December 6, 2018

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Keystone Building, 2nd Floor W.
400 N. Street
Harrisburg, PA 17120

Re: Michal Bruce v. Duquesne Light Company
Docket No. C-2018-3005754

Dear Secretary Chiavetta,

Enclosed please find my response to Duquesne Light Company's Answer and New Matter submitted on November 21, 2018.

I have also sent a copy of my response to Mr. Farrell and Mr. Miller, representing Duquesne Light Company.

I truly appreciate the Pennsylvania Public Utility Commission's review and consideration of my response to this matter.

Sincerely,

Michal Bruce

Michal Bruce

167 Holt Road
Aliquippa, PA 15001
724-622-8980

RESPONSE TO DUQUESNE LIGHT'S ANSWER AND NEW MATTER

In response to the Answer from Duquesne Light Company, I wholeheartedly disagree with the claim that the installation of a smart meter on my property would not endanger the health and wellbeing of my family. In addition, I also disagree with the statement that smart meters do not threaten my safety.

In regards to safety, I feel there are two primary issues: physical safety and personal privacy.

Physical Safety

In terms of physical safety, there are many pending lawsuits and cases that cite smart meters as the cause of fires. In California, smart meters are cited as the source of many residential fires. In the case of Jose Valdez[1], a smart meter is blamed for the fire at his home. According to the article, the "Investigation after the fire was put out revealed that in all probability the fire was caused by a problem in the electrical panel and the problem in the electrical panel, in my belief, was the Smart Meter that was installed in the panel by PG&E," said John Borboa.

In this instance, the Fire Chief is not the only one who believes a smart meters caused the fire at Mr. Valdez's home. Mr. Valdez's insurance company is also suing PG&E to take responsibility for the fire.

In 2014, several fires in Nevada are suspected to be caused by smart meters. In Reno and Sparks, NV, Fire Chiefs have asked the Public Utilities Commision to investigate the safety of smart meters, citing nine (9) fires in their jurisdiction associated with smart meters[2]. In one instance, a smart meter burst into flames when a breaker was switched, scorching a man's face who was standing in front of it. The fire chief, Tom Garrison, expressed additional concern for fire sparked by smart meters because these fires start on the outside of a home and won't be picked up by internal smoke detectors. Referring to the fire hazard, he stated, "It can burn a long time and enter the attic or the walls. The occupants inside may not even be aware the house is on fire. This is very alarming to me."[3]

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[1] "Lawsuits claim faulty PG&E Smart Meters started house fires | abc30 ...." 17 Nov. 2017, https://abc30.com/lawsuits-claim-faulty-pg-e-smart-meters-started-house-fires/2657513/. Accessed 3 Dec. 2018.

[2] "Reno, Sparks fire chiefs call for smart meter probe." 13 Sep. 2014, https://www.rgj.com/story/news/2014/09/13/reno-sparks-fire-chiefs-call-smart-meter-probe/15580069/. Accessed 3 Dec. 2018.

[3] "Reno, Sparks fire chiefs call for smart meter probe." 13 Sep. 2014, https://www.rgj.com/story/news/2014/09/13/reno-sparks-fire-chiefs-call-smart-meter-probe/15580069/. Accessed 4 Dec. 2018.

In Stockton, CA, smart meters literally exploded after a power surge. According to the report, Fire Captain Bryan Carr stated that "In some cases, meters were literally blown off the panels."[4]

These are just a few of the many cases citing smart meters as the cause of fires, destructions to homes, and physical harm to humans. I do not feel that installing a smart meter on my home is a safe option for myself or my family. In addition the location of our current meter is outside of our master bedroom. If a fire were to start quickly, we would have no clear exit if our bedroom was consumed in fire. In addition, like Fire Chief Garrison's concern, our internal smoke detector would likely not go off because the potential fire would be starting outside the home, leaving us without any warning. Forcing a smart meter on my home is creating ultrahazardous activity, especially considering that I have no ability to eliminate this risk since an opt-out program is not being offered.

Personal Privacy

The use and collection of data is a violation of the Amendment IV in the Constitution of the United States. The Fourth Amendment secures, " The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue, but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized."

Exhibit B in the response from Duquesne Light states that the advanced digital meters will "transmit RF waves only for a very short periods every day;" however, it fails to specify when these periods of time occur and how frequently they are happening. In addition, I have not been able to find information relating to how long Duquesne Light will maintain my personal electricity reading information and what kind of protection I have from this information being hacked or sold to a Third Party Organization.

With the collection of my personal energy usage and tracking of appliance usage through the smart meter network, utility companies like Duquesne Light can determine when I am home or away, and have access to sensitive data like when I typically shower, what time I prepare meals, etc. This data is personal in nature and should not be shared without my consent.

Also alarming are the numerous cases, like the one cited for City Light, where utility companies have provided personal consumer information to law enforcement without any justification from law enforcement agents in regards to why they were requesting the information, nor did they

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[4] "Dozens of smart meters explode from power surge - EMF Safety Network." 30 Mar. 2015, http://emfsafetynetwork.org/dozens-of-smart-meters-explode-from-power-surge/. Accessed 5 Dec. 2018.

provide a warrant.[5] This truly violates one's Fourth Amendment rights to unreasonable search and seizure.

In August 2018, the Seventh Circuit ruled that the Fourth Amendment protects energy-consumption data collected by smart meters. In the Seventh Circuit's ruling, they admitted that there are significant differences in analog and smart meters.[6]

"Using traditional energy meters, utilities typically collect monthly energy consumption in a single lump figure once per month. By contrast, smart meters record consumption much more frequently, often collecting thousands of readings every month. Due to this frequency, smart meters show both the amount of electricity being used inside a home and when that energy is used."

The Seventh Circuit confirms my belief that smart meters pose a personal safety and privacy risk by stating that a smart meter "reveals information about the happenings inside a home." The Court held that the "ever-accelerating pace of technological development carries serious privacy implications" and that smart meters "are no exception."

In addition, the Seventh Circuit ruled, "a home occupant does not assume the risk of near constant monitoring by choosing to have electricity in her home." They continue to explain that the third-party doctrine rests on "the notion that an individual has a reduced expectation of privacy in information knowingly shared with another" and "in this context, a choice to share data imposed by fiat is no choice at all."[7]

The Court also noted that,"Naperville could have avoided this controversy—and may still avoid future uncertainty—by giving its residents a genuine opportunity to consent to the installation of smart meters, as many other utilities have."

To make matters worse, companies like Onzo and other large data aggregators, have produced videos like the one attached explaining how they harvest smart meter data to give utility companies "the ability to monetize their customer data by providing a direct link to appropriate third-party organizations based on the customer's identified character."

https://www.youtube.com/watch?time_continue=84&v=YIkT5GmoIgQ

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[5] "City Light provided customer information to ICE | Crosscut." 18 Apr. 2018, https://crosscut.com/2018/04/city-light-provided-customer-information-ice. Accessed 5 Dec. 2018.

[6] "Win! Landmark Seventh Circuit Decision Says Fourth Amendment ...." 21 Aug. 2018, https://www.eff.org/deeplinks/2018/08/win-landmark-seventh-circuit-decision-says-fourth-amendment-applies-smart-meter. Accessed 3 Dec. 2018.

[7] "WIN! Landmark Seventh Circuit Decision Says ... - Technocracy News." 25 Aug. 2018, https://www.technocracy.news/win-landmark-seventh-circuit-decision-says-fourth-amendment-applies-to-smart-meter-data/. Accessed 5 Dec. 2018.

Health

On page 2 of Duquesne Light's Answer, it states that the Federal Communications Commision (FCC) has established safe limits for Radio Frequency (RF) exposure and that Duquesne Light's RF exposure from smart meters is "well below the limits;" however, Duquesne Light has not provided information on the actual RF level that is being transmitted from its devices. I would like Duquesne Light to provide documentation in regards to the RF exposure that I would be subject to based on their particular smart meter devices.

In addition, while the FCC has determined a "safe limit" for RF exposure, I would argue that this limit is a cumulative limit for ALL RF exposure, not just specifically the amount of RF that is transmitted through smart meters. In our household we take measures to avoid RF radiation when possible, by using EMF protection on our laptops, unplugging devices when not in use, almost never using our microwave, not having the bluetooth feature on continuously, and putting our phones on airplane mode at night. However, we are still being bombarded with unavoidable RF radiation, including the RF fields being transmitted by our neighbors smart meter. The additional RF emitted by a smart meter will just greaten the toxic load that is already taxing our bodies.

