G because it poses an immediate threat to life on earth. They rely on evidence-based information and non-violent actions in keeping with the vision of Stop 5G International. Their financing is through Ecological Options Network, a 501(c)(3) organization.

STOP 5G JAX is an activist group of citizens whose mission is education and opposition to 5G in Jacksonville, FL and in the rest of Florida.

STOP SMART METERS! is based in California and their fiscal sponsor is California for Renewable Energy. It is an advocacy, media outreach and direct action network providing activism, consultation and advice to dozens of local groups who are opposing wireless smart utility meter deployments for health, privacy, safety and other reasons.

STOP SMART METERS NEW YORK was created in 2013 as an information hub and help line for New York State residents who are concerned about the forced installation of digital utility meters in the state. This step was required due to the absence of any state-provided consumer protection for utility customers. Their mission is to secure a no-fee safe analog utility meter choice for all New York State residents.

SWEETWATER COLLABORATIVE is a 501(c)(3) nonprofit from California whose mission is to demonstrate how to live in balance with their local watershed using regenerative, waterwise landscape practices. They provide education, workshops, and training for sustainable water management as well as consultations, design, and installations of greywater and rainwater harvesting systems, food forests and drought-tolerant and edible landscapes. They work

with homeowners, organizations, businesses and neighborhoods in a variety of capacities. They are concerned about the impact of wireless radiation on landscapes and ecosystems.

TOXICS INFORMATION PROJECT (TIP) is a 501(c)(3) nonprofit corporation based in Rhode Island which strongly opposes deployment of 5G systems and informs residents about the high radiation installations and their dangerous and unhealthy effects.

VERMONTERS FOR A CLEAN ENVIRONMENT is an organization whose mission is fighting for the economic well-being of all Vermonters assuring appropriate use of their resources — our people, our land, our air and our water. They are united in the belief that Vermont's future lies in conserving its clean, rural, small-town environment. They have joined together to pursue the common goals of encouraging economic development with minimal environmental impacts and preserving Vermont's natural beauty. VCE is committed to providing facts and information so that people can make informed decisions.

WINDHEIM EMF SOLUTIONS is an organization from California that believes that fewer electromagnetic fields lead to better health and longer life.

WIRE AMERICA is a citizen journalist and advocacy organization in California, working to preserve local control over wired broadband and wireless telecommunications infrastructure. Local communities must retain the freedom to integrate the best broadband options for their residents. It has worked at the federal, state and local levels to tame the unnecessarily dense deployment of 4G/5G so-called “small” wireless telecommunications facilities (sWTFs) in residential neighborhoods.

WiRED is an organization based in California that exists to educate the public about wireless radiation and to defend communities against it. They are the local embodiment of a state-wide, national and worldwide movement advocating for safer technology and resisting the corporate imposition of wireless and cellular technologies on the public without fully-informed consent. They seek to inform the public via independent, evidence-based, peer-reviewed scientific studies. They seek to awaken and empower ordinary folks to unite to take back the autonomy of our communities from the colonizing control of transnational telecommunications corporations.

WIRED BROADBAND, INC. is a nonprofit corporation in New York whose mission is to educate the public and government officials about the dangers associated with radio frequency radiation from wireless facilities and to advocate

for the use of fiber optics as a safer, faster and more secure solution to broadband deployment in New York City and throughout the United States.

WIRELESS EDUCATION ACTION is an educational organization based in Oregon whose mission is education regarding the potential health effects of wireless technology and how to reduce exposure, education of local and federal representatives, and of health practitioners. They wish to build a greater and greater grass root movement to affect change in Oregon.

WIRELESS RADIATION EDUCATION & DEFENSE is a grassroots nonprofit organization based in California composed of concerned scientists, educators, parents, and activists. This organization is a fiscal project of Ecological Options Network (EON), which is a 501(c)(3) nonprofit corporation. Its mission is to empower the public to regain autonomy and rights over adverse telecommunication company interests.

CERTIFICATE OF COMPLIANCE

Pursuant to Pa. R. App. P. 531(b)(3) and 2135(d), the undersigned certifies that this Brief complies with the type-volume limitations of Pa. R. App. P. 531(b)(3) because this Brief contains 6,985 words, excluding those parts exempted by Pa. R. App. P. 2135(b).

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CERTIFICATION OF CONFIDENTIAL INFORMATION

I hereby certify that this filing complies with the provisions of the *Case Records Public Access Policy of the United Judicial System of Pennsylvania* that require filing confidential information and documents differently than non-confidential information and documents.

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CERTIFICATE OF SERVICE

I hereby certify that on this 14th day of September 2021, I electronically filed the foregoing with the Clerk of Courts using the PACFile appellate court electronic filing system, which will send notice of such filing to all registered PACFile users.

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ADDENDUM

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IN THE SUPREME COURT OF PENNSYLVANIA
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PHYSICIANS STATEMENT

SMART METER EFFECTS ON PATIENTS WHO ARE ADVERSELY AFFECTED BY EXPOSURE TO RADIOFREQUENCY AND ELECTROMAGNETIC EMISSIONS

Purpose of Statement

1. The undersigned are physicians - medical doctors (MDs) and Doctor of Osteopathic Medicine (DOs). Our duty as physicians is to help our patients and protect our community's public health. The American Medical Association's Code of Medical Ethics also demands that we seek legal outcomes that are in the best interests of the patient. Code of Medical Ethics Opinion 8.1 states that "While a physician's role tends to focus on diagnosing and treating illness once it occurs, physicians also have a professional commitment to prevent disease and promote

health and well-being for their patients and the community." Our Hippocratic Oath requires that we take all necessary steps to "prevent disease whenever we can." Our professional ethics therefore demand that we participate in efforts to prevent patient harm.

2. We file this statement to share with the Court our knowledge of the scientific and medical literature and our experience working with those of our patients, adults and children, who are adversely affected by exposure to wireless-based technologies, including smart meters. Combined we have over 3,000 patients who suffer from electro-sensitivity and/or other conditions which are aggravated by exposure. We hope our statement will help the Court reach an informed and equitable decision in this extremely important case that may have widespread implications on the lives of those adults and children who are adversely affected across the country.

3. It is our unequivocal opinion that Smart meters must not be forced on patients who experience a negative response to RF/EMF, and the only reasonable and humane accommodation is analog meters, the same meters we have had for many decades.

Introduction and Summary of Filing

4. Wireless-based technologies such as cell phones, Wi-Fi and smart meters use and emit pulsed electromagnetic fields (EMFs) and radiofrequency

(RF) radiation (collectively RF/EMF). Exposure to RF/EMF can be harmful, at least to some people. It can directly injure; it can exacerbate pre-existing conditions; and it can interfere with treatment.

5. The undersigned doctors have patients who suffer adverse reactions to RF/EMF, and some of the undersigned doctors themselves are adversely affected and personally experience the painful and debilitating effects of exposure.

6. Adverse effects from RF/EMF are real, proven and a major threat to some people's health**.** Human physiology has many bioelectric elements, and this is especially true of the heart, brain, nervous system, and intercellular communication. Pulsed and modulated RF/EMF are stressors that directly affect this physiology. Humans vary in their physiology and in their resilience to stressors. Some people lose the ability to cope at a lower level of exposure to toxins than others and some may never get sick.

7. The only treatment for those who suffer impairments worsened by RF/EMF exposure is avoidance. However, with the ever-growing ubiquitous, involuntary exposure to RF/EMF from wireless technology and infrastructure,[1] their home environment is the only place they have some ability to control exposure. It is their last place of refuge.

[1] https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(18)30221-3/fulltext.

8. Mandatory smart meter deployment in homes, without a meaningful accommodation for those adversely affected by RF/EMF, will frustrate our ability to maintain or improve our patients' well-being; cause them intolerable harm; and take away from them their only possible refuge, the only place to which they have some control over exposure, and which must be a sanctuary.

9. For those who are adversely affected, having a wireless or digital smart meter is not an option. The *only* reasonable accommodation is an analog meter. It does not create the adverse elements on the electric system created by the operation of the digital/wireless "smart" meters that adversely affect them.

Electro-Sensitivity

10. The most widespread sickness associated with exposure to pulsed RF/EMF is likely "electro-sensitivity."[2] The condition is also referred to in the scientific literature as "electromagnetic hypersensitivity" (EHS), "microwave sickness" and "radiation sickness."

11. The condition is characterized by a constellation of mostly neurological symptoms that occur as a result of exposure to RF/EMF. Common symptoms include headaches, cognitive and memory problems, exhaustion, heart palpitations, anxiety-like symptoms, seizures, sleep issues, ringing in the ears,

[2] https://www.aaemonline.org/wp-content/uploads/2020/12/AAEMEMFmedicalconditions.pdf.

tingling, nausea, skin reactions, dizziness, noise sensitivity, digestive problems, and nosebleeds.

12. Electro-sensitivity is not truly a sensitivity; it is a sickness caused and/or aggravated by exposure to pulsed RF/EMF, with serious physiological complications. Many hundreds of studies have proven that RF/EMF exposure can cause and/or aggravate these symptoms[3] and the underlying injuries[4] and establish the causal mechanisms of harm.[5]

13. There are diagnosis guidelines and International Codes of Diseases classifications. Doctors and scientists warn that it is widespread, and the rates are growing. It is recognized as a disability by US agencies.[6]

[3] Neurological effects: https://bioinitiative.org/wp-content/uploads/2020/09/6-RFR-Neurological-Effects-Abstracts-2020.pdf; https://bioinitiative.org/wp-content/uploads/2020/10/13-Neurological-Effects-Studies-Percent-Comparison-2020.pdf.

[4] https://direct.mit.edu/neco/article/30/11/2882/8424/Diplomats-Mystery-Illness-and-Pulsed.

[5] Mechanism of harm: https://bioinitiative.org/wp-content/uploads/2020/09/3-RFR-Free-Radical-Oxidative-Damage-Abstracts-2020.pdf (oxidative stress); https://direct.mit.edu/neco/article/30/11/2882/8424/Diplomats-Mystery-Illness-and-Pulsed'; https://direct.mit.edu/neco/article/30/11/2882/8424/Diplomats-Mystery-Illness-and-Pulsed.

[6] See further discussion in the Amicus Brief. Also: https://childrenshealthdefense.org/wp-content/uploads/rf-accomodation-nibs.pdf; Dept. of Education: https://childrenshealthdefense.org/wp-content/uploads/rf-accomodation-education.pdf; Dept. of Labor: https://childrenshealthdefense.org/wp-content/uploads/rf-accomodation-labor.pdf.

14. For many of our patients, RF/EMF exposure adversely and severely affects their ability to physically and mentally function. Exposure can interfere with brain wave operation and impair blood flow to the brain. These effects can cause interference with various brain functions including sleep and cognitive functions. Exposure can also damage the blood-brain barrier (BBB) which can lead to brain damage and neurodegenerative conditions. RF/EMF interfere with the nervous system and bioelectric functions.[7]

15. Those affected react to RF/EMF exposures they were able to tolerate previously and at levels that may not evoke a negative response in others. With avoidance, the symptoms decrease and can even completely disappear. But with re-exposure they reappear. Continued exposure leads to increase in symptom frequency, severity and additional symptoms may appear. It can also worsen the underlying injuries.

16. The scientific evidence explaining causation and mechanisms of harm associated with RF/EMF injuries is now robust. Oxidative stress is an established

[7] https://direct.mit.edu/neco/article/30/11/2882/8424/Diplomats-Mystery-Illness-and-Pulsed.

mechanism of harm for RF/EMF-related injuries;[8] known physiological biomarkers and genetic predispositions[9] help us in our diagnoses.

Diagnosis Guidelines

17. There are reliable diagnostic guidelines that we use and rely on in our practice. In 2016 the European Academy for Environmental Medicine's (EUROPAEM) "EMF Working Group" developed official diagnosis guidelines: "EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses"[10] (Exhibit 1). These guidelines were developed by the world leading experts; they were peer-reviewed and published and are used by doctors in the US and around the world. They provide a comprehensive review of the scientific evidence regarding the symptoms, the physiological damage, mechanisms of harm and biomarkers associated with RF/EMF-related health effects, and they reference 235 peer-reviewed studies. The guidelines are based on the Austrian Medical Association's guidelines.[11]

18. When diagnosing the condition, we use the World Health Organization (WHO) International Classification of Diseases' Code T-66 for a

[8] https://direct.mit.edu/neco/article/30/11/2882/8424/Diplomats-Mystery-Illness-and-Pulsed.

[9] https://www.hindawi.com/journals/mi/2014/924184/.

[10] https://pubmed.ncbi.nlm.nih.gov/27454111/.

[11] https://ecfsapi.fcc.gov/file/1092912632123/48-Attachment%2048-%20Austrian%20Medical%20Assoc%20Guideline%20EMF%20Disease.pdf.

diagnosis of "Radiation Sickness" and Code W90 which recognizes that "Exposure to Other Nonionizing Radiation" can cause injury.

19. The knowledge regarding the etiology of the condition is constantly evolving. Professor Dominique Belpomme is a member of the EMF Working Group that developed the diagnosis guidelines. Since 2009, he and his team have been conducting extensive testing on people who suffer from electro-sensitivity to identify the underlining injuries and biomarkers. They have tested over 700 people. Some of the lab tests recommended by the EUROPAEM's guidelines are based on his work.[12] To keep doctors appraised of the newly identified biomarkers, in 2020 he published peer-reviewed guidelines[13] to reflect the most current findings and biomarkers to help doctors diagnose, treat, and prevent this condition.[14]

20. We also consult with guidelines from clinics specializing in diagnosis of RF/EMF-related injuries such as those developed by Professor Riina Bray, MD, BASC, MSC, FFCP, MHSC. Prof. Bray leads the largest government hospital

[12] https://pubmed.ncbi.nlm.nih.gov/26613326/.

[13] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7139347/.

[14] Belpomme's studies provide clear evidence of physiological biomarkers indicating serious physiological injuries, and he concludes that these findings negate the hypothesis that electro-sensitivity could be psychosomatic or caused by a "nocebo" effect. These studies include objective tests that measure physiological reactions, not subjective perception, and prove that electro-sensitivity and exposure can lead to severe injuries.

clinic specializing in diagnosing electro-sensitivity.[15] Her diagnosis guidelines[16] are based on the knowledge she and the seven doctors in the clinic accumulated over the past 23 years seeing many hundreds of patients with electro-sensitivity (Exhibit 2).

Clinical Diagnosis

21. Those who suffer from electro-sensitivity develop symptoms from RF/EMF exposure. However, the underlying physical injury may be different from one patient to another, because pulsed RF/EMF can cause various physiological injuries.

22. For example, a peer-reviewed study on 675 subjects with electro-sensitivity[17] showed that 28% had leakage of the blood-brain barrier; 40% had chronic inflammation indicating oxidative stress; 23% had autoimmune antibodies; and 100% had reduced melatonin levels. Substantive scientific evidence shows that each of these injuries can be caused by pulsed RF/EMF exposure.

23. For this reason, there is no one test for diagnosis and therefore, as with many other conditions, the diagnosis must be clinical, involve direct

[15] https://www.womenscollegehospital.ca/care-programs/environmental-health-clinic/.

[16] https://www.womenscollegehospital.ca/assets/pdf/environmental/Preliminary%20Clinical%20Guidelines%20%20for%20EHS.pdf.

[17] https://pubmed.ncbi.nlm.nih.gov/26613326/.

evaluation of the patient, and requires medical judgment. Diagnosis is based on identifying the underlying cause of the patient's complaints based on symptoms and medical history rather than on one specific test. Not all ailments have classic signs from blood tests or imaging, and in lieu of these, a physician must use clinical judgment to draw a reasonable and sensible conclusion based on personal and direct observation and the scientific literature.[18]

24. When taking a patient's medical history, we look for description of situations which would be the equivalent of a blinded test, i.e., situations in which the patient was unaware of the exposure and the appearance of symptoms was a clear result of the exposure; and vice versa, where the source of exposure was removed without the knowledge of the patient and the symptoms improved. We also look for evidence of physiological reactions which are not based on subjective perception and on "natural experiment": if exposure elimination/reduction leads to diminished symptoms, then avoidance is the recommended treatment.

25. When relevant and possible, we support our clinical diagnosis with the lab tests suggested by the diagnosis guidelines. These lab tests are based on

[18] We understand that the utility's medical expert's opinion was formed and expressed without any direct contact or personal evaluation of the Complainants below, whereas the Complainants' medical evidence was based on personal knowledge, at least in part. Remote diagnostics are contra-indicated, especially in this area. The Commission's decision to accept the utility's medical evidence over that of an actual attending physician is highly questionable. We note that the federal disabilities rules expressly discount remote "records-only" evaluations.

biomarkers that have been associated with exposure to RF/EMF. For example, we use blood tests for free radicals that indicate oxidative stress damage because oxidative stress is a well-recognized mechanism of harm of RF/EMF exposure.[19]

26. Our patients' symptoms can be very severe and debilitating and for many, they significantly affect major life functions. This is so regardless of the name attached to the condition or its alleged controversial nature.

Recognition

27. US agencies have recognized the condition as a disability entitled to accommodations including: the US Access Board;[20] National Institute of Buildings Science;[21] the Department of Labor;[22] the Department of Education;[23] and the

[19] Many studies have shown that RF/EMF cause oxidative stress, and it is a recognized underlying mechanism for EMF-related sicknesses, including electro-sensitivity. https://bioinitiative.org/wp-content/uploads/2020/09/3-RFR-Free-Radical-Oxidative-Damage-Abstracts-2020.pdf; https://pubmed.ncbi.nlm.nih.gov/26151230/.

[20] https://childrenshealthdefense.org/wp-content/uploads/rf-accomodation-access-board.pdf#page=3.

[21] The report concludes that RF/EMF is an "access barrier" and can render buildings "inaccessible" to those with electro-sensitivity and provides accessibility guidelines. https://www.access-board.gov/research/building/indoor-environmental-quality/; https://childrenshealthdefense.org/wp-content/uploads/rf-accomodation-nibs.pdf.

[22] https://childrenshealthdefense.org/wp-content/uploads/rf-accomodation-labor.pdf.

[23] In 2011, DOE issued a memorandum regarding accommodation of people with Multiple Chemical Sensitivities ("MCS"). It included recommendations to minimize exposure to EMFs and to ensure the home environment is a "sanctuary," free from

Social Security Administration. In their publications some of these agencies explain that accommodation of those affected by RF/EMF should be removal/minimizing exposure and that their home should be a sanctuary free from EMF.

28. In the past couple of decades, and mainly in the past 10 years, the number of patients we see in our clinics who suffer greatly from RF/EMF has grown.[24] This is not surprising given the exponential increase in wireless deployment and use. The general public faces constant saturation in all public places and in the workplace.[25]

29. This sickness has been recognized by courts and by many medical and official international organizations such as the Council of Europe[26] and the

EMFs because they may trigger symptoms. https://childrenshealthdefense.org/wp-content/uploads/rf-accomodation-education.pdf#page=5.

[24] See statement from the American Academy of Environmental Medicine: https://www.aaemonline.org/wp-content/uploads/2020/12/AAEMEMFmedicalconditions.pdf.

[25] https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(18)30221-3/fulltext.

[26] Resolution 1815 (2011) Section 8.1.4: "pay particular attention to "electrosensitive" people who suffer from a syndrome of intolerance to electromagnetic fields and introduce special measures to protect them, including the creation of wave-free areas not covered by the wireless network." Available at http://assembly.coe.int/nw/xml/XRef/Xref-XML2HTML-en.asp?fileid=17994&.

European Parliament which stated in a resolution that the rates of electro-sensitivity are growing "exponentially."[27]

30. In 2019, the New-Hampshire legislature voted unanimously to establish a committee to study the effects of 5G and wireless radiation. The committee was comprised of scientists, public officials, and representatives of the wireless industry (through CTIA, the wireless industry lobby association). Following a year of hearing expert testimony and reviewing the science, the committee's majority report, published in October 2020, concluded that wireless radiation can be harmful. The report acknowledged electro-sensitivity and the need to accommodate those who suffer from the condition. It emphasized the need to educate doctors.[28]

31. Indeed, doctors' awareness of RF/EMFs harms is constantly growing. The California Medical Association passed a Resolution which highlighted RF/EMF effects consistent with electro-sensitivity. In 2021, close to 200 physicians participated in a medical conference about health effects associated

[27] European Parliament Written declaration on the recognition of multiple chemical sensitivity and electrohypersensitivity in the International Statistical Classification of Diseases and Related Health Problems. Available at https://www.europarl.europa.eu/doceo/document/DCL-7-2012-0014_EN.pdf?redirect.

[28] http://www.gencourt.state.nh.us/statstudcomm/committees/1474/reports/5G%20final%20report.pdf.

with RF/EMF exposure.[29] Participants received continued medical education (CME) credits.

32. We have no doubt that for some of our patients, RF/EMF are the cause of their symptoms. Only those who have not had patients who are affected, have not performed direct evaluations or are ignorant of the scientific and medical literature and the operation of the human body, can doubt these patients and their suffering from pulsed RF/EMFs.

Smart Meter Specific Issues

33. The problems with smart meters arise not only from the RF signal used to wirelessly transfer the data to the utility company. A major problem is that smart meters inject pulsed RF and extremely low-frequency (ELFs) EMFs over a house's electric wiring, effectively turning the entire home into a radiating antenna. Locating the smart meter further away from the house is not an acceptable solution or reasonable accommodation because it does not eliminate this "antenna" effect.[30]

34. This problem is exacerbated because the RF/EMF that enter the electric system are intensely pulsed,[31] and pulsation has consistently been

[29] https://emfconference2021.com/.

[30] See expert engineer Erik Anderson statement which is part of the amicus brief.

[31] https://docs.cpuc.ca.gov/PublishedDocs/EFILE/BRIEF/171336.PDF.

identified as a central element in RF/EMF related injuries.[32] EMFs used for medical treatments are pulsed because the pulsation makes the signal more bioactive.[33]

35. Some of our patients reported symptom onset after a smart meter was installed on their homes. Many were not aware of the installation at the time, did not suffer from adverse effects from wireless devices and had no idea that these meters or any wireless device can cause harm. In many of the cases, the association between the meter installation and the appearance of symptoms is clear.[34]

36. However, the best evidence of the adverse effects of these meters is the changes we see almost immediately after a smart meter is removed and replaced with an analog meter. Our patients' symptoms usually disappear or at least significantly lessen.

37. Adverse reactions which are not affected by subjective perception disappear and thus the evidence is indisputable and cannot be deemed a "nocebo" effect. It establishes clear and direct causation. For example, a common symptom we see in patients from smart meters is nosebleeds, including in children. When the

[32] https://ecfsapi.fcc.gov/file/10709642227609/Carlo%20paper%20%20Real%20versus%20Simulated%20Mobile%20Phone%20Exposures%20in%20Experimental%20Studies.pdf.

[33] https://ecfsapi.fcc.gov/file/7520940777.pdf.

[34] https://ecfsapi.fcc.gov/file/7520958363.pdf.

family has the smart meter removed, the nosebleeds usually disappear almost overnight. Studies have explained the mechanism behind pulsed RF/EMF exposure and nosebleeds.[35]

38. We must emphasize that the question of initial causation is irrelevant. The smart meter may or may not be the source that first generates symptom onset. What is relevant is that once a person begins to react to pulsed RF/EMFs, any and all exposure must be avoided, since avoidance is the primary and only truly effective treatment. People can turn off a cell phone, but they cannot turn off the smart meter or shield themselves from its effects.

39. People with major life function impairments require accommodation, without regard to initial cause. The accommodation requirement merely allows them to better function and have some chance of a tolerable life.

40. Forcing smart meters on our patients who are adversely affected by RF/EMF, in their homes, means exposing them 24/7 to a toxin that instigates dysfunction, tormenting pain and severe physiological injuries and reactions, some of which can be life-threatening.

41. Our patients and those like them cannot be required to endure exposure that is toxic and can be even deadly to them in their own home as a

[35] https://ecfsapi.fcc.gov/file/1091442657471/Cuban%20Embassy-Beatrice%20Golomb%20PhD-Microwave%20Attack.pdf#page=20.

condition of utility service. If they cannot have a safe environment in their homes, their condition will undoubtedly worsen and can result in death. Their home is their only refuge.

42. The main recommendation to our patients beyond avoidance is to contact professionals who specialize in EMF mitigation, to help them mitigate RF/EMF exposure and shield the home from outside exposure sources. However, no amount of shielding can protect those who are sick from the effects of smart meters, since they turn the home's electric wiring into a transmitting antenna. This is the worst-case scenario for the electro-sensitive.

Summary

43. Based on our knowledge and experience, we unequivocally determine that wireless and digital "smart" meters must not be forced on those who suffer adverse reactions from RF/EMF exposure. Those who are affected must have the choice of mechanical analog meters. Any other outcome will lead to immense suffering and even death. It would be unconscionable.

44. This accommodation is necessary, simple and reasonable. All that is required is to allow them to use the same mechanical analog utility meter that was installed for many decades on homes.

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PHYSICIANS STATEMENT – Exhibit 1

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EUROPAEM EMF Guideline 2015 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses

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Abstract: Chronic diseases and illnesses associated with unspecific symptoms are on the rise. In addition to chronic stress in social and work environments, physical and chemical exposures at home, at work, and during leisure activities are causal or contributing environmental stressors that deserve attention by the general practitioner as well as by all other members of the health care community. It seems certainly necessary now to take "new exposures" like electromagnetic field (EMF) into account. Physicians are increasingly confronted with health problems from unidentified causes. Studies, empirical observations, and patient reports clearly indicate interactions between EMF exposure and health problems. Individual susceptibility and environmental factors are frequently neglected. New wireless technologies and applications have been introduced without any certainty about their health effects, raising new challenges for medicine and society. For instance, the issue of so-called non-thermal effects and potential long-term effects of low-dose exposure were scarcely investigated prior to the introduction of these technologies. Common EMF sources include Wi-Fi access points, routers and clients, cordless and mobile phones including their base stations, Bluetooth devices, ELF magnetic fields from net currents, ELF electric fields from electric lamps and wiring close to the bed and office desk. On the one hand, there is strong evidence that long-term-exposure to certain EMF exposures is a risk factor for diseases such as certain cancers, Alzheimer's disease and male infertility. On the other hand, the emerging electromagnetic hypersensitivity (EHS) is more and more recognized by health authorities, disability administrators and case workers, politicians, as well as courts of law. We recommend treating EHS clinically as part of the group of chronic multisystem illnesses (CMI) leading to a functional impairment (EHS), but still recognizing that

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the underlying cause remains the environment. In the beginning, EHS symptoms often occur only occasionally, but over time they may increase in frequency and severity. Common EHS symptoms include headaches, concentration difficulties, sleeping problems, depression, lack of energy, fatigue and flu-like symptoms. A comprehensive medical history, which should include all symptoms and their occurrences in spatial and temporal terms and in the context of EMF exposures, is the key to the diagnosis. The EMF exposure can be assessed by asking for typical sources like Wi-Fi access points, routers and clients, cordless and mobile phones and measurements at home and at work. It is very important to take the individual susceptibility into account. The primary method of treatment should mainly focus on the prevention or reduction of EMF exposure, that is, reducing or eliminating all sources of EMF at home and in the workplace. The reduction of EMF exposure should also be extended to public spaces such as schools, hospitals, public transport, and libraries to enable persons with EHS an unhindered use (accessibility measure). If a detrimental EMF exposure is reduced sufficiently, the body has a chance to recover and EHS symptoms will be reduced or even disappear. Many examples have shown that such measures can prove effective. Also the survival rate of children with leukemia depends on ELF magnetic field exposure at home. To increase the effectiveness of the treatment, the broad range of other environmental factors that contribute to the total body burden should also be addressed. Anything that supports a balanced homeostasis will increase a person's resilience against disease and thus against the adverse effects of EMF exposure. There is increasing evidence that EMF exposure has a major impact on the oxidative and nitrosative regulation capacity in affected individuals. This concept also may explain why the level of susceptibility to EMF can change and why the number of symptoms reported in the context of EMF exposures is so large. Based on our current understanding, a treatment approach that minimizes the adverse effects of peroxynitrite – as has been increasingly used in the treatment of multisystem disorders – works best. This EMF Guideline gives an overview of the current knowledge regarding EMF-related health risks and provides concepts for the diagnosis and treatment and accessibility measures of EHS to improve and restore individual health outcomes as well as for the development of strategies for prevention.

Keywords: accessability measures; alternating; Alzheimer's; cancer; chronic multisystem illnesses (CMI); diagnosis; electric; electromagnetic field (EMF); electromagnetic hypersensitivity (EHS); functional impairment; infertility; leukemia; magnetic; medical guideline; nitrosative stress; nonionizing; oxidative stress; peroxynitrite; prevention; radiation; static; therapy; treatment.

Current state of the scientific and political debate from a medical perspective

Introduction

The Environmental Burden of Disease Project assessed the influence of nine environmental stressors (benzene, dioxins including furans and dioxin-like PCBs, secondhand smoke, formaldehyde, lead, noise, ozone, particulate matter and radon) on the health of the population of six countries (Belgium, Finland, France, Germany, Italy, and the Netherlands). Those nine environmental stressors caused 3%–7% of the annual burden of disease in the six European countries (1).

The Bundespsychotherapeutenkammer (BPtK) study in Germany showed that mental disorders had increased further and especially burnout as a reason of inability to work escalated seven-fold from 2004 to 2011 (2). In Germany, 42% of early retirements in 2012 were caused by mental disorders, depression being the leading diagnosis (3). In Germany, psychotropic drugs are at third place for the prescriptions of all drugs (4).

The consumption of methylphenidate (Ritalin, Medikinet, Concerta), a psychotropic drug prescribed as a treatment for attention deficit hyperactivity disorder (ADHD) especially for young children and adolescents, has increased alarmingly since the early 1990s. According to statistics of the German Federal Institute for Drugs and Medical Devices (Bundesinstitut für Arzneimittel und Medizinprodukte), prescriptions have increased even more dramatically since 2000 and reached a climax in 2012. In 2013, only a slight decline in the number of prescriptions was observed (5). Interestingly the rapid increase in the use of methylphenidate coincides with the enormous expansion of mobile telecommunication and other related technologies, posing an open research question.

In Germany, work disability cases and absence days due to mental health disorders more than doubled from 1994 to 2011 (6). In OECD countries, a huge variability in the prescription of antidepressants has occurred and generally an increasing trend has been observed. Socioeconomic status and therapeutic standards cannot fully

explain these observations (7). Functional disturbances like chronic inflammation and changes of neurotransmitter functions caused by environmental influences are not investigated.

A steady increase in the prevalence of allergic/asthmatic diseases globally has occurred, with about 30%–40% of the world population now being affected by one or more allergic/asthmatic conditions (8).

It is suspected that environmental conditions such as the increasing exposure of the population to electromagnetic fields (EMFs) like radio-frequency radiation (RF), emanating from e.g. cordless phones (DECT), mobile phone base stations and cell phones (GSM, GPRS, UMTS, LTE) – especially smartphones, data cards for laptop and notebook computers, wireless LAN (Wi-Fi), wireless and powerline communication-based smart meters, but also exposure to extremely low frequency (ELF) electric and magnetic fields including "dirty electricity", emanating from disturbances on the electric wiring, power lines, electric devices, and other equipment, do play a causal role for EMF-related health effects (9–12). For the society and the medical community, all of this raises new challenges.

Chronic diseases and illnesses associated with unspecific symptoms are on the rise. In addition to chronic stress in social and work environments, physical and chemical exposures at home, at work, and during leisure activities are causal or contributing environmental stressors that deserve attention by the general practitioner as well as by all other members of the health care community. It seems certainly necessary now to take "new exposures" like EMF into account.

Worldwide statements of organizations regarding EMF

The recommendations of the World Health Organization (WHO) regarding extremely low frequency (ELF) electric and magnetic fields and radio-frequency radiation, compiled by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) (13, 14), are based on inductions of currents in the body and thermal effects (SAR values). These recommendations were adopted by the EU in its Council Recommendation of 1999 without taking into account long-term nonthermal effects. However, it should be stressed that at an international EMF conference in London (2008), Professor Paolo Vecchia, head of ICNIRP, said about the exposure guidelines "What they are not": "They are not mandatory prescriptions for safety", "They are not the 'last word' on the issue", and "They are not defensive walls for industry or others" (15).

Even for short-term effects, the application of specific absorption rate (SAR) estimates seems to be not appropriate (16).

In contrast to the WHO headquarter in Geneva, the International Agency for Research on Cancer (IARC) , a WHO-affiliated specialized agency in Lyon, classified extremely low frequency magnetic fields as possibly carcinogenic to humans (Group 2B) in 2002 (17) and radiofrequency radiation in 2011 (18).

In August 2007 and December 2012, the BioInitiative Working Group, an international group of experts, published comprehensive reports calling for preventive measures against EMF exposure based on the available scientific evidence (9, 10).

Since it is mostly neglected as a health hazard, the European Environment Agency compared the risks of nonionizing radiation (EMF) to other environmental hazards such as asbestos, benzene and tobacco, urgently recommending to implement a precautionary approach regarding EMF (19). This position was confirmed and elaborated more deeply in further publications in 2011 and 2013 (20, 21).

In September 2008, a statement of the European Parliament called for a review of the EMF limits set out in the EU Council Recommendation of 1999, which was based on the ICNIRP guidelines, with reference to the BioInitiative Report (22). This was further strengthened in the European Parliament resolution of April 2009 (23).

In November, 2009, a scientific panel met in Seletun, Norway, for 3 days of intensive discussion on existing scientific evidence and public health implications of the unprecedented global exposures to artificial electromagnetic fields. Such electromagnetic field exposures (static to 300 GHz) result from the use of electric power and from wireless telecommunications technologies for voice and data transmission, energy, security, military and radar use in weather and transportation.

At the meeting, the Seletun Scientific Panel adopted a Consensus Agreement (24) that recommends preventative and precautionary actions that are warranted now, given the existing evidence for potential global health risks. It recognizes the duty of governments and their health agencies to educate and warn the public, to implement measures balanced in favor of the Precautionary Principle (25), to monitor compliance with directives promoting alternatives to wireless, and to fund research and policy development geared toward prevention of exposures and development of new public safety measures.

The Scientific Panel recognizes that the body of evidence on electromagnetic fields requires a new approach to protection of public health; the growth and development of the fetus, and of children; and argues for strong

preventative actions. These conclusions are built upon prior scientific and public health reports documenting the following:

1) Low-intensity (non-thermal) bioeffects and adverse health effects are demonstrated at levels significantly below existing exposure standards.
2) ICNIRP and IEEE/FCC public safety limits are inadequate and obsolete with respect to prolonged, low-intensity exposures.
3) New, biologically-based public exposure standards are urgently needed to protect public health world-wide.
4) It is not in the public interest to wait.

The Panel also strongly recommends that persons with electromagnetic hypersensitivity symptoms (EHS) be classified as functionally impaired in all countries rather than with "idiopathic environmental disease" or similar indistinct categories. This terminology will encourage governments to make adjustments in the living environment to better address social and well-being needs of this subpopulation of highly sensitive members of society, and – as a consequence – protect everyone now as well as in the coming generations from toxic environmental exposures.

It is important to note that numeric limits recommended by the Seletun Scientific Panel, as well as by other bodies of society, do not yet take into account sensitive populations (EHS, immune-compromised, the fetus, developing children, the elderly, people on medications, etc.). Another safety margin is, thus, likely justified further below the numeric limits for EMF exposure recommended by the Panel.

In May 2011, the Parliamentary Assembly of the Council of Europe adopted the report "The potential dangers of electromagnetic fields and their effects on the environment" (26). The Assembly recommended many preventive measures for the member states of the Council of Europe with the aim to protect humans and the environment, especially from high-frequency electromagnetic fields such as: "Take all reasonable measures to reduce exposure to electromagnetic fields, especially to radiofrequencies from mobile phones, and particularly the exposure of children and young people who seem to be most at risk from head tumors" or "Pay particular attention to "electrosensitive" people who suffer from a syndrome of intolerance to electromagnetic fields and introduce special measures to protect them, including the creation of wave-free areas not covered by the wireless network."

Recognizing that patients are being adversely affected by EMF exposure, the American Academy of Environmental Medicine published recommendations regarding EMF exposure in July 2012. The AAEM called for physicians to consider electromagnetic exposure in diagnosis and treatment and recognize that EMF exposure "may be an underlying cause of the patient's disease process" (27).

Since 2014 the Belgium government has prohibited the advertising of cell phones for children under the age of seven and has required the specific absorption rate (SAR) of cell phones be listed. Furthermore, at the point of sale, well-marked warnings must be posted that instruct users to use headsets and to minimize their exposure (28).

In January 2015, the French parliament adopted a comprehensive law that protects the general public from excessive exposure to electromagnetic waves. Among other things, it was passed to ban Wi-Fi in nurseries for children under the age of three and to enable Wi-Fi at primary schools with children under the age of 11 only when used specifically for lessons. Public places offering Wi-Fi must clearly advertise this fact on a sign. At the point of sale of cell phones, the SAR value must be clearly shown. In the future, any cell phone advertisement must include recommendations on how users can reduce RF radiation exposure to the head such as the use of headsets. Data on local EMF exposure levels shall be made more easily accessible to the general public, among others, through country-wide transmitter maps. Also, the French government will have to submit a report on electromagnetic hypersensitivity to the parliament within a year (29).

In May 2015 almost 200 scientists directed an international appeal to United Nations (UN) and WHO and called for protection from nonionizing electromagnetic field exposure. In the appeal the scientifically proven effects on health and the hitherto inadequate international guidelines (ICNIRP) and their use by WHO had been addressed. In addition, various demands were made in nine points, such as that: "the public be fully informed about the potential health risks from electromagnetic energy and taught harm reduction strategies" and "that medical professionals be educated about the biological effects of electromagnetic energy and be provided training on treatment of patients with electromagnetic sensitivity" (30).

Finally, in 2015 Pall (12) published a comprehensive paper with the title "Scientific evidence contradicts findings and assumptions of Canadian Safety Panel 6: microwaves act through voltage-gated calcium channel activation to induce biological impacts at non-thermal levels, supporting a paradigm shift for microwave/lower frequency electromagnetic field action".

EMF and cancer

Except for a few investigations in occupational settings, epidemiological research of EMF started in 1979 when Wertheimer and Leeper published their study about the relationship between the proximity to so-called power line poles with "service drop" wires and the occurrence of childhood cancer (specifically leukemia and brain tumors) (31). At the same time Robinette et al. studied mortality in a cohort of Korean War veterans having been trained on military radars in the early 1950s (32). Both studies found indications of increased risks and initiated a new era of studying health-relevant effects from exposure to EMFs.

In the following years, a large number of investigations about the relationship between childhood leukemia and extremely low frequency magnetic fields (ELF MF) have been published. However, the results seemed inconsistent until in 2000 two pooled analyses (33, 34) were conducted, providing little indication of inconsistency and demonstrating an increase of leukemia risk with increasing average exposure levels that was significant for levels above 0.3 or 0.4 μT relative to averages below 0.1 μT but without indication of a threshold. Based on these findings, the International Agency for Research on Cancer (IARC) classified ELF MF in 2002 as a Group 2B (possible) carcinogen (17). To this category belong e.g. lead, DDT, welding fumes, and carbon tetrachloride.

Since then additional epidemiological studies have been conducted that gave essentially the same results (35, 36). In a review on childhood leukemia and ELF MF, Kundi concluded that there is sufficient evidence from epidemiological studies of an increased risk for childhood leukemia from exposure to power-frequency MF that cannot be attributed to chance, bias, or confounding. Therefore, according to the rules of IARC, such exposures ought to be classified as a Group 1 (definite) carcinogen (10).

The prognosis of certain diseases can be influenced by EMF-reduction. For example, children who have leukemia and are in recovery have poorer survival rates if their ELF magnetic field exposure at home (or where they are recovering) is between 1 mG [0.1 μT] and 2 mG [0.2 μT] or above 2 mG [0.2 μT] in one study, over 3 mG [0.3 μT] in another study (9).

Epidemiological studies of radio-frequency fields before the general rise in exposure to mobile telecommunication networks was quite restricted and only a few studies had been conducted in the vicinity of radio transmitters, radar stations, other occupational exposures, a in radio amateurs. After the introduction of digital mobile telephony, the number of users of mobile phones increased dramatically and it was recommended in the 1990s to perform epidemiological studies with a focus on intracranial tumors. Since the first publication in 1999 by the Swedish group around Prof. Lennart Hardell (37), about 40 studies have been published. The majority of these studies investigated brain tumors, but also salivary gland tumors, uveal melanoma, nerve sheath tumors, testicular cancer, and lymphoma. Many of these studies are inconclusive because of too short exposure durations; however, two series of investigations, the international Interphone study conducted in 13 countries and the Swedish studies of the Hardell group, had a significant proportion of long-term mobile phone users and could in principle be used for risk assessment. In 2011, IARC classified radio-frequency electromagnetic fields (RF) as a Group 2B carcinogen based on evidence from epidemiological studies and animal experiments (18). Since then, additional studies have corroborated the assumption of a causal relationship between mobile phone use and cancer (38–40). Hardell and Carlberg (41) concluded that RF-EMF ought to be classified as a definitive human carcinogen (IARC Group 1). The evidence for a causal relationship between long-term mobile and cordless phone use and the risk for glioma has increased further in 2015 (42).

In Italy, the Supreme Court upheld a ruling in October 2012 for an 80% disability rating and permanent disability pension due to a tumor, which was causally connected with the occupation-related heavy use of cell and cordless phones (43).

EMF and neurodegeneration

Neurological effects are caused by changes in the nervous system, including direct damage (neurodegeneration) to nerve cells and their processes, the axons and dendrites, as well as their terminal common functional entities, the synapses with their receptors, ion channels and comodulators. Factors that act directly or indirectly on the nervous system causing morphological, chemical, and/or electrical changes in the nervous system can lead to neurological alterations. The final manifestation of these effects can be seen in neurocognitive changes, e.g. memory, learning and perception, as well as in primary sensory and motor incapacities.

The nervous system is an electrical organ based on a very complex chemistry. Thus, it should not be surprising that exposure to electromagnetic fields could lead to neurodegeneration and concomitant or consecutive neurological changes. Morphological, chemical, electrical, and behavioral changes have been reported in animals, cells and tissues after exposure to electromagnetic fields across a range of frequencies.

The consequences of physiological changes in the nervous system are very difficult to assess. We do not fully understand how the nervous system functions and reacts to external perturbations. The neuronal plasticity of the nervous system could compensate for external disturbances, at least to a certain degree. On the other hand, the consequence of neural perturbation is also situation-dependent. An EMF-induced severe change in brain performance, for instance, could lead to different consequences depending on whether a person is sitting in a sofa watching TV or driving a car. The latter could very well end dramatically, even fatally.

It should be noted that analyses of the recent neurological literature show that there are more publications showing effects than no effects. So the question is not if EMFs cause effects, but rather how serious they will be for a given person.

Neurological effects of radio-frequency radiation (RFR)

There are many studies on human subjects. Many of the published papers are on changes in brain electrical activities, the EEG, as well as impacts on sleep, after acute exposure to cell phone radiation.

Bak et al. (44) reported effects on event-related potentials. Maganioti et al. (45) further reported that RFR affected the gender-specific components of event-related potentials [see also Hountala et al. (46)]. Croft et al. (47) reported changes of the alpha wave power in the EEG. The same authors (48) further reported that effects differed between various new cell phone transmission systems, which have different signaling characteristics. They observed effects after exposure to second generation (2G), but not third generation (3G) radiation, whereas Leung et al. (49) found similar EEG effects with both 2G and 3G types of radiation. Lustenberger et al. (50) found increased slow-wave activity in humans during exposure to pulse-modulated RF EMF toward the end of the sleep period. Vecchio and associates reported that cell phone RFR affected EEG and the spread of neural synchronization conveyed by interhemispherical functional coupling of EEG rhythms (51) and enhanced human cortical neural efficiency (52). An interesting finding is that RFR could interact with the activity of brain epileptic foci in epileptic patients (53, 54). However, no significant effect on EEG was reported by Perentos et al. (55) or Trunk et al. (56). And Kleinlogel et al. (57, 58) also reported no significant effects on resting EEG and event-related potentials in humans after exposure to cell phone RFR. Furthermore, Krause et al. (59) reported no significant effect of cell phone radiation on brain oscillatory activity, and Inomata-Terada et al. (60) concluded that cell phone radiation does not affect the electrical activity of the motor cortex.

There are studies on the interaction of cell phone radiation on EEG during sleep. Changes in sleep EEG have been reported by Hung et al. (61), Regel et al. (62), Lowden et al. (63), Schmid et al. (64, 65), and Loughran et al. (66), whereas no significant effect was reported by Fritzer et al. (67), Mohler et al. (68, 69) and Nakatani-Enomoto et al. (70). Loughran et al. (66) provided an interesting conclusion in their paper: "These results confirm previous findings of mobile phone-like emissions affecting the EEG during non-REM sleep". Importantly, this low-level effect was also shown to be sensitive to individual variability. Furthermore, this indicates that "previous negative results are not strong evidence for a lack of an effect…" Increase in REM sleep was reported by Pelletier et al. (71) in developing rats after chronic exposure. Mohammed et al. (72) reported a disturbance in REM sleep EEG in the rat after long term exposure (1 h/day for 1 month) to a 900-MHz modulated RFR. A Swiss Study revealed that, under pulse-modulated radiofrequency electromagnetic field exposure, sleep slow-wave activity is increased and – fitting to that – the sleep-dependent performance improvement is decreased (50).

Among the very many effects reported in the ever increasing number of scientific papers are also reduction in behavioral arousal, sleep latency alterations, effects on cognitive functions and EEG, on spatial working memory, on well-being, influences on overall behavioral problems in adolescents, alteration of thermal pain threshold and visual discrimination threshold, respectively, induced hyperactivity, hypoactivity and impaired memory, respectively, contextual emotional behavior deficit, olfactory and/or visual memory deficit, impact on food collection behavior (in ants), decreased motor activity, learning behavior deficit, induction of stress behavioral patterns, passive avoidance deficit, and reduced memory functions.

Almost all the animal studies reported effects, whereas more human studies reported no effects than effects. This may be caused by several possible factors: (a) Humans are less susceptible to the effects of RFR than are rodents and other species. (b) Non-thermal effects of RFR depend on a number of physical and biological parameters (73). The same exposure can induce effects in certain biological species while being ineffective in others. IARC also admits that some of the discrepancies between RFR studies could be due to differences in species [(18), p. 416]. (c) It may be more difficult to do human than animal experiments, since, in general, it is easier to control the variables and confounding factors in an animal experiment. (d) In the animal studies, the cumulative exposure duration was

generally longer and studies were carried out after exposure, whereas in the human studies, the exposure was generally at one time and testing was done during exposure. This raises the question of whether the effects of RFR are cumulative. This consideration could have very important implications on real-life human exposure to EMF. However, it must be pointed out that neurophysiological and behavioral changes have been reported in both animals and humans after acute (one-time) exposure to RFR, and most of the EEG studies mentioned above are acute exposure experiments.

Neurological effects of extremely low frequency electromagnetic fields (ELF-EMF)

A number of authors have reported effects of ELF-EMF on various animal transmitter receptors in the brain such as NMDA receptors, dopamine and serotonin receptors, including the 5HT(2A) subtype of serotonin receptors. The latter is classically, particularly in the frontal cortex, believed to be related to the psychiatric syndromes of depression in humans. Kitaoka et al. (74) and Szemerszky et al. (75) did report depression-like behavior in both mice and rats, after chronic exposure to ELF magnetic fields. There are two reports on dopamine receptors. Shin et al. (76, 77) reported an increase in D-1 dopamine receptors and activity in the striatum of the rat after ELF magnetic field exposure. Dopamine in the striatum is, of course, involved in Parkinson's disease. Wang et al. (78) reported that ELF magnetic fields potentiated morphine-induced decrease in D-2 dopamine receptors. Both D-1 and D-2 dopamine receptors in the brain are involved in depression and drug addiction. Ravera et al. (79) reported changes in the enzyme acetylcholinesterase in cell membrane isolated from the cerebellum after ELF magnetic field exposure. Interestingly, these researchers also reported "frequency window" effects in their experiment. Window effects, i.e. effects are observed at a certain range(s) of EMF frequencies or intensities, were first reported by Ross Adey, Susan Bawin, and Carl Blackman in the 1980s. A study by Fournier et al. (80) reported an 'intensity window' effect of ELF magnetic field on neurodevelopment in the rat. The cholinergic systems in the brain play a major role in learning and memory functions.

Behavioral effects of ELF-EMF have been further substantiated in recent research. These include: changes in locomotor activity (76, 77, 81–86), learning and memory functions (80, 87–95), anxiety (81, 93, 96–98), depression-like behavior (74, 75), perception (99), cognitive dysfunction (100), emotional state (101), sleep onset (61), and comb building in hornets (102). As different behavioral effects have been observed in different exposure conditions, species of animals, and testing paradigms, they provide the strongest evidence that exposure to ELF-EMF can affect the nervous system.

The possible medical applications of ELF-EMF should also be given more attention. Several studies indicate that ELF-EMF (however, mostly at high exposure levels) could enhance recovery of functions after nervous system damage and have protective effects against development of neurodegenerative diseases. The majority of the studies used magnetic fields above 0.1 mT (1 gauss; the highest was 8 mT). The intensities are much higher than those in the public environment. Thus, caution should be taken in extrapolating the high-intensity cell and animal studies to long-term environmental human exposure situations.

In addition, however, there are studies at low or very low magnetic field exposure levels. Humans are sensitive to magnetic fields at levels <1 μT. A study by Ross et al. (99) showed "perception" alteration in human subjects exposed to a magnetic field at 10 nT (0.00001 mT), a study by Fournier et al. (80) showed an effect on brain development in the rat at 30 nT (0.00003 mT), and a study by Stevens (101) indicated changes in emotional states in humans exposed to 8–12 Hz magnetic fields at 5 μT (0.005 mT). These data do suggest magnetic fields at very low intensities could cause neurological effects in humans. In the 1990s, there was a series of more than 20 studies published by Reuven Sandyk, showing that pulsed magnetic fields at picotesla levels (1 pT=0.000000001 mT) could have therapeutic effects on Parkinson's disease and multiple sclerosis [see e.g. (103)]. However, Sandyk's findings have never been independently confirmed.

The above mentioned therapeutic applications of EMF elicit that different EMF-exposures have biological effects under certain conditions for short-term use.

Alzheimer's disease

Amyloid beta (Aβ) protein is generally considered the primary neurotoxic agent causally associated with Alzheimer's disease. Aβ is produced by both brain and peripheral cells and can pass through the blood brain barrier.

The BioInitiative review 2012 (10) summarized the evidence concerning Alzheimer's disease as follows:

1) There is longitudinal epidemiologic evidence that high peripheral blood levels of Aβ, particularly Aβ1-42, are a risk factor for Alzheimer's disease.
2) There is epidemiologic evidence that extremely low frequency (ELF, 50–60 Hz) magnetic field (MF) exposure upregulates peripheral blood levels of Aβ.

3) There is evidence that melatonin can inhibit the development of Alzheimer's disease and, thus, low melatonin levels may increase the risk of Alzheimer's disease.
4) There is strong epidemiologic evidence that significant (i.e. high), occupational ELF-MF exposure can lead to the downregulation of melatonin production. The precise components of the magnetic fields causing this downregulation are unknown. Other factors which may influence the relationship between ELF-MF exposure and melatonin production are unknown, but certain medications may play a role.
5) There is strong epidemiologic evidence that high occupational ELF MF exposure is a risk factor for Alzheimer's disease, based on case-control studies which used expert diagnoses and a restrictive classification of ELFMF exposure.
6) There are only single epidemiologic studies of Alzheimer's disease and radio-frequency electromagnetic field exposure, and only one epidemiology study of non-acute radio-frequency electromagnetic field exposure and melatonin. So, no final conclusions concerning health consequences due to RF exposure and Alzheimer's disease are currently possible.

Hallberg and Johansson (104) demonstrated that the mortality in Alzheimer's disease appears to be associated with mobile phone output power. Deeper studies in this complex area are still necessary.

There is epidemiological evidence that also residential exposure to ELF magnetic fields is associated with an increased risk for Alzheimer's disease (105, 106).

Earlier reviews of the association between exposure to ELF MF and neurodegenerative diseases came to different conclusions (107, 108). The discrepancy is mainly due to two aspects: the assessment of a possible publication bias and the selection and classification of exposed groups. Since most studies are about occupational exposure, it is mandatory to avoid misclassification. If care is taken to avoid such ambiguity, there is a clear meta-analytical relationship and an increased risk for Alzheimer's disease and amyotrophic lateral sclerosis (ALS). This association shows little heterogeneity across studies if the different methodologies are considered and publication bias has been detected for studies relying on mortality registries only (109).

EMF and infertility and reproduction

Infertility and reproduction disorders are on the rise. The BioInitiative review 2012 (10) summarized the evidence concerning infertility and reproduction as follows – with small adaptations by the authors:

Human sperm are damaged by cell phone radiation at very low intensities, in the low microwatt and nanowatt per cm^2 range (0.00034–0.07 $\mu W/cm^2$=3.4–700 $\mu W/m^2$). There is a veritable flood of new studies reporting sperm damage in humans and animals, leading to substantial concerns for fertility, reproduction, and health of the offspring (unrepaired de novo mutations in sperm). Exposure levels are similar to those resulting from wearing a cell phone on the belt or in a pants pocket, or from using a wireless laptop computer on the lap. Sperm lack the ability to repair DNA damage.

Several international laboratories have replicated studies showing adverse effects on sperm quality, motility, and pathology in men who use cell phones and particularly those who wear a cell phone, PDA, or pager on their belt or in a pocket (110–115). Other studies conclude that the use of cell phones, exposure to cell phone radiation, or storage of a cell phone close to the testes of human males affect the sperm count, motility, viability, and structure (110, 116, 117). Animal studies have demonstrated oxidative and DNA damage, pathological changes in the testes of animals, decreased sperm mobility and viability, and other measures of deleterious damage to the male germ line (118–122).

There are fewer animal studies that have studied effects of cell phone radiation on female fertility parameters. Panagopoulos (123) report decreased ovarian development and size of ovaries, and premature cell death of ovarian follicles and nurse cells in *Drosophila melanogaster*. Gul et al. (124) report rats exposed to standby level RFR (phones on but not transmitting calls) caused decrease in the number of ovarian follicles in pups born to these exposed dams. Magras and Xenos (125) reported irreversible infertility in mice after five (5) generations of exposure to RFR at cell phone tower exposure levels of less than one microwatt per centimeter squared (<1 $\mu W/cm^2$=<10 mW/m^2).

Electromagnetic hypersensitivity (EHS)

An increasing number of human beings are continuously exposed in their daily life to increasing levels of a combination of static, ELF and VLF electric and magnetic fields and RF electromagnetic fields. These exposures are of different signal patterns, intensities, and technical applications for varying periods of time. All these fields are summarized as EMF, colloquially referred to as "electrosmog".

In a questionnaire survey in Switzerland in 2001, which was addressed to persons attributing specific health problems to EMF exposure, of the 394 respondents 58% suffered from sleep problems or disorders, 41% from headaches, 19% from nervousness, 18% from fatigue and 16% from difficulties with concentration. The respondents attributed their symptoms, e.g. to mobile phone base stations (74%), cell phones (36%), cordless phones (29%), and high-voltage power lines (27%). Two thirds of the respondents had taken measures to reduce their symptoms, the most frequent one being to avoid exposure (126).

In a survey conducted 2009 in a Japanese EHS and multiple chemical sensitivity (MCS) self-help group (n=75), 45% of the respondents had EHS as a medical diagnosis, 49% considered themselves EHS. Every second responder had medically diagnosed MCS (49%) and self-diagnosed MCS had 27%. The main EHS-related symptoms were fatigue (85%), headache (81%), concentration problems (81%), sleeping disorders (76%) and dizziness (64%). The most frequent causes include: base stations (71%), other persons mobile phones (64%), PC (63%), power lines (60%), television (56%), own mobile phone (56%), public transportation (55%) , cordless phones (52%), air conditioner (49%) and car (49%). Suspected EMF source of EHS onset were: mobile phone base stations (37%), PC (20%), electric home appliances (15%), medical equipment (15%), mobile phones (8%), power lines (7%) and induction cookers (7 %) (127).

In 2001, 63 persons who attributed health problems to environmental exposure were counseled in an interdisciplinary environmental medicine pilot project in Basel. An interdisciplinary expert team assessed the individual symptoms by a medical psychological-psychiatric and environmental examination, including visits and environmental measurements at home. With respect to the 25 persons with EHS, the expert team attested that in one third of them, at least one symptom was plausibly related to electrosmog, although the EMF exposure was within the Swiss limits. They concluded that persons with EHS should be advised interdisciplinary, not only medically and psychologically but also environmentally (128, 129).

A representative telephone survey (n=2048; age >14 years) carried out in 2004 in Switzerland yielded a frequency of 5% (95% CI 4%–6%) for having symptoms attributed to electrosmog, so-called electromagnetic hypersensitivity. Remarkably, only 13% consulted their family doctor. Individuals with a past history of symptoms attributable to EMF gave "turned off the source" as the answer three times as often as the ones who still had symptoms (130).

In a Swiss questionnaire study of GPs in 2005, two-thirds of the doctors were consulted at least once a year because of symptoms attributed to EMF. Fifty-four percent of the doctors assessed a relation as possible. The doctors in this questionnaire asked for more general information about EMF and health and instructions on how to deal with persons with EHS (131).

In another questionnaire study, also mandated by the Swiss Federal Government and performed by the University of Bern in 2004, Swiss doctors working with complementary diagnostic and therapeutic tools reported that 71% of their consultations related to EMF. Remarkably, not only the patients, but even more so the doctors suspected a possible relation between illness and EMF. The reduction or elimination of environmental sources was the main therapeutic instrument in treating symptoms related to EMF (132).

A questionnaire study of Austrian doctors yielded similar results. In this study, the discrepancy between the physicians' opinions and established national and international health risk assessments was remarkable, considering that 96% of the physicians believed to some degree in or were totally convinced of a health-relevant role of environmental electromagnetic fields (133).