Per the FCC's website in regards to the biological effects of RF energy, the FCC states, "Furthermore, since much of the research is not done on whole bodies (in vivo), there has been no determination that such effects constitute a human health hazard. It is generally agreed that further research is needed to determine the generality of such effects and their possible relevance, if any, to human health."[8] Consumers like myself should not be forced into subjecting ourselves and our families to dangerous RF radiation when the true biological effects on human health are not yet known.

Page 3 of Duquesne Light's Answer also references that the World Health Organization (WHO) concluded that no adverse health effects have been demonstrated to result from exposure to low-level RF. However, in 2011, the World Health Organization International Agency for Research on Cancer classified radiofrequency electromagnetic fields as "possibly carcinogenic to humans" based on the increased risk for brain cancer due to the use of wireless phones. The full response from the World Health Organization International Agency for Research on Cancer is included for your reference in Exhibit A attached. Although it may be less than what a wireless phone emits, the location of my current electric meter at the head of my bed would be exposing myself and my wife to RF emissions for a period of 8+ hours daily, which is a drastically larger amount of time than one would spend on a wireless phone each day.

Dr. Anthony B. Miller, trusted World Health Organization advisor and physician who specializes in cancer, has updated his opinion and expressed that radiofrequency radiation from ANY

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[8] "RF Safety FAQ | Federal Communications Commission." 25 Nov. 2015, https://www.fcc.gov/engineering-technology/electromagnetic-compatibility-division/radio-frequency-safety/faq/rf-safety. Accessed 3 Dec. 2018.

source "fully meets the criteria to be classified as a Group 1 carcinogenic to humans."[9] As defined by the World Health Organization International Agency for Research on Cancer (Exhibit A), "Group 1" means that the agents is carcinogenic to humans. Per their report, this group is used when there is sufficient evidence of carcinogenicity in humans or if the human evidence is less than sufficient, there is sufficient evidence of carcinogenicity in experimental animals and strong evidence in exposed humans that the agent acts through relevant mechanism of carcinogenicity. Dr. Miller states that "The evidence indicating wireless is carcinogenic has increased and can no longer be ignored."[10]

For reference, also included (Exhibit B) is a letter that Dr. Anthony B. Miller wrote to Petaluma City Schools, expressing his concern for the adverse effects of radiofrequency fields in schools. In it he states, "It is important to recognize that there are no safe levels of exposure to human carcinogens. Risk increases with increasing intensity of exposure, and for many carcinogens, even more with increasing duration of exposure." He goes on to state, "the only way to avoid the carcinogenic risk is to avoid exposure altogether." In his final plea, he states "An individual, if appropriately informed, can reduce her or his exposure to radiofrequency fields from devices that use wi-fi, but in the case of cell towers, smart meters, and wi-fi in schools, the exposure they receive is outside their control. Then, with people who manufacture these devices and those who promote wi-fi failing to issue adequate health warnings, we are reaching a situation where schools, workplaces and home are being saturated with radiofrequency fields."

Dr. David Carpenter, Harvard Medical School trained physician and employee for the New York State Department of Health, expresses his concern for the continual exposure to radiofrequency from smart meters in this Youtube interview.

https://www.youtube.com/watch?v=n7L21XOC2wA&feature=player_embedded

He states, "the evidence demonstrates convincingly and consistently that exposure to radiofrequency radiation at elevated levels for long periods of time increases the risk of cancer, increases the damage to the nervous system, causes lipo sensitivity, has adverse reproductive effects, and a variety of other effects on different organ systems."

For further consideration, Exhibit C is included as a reference from the BioInitiative Report in 2012. It details the staggering amount of adverse biological and health effects from low-level

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[9] "Cancer Expert Declares Cell Phone and Wireless Radiation as ...." https://ehtrust.org/cancer-expert-declares-cell-phone-wireless-radiation-carcinogenic-humans/. Accessed 3 Dec. 2018.

[10] "Cancer Expert Declares Cell Phone and Wireless Radiation ... - SBWire." 16 Aug. 2017, http://www.sbwire.com/press-releases/cancer-expert-declares-cell-phone-and-wireless-radiation-as-carcinogenic-to-humans-849135.htm. Accessed 4 Dec. 2018.

RF exposure.[11] Also included is the list of contributors to the BioInitiative Report and their full credentials.

My health concerns continue to grow because my wife and I would like to start a family soon. The stress on a mother and fetus is already enough, but compounding it with additional RF radiation is a real concern. The BabySafe Project is a public awareness platform that was created to inform women about the risks of wireless radiation during pregnancy. It uses independent, peer-reviewed science to educate women about the possible biological harms caused by radiofrequency waves. They offer several suggestions to reduce exposure, and one of them is to sleep as far away as possible from wireless smart meters - or better yet, do not have one installed at all.[12] This is additional evidence that the current location of our meter at the head of our bed is not safe and not a risk that I am willing to take that could adversely affect the health of my wife and future child.

Although few humans studies have been done linking the dangers of wireless radiation and pregnancy, as this would be a difficult and highly dangerous study, plenty of studies have been completed on mice. Many physicians, including Dr. Devra Davis of the Environmental Health Trust, relate smart meters and wireless radiation to the history of tobacco and asbestos in the United States.[13] Dr. Davis argues that "a precautionary approach" needs to be taken regarding wireless radiation, since we have learned hard lessons in the past relating to poor health effects from exposure to tobacco and asbestos.

In 2013, a human study was conducted by UCLA researchers. In a study of 13,000 mothers and children, they concluded that prenatal exposure to cell phones and wireless radiation caused a higher risk of behavioral problems and hyperactivity in children.[14] The BabySafe Project has many more scientific research cases listed on their website:

https://www.babysafeproject.org/science.html

Duquesne Light denies that the installation of a smart meter would endanger my health or wellbeing, and I could not disagree more. Without conclusive evidence to prove that there is no health risk to my family, I should not be subjected to any human carcinogens in an effort for electric utility companies to conserve energy and save money. Although smart meter technology is relatively new, the cases cited substantiate my concern for the health and wellbeing of myself and my family. Just because risks are not fully confirmed or researched yet, does not mean that there is no risk present. Exposing myself and family to additional

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[11] "RF Color Charts - The BioInitiative Report." http://www.bioinitiative.org/rf-color-charts/. Accessed 3 Dec. 2018.
[12] "The BabySafe Project." https://www.babysafeproject.org/. Accessed 4 Dec. 2018.
[13] "BabySafe Project – Know Your Exposure, Protect Your Baby « Stop ...." 7 Jun. 2014, http://stopsmartmeters.org.uk/babysafe-project-know-your-exposure-protect-your-baby/. Accessed 4 Dec. 2018.
[14] "SCIENCE - THE BABYSAFE PROJECT." https://www.babysafeproject.org/science.html. Accessed 4 Dec. 2018.

radiofrequency levels, whether it is considered an "acceptable" or "safe" limit or not, is not acceptable and should not be required.

Requests for Additional Information

In the literature provided, there is conflicting information in terms of the frequency of information transmission. In the last paragraph on page 2 of Duquesne Light's Answer, it states that the Company's smart meters transmit RF waves "for only short periods each month." However, Exhibit B contradicts this information when it states on page 1 that the new advanced meters "collect information more times throughout the day." Also, on page 2 of Exhibit B, it states that "advanced meters will transmit RF waves only for very short periods every day." I was not able to find any clear answers in regards to the daily frequency and the radio frequency level specific to Duquesne Lights smart meters. Prior to coming to any kind of agreement, I am requesting that Duquesne Light:

1. Clarify the daily frequency that information is recorded and transmitted.
2. Explain why data needs to be collected so frequently.
3. Explain my protection as a consumer from personal data being hacked or sold to a Third Party Organization.
4. Clarify how long Duquesne Light maintains energy consumption records.
5. Specify the amount of RF that is being transmitted by Duquesne Light's smart meter.
6. Provide documentation as to why Duquesne Light feels that smart meter installation is safe and NOT a risk to my health and wellbeing.

In Supplement No. 107, Second Revised Page No. 21. , Section 14.2 it states, "If a customer wishes to replace the Company billing meter to the extent technically possible, the Company will offer, provide, and support a selection of qualified meters to conform with the Company standards." I would like to be educated on my options as a consumer before coming to a decision. As such, I would like to request:

1. Additional information as to what other meter options are available to me.
2. If there are several options for smart meters, are there any options that transmit information and RF less frequently?