The question, whether EHS is causally associated with EMF exposure remains controversial. On the one hand, physicians judge a causal association between EMF exposures as plausible based on case reports, on the other hand, national and international health risk assessments mostly claim that there is no such causal association, because provocation studies under controlled blinded conditions mostly failed to show effects. However, all these studies used a very limited number of exposure conditions, the exposure duration and the examined effects were short, and the recruitment of the persons with EHS was not medically assessed.

The WHO, for example, does not consider EHS as a diagnosis and recommends to medical doctors that the treatment of affected individuals should focus on the health symptoms and the clinical picture, and not on a person's perceived need for reducing or eliminating EMF in the workplace or home (134).

The evaluation report about electromagnetic hypersensitivity mandated by the Swiss federal government assessed the evidence of a causal relationship between EMF exposure and biological and health effects. It took into account not only experimental, observational studies and meta-analyses, but also individual experiments and case reports. For the evaluation of the scientific evidence, the GRADE criteria were applied. Individual case reports were considered to be of great importance because it is

likely that, at the same exposure level, not all people react the same as rare cases may be misunderstood by otherwise statistically reliable scientific methods of investigation, and since habituation and sensitization processes of a person's reaction can change during the time of exposure. The significance of case reports with regard to scientific evidence based on the strict GRADE criteria used in this evaluation, however, was considered to be limited, mainly because of the distortion due to methodological flaws. It was noted in the report that individual case experiments with repeated testing of an EHS person under double-blind conditions and controlled exposure would be more revealing than experimental studies with larger groups. Ideally, a test of the person concerned should be carried out in their familiar surroundings (e.g. at home) with a reliable and accurate measurement of exposure. With positive test results, a re-evaluation would be required also from a scientific perspective (135).

The paper "Electromagnetic hypersensitivity: fact or fiction" by Genius and Lipp (136) offers an instructive review of studies of the last decades concerning EHS, including historical milestones, reviews, pathogenesis, biochemical markers, therapeutic management, as well as the debate about the legitimacy of EHS.

In Sweden, EHS is an officially fully recognized functional impairment (i.e. it is not regarded as a disease). Survey studies show that somewhere between 230,000 and 290,000 Swedish men and women out of a population of 9,000,000 – report a variety of symptoms when being in contact with EMF sources. With reference to UN Resolution 48/96, Annex, of 20 December 1993, the Swedish government grants support to individuals with EHS. Employees with EHS have a right to support from their employers so as to enable them to work despite this impairment. Some hospitals in Sweden provide rooms with low-EMF exposure (137).

In Sweden, impairments are viewed from the point of the environment. No human being is in itself impaired; there are instead shortcomings in the environment that cause the impairment (as with the lack of ramps for the person in a wheelchair or rooms requiring low-EMF remediation for the person with EHS). Furthermore, this environment-related perspective of the impairment EHS means that – even though we do not have a complete scientific explanation, and, in contrast, to what many individuals involved in the EMF discourse at present think – any person with EHS shall always be met in a respectful way and with all necessary support required to eliminate the impairment. This implies that the person with EHS shall have the opportunity to live and work in a low-EMF environment (138).

In Sweden, the City of Stockholm offers low-EMF housing on its outskirts to electrosensitive individuals. In France, the first low-EMF zone has been established at Drôme in July 2009 (139). In Austria, the construction of a multi-family house has been planned for 2015, which was designed by a team of architects, building biology professionals, and environmental medicine health care professionals to provide a sustainable healthy living environment. Both the outdoor and indoor environments were explicitly chosen and designed to meet low-EMF requirements (140). The implementation of low-EMF zones for electrosensitive individuals is pursued in numerous countries. The realization of such projects greatly depends on the understanding, knowledge, and tolerance of the members of the chosen community.

In a human provocation study, Johansson (141), using a controlled, double-blind pilot setup, found one EHS person that correctly identified the presence of a mobile phone nine times out of nine provocations ($p<0.002$), both in the "acute" phase as well as in the "chronic" phase ($p<0.001$).

In facial skin samples of electrohypersensitive persons, the most common finding has been a profound increase of mast cells (142). From this and other studies, it is clear that the number of mast cells in the upper dermis is increased in the EHS group. A different pattern of mast cell distribution also occurred in the EHS group. Finally, in the EHS group, the cytoplasmic granules were more densely distributed and more strongly stained than in the control group, and the size of the infiltrating mast cells was generally found to be larger in the EHS group as well. It should be noted that increases of similar nature later on were demonstrated in an experimental situation, employing normal healthy volunteers in front of cathode ray tube (CRT) monitors, including ordinary household television sets (143).

In one of the early papers, Johansson et al. (144) made a sensational finding when they exposed two electrically sensitive individuals to a TV monitor situated at a distance of 40–50 cm away from them. The scientists used an open-field provocation in front of an ordinary TV set with persons regarding themselves as suffering from skin problems due to work at video display terminals. Employing fluorescence microscopy-based immunohistochemistry, in combination with a wide range of antisera directed towards cellular and neurochemical markers, they were able to show a high to very high number of somatostatin-immunoreactive dendritic cells as well as histamine-positive mast cells in skin biopsies from the anterior neck taken before the start of the provocation. At the end of the provocation, however the number of mast cells was unchanged and the somatostatin-positive cells had seemingly disappeared. The reason for this latter

finding could be discussed in terms of loss of immunoreactivity, increase of breakdown, etc. The high number of mast cells present may explain the clinical symptoms of itch, pain, edema, and erythema.

Against this background, it is interesting to see that the early Swedish findings from the 1980s and 1990s are supported by the latest work of Belpomme and Irigaray (145). Since 2009, Belpomme and Irigaray prospectively investigated clinically and biologically 1200 consecutive EHS and/or MCS-self reported cases in an attempt to establish objective diagnosis criteria and to elucidate the pathophysiological aspects of these two disorders.

In their preliminary results, as presented at the Fifth Paris Appeal Congress in Belgium in 2015 – based on the analysis of 839 originally enrolled cases of which 810 met the inclusion criteria and 727 were evaluable – 521 were diagnosed with EHS, 52 with MCS, and 154 with both EHS and MCS. Concomitant multiple food intolerance was found in 28.5%, 41.9%, and 70.4% of the cases in the three groups, respectively. Histamine levels were analyzed in the blood of patients, and 37%, 36.7% and 41.5% of the persons respectively in the three above individualized groups showed a significant increase in histaminemia (>10 nmol/L), meaning that a chronic inflammatory response can be detected in these patients.

They also measured nitrotyrosin (NTT), a marker of both peroxynitrite (ONOO.-) production and opening of the blood brain barrier (BBB). NTT was increased in the blood (>0.90 µg/mL) in 29.7%, 26%, and 28% of the cases in the three groups, respectively. Likewise protein S100B, another marker of BBB opening was found to be increased in the blood (>0.105 µg/L) in 14.7%, 19.7%, and 10.7% of their cases, respectively. Circulating antibodies against O-myelin, heat shock protein (Hsp) 27, and/or Hsp 70 protein were also found to be increased in 43.1%, 25%, and 52% of their cases, respectively, indicating that EHS and MCS are associated with some autoimmune response. Since most patients reported chronic insomnia and fatigue, they also determined the 24-h urine melatonin/creatinine ratio and found it was decreased (<0.8) in all investigated cases.

Finally, in order to gain further information about the underlying mechanisms of EHS and MCS, they serially measured the brain blood flow in the temporal lobes of each patient by using pulsed brain echodoppler. They found that both EHS and MCS were associated with a hypoperfusion in the capsulo-thalamic area of the brain, suggesting that the inflammatory process may in fact involve the limbic system and the thalamus. Both EHS and MCS thus appear to paint a common picture of inflammation-related hyper-histaminemia, oxidative stress, autoimmune response, and BBB opening, and a deficit in melatonin excretion. According to Belpomme and Irigaray, EHS and MCS probably share a common pathological mechanism mainly involving the central nervous system (145).

While a 2006 study by Regel et al. (146) described no exposure effects, two provocation studies on exposure of "electrosensitive" individuals and control subjects to mobile phone base station signals (GSM, UMTS or both) found a significant decline in well-being after UMTS exposure in the individuals reporting sensitivity (147, 148). Most so-called provocation studies with EHS show no effects. However, all these studies used a very limited number of exposure conditions. Taking in account the strong dependence of EMF effects on a variety of physical and biological variables (73), available provocation studies are scientifically difficult to interpret and, in fact, are not suitable to disprove causality.

There is increasing evidence in the scientific literature of various subjective and objective physiological alterations, e.g. heart-rate variability (HRV) as apparent in some persons with EHS claiming to suffer after exposure to certain frequencies of EMR like DECT or Wi-Fi (149–153).

Analysis of the data available on the exposure of people living near mobile phone base stations has yielded clear indications of adverse health effects like fatigue, depression, difficulty in concentrating, headaches, dizziness, etc. (154–158).

The frequency spectrum between ELF and RF is referred as kHz range or intermediate frequency range. Residential exposures in this range are often due to "dirty power"/ "dirty electricity" originating from voltage and/or current perturbations from diverse sources like electronic power supplies for TVs, monitors, PCs, motor drives, inverters, dimmers, CFLs, phase-angle control devices, as well as sparking and arcing from switching operations and from electric motors with brushes. The kHz waves/transients travel along the electric wiring and grounding systems (conducted emissions) and radiate electric and/or magnetic fields into free space (radiated emissions), leading to human exposures in the vicinity.

Epidemiological evidence links dirty electricity to most of the diseases of civilization including cancer, cardiovascular disease, diabetes, suicide, and attention deficit hyperactivity disorder in humans (159).

When it comes to health effects of static magnetic fields, this type of EMF exposure is frequently underestimated. Blackman reports in the 2007 BioInitiative Report (9): "The magnetic field of the earth at any given location has a relatively constant intensity as a function of time. However, the intensity value, and the inclination of the field with respect to the gravity vector, varies considerable

over the face of the earth. More locally, these features of the earth's magnetic field can also vary by more than 20% inside man-made structures, particularly those with steel support structures. There are many reports of EMF-caused effects being dependent on the static magnetic field intensity (cf. Blackman et al., 1985) and of its orientation, with respect to an oscillating magnetic field (Blackman et al., 1990; Blackman et al., 1996). One aspect common to many of these reports is that the location in the active frequency band is determined by the intensity of the static magnetic field. There have been many attempts to explain this phenomenon but none has been universally accepted. However, it is clear that if a biological response depends on the static magnetic field intensity, and even its orientation with respect to an oscillating field, then the conditions necessary to reproduce the phenomenon are very specific and might easily escape detection (cf. Blackman and Most, 1993). The consequences of these results are that there may be exposure situations that are truly detrimental (or beneficial) to organisms but that are insufficiently common on a large scale that they would not be observed in epidemiological studies; they need to be studied under controlled laboratory conditions to determine impact on health and wellbeing".

On July 8, 2015, a court in Toulouse, France, ruled in favor of a woman with the diagnosis "syndrome of hypersensitivity to electromagnetic radiation" and determined her disability to be 85% with substantial and lasting restrictions on access to employment (160).

Possible mechanism of EHS

Based on the scientific literature on interactions of EMF with biological systems, several mechanisms of interaction are possible. A plausible mechanism at the intracellular and intercellular level, for instance, is an interaction via the formation of free radicals or oxidative and nitrosative stress (161–169). A review by Pall (12, 170, 171) provides substantial evidence for a direct interaction between static and time varying electric fields, static and time varying magnetic fields and electromagnetic radiation with voltage-gated calcium channels (VGCCs). The increased intracellular Ca^{2+} produced by such VGCC activation may lead to multiple regulatory responses, including increased nitric oxide levels produced through the action of the two Ca^{2+}/calmodulin-dependent nitric oxide synthases, nNOS and eNOS. In most pathophysiological contexts, nitric oxide reacts with superoxide to form peroxynitrite, a potent nonradical oxidant, which can produce radical products, including hydroxyl and NO_2 radicals.

Peroxynitrite is by far the most damaging molecule in our body. Although not a free radical in nature, peroxynitrite is much more reactive than its parent molecules NO and O_2. The half-life of peroxynitrite is short (10–20 ms), but sufficiently long to cross biological membranes, diffuse one to two cell diameters, and allow significant interactions with most critical biomolecules and structures (cell membranes, nucleus DNA, mitochondrial DNA, cell organelles), and a large number of essential metabolic processes (165). Elevated nitrogen monoxide, formation of peroxynitrite, and induction of oxidative stress can be associated with chronic inflammation, damage of mitochondrial function and structure, as well as loss of energy, e.g. via the reduction of adenosine triphosphate (ATP).

The importance of ATP has been shown for CFS (172) and for stress control (173). Those patients describe the same symptoms as those suffering from CMI. This could indicate similarities in the pathomechanisms. Similar disturbances in neurotransmitter expression had been described both with chronic exposure to EMF (174) and in CMI patients (163, 175).

Redmayne and Johansson (176) published a review considering the evidence for an association between myelin integrity and exposure to low-intensity radiofrequency electromagnetic fields (RF-EMFs) typical in the modern world, pointing to that RF-EMF-exposed animals/humans show: 1) significant morphological lesions in the myelin sheath of rats; 2) a greater risk of multiple sclerosis in a study subgroup; 3) effects in proteins related to myelin production; and 4) physical symptoms in individuals with the functional impairment electrohypersensitivity, many of which are the same as if myelin were affected by RF-EMF exposure, giving rise to symptoms of demyelination. In the latter, there are exceptions; headache is common only in electrohypersensitivity, while ataxia is typical of demyelination but infrequently found in the former group. Overall, evidence from in vivo and in vitro and epidemiological studies suggests an association between RF-EMF exposure and either myelin deterioration or a direct impact on neuronal conduction, which may account for many electrohypersensitivity symptoms. The most vulnerable are likely to be those in utero through to at least mid-teen years, as well as ill and elderly individuals.

Complaints in chronic fatigue syndrome (CFS), fibromyalgia (FM), multiple chemical sensitivity (MCS), posttraumatic stress disorder (PTSD) and Gulf War syndrome (GWS) are almost the same. But the cardinal symptoms are different. Meanwhile, they are summarized as chronic multisystem illnesses (CMI) (175). In all of them, various disturbances of functional cycles have been shown as activation of nitrogen oxide and peroxynitrite,

chronic inflammation by activation of NF-kB, IFN-y, IL-1, IL-6, and interaction with neurotransmitter expression (163, 175, 177). We recommend classifying EHS as part of CMI (170, 178) leading to a functional impairment (EHS), but still recognizing that the underlying cause remains only the environment (see Figure 1).

Other diseases that require attention with respect to EMF

There is some evidence that transient electromagnetic fields (dirty electricity), in the kilohertz range on electrical wiring, may be contributing to elevated blood sugar levels among diabetics and pre-diabetics. In an electromagnetically clean environment, Type 1 diabetics required less insulin and Type 2 diabetics had lower levels of plasma glucose. Dirty electricity, generated by electronic equipment and wireless devices, is ubiquitous in the environment. Exercise on a treadmill, which produced dirty electricity, increased plasma glucose. These findings may explain why brittle diabetics have difficulty regulating blood sugar. Based on estimates of people who suffer from symptoms of electrohypersensitivity (3%–35%), as many as 5–60 million diabetics worldwide may be affected (179).

The Bioinitiative Report 2012 (10) concluded: Fetal (in-utero) and early childhood exposures to cell phone radiation and wireless technologies in general may be a risk factor for hyperactivity, learning disorders and behavioral problems in school. Common sense measures to limit both ELF-EMF and RF EMF in these populations is needed, especially with respect to avoidable exposures like incubators that can be modified; and where education of the pregnant mother with respect to laptop computers, mobile phones and other sources of ELF-EMF and RF EMF are easily instituted.

This section deserves special attention in order to respond timely to the rapid technological development leading to more and more complex EMF exposures.

Recommendations for action

EUROPAEM has developed guidelines for differential diagnosis and potential treatment of EMF-related health problems with the aim to improve/restore individual health outcomes and to propose strategies for prevention.

Evidence of treatment strategies for EMF-related illness including EHS

There are only a few studies assessing evidence-based therapeutic approaches to EHS. The interdisciplinary based assessing and counseling of EHS in the Swiss environmental pilot project performed in 2001 showed in an evaluation interview half a year after counseling, that 45% of persons with EHS had benefitted from realizing certain advice, for example, changing the bedroom (128, 129).

In the 2005 Swiss questionnaire study of physicians working with complementary therapeutic tools, two-thirds chose exposure reduction as a principal tool,

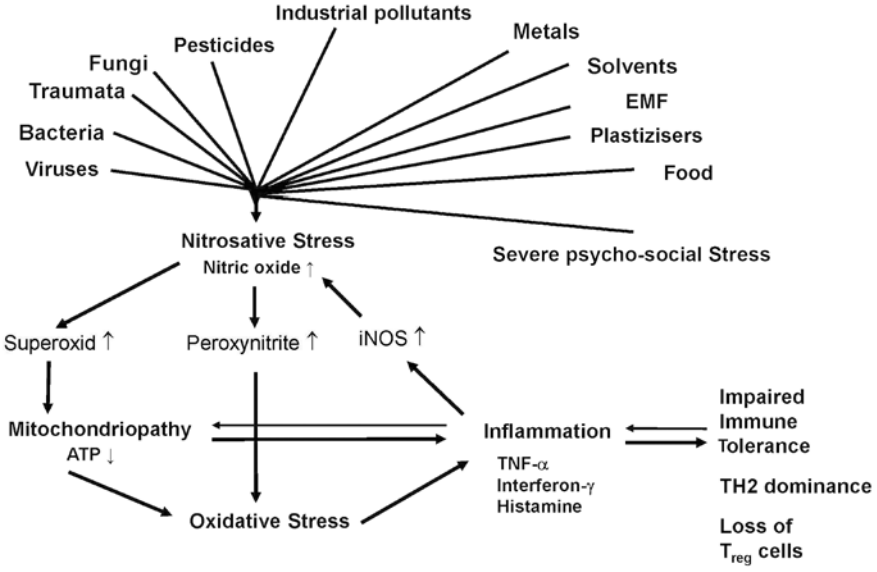

Figure 1: Pathogenesis of inflammation, mitochondriopathy, and nitrosative stress as a result of the exposure to trigger factors (177).

whereas complementary therapeutics were only chosen as a supplement (132).

Since 2008, the Swiss Society of Doctors for the Environment has run a small interdisciplinary environmental medicine counseling structure for persons with EHS, which is embedded in everyday practice with a central coordination and consultation office as well as a network of general practitioners interested in environmental medicine who perform environmental medical assessments and consultations based on a standard protocol. If necessary, environmental experts are consulted and home inspections are conducted. The aim of the assessments is to detect or rule out common diseases and to analyze the impact of suspected environmental burdens on the complaints in order to find individual therapeutic approaches. The main instrument of the assessment is an extensive medical and psycho-social history with an additional environmental history, including a systematic questionnaire and environmental key questions.

In the first years, the project was scientifically assessed. In a questionnaire one year after counseling, 70% of the persons recommended the interdisciplinary-based counseling structure and 32% of them considered the counseling as being helpful. Therefore, a model based on such an interdisciplinary concept, embedded in the family doctor's holistic and lasting concept of treatment, seems to be promising for a better therapeutic approach to EHS, also including accessibility measures targeted at the actual environment (180).

In Finland, psychotherapy is the officially recommended therapy of EHS. In a questionnaire study of EHS people in Finland, symptoms, perceived sources and treatments, the perceived efficacy of medical and complementary alternative treatments (CAM) in regards to EHS were evaluated by multiple choice questions. According to 76% of the 157 respondents, the reduction or avoidance of EMF helped in their full or partial recovery. The best treatments for EHS were given as weighted effects: "dietary change" (69.4%), "nutritional supplements" (67.8%), and "increased physical exercise" (61.6%). The official treatment recommendations of psychotherapy (2.6%) were not significantly helpful, or for medication (–4.2%) even detrimental. The avoidance of electromagnetic radiation and fields effectively removed or lessened the symptoms in persons with EHS (181, 182).

The prognosis of certain diseases can be influenced by EMF-reduction. For example, children who have leukemia and are in recovery have poorer survival rates if their ELF magnetic field exposure at home (or where they are recovering) is between 1 mG [0.1 μT] and 2 mG [0.2 μT] or above 2 mG [0.2 μT] in one study, over 3 mG [0.3 μT] in another study (9).

Response of physicians to this development

In cases of unspecific health problems (see Questionnaire) for which no clearly identifiable cause can be found – beside other factors like chemicals, nonphysiological metals, mold – EMF exposure should, in principle, be taken into consideration as a potential cause or cofactor, especially if the person presumes it.

A central approach for a causal attribution of symptoms is the assessment of variation in health problems depending on time and location and individual susceptibility, which is particularly relevant for environmental causes such as EMF exposure.

Regarding such disorders as male infertility, miscarriage, Alzheimer's, ALS, blood sugar fluctuations, diabetes, cancer, hyperactivity, learning disorders and behavioral problems in school, it would be important to consider a possible link with EMF exposure. This offers an opportunity to causally influence the course of the disease.

How to proceed if EMF-related health problems are suspected

The recommended approach to diagnosis and treatment is intended as an aid and should, of course, be modified to meet the needs of each individual case (see Figure 2).

1. History of health problems and EMF exposure
2. Examination and findings
3. Measurement of EMF exposure
4. Prevention or reduction of EMF exposure
5. Diagnosis
6. Treatment

History of health problems and EMF exposure

In order to put later findings into a larger context, a general medical history is necessary. In the next steps, we focus only on EMF-related health effects.

A questionnaire to take a systematic history of health problems and EMF exposure, compiled by the EUROPAEM EMF Working Group, is available in the Annex of this EMF Guideline.

The questionnaire consists of three sections:

a) List of symptoms
b) Variation of health problems depending on time, location, and circumstances
c) Assessment of certain EMF exposures that can be estimated by questionnaire

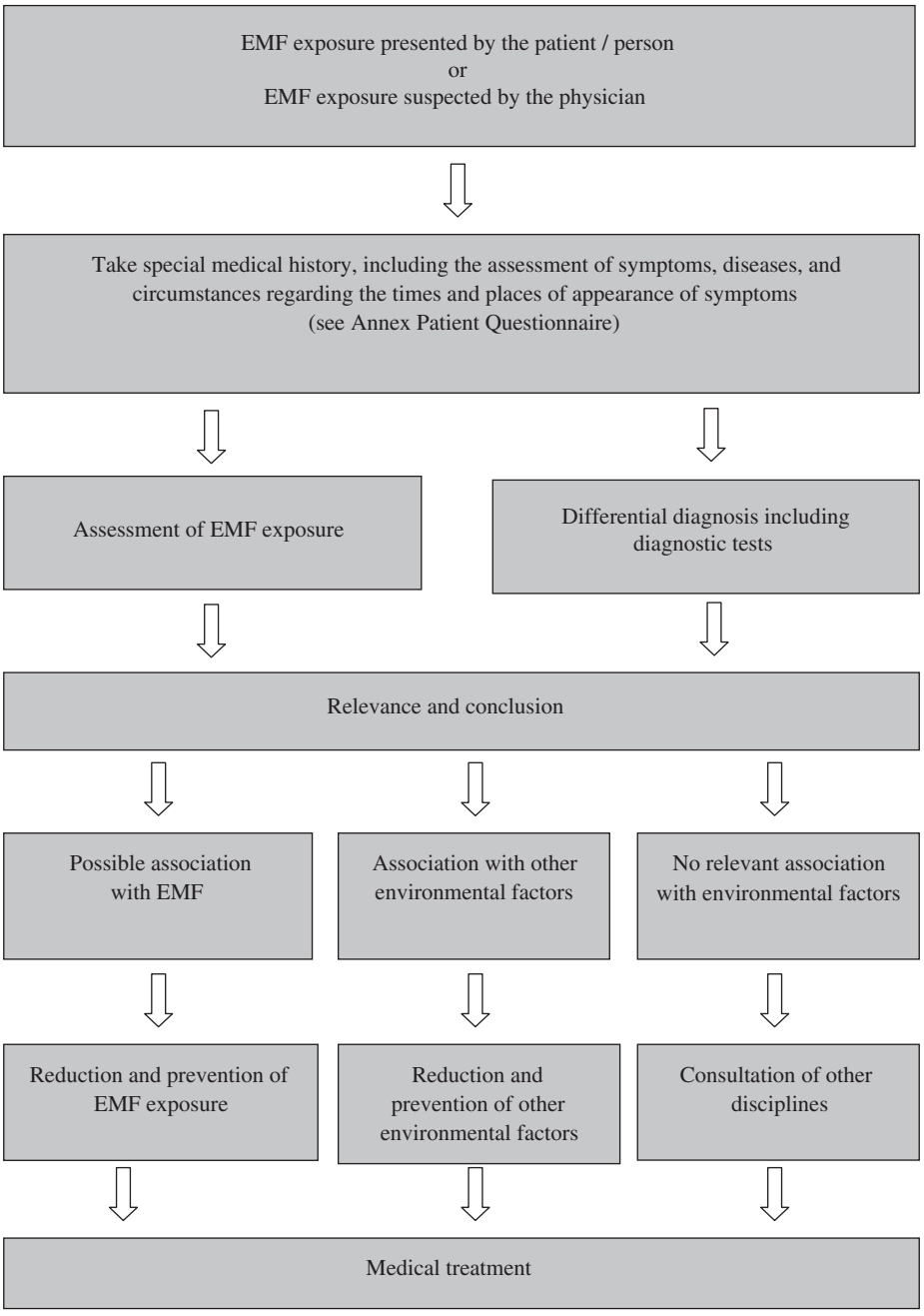

Figure 2: Flowchart for the handling of EMF-related health problems

List of symptoms

The list of symptoms in the questionnaire serves to systematically quantify health problems regardless of their causes. It also includes questions as to when the health problems first occurred. Most EMF-related symptoms are nonspecific and fall within the scope of health problems due to inadequate regulation (decompensation), e.g. sleep problems, fatigue, exhaustion, lack of energy, restlessness, heart palpitations, blood pressure problems, muscle and joint pain, headaches, increased risk for infections, depression, difficulty concentrating, disturbances of coordination, forgetfulness, anxiety, urinary urgency, anomia (difficulty finding words), dizziness, tinnitus, and sensations of pressure in the head and ears.

The health problems may range in severity from benign, temporary symptoms, such as slight headaches or paresthesia around the ear, e.g. when using a cell phone, or flu-like symptoms after maybe some hours of whole body EMF exposure, to severe, debilitating symptoms that drastically impair physical and mental health. It has to be stressed that, depending on the individual state of

susceptibility, EHS symptoms often occur only occasionally, but over time they may increase in frequency and severity. On the other hand, if a detrimental EMF exposure is sufficiently reduced, the body has a chance to recover and EHS symptoms will be reduced or will vanish.

Variation of health problems depending on time, location, and circumstances

The answers to questions of when and where the health problems occur or recede, and when and where the symptoms increase or are particularly evident, provide only indications. They must be interpreted by the investigator (e.g. regarding the correct attribution between location/EMF sources and health problems). Special attention should be drawn to sleeping areas, because of the duration of influence and the vital role of sleep for regeneration.

Assessment of certain EMF exposures that can be estimated by questionnaire

The assessment of EMF exposure usually starts with certain questions of usual EMF sources. Regardless of whether or not the patient suspects EMF exposure as a cause, these questions should be used to assess the existing exposure level, at least as a rough estimate. It is important to note that only certain types of EMF exposure can be assessed by means of questions, such as the use of compact fluorescent lamps (CFLs), cell phones, and cordless phones. Detection of other types of EMF exposure, e.g. due to RF transmitter sites or the electric or magnetic fields from electric wiring, generally requires measurements. In principle, questions should be asked to assess EMF exposure at home and at work and when on holidays and so on, keeping in mind that the degree of EMF exposure may vary at different times.

Examination and findings

We do not have any clinical findings yet that are specific to EMF, which makes diagnosis and differential diagnosis a considerable challenge.

A method that has proven useful is to use stress-associated findings for diagnosis and followup and to evaluate them synoptically. Basic diagnostic tests should be carried out as a first step, followed by measurements of EMF exposure as a second step. The core diagnosis should focus on investigations of nitric oxide production (nitrotyrosine), mitochondriopathy (intracellular ATP), oxidative stress-lipid peroxidation (MDA-LDL) and inflammation (TNF-alpha, INF-G (IP-10), IL-1b).

Then additional diagnostic tests can be considered.

Functional tests

Basic diagnostic tests

- Blood pressure and heart rate (in all cases resting heart rate in the morning while still in bed), including self-monitoring, possibly several times a day, e.g. at different locations and with journaling of subjective well-being for a week.

Additional diagnostic tests

- 24-h blood pressure monitoring (absence of nighttime decline)
- 24-h ECG (heart rhythm diagnosis)
- 24-h heart rate variability (HRV) (autonomous nervous system diagnosis)
- Ergometry under physical stress
- Sleep EEG at home

Laboratory tests

Basic diagnostic tests

- Blood
  - Bilirubin
  - Blood count and differential blood count
  - BUN
  - Cholesterol, LDL, HDL, triglycerides
  - Creatinine kinases (CK-MB, CK-MM)
  - CRP
  - Cystatin C (glomerular filtration rate)
  - Electrolytes
  - Fasting blood glucose
  - Ferritin
  - HBA1c
  - Histamine and diaminoxidase (DAO)
  - INF-G (IP-10)
  - Interleukin-1 (e.g. IL-1a, IL-1b)
  - Intracellular ATP
  - Liver enzymes (e.g. ALT, AST, GGT, LDH, AP)
  - Magnesium (whole blood)
  - malondialdehyde-LDL
  - Nitrotyrosine
  - Potassium (whole blood)
  - Selenium (whole blood)
  - TSH
  - Tumor necrosis factor alpha (TNFα)
  - Vitamin D
  - Zinc (whole blood)

- Standard urine
  - Leucocytes, erythrocytes, albumin, urobilinogen, pH, bacteria, glucose, microalbumin
- Second morning urine
  - 6-OH melatonin sulfate
  - Adrenaline
  - Dopamine
  - Noradrenaline
  - Noradrenaline/adrenaline quotient
  - Serotonin
- Saliva
  - Cortisol (8 a.m., 12 a.m., and 8 p.m.)

Additional diagnostic tests

- Urine
  - Metals
- Second morning urine
  - Gamma-aminobutyric acid (GABA)
  - Glutamate
  - Kryptopyrrole
- Saliva
  - Dehydroepiandrosterone DHEA (8 a.m. and 8 p.m.)
- Blood
  - 8-hydroxydeoxyguanosine (DNA oxidation)
  - Biotin
  - Differential lipid profile
  - Folate
  - Holotranscobolamin
  - Homocysteine
  - Interferon-gamma (IFNγ)
  - Interleukin-10 (IL-10)
  - Interleukin-17 (IL-17)
  - Interleukin-6 (IL-6)
  - Interleukin-8 (IL-8)
  - Intracellular glutathione (redox balance)
  - Lactate, pyruvate incl. ratio
  - Lipase
  - NF-kappa B
  - Ubiquinone (Q10)
  - Vitamin B6 (whole blood)

Provocation tests

Special facilities with the use of a variety of signals, e.g. DECT or Wi-Fi exposure (e.g. 20–60 min, depending on the individual regulation capacity, susceptibility, and observed response)

- Heart rate variability (HRV) (autonomous nervous system diagnosis)
- Microcirculation
- Oxidative stress (lipid peroxidation, malondialdehyde-LDL)

Individual susceptibility

- Blood (genetic parameters and actual function)
  - Glutathione S transferase M1 (GSTM1) – detoxification
  - Glutathione S transferase T1 (GSTT1) – detoxification
  - Superoxide dismutase 2 (SOD2) – protection of mitochondria
  - Catechol-O-methyltransferase (COMT) – stress control

Measurement of EMF exposure

The evolutionary development of the human species took place under the presence of the natural electromagnetic spectrum (Earth's magnetic field, Earth's electric field, spherics, Schumann resonance). Those influences have been part of our biosphere like the oxygen content in the air or the visible light spectrum, and they have been integrated into the biological functions.

By now, nearly all nonionizing parts of the electromagnetic spectrum are filled with artificial, technical EMF sources due to electrification and (wireless) communication technologies, but are very rarely found in nature (see Figure 3). EMF measurements and/or exposure damages are usually not covered by statutory health care insurance.

In general, a wide variety of EMF exposure types should be considered: cordless phones (DECT), wireless Internet access (Wi-Fi), electrical wiring and electrical devices in buildings, compact fluorescent lamps (CFLs), mobile phone base stations, radio and TV transmitters, high-voltage power lines or transformer stations, and "dirty electricity".

In the sleeping area, the most important exposure point is the head and trunk region followed by all other points with chronic or high exposure.

EMF measurements should be planned and carried out by specially trained and experienced testing specialists and always in accordance with relevant standards, e.g. the VDB Guidelines of the German Association of Building Biology Professionals (184). In addition to the measurement results, the measurement report should also include suggestions on how to possibly reduce the EMF exposure.

To clarify certain issues, personal dosimeters with a data logging function are available to measure ELF magnetic fields and radio-frequency radiation.

After the measurements have been commissioned by the person and carried out, the results should be discussed with a physician familiar with the EMF issue.

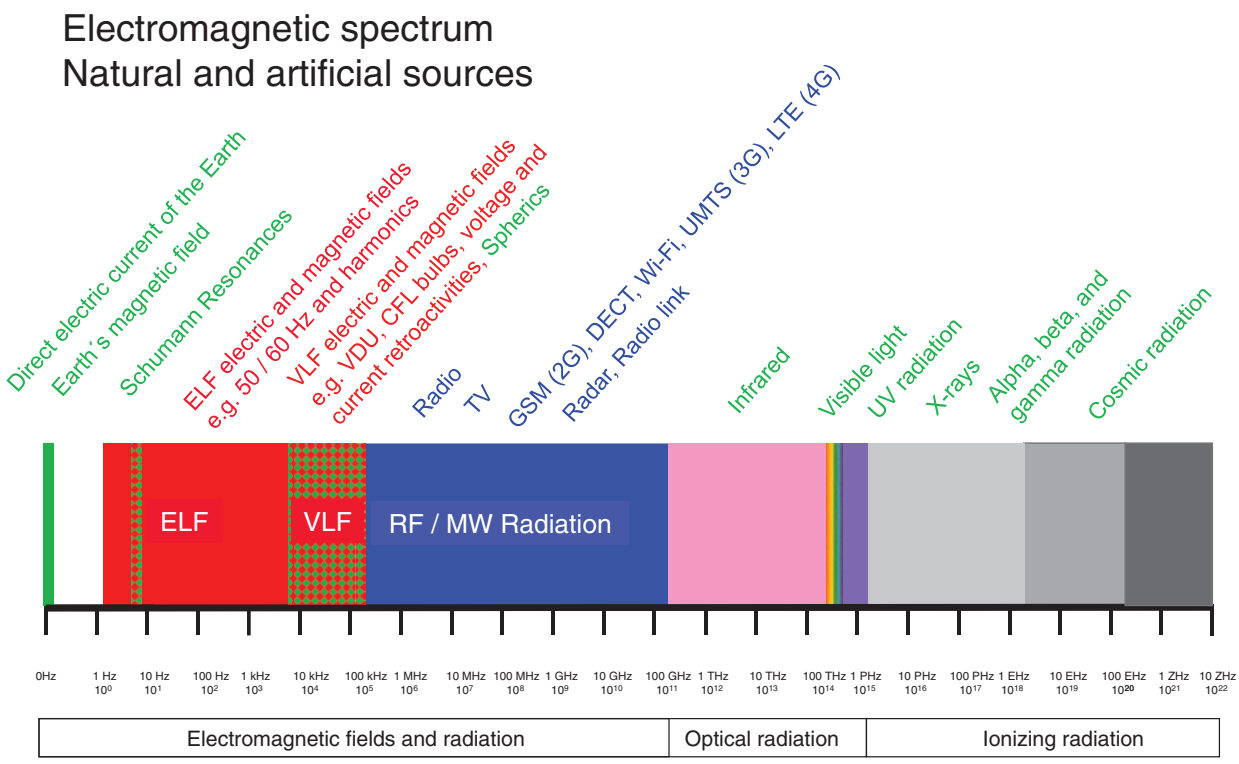

Figure 3: Examples of natural (green) and artificial (red and blue) EMF sources along the electromagnetic spectrum (183).

EMF guidance values

In each case, the following aspects should be individually taken into account when evaluating EMF measurement results (73):

- The person's individual susceptibility
- The person's individual total body burden (e.g. exposure to noise, chemicals)
- Duration of EMF exposure
- EMF exposure during the night and day
- Multiple exposure to different EMF sources
- Signal intensity (W/m², V/m, A/m)
- Signal characteristics (was taken into account in the EMF guidance values – see Supplement 3)
  - Frequency
  - Risetime (ΔT) of bursts, transients, etc.
  - Frequency and periodicity of bursts, e.g. certain GSM base stations (8.3 Hz), Wi-Fi networks (10 Hz), DECT cordless phones (100 Hz)
  - Type of modulation (frequency modulation, amplitude modulation, phase modulation)

Regardless of the ICNIRP recommendations for specific acute effects, the following guidance values apply to sensitive locations with long-term exposure of more than 20 h per week (185). They are based on epidemiological studies (9, 10, 73, 186–189), empirical observations, and measurements relevant in practice (190, 191) as well as recommendations by the Parliamentary Assembly of the Council of Europe (26). The proposed guidance values are based on scientific data including a preventive component and aim to help restore health and well-being in already compromised patients/functionally impaired persons.

Basic measurements

ELF magnetic fields (extremely low frequency) (ELF MF)

Measurement specifications

Frequency range:	50/60 Hz mains electricity, up to 2 kHz 16.7 Hz railroad systems in Austria, Germany, Switzerland, Sweden, and Norway
Type of measurement:	Magnetic induction or flux density [T; mT; μT; nT]
Field probe:	Isotropic magnetic field probe (three orthogonal axes)
Detector mode:	RMS (root mean square)
Measurement volume:	Short-term: Bed: Complete sleeping area of bed Short-term: Workplace: Complete working space of workplace (e.g. sitting position) Long-term: e.g. point close to the head/trunk in bed or at workplace

Measurement period:	Short-term measurements to identify field sources Long-term measurements during sleep and work shift
Basis for evaluation:	Long-term measurements: maximum (MAX) and arithmetic mean (AVG)

Precautionary guidance values

In areas where people spend extended periods of time (>4 h per day), minimize exposure to ELF magnetic fields to levels as low as possible or below the precautionary guidance values specified below.

ELF magnetic field	Daytime exposure	Nighttime exposure	Sensitive populations
Arithmetic mean (AVG)	**100 nT** (1 mG)[1),2)]	**100 nT** (1 mG)[1),2)]	**30 nT** (0.3 mG)[4)]
Maximum (MAX)	**1000 nT** (10 mG)[2),3)]	**1000 nT** (10 mG)[2),3)]	**300 nT** (3 mG)[4)]

Based on: [1)]BioInitiative (9, 10); [2)]Oberfeld (189); [3)]NISV (192); [4)]precautionary approach by a factor 3 (field strength).

Evaluation guidelines specifically for sleeping areas

Higher frequencies than the mains electricity at 50/60 Hz and distinct harmonics should be evaluated more critically. See also the precautionary guidance values for the intermediate frequency range further below. If applicable, mains current (50/60 Hz) and traction current (16.7 Hz) should be assessed separately but added (squared average). Long-term measurements should be carried out especially at nighttime, but at least for 24 h.

ELF electric fields (extremely low frequency) (ELF EF) Measurement specifications

Frequency range:	50/60 Hz mains electricity, up to 2 kHz 16.7 Hz railroad systems in Austria, Germany, Switzerland, Sweden, and Norway
Type of measurement:	Electric field [V/m] without ground reference (potential-free) and/or body-current [A/m^2] see separate paragraph
Field probe:	Isotropic electric field probe (three orthogonal axes)
Detector mode:	RMS (root mean square)
Measurement volume:	Bed: nine points across sleeping area Workplace: Complete working space (e.g. sitting position three or six points)
Measurement period:	Spot measurements to asses the exposure as well as to identify field sources. Since electric field exposure levels in the ELF frequency range usually do not change, long-term measurements are not needed.
Basis for evaluation:	Spot measurements (maximum) at relevant points of exposure

Precautionary guidance values

In areas where people spend extended periods of time (>4 h per day), minimize exposure to ELF electric fields to levels as low as possible or below the precautionary guidance values specified below.

ELF electric field	Daytime exposure	Nighttime exposure	Sensitive populations
Maximum (MAX)	**10 V/m**[1),2)]	**1 V/m**[2)]	**0.3 V/m**[3)]

Based on: [1)]NCRP Draft Recommendations on EMF Exposure Guidelines: Option 2, 1995 (188); [2)]Oberfeld (189); [3)]precautionary approach by a factor 3 (field strength).

Evaluation guidelines specifically for sleeping areas

Higher frequencies than the mains electricity at 50/60 Hz and distinct harmonics should be evaluated more critically. See also the precautionary guidance values for the intermediate frequency range further below.

Radio-frequency electromagnetic radiation (RF EMR) Measurement specifications

Frequency range:	Radio and TV broadcast transmitters Mobile phone base stations, e.g. TETRA (400 MHz), GSM (900 and 1800 MHz), UMTS (2100 MHz), LTE (800, 900, 1800, 2500–2700 MHz), Cordless phone base stations, e.g. DECT (1900) Wi-Fi access points and clients (2450 and 5600 MHz) WiMAX (3400–3600 MHz) (above frequencies in MHz refer to European networks)
Type of measurement:	Electric field [V/m] -> calculated power density [W/m^2; mW/m^2; μW/m^2]
Field probe:	Isotropic, biconical, logarithmic-periodic antennas
Detector mode:	Peak detector with max hold
Measurement volume:	Point of exposure across bed and working space
Measurement period:	Usually short-term measurements to identify RF field sources (e.g. acoustic analysis) and peak readings
Basis for evaluation:	Band-specific or frequency-specific spot measurements (peak detector with max hold) of common signals at relevant points of exposure (e.g. with spectrum analyzer or at least band-specific RF meter)

Precautionary guidance values for selected RF sources

In areas where people spend extended periods of time (>4 h per day), minimize exposure to radio-frequency electromagnetic radiation to levels as low as possible or below the

precautionary guidance values specified below. Frequencies to be measured should be adapted to each individual case.

The specific guidance values take the signal characteristics of risetime (ΔT) *and periodic ELF "pulsing" into account* (191). *Note: Rectangular signals show short risetimes and consist of a broad spectrum of frequencies. The body current density increases with increasing frequency in an approximately linear relationship* (*Vignati and Giuliani, 1997*).

RF source Max Peak/Peak Hold	Daytime exposure	Nighttime exposure	Sensitive populations[1)]
Radio broadcast (FM)	**10,000 µW/m²**	**1000 µW/m²**	**100 µW/m²**
TETRA	**1000 µW/m²**	**100 µW/m²**	**10 µW/m²**
DVBT	**1000 µW/m²**	**100 µW/m²**	**10 µW/m²**
GSM (2G) 900/1800 MHz	**100 µW/m²**	**10 µW/m²**	**1 µW/m²**
DECT (cordless phone)	**100 µW/m²**	**10 µW/m²**	**1 µW/m²**
UMTS (3G)	**100 µW/m²**	**10 µW/m²**	**1 µW/m²**
LTE (4G)	**100 µW/m²**	**10 µW/m²**	**1 µW/m²**
GPRS (2.5G) with PTCCH* (8.33 Hz pulsing)	**10 µW/m²**	**1 µW/m²**	**0.1 µW/m²**
DAB+ (10.4 Hz pulsing)	**10 µW/m²**	**1 µW/m²**	**0.1 µW/m²**
Wi-Fi 2.4/5.6 GHz (10 Hz pulsing)	**10 µW/m²**	**1 µW/m²**	**0.1 µW/m²**

*PTCCH, Packet Timing Advance Control Channel.
Based on: BioInitiative (9, 10); Kundi and Hutter (186); Leitfaden Senderbau (187); Belyaev (73); PACE (26). [1)]Precautionary approach by a factor 3 (field strength)=factor 10 power density.

Conversion of RF measurement units	**mW/m²**	10	1	0.1	0.01	0.001	0.0001
	µW/m²	10,000	1000	100	10	1	0.1
	µW/cm²	1	0.1	0.01	0.001	0.0001	0.00001
	V/m	1.9	0.6	0.19	0.06	0.019	0.006

Additional measurements

Body-current (extremely low frequency) (ELF BC)

The type of body current measurement has been developed in Germany (193) and is used by so-called electrobiologists (194). The methodology offers the possibility to assess directly the relevant effect – the body current – caused by electric and magnetic fields (195). To date, the effects of electric fields on human health with a view to their distribution and relevance to increase the body current density are massively underestimated. We strongly recommend to perform epidemiological studies (e.g. intervention, case-control, cohort) for the health endpoints discussed and – besides other EMF exposures – to take the following measurements in this order: 1) body current (A/m²), 2) electric field (V/m) without ground reference (potential-free) without and with a person or a 3D dummy (not grounded!) to simulate the conductive body. In order to distinguish as to whether the measured body currents are caused by electric or magnetic fields, the magnetic fields have to be measured as well in all three axes. Long-term measurements of ELF magnetic fields should be performed with an isotropic magnetic field probe (three orthogonal axes) according to the corresponding paragraph in this chapter.

Measurement specifications

Frequency range:	50/60 Hz mains electricity, up to 2 kHz 16.7 Hz railroad systems in Austria, Germany, Switzerland, Sweden, and Norway
Type of measurement:	Body-current [A/m²]
Field probe:	Magnetic field probe (one orthogonal axis)
Detector mode:	RMS (root mean square)
Measurement volume:	10 specific points close to the body (head, trunk and limbs)
Measurement period:	Spot measurements to asses the exposure as well as to identify field sources. As electric field exposure levels in the ELF frequency range usually do not change, long-term measurements are not needed.
Basis for evaluation:	Spot measurements (maximum) at relevant points of exposure

Precautionary guidance values

In areas where people spend extended periods of time (>4 h per day), minimize exposure to ELF body-current to levels as low as possible or below the precautionary guidance values specified below.

ELF body-current	Daytime exposure	Nighttime exposure	Sensitive populations
Maximum(MAX)	**0.25 µA/m² [1)]**	**0.25 µA/m² [1)]**	**0.05 µA/m² [2),3)]**

Based on: [1)]0.25 µA/m² corresponds to 100 nT (RMS, AVG); [2)]0.05 µA/m² corresponds to 20 nT (RMS, AVG), Arbeitskreis Elektrobiologie (194), based on empirical observations; [3)]precautionary approach by a factor 5 (field strength).

Evaluation guidelines specifically for sleeping areas

Higher frequencies than the mains electricity at 50/60 Hz and distinct harmonics should be evaluated more critically.

See also the precautionary guidance values for the intermediate frequency range further below.

Magnetic fields in the intermediate frequency range (VLF) (IF MF)
Measurement specifications

Frequency range:	3 kHz–3 MHz Frequency-specific measurements (spectrum analyzer/EMF meter), e.g. "dirty power," powerline communication (PLC), radio-frequency identification transmitters (RFID), compact fluorescent lamps (CFL)
Type of measurement:	Magnetic field [A/m] -> calculated magnetic induction [T; mT; μT; nT]
Field probe:	Isotropic or anisotropic magnetic field probe
Detector mode:	RMS (root mean square)
Measurement volume:	Point of exposure across bed and working space
Measurement period:	Short-term measurements to identify field sources Long-term measurements during sleep and work shift
Basis for evaluation:	Long-term measurements: RMS detector arithmetic mean and maximum at relevant points of exposure

Precautionary guidance values

In areas where people spend extended periods of time (>4 h per day), minimize exposure to intermediate frequency magnetic fields to levels as low as possible or below the precautionary guidance values specified below.

[4)]*The body current density increases with increasing frequency in an approximately linear relationship (Vignati and Giuliani, 1997). Therefore, the guidance value of the magnetic field in the intermediate frequency range should be lower than the one of the 50/60 Hz magnetic field, e.g. assuming 100 nT RMS/100=1 nT.*

IF magnetic field	Daytime exposure	Nighttime exposure	Sensitive populations
Arithmetic mean	**1 nT** (0.01 mG)[1),2)]	**1 nT** (0.01 mG)[1),2)]	**0.3 nT** (0.003 mG)[4)]
Maximum	**10 nT** (0.1 mG)[2),3)]	**10 nT** (0.1 mG)[2),3)]	**3 nT** (0.03 mG)[4)]

Based on: [1)]BioInitiative (9, 10); [2)]Oberfeld (189); [3)]NISV (192); [4)]precautionary approach by a factor 3 (field strength).

Electric fields in the intermediate frequency range (VLF) (IF EF)
Measurement specifications

Frequency range:	3 kHz–3 MHz Frequency-specific measurements (spectrum analyzer/EMF meter), e.g. "dirty power," powerline communication (PLC), radio-frequency identification transmitters (RFID), compact fluorescent lamps (CFL)
Type of measurement:	Electric field [V/m]
Field probe:	Isotropic, biconical, logarithmic-periodic electric field probe
Detector mode:	RMS arithmetic mean
Measurement volume:	Point of exposure across bed and working space
Measurement period:	Short-term measurements to identify field sources Long-term measurements during sleep and work shift
Basis for evaluation:	Long-term measurements: arithmetic mean at relevant points of exposure

Precautionary guidance values

In areas where people spend extended periods of time (>4 h per day), minimize exposure to intermediate frequency electric fields to levels as low as possible or below the precautionary guidance values specified below.

[4)]*The body current density increases with increasing frequency in an approximately linear relationship (Vignati and Giuliani 1997). Therefore, the guidance value of the magnetic field in the intermediate frequency range should be lower than the one of the 50/60 Hz magnetic field, e.g. assuming 10 V/m RMS arithmetic mean/100=0.1 V/m.*

IF electric field	Daytime exposure	Nighttime exposure	Sensitive populations
Arithmetic mean	**<0.1 V/m**[1),2)]	**<0.01 V/m**[2)]	**<0.003 V/m**[3)]

Based on: [1)]NCRP Draft Recommendations on EMF Exposure Guidelines: Option 2, 1995 (188); [2)]Oberfeld (189); [3)]precautionary approach by a factor 3 (field strength).

Static magnetic fields
Measurement specifications

Frequency range:	0 Hz
Type of measurement:	Magnetic induction or flux density [T; mT; μT; nT]

Field probe:	Anisotropic magnetic field probe (for one spatial axis – vertical) or Isotropic magnetic field probe (three orthogonal axes)
Detector mode:	RMS (root mean square)
Measurement volume:	Point of exposure across bed and working space
Measurement period:	Short-term measurements to identify field sources that distort the Earth's magnetic field
Basis for evaluation:	Spot measurements (RMS maximum) at relevant points of exposure

Precautionary guidance values

In areas where people spend extended periods of time (>4 h per day), minimize exposure to static magnetic fields that distort the naturally occurring Earth's magnetic field to levels as low as possible.

Evaluation guidelines specifically for sleeping areas

First determine the natural background level in a reference location, e.g. close to the bed. The field probe must not be moved during the measurement process in order to prevent false readings due to induced currents by the Earth's magnetic field. The guidance values below are meant in addition to the Earth's magnetic field.

Static magnetic field	No anomaly	Slight anomaly	Significant anomaly	Extreme anomaly
Deviation from natural background	**≤1 µT** ≤10 mG	**1–2 µT** 10–20 mG	**2–10 µT** 20–100 mG	**>10 µT** >100 mG

Based on: Building Biology Evaluation Guidelines (SBM-2015) (190), which are based on empirical observations.

Static electric fields

Measurement specifications

Frequency range:	0 Hz
Type of measurement:	Electric field [V/m]
Field probe:	Anisotropic or isotropic electric field probe
Detector mode:	RMS (root mean square)
Measurement volume:	Point of exposure across bed and working space
Measurement period:	Short-term measurements to identify field sources
Basis for evaluation:	Spot measurements (maximum) at relevant points of exposure

Precautionary guidance values

In areas where people spend extended periods of time (>4 h per day), minimize exposure to static electric fields that exceed the naturally occurring fair-weather atmospheric electric field.

Evaluation guidelines specifically for sleeping areas

Static electric field	No anomaly	Slight anomaly	Significant anomaly	Extreme anomaly
Maximum	**<100 V/m**	**100–500 V/m**	**500–2000 V/m**	**>2000 V/m**

Based on: Building Biology Evaluation Guidelines (SBM-2015) (190), which are based on empirical observations.

Prevention or reduction of EMF exposure

Preventing or reducing EMF exposure after consulting a testing specialist is advantageous for several reasons:

a) To prevent and reduce risks to individual and public health,
b) To identify any links to health problems,
c) To causally treat the EMF-related health problems.

There are numerous potential causes of relevant EMF exposures, and this EMF Guideline can only give a few examples. Further information can be found, for instance, in the document "Options to Minimize EMF/RF/Static Field Exposures in Office Environments" (196) and "Elektrosmog im Alltag" (197). For detailed information on physics, properties and measurement of EMF, see Virnich (198); regarding reduction of radio-frequency radiation (RFR) in homes and offices, see Pauli and Moldan (199).

In most cases, it will be necessary to consult an expert (e.g. building biology testing specialist, EMF/RF engineer) and/or electrician who will advise the person on what measures could be taken to reduce EMF exposure.

EMF exposure reduction – First steps

As a first step, it might be useful to recommend to persons that they take certain actions (also as preventive measures) to eliminate or reduce typical EMF exposures, which may help alleviate health problems within days or weeks. The following actions may be suggested:

Preventing exposure to radio-frequency radiation (RFR)

– Disconnect (unplug) the power supply of all DECT cordless phone base stations. So called "ECO Mode" or "zero-emission" DECT phones are only conditionally recommended because the exposure by the handset is

not or not substantially reduced. Therefore, the use of "traditional" corded phones is recommended.
- Disconnect (unplug) the power supply to all Wi-Fi access points or Wi-Fi routers. Many LAN routers now come equipped with additional Wi-Fi. Call the provider of the LAN router and ask to have the Wi-Fi deactivated. It is usually also possible to do so online by following the provider's instructions.
- Avoid wearing the cell phone/smartphone close to the body.
- Deactivate all nonessential wireless cell phone apps, which cause periodic radiation exposure.
- Keep cell phones/smartphones in "airplane mode" whenever possible.
- In case of external RF radiation sources, rooms – especially sleeping rooms – facing away from the source should be chosen.
- Avoid powerline communication for Internet access (dLAN) and instead use a hardwired Ethernet cable (LAN).
- Avoid exposure to RF radiation (e.g. Bluetooth, Wi-Fi) at home (e.g. home entertainment, headsets), in offices, and in cars.

Preventing exposure to ELF electric and magnetic fields
- Move the bed or desk away from the wiring in the walls and power cords. A minimum distance of 30 cm (1 ft) from the wall is recommended.
- Another simple complementary action is to disconnect the power supply to the bedroom (turn off circuit breaker or fuse) for the nighttime while sleeping; try it for a test phase of, e.g. 2 weeks. In general, this measure is not always successful because circuits of adjacent rooms contribute to the electric field levels. ELF electric field measurements are required to know exactly which circuit breakers need to be disconnected.

  The benefits should be weighed against the potential risk of accidents; therefore, the use of a flashlight for the test phase should be recommended.
- Disconnect the power supply to all nonessential electric circuits, possibly in the entire apartment or house. (N.B. See note above.)
- Avoid using an electric blanket during sleep; not only turn it off, but also disconnect it.

Preventing exposure to static magnetic fields
- Sleep in a bed and mattress without metal.
- Avoid to sleep close to iron materials (radiator, steel, etc.)

EMF exposure reduction – second steps

As a second step, EMF measurements and mitigation measures should be carried out. Typical examples are:
- Measure the ELF electric field in the bed or the body current density of the person while in bed. Based on the measurement results, have automatic demand switches in those circuits installed that increase the exposure.
- Measure the ELF electric field at all other places that are used for extended periods at home and at work. If necessary, choose lamps used close to the body with a shielded electric cable and a grounded lamp fixture (metal). Especially in lightweight construction (wood, gypsum board), electrical wiring without grounding (two-slot outlets) might have to be replaced with grounded electrical wiring or shielded electrical wiring. In special cases, the whole building might have to have shielded wiring and shielded outlets installed.
- Measure the ELF magnetic field close to the bed, e.g. for 24 h. If net currents are detected, the electrical wiring and grounding system of the building must be corrected as to reduce the magnetic fields.
- Install a residual current device (RCD) or ground-fault circuit interrupter (GFCI) to prevent electric shocks (safety measure).
- Measure radio-frequency radiation and mitigate high exposure levels by installing certain RF shielding materials for the affected walls, windows, doors, ceilings, and floors.
- Measure dirty electricity/dirty power (electric and magnetic fields in the intermediate frequency range) and identify the sources in order to remove them. If this is not possible, appropriate power filters in line with the source may be used.

Diagnosis

We will have to distinguish between EHS and other EMF-related health problems like certain cancers, Alzheimer's, ALS, male infertility etc. that might have been induced, promoted, or aggravated by EMF exposure. An investigation of the functional impairment EHS and other EMF-related health problems will largely be based on a comprehensive case history, focusing, in particular, on correlations between health problems and times, places, and circumstances of EMF exposure, as well as the progression of symptoms over time and the individual susceptibility. In addition, measurements of EMF exposure and the results of additional diagnostic tests (laboratory tests, cardiovascular system) serve to support the

diagnosis. Moreover, all other potential causes should be excluded as far as possible.

In 2000 the Nordic Council of Ministers (Finland, Sweden, and Norway) adopted the following ICD-10 code for EHS: Chapter XVIII, Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified, code R68.8 "Other specified general symptoms and signs" (Nordic ICD-10 Adaptation, 2000) (200).

Regarding the current International Classification of Diseases (ICD), ICD-10-WHO 2015, we recommend at the moment:

a) Electromagnetic hypersensitivity (EHS): to use the existing diagnostic codes for the different symptoms **plus** code R68.8 "Other specified general symptoms and signs" **plus** code Z58.4 "Exposure to radiation" and/ or Z57.1 "Occupational exposure to radiation".
b) EMF-related health problems (except EHS): to use the existing diagnostic codes for the different diseases/ symptoms **plus code** Z58.4 "Exposure to radiation" and/or Z57.1 "Occupational exposure to radiation".