Relief Requests

My first request would that be attempts to install a smart meter on my home cease and that my electric service is not shut off. I ask that an extension past December 31, 2018 be granted since the full deployment of smart meters in the state of Pennsylvania is not scheduled for completion until 2023.

Due to the nature of the concerns listed above, and in addition the information requested above, I would like information on Duquesne Light's offer made under item 35 under the "New Matter." In Duquesne Light's response, they state that Duquesne Light is willing to cooperate with me to

relocate the meter to a mutually agreeable location. If Duquesne Light is willing to cooperate, and if my first relief request is denied, I am requesting that Duquesne Light assume all costs associated with the movement and installation of a new meter. If it is argued that installation is a contingency of my service and must be installed, I would plea again that by installing this smart meter and exposing my family to carcinogens against my will, Duquesne Light should be responsible for all costs of moving my current meter.

I truly appreciate your consideration. As I hope it is evident in my response, I have a genuine concern for the health and safety of my family, and I respectfully ask that the Pennsylvania Public Utility Commission consider all of my arguments, requests for additional information, and relief requests when making their judgement.

Respectfully Submitted,

Michal Bruce

Michal Bruce

167 Holt Road
Aliquippa, PA 15001
724-622-8980

Works Cited

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International Agency for Research on Cancer

World Health Organization

PRESS RELEASE
N° 208

31 May 2011

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

Lyon, France, May 31, 2011 -- The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer[1], associated with wireless phone use.

Background

Over the last few years, there has been mounting concern about the possibility of adverse health effects resulting from exposure to radiofrequency electromagnetic fields, such as those emitted by wireless communication devices. The number of mobile phone subscriptions is estimated at 5 billion globally.

From May 24–31 2011, a Working Group of 31 scientists from 14 countries has been meeting at IARC in Lyon, France, to assess the potential carcinogenic hazards from exposure to radiofrequency electromagnetic fields. These assessments will be published as Volume 102 of the IARC *Monographs*, which will be the fifth volume in this series to focus on physical agents, after Volume 55 (Solar Radiation), Volume 75 and Volume 78 on ionizing radiation (X-rays, gamma-rays, neutrons, radio-nuclides), and Volume 80 on non-ionizing radiation (extremely low-frequency electromagnetic fields).

The IARC Monograph Working Group discussed the possibility that these exposures might induce long-term health effects, in particular an increased risk for cancer. This has relevance for public health, particularly for users of mobile phones, as the number of users is large and growing, particularly among young adults and children.

The IARC Monograph Working Group discussed and evaluated the available literature on the following exposure categories involving radiofrequency electromagnetic fields:

- occupational exposures to radar and to microwaves;
- environmental exposures associated with transmission of signals for radio, television and wireless telecommunication; and
- personal exposures associated with the use of wireless telephones.

International experts shared the complex task of tackling the exposure data, the studies of cancer in humans, the studies of cancer in experimental animals, and the mechanistic and other relevant data.

[1] 237 913 new cases of brain cancers (all types combined) occurred around the world in 2008 (gliomas represent 2/3 of these). Source: Globocan 2008

EXHIBIT A

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

Results

The evidence was reviewed critically, and overall evaluated as being *limited*[2] among users of wireless telephones for glioma and acoustic neuroma, and *inadequate*[3] to draw conclusions for other types of cancers. The evidence from the occupational and environmental exposures mentioned above was similarly judged inadequate. The Working Group did not quantitate the risk; however, one study of past cell phone use (up to the year 2004), showed a 40% increased risk for gliomas in the highest category of heavy users (reported average: 30 minutes per day over a 10-year period).

Conclusions

Dr Jonathan Samet (University of Southern California, USA), overall Chairman of the Working Group, indicated that "the evidence, while still accumulating, is strong enough to support a conclusion and the **2B classification**. The conclusion means that there could be some risk, and therefore we need to keep a close watch for a link between cell phones and cancer risk."

"Given the potential consequences for public health of this classification and findings," said IARC Director Christopher Wild, "it is important that additional research be conducted into the long-term, heavy use of mobile phones. Pending the availability of such information, it is important to take pragmatic measures to reduce exposure such as hands-free devices or texting. "

The Working Group considered hundreds of scientific articles; the complete list will be published in the Monograph. It is noteworthy to mention that several recent in-press scientific articles[4] resulting from the **Interphone study** were made available to the working group shortly before it was due to convene, reflecting their acceptance for publication at that time, and were included in the evaluation.

A concise report summarizing the main conclusions of the IARC Working Group and the evaluations of the carcinogenic hazard from radiofrequency electromagnetic fields (including the use of mobile telephones) will be published in **The Lancet Oncology in its July 1 issue, and in a few days online.**

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[2] '***Limited evidence of carcinogenicity***': A positive association has been observed between exposure to the agent and cancer for which a causal interpretation is considered by the Working Group to be credible, but chance, bias or confounding could not be ruled out with reasonable confidence.

[3] '***Inadequate evidence of carcinogenicity***': The available studies are of insufficient quality, consistency or statistical power to permit a conclusion regarding the presence or absence of a causal association between exposure and cancer, or no data on cancer in humans are available.

[4] a. 'Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study' (the Interphone Study Group, in Cancer Epidemiology, *in press*)
b. 'Estimation of RF energy absorbed in the brain from mobile phones in the Interphone study' (Cardis et al., Occupational and Environmental Medicine, *in press*)
c. 'Risk of brain tumours in relation to estimated RF dose from mobile phones – results from five Interphone countries' (Cardis et al., Occupational and Environmental Medicine, *in press*)
d. 'Location of Gliomas in Relation to Mobile Telephone Use: A Case-Case and Case-Specular Analysis' (American Journal of Epidemiology, May 24, 2011. [Epub ahead of print].

IARC, 150 Cours Albert Thomas, 69372 Lyon CEDEX 08, France - Tel: +33 (0)4 72 73 84 85 - Fax: +33 (0)4 72 73 85 75

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

For more information, please contact
Dr Kurt Straif, IARC Monographs Section, at +33 472 738 511, or straif@iarc.fr; Dr Robert Baan, IARC Monographs Section, at +33 472 738 659, or baan@iarc.fr; or Nicolas Gaudin, IARC Communications Group, at com@iarc.fr (+33 472 738 478)
Link to the **audio file** posted shortly after the briefing:
http://terrance.who.int/mediacentre/audio/press_briefings/

About IARC

The International Agency for Research on Cancer (IARC) is part of the World Health Organization. Its mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. The Agency is involved in both epidemiological and laboratory research and disseminates scientific information through publications, meetings, courses, and fellowships.

If you wish your name to be removed from our press release e-mailing list, please write to com@iarc.fr.

Nicolas Gaudin, Ph.D.
Head, IARC Communications
International Agency for Research on Cancer
World Health Organization
150, cours Albert-Thomas
69008 Lyon
France

Email com@iarc.fr
http://www.iarc.fr/

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

ABOUT THE IARC MONOGRAPHS

What are the IARC Monographs?

The *IARC Monographs* identify environmental factors that can increase the risk of human cancer. These include chemicals, complex mixtures, occupational exposures, physical and biological agents, and lifestyle factors. National health agencies use this information as scientific support for their actions to prevent exposure to potential carcinogens. Interdisciplinary working groups of expert scientists review the published studies and evaluate the weight of the evidence that an agent can increase the risk of cancer. The principles, procedures, and scientific criteria that guide the evaluations are described in the Preamble to the IARC Monographs.

Since 1971, more than 900 agents have been evaluated, of which approximately 400 have been identified as **carcinogenic or potentially carcinogenic** to humans.

Definitions

Group 1: The agent is *carcinogenic to humans*.

This category is used when there is *sufficient evidence of carcinogenicity* in humans. Exceptionally, an agent may be placed in this category when evidence of carcinogenicity in humans is less than *sufficient* but there is *sufficient evidence of carcinogenicity* in experimental animals and strong evidence in exposed humans that the agent acts through a relevant mechanism of carcinogenicity.

Group 2.

This category includes agents for which, at one extreme, the degree of evidence of carcinogenicity in humans is almost *sufficient*, as well as those for which, at the other extreme, there are no human data but for which there is evidence of carcinogenicity in experimental animals. Agents are assigned to either Group 2A (*probably carcinogenic to humans*) or Group 2B (*possibly carcinogenic to humans*) on the basis of epidemiological and experimental evidence of carcinogenicity and mechanistic and other relevant data. The terms *probably carcinogenic* and *possibly carcinogenic* have no quantitative significance and are used simply as descriptors of different levels of evidence of human carcinogenicity, with *probably carcinogenic* signifying a higher level of evidence than *possibly carcinogenic*.