Regarding the next ICD-update (ICD-11 WHO) to be published 2018), we recommend to:

a) Create ICD codes for all chronic environmentally induced chronic multisystem illnesses (CMI) like multiple chemical sensitivity (MCS), chronic fatigue syndrome (CFS), fibromyalgia (FM), and electromagnetic hypersensitivity (EHS).
b) Expand Chapter XIX, Injury, poisoning and certain other consequences of external causes (T66-T78) to include/distinguish effects of EMF (static magnetic field, static electric field, ELF magnetic field, ELF electric field, VLF/LF magnetic field, VLF/LF electric field, Radio-frequency electromagnetic radiation) infrared, visible light, UV-light and ionizing radiation.
c) Expand Chapter XXI, Factors influencing health status and contact with health services (Z00-Z99) to include/ distinguish factors as EMF (static magnetic field, static electric field, ELF magnetic field, ELF electric field, VLF/LF magnetic field, VLF/LF electric field, Radio-frequency electromagnetic radiation), infrared, visible light, UV-light, and ionizing radiation.

Treatment/accessibility measure

The primary method of treatment should mainly focus on the prevention or reduction of EMF exposure that is reducing or eliminating all sources of EMF at home and in the workplace. The reduction of EMF exposure should also be extended to schools, hospitals, public transport, public places like libraries, etc. in order to enable EHS persons an unhindered use (accessibility measure). Many examples have shown that such measures can prove effective. With respect to total body load of other environmental influences, they must also be regarded.

Beside EMF reduction, other measures can and must be considered. These include a balanced homeostasis in order to increase the "resistance" to EMF. There is increasing evidence that a main effect of EMF on human beings is the reduction of oxidative and nitrosative regulation capacity. This hypothesis also explains observations of changing EMF sensitivity and the large number of symptoms reported in the context of EMF exposure. From the current perspective, it appears useful to recommend a treatment approach, as those gaining ground for multisystem disorders, that aims at minimizing adverse peroxynitrite effects.

It should be stressed, that psychotherapy has the same significance as in other diseases. Products that are offered in the form of plaques and the like to "neutralize" or "harmonize" electrosmog should be evaluated with great restraint.

In summary, the following treatment and accessibility measures appear advantageous, depending on the individual case:

Reduction of EMF exposure

This should include all types of EMF exposures relevant to the person, especially during sleep and at work. For more information, see e.g. "Options to Minimize EMF/RF/Static Field Exposures in Office Environment" (196) and "Elektrosmog im Alltag" (197).

Environmental Medicine treatments

Until now, no specific treatment of EHS has been established. Controlled clinical trials would be necessary to assess optimal treatment and accessibility measures. Actual data indicate that the functional deficits, which can be found in persons with EHS, correspond to those we can find in CMI such as MCS, CFS, and FM. The target of the therapy is the regulation of the physiological dysfunction detected by diagnostic steps (Examination and findings). The main therapeutic target includes both general and adjuvant procedures and specific treatments. The latter are challenging and need special knowledge and experience in clinical environmental medicine treatments. Main therapeutic targets include:

– **Control of total body burden**
  Besides the reduction of EMF exposure, the reduction of the total body burden by various

environmental pollutants (home, working place, school, hobby), food additives, and dental materials is indicated.

- **Reduction of oxidative and/or nitrosative stress**
  Reactive oxygen species (ROS) and reactive nitrogen species (RNS) are free radicals naturally produced in cells. Scavengers guarantee the balance between the production of free radicals and the rate of their removal. Many biologically important compounds with antioxidant (AO) function have been identified as endogenous and exogenous scavengers. Among the endogenous AO, we distinguish between enzymatic AO (catalase, glutathione peroxidase, glutathione reductase, superoxide dismutase) and nonenzymatic AO (bilirubin, ferritin, melatonin, glutathione, metallothionin, N-acetyl cysteine (NAC), NADH, NADPH, thioredoxin, 1,4,-bezoquinine, ubiquinone, uric acid). They interact with exogenous dietary and/or synthetic AO (carotenoids, retinoids, flavonoids, polyphenols, glutathione, ascorbic acid, tocopherols). The complex regulation and use of these substances is the therapeutic challenge (163, 201).
- **Regulation of intestinal dysfunction**
  Endogenous and exogenous scavengers act synergistically to maintain the redox homeostasis. Therefore, dietary or natural antioxidants play an important role to stabilize this interaction.
  Treatment of a leaky gut, food intolerance, and food allergy is a prerequisite for maintaining redox homeostasis (202) and also requires special knowledge and experience.
- **Optimizing nutrition**
  Bioactive food is the main source of antioxidant components such as vitamin C, vitamin E, NAC, carotenoids, CoQ10, alpha-lipoic acid, lycopene, selenium, and flavonoids (203, 204). For instance, the regeneration of vitamin E by glutathione or vitamin C is needed to prevent lipid peroxidation. The dietary antioxidants only can have beneficial effects on the redox system if they are present in sufficient concentration levels (201). Alpha-lipoic acid acts directly and indirectly as a scavenger of free radicals including peroxynitrite, singlet oxygen, superoxide, peroxyl radicals, and the breakdown radicals of peroxynitrite (163). It had been shown that the number of free electrons in micronutrients determines how effective they are. In organic food, the number of free electrons is higher than in conventionally produced food (205). Especially in the case of food intolerances, the tailored substitution of micronutrients in the form of supplements is necessary.
- **Control of (silent) inflammation**
  Elevated nitric oxide levels and the reaction with superoxide always leads to elevated peroxynitrate levels, which induce ROS levels as no other substance does ($NO/ONOO^-$ cycle). As a result, the nuclear factor κB (NF-κB) is activated, inducing inflammatory cytokines such as tumor necrosis factor α (TNF-α), interleukin-1β (IL-1β), interleukin-6 (IL-6), interkeukin-8 (IL-8), and interferon gamma (IFNγ) and activating various NO synthases (163). Tocopherols (206, 207), carotinoids at low concentration levels (208), vitamin C (209, 210), NAC (211), curcumin (212), resveratrol (213, 214), flavonoids (215) have shown to interrupt this inflammatory cascade at various points.
- **Normalization of mitochondrial function**
  Mitochondrial function may be disturbed in two ways. First: the high amount of free radicals may block production of adenosine triphosphate (ATP), leading to muscle pain and fatigue. Second: in the case of silent (smoldering) inflammation, the demand for more energy is elevated by 25% (167), causing a high consumption of ATP. In this case, NADH, L-carnitine and CoQ10 are essential for ATP synthesis.
  Due to the lack of ATP, the stress regulation of catecholamines especially norepinephrine (NE) is reduced because catabolism of NE by S-adenosylmethionine is ATP dependent (216–218). Furthermore, stress regulation has a high demand for folate, vitamin B6, and methylcobalamine. Genetic polymorphisms of COMT and MTHFR influence the individual need for those substances (173, 219).
- **Detoxification**
  In humans, the accumulation of environmental toxicants has an individual profile of many different inorganic and organic chemicals, which make up the total body load (220).
  Among the inorganic substances, metals and their salts play the dominant role and might be of importance to persons with EHS. Elemental mercury (Hg°) and other heavy metals such as lead (Pb) accumulate in the brain (221), especially at chronic low dose exposure. They may have toxic effects and can induce various immune reactions (222, 223). Whereas, generally, no specific active substance exists for the detoxification of chemicals, there are two groups of substances with more specific effects that can be used for the detoxification of metals.
  1. Substances with nonspecific physiological effects:
     Glutathione, NAC, alpha-lipoic acid, vitamin C and selenium.

2. Chelating agents for detoxification of metals (224–226)
   The most important chelating agents are:
   Sodium thiosulfate 10%
   DMPS (2,3-dimercapto-1-propanesulfonic acid)
   DMSA (meso-dimercaptosuccinic acid)
   EDTA (2,2′,2″,2‴-ethane-1,2-diyldinitrotetraacetic acid)

   It should be noted that these substances should be used only by those designated as experts in this particular field.

– **Adjuvant therapies**

1. Drinking water

For detoxification reasons, a higher intake of high-quality drinking water with low mineral content and no CO_2 is needed. The intake quantity should range from 2.5 to 3.0 L (10–12 8-oz glasses) daily.

2. Light

Most of the people in central and northern Europe are depleted of vitamin D. Sufficient natural daylight exposure during the vitamin D-producing months (spring to fall) is one important factor. At the same time, prevention of actinic damage to the skin is necessary.

3. Sauna

Sauna and therapeutic hyperthermia is an adjuvant therapy for the detoxification of almost all xenobiotics. These therapies have to be carefully used. An interaction with detoxifying drugs takes place. Sauna helps to regenerate tetrahydrobiopterin from dihydrobiopterin, which is essential for the metabolism of catecholamines and serotonin (163).

4. Oxygen

A part of persons with EHS suffer from mitochondrial dysfunction. Sufficient natural oxygen is helpful. As both hypoxia and hyperbaric oxygen can produce oxidative stress, hyperbaric oxygen therapy should only be performed if the persons are treated with sufficient antioxidants at the same time.

5. Exercise

The optimal amount of exercise is still being debated. A person's physical capacity should be assessed by ergometry in order to prescribe an individual exercise regime. Environmental medicine experience indicates that for sick people only low-impact aerobic exercise should be used. In general, start with a work load of 20–30 watts that often can be finished at 60–70 watts. Exercise on an ergometer allows better control of the consumption of energy compared to walking or running. No fatigue should result from exercising, at least after half an hour.

6. Sleep

Sleeping disorders are very common in persons with EHS. Sleep disturbance is associated with reduced melatonin level. In the case of chronic inflammation, the activation of IDO (indolamine-2,3-dioxygenase) reduces the production of serotonin and, in turn, it also reduces melatonin levels. EMF exposure might block the parasympathetic activity while sympathetic activity persists. Concerning sleep disturbances, any therapy has to follow the pathogenic causes. Optimal sleep is necessary to save energy and to regulate the functions of the immune and neuroendocrine systems.

7. Protection from blue light

Wavelengths of visible light below 500 nm are called "blue light". Low doses of blue light can increase feelings of well-being, but larger amounts can be harmful to the eyes. In natural daylight, the harmful effects of "blue light" are balanced out by the regenerative effect of the red and infrared content. The escalating use of electronic light sources – such as fluorescent tubes and compact fluorescent lamps (CFL), computer screens, laptops, tablets, smartphones, and certain LED bulbs – has increased our exposure to "blue light", which at this level is suspected of playing a role in the development of age-related macular degeneration and circadian misalignment via melatonin suppression, which is associated with the increased risk of sleep disturbance, obesity, diabetes mellitus, depression, ischemic heart disease, stroke, and cancer. Extended exposure to artificial "blue light" in the evening should therefore be limited. Antioxidants, especially melatonin (227, 228) and blue light screen filters (229–231) could be helpful.

Dental medicine

Dental medicine still works with toxic or immunoreactive materials, e.g. mercury, lead oxide, gold, and titanium. Environmental dental medicine demands that these materials not be used (232–235). The removal of toxic dental materials must take place under maximum safety conditions (avoid inhalation!). The elimination of particularly heavy metals from the body might be indicated. In general

terms, endoprosthetic materials should be inert with respect to immunoreactivity. Based on our current knowledge, zirconium dioxide seems to be a neutral material. However, mechanical abrasion of the coated surface by the dentist should be avoided.

Immunotoxic metals show a similar pathophysiology with respect to oxidative stress, mitochondriopathy, and inflammation.

Lifestyle coaching

Lifestyle coaching may include balanced exercise, nutrition, reduction of addictive substances, change of sleeping habits, etc. and stress reduction measures (reduction of general stress and work stress), as well as methods to increase stress resistance via, e.g. autogenic training, yoga, progressive muscle relaxation, breathing techniques, meditation, tai chi, and qigong.

Treatment of symptoms

A well-balanced treatment of symptoms is justified until the causes have been identified and eliminated. However, it is of paramount importance to realize that the reduction of symptoms may put the person at risk for an increased environmental EMF-load, thus generating possible future, long-term health effects, including neurological damage and cancer. It is a very difficult ethical task for the physician to risk such, and they must be pointed out – in an equally well-balanced way – to the patient in question. Ethically, to treat the symptoms is, of course, a very good start in the immediate sense but without a parallel environmental exposure reduction and lifestyle coaching it may prove counter-productive in the long run. For a standardly trained physician this might seem a very new way of reasoning, but is the only way to a successful and everlasting symptom alleviation and complete clinical remedy when dealing with chronic multisystem illnesses (CMI) and EHS.

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PHYSICIANS STATEMENT – Exhibit 2

PRELIMINARY
Clinical Practice Guidelines in the Diagnosis and Management of Electromagnetic Field Hypersensitivity (EHS)

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Introduction

Environmental health is the study of effects upon human beings of external physical/ electromagnetic, chemical and biological factors in air, water, soil, food and other environmental media which impact on the general population as well as genetic aberrations and psychosocial stressors.[1] Environmental health is an evidence- and public- health-based discipline. The physical environment is a determinant of health and is interrelated with socioeconomic, social-justice and equity issues. The impact of the environment is an especially important part of our public health domain.[2]

In 2014, a systematic review of 63 studies[3] revealed that despite heterogeneity, the criteria predominantly used to identify idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) individuals were:

1. Self-report of being (hyper)sensitive to electromagnetic fields (EMF)
2. Attribution of non-specific physical symptoms (NSPS) to at least one EMF source
3. Absence of medical or psychiatric/psychological disorder capable of accounting for these symptoms
4. Symptoms should occur soon (up to 24 hours) after the individual perceives an exposure source or exposed area

Electromagnetic Field Hypersensitivity (EHS) is a spectrum disorder in which there is an awareness and/or adverse response to electromagnetic fields.[4] Environmental Sensitivities are recognized as a disability under the Canadian Human Rights Commission (Federal).[5]

Demographics

EHS can occur in all age groups, genders (women are more genetically predisposed[6]), races and income levels. Since 2005, the physicians at the Environmental Health Clinic at Women's College Hospital have assessed an increasing number of patients who, due to co-morbid conditions coupled with chronic

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exposures to electromagnetic fields. Patients present to the clinic after become unwell with a pattern of functional impairments, some becoming disabled, losing their jobs or becoming homeless. Prolonged and/or excessive exposures to these factors cause functional impairments in individuals, and a huge burden of suffering.[7]

Etiology and Pathophysiology

The pathophysiology is poorly characterized. The degree of functional impairment caused by EMF exposure is dependent upon genetic polymorphisms[8] that predispose the individual to a poor detoxification profile and therefore an increased total body burden (Figure 1). A poor detoxification profile can also lead to co-morbid illnesses such as Multiple Chemical Sensitivities (MCS), nervous, cardiac and immune system dysfunction which renders a person vulnerable to EMF exposures. Most commonly, patients have had prolonged chronic exposures to radiofrequency radiation, microwaves, electrical and/or magnetic fields from either wired or wireless technology. Patients can react to electric fields (measured in volts per meter), magnetic fields (measured in milligauss or nano Tesla), dirty electricity (high frequency voltage transients, which are deviations from a pure 50-60H Hz sine wave), radiofrequency radiation, microwave radiation, ground currents and electrosmog.

The severity of the impact appears to depend upon the nature, dose, and timing of exposures, as well as a person's allostatic load, which is the maximum tolerated dose for combined environmental stressors.[9] Patients can be identified as having environmental sensitivities, electrical sensitivities or as being "EMF sensitive" or "EMF susceptible" rather than "hyper" in order to decrease stigmatization potential.

Radiofrequency radiation can cause the following adverse biological effects:[10] [11]

- Cerebral **hypoperfusion/ hypoxia-related neuroinflammation**
- Histamine release causing oxidative stress in biological systems[12]
- Peroxidation, DNA damage, changes to antioxidant enzymes
- Voltage gated calcium channel dysregulation effecting the cardiac and nervous system
- Peroxynitrite formation which causes chronic inflammation, damage to mitochondrial function and structure and reduction of ATP
- Reduced glutathione and CoQ10
- TRPV1 receptor activation[13] [14]

Radiofrequency radiation and microwaves can cause thermal (heat related) or non-thermal effects. Under the non-thermal category, adverse physiological effects have been identified including DNA damage, immune system suppression, increased blood-brain barrier permeability, increased blood viscosity with rouleaux formation.

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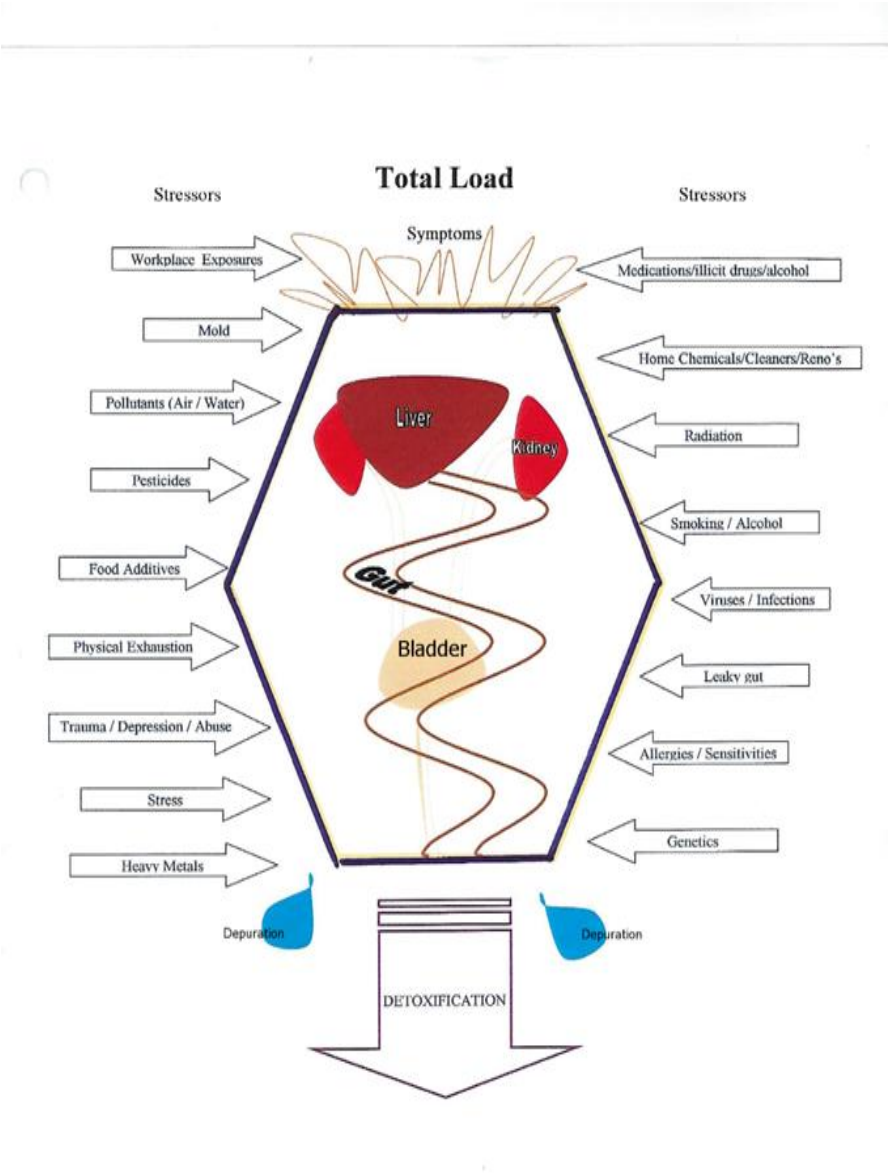

Figure 1: Total Toxic Load (Bray and Marshall, 2005)

History

The clinician is advised to:

1. Conduct a complete exposure history using the CH2OPD2 mnemonic[15] [16] to determine total toxic load in the form of EMF/ RFR exposure, toxic metal exposure sources (diet, water, prosthetics, implants, gadolinium), mould, and other potentially toxic chemical exposures.

[15] Marshall et al, 2002
[16] Bray, 2020
https://static1.squarespace.com/static/593f8894e3df288fc64b6cf0/t/598bbabdf14aa18c52a6dcce/1502329836033/Environmental+Health+Clinic+Pre-Visit+Questionnaire.pdf

CH2OPD2 mnemonic

- Community
- Home
- Hobby
- Occupation
- Personal habits
- Diet
- Drugs

2. Determine specific community, work, school and home exposures to EMFs: proximity of cell phone towers, routers, DECT cordless phones, any other wireless technology. Most importantly, determine if the sleeping area is affected.[17] [18]

A helpful mnemonic to determine the parameters of exposure is (F.I.N.D.)[19]

- **F- frequency (Hertz)**
- **I- intensity (Power in µW/m$^{2)}$**
- **N- nearness**
- **D- duration**

3. Have a high index of suspicion for immune deficiencies (which can, for example, lead to candida infection), gut dysbiosis and possible mast cell activation disorder (MCAS).

Symptoms Commonly Occurring Singularly or in Combination:

- Irritability, lack of appetite, memory problems, vertigo; visual, skin and vascular problems[20]
- Tinnitus, sleep disorders (disrupted stage 4 sleep with alpha wave intrusions and reduced REM[21]) mood changes (anxiety, depression, irritability, panic attacks)[22]
- Headache, weakness, pressure in the head, racing or fluttering heart[23]
- Dermatological: itch, pain, edema, erythema secondary to elevated transthyretin concentrations[24]
- Neurasthenic and vegetative symptoms: fatigue, tiredness, cognitive problems, concentration difficulties, dizziness, nausea, heart palpitations (tachycardia, PACs and PVCs), and digestive disturbances[25]

Etiology of Common Clinical Presentations

<u>Category I</u>

Patients can present with a toxic metal body burden, most commonly mercury, due to the overconsumption of aquatic, contaminated seafood. Methylmercury (half-life of 27 years in the brain) is neurotoxic causing axonal demyelination and inflammation. Zinc/nickel/mercury dental amalgams also release elemental mercury vapour which enters the brain through the olfactory bulb, and then is converted to methylmercury. Patients can present with cardiac and neurological manifestations. Those with metallic

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hardware implants such Harrington rods, braces, wire meshes, pins and screws can potentially be affected. Those with excessive gadolinium from multiple contrast studies are also at risk. Other toxic metals include nickel (jewelry, cookware), lead (old water pipes), cadmium (smokers), aluminum(soy products, contaminated water, medications) and arsenic (rice, fish, almonds, well water), all of which increase total load. First Nations populations are at high risk given exposure to contaminated fish with methylmercury. Patients present with headaches (lancinating and heaviness), brain fog, fatigue and anxiety when exposed to EMFs.

Category II

Patients fall into this category if they suffer from infectious diseases such as Lyme disease, co-infections of Lyme, and other infections which affect the nervous system. These patients have central or peripheral nervous system vulnerability, neuroborreliosis, cerebral vasculitis, polyneuropathy, chronic encephalomyelitis and cranial neuropathy (all late manifestations of Lyme). They present with tremor, dysarthria, ataxia, extreme fatigue, headache, cognitive dysfunction, presyncope and mood disturbances. It is important to reduce body burden through detoxification in order to decrease inflammation. Oxygen therapy is useful in order to help with hypoxia from compromised cerebral blood flow to the bi-frontal cortices and temporal lobes, but provides only short, temporary relief. This may help to confirm the diagnosis, however. fMRI, SPECT, and PET scans can help further reveal pathology. Treatment of Lyme with antibiotics can potentially decrease EHS symptoms.[26]

Category III

This category of patients suffer from lesions of the brain (including tumours such as pituitary adenomas), demyelination, microangiopathic changes, diffuse ischemia, inflammation (from neurotoxic pesticides) and neurodegenerative diseases (multiple sclerosis and ALS for example).[27] Nonspecific white matter findings due to simple aging and dementia should also be considered. They present with headaches, brain fog, fatigue, restlessness and low mood, tinnitus(+/-) and potentiation of their already pre-existing signs and symptoms related to their disease. The mechanism of action is associated with the impact of EMFs on voltage gated calcium channel (VGCC) integrity, causing increases in intracellular calcium and thus increase of oxidative stress from ONOO- formation.[28]

Category IV

These patient suffer from heart rhythm disturbances: either exacerbations of existing conditions or new onset caused by radio and microwaves.[29] There are periods of poor blood circulation at the capillary level due to rouleaux formation and there is a disturbance of heart conduction because of effects on VGCC. Tachycardic spells, especially at night, can occur. People also experience premature ventricular contractions, premature atrial contractions, atrial flutter and fibrillation. Those with Wolff Parkinson White syndrome are especially at risk for sudden cardiac death due to EMF exposures.[30] Conduction problems also affect the autonomic nervous system, causing increased sympathetic tone. A Holter monitor will show rhythm disturbances near cellphone towers and in areas with high Wi-Fi usage. These symptoms are very alarming to the patient and causes severe, prolonged anxiety. Sleep time can be also particularly difficult causing frequent awakenings due to hyper-vigilance with tachycardic spells or PAC/ PVCs.

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Category V

These patients include students and teachers. University, college, high school, and grade school students are all being exposed to high levels of radiation. They frequently work under fluorescent lights. They get eye strain, and sometimes develop rashes related to exposure of this radiation. The epidemic of anxiety, depression, and suicide at universities and colleges is in part being fuelled by the increased level of agitation and anxiety caused by radio and microwave radiation on mood. Students have extremely high levels of nighttime exposure to RFR or electric fields/ dirty electricity. Before prescribing methylphenidate or amphetamines, reducing EMFs in the workspace is critical.

Category VI

A minority of patients, approximately 1%, exhibit a nocebo response in which inert substances or mere suggestions of substances actually bring about negative effects, i.e. feelings of malaise and anxiety. This is understandable, given the ubiquitous nature of electrical devices in our everyday lives which is unnatural. These patients tend to feel better using wearable jewellery, stickers on cellphones, and special rocks (shungite).

Category VII

There are many clinical similarities and overlapping comorbid conditions between EHS and multiple chemical sensitivities (MCS) that are reflected in similar genetic polymorphism profiles. Inflammation resulting from impaired detoxification biochemical processes create illness and functional impairment.[31] [32]

Physical Examination

Do a complete physical looking for dental amalgam load, metal appliances in the mouth, rashes on the face and/or hands, signs of inflammation and edema, arrhythmias, autoimmunity. Abdomen may be tender due to peristaltic abnormalities and bacterial dysbiosis. Usually a physical exam will reveal neurological, dermatological and/or cardiac signs in the way of arrhythmia and/or poor circulation. Tremor of the tongue and hands may be indicative of mercury overload.

There is no gold standard for EHS diagnosis except for elimination of the source and reintroduction/ provocation to confirm if the signs and symptoms are reproduced.

Laboratory and Diagnostic Tests

Studies have shown that approximately 30% of patients with EHS have no abnormal laboratory biomarkers,[33] but genetic polymorphisms are likely prevalent and need further investigation. Some blood tests are expensive and not sensitive or specific but can help guide management if deficiencies or other disease states exist that must be corrected.[34] The following laboratory tests will help shed light on the total toxic load and detoxification profile, and it is the **combination** that allows for the best management of the patient:

- Essential mineral and toxic metal panel (RBC)
- GGT
- Bilirubin
- ALP
- Chromogranin A

[31] De Luca C, Thai JC, Raskovic D, et al. Metabolic and genetic screening of electromagnetic hypersensitive subjects as a feasible tool for diagnostics and intervention. Mediators Inflamm. 2014;2014:924184. doi:10.1155/2014/924184

[32] Belpomme, Dominique, Christine Campagnac, and Philippe Irigaray. "Reliable disease biomarkers characterizing and identifying electrohypersensitivity and multiple chemical sensitivity as two etiopathogenic aspects of a unique pathological disorder." Reviews on environmental health 30.4 (2015): 251-271.

[33] Belpomme D, Irigaray P. Electrohypersensitivity as a Newly Identified and Characterized Neurologic Pathological Disorder: How to Diagnose, Treat, and Prevent It. International Journal of Molecular Sciences. 2020 Jan;21(6):1915.

[34] Europaem 2015/ Oberfeld, 2016/ Belpomme, 2015

- Tryptase.[35]
- Vitamin D2-D3
- **IgE**, IgG, IgM, IgA
- Inflammatory markers (ESR, hsCRP, CRP, interleukins)
- Histamine
- Autoimmune markers (including thyroid antibodies)
- Presence of infectious diseases – screen for Lyme and co-infections (ELISA and Western blot)
- Mitochondriopathy (intracellular ATP)
- Oxidative stress lipid peroxidation markers
- Anti-myelin-O antibodies
- Nitrotyrosin (NTT) - Nitric oxide production increasing BBB permeability
- Melatonin (hydroxy-melatonin sulfate – 6-OHMS)
- SPEP – effects on bone marrow
- Salivary cortisol
- Alpha-amylase
- Transthyretin
- Blood sugar levels after provocation

Biomarker	Normal range
High-sensitivity C reactive protein (hs-CRP)	≤ 3 mg/L
Vitamin D2-D3	≥ 30 ng/mL
Histamine	≤ 10 nmol/L
IgE	≤ 100 UI/mL
Protein S100B	≤ 0.105 µg/L
Nitrotyrosine (NTT)	≥ 0.6 µg/L and ≤ 0.9 µg/mL
Heat shock protein 70 (HSP70)	≤ 5 ng/mL
Heat shock protein 27 (HSP27)	≤ 5 ng/mL
Anti-O-myelin autoantibodies	Negative
Hydroxy-melatonin sulfate (6-OHMS)	≥ 5 ng/L and ≤ 40 ng/L
6-OHMS/creatinine	≥ 0.8 and ≤ 8

Figure 2: (Belpomme et al., 2015)

To further aid in diagnosis:[36]

- Genetic testing to determine SNPs related to detoxification[37]
- Weighted MRI showing hypoperfusion in limbic system and thalamus
- Ultrasonic cerebral tomosphygmography (UCTS) and Transcranial Doppler US (TDU)[38] showing temporal lobe hypoperfusion due to decreased flow in the middle cerebral artery

[35] Belpomme, et al, 2015
[36] Havas, 2010
[37] The DNA Company. https://www.thednacompany.com/
[38] Belpomme, Dominique, Philippe Irigaray. "Electrohypersensitivity as a Newly Identified and Characterized Neurologic Pathological Disorder: How to Diagnose, Treat, and Prevent It" Int. J. Mol. Sci. 2020; 21,1915.

- BP and heart rhythm monitoring for 24 hours (night-time changes) for heart rate variability and heart rate abnormalities[39]
- Sleep study showing abnormalities due to wireless technology in the sleep labs. Alpha wave intrusions and reduced REM sleep are the most likely finding.[40]

Co-Morbid Conditions

1. Toxic metal overload – mercury
2. Infectious diseases causing neural inflammation – e.g. Lyme disease
3. Toxic Mold Syndrome
4. Cardiac conduction abnormalities – PVC, PAC, atrial fibrillation
5. Neurodegenerative diseases
6. Multiple chemical Sensitivities (MCS)

Management

Allopathic

All co-morbid conditions need to be investigated further and treated. Referrals to specialists may be required to address medial issues that may have been overlooked.

Pharmacological

Sleep restoration is paramount, and pharmaceuticals can be used if natural remedies are not effective. Antihistamines with sedative effects are the drug of choice. For heart palpitations and arrhythmias, especially those occurring at night, bisoprolol 1.25-2.5mg QHS helps. For sudden tachycardic spells, waves of anxiety, and sympathetic overdrive, propranolol 2.5-5mg po QID PRN is also helpful. Acetylsalicylic acid 81mg daily prevents coagulation secondary to high intensity effects due to the close proximity of routers, DECT base stations and other potent emitters and combinations thereof. A calcium channel blocker, such as diltiazem 15-30mg daily PRN, could help reduce symptoms. Gentle chelation therapy may be required if toxic metal load is too high[41].

Remediation

Health-care providers need to encourage patients to seek help from building biologists. These technicians can assess the degree of EMF exposure a person is receiving in their home and make sensible recommendations. The impacts of cell phone towers, smart meters and hydro wires on living spaces can be determined, as well as anything internally generating EMFs. Voltage, power density and magnetic fields, as well as dirty electricity can be measured. Proximity to wind turbines which, due to poor enforcement of safety standards, emit ground currents that increase symptoms of EHS, can be identified.

Advise patients to use only corded phones without any electronic features. DECT cordless phones emit RFR and need to be removed altogether.

Metallic paint on interior or exterior walls can be used to reflect radiation coming in from neighbours, cell towers or other emitting devices. Any other type of shielding using metallic reflective surfaces can help attenuate the signals.

Advise patients to turn off all wireless devices in the home and replace with ethernet cables or hardwire everything were possible. Smartmeter removal or shielding installed by a technician is recommended.

[39] Havas M. Radiation from wireless technology affects the blood, the heart, and the autonomic nervous system. Reviews on Environmental Health. 2013 Nov 1;28(2-3):75-84.
[40] Andrianome S, Hugueville L, de Seze R, Hanot-Roy M, Blazy K, Gamez C, Selmaoui B. Disturbed sleep in individuals with idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF): Melatonin assessment as a biological marker. Bioelectromagnetics. 2016 Apr;37(3):175-82.
[41] Sears ME. Chelation: harnessing and enhancing heavy metal detoxification—a review. The Scientific World Journal. 2013 Jan 1;2013.

Integrative
A diet rich in antioxidants and low in pro-inflammatory foods is strongly recommended. Eat organic if possible. Omega-3 (balanced DHA:EPA 1:1) 1500mg daily will help with inflammation and neural health. Vitamin D3 is also neuroprotective and should be taken at a dose of at least 4000IU per day.

Electrolytic imbalances for whatever reason (i.e. low K+, Na+, Cl-, etc.) need to be corrected with oral rehydration solutions. To manage *adrenal* fatigue, adaptogen herbs and mindfulness based stress reduction (MBSR) can be useful. Homeopathic treatments are useful for those with chemical sensitivities.

Enhance Natural Detoxification to Reduce Body Burden

- Natural detoxification strategies include: sauna therapies (depuration), MBSR, balanced diet, supplements, exercise.
- To decrease body burden of oxidative stress (peroxynitrite ONOO-) or methylmercury take antioxidants: vitamins E and C, glutathione, alpha-lipoic acid, N-acetyl-cystine, B vitamin complex, zinc, resveratrol, CoQ10, selenium, turmeric. A high fibre diet (especially in the form of bran) will assist with elimination of methylmercury.
- Correct any dental work with toxic or immunoreactive materials such as mercury, lead oxide, gold or titanium and replace with zirconium dioxide, porcelain or composite.
- Mercury amalgams (mercury (50%), silver (~22–32%), tin (~14%), copper (~8%)) need to be removed using proper protocol. [42] [43]

Fasting is not recommended due to the possibility of already existing poor nutritional status thus inadequate supplies of vitamins, minerals and other antioxidant substrates in their body.[44] Food sensitivities/intolerances must be addressed.

Lifestyle
Tell patients to hold the cell phone away from their heads when in use and keep it in airplane mode when not in use. The Bluetooth, data and Wi-Fi functions should be off if they are not being used. Extended videogaming and high electronic equipment use can exacerbate symptoms and must be curtailed. Laptop use in wireless mode needs to be switched to ethernet cable connectivity to decrease exposure.

Clothing (including the lining of hats) made of cotton fabric with copper or silver weave provides relief during travel at airports, in hotels, etc., when shielding the torso and head. This can reduce palpitations and headaches. Blankets/sheets with similar construction can be used to block out in-coming radiation into habitable spaces during travel or at work.

A Faraday cage (canopy) can be used at night to reduce radiation on the body which can seriously interfere with sleep quality. For sleep, herbal remedies and supplements are helpful. Magnesium bisglycinate 100mg po QHS, increasing by 100mg weekly to bowel tolerance, can help with palpitations and shock sensations.

Grounding practices are important to balance out the electron shifts. This should not be done under hydro wires, where magnetic fields are extraordinarily strong. There will be a depletion of electrons. The aim is to replenish lost electrons. Therefore, placing one's bare feet on a special grounding mat, walking barefoot on grass and sand or in lake shallows, pools or a bath tub can help. Grounding can be important to balance out the electrons and replenish the electrons that have been depleted from the body.

Airpods and other wireless earpieces should not be used due to the proximity and intensity of the radiation to the brain.

[42] De Luca, 2014
[43] Institute for Functional Medicine. Textbook of Functional Medicine. 2010.
[44] Institute for Functional Medicine. Textbook of Functional Medicine. 2010.

Remove all harmful substances used in personal care products, cleaning and other household products, as well as unnecessary medications.

Psychological

Finally, patients need a lot of psychosocial support in dealing with and removing stress triggers. Mindfulness Based Stress Reduction, and CBT can be useful to decrease sympathetic nervous system overdrive.

Connecting with support groups such C4ST, EPIC, WEEP and Electrosensitive Society, all of which are Canadian based, can decrease social isolation.

Advocacy for Public Health Protection

- Accommodation at work, school or any learning institution should be supported thereby respecting a person's right to work and live in a space that is free of any potentially harmful EMF exposure impacting on their biopsychosocialspiritual well-being.
- Students should be given letters/notes informing teachers of the need to be at a maximal distance from routers and that laptops need ethernet access.
- People must be able to exercise their rights to refuse harm from EMFs which may be impacting them, their children and loved ones or their fetus/embryo, if that be the situation. Each person, should know exactly how much and what sort of radiation is impacting on their bodies.[45] [46]
- Recommendations presented in the HESA report to the House of Commons – Radiofrequency Electromagnetic Radiation and the Health of Canadians, 2010 and 2015 – can be used for guidance in community events.
- Ontario wide, mandatory physician surveys, of how many patients they see in their roster who complain of possible EMF-related signs and symptoms, should be implemented.
- Validated screening tools need to be developed through further research studies.
- Physician education through CME is critical.

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[45] Right to Know, CCOHS https://www.ccohs.ca/oshanswers/legisl/responsi.html

[46] Government of Canada. Guide for Assessing Persons with Disabilities - How to determine and implement assessment accommodations - Environmental Sensitivities. https://www.canada.ca/en/public-service-commission/services/public-service-hiring-guides/guide-assessing-persons-disabilities/guide-assessing-persons-disabilities/guide-assessing-persons-disabilities-determine-implement-assessment-accommodations-environmental-sensitivities.html. 2007.

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Peer Reviewers: Dr. John Molot, Dr. Kathleen Kerr, Dr. Sarah Selke, Dr. Jennifer Swales,

SCIENTISTS STATEMENT

IN THE SUPREME COURT OF PENNSYLVANIA
MIDDLE DISTRICT

RE: No. 34 MAP 2021, *Povacz, M, et al. v. PUC*
Associated Case(s):
35 MAP 2021 Consolidated
36 MAP 2021 Consolidated
37 MAP 2021 Consolidated
38 MAP 2021 Consolidated
39 MAP 2021 Consolidated
40 MAP 2021 Consolidated
41 MAP 2021 Consolidated
42 MAP 2021 Consolidated
43 MAP 2021 Consolidated
44 MAP 2021 Consolidated
45 MAP 2021 Consolidated

SCIENTISTS' STATEMENT

RF/EMF & SMART METERS HARM

THE EFFECTS OF PULSED RADIOFREQUENCY AND ELECTROMAGNETIC RADIATION EMISSIONS OF SMART METERS; ESPECIALLY AS IT PERTAINS TO THOSE ADVERSELY AFFECTED

General Statement

We, the undersigned scientists, have cumulatively published hundreds of peer-reviewed papers on biological effects of pulsed electromagnetic fields (EMFs) and radiofrequency (RF) radiation and reviewed thousands more. For all of us the study of the effects of pulsed RF/EMFs is one of our main areas of study; for some, it is the main one. (A short bio for each of the undersigned is attached.)

We are filing this statement to clarify the state of the current science regarding RF/EMF-based wireless technology adverse health effect and to explain why smart meters can be harmful, at least to some people. Pulsed RF/EMF-based wireless technology harms are not hypothetical. They are scientifically established, and a significant number of people have already been seriously injured. Therefore, we cannot stand by and allow the science to be misrepresented, especially in a case of such importance involving public safety, where lives are at stake, the harms are irreparable, and people are injured and could die.

RF Basics

1. Wireless technology uses electromagnetic waves to carry information.1 A wave "frequency" is the number of wave cycles per second. Each cycle per second equals a "Hertz" ("Hz").2 Example: A 60 Hz frequency used for home electricity has 60 wave cycles per second. The smart meter antenna that

[1] An electromagnetic field (EMF") is created by electric and magnetic components emitted by moving charges and propagated through "waves" at the speed of light. The interaction between the electric and magnetic fields "radiates" energy ("radiation"). The electromagnetic spectrum is divided into classes: Extremely Low Frequencies (ELFs), radio frequencies (microwaves are a subgroup of RFs), infrared, visible light, ultraviolet, X-rays and gamma rays. RFs have a wave-cycle between 3 kilohertz and 300 gigahertz

[2] 1,000 Hz is a kilohertz ("KHz"). 1,000,000 Hz is a megahertz ("MHz"). 1,000,000,000 Hz is a gigahertz ("GHz").

transmits the usage data uses frequencies around 900 MHz, or about 900 million wave cycles per second.

2. The Radio-Frequency ("RF") "signal" is the "carrier wave." But communications require carrier wave manipulation to "encode" the data. Two main techniques are used: "pulsation" and "modulation." Modulation places additional "mini"-waves on the RF. Pulsation injects "bursts" or turns the signal on/off. Different technologies have their own protocols or "code." Two devices using the same code can "communicate" and exchange information.

3. Smart meters operate in the same way. They contain an RF antenna that wirelessly transmits the usage data to the utility company. The antenna's carrier wave is around 900 MHz, but the data usage is transferred by modulating the carrier wave. Furthermore, the communications occur every few seconds, so the transmissions alternate between "silent" and "active." This leads to an intensely pulsed signal that has a jarring "on/off" effect on the body.

4. RFs emit "non-ionizing" radiation. Non-ionizing radiation does not have sufficient energy to directly pull electrons from atoms and molecules to create "ionization." The FCC guidelines assume that non-ionizing radiation is not harmful, unless it has high intensity power that causes tissue to heat as it absorbs the radiated energy. This is called the "thermal effect." The FCC's regulations

acknowledge only thermal effects. Considering many thousands of studies have proven non-thermal effects, this assumption cannot be defended.

CHD v. FCC and FCC Admission of Harm

5. On August 13, 2021, in a case amici Children's Health Defense brought against the FCC, the US Court of Appeals for the DC Circuit ruled that the FCC failed to adequately consider and address the scientific and medical evidence showing that its 1996 thermally-based guidelines do not sufficiently protect the public. The Court held the FCC did not fully consider non-thermal harms other than cancer effects, and as a result failed to engage in reasoned decision making.[3]

6. The FCC will have a hard time sticking to its current "no non-thermal harm" construct on remand since it recently admitted there are neurological harms from RF exposures, at least in the range between 3 Hz and 10 MHz.[4] The FCC noted "[a]dverse neural stimulation effects …such as perception of tingling, shock, pain, or altered behavior due to excitation of tissue in the body's peripheral nervous system." It also admitted that these harms occur *instantaneously*, which

[3] *Envtl. Health Tr., et al v. FCC*, Nos. 20-1025, 20-1138, 2021 U.S. App. LEXIS 24138 (D.C. Cir. Aug. 13, 2021).

[4] *Proposed Changes in the Commission's Rule Regarding Human Exposure to Radiofrequency Electromagnetic Fields; Reassessment of Federal Communication Commission Radiofrequency Exposure Limits and Policies*, ¶¶122-124 & nn. 322-335, 34 FCC Rcd 11687, 11743-11745 (2019).

means the FCC's current method of averaging exposure levels over 30 minutes – which completely obscures pulsation effects – is entirely inappropriate.[5]

The Scientific Consensus of Non-Thermal Harms

7. Some of the scientists who signed below published the evidence presented in the DC Circuit court case, including the BioInitiative Report (BioInitiative).[6] The Bioinitiative is the most comprehensive scientific review on the biological and health effects of Electromagnetic Fields (EMF) and RF-based wireless technology by independent scientists (those with no conflict of interests). The Bioinitiative concluded that bioeffects are established and can occur within minutes of exposure to even very low levels of RF, including those emitted by smart meters. With chronic exposures the biological effects can become adverse effects and result in illness.[7]

8. Humans are bioelectrical beings. Our bodies use internally-generated non-thermal EMFs to function. Our physiology is dependent on very sensitive bioelectric systems, especially the heart, brain, nervous system, and intercellular

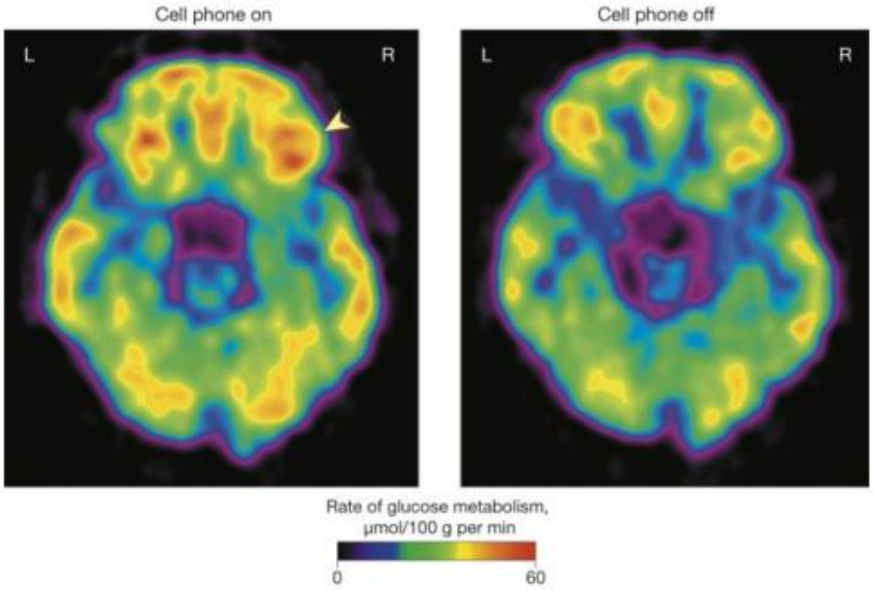
[5] The Engineer's Report attached to the amicus brief reveals that smart meters pulse RF frequencies within this range (3 kHz – 50 KHz). The utility's evidence below relied in part on the FCC's 30-minute averaging as the basis to deny any negative pulsation effects.

[6] https://bioinitiative.org/participants/.

[7] https://bioinitiative.org/conclusions/.

communication.[8] As the FCC stated in its admission, externally generated EMF interferes with humans' internal electrical communications system, and evokes internal biological responses. These responses have nothing to do with power level or tissue heating. The direct effect of pulsed RF/EMFs on humans' physiology are indisputable.

9. A 2011 National Institutes of Health ("NIH") study[9] is sufficient by itself to destroy any denial of RF biological effects. Brain scans of 47 human participants revealed that pulsed non-thermal RF radiation induced biological brain glucose metabolism changes in every subject. See image below.



[8] https://childrenshealthdefense.org/wp-content/uploads/rf-martin-blank.pdf.

[9] https://pubmed.ncbi.nlm.nih.gov/21343580/.

10. Denial of biological effects of RF/EMFs cannot co-exist with the fact that physicians routinely use FDA-approved, non-thermal pulsed EMF devices to treat diseases, bone fractures10 and chronic pain,[11] or that RF/EMF is used to treat cancer.[12]

11. The only question is whether the biological responses can be adverse. Numerous studies show indisputable evidence of adverse responses to pulsed RF/EMF exposure on various bodily functions, especially when the RF exposure is chronic and pulsed (like the exposure to smart meters).

12. Biological and even positive effects can become adverse effects. RF signals affect living tissue and stimulate biochemical and bioelectrical changes, which can generate biological effects which then, with chronic exposure, can become adverse effects and cause various symptoms and may lead to sickness.[13] A good example of this mixed effect comes from the immune system: "short-term exposure… may temporarily stimulate certain humoral or cellular immune functions, while prolonged irradiation inhibits the same functions."[14]

[10] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3441225/.

[11] https://www.accessdata.fda.gov/cdrh_docs/pdf19/K190251.pdf "the application of electromagnetic energy to non-thermally treat pain."

[12] https://childrenshealthdefense.org/wp-content/uploads/rf-medical-treat-cancer.pdf.

[13] https://bioinitiative.org/conclusions/.

[14] https://www.sciencedirect.com/science/article/abs/pii/S0048969713003276.

Scientific Consensus

13. Numerous scientists,[15] doctors, and medical and scientific organizations from the US and around the world have warned of the negative non-thermal effects of RF/EMF and the growing sickness it has been causing. They include the EMF Scientist organization (250 scientists who combined published over 2,000 peer-reviewed papers on the effects of RF/EMF);[16] the American Academy of Pediatrics; [17] the Austrian Medical Association;[18] and doctors' appeals from the US;[19] Belgium;[20] and Germany.[21] In 2021, close to 200 physicians participated in a medical conference about RF/EMF effects, for which they received medical continuing education credits.[22]

[15] https://childrenshealthdefense.org/wp-content/uploads/rf-2017-expert-letters-compilation.pdf.

[16]https://www.emfscientist.org;https://ecfsapi.fcc.gov/file/10916233196437/International_EMF_Scientist-Appeal%208-25-2019.pdf.

[17] https://childrenshealthdefense.org/wp-content/uploads/rf-2013-american-academy-of-pediatrics.pdf.

[18] https://childrenshealthdefense.org/wp-content/uploads/rf-2011-austrian-medical-association-guidelines.pdf.

[19] Baby Safe Project: https://www.babysafeproject.org/joint-statement.

[20] Appeal of 539 Belgium Doctors: https://en.hippocrates-electrosmog-appeal.be/medical.

[21] Appeal of 1,000 German doctors http://freiburger-appell-2012.info/media/International_Doctors_Appeal_2012_Nov.pdf.

[22] https://emfconference2021.com/faculty/.

14. A California Medical Association resolution[23] concludes that the peer-reviewed research demonstrates wireless RF/EMF adverse effects, including "single and double stranded DNA breaks, creation of reactive oxygen species, immune dysfunction, cognitive processing effects, stress protein synthesis in the brain, altered brain development, sleep and memory disturbances, ADHD, abnormal behavior, sperm dysfunction, and brain tumors."

15. Causal mechanisms of harms have been established. Oxidative Stress is one such mechanism. Over 90% of studies on RF and oxidative stress[24, 25] have established that indeed exposure to RF/EMFs induces an increase in free radicals, and chronic exposure causes oxidative stress which leads to several adverse health effects: disease, dysfunction, including electro-sensitivity, cancer, and DNA damage.

16. Even though RF does not have the energy to directly break chemical bonds (the way ionizing radiation does), there is strong scientific evidence that this energy can indirectly cause DNA damage.[26] Dr. Ron Melnick PhD, a retired

[23] https://childrenshealthdefense.org/wp-content/uploads/rf-2014-ca-medical-association-resolution.pdf.

[24] https://bioinitiative.org/wp-content/uploads/2020/09/3-RFR-Free-Radical-Oxidative-Damage-Abstracts-2020.pdf.

[25] https://childrenshealthdefense.org/wp-content/uploads/rf-2015-yakymenko-oxidative-stress.pdf.

[26] https://bioinitiative.org/wp-content/uploads/2020/09/10.-Comet-Assay-Studies-Percent-Comparison-2020.pdf.

National Institute of Environmental Health Science (NIEHS) scientist, was the Senior Toxicologist and Director of Special Programs in the National Toxicology Program (NTP).[27] He stated that the old notion that non-ionizing RF cannot break DNA "should [be] put to rest."[28]

17. Many thousands of studies, including US government and military studies and reports, show the biological and adverse effects of pulsed RF/EMFs.[29] In 2014 the US Department of Interior concluded that the FCC's thermally-based guidelines are "nearly 30 years out of date and inapplicable today."[30]

18. The clear majority of studies show adverse effects.[31] For example, 244 of the 335 total studies (73%) published on neurological effects of RF Radiation between 2007 and 2020 found effects.[32] Of the 261 total studies on RF radiation

[27] https://emfconference2021.com/speaker/ronald-l-melnick-phd/.

[28] https://microwavenews.com/news-center/ntp-comet-assay.

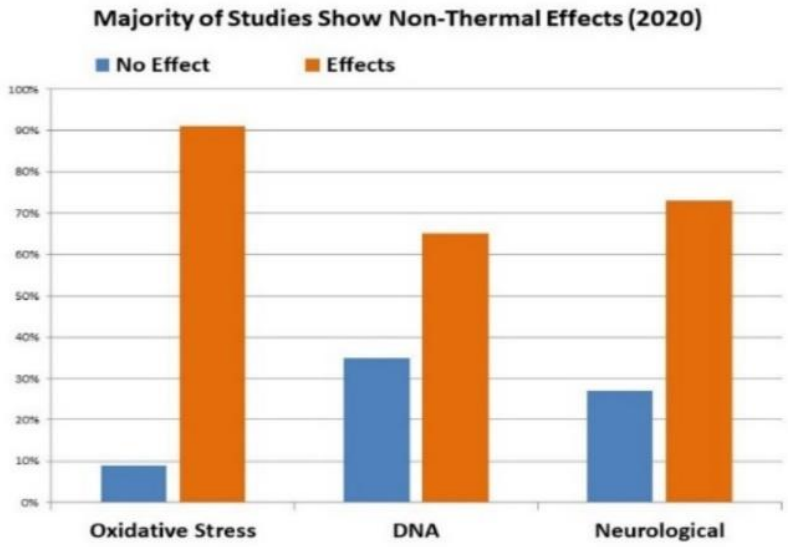
[29] Navy report includes 2,300 studies. Pages 10-14 list the RF effects found. https://childrenshealthdefense.org/wp-content/uploads/rf-1971-navy-2300-studies.pdf; Air-Force: https://electroplague.files.wordpress.com/2014/09/rf-microwave-radiation-biological-effects-rome-labs.pdf; NASA https://www.orsaa.org/uploads/6/7/7/9/67791943/_____nasa_emf_field_interactions_-_observed_effects___theories_1981.pdf.

[30] https://drive.google.com/file/d/1XqbMLFUkVNUZIB5AFJAjr6KWqL6vK8ud/view.

[31] https://bioinitiative.org/research-summaries/.

[32] https://bioinitiative.org/wp-content/uploads/2020/10/13-Neurological-Effects-Studies-Percent-Comparison-2020.pdf.

and oxidative stress, 240 (91%) show effects.[33] 224 of 346 total studies (65%) show DNA damage. See image below.[34, 35]



19. The evidence is getting even stronger. Since 2016, when the evidentiary record in this case was generated, hundreds more published peer-reviewed studies, including by the US government, have established RF/EMF effects.[36]

[33] https://bioinitiative.org/wp-content/uploads/2020/09/9.-Free-Radical-Studies-Percent-Comparison-2020.pdf.

[34] https://bioinitiative.org/wp-content/uploads/2020/09/11-Genetics-Percent-Graphic-Sept-1-2020.pdf.

[35] https://bioinitiative.org/wp-content/uploads/2020/09/10.-Comet-Assay-Studies-Percent-Comparison-2020.pdf.

[36] Abstract of over 700 papers (positive and negative published 2016-2019) https://childrenshealthdefense.org/wp-content/uploads/rf-jmm-2016-2019-studies.pdf; US Government NTP DNA Study https://onlinelibrary.wiley.com/doi/full/10.1002/em.22343.

20. For example, in 2021 the Swiss government expert advisory group on electromagnetic fields and non-ionizing radiation, BERENIS,[37] evaluated the scientific literature on non-thermal RF/EMF.[38] The committee published a preliminary paper which concludes that exposure could cause or worsen several chronic illnesses, and that children, the elderly and people with immune deficiencies or diseases are especially at risk. It also acknowledged that oxidative stress is the underlying causal mechanism of harm.

21. In 2019, the New-Hampshire (NH) legislature voted unanimously to establish a committee to learn the effects of 5G and wireless radiation. The committee included scientists, public representatives, and representatives of the wireless industry (through CTIA, the wireless industry lobby association). After a year of hearing experts on both sides and reviewing the science, in October 2020, the committee's report was published. It concluded that wireless radiation non-thermal harms are established. The committee recognized Electro-sensitivity and the right for accommodation of those who suffer and emphasized the need to

[37] https://www.bafu.admin.ch/bafu/en/home/topics/electrosmog/newsletter-of-the-swiss-expert-group-on-electromagnetic-fields-a/beratende-expertengruppe-nis-berenis.html.

[38] https://childrenshealthdefense.org/wp-content/uploads/rf-swiss-berenis-2021-report.pdf.

educate doctors. NH is the only state in the US that has conducted an independent full-scale investigation as to the harms of these technologies.

22. Former senior experts from government agencies responsible for this issue are also part of the consensus on non-thermal harms. In addition to Dr. Melnick, they also include: *Dr. Linda Birnbaum*, the former director (2009-2019) of the National Institute of Environmental and Health Sciences (NIEHS); [39] *Dr. Christopher Portier*, [40] former director of the National Center for Environment Health at the Centers for Disease Control and Prevention (CDC), who also carried various senior positions in the NIEHS, including Associate Director of the National Toxicology Program (NTP). He wrote: "Most scientists consider non-thermal effects as well established;"[41,] *Dr. Carl Blackman*,[42] a biophysicist who worked as a research scientist for the EPA from 1970 until his recent retirement. Dr. Blackman's research on RF/EMF resulted in several discoveries including

[39] https://childrenshealthdefense.org/wp-content/uploads/sandri-birnbaum-amicus-motion-and-brief-correct-final-8-6-2020.pdf#page=20.

[40] https://www.iarc.who.int/wp-content/uploads/2018/07/PORTIER_Bio.pdf; https://pubmed.ncbi.nlm.nih.gov/27656641/.

[41] https://childrenshealthdefense.org/wp-content/uploads/rf-2016-portier-consensus.pdf#page=1.

[42] http://www.icems.eu/docs/Bios_Blackman.pdf.

multiple pulsation effects[43] and treatment using RF/EMF.[44] He is part of the BioInitiative Working Group and wrote the 2007 Report's section on pulsation and modulation;[45] *Dr. Alan Frey*,[46] a US navy funded scientist was the first to show non-thermal auditory effects and blood-brain barrier leakage. His studies tie pulsation to the aggravating effects of RF signals.