Group 2A: The agent is *probably carcinogenic to humans*.

This category is used when there is *limited evidence of carcinogenicity* in humans and *sufficient evidence of carcinogenicity* in experimental animals. In some cases, an agent may be classified in this category when there is *inadequate evidence of carcinogenicity* in humans and *sufficient evidence of carcinogenicity* in experimental animals and strong evidence that the carcinogenesis is mediated by a mechanism that also operates in humans. Exceptionally, an agent may be classified in this category solely on the basis of *limited evidence of carcinogenicity* in humans. An agent may be assigned to this category if it clearly belongs, based on mechanistic considerations, to a class of agents for which one or more members have been classified in Group 1 or Group 2A.

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

Group 2B: The agent is *possibly carcinogenic to humans*.

This category is used for agents for which there is *limited evidence of carcinogenicity* in humans and less than *sufficient evidence of carcinogenicity* in experimental animals. It may also be used when there is *inadequate evidence of carcinogenicity* in humans but there is *sufficient evidence of carcinogenicity* in experimental animals. In some instances, an agent for which there is *inadequate evidence of carcinogenicity* in humans and less than *sufficient evidence of carcinogenicity* in experimental animals together with supporting evidence from mechanistic and other relevant data may be placed in this group. An agent may be classified in this category solely on the basis of strong evidence from mechanistic and other relevant data.

Group 3: The agent is *not classifiable as to its carcinogenicity to humans*.

This category is used most commonly for agents for which the evidence of carcinogenicity is *inadequate* in humans and *inadequate* or *limited* in experimental animals.

Exceptionally, agents for which the evidence of carcinogenicity is *inadequate* in humans but *sufficient* in experimental animals may be placed in this category when there is strong evidence that the mechanism of carcinogenicity in experimental animals does not operate in humans.

Agents that do not fall into any other group are also placed in this category.

An evaluation in Group 3 is not a determination of non-carcinogenicity or overall safety. It often means that further research is needed, especially when exposures are widespread or the cancer data are consistent with differing interpretations.

Group 4: The agent is probably not carcinogenic to humans.

This category is used for agents for which there is *evidence suggesting lack of carcinogenicity* in humans and in experimental animals. In some instances, agents for which there is *inadequate evidence of carcinogenicity* in humans but *evidence suggesting lack of carcinogenicity* in experimental animals, consistently and strongly supported by a broad range of mechanistic and other relevant data, may be classified in this group.

Definitions of evidence, as used in IARC Monographs for studies in humans

The evidence relevant to carcinogenicity from studies in humans is classified into one of the following categories:

Sufficient evidence of carcinogenicity: The Working Group considers that a causal relationship has been established between exposure to the agent and human cancer. That is, a positive relationship has been observed between the exposure and cancer in studies in which chance, bias and confounding could be ruled out with reasonable confidence. A statement that there is *sufficient evidence* is followed by a separate sentence that identifies the target organ(s) or tissue(s) where an increased risk of cancer was observed in humans. Identification of a specific target organ or tissue does not preclude the possibility that the agent may cause cancer at other sites.

IARC, 150 Cours Albert Thomas, 69372 Lyon CEDEX 08, France - Tel: +33 (0)4 72 73 84 85 - Fax: +33 (0)4 72 73 85 75

Limited evidence of carcinogenicity: A positive association has been observed between exposure to the agent and cancer for which a causal interpretation is considered by the Working Group to be credible, but chance, bias or confounding could not be ruled out with reasonable confidence.

Inadequate evidence of carcinogenicity: The available studies are of insufficient quality, consistency or statistical power to permit a conclusion regarding the presence or absence of a causal association between exposure and cancer, or no data on cancer in humans are available.

Evidence suggesting lack of carcinogenicity: There are several adequate studies covering the full range of levels of exposure that humans are known to encounter, which are mutually consistent in not showing a positive association between exposure to the agent and any studied cancer at any observed level of exposure. The results from these studies alone or combined should have narrow confidence intervals with an upper limit close to the null value (e.g. a relative risk of 1.0). Bias and confounding should be ruled out with reasonable confidence, and the studies should have an adequate length of follow-up. A conclusion of *evidence suggesting lack of carcinogenicity* is inevitably limited to the cancer sites, conditions and levels of exposure, and length of observation covered by the available studies. In addition, the possibility of a very small risk at the levels of exposure studied can never be excluded.

In some instances, the above categories may be used to classify the degree of evidence related to carcinogenicity in specific organs or tissues.

IARC, 150 Cours Albert Thomas, 69372 Lyon CEDEX 08, France - Tel: +33 (0)4 72 73 84 85 - Fax: +33 (0)4 72 73 85 75

Dr. Anthony B. Miller
3800 Yonge Street, Suite 406,
Toronto, ON, M4N 3P7
Telephone 416 487 5825
Email: ab.miller@sympatico.ca

August 4, 2016

Petaluma City Schools
District Office
200 Douglas Street
Petaluma, California
94952

Re: Adverse Effects of Radiofrequency fields

I am writing to express my concern over the increasing exposure of children in schools to Radiofrequency Fields (e.g. from wi-fi, as required for cell phones and iPads, and emitted by cell towers) and the lack of concern expressed by many councils, governments and School Boards on this issue. In particular, justification for the "safety" of radiofrequency fields is placed upon the use of outdated safety standards, based upon tissue heating, whereas it has now been well demonstrated that adverse biological effects occur at far lower levels of radiofrequency fields that do not induce tissue heating, including a recent animal study performed by the National Toxicology Program in the United States which found an increased incidence of brain cancers and other cancers in rats exposed to prolonged Radiofrequency fields.

I am a physician and epidemiologist specializing in cancer etiology, prevention, and screening, expert in epidemiology, and particularly causes of human cancer. I have performed research on ionizing radiation and cancer, electromagnetic fields and cancer, and have served on many committees assessing the carcinogenicity of various exposures, including working groups of the International Agency for Research on Cancer (IARC), widely regarded as providing unbiased assessment on the carcinogenicity of chemicals and other exposure to humans.

In 2011, an IARC working group designated radiofrequency fields as a class 2B carcinogen, a possible human carcinogen. Since that review a number of additional studies have been reported. One of the most important was a large case-control study in France, which found a doubling of risk of glioma, the most malignant form of brain cancer, after two years of exposure to cell phones. After five years exposure the risk was five-fold. They also found that in those who lived in urban environments the risk was even higher. In my view, and that of many colleagues who have written papers on this issue, these studies provide evidence that radiofrequency fields are not just a possible human carcinogen but a probable human carcinogen, i.e. IARC category 2A. It would be impossible to ignore such an assessment in regulatory approaches.

EXHIBIT B

It is important to recognize that there are no safe levels of exposure to human carcinogens. Risk increases with increasing intensity of exposure, and for many carcinogens, even more with increasing duration of exposure. The only way to avoid the carcinogenic risk is to avoid exposure altogether. This is why we ban known carcinogens from the environment and why much effort is taken to get people, particularly young people, not to smoke. We now recognize that exposure to carcinogens in childhood can increase the risk of cancer in adulthood many years later. Further, people vary in their genetic makeup, and certain genes can make some people more susceptible than others to the effect of carcinogens. It is the young and those who are susceptible we should protect.

As an epidemiologist who has done a great deal of work on breast cancer, I have been concerned by a series of case reports from California and elsewhere of women who developed unusual breast cancers in the exact position where they kept cell phones in their bras. These are unusual cancers. They are multifocal, mirroring where the cell phone was kept. Thus in these relatively young women the radiofrequency radiation from very close contact with a cell phone has caused breast cancer.

Not only brain and breast cancers but parotid gland tumors, tumors of the salivary gland, have been associated with prolonged exposure to cell phones.

Given the long natural history of cancer and the fact that human populations have not been exposed for a sufficient length of time to reveal the full adverse effects of radiofrequency fields, it is extremely important to adopt a precautionary approach to the exposure of humans to such fields. An individual, if appropriately informed, can reduce her or his exposure to radiofrequency fields from devices that use wi-fi, but in the case of cell towers, smart meters and wi-fi in schools, the exposure they receive is outside their control. Then, with the people who manufacture these devices and those who promote wi-fi failing to issue adequate health warnings, we are reaching a situation where schools, work places and homes are being saturated with radiofrequency fields.