Electro-Sensitivity

23. Electro-sensitivity is the earliest reported and likely the most direct manifestation of RF/EMF-induced sickness. The condition, described by the appearance of mostly neurological symptoms caused by RF/EMF exposure, has been documented in the scientific literature for many decades, including by many US government and military studies and reports.[47] Many hundreds of studies

[43] https://www.emfanalysis.com/wp-content/uploads/2015/06/blackman-modulation-2009.pdf.

[44] https://pubmed.ncbi.nlm.nih.gov/28930547/.

[45] https://bioinitiative.org/wp-content/uploads/pdfs/sec15_2007_Modulation_Blackman.pdf.

[46] https://www.cellphonetaskforce.org/the-work-of-allan-h-frey/.

[47] https://childrenshealthdefense.org/rf-1971-navy-2300-studies/; https://electroplague.files.wordpress.com/2014/09/rf-microwave-radiation-biological-effects-rome-labs.pdf; https://www.orsaa.org/uploads/6/7/7/9/67791943/_____nasa_emf_field_interactions_-_observed_effects___theories_1981.pdf.

confirm the neurological effects and other symptoms[48] reported by those who suffer from the condition, and they have identified a genetic predisposition.[49]

24. The understanding of etiology, mechanisms and underlying injuries involved with this condition has significantly progressed since 2016. New diagnosis guidelines by leading EMF scientists and medical doctors have been developed and published [50,51] There are more known biomarkers for diagnosis.[52]

25. Professor Beatrice Golomb, MD PhD was to the first to show compelling evidence in a 2018 paper that the "mystery illness" (aka "Havana Syndrome") suffered by some US diplomats in Cuba and China was likely caused by pulsed RF/EMF.[53] She concluded that the diplomats suffer from Electro-sensitivity, which she refers to as Microwave Illness.[54]

[48] https://childrenshealthdefense.org/wp-content/uploads/rf-2018-neurological-lai-book-chapter.pdf.

[49] https://pubmed.ncbi.nlm.nih.gov/24812443/.

[50] https://www.degruyter.com/document/doi/10.1515/reveh-2016-0011/html.

[51] https://www.womenscollegehospital.ca/assets/pdf/environmental/Preliminary%20Clinical%20Guidelines%20%20for%20EHS.pdf.

[52] https://emf-experts.news/wp-content/uploads/2020/09/Belpomme-EHSdiagnosis-Study2020.pdf.

[53] https://pubmed.ncbi.nlm.nih.gov/30183509/.

[54] "Microwave" is a subclass of RF, and generally comprises frequencies between 300 MHz and 300 GHz. From an FCC nomenclature perspective, the "microwave" portion is anything above 890 MHz.

26. The US State Department asked the National Academy of Sciences, Engineering and Medicine (NAS) to analyze and provide input on the diplomats' "mystery illness." Prof. Golomb was invited to present to the committee.[55] In December 2020, The NAS report was published. [56] It concluded that many of the observed symptoms are consistent with the scientific literature on the effects of pulsed RF exposure, and that it is likely the cause of the diplomats' sickness.

27. Not all the diplomats became ill, only some, similar to Electro-sensitivity in the general population. Human physiology varies, and as with other stressors, some people get sick sooner than others or at lower levels of exposure than others, and some will never become ill.

28. Prof. Golomb's paper shows Electro-sensitivity can occur as the byproduct of wireless technology, whether the result of an intentional assault through a pulsed RF/EMF weapon or by commercial wireless technology. The harm caused by these weapons comes primarily from the pulsation, not the intensity of the RF/EMF. Indeed, it would be possible for RF/EMF weapons to operate entirely within FCC guidelines and still cause harm from pulsation. Pulsation is also a driver of the harm flowing from commercial RF/EMF-emitting

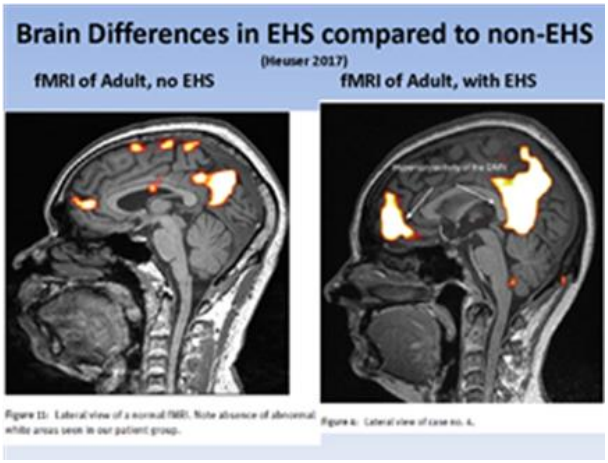
[55] https://childrenshealthdefense.org/wp-content/uploads/rf-2018-golomb-diplomats-3.pdf; https://childrenshealthdefense.org/wp-content/uploads/rf-nas-golumb-email.pdf.

[56] https://www.nap.edu/read/25889/chapter/1.

technology, including smart meters. Nevertheless, FCC rules regarding wireless technology ignore their effects.

29. Electro-sensitivity is not a mere "sensitivity." Studies have shown that the symptoms indicate severe physiological injuries associated with exposure to RF/EMF.[57]

30. A 2017 functional MRI study observed brain injury in persons with Electro-sensitivity.[58] The scans for each of the 10 subjects had similar abnormalities, all resembling those flowing from traumatic brain injury. The diplomats had the same abnormalities. This injury indicates impaired blood flow in certain regions of the brain.



[57] https://pubmed.ncbi.nlm.nih.gov/26613326/.
[58] https://pubmed.ncbi.nlm.nih.gov/28678737/.

31. A 2020[59] and a 2015[60] papers confirm the blood flow effects and show additional injuries. They are based on a study of 700 people with electro-sensitivity showing the subjects suffered from permeability of the blood-brain barrier, depressed melatonin levels, oxidative stress and aggravated auto-immune response. These effects were shown to be connected to RF exposure[61]. In CHD's case against the FCC, the court specifically mentioned that the FCC failed to respond to the evidence showing these effects.[62]

32. Those who want to propagate this technology have consistently generated perceived "controversy" as a method to deny Electro-sensitivity. They do so by funding negative subjective-perception provocation studies so they can claim that it is psychological or fear-induced (the "nocebo effect"). These studies suffer from numerous fatal design flaws.[63]

33. The most ironic design flaw in these studies is that they do not control for the nocebo effect, which is a prerequisite to the validity of any provocation

[59] https://emf-experts.news/wp-content/uploads/2020/09/Belpomme-EHSdiagnosis-Study2020.pdf.

[60] https://pubmed.ncbi.nlm.nih.gov/26613326/.

[61] https://bioinitiative.org/wp-content/uploads/pdfs/sec01_2012_summary_for_public.pdf#page=10; https://bioinitiative.org/table-of-contents/.

[62] *Envtl. Health Tr. v. FCC*, Nos. 20-1025, 20-1138, 2021 U.S. App. LEXIS 24138, at *12-*16 (D.C. Cir. Aug. 13, 2021).

[63] Many of those provocation studies were heavily funded by mobile phone carriers and led by James Rubin PhD, a psychologist (not EMF expert).

study. Then they conclude that the symptoms are likely a result of a nocebo effect.[64]

34. Another primary flaw in these studies is the illogical assumption that all people with Electro-sensitivity should be able to immediately "detect" when the RF signal is on/off. But those affected do not typically "sense" radiation. They develop symptoms that take time to appear and subside. There are many other flaws. Nevertheless, properly conducted studies without predetermined agenda show that some sufferers can detect the signal.[65]

35. Subjective-perception provocation studies are considered the worst science because they can be easily manipulated.[66] Industry uses these studies to produce the required results to divert attention from hundreds of high-quality peer-reviewed credible studies that do not depend on subjective-perception and confirm the symptoms people develop, the corresponding physiological injuries and established causal mechanisms.[67, 68]

[64] https://www.bmj.com/content/bmj/332/7546/886.full.pdf.

[65] For example, a large scale study by the Dutch government, known as the TNO study: https://childrenshealthdefense.org/wp-content/uploads/rf-electrosensitivity-provocation-tno.pdf.

[66] https://ecfsapi.fcc.gov/file/7520940903.pdf#page=25.

[67] https://childrenshealthdefense.org/rf-2018-Golomb-Diplomats-2/#page=9.

[68]https://childrenshealthdefense.org/rf-2014-electrosensitivity-dr-blythe/.

36. It is important to emphasize that while widely quoted and used to deny Electro- sensitivity, subjective-provocation studies are not used to diagnose any condition and are definitely "not suitable to disprove causality."[69] A person's inability to detect the pathogen that causes the reaction does not mean the individual is unaffected by the pathogen. "Human RF-detector" is not a mandatory symptom for Electro-sensitivity.

Smart Meters' Effects

37. Beyond individual predisposition, the appearance of adverse effects can depend on signal intensity, exposure duration; specific frequencies involved; exposure to multiple frequencies and sources which create high exposure variability; on-off pulsation and sharp "peaks and valleys."

38. Expert smart meter testing indicates there are three primary RF exposure issues.[70, 71, 72,73] First, the RF antennas within the meter send usage data and communicate with other meters and smart devices. They wirelessly emit

[69] https://childrenshealthdefense.org/wp-content/uploads/rf-2016-europaem-guidelines.pdf #page=11.

[70] https://childrenshealthdefense.org/wp-content/uploads/pa-amicus-sage-smart-meters.pdf.

[71] https://childrenshealthdefense.org/wp-content/uploads/rf-pa-amicus-engineer-expert-erik-anderson-report.pdf.

[72] https://childrenshealthdefense.org/wp-content/uploads/pa-amicus-isotrope.pdf.

[73] https://childrenshealthdefense.org/wp-content/uploads/pa-amicus-bathgate-pa-smart-meters.pdf.

intensely pulsed RF/EMF. Second, these antennas' RF emissions also conduct over the home electric wiring,[74] transforming the entire house into a "repeater" antenna.

39. Finally, the switch mode power supply (SMPS) creates RF frequencies as a byproduct of the AC/DC conversion process. The traditional analog meters used for decades do not have SMPS and do not create these emissions. SMPS-generated emissions are typically in the range of 2-150 KHz. They enter the house's electric wiring and then radiate RF in various parts of the house. Digital meters also use SMPS; therefore, they too create RF frequencies, even though they do not have transmitting RF antennas.

40. As noted, the FCC admitted there are neurological effects from non-thermal RF emissions[75] and its admission applies to frequencies in the kilohertz range created by the SMPS. The symptoms the FCC recites are similar to those reported by those who assert adverse effects from smart meters including tingling, shock, pain, or altered behavior due to excitation of tissue in the body's peripheral nervous system.[76] The FCC explained that the presence of these frequencies outside the body induce "internal electric fields" within the human body.

[74] https://childrenshealthdefense.org/wp-content/uploads/pa-amicus-isotrope.pdf.

[75] *Proposed Changes in the Commission's Rule Regarding Human Exposure to Radiofrequency Electromagnetic Fields; Reassessment of Federal Communication Commission Radiofrequency Exposure Limits and Policies*, ¶¶122-124 & nn. 322-335, 34 FCC Rcd 11687, 11743-11745 (2019).

[76] FN. 328, p.58.

41. A single smart meter antenna can emit up to 190,000 short but intense RF pulses (bursts/spikes) each day to transmit the usage data to the utility. These bursts can be two and a half times above the FCC's limits, if you do not apply the 30-minute "averaging" used in the FCC testing. The D.C. Circuit questioned[77] this averaging and the FCC proposes to abandon it, at least in part.[78] Depending on how close the meter is to occupied space within a home, a smart meter can cause very high intensity RF/EMF exposures.

42. People in proximity to a smart meter are at risk of significantly high aggregate whole-body exposure to RF/EMF. This is especially true regarding people living near multiple meters mounted together in an apartment complex or those who have a utility collector meter installed on their home which relays RF signals of up to 5,000 homes.[79] The cumulative 24/7 exposure is never measured but undoubtedly harmful, at least to some.

43. Studies have consistently shown that the pulsing is a major element in the creation and/or aggravation of effects from RF exposure. It is possibly more

[77] *Envtl. Health Tr. v. FCC*, Nos. 20-1025, 20-1138, 2021 U.S. App. LEXIS 24138, at *12 (D.C. Cir. Aug. 13, 2021).

[78] *Proposed Changes in the Commission's Rule Regarding Human Exposure to Radiofrequency Electromagnetic Fields; Reassessment of Federal Communication Commission Radiofrequency Exposure Limits and Policies*, ¶¶122-124 & nn. 322-335, 34 FCC Rcd 11687, 11743-11745 (2019).

[79] https://childrenshealthdefense.org/pa-amicus-sage-smart-meters/#page=3.

important than the radiation levels.[80] EMF-based medical treatments, for example, recognize the higher bio-active nature of pulsation; they purposefully pulse the signal to obtain a higher biological response.

44. The effects of continuous exposure and the on/off pulsation effects were shown in a 2011 study.[81] The study tested a physician with Electro-sensitivity. She developed temporal pain, headache, muscle twitching, and skipped heartbeats within 100 seconds after each signal exposure. The study showed that the symptoms appeared in response to the on-off pulsing of the signal rather than the presence of a continuous EMF field or its intensity. "EMF hypersensitivity can occur as a bona fide environmentally inducible neurological syndrome."

45. The energy emitted by the RF antennas and from the operation of the SMPS enters the wiring system through "high variability" spikes in various RF frequencies. This has an on/off effect on the body. Studies have shown that the body is especially sensitive to "high variability" emissions.[82]

[80] https://bioinitiative.org/wp-content/uploads/pdfs/sec15_2007_Modulation_Blackman.pdf; https://bioinitiative.org/wp-content/uploads/pdfs/sec15_2012_Evidence_Disruption_Modulation.pdf.

[81] https://www.stopumts.nl/pdf/McCarty%20Marino%202011%20EMF%20ES%20&%20neurological%20syndrome%20Int%20J%20Neurosci%20July.pdf.

[82] https://childrenshealthdefense.org/wp-content/uploads/rf-2015-Panagopoulos-variability-effects.pdf.

Conclusion

46. Anyone who claims smart meters cannot produce the symptoms described by the customers is ignorant of the FCC's recent admission. They either do not understand or are misrepresenting the science on biological and adverse effects from pulsed RF/EMF. Many have reported getting ill following the installation of these smart meters. Considering the way smart meters operate and the multitude of complex emissions they create, it is no wonder. Forcing these meters on people who have become affected by RF/EMF is unconscionable. Those with Electro-sensitivity and others who are affected by RF/EMF must be allowed to secure analog meters because it is the only type of meter that does not cause or worsen their condition.

Respectfully Submitted,

Scientists Statement Signatories

Professor David O. Carpenter, MD, Professor of Environmental Health Sciences, and Director, Institute for Health and the Environment at the University of Albany, a collaborating center for the World Health Organization (WHO). Dr. Carpenter is a Harvard trained public health expert who focuses on the study of environmental causes of human disease with expertise in electrophysiology, low-frequency electromagnetic field and radiofrequency (RF) radiation bioeffects. He was Chairman of the Neurobiology Department of

Armed Forces Radiobiology Research Institute at the Defense Nuclear Agency in Washington DC; the Director of Wadsworth Center for Laboratories and Research of the New York State Department of Health; and Executive Secretary of the NY State Power Line Project regarding health effects associated with exposure to EMFs. After the project concluded, he became spokesperson for NY state on all matters associated with EMFs. He is the Co-Editor of the BioInitiative: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields. Dr. Carpenter has authored more than 400 scientific papers.

Professor Igor Belyaev, DSc, Head, Department of Radiobiology; Cancer Research Institute, Biomedical Research Center, Slovak Republic. He has an MSc. Degree in Radiation Physics and Dosimetry; PhD in Radiobiology; and DSc. degree in Genetics. He was an Associate Professor of Toxicological Genetics at the Stockholm University, Sweden, as well as a senior research scientist and group leader in the departments of Radiobiology, Molecular Genome Research, Genetic and Cellular Toxicology, Genetics, Toxicology and Microbiology. He is now or formerly a member of: The Working Group of the International EMF Project of the World Health Organization; the Working Group for the evaluation of RF carcinogenicity of the International Agency on Research in Cancer (IARC); the Swedish National Committee for Radio-Science; the Russian National Committee on Non-Ionizing Radiation Protection; the EMF Working Group of the European Academy for Environmental Medicine (EUROPAEM). He serves as Associate Editor for the International Journal of Radiation Biology and on the Editorial Board of Electromagnetic Biology and Medicine. He published over 100 scientific papers and was awarded by the Bioelectromagnetics Society for the most influential

paper in Bioelectromagnetics 2006-2010. He is a member of the BioInitiative Working Group and authored the BioInitiative's 2012 Section on the effects of Pulsation and Modulation.

Professor Beatrice Golomb, MD, PhD, Professor of Medicine at the University of California, San Diego. She also leads a research group which focuses on the relation of oxidative stress and mitochondrial function to health, aging, behavior, illness, environmental and medication effects, nutrition, and bioenergetics. She served as a primary care doctor of veteran patients for over 15 years. She is known for her work on Gulf War Illness, statins and placebos and for her 2018 paper "*Diplomats' Mystery Illness and Pulsed Radiofrequency/Microwave Radiation*" which concludes, "Reported facts appear consistent with pulsed RF/MW as the source of injury in affected diplomats." She was invited to present to the National Academy of Sciences about these findings. She has published 136 scientific papers.

Professor Reba Goodman, PhD, Professor Emeritus in Clinical Pathology at Columbia University. Dr. Goodman received an MA and a PhD in Developmental Genetics from Columbia University. She has authored a great many studies, including at least 76 studies on effects of electromagnetic fields. Early on, in her paper in Science entitled "*Pulsed electromagnetic fields induce cellular transcription*," (1983), she showed how even weak, pulsing electromagnetic fields could modify biological processes.

Professor Lennart Hardell, MD, PhD, is a retired Professor of Oncology and Cancer Epidemiology, from Örebro University Hospital in Sweden. Dr. Hardell continues his work through his involvement with the Environment and Cancer Research Foundation. His research focus has been the environmental

risk factors for cancer. Prof. Hardell has been awarded several scientific prizes for his research. In recent decades his research focused on the effects of RFR exposure, especially on mobile phones and the risk of brain tumours. The research by the Hardell group influenced IARC's 2011 classification of radiofrequency radiation as a possible 2B carcinogen. Dr. Hardell was also a member of IARC's evaluating group. He has published more than 350 peer-reviewed scientific papers, including many on the biological effects of electromagnetic radiation.

Professor Paul Héroux, PhD, Director of the Occupational Health Program, Faculty of Medicine, McGill University, Canada. Dr. Heroux is a toxicologist with a PhD in Physics. He teaches courses at McGill University about the adverse health effects of EMFs. He has published 42 scientific papers, 27 of them on the effects of EMFs. He also authored several text books. His most recent paper is "*Adverse health effects of 5G mobile networking technology under real-life conditions*." (Toxicol. Let 2020). He is a member of the BioInitiative Working Group and was a member of the committee appointed by the New Hampshire legislature to review the effects of 5g and wireless technologies.

Professor Olle Johansson, PhD, retired associate professor at the Karolinska Institute, Department of Neuroscience, and head of The Experimental Dermatology Unit from the Karolinska Institute, and the Royal Institute of Technology, Stockholm, Sweden. He has published more than 800 papers, conference reports, book chapters, commentaries, and debate articles. His main focus was basic and applied neuroscience. Starting in 1977, his research focused on the adverse health and biological effects of man-made pulsed RF-

based wireless technologies. He has published more than 330 papers in that field, many with a focus on the effects on the skin.

Professor Anthony B. Miller, MD, CM, FRCP, FRCP(C), Professor Emeritus, Dalla Lana School of Public Health, University of Toronto. He was the Director, Epidemiology Unit, National Cancer Institute of Canada; Professor, and Chair of the Department of Preventive Medicine and Biostatistics, University of Toronto; Special Expert in the Division of Cancer Prevention, US National Cancer Institute; Senior Epidemiologist, International Agency for Research on Cancer; Head, Division of Epidemiology, German Cancer Research Centre; Associate Director Research, Dalla Lana School of Public Health, University of Toronto. In 2019 he was elected a Member of the Order of Canada for his work on Cancer Control. He has published 354 peer-reviewed papers. In the past few years he has focused on RF/EMF effects. He has published six papers on the topic of RF/EMF and has presented in many conferences on this issue.

Professor Martin Pall, PhD, Professor Emeritus of Biochemistry and Basic Medical Sciences at Washington State University. Dr. Pall is a published and widely cited scientist on the biological effects of electromagnetic fields and speaks internationally on this topic. His expertise includes how RF/EMF impacts the electrical systems in our bodies with a focus on the VGCC injury mechanism. He published seven papers showing that pulsed RF/EMF interferes with the operation of the voltage-gated calcium channel, a sensor that is responsible for the entry of calcium into our cells.

Alfonso Balmori, BSc, M.S.Ed, is a world renowned biologist, with a master in environmental education. He has published more than 50 scientific papers published in peer-reviewed journals on environment, ecology, and biodiversity conservation issues. He is known worldwide for his work on the effects of electromagnetic RF radiation on animals and plants, mainly on the effects of cell towers. His papers were quoted in the US Department of the Interior 2014 letter concluding that cell towers harm migratory birds and that the FCC guidelines are 30 years out of date. This letter was referenced by the Court in the Remand Guidelines decision.

Professor Kent Chamberlin, PhD, Past Chair and Professor Emeritus, Department of Electrical and Computer Engineering, University of New Hampshire. The focus of his research has been Computational Electromagnetics. He also investigated the interaction of electromagnetic fields and the human body, which resulted in seven publications. He was appointed by the Chancellor to the New Hampshire Commission to Study the Environmental and Health Effects of Evolving 5G Technology, which concluded that 5G and pulsed RF-based wireless technologies are harmful to health.

Dr. Priyanka Bandara, PhD, is a scientist with a PhD in Biochemistry and Molecular Genetics. She served as senior manager of a research team and a clinical team at Westmead Children's Hospital, Australia. She then became involved in environmental health and disease prevention. Her current focus is the impact of pulsed RF-based wireless technologies on health. Dr. Bandara has published 13 papers on the effects of electromagnetic radiation in international scientific journals, and has presented at major conferences and academic institutions. She serves as Associate Editor of the Journal of the Australasian

College of Nutritional and Environmental Medicine and as peer-reviewer for several international medical journals.

Dr. Frédéric Greco, MD, is a practitioner in the neuro-intensive care unit at the University Hospital of Montpellier, France, and teaches at the university's Faculty of Medicine. He is a member of the working group set up by the French government's health department to implement national recommendations for the medical care of electrosensitive people. He is the principal investigator of the ongoing clinical study "*Migraine in Electrohypersensitive Patients.*"

Dr. Yael Stein, ***MD,*** is head of the Electromagnetic Radiation Research Clinic at Hadassah Medical Center, Jerusalem, Israel, focusing on electro-sensitivity diagnosis and treatment. She is a certified Anesthesiologist at Hadassah Medical Center and researcher at the Hebrew University Medical School. She also specializes in Pain Medicine and is currently completing an MPH at the Hebrew University School of Public Health. She has extensive experience in research on the health effects of electromagnetic fields on humans from the epidemiologic and biological/medical points of view, and has worked in this field since 2007.

Cindy Sage, MA, is an environmental sciences consultant and researcher on electromagnetic fields and radiofrequency radiation. She is the founder of the international BioInitiative Working Group, and the co-editor of the BioInitiative Reports (2007 and 2012). Ms. Sage has provided expert testimony and scientific testimony on non-ionizing radiation to the Federal Communications Commission, the US Food and Drug Administration, the California Public Utility Commission, the European Commission's Directorate of Public Health - Scientific Committee on Emerging and Newly Identified Health Risks

(SCENIHR). She has advised numerous state and federal agencies on wireless health risks, smart meter emissions and safety limit inadequacies. She has published 24 peer-reviewed papers on the evidence of health risks from electromagnetic fields and radiofrequency radiation, and she studies the effects of smart meters.

Dr. Cindy Russell, MD, is a surgeon and Executive Director of Physicians for Safe Technology. Since 1995, she has been a member of the Santa Clara County Medical Association Environmental Health Committee. Dr. Russell has published several peer-reviewed papers on the impacts of wireless technology on human health and the environment with hundreds of scientific references. Her focus continues to be disease prevention and environmental health through toxics reduction.

Dr. Mary Redmayne, PhD, is a researcher, educator and consultant with Adjunct Research Fellowships at Victoria University of Wellington and at Monash University, Melbourne. Her research interests and experience include children's use of wireless devices and their effect on health and well-being. She has many peer-reviewed papers, with at least 22 on health and electromagnetic fields and RF radiation. She lectures on these issues both in New Zealand and internationally. Dr. Redmayne is a Participating Member of Standards Australia Committee on Human Exposure to Electromagnetic Fields, a technical committee responsible for standards settings. She is a scientific advisor for the Oceania Radiofrequency Scientific Advisory Association, and for the Building Biology and Ecology Institute, NZ.

ENGINEER REPORT

IN THE SUPREME COURT OF PENNSYLVANIA
MIDDLE DISTRICT

RE: No. 34 MAP 2021, *Povacz, M, et al. v. PUC*
Associated Case(s):
35 MAP 2021 Consolidated
36 MAP 2021 Consolidated
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38 MAP 2021 Consolidated
39 MAP 2021 Consolidated
40 MAP 2021 Consolidated
41 MAP 2021 Consolidated
42 MAP 2021 Consolidated
43 MAP 2021 Consolidated
44 MAP 2021 Consolidated
45 MAP 2021 Consolidated

Engineer Report – Smart Meters Operation & RF Emissions

Purpose of Statement

1. My name is Erik S. Anderson, P.E. I am a forensic electrical engineer working on root cause failure analysis of matters that cause loss of property, personal injury, and loss of life.

2. I am submitting my expert opinion regarding the operation of smart meters and digital meters and in support of the *amici*.

Credentials

3. I am the president of an engineering firm that offers professional engineering and investigation services across the United States and manufactures current transformers.[83]

4. It is my expert opinion that these smart and digital meters cause a significant amount of radio-frequency (RF) "noise" on homes' electric wiring system, thereby transforming them into a whole house antenna.

5. I have a Bachelor's of Science degree from North Dakota State University, Fargo, North Dakota, in Electrical and Electronic Engineering. I am a licensed Professional Engineer in the states of Minnesota, Illinois, Arizona, Wisconsin, Indiana, Iowa, New Mexico, Texas, Louisiana, California, Kentucky, Michigan, and Nevada. I am a licensed Class A Master Electrician in the state of Minnesota. I also hold a Private Investigator License in Arizona and I am a Certified Fire and Explosion Investigator.

6. I have 30 years of experience as a forensic engineer. I have over 20 years of experience of design and manufacture of current transformers. I have been involved in many thousands of matters concerned with determining the root cause of failures of electrical devices that may have caused a loss of property, personal injury, or loss of life. I have given expert witness testimony in approximately 113

[83] https://www.aenpi.com/

separate matters. I personally have tested smart meters and given expert testimony regarding their operation and emissions. My *curriculum vitae* is attached (Exhibit 1).

7. As a designer and manufacturer of transformers, their operation is one of my main areas of expertise. Switch Mode Power Supply modules used by smart and digital meters are merely another type of transformers. I have investigated the involvement of the operation of the Switch Mode Power Supply in these meters and their involvement in the creation of radio frequency (RF) emissions.[84]

8. My expert determination principally relies on my own smart meter testing. I do also rely on reviews by other experts, their' testing reports and my professional education and vast experience.

Smart Meter Operation

9. Smart meters create intense exposure to pulsed radio frequencies (RF) in a few ways. RF antennas are embedded within the smart meter to transmit data usage to utility companies and/or to communicate with other smart meters or with other "smart" devices like home thermostats. These antennas emit pulsed RF radiation. The various radiofrequencies emitted by these antennas also conduct through the home electric wiring. RF "wire conducted" frequencies come also

[84] An explanation of what are radio frequencies and about the electromagnetic spectrum can be found in the scientists' statements which is also attached to the *amicus* brief as well as in the *amicus* brief itself.

from the conversion process from alternating current (AC) to direct current (DC) handled by the Switch Mode Power Supply (SMPS).[85] Non-transmitting digital meters also use SMPS, and therefore they too create RF, even though they do not contain a transmitting RF antenna for communications. These radio frequencies are transmitted on the residence's electrical distribution system and conduct over the internal wiring, thereby turning the home into a whole-house antenna.

RF Emissions from the Transmitting Antennas

10. The RF antennas that wirelessly transmit the consumer's electrical power usage data to the utility company use frequencies in the 900 MHz & 2,400 MHz range. These emissions are intense and can occur often, up to 190,000 times a day.[86] From my experience and testing done by others, these meters transmit more times than the electric companies report. This can easily be shown by measuring the emissions with a simple RF meter.

11. "Isotrope Wireless,"[87] which provides industry and municipalities with design, specification, evaluation, and construction support for wireless facilities, tested smart meters in three houses.[88] This testing showed that RF emission from the smart meters' transmitting antennas could be detected

[85] In some meters the conversion is done using capacitators instead of SMPS.
[86] https://childrenshealthdefense.org/pa-amicus-sage-smart-meters/.
[87] https://www.isotrope.im/about-2/.
[88] https://childrenshealthdefense.org/pa-amicus-isotrope/.

throughout the house and were "well above" the ambient RF radiation levels.[89] These pulsed RF emissions exceed the absolute energy output limits[90] stated in Federal Communications Commission (FCC) guidelines (if the emissions are not averaged over a 30-minute exposure as prescribed by those guidelines).[91]

RF from Wireless Antennas Enter the House's Electrical System

12. The Isotrope testing also showed that the house's electrical wiring conducted substantial levels of the RF emissions at 915 MHz – the communications-related frequency for that meter[92] – and this frequency was then radiated from outlets (electrical power delivery points) and along the house wiring (branch circuitry).

[89] https://childrenshealthdefense.org/pa-amicus-isotrope/#page=12.

[90] https://childrenshealthdefense.org/pa-amicus-sage-smart-meters/#page=3.

[91] On August 13, 2021, the Court of Appeals for the DC Circuit ruled that the FCC's 2019 decision that its guidelines adequately protect the public's health are arbitrary, capricious and not evidence-based. The Children's Health Defense is a Petitioner in this case. *Envtl. Health Tr., et al v. FCC*, Nos. 20-1025, 20-1138, 2021 U.S. App. LEXIS 24138 (D.C. Cir. Aug. 13, 2021). The opinion specifically questioned whether the FCC's testing procedures adequately captured the effect of pulsation or modulation. 2021 U.S. App. LEXIS 24138, *12, *29.

[92] Smart meters use a variety of frequencies for communications depending on the manufacturer's choice. PECO's meters operate at around 901 MHz. They also contain a "Zigbee" antenna that can be turned on and then communicate with nearby wireless smart devices. Zigbee uses 2400 MHz band.

13. Thus, the pulsed RF emissions from the smart meter's transmitting antenna not only enter the house wirelessly but also enter into and are conducted along the house's electrical wiring

RF "Noise" From the Switch Mode Power Supply

14. Other RF frequencies besides the RFs from the transmitting antennas, also enter the house electric system. In my testing I have witnessed and analyzed smart meters' effects on the incoming electrical power voltage waveform. These frequencies are a byproduct of the AC/DC conversion process which is done by the Switch Mode Power Supply (SMPS). The conversion process is necessary because utility service employs alternating current whereas the electrical components in smart meters use direct current.[93]

15. SMPS converts the 240 Volt AC power coming into the meter from the main power transformer, into the much lower DC voltage that the electronic devices require to function. The rapid back-and-forth conversion process used to remove the "alternating" aspect creates *unintended* RF frequencies. The on/off, back-and-forth, pulses can occur up to 150,000 times per second, which means frequencies of up to 150,000 Hz (150 KHz[94]), are created. These kilohertz

[93] Smart meters also rely on AC for some of the non-electronic functions they perform.

[94] 1,000 Hz is a kilohertz ("KHz"). 1,000,000 Hz is a megahertz ("MHz"). 1,000,000,000 Hz is a gigahertz ("GHz").

frequencies are within the RF band of frequencies.[95] Most of the observed "noise" spikes are in the range of 2 to 50 kHz (2,000 to 50,000 Hz).[96] The switching RF "spikes" are variable, and they are being imposed on the 60 Hz house electricity wave,[97] creating significant unintended RF "noise."

16. These frequencies are present all the time but are worse when less electricity is being used (e.g., at night) and when the smart meter's electronics need more power, for example, when transmitting RF bursts to the utility. These RF transmission bursts cause spikes over the electric wiring, and they are created because the SMPS has to suddenly supply more DC power.

Digital Meters Use SMPS and Therefore Also Created Unintended RF

17. Digital meters also use SMPS. Therefore, even though they do not contain an RF communications antenna, the AC/DC conversion process creates significant and variable RF spikes over the electrical wiring, which is then radiated into the house.

[95] FCC defines RF as frequencies between 3 KHz – 300 GHz.

[96] Finding of Fact 87 in *McKnight v. PECO* (once of the cases on hold below) states that "PECO's AMI meters do not produce 5 Hz, 3 kilohertz, or 5 megahertz fields. (April 13, Tr. 75-76)." While I have some doubt this is actually so, this finding does not rule out emissions in the other frequencies I list.

[97] Electricity comes to the house at a frequency of 60 Hz.

Analog Meters Do Not Have SMPS and Do Not Create RF Spikes

18. In contrast, unlike wireless smart meters and digital meters, analog meters do not contain an SMPS or other electronic components that create unintended RF frequencies. No AC/DC conversion is necessary, and unlike smart and digital meters, analog meters have a separate wired grounding rod that eliminates much of the "noise" that may come from the energy feed.

19. The images below compare a smart meter like that used by PECO[98] with an analog meter. The red waveform is the 60 Hz house electricity frequency. The yellow waveform indicates the RF frequencies imposed over the 60 Hz. **Image 1**shows that an analog meter does not create RF spikes. **Image 2** shows the smart meter causing significant RF spikes "noise" over the 60 Hz frequency house electric wiring system. [99]

[98] https://childrenshealthdefense.org/wp-content/uploads/pa-amicus-bathgate-pa-smart-meters.pdf. Pages 17-18.

[99] https://childrenshealthdefense.org/wp-content/uploads/pa-amicus-bathgate-pa-smart-meters.pdf#page=14.

Image 1: Analog Meter – No RF Spikes

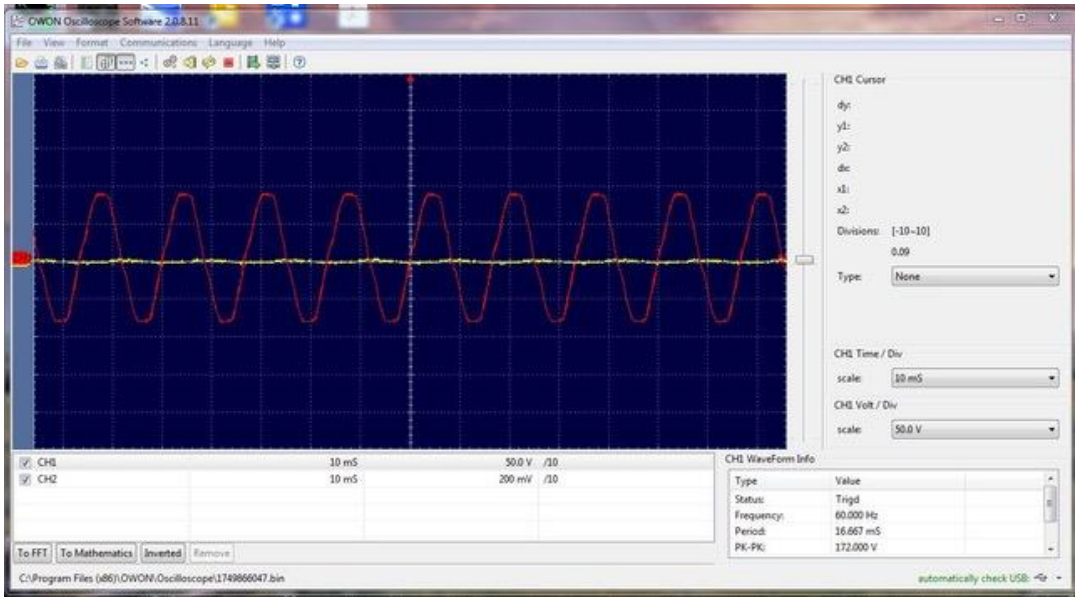
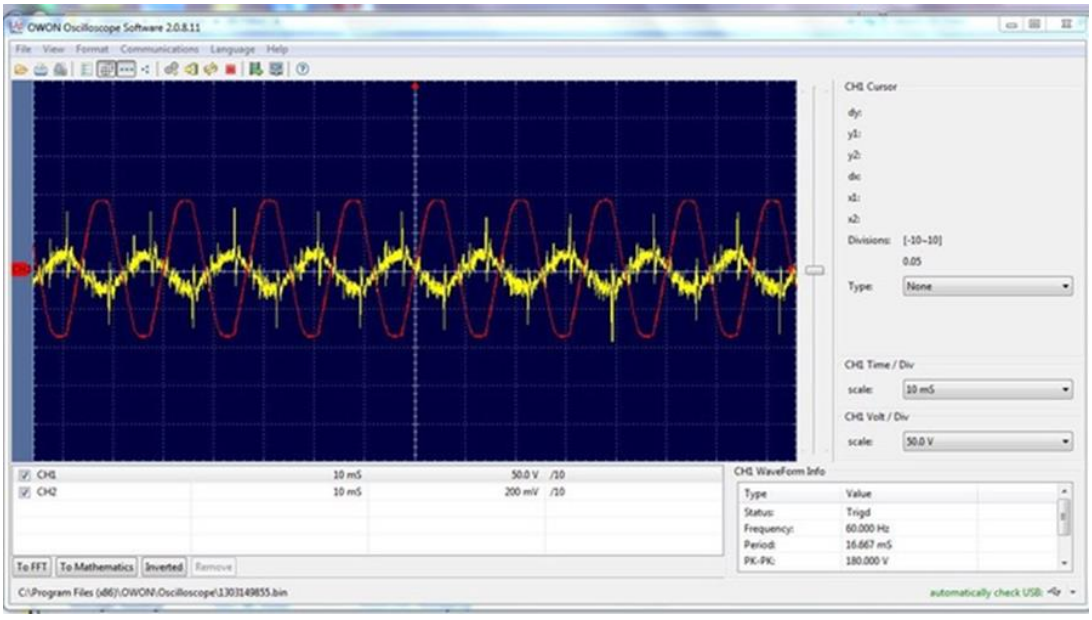


Image 2: Smart Meter – Intense RF spikes.



My Smart Meter Testing:

20. My test setup consisted of a meter socket enclosure suitable for 120/240 Volt, single-phase, three-wire connection. A smart meter, Landis & Gyr,

Gridstream RF, Focus AXR-SD, Form 2S, CL200, 240 V, 3 W, 60 Hz, power meter was used.[100] The voltage waveform was captured with a Fluke 215C Scopemeter. One input to the Scopemeter was connected to the incoming voltage, 120 Volts-to-Ground, unfiltered. The other input to the Scopemeter was connected to the incoming voltage with the 60 Hz waveform filtered out. A radiofrequency emissions meter was also used to indicate when an RF signal increase was detected.

21. When the test equipment was connected to the incoming power, the waveform of the incoming electrical power was observed. The 60 Hz signal was recognized as the dominant frequency with some noise observed on the waveform. The 60 Hz was filtered out to analyze the noise on the signal.

22. When the smart meter was not connected, the noise level was approximately 45 milliVolts at its peak. When the smart meter was added to the circuit, the noise on the 60 Hz sine wave was noticeably larger, approximately 85 milliVolts. This is nearly double the amount of noise than without the smart meter.

23. The dominant frequencies are in the range of 2 to 50 kHz. These are the frequencies that the "smart meter" generates when it is transmitting.

[100] PECO uses this meter, or one quite like it. R995a, 1046a.

Conclusion and Opinion

24. There is no doubt that smart and digital meters create pulsed RF emissions and these emissions, from the smart meters' antennas and the RF created by the SMPS, both enter the house's electric system. The result is that the entire house is transformed into a radiating RF antenna.

25. Any meter with a switch mode power supply will create RF frequencies in the Kilohertz range that enter the electrical wiring system of the house. Smart meters and digital meters inject significant levels of RF onto the home's electrical distribution system.

26. This report is based on information learned to date. I reserve the right to amend, clarify, or change my opinions based on more work or information learned.

Respectfully Submitted:

Erik S. Anderson, P.E.

ENGINEER REPORT – Exhibit 1

ANDERSON ENGINEERING OF NEW PRAGUE, INC.
9007 S. Third Street
Phoenix, Arizona 85042
Office: (602) 437-5455
Mobile: (952) 292-6416
Email: eanderson@aenpi.com

ERIK S. ANDERSON

Registered Professional Engineer

REGISTRATION:

Licensed Professional Engineer

State of Minnesota	1991	21471
State of Illinois	1999	062052733
State of Arizona	2003	39627
State of Wisconsin	2008	39418-006
State of Indiana	2008	PE.10809314
State of Iowa	2008	18758
State of New Mexico	2008	19001
State of Texas	2009	102714
State of Louisiana	2009	PE.0034787
State of California	2010	105359
State of Kentucky	2012	28492
State of Michigan	2013	6201060247
State of Nevada	2013	022690

Other Licenses:

Licensed Class A Master Electrician – State of Minnesota	1995	AM005344
Private Investigator – Arizona	2011	1615601
Private Detective – Illinois	2017	115.002549
Private Investigator – Minnesota	2019	PDC 2098
Certified Fire and Explosion Investigator (NAFI -CFEI)	2012, 2017	17853-9760

EDUCATION:

B.S. in Electrical and Electronic Engineering
North Dakota State University, Fargo, North Dakota, 1987.

Chemical Engineering Course Work
University of Minnesota, Minneapolis, Minnesota, 1981-1983.

CONTINUING EDUCATION:

Hazardous Materials: HAZWOPER: 40-hour worker 2008
Annual 8-Hr. HAZWOPER Refresher Course: 2009, 2010, 2011, 2012, 2013, 2014, 2015

Asbestos Awareness: 05/09, 3/14, 09/16, 01/2020

Annual Fire Investigation Seminar Instructor
Maricopa AZ: 04/08, 03/09, 03/12, 03/13

Minnesota Chapter IAAI Fire & Arson Conference
3/88, 3/89, 3/90, 3/01, 3/05, 3/06.

Instructor: Fire/Arson Level 3
Mesa, Arizona, 10/03.

Illinois Chapter IAAI Northern Zone Winter Seminar
Instructor: Electrical Appliance Fires, 2/03.

Completed Code & Code Change Class
Minnesota Electrical Association – National Electrical Code
1/99, 2/01, 1/03, 1/05, 1/07, 1/09, 1/11, 2/13, 5/15, 2/17, 3/19, 2/21

Illinois Chapter IAAI Fire Investigation Conference
Instructor: Forensic Electrical Engineering Principles & Practices, 9/99.

Graduate Course Work, University of Minnesota
Minneapolis, Minnesota, 1995-1997.

Master Electrician Course, Hennepin County Technical College, Eden Prairie, Minnesota 3/95.

Completed Designing Electrical Systems for Hazardous Locations University of Wisconsin-Madison, 4/92.

Completed Electrical Fires Accidental and Deliberate
Sponsored by Georgia Chapter of IAAI, 12/91.

Completed Fire and Arson Investigation Course,
Nebraska State Fire & Arson Investigators Conference, 10/87

EXPERIENCE:

01/05 - Present Anderson Engineering of New Prague, Inc., Phoenix, AZ
President & Forensic Electrical Engineer. Responsible for all aspects of business operations including engineering services to clients, product testing, fire investigation, and failure analysis.

Our case load also includes construction defect cases involving the evaluation of the workmanship of the electrical subcontractor and personal injury cases involving electric shock and/or electrocutions.

4/87 – 1/05 Anderson Engineering of New Prague, Inc., New Prague, MN
Electrical Engineer. Responsible to client for engineering services including product testing, fire investigation, and failure analysis.

Midwest Current Transformer, Division of Anderson Engineering of New Prague, Inc., New Prague, MN.
Designer, manufacturer, and quality control engineer of current transformers.

1/84 - 11/84 O.S. Anderson Engineering, Inc., New Prague, MN.
Research and Design Coordinator. Duties included work on transponder design for communications system through earth.

6/83 - 9/83 Koch Refinery, Southeast St. Paul, MN. Conducted ultrasound testing on oil refinery systems.

1981 & 1982 (Summers) O.S. Anderson Engineering, Inc., New Prague, MN.
Assistant Engineer. Designed software for and compiled data of E-fields generated by high voltage transmission lines, assisted in investigations of various cases involving questions of product liability.

PROFESSIONAL AFFILIATIONS:
Member Institute of Electrical and Electronic Engineers.
Member National Society of Professional Engineers.
Member Minnesota Society of Professional Engineers.
Member International Association of Arson Investigators.
Member National Fire Protection Association.
Member National Association of Fire Investigators.
Member American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

EXPERT TESTIFYING WITNESS:

Arbitrations:	02
Depositions:	91
Trials:	27
Arizona Corporation Commission	01

BUILDING BIOLOGY INSTITUTE
REPORT

IN THE SUPREME COURT OF PENNSYLVANIA
MIDDLE DISTRICT

RE: No. 34 MAP 2021, *Povacz, M, et al. v. PUC*
Associated Case(s):
35 MAP 2021 Consolidated
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43 MAP 2021 Consolidated
44 MAP 2021 Consolidated
45 MAP 2021 Consolidated

THE BUILDING BIOLOGIST INSTITUTE REPORT

General Statement

1. My name is Lawrence James Gust. I am the President of the Board of Directors of the Building Biology Institute (BBI).[1] I have a degree in electrical engineering and an MBA. I have been an environmental consultant for over 20 years and have trained hundreds of environmentally safer buildings consultants via the BBI.

2. The Building Biology Institute (BBI) is a 501(c)(3) non-profit corporation. BBI was founded in the US in 1993 and it follows the Principles of

[1] https://buildingbiologyinstitute.org/about/our-mission/

the Institute fur Baubiologie und Ecologie in Germany.[2] Our mission is to help meet the ever-increasing public demand for proven methods that secure homes, schools, and workplaces from toxic indoor air, tap-water pollutants, and hazards posed by electromagnetic fields ("EMF") and radiofrequency radiation ("RFR") exposure.

3. BBI offers three professional certifications: (1) Building Biology Environmental Consultant (BBEC); (2) Electromagnetic Radiation Specialist (EMRS); and (3) Building Biology New Build Consultant (BBNC). Each certification requires the participants to complete online courses, participate in a multi-day on-site seminar, undergo a mentored final project and pass various tests. To be listed as a practicing professional on the BBI website,[3] certified BBEC professionals must obtain approved continuing education credits.

4. Our trained RF/EMF mitigation consultants measure the electromagnetic fields and radiation at the site, provide a plan on how to mitigate these emissions and work with other professionals such as electricians and IT professionals to put in place the identified mitigating measures.

[2] https://www.ibo.at/en/

[3] https://buildingbiologyinstitute.org/find-an-expert/certified-consultants/electromagnetic-radiation-specialists/.

5. Most of our clients are people who are sick or have family members who have adverse reactions to RFR exposure. As with other environmental toxins, and according to doctors, avoidance is the main and most effective treatment for those who are affected. Our services help them mitigate exposures in their homes, so they are part of the medical regimen prescribed by doctors. Many physicians encourage their patients to contact building biologists to optimize their living environment.[4]

6. We have a unique perspective and specific protocols driven by our extensive science-based knowledge, methods as well as experience working with those who suffer. Every day we see the widespread sickness caused by wireless devices and infrastructure. We personally witness how devastating this sickness is. Most important, we know our methods significantly improve the health and well-being of those who must avoid RFR. Remediation efficacy is well documented and undeniable.

7. Our knowledge and experience will provide the court valuable and important information necessary to reach a just decision in this case.

Smart Meters

[4]https://www.womenscollegehospital.ca/assets/pdf/environmental/Preliminary%20Clinical%20Guidelines%20%20for%20EHS.pdf#page=18.

8. We often confront sickness caused or exacerbated by smart meters. Simply removing the meter often leads to immediate and consequential health improvement. Unfortunately, we also routinely witness intolerable suffering by those forced to have smart meters as a condition of service without any means to opt-out.

9. People can turn off their cell phones, they can turn off the Wi-Fi in the router and use hard-wired internet. They cannot turn off the smart meters and therefore are forced to be exposed to the toxin that caused them to be sick 24/7, in their home. It is a torture.

Demand increase correlates with exposure growth

10. There has been a significant increase in requests for our RFR mitigation services over the last 20 years. Wireless services were first commercialized for the mass market in the mid-1980s. Back then and for around 10 years RFR mitigation was a very small part of our work. But that began to change in the early 2000s. Demand for our services has skyrocketed. RFR mitigation is now the most frequently requested service in our portfolio and constitutes about 75% of what we do. BBI consultants have a hard time fulfilling the demand. This directly correlates with and is the clear result of with the exponential growth in public exposure to wireless related pulsed RFR from wireless devices and infrastructure. Pervasive and chronic exposure leads to

endemic sickness. We see it every day in our work, and it is devastating for those who are afflicted.

11. This increase in demand is also reflected in the number of professionals who are taking the certification course and become a certified "building biologist." Since we started to operate, 27 years ago, we have certified approximately 308 building biologists. Thirty percent of them, approximately 100, were certified in 2020/2021.

Collaborating With Treating Physicians

12. We collaborate with doctors whose patients suffer from electro-sensitivity. The only effective treatment is avoidance and in many cases the house is the cause or at least an aggravating factor for their patients' illness. Doctors refer their patients to us, as ensuring that the home environment of those affected is as clean as possible from pulsed RF radiation is critical for any improvement.

Human Consequences

13. The human dimension of electro-sensitivity is tragic. People with the condition call me and other building biologists in ever increasing numbers. In many cases, people who used the technology "normally" and had no medical issues suddenly become ill. They share with me the overwhelming and life-altering changes confronting them when they or their children become sick. They literally beg us to help them return to a normal life.

14. These people endure tremendous physical suffering. Frequent and debilitating headaches. Inability to sleep. Heart arrhythmia. Pain in extremities. Burning skin. Mental confusion, cognitive problems, and memory loss. Non-stop ringing in the ears. Persistent nosebleeds are also common, especially with children. For many the symptoms are disabling and prevent them from functioning. They endure social isolation. They cannot work, go or be anywhere. Their lives are becoming increasingly impossible. In addition, they have to deal with ignorant and cruel denial of their condition because their sickness is an inconvenient problem to those promoting wireless technology.

15. The problem is real and overwhelming. BBI's certified practitioners operate at ground zero. They alleviate the suffering of a rapidly growing number of people across the United States. Building Biologists often care for clients who are severely ill and desperately struggling simply to survive even in their own homes. For these individuals and their families, the implementation of mitigative measures recommended by BBI's certified consultants offer the first and last resort. For these clients and thousands like them, the services of Building Biologists are lifesaving.

16. Many of our clients are unable to work because places of employment are saturated with wireless devices. They are unable to drive to work because roadways are flanked by cell towers irradiating passing vehicles with very high and

ever-growing RF levels. They are unable to live in urban and suburban areas because houses are being irradiated by ever increasing numbers of cell phone antennas, neighbors' wireless devices and – as here – from utility smart meters.

17. However, when remediation reduces pulsed RFR radiation by shielding the residence, symptoms usually abate or reduce, depending on the initial power density and the overall ability of the shield.

RF Levels

18. The levels of pulsed RF radiation we measure (shown in power density) are usually well below the FCC guidelines. However, power density is still significantly millions and trillions of times above natural environmental levels,[5] and sometimes millions and more times higher than the levels that can cause adverse health effects reported in peer-reviewed research.

19. The FCC guidelines are not biologically-based and not evidence-based. The FCC guidelines do not address non-thermal effects or pulsation and they average exposure over 30 minutes (which hides the true biological response to exposure) and test for exposure from only one device. They do not protect from chronic long-term exposure or from exposure to multiple devices, radiation sources, frequencies, and modulations. They do not protect the public health, or at

[5] https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(18)30221-3/fulltext.

least not for a significant part of the population. Our clients are the evidence, and the growing sickness is a clear proof this is so.

20. The FCC's averaging does not account for pulsed digital signals occurring in milliseconds. Therefore, they vastly underate the power density (typically measured in milliwatts per square centimeter, or mW/cm^2) that the human body must deal with on account of unremitting exposure to pulsed, modulated radiofrequency radiation. We see the peaks and pulses hidden by averaging, and witness first-hand what it does to people. BBI practitioners measure the aggregate RF exposure on the human body when in clients' homes.

Shielding

21. Those affected by RF/EMF face a living hell. They cannot be or go anywhere. Their home is their only refuge. Even this refuge is constantly under threat, and many are required to shield their homes. Reducing RF levels enough to be effective is a costly process. Unfortunately, the expense prevents many people from effecting the best remediation plan or any plan at all.

22. Shielding is expensive because the shielding materials are metal based, as metal blocks radiation. For example, shielding a parent's queen size bed with an RF protection tent ranges from $1,250 to $1,700 depending on the shielding capability of the material. Shielding a child's single bed will cost between $1,000 to $1,400. Instead, it is possible to shield the bedroom itself by

painting the walls with RF protection paint and putting RF protection film on the windows instead of tenting the bed. The cost for an average 12’ x 12’ bedroom is $2,450. A family with two children would have to spend about $7,350.

23. Building Biologists focus on shielding sleeping areas because this is where people are most vulnerable to RF radiation. But this alone does not adequately protect people who are home all day.

24. Whole-house RF Radiation reduction requires painting the outside of the house and the inside ceiling on the top floor with an RF protection paint. The cost for 2,000 square feet is approximately $14,000. This cost is for two coats of paint. But with growing RF levels, three coats are often needed, so the cost is higher.

25. Metal reflects RF back into a shielded area. Therefore, whenever these materials are applied, a careful analysis is required to ensure the materials do not actually increase exposure. Shielding requires experts to do the job and this increases total cost.

26. People sick from environmental exposure should not be forced to be exposed in their home to the toxin that makes them severely sick. The considerable cost of creating a livable environment is unfairly shifted to the injured, who have no ability to recover from those who caused the injury.

Shielding & Smart Meters

27. Shielding materials attenuate the radiation, they do not entirely block it. Reducing exposure enough to have a salutary effect is becoming increasingly difficult because of the densification of wireless infrastructure including 5G, and because home devices are becoming more powerful.

28. Smart Meters are without a doubt one of the most significant problem sources. In 2013 I filed a letter with the FCC in response to the agency's 2013 inquiry whether it should review its 1996 guidelines. I wrote to the FCC that the most significant frequent initial sensitizing event we have seen over the last two years has been the installation of smart meters. Now, 8 years later, this is still true. Smart meters are the most significant sickness agent we must confront. 5G antennas near homes is yet another major sickness agent, but they, at least, do not typically also cause conduction through the homes' over the cage of wiring that encircles the entire living space– in the walls, ceiling and floor.

29. Smart meters' antennas send intense RF pulses every few seconds and these emissions affect the entire house. Proximity of the RF radiation-emitting source directly impacts our ability to attenuate the radiation, as radiation drops with distance. Smart meters' location on or in close proximity to the house is why they are the worst offenders for those who suffer from pulsed RFR.

30. The radiation from meters installed further away from the house still creates RF inside the house. The RF frequencies from the antenna and from the switch mode power supply are conducted through the house electric wiring. This pulsed RF radiation enters the living spaces through the floors, walls, and ceilings and via the power cords on all plugged-in electrical devices.

31. While one can take measures to reduce the radiation from smart meters' antennas, shielding from the RF emissions that go into the house electric wiring system from the RF antenna and from the switch mode power supply (SMPS) is complex, expensive, and not very effective.

32. There are filters that help reduce the RF "noise" created by the meter's switch mode power supply that conducts through the electric wiring. However, some are very expensive. Others emit high magnetic fields that are also problematic for those who are sick. Filters provide only partial solution as many reduce higher frequencies while creating new, lower frequencies that are below the typical measurement range of the meter.

33. Shielding is used to block radiation coming from the outside. Shielding materials should be installed only when no pulsed RF-based wireless devices are in the house.[6] Otherwise, the shielding would be counterproductive and

[6] Part of our remediation includes eliminating all other emission sources inside the house, including things like SMPS used in laptop computers or other electronic devices or wireless "Internet of Things" devices. Our clients can control such

even increase exposure because the inside-home emissions become “trapped” within the house because of the shielding. For that reason, shielding the house from outside sources can aggravate the problem caused by smart and digital meters.

34. A smart or digital meter on a house with resident adults and children who adversely react to RF/EMF harms them both directly and indirectly. They directly suffer from the meter effects, and they cannot shield emissions from the outside like from cell towers, or neighbors’ smart meters and Wi-Fi networks.

Conclusion

35. People are being told that wireless technology is safe. That smart meters are safe. They trust the government and the equipment manufacturers to have their best interests and safety at heart. Nothing is further from the truth as the recent case of the Children’s Health Defense against the FCC exposed. We see the devastating sickness daily in our work. We hope this court will protect those who need it the most.

36. The only reasonable accommodation for those who suffer from pulsed RF radiation is an analog meter. They are the only meters that do not emit RFs and do not aggravate the situation of those whose life is already a torturous nightmare. Analog meters are inexpensive, last much, much longer than digital meters - they

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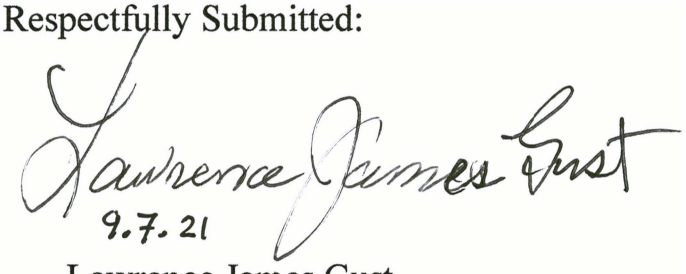
things. But they cannot control what the smart or digital meter does nor can they turn it off.

cost less than $100, and they have served us reliably for many decades. There cannot be any justified reason not to accommodate the sick when the solution exists.

Respectfully Submitted:



9.7.21

Lawrence James Gust