Thus to avoid a potential epidemic of cancer caused by radiofrequency fields from wi-fi and other devices, we should introduce means to reduce exposure as much as reasonably achievable, use hard wire connections to the internet and strengthen the codes that are meant to protect the public.

Yours sincerely

Anthony B. Miller, MD, FRCP(C), FRCP, FACE
Professor Emeritus
Dalla Lana School of Public Health, University of Toronto, Ontario, Canada

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure

(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

Power Density (Microwatts/centimeter2 - uW/cm2)		Reference
As low as (10^{-13}) or *100 femtowatts/cm2*	Super-low intensity RFR effects at MW reasonant frequencies resulted in changes in genes; problems with *chromatin conformation (DNA)*	Belyaev, 1997
5 picowatts/cm2 (10^{-12})	Changed growth rates in yeast cells	Grundler, 1992
0.1 nanowatt/cm2 (10^{-10}) or 100 picowatts/cm2	Super-low intensity RFR effects at MW reasonant frequencies resulted in changes in genes; problems with chromatin condensation (DNA) intensities comparable to base stations	Belyaev, 1997
0.00034 uW/cm2	Chronic exposure to mobile phone pulsed RF significantly reduced sperm count,	Behari, 2006
0.0005 uW/cm2	RFR decreased cell proliferation at 960 MHz GSM 217 Hz for 30-min exposure	Velizarov, 1999
0.0006 - 0.0128 uW/cm2	Fatigue, depressive tendency, sleeping disorders, concentration difficulties, cardio- vascular problems reported *with exposure to GSM 900/1800 MHz cell phone signal at base station level exposures.*	Oberfeld, 2004
0.003 - 0.02 uW/cm2	In children and adolescents (8-17 yrs) short-term exposure caused headache, irritation, concentration difficulties in school.	Heinrich, 2010
0.003 to 0.05 uW/cm2	In children and adolescents (8-17 yrs) short-term exposure caused conduct problems in school (behavioral problems)	Thomas, 2010
0.005 uW/cm2	In adults (30-60 yrs) chronic exposure caused sleep disturbances, (but not significantly increased across the entire population)	Mohler, 2010
0.005 - 0.04 uW/cm2	Adults exposed to short-term cell phone radiation reported headaches, concentration difficulties (differences not significant, but elevated)	Thomas, 2008
0.006 - 0.01 uW/cm2	*Chronic exposure to base station RF (whole-body) in humans showed increased stress hormones; dopamine* levels substantially decreased; higher levels of adrenaline and nor-adrenaline; dose-response seen; produced chronic physiological stress in cells even after 1.5 years.	Buchner, 2012
0.01 - 0.11 uW/cm2	RFR from cell towers caused fatigue, headaches, sleeping problems	Navarro, 2003

Stress proteins, HSP, disrupted immune function	Brain tumors and blood-brain barrier
Reproduction/fertility effects	Sleep, neuron firing rate, EEG, memory, learning, behavior
Oxidative damage/ROS/DNA damage/DNA repair failure	Cancer (other than brain), cell proliferation
Disrupted calcium metabolism	Cardiac, heart muscle, blood-pressure, vascular effects

EXHIBIT C

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

Power Density (Microwatts/centimeter2 - uW/cm2)		Reference
0.01 - 0.05 uW/cm2	Adults (18-91 yrs) with short-term exposure to GSM cell phone radiation reported headache, neurological problems, sleep and concentration problems.	Hutter, 2006
0.005 - 0.04 uW/cm2	Adults exposed to short-term cell phone radiation reported headaches, concentration difficulties (differences not significant, but elevated)	Thomas, 2008
0.015 - 0.21 uW/cm2	Adults exposed to short-term GSM 900 radiation reported changes in mental state (e.g., calmness) but limitations of study on language descriptors prevented refined word choices (stupified, zoned-out)	Augner, 2009
0.05 - 0.1 uW/cm2	**RFR linked to adverse neurological, cardio symptoms and cancer risk**	Khurana, 2010
0.05 - 0.1 uW/cm2	RFR related to headache, concentration and sleeping problems, fatigue	Kundi, 2009
0.07 - 0.1 uW/cm2	Sperm head abnormalities in mice exposed for 6-months to base station level RF/MW. Sperm head abnormalities occurred in 39% to 46% exposed mice (only 2% in controls) abnormalities was also found to be dose dependent. The implications of the pin-head and banana-shaped sperm head. The occurrence of sperm head observed increase occurrence of sperm head abnormalities on the reproductive health of humans living in close proximity to GSM base stations were discussed."	Otitoloju, 2010
0.38 uW/cm2	RFR affected calcium metabolism in heart cells	Schwartz, 1990
0.8 - 10 uW/cm2	RFR caused emotional behavior changes, free-radical damage by super-weak MWs	Akoev, 2002
0.13 uW/cm2	RFR from 3G cell towers decreased cognition, well-being	Zwamborn, 2003
0.16 uW/cm2	Motor function, memory and attention of school children affected (Latvia)	Kolodynski, 1996
0.168 - 1.053 uW/cm2	Irreversible infertility in mice after 5 generations of exposure to RFR from an 'antenna park'	Magras & Zenos, 1997
0.2 - 8 uW/cm2	RFR caused a two-fold increase in leukemia in children	Hocking, 1996
0.2 - 8 uW/cm2	RFR decreased survival in children with leukemia	Hocking, 2000
0.21 - 1.28 uW/cm2	Adolescents and adults exposed only 45 min to UMTS cell phone radiation reported increases In headaches.	Riddervold, 2008

Stress proteins, HSP, disrupted immune function	**Brain tumors and blood-brain barrier**
Reproduction/fertility effects	**Sleep, neuron firing rate, EEG, memory, learning, behavior**
Oxidative damage/ROS/DNA damage/DNA repair failure	**Cancer (other than brain), cell proliferation**
Disrupted calcium metabolism	**Cardiac, heart muscle, blood-pressure, vascular effects**

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

Power Density (Microwatts/centimeter2 - uW/cm2)		Reference
0.5 uW/cm2	*Significant degeneration of seminiferous epithelium in mice at 2.45 GHz, 30-40 min.*	*Saunders, 1981*
0.5 - 1.0 uW/cm2	Wi-FI level laptop exposure for 4-hr resulted in decrease in sperm viability, DNA fragmentation with sperm samples placed in petri dishes under a laptop connected via WI-FI to the internet.	Avendano, 2012
1.0 uW/cm2	RFR induced pathological leakage of the blood-brain barrier	Persson, 1997
1.0 uW/cm2	RFR caused significant effect on immune function in mice	Fesenko, 1999
1.0 uW/cm2	RFR affected function of the immune system	Novoselova, 1999
1.0 uW/cm2	Short-term (50 min) exposure in electrosensitive patients, caused loss of well-being after GSM and especially UMTS cell phone radiation exposure	Eltlti, 2007
1.3 - 5.7 uW/cm2	RFR associated with a doubling of leukemia in adults	Dolk, 1997
1.25 uW/cm2	*RFR exposure affected kidney development in rats (in-utero exposure)*	Pyrpasopoulou, 2004
1.5 uW/cm2	RFR reduced memory function in rats	Nittby, 2007
2 uW/cm2	RFR induced double-strand DNA damage in rat brain cells	Kesari, 2008
2.5 uW/cm2	RFR affected calcium concentrations in heart muscle cells	Wolke, 1996
2 - 4 uW/cm2	Altered cell membranes; acetycholine-induced ion channel disruption	D'Inzeo, 1988
4 uW/cm2	RFR caused changes in hippocampus (brain memory and learning)	Tattersall, 2001
4 - 15 uW/cm2	Memory impairment, slowed motor skills and retarded learning in children	Chiang, 1989
5 uW/cm2	RFR caused drop in NK lymphocytes (immune function decreased)	Boscolo, 2001
5.25 uW/cm2	20 minutes of RFR at cell tower frequencies induced cell stress response	Kwee, 2001
5 - 10 uW/cm2	RFR caused impaired nervous system activity	Dumansky, 1974
6 uW/cm2	RFR induced DNA damage in cells	Phillips, 1998

Stress proteins, HSP, disrupted immune function	Brain tumors and blood-brain barrier
Reproduction/fertility effects	Sleep, neuron firing rate, EEG, memory, learning, behavior
Oxidative damage/ROS/DNA damage/DNA repair failure	Cancer (other than brain), cell proliferation
Disrupted calcium metabolism	Cardiac, heart muscle, blood-pressure, vascular effects

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

Power Density (Microwatts/centimeter2 - uW/cm2)		Reference
8.75 uW/cm2	RFR at 900 MHz for 2-12 hours caused DNA breaks in leukemia cells	Marinelli, 2004
10 uW/cm2	Changes in behavior (avoidance) after 0.5 hour exposure to pulsed RFR	Navakatikian, 1994
10 - 100 uW/cm2	Increased risk in radar operators of cancer; very short latency period; dose response to exposure level of RFR reported.	Richter, 2000
12.5 uW/cm2	RFR caused calcium efflux in cells - can affect many critical cell functions	Dutta, 1989
13.5 uW/cm2	RFR affected human lymphocytes - induced stress response in cells	Sarimov, 2004
20 uW/cm2	Increase in serum cortisol (a stress hormone)	Mann, 1998
28.2 uW/cm2	RFR increased free radical production in rat cells	Yurekli, 2006
37.5 uW/cm2	Immune system effects - elevation of PFC count (antibody producing cells	Veyret, 1991
45 uW/cm2	Pulsed RFR affected serum testosterone levels in mice	Forgacs, 2006
50 uW/cm2	Cell phone RFR caused a pathological leakage of the blood-brain barrier in 1 hour	Salford, 2003
50 uW/cm2	An 18% reduction in REM sleep (important to memory and learning functions)	Mann, 1996
60 uW/cm2	RFR caused structural changes in cells of mouse embryos	Somozy, 1991
60 uW/cm2	Pulsed RFR affected immune function in white blood cells	Stankiewicz, 2006
60 uW/cm2	Cortex of the brain was activated by 15 minutes of 902 MHz cell phone	Lebedeva, 2000
65 uW/cm2	RFR affected genes related to cancer	Ivaschuk, 1999
92.5 uW/cm2	RFR caused genetic changes in human white blood cells	Belyaev, 2005
100 uW/cm2	Changes in immune function	Elekes, 1996
100 uW/cm2	A 24.3% drop in testosterone after 6 hours of CW RFR exposure	Navakatikian, 1994
120 uW/cm2	A pathological leakage in the blood-brain barrier with 915 MHz cell RF	Salford, 1994

Stress proteins, HSP, disrupted immune function	**Brain tumors and blood-brain barrier**
Reproduction/fertility effects	**Sleep, neuron firing rate, EEG, memory, learning, behavior**
Oxidative damage/ROS/DNA damage/DNA repair failure	**Cancer (other than brain), cell proliferation**
Disrupted calcium metabolism	**Cardiac, heart muscle, blood-pressure, vascular effects**

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

Power Density (Microwatts/centimeter2 - uW/cm2)		Reference
500 uW/cm2	Intestinal epithelial cells exposed to 2.45 GHz pulsed at 16 Hz showed changes in intercellular calcium.	Somozy, 1993
500 uW/cm2	*A 24.6% drop in testosterone and 23.2% drop in insulin after 12 hrs of pulsed RFR exposure.*	*Navakatikian, 1994*

STANDARDS		
530 - 600 uW/cm2	Limit for uncontrolled public exposure to 800-900 MHz	ANSI/IEEE and FCC
1000 uW/cm2	*PCS STANDARD for public exposure (as of September 1,1997)*	*FCC, 1996*
5000 uW/cm2	PCS STANDARD for occupational exposure (as of September 1, 1997)	FCC, 1996
BACKGROUND LEVELS		
0.003 uW/cm2	Background RF levels in US cities and suburbs in the 1990s	Mantiply, 1997
0.05 uW/cm2	Median ambient power density in cities in Sweden (30-2000 MHz)	Hamnierius, 2000
0.1 - 10 uW/cm2	Ambient power density within 100-200' of cell site in US (data from 2000)	Sage, 2000

Stress proteins, HSP, disrupted immune function	Brain tumors and blood-brain barrier
Reproduction/fertility effects	Sleep, neuron firing rate, EEG, memory, learning, behavior
Oxidative damage/ROS/DNA damage/DNA repair failure	Cancer (other than brain), cell proliferation
Disrupted calcium metabolism	Cardiac, heart muscle, blood-pressure, vascular effects

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

SAR (Watts/Kilogram)		Reference
0.000064 - 0.000078 W/Kg	Well-being and cognitive function affected in humans exposed to GSM-UMTS cell phone frequencies; RF levels similar near cell sites	TNO Physics and
0.00015 - 0.003 W/Kg	Calcium ion movement in isolated frog heart tissue is increased 18% (P<.01) and by 21% (P<.05) by weak RF field modulated at 16 Hz	Schwartz, 1990
0.000021 - 0.0021 W/Kg	Changes in cell cycle; cell proliferation (960 MHz GSM mobile phone)	Kwee, 1997
0.0003 - 0.06 W/Kg	Neurobehavioral disorders in offspring of pregnant mice exposed in utero to cell phones - dose-response impaired glutamatergic synaptic transmission onto layer V pyramidal neurons of the prefrontal cortex. Hyperactivity and impaired memory function in offspring. Altered brain development.	Aldad, 2012
0.0016 - 0.0044 W/Kg	Very low power 700 MHz CW affects excitability of hippocampus tissue, consistent with reported behavioral changes.	Tattersall, 2001
0.0021 W/Kg	Heat shock protein HSP 70 is activated by very low intensity microwave exposure in human epithelial amnion cells	Kwee, 2001
0.0024 - 0.024 W/Kg	Digital cell phone RFR at very low intensities causes DNA damage in human cells; both DNA damage and impairment of DNA is reported	Phillips, 1998
0.0027 W/Kg	Changes in active avoidance conditioned behavioral effect is seen after one-half hour of pulsed radiofrequency radiation	Navakatikian, 1994
0.0035 W/Kg	900 MHz cell phone signal induces DNA breaks and early activation of p53 gene; short exposure of 2-12 hours leads cells to acquire greater survival chance - linked to tumor agressiveness.	Marinelli, 2004
0.0095 W/Kg	MW modulated at 7 Hz produces more errors in short-term memory functioin on complex tasks (can affect cognitive processes such as attention and memory)	Lass, 2002
0.001 W/Kg	750 MHz continuous wave (CW) RFR exposure caused increase in heat shock protein (stress proteins). Equivalent to what would be induced by 3 degree C. heating of tissue (but no heating occurred)	De Pomeral, 2000
0.001 W/Kg	Statistically significant change in intracellular calcium concentration in heart muscle cells exposed to RFR (900 MHz/50 Hz modulation)	Wolke, 1996

Stress proteins, HSP, disrupted immune function	**Brain tumors and blood-brain barrier**
Reproduction/fertility effects	**Sleep, neuron firing rate, EEG, memory, learning, behavior**
Oxidative damage/ROS/DNA damage/DNA repair failure	**Cancer (other than brain), cell proliferation**
Disrupted calcium metabolism	**Cardiac, heart muscle, blood-pressure, vascular effects**

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

SAR (Watts/Kilogram)		Reference
0.0021 W/Kg	A significant change in cell proliferation not attributable to thermal heating. RFR induces non-thermal stress proteins (960 MHz GSM)	Velizarov, 1999
0.004 - 0.008 W/Kg	915 MHz cell phone RFR caused pathological leakage of blood-brain barrier. Worst at lower SAR levels and worse with CW compared to Frequency of pathological changes was 35% in rats exposed to pulsed radiation at 50% to continuous wave RFR. Effects observed at a specific absorption (SA) of > 1.5 joules/Kg in human tissues	Persson, 1997
0.0059 W/Kg	Cell phone RFR induces glioma (brain cancer) cells to significantly increase thymidine uptake, which may be indication of more cell division	Stagg, 1997
0.014 W/Kg	Sperm damage from oxidative stress and lowered melatonin levels resulted from 2-hr per day/45 days exposure to 10 GHz.	Kumar, 2012
0.015 W/Kg	*Immune system effects - elevation of PFC count (antibody-producing cells)*	Veyret, 1991
0.02 W/Kg	A single, 2-hr exposure to GSM cell phone radiation results in serious neuron damage (brain cell damage) and death in cortex, hippocampus, and basal ganglia of brain- even 50+ days later blood-brain barrier is still leaking albumin (P<.002) following only one cell phone exposure	Salford, 2003
0.026 W/Kg	Activity of c-jun (oncogene or cancer gene) was altered in cells after 20 minutes exposure to cell phone digital TDMA signal	Ivaschuk, 1997
0.0317 W/Kg	Decrease in eating and drinking behavior	Ray, 1990
0.037 W/Kg	Hyperactivity caused by nitric oxide synthase inhibitor is countered by exposure to ultra-wide band pulses (600/sec) for 30 min	Seaman, 1999
0.037 - 0.040 W/Kg	A 1-hr cell phone exposure causes chromatin condensation; impaired DNA repair mechanisms; last 3 days (longer than stress response) the effect reaches saturation in only one hour of exposure; electro- sensitive (ES) people have different response in formation of DNA repair foci, compared to healthy individuals; effects depend on carrier frequency (915 MHz ≈ 0.037 W/Kg but 1947 MHz = 0.040 W/Kg)	Belyaev, 2008
0.05 W/Kg	Significant increase in firing rate of neurons (350%) with pulsed 900 MHz cell phone radiation exposure (but not with CW) in avian brain cells	Beason, 2002

Stress proteins, HSP, disrupted immune function	Brain tumors and blood-brain barrier
Reproduction/fertility effects	Sleep, neuron firing rate, EEG, memory, learning, behavior
Oxidative damage/ROS/DNA damage/DNA repair failure	Cancer (other than brain), cell proliferation
Disrupted calcium metabolism	*Cardiac, heart muscle, blood-pressure, vascular effects*

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

SAR (Watts/Kilogram)		Reference
0.09 W/Kg	900 MHz study of mice for 7 days, 12-hr per day (whole-body) resulted in significant effect on mitochondria and genome stability	Aitken, 2005
0.091 W/Kg	Wireless internet 2400 MHz, 24-hrs per day/20 weeks increased DNA damage and reduced DNA repair; levels below 802.11 g Authors say "findings raise questions about safety of radiofrequency exposure from Wi-Fi internet access devices for growing organisms of reproductive age, with a potential effect on fertility and integrity of germ cells" (male germ cells are the reproductive cells=sperm)	Atasoy, 2012
0.11 W/Kg	Increased cell death (apoptosis) and DNA fragmentation at 2.45 GHz for 35 days exposure (chronic exposure study)	Kesari, 2010
0.121 W/Kg	**Cardiovascular system shows significant decrease in arterial blood pressure (hypotension) after exposure to ultra-wide band pulses**	Lu, 1999
0.13 - 1.4 W/Kg	Lymphoma cancer rate doubled with two 1/2-hr exposures per day of cell phone radiation for 18 months (pulsed 900 MHz cell signal)	Repacholi, 1997
0.14 W/Kg	Elevation of Immune response to RFR exposure	Elekes, 1996
0.141 W/Kg	Structural changes in testes - smaller diameter of seminiferous	Dasdag, 1999
0.15 - 0.4 W/Kg	Statistically significant increase in malignant tumors in rats chronically exposed to RFR	Chou, 1992
0.26 W/Kg	Harmful effects to the eye/certain drugs sensitize the eye to RFR	Kues, 1992
0.28 - 1.33 W/Kg	Significant increase in reported headaches with increasing use of hand-held cell phone use (maximum tested was 60 min per day)	Chia, 2000
0.3 - 0.44 W/Kg	Cell phone use results in changes in cognitive thinking/mental tasks related to memory retrieval	Krause, 2000
0.3 - 0.44 W/Kg	Attention function of brain and brain responses are speeded up	Preece, 1999
0.3 - 0.46 W/Kg	Cell phone RFR doubles pathological leakage of blood-brain barrier permeability at two days (P=.002) and triples permeability at four days (P=.001) at 1800 MHz GSM cell phone radiation	Schirmacher, 2000
0.43 W/Kg	Significant decrease in sperm mobility; drop in sperm concentration; and decrease in seminiferous tubules at 800 MHz, 8-hr/day, 12 weeks, with mobile phone radiation level on STANDBY ONLY (in rabbits)	Salama, 2008

Stress proteins, HSP, disrupted immune function	**Brain tumors and blood-brain barrier**
Reproduction/fertility effects	**Sleep, neuron firing rate, EEG, memory, learning, behavior**
Oxidative damage/ROS/DNA damage/DNA repair failure	**Cancer (other than brain), cell proliferation**
Disrupted calcium metabolism	**Cardiac, heart muscle, blood-pressure, vascular effects**

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

SAR (Watts/Kilogram)		Reference
0.5 W/Kg	900 MHz pulsed RF affects firing rate of neurons (Lymnea stagnalis) but continuous wave had no effect	Bolshakov, 1992
0.58 - 0.75 W/Kg	Decrease in brain tumors after chronic exposure to RFR at 836 MHz	Adey, 1999
0.6 - 0.9 W/Kg	Mouse embryos develop fragile cranial bones from in utero 900 MHz The authors say "(O)ur results clearly show that even modest exposure (e.g., 6 min daily for 21 days" is sufficient to interfere with the normal mouse developmental process"	Fragopoulou, 2009
0.6 and 1.2 W/Kg	Increase in DNA single and double-strand DNA breaks in rat brain cells with exposure to 2450 MHz RFR	Lai & Singh, 1996
0.795 W/Kg	GSM 900 MHz, 217 Hz significantly decreases ovarian development and size of ovaries, due to DNA damage and premature cell death of nurse cells and follicles in ovaries (that nourish egg cells)	Panagopoulous, 2012
0.87 W/Kg	Altered human mental performance after exposure to GSM cell phone radiation (900 MHz TDMA digital cell phone signal)	Hamblin, 2004
0.87 W/Kg	Change in human brainwaves; decrease in EEG potential and statistically significant change in alpha (8-13 Hz) and beta (13-22 Hz) brainwave activity in humans at 900 MHz; exposures 6/min per day for 21 days (chronic exposure)	D'Costa, 2003
0.9 W/Kg	Decreased sperm count and more sperm cell death (apoptosis) after 35 days exposure, 2-hr per day	Kesari, 2012
< 1.0 W/Kg	Rats exposed to mobile phone radiation on STANDBY ONLY for 11-hr 45-min plus 15-min TRANSMIT mode; 2 times per day for 21 days showed decreased number of ovarian follicles in pups born to these pregnant rats. The authors conclude "the decreased number of follicles in pups exposed to mobile phone microwaves suggest that intrauterine exposure has toxic effects on ovaries."	Gul, 2009
0.4 - 1.0 W/Kg	One 6-hr exposure to 1800 MHz cell phone radiation in human sperm cells caused a significant dose response and reduced sperm motility and viability; reactive oxygen species levels were significantly increased after exposure to 1.0 W/Kg; study confirms detrimental effects of RF/MW to human sperm. The authors conclude "(T)hese findings have clear implicatiions for the safety of extensive mobile phone use by males of reproductive age, potentially affecting both their fertility and the health and wellbeing of their offspring."	De Iuliis, 2009
1.0 W/Kg	Human semen degraded by exposure to cell phone frequency RF increased free-radical damage.	De Iuliis, 2009

Stress proteins, HSP, disrupted immune function	Brain tumors and blood-brain barrier
Reproduction/fertility effects	Sleep, neuron firing rate, EEG, memory, learning, behavior
Oxidative damage/ROS/DNA damage/DNA repair failure	Cancer (other than brain), cell proliferation
Disrupted calcium metabolism	Cardiac, heart muscle, blood-pressure, vascular effects

Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

SAR (Watts/Kilogram)		Reference
1.0 W/Kg	Motility, sperm count, sperm morphology, and viability reduced in active cell phone users (human males) in dose-dependent manner.	Agarwal, 2008
1.0 W/Kg	GSM cell phone use modulates brain wave oscillations and sleep EEG	Huber, 2002
1.0 W/Kg	Cell phone RFR during waking hours affects brain wave activity. (EEG patterns) during subsequent sleep	Achermann, 2000
1.0 W/Kg	Cell phone use causes nitric oxide (NO) nasal vasodilation (swelling inside nasal passage) on side of head phone use	Paredi, 2001
1.0 W/Kg	Increase in headache, fatigue and heating behind ear in cell phone users	Sandstrom, 2001
1.0 W/Kg	Significant increase in concentration difficulties using 1800 MHz cell phone compared to 900 MHz cell phone	Santini, 2001
1.0 W/Kg	Sleep patterns and brain wave activity are changed with 900 MHz cell phone radiation exposure during sleep	Borbely, 1999
1.4 W/Kg	GSM cell phone exposure induced heat shock protein HSP 70 by 360% (stress response) and phosphorylation of ELK-1 by 390%	Weisbrot, 2003
1.46 W/Kg	850 MHz cell phone radiation decreases sperm motility, viability is significantly decreased; increased oxidative damage (free-radicals) significantly decreased; increased oxidative damage (free-radicals)	Agarwal, 2009
1.48 W/Kg	A significant decrease in protein kinase C activity at 112 MHz with 2-hr per day for 35 days; hippocampus is site, consistent with reports that RFR negatively affects learning and memory functions	Paulraj, 2004
1.0 - 2.0 W/Kg	Significant elevation in micronuclei in peripheral blood cells at 2450 MHz (8 treatments of 2-hr each)	Trosic, 2002
1.5 W/Kg	GSM cell phone exposure affected gene expression levels in tumor suppressor p53-deficient embryonic stem cells; and significantly increased HSP 70 heat shock protein production	Czyz, 2004
1.8 W/Kg	Whole-body exposure to RF cell phone radiation of 900-1800 MHz 1 cm from head of rats caused high incidence of sperm cell death; deformation of sperm cells; prominent clumping together of sperm cells into "grass bundle shapes" that are unable to separate/swim. Sperm cells unable to swim and fertilize in normal manner.	Yan, 2007

Stress proteins, HSP, disrupted immune function	Brain tumors and blood-brain barrier
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Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
(Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

SAR (Watts/Kilogram)		Reference
2.0 W/Kg	GSM cell phone exposure of 1-hr activated heat shock protein HSP 27 (stress response) and P38 MAPK (mutagen-activated protein kinase) that authors say facilitates brain cancer and increased blood-brain barrier permeability, allowing toxins to cross BBB into brain	Leszczynski, 2002
2 W/Kg	900 MHz cell phone exposure caused brain cell oxidative damage by increasing levels of NO, MDA, XO and ADA in brain cells; caused statistically significant increase in 'dark neurons' or damaged brain cells in cortex, hippocampus and basal ganglia with a 1-hr exposure for 7 consecutive days	Ilhan, 2004
2.6 W/Kg	900 MHz cell phone exposure for 1-hr significantly altered protein expression levels in 38 proteins following irradiation; activates P38 MAP kinase stress signalling pathway and leads to changes in cell sie and shape (shrinking and rounding up) and to activation of HSP 27, a stress protein (heat shock protein)	Leszczynski, 2004
2.0 - 3.0 W/Kg	RFR accelerated development of both skin and breast tumors	Szmigielski, 1982
2 W/Kg	Pulse-modulated RFR and MF affect brain physiology (sleep study)	Schmidt, 2012

STANDARDS		
0.08 W/Kg	IEEE Standard uncontrolled public environment (whole body)	IEEE
0.4 W/Kg	IEEE Standard controlled occupational environment (whole body)	IEEE
1.6 W/Kg	FCC (IEEE) SAR limit for 1 gram of tissue in a partial body exposure	FCC, 1996
2 W/Kg	ICNIRP SAR limit for 10 grams of tissue	ICNIRP, 1996

Stress proteins, HSP, disrupted immune function	Brain tumors and blood-brain barrier
Reproduction/fertility effects	Sleep, neuron firing rate, EEG, memory, learning, behavior
Oxidative damage/ROS/DNA damage/DNA repair failure	*Cancer (other than brain), cell proliferation*
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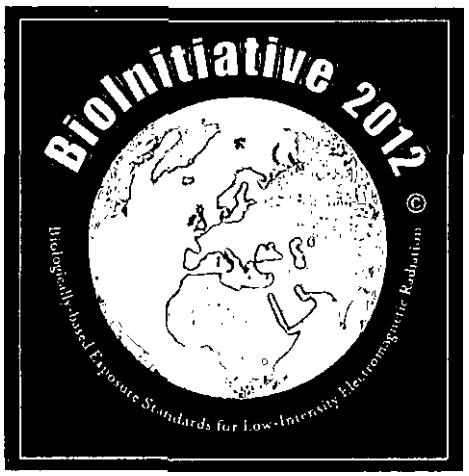

SECTION 25

List of BioInitiative Participants

Prepared for the BioInitiative Working Group

2007-2012

BioInitiative 2012 Working Group - Participants

Editors

Cindy Sage, MA
Sage Associates
Santa Barbara, CA USA
Full member, Bioelectromagnetics Society

David O. Carpenter, MD
Director, Institute for Health and the Environment
University at Albany
Rensselaer, New York USA

Contributing Authors

Prof. Jitendra Behari, PhD
Bioelectromagnetics Laboratory
School of Environmental Sciences
Jawaharlal Nehru University
New Delhi, India

Prof. Carlo V. Bellieni, MD
Neonatal Intensive Care Unit
University of Siena
Siena, Italy

Igor Belyaev, Dr. Sc.
Cancer Research Institute
Slovak Academy of Science
Bratislava, Slovak Republic

Carl F. Blackman, PhD
Raleigh, North Carolina USA
Founder, Former President and Full Member, Bioelectromagnetics Society
*opinions expressed are not necessarily those of his employer,
the US Environmental Protection Agency

Martin Blank, PhD Associate Professor (ret.)
Dept. of Physiology. College of Physicians and Surgeons
Columbia University, New York USA
Former President and Full Member, Bioelectromagnetics Society

Michael Carlberg, MSc
Department of Oncology
Orebro University Hospital
Orebro, Sweden

Zoreh Davanipour, DVM, PhD
Friends Research Institute
Los Angeles, CA USA

David Gee, Senior Advisor
Science, Policy, Emerging Issues, Integrated Environmental Assessment
European Environmental Agency
Copenhagen, Denmark

Adamantia F. Fragopoulou, PhD
Department of Cell Biology and Biophysics
Faculty of Biology, University of Athens
Athens, Greece

Prof. Yury Grigoriev, MD
Chairman, Russian National Committee
on Non-Ionizing Radiation Protection
Moscow, Russia.

Prof. Kjell Hansson Mild, PhD
Umeå University, Dept of Radiation Sciences
Umeå, Sweden
Former President and Full Member (emeritus), Bioelectromagnetics Society

Prof. Lennart Hardell, MD
Department of Oncology
Orebro University Hospital
Orebro, Sweden

Martha Herbert, MD, PhD
Pediatric Neurology
TRANSCEND Research Program
Massachusetts General Hospital
Harvard Medical School
Boston, MA USA

Prof. Paul Héroux, PhD
Department of Epidemiology, Biostatistics and Occupational Health
McGill University Faculty of Medicine, and
Department of Surgery, InVitroPlus Laboratory
Montreal, Quebec Canada

Prof. Michael Kundi, PhD med habil
Institute of Environmental Health,
Medical University of Vienna
Vienna, Austria
Full Member, Bioelectromagnetics Society

Prof. Henry Lai, PhD (emeritus)
Department of Bioengineering
University of Washington
Seattle, Washington USA

Prof. Abraham R Liboff, PhD, Professor Emeritus
Department of Physics, Oakland University
Rochester Hills, Michigan
Full Member Emeritus, Bioelectromagnetics Society

Ying Li, PhD
McGill University Health Center
Department of Surgery, InVitroPlus Laboratory
Montreal, Quebec
Canada

Prof. Lukas H. Margaritis, PhD
Department of Cell Biology and Biophysics
Faculty of Biology, University of Athens
Athens, Greece

Henrietta Nittby, MD, PhD
Department of Neurosurgery
Lund University Hospital
Lund, Sweden

Bertil R. Persson, PhD, MD h.c.
Department of Neurosurgery
Lund University Hospital
Lund, Sweden

Dr. med. univ. Gerd Oberfeld
Amt der Salzburger Landesregierung
Landessanitätsdirektion
Referat Gesundheit, Hygiene und Umweltmedizin
Salzburg, Austria

Dr Iole Pinto, PhD
Director, Physical Agents Laboratory
Tuscany Health and Safety Service
Siena, Italy

Paulraj Rajamani, PhD
School of Environmental Sciences
Jawaharlal Nehru University
New Delhi, India

Prof. Leif Salford, MD, PhD
Professor and Chairman
Department of Neurosurgery
Lund University Hospital
Lund, Sweden

Eugene Sobel, PhD
Friends Research Institute
Los Angeles, CA USA

Amy Thomsen, MPH, MSPAS, PA-C
Research Associate
Pinole, CA USA

Bruce
167 Holt Rd.
Aliquippa, PA 15001

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7015 0640 0002 3274 7462

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Pennsylvania Public Utility Commission
